IRSE

Institution of Railway Signal Engineers

Proceedings

2018-2019

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The Institution of Railway Signal Engineers

Proceedings for the Year 2018 to 2019

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Introduction & Summary of the Year

The IRSE's Presidential Year started in April 2018 with the 105th Annual General Meeting held at the Institution of Engineering and Technology in London, chaired by retiring President Peter Symons. The inauguration of new President Markus Montigel took place who then gave his Presidential Address with the theme, *The Winds of Change*. Before giving his address, Markus paid tribute to Peter for his leadership of the IRSE during the past year.

The 2018 International Technical Convention was hosted by President Markus Montigel and the Swiss Section from 28th May to 1st June. The event included a week of activities for members and site visits across Switzerland, including a visit to the 57km Gotthard Base Tunnel, the 23km Ceneri Base Tunnel further south, and the new Albula Tunnel to the east which was still under construction.

The IRSE's International Technical Committee (ITC) has 18 fully participating and ten correspondence members from across the world. During the year the ITC held four meetings in London UK, Lugano in Switzerland, Berlin in Germany and Amersfoort in the Netherlands. It also produced eight papers published in IRSE News.

The IRSE makes a number of awards each year to recognise, reward and encourage the professional development of engineers, particularly those in the early stages of their career. No award was made for the 2018 Thorrowgood Scholarship in respect to the 2017 professional exam. A Merit Award was presented to Mike Tyrrell for services as Secretary of the Minor Railways Section and to the London IRSE office for his maintenance of the telephone system. The Dell Award was made to Mohammed Addil Akram of London Underground who, in his 13 years with LUL, has worked on a variety of projects including the Four Lines Modernisation Programme. The IRSE Signet Award was presented to Robin Lee of Park Signalling. He obtained a Distinction (86%) in module 2 of the Exam.

The IRSE makes two awards annually to Network Rail's apprentices, one to the outstanding signalling apprentice and one to the outstanding telecommunications apprentice. This year's awards were given to Andrew Hughes (signalling) and Carl Burns (telecoms).

The Institution received 452 applications for new membership in 2018 and there was a decrease in the membership total of last year, from 5298 members to 4953. The figure is higher as a result of the change in procedure in 2018 when the decision was taken to remove members who had not paid their subscriptions after a year, instead of the two-year period previously allowed. The IRSE received a good number of applications for Engineering Council registration and registered the same number as in 2017. This figure was made up of 11 Chartered Engineers, 15 Incorporated Engineers and 15 Engineering Technicians.

Blane Judd
Chief Executive and General Secretary, IRSE
December 2019

(Francis How stepped down as CEO of the IRSE on June 31 2018).

IRSE///

Institution of Railway Signal Engineers

Annual Report

Number 106

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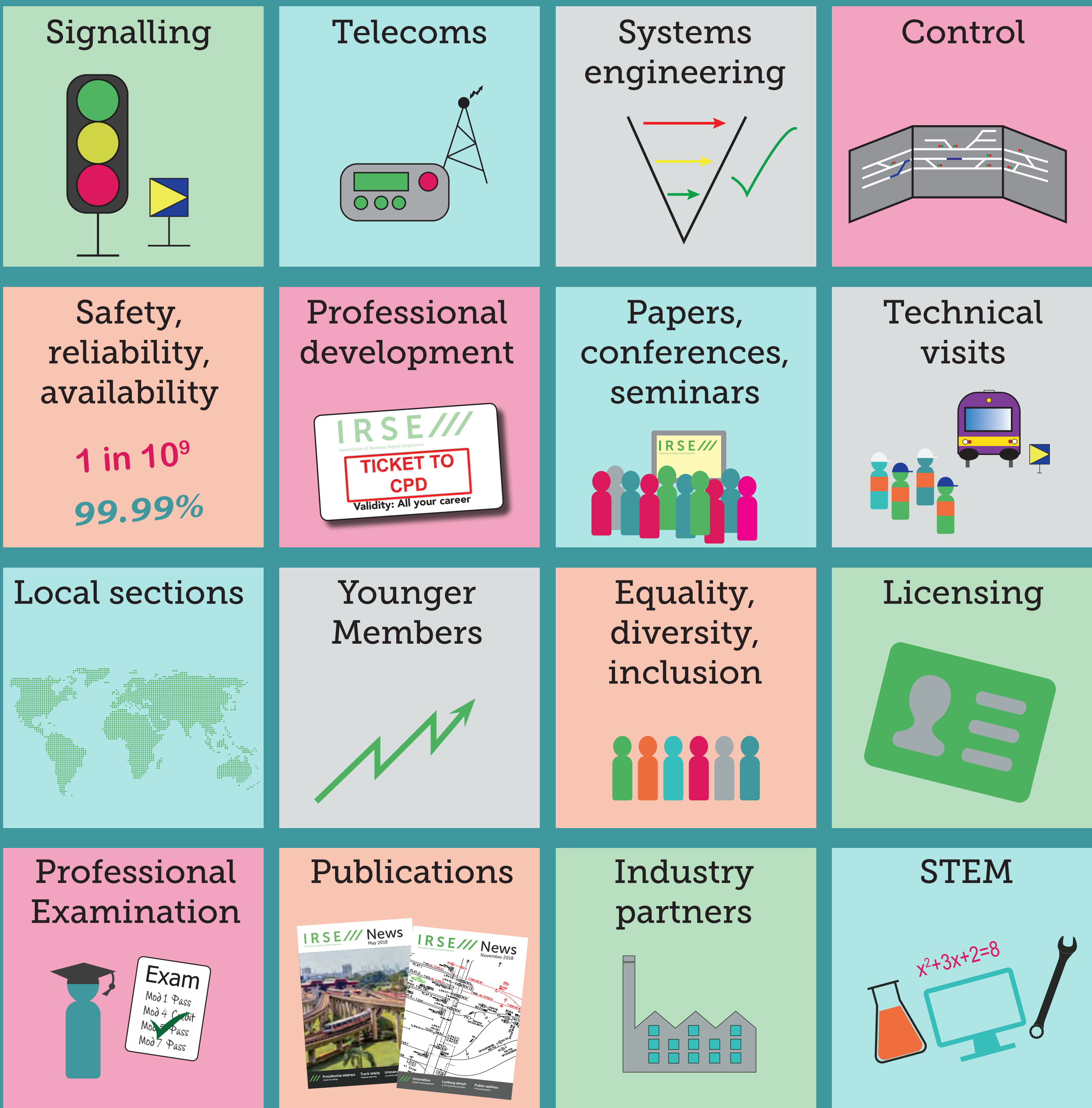

Contents

This Annual Report briefly describes the activities undertaken by the Institution of Railway Signal Engineers (IRSE) throughout the world during 2018. Our President from April 2018 has been Dr Markus Montigel from Switzerland.

For up to date information about the Institution or its activities, or to download a membership application form, log on to the IRSE website **www.irse.org**.

Follow us on Twitter **@IRSEHQ**

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An introduction from our President

There are things which humans experience only once in their lifetime, becoming the IRSE President being certainly one of them. To be entrusted with this office and to lead an institution of so many fine engineers with such a long tradition should honour and make proud anyone given this opportunity, and it certainly did me. This year is the culmination of a longer process, consisting of being elected as an IRSE Council member, a member of Management Committee, and then as the Junior and Senior Vice President (SVP), before finally becoming the President. This process is good: it makes Presidents better understand the true nature of the IRSE, its heart and soul.

When I started out as a Council member, I did so with the general goal of radically modernising the IRSE. At the beginning I tried to do so without compromising. This turned out to be hard, of course, because the thinking of many colleagues in the various committees was much more traditional than mine. However, surprisingly, it became ever harder also for me personally to vote for changing things, as I started to understand and respect these traditions better.

This struggle is also reflected upon in my theme of my year, "Winds of Change", based on the Chinese proverb: "When the direction of the wind changes, some build a wall, some build a windmill", which was supposed to motivate our members, and the industry to reflect on the way innovation happens in railway signalling, and to find ways of increasing the speed of introducing modern technology into our field, thereby harvesting its benefits.

Increasing the speed almost inevitably means choosing a more disruptive approach, which rather contradicts the traditional thinking, which seeks continuity, not disruption. This applies not only to the technical activities happening in our field, but also to the activities within the IRSE as an organisation. After having held this office, I am convinced that one of the main roles of the IRSE President is to be the mediator between tradition and disruption, and to find the best compromise and future benefit for the Institution, while still bringing in their own views of how to shape the future.

Let us have a look at my period in office and see what has been achieved in this respect.

On the traditional side, we certainly had a fine series of Presidential Papers, which were given by key figures of the industry. These took up some of the main elements laid out in the International Technical Committee's paper Strategic drivers of change in the signalling industry, produced at my suggestion when I was still the SVP. I reprise these briefly here:

Ulrich Weidmann (Swiss Federal Institute of Technology) reflected quite generally on "How to innovate on the railway?", also a main question of my Presidential address. Josef Doppelbauer, Executive Director, European Union Agency for Railways provided his view on modern signalling in his lecture "Command and Control 4.0". In "Location and control of railway things", Steffen Schmidt of Swiss Federal Railways (SBB) discussed some elements of "SmartRail 4.0", SBB's project implementing such a system. "Big Data for railway applications" was the topic of the paper presented by Pierre-Damien Jourdain of Alstom and Yan Freson of SNCF. In the area of automation, we had "Crossrail and Thameslink: technical and operational challenges" by Andrew Simmons and Nicola Furness of Network Rail. In early 2019 "Human factors in cockpits: Lessons learnt in the light of ATO" will be discussed by Michael McNamara of Gannett Fleming Transit & Rail Systems. Another current topic, cybersecurity, will be presented in "Cybersecurity and railway signalling" by Stefan Katzenbeisser (TU Darmstadt) and "The balancing act of implementing cyber security" by Max Schubert (DB).

The 2018 Swiss Convention presented the technical achievements in tunnel construction and safety in the Gotthard and Albula tunnels, but as such it was a very traditional event, with a full social day, an extensive partners' programme, and traditional Swiss music. Other IRSE events I attended included the Younger Members Seminar in Birmingham, UK the CBTC Seminar in Toronto, Canada and the Australasian IRSE Conference in Brisbane, Australia.

It is certainly my impression that with these and many other IRSE events we delivered on our members' expectations of providing cutting-edge input for their ongoing professional development and for furthering their careers.

On behalf of myself and the members of the IRSE I would like to express our gratitude to all those people who put in thousands of hours of volunteer to help organise all these events, and let us not forget everyone who contributed to IRSE committees, worked as Section officers or in other IRSE capacities in the past year.

I would also like to take this opportunity to thank our new CEO, Blane Judd, and his team, for their successful efforts in making this transition as smooth as possible, while taking up the challenge of modernising the ways of working at the IRSE HQ.

The very beginning of my Presidential year saw the introduction of the new IRSE logo and branding, which for me is the very symbol of the struggle between disruption and tradition. While I understood those who liked the traditional logo very much, I was a great supporter of the desire to modernise the IRSE's appearance during my year as the SVP. Despite the inevitable criticism from some quarters, I am still convinced that this was the right thing to do for the IRSE's future, and the strong support of younger members seems to back this up.

To sum up, this was certainly a period which has leaned more towards the disruptive side, but in my opinion this was all in a very positive sense. In any case, I will leave this office as a happy man with great impressions of a fantastic community, and I wish my successor, George Clark, a fulfilling presidential year.

Markus Montigel
President, IRSE 2018-2019

Objectives of the Institution

The Institution's objectives are written in our Articles of Association and can be traced back to the formation of the Institution in 1912. They are:

a) The advancement for the public benefit of the science and practice of signalling by the promotion of research, the collection and publication of educational material and the holding of conferences, seminars and meetings, and

b) The maintenance of high standards of practice and professional care amongst those working within the industry and the promotion of improved safety standards for the protection of the general public.

Although it might appear that the IRSE is concerned only with railway signalling, the full text of the objectives makes clear that all forms of train control and traffic management, and communications systems, are all within our scope of interest.

There is a clear emphasis in the objectives on 'public benefit'. This is most obvious in the sense of contributing to safety on the world's railways, where train control systems play a critical role. But we are also interested in ensuring that railways are efficient, cost-effective and sustainable (in the widest sense). We meet our obligations to the public through the following principal mechanisms:

- The dissemination of knowledge, experience and good practice in the fields of railway signalling, control and communications and allied topics, to help ensure that those working in the profession do so with the best available knowledge for the safe, efficient and cost-effective construction and operation of the world's railways.
- The provision and management of the IRSE Licensing Scheme to assure the competence of those working in the profession. The Scheme is focused predominantly, but not exclusively, on ensuring safety in the design, construction, testing and maintenance of signalling and telecommunications systems.
- Our Code of Professional Conduct, with which IRSE members are required to comply in the course of their work. It emphasises topics such as personal responsibility for work undertaken or managed by IRSE members, the importance of safeguarding the public interest (particularly safety), environmental management, the efficient use of resources, handling conflicts of interest etc.
- Undertaking specific initiatives to help ensure the safety and efficiency of railways. By bringing the IRSE Sections around the world together, we will facilitate the sharing of best practice and new initiatives to help engineers and others enhance their knowledge and professionalism. We will continue to reach out and grow our network of professionals around the world to harness the collective knowledge they possess for the benefit of all operators and users of railway transport.

The financial resources of the Institution are applied to achieve the objectives of the Institution, in addition to which members make a significant contribution to delivering the Institution's aims by their volunteer activities. The Institution has only a small number of full and part-time staff and most of the activities are organised by our members acting in a voluntary capacity.

Our Strategy

In mid-2015 the IRSE launched its new Strategy, to cover the period 2015-2020. The Strategy is supported by an Implementation Plan that sets out in more detail the specific initiatives to be delivered. Both the Strategy and the Plan are published on the IRSE website. By the end of 2018 we were well on the way to delivering to that document. The Plan, which is subject to regular monitoring and review by the IRSE's governing Council, addresses a number of key areas, including:

- Enabling growth of the IRSE as a global Engineering Institution, to promote professional standards throughout the world.
- Tackling the skills gap facing railway signal, control and communications engineering in the UK and other countries in the world.
- Encouraging employer support for IRSE to help ensure that the Institution's activities align with the needs of the wider industry.

Progress continued to be made throughout the year in developing the international dimension of the Institution, with plans for the next ASPECT Conference in 2019 and the Convention in 2020 well underway. We continue to support the Local Sections, and the work of the Local Section Coordinator has made a significant contribution in supporting this aim.

While the challenge to close the skills gap has been difficult, we are working to build relationships with other bodies who are operating in this space, with a view to presenting a united approach which is both complimentary and effective.

Support by companies for the IRSE and its work continue to grow, and the Plan contains actions to further strengthen this support. We launched the Industry Partnership Scheme aimed at increasing closer relationships with employers in the rail industry. Building on last year's Digital Railway White Paper we have agreed to work with Industry partners on similar publications as we move into the next stage of our strategic development.

The successful launch of the rebranded IRSE took place in the year and work has begun on a new website which will enhance the communication channels with our members and others who we wish to engage. We have utilised social media and digital technologies to provide a greater access to technical paper presentations to our global membership.

Recognising that we are coming to the end of this current document, work has already begun on developing a Strategic document which extends beyond 2020.

Governance

Council

The IRSE is governed by an elected Council of 21 Corporate Members, led by the President, who are the Trustees of the Institution.

Six meetings of the Council were held during the year during which the business of the Institution was conducted. The Articles of Association permit the current Chairs of all local sections, both in and outside the UK, and also country vice-presidents to attend Council meetings. During the year a number of chairs and country vice-presidents attended meetings, either in person or using video conference facilities.

In addition to conducting all the normal Council business during the year, Council discussions included the following topics:

- Progress with the Strategy 2015-20 and the associated Implementation Plan
- Development of the Strategy for 2020 and beyond
- Oversight of the new brand roll-out and commission of the new website build
- Delivery of the new Industry Partnership Scheme
- Establishing a succession plan for the office of President

Council also receives and reviews the annual report from each of the international Sections of the IRSE.

Committees

The Institution has a number of committees which are accountable to Council, through which our activities are managed. The principal committees and their relationships to Council are shown in the diagram opposite. In addition, ad-hoc working groups are formed from time to time which focus on specific tasks.

Audit

External audit

A number of areas of the Institution's business are audited on a regular basis by various external audit bodies:

- All areas of finance are subject to audit annually by independent external auditors who submit their report to the Annual General Meeting;
- The Licensing Scheme is subject to an annual external audit by the United Kingdom Accreditation Service (UKAS).
- As a registered charity, the Institution is subject to periodic external review by the Charity Commission.
- As the Institution is licensed by the Engineering Council in the UK to register Chartered and Incorporated Engineers and Engineering Technicians, it is subject to a review every five years by the Engineering Council in order to ensure compliance with their registration standards.

Internal audit

The IRSE's internal Audit Committee undertakes independent audits to complement the external audits, in order to ensure the Institution is running efficiently and effectively. The audits focus primarily on the role and remit of each of the principal committees of the Institution.

The Audit Committee normally performs two audits per annum. Each audit results in a report, which is presented to the chair of that committee and subsequently the Council, which uses the recommendations to improve the management of the Institution's affairs for public benefit and for the benefit of its members. The Institution maintains a Risk Register, which is reviewed annually by Council, and this was used as the basis for the audit.

IRSE Enterprises

IRSE Enterprises Ltd is the trading company wholly owned by the Institution. The trading company handles a number of activities which are associated with, but outside the direct scope of the charity. The directors of the company appointed for the year April 2018 to April 2019 were Peter Symons (Chair), George Clark (Senior Vice President), Daniel Woodland (Junior Vice President), Andrew Smith (IRSE Treasurer), and the Chief Executive: Francis How (until 1 August 2018), Blane Judd (from 1 August 2018).

Any profits from the company are, where possible, gift-aided back to the Institution.

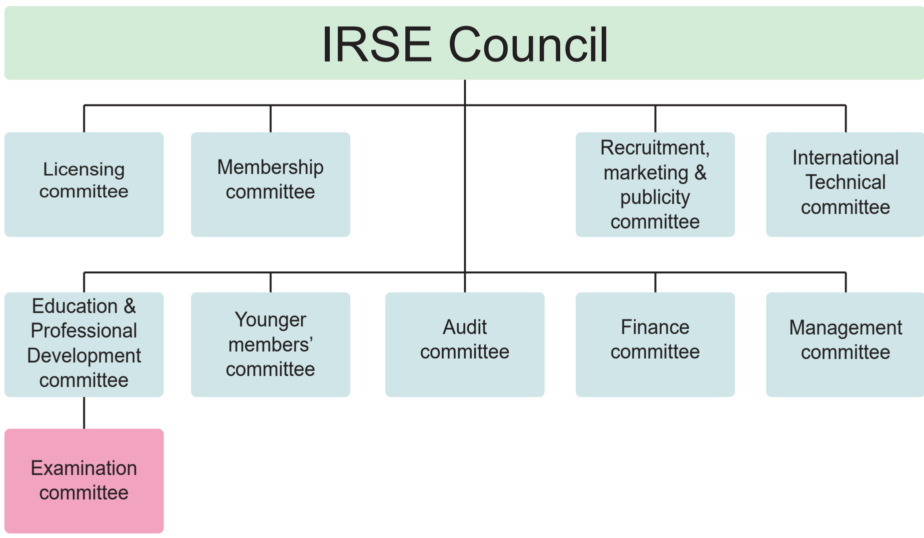
Sections

The IRSE Sections around the world exist by authority of the IRSE Council, and they operate in accordance with a set of Articles of Association (or Byelaws) that have been approved by Council. At the end of 2018 there were 21 sections in total. 19 sections outside the UK in various parts of the world (Australasia, China, France, Hong Kong, India, Indonesia, Ireland, Japan, Malaysia, Netherlands, North America, Southern Africa, Thailand) and six of which are UK-based. The North America Section includes the USA, Canada and Mexico. The Ireland Section includes both Northern Ireland and the Republic of Ireland.

London and the South East is the most recently formed UK section, established in March 2018.

Two other sections also exist – the Younger Members Section and the Minor Railways' Section. These are not geographically-based, although their activities are predominantly within the UK. Some geographical sections also have Younger Members groups.

Each section has an organising committee, with elected officers for key roles.



Professional development

Supporting professional development of IRSE members and prospective members throughout the world is a key objective of the IRSE.

To do this, we have Judith Ward as our Professional Development Manager, the Education and Professional Development Committee and the Examination Committee.

IRSE Professional Examination

The IRSE professional examination is a Masters-level academic qualification which tests knowledge and understanding of railway systems with a particular emphasis on safety. To pass the exam, the candidates must pass four modules including a compulsory module on safety systems.

Passing the IRSE exam is one route to obtain either Associate Member or Member of the IRSE.

Passing the IRSE exam can "top up" engineering or technology qualifications for professional registration with UK's Engineering Council. An accredited Bachelor's degree with honours plus IRSE exam may demonstrate knowledge and understanding for Chartered Engineer applicants and an accredited Higher National Diploma/ Foundation Degree plus IRSE exam may demonstrate knowledge and understanding for Incorporated Engineer applicants.

Many volunteers run exam study groups and the independent exam forum website to support prospective examination candidates.

The number of candidates sitting the exam in 2018 had increased from 2017 and the quality of scripts from candidates has again increased, with the overall percentage of those achieving pass grade or higher was 60%. Candidate sat the exam in 16 exam centres across the globe, with new exam centres for 2018 in South Africa and Canada.

The creation, facilitation and marking of the exam is a major challenge, and the IRSE is very grateful to the Exam Committee, Examiners, Study Group Leaders, Forum coordinators, Facilitators, Invigilators and IRSE staff for their continued contribution in supporting the whole exam process.

As the structure of the examination has not changed over the past 23 years, a review was carried out to identify any alterations needed following changes in technology and best practice assessment methods. The review recommended a reduction in the number of modules and the provision of a new foundation level qualification for those who may not have the aptitude or experience needed to pass the Professional Examination, but whose ability could nevertheless be recognised. The development of new modules to meet these recommendations has just started, and introduction of the new structure will be announced, subject to Council approval.

Continuing Professional Development (CPD)

The second annual random monitoring of UK Engineering Council's registered engineers' CPD records took place in 2018 by volunteers and the Professional Development Manager. Only 56% of those randomly selected chose to engage with the process and submit their records for monitoring. Those who did engage were given personalised feedback on their records. There will be another random monitoring review in 2019 as required by Engineering Council.

The Engineering Council requires that from 2020, those who do not engage in the CPD monitoring process are subject to sanction, the ultimate of which is removal from the Register.

Information about the importance of developing and maintaining members' professional competence through CPD has continued to be provided through IRSE NEWS and the website.

The IRSE recommends the use of the 'Mycareerpath' system for CPD planning, recording, reflecting and reviewing. More information about Mycareerpath is available on the IRSE website.

Certified courses

The IRSE offers a process by which training providers can have their courses assessed and certificated by the IRSE.

This year Signet Solutions gained IRSE certification for their 'Intermediate Signalling Technology – Layouts (IST-L)/ Signalling the Layout' course.

Other training providers are in the process of having their signalling and telecommunications courses assessed.

Professional Registration

The IRSE is licensed by the UK's Engineering Council to register suitably qualified members as Chartered Engineer (CEng), Incorporated Engineer (IEng) and Engineering Technician (EngTech).

The requirements for these are defined by the Engineering Council for knowledge, understanding, competence, relevant work experience and commitment. Brief definitions are that: Engineering Technicians apply proven techniques and procedures to practical problems; Incorporated Engineers maintain and manage applications of current and developing technology; Chartered Engineers develop solutions to engineering problems using new or existing technologies and/or have technical accountability for complex systems with significant levels of risk.

Work is taking place with Membership & Registration Committee and our Individual Case Panel to provide more guidance for those considering applying for professional registration and in particular to those without acceptable formal qualifications.

Apprenticeships

IRSE are End Point Assessment Organisation (EPAO) for two English apprenticeships: Rail Engineering Design Technician (Level 3) and Rail Engineering Technician (Level 3).

The End Point Assessments will encompass our existing processes (licensing at an appropriate level and EngTech professional registration). The first End Point Assessments are expected to take place in autumn 2019.

Membership and registration

The Membership Committee had another busy year in 2018 assessing membership applications and Engineering Council registration applications, as well as considering procedural and policy matters. 452 applications for membership were considered; almost the same number as 2017 (450).

Towards the end of the year, an online Affiliate form was introduced as a trial and it appears to have been very popular. We are hoping to trial a version of the form to be used by those applying for Corporate membership in 2019.

There was a decrease in the membership total of last year, from 5298 members to 4953. The number of members in each grade is shown in the infographic.

IRSE received a good number of applications for Engineering Council registration, and registered the same number as in 2017. This figure was made up of 11 Chartered Engineers, 15 Incorporated Engineers and 15 Engineering Technicians. Many of those seeking EngTech registration applied via the IRSE licence route.

This year a process began to integrate the additional competences into the licences identified as 'EngTech Ready'. The purpose of this is to simplify the process for engineers applying via this route.

The Institution was sad to report the deaths of the following members during 2018: Roy Bell MBE, Dudley Both, Paul Cheshire MBE, Peter Corser, Michael Fish, Stanley Hall MBE, David Harris, Dennis Howells MBE, Richard Moorfield, George Nelson, Robin Nelson, Frank Rayers, Mark Roome, John Rose, Richard Sales, Bengt Sterner, Sinta Wati, Nigel Webb, Werner Welti and Bob Woodhead.

Licensing

The IRSE operates a competence certification scheme, known as the IRSE Licensing Scheme, which exists in order to provide assurance for the competence of individuals to carry out technical safety-critical or safety-related work on rail control systems. The Scheme provides a cross-industry accepted benchmark of competence for personnel carrying out a range of activities.

All competence standards are reviewed at least 5-yearly and during 2018 the Design and Team Leader suites of licences, as well as the Factory Installer, Point Fitter and Mechanical Locking fitter licence underwent review in order to ensure that the competence criteria remain consistent with Industry developments, for example with regard to cyber security .

There are now a range of licence categories that have been mapped to the UK Engineering Council competences for Engineering Technician. This allows licence holders of those categories with appropriate qualifications to apply for EngTech registration without having to complete any further competence assessment paperwork.

The Scheme is managed by the Licensing Registrar supported by a small team in the IRSE offices in London, which works under the direction of the Licensing Committee, chaired by Colin Porter. Since August 2017 the Registrar position has been covered by David Weedon, supported by Karen Boyd as Deputy Registrar. Paula Persson, who had been the Registrar, was seconded to a Communications and Marketing Project for the IRSE and resigned from the Institution in October.

During the year 1569 licences were issued, and the total number of valid licences on 31 December 2018 was 6512, a slight decrease from 6566 at the end of 2017. Each licence is valid for five years. For operations within the UK, the Licensing Scheme continues to hold full approval by the United Kingdom Accreditation Service (UKAS) against the competence standard for the certification of persons: ISO17024:2012, with four-yearly re-accreditation successfully achieved during 2018.

IRSE Assessing Agents are approved and appointed for the purposes of performing assessments of candidates for licences, and they are an essential part of the Licensing Scheme. Currently the number of approved Assessing Agencies is 27, with three having ceased to operate during the year.

Awards

The IRSE makes a number of awards each year. The majority of these are to recognise, reward and encourage the professional development of engineers, particularly those in the earlier stages of their careers. The purpose behind this is not simply to assist their career development, but to promote high standards of engineering excellence, thereby contributing to the public benefit objectives of the Institution.

Thorrowgood Scholarship

The Thorrowgood scholarship is awarded under a bequest of the late W J Thorrowgood (Past President) to assist the development of a young engineer employed in the signalling and telecommunications field of engineering. The award is made to a candidate who has excelled in the IRSE professional examination and comprises of an engraved medallion and funding for a study tour of railway signalling installations or signalling manufacturing facilities.

No award was made in 2018 in respect to the 2017 professional exam.

Frank Hewlett Bequest and Alan Fisher Memorial Fund

Frank Hewlett was an Associate Member of the Institution. He died in September 2008 and left a very generous and substantial bequest to the Institution. In 2009 the IRSE Council launched an appeal to establish a memorial fund for Alan Fisher, who died unexpectedly during his Presidency of the Institution. The intention was to use the fund to support the development of young S&T engineers, particularly those outside the UK.

The income from the two funds is used predominantly to provide a number of travelling bursaries for younger members from all over the world to support their attendance at major IRSE events.

In 2018 ten people benefited from the fund, enabling them to attend the IRSE's International Technical Convention in Switzerland.

IRSE Merit Award

The Merit Award was introduced in 2007 In order to recognise exceptional service to the Institution by a volunteer or staff member anywhere in the world. The award is made by the Council following receipt of a nomination, and takes the form of a plaque mounted on a rectangular plinth with an engraved citation.

This year's Merit Award was presented to Mike Tyrrell (pictured opposite, receiving his award from Past President Peter Symons) for services as Secretary of the Minor Railways Section and to the London IRSE office for his maintenance of the telephone system.

Dell Award

The Dell Award is made annually under a bequest of the late Robert Dell OBE (Past President). It is awarded to a member of the Institution employed by London Underground (or its successor bodies) for achievement of a high standard of skill in the science and application of railway signalling. The award takes the form of a plaque with a uniquely designed shield with an engraved plate being added each year with the recipient's name.

This year's award was presented to Mohammed Addil Akram of London Underground, who in his thirteen years with LUL has worked on a variety of projects including at the time of the award, the Four Lines Modernisation Programme.

IRSE/Network Rail Apprentices of the Year

The IRSE makes two awards annually to Network Rail's apprentices, one to the outstanding signalling apprentice and one to the outstanding telecommunications apprentice. The Award for Signalling is a trophy consisting of a working model of a four-aspect colour light signal. The Award for Telecommunications is a silver trophy. Each recipient also receives a cheque for £100 and a year's free membership of the Institution.

This year's awards were given to Andrew Hughes (signalling, pictured right) and Carl Burns (telecoms, far right) at the Network Rail Training Centre, UK in June by Francis How.

IRSE-Signet Award

The IRSE-Signet Award is the most recent of awards, introduced in 2016 and sponsored by Signet Solutions. This Award is given annually to the person who obtains the highest marks in any single module of the IRSE Examination. The Award takes the form of the Signet logo 'person' on a small plinth, engraved with the name and year of the winner, and bearing the IRSE's logo. The Award also comprises funding for the winner to attend the annual IRSE Convention.

This year's IRSE-Signet Award was presented to Robin Lee of Park Signalling. Robin was at the time of the award engaged mainly on testing and documenting track-worker safety products for Network Rail. He obtained a Distinction (86%) in module 2 of the Exam. Robin received his award from Andy Knight of Signet Solutions (centre) and Peter Symons.

London office and personnel

The Institution leases a small suite of offices on the 4th floor of the Institution of Mechanical Engineers, 1 Birdcage Walk, London, UK, from where the centrally organised activities of the Institution are managed – membership, licensing, events administration, financial administration, publicity, communications and IT systems operation.

The Chief Executive and General Secretary of the Institution is Blane Judd, a Chartered Engineer and Fellow of the Institution of Engineering and Technology. He is responsible for directing and managing the resources of the Institution in order to implement the decisions of Council in an efficient manner and in compliance with UK company and charity law. He is accountable to the Council. He also provides the focal point of contact for other Institutions and external organisations, including the UK's Engineering Council and the Royal Academy of Engineering, government agencies, the chief officers of other professional bodies, and the scientific, engineering and technology community. He is also responsible for ensuring compliance with the requirements of the Institution's Articles of Association, Companies House, the Charities Commission and relevant legislation.

The office team comprises:

- Christine White, Membership and Registration Manager
- Hilary Cohen, Administration Manager
- Paula Persson, Marketing and Communications Project Manager (left October 2018)
- Judith Ward, Professional Development Manager (part-time)
- David Weedon, Licensing Registrar
- Karen Boyd, Deputy Licensing Registrar
- Roger Button, Licensing Assistant
- Caterina Indolenti, Membership and Registration Administrator
- Anja Laitinen, Administration Assistant (part-time)
- Hannah Mueller, Finance Assistant (part-time)

The Institution's Marketing and Communication activities have been operated externally since November by Lindsay Jones of LJPR Ltd. Lindsay is a trained journalist and is actively promoting the Institution to a wide stakeholder group.

Andrew Smith is the Institution's Treasurer, with responsibility for the production of the budgets and accounts, and for monitoring the health of the Institution's savings and investments.

Debbie Bailey is our Personnel Manager and Spencer Williamson is our IT Manager. These staff work on part-time contract basis.

Members of the IRSE team pictured during a visit to the Tunnelling and Underground Construction Academy in East London. From left to right, Judith Ward, Caterina Indolenti, Christine White, Blane Judd, Karen Boyd, Debbie Bailey, Bruce Lawson of TUCA – the group's host for their visit, Hannah Mueller, David Weedon and Roger Button.

Presidential programme

Each year the IRSE President plans a programme of major events, comprising a series of high profile technical papers, the annual Convention and other events as appropriate.

Our President up to April 2018 was Peter Symons, and the final three technical papers in his year, presented in early 2017, were on the subjects of potential effects of Brexit on railway signalling and communications, continuous improvements for lifelong learning and track worker safety.

Markus Montigel our President for twelve months from April 2018 took as his presidential theme "The Winds of Change", aiming to reflect on the possible mechanisms at work to demonstrate some elements on which these big changes could probably be based, and to prepare the IRSE for this future.

The first four papers delivered during 2018 were on the subjects of Command and Control 4.0, Big Data for railway applications, how to innovate the railway, location and control of railway 'things' and technical and operational challenges facing the Crossrail and Thameslink projects in London, UK. These presentations took place in London, Paris and Zurich and were live-streamed for the first time in the Institution's history. "The Winds of Change" theme continues with two further papers in 2019.

All the papers are published in our monthly journal, IRSE News, and the presentations are available as webcasts on the IRSE website.

Section activities

In addition to the Presidential Programme, every year there is a programme of lectures, seminars and technical visits organised by the Institution's sections in Australasia, China, France, Hong Kong, India, Indonesia, Ireland, Japan, Malaysia, Netherlands, North America, Singapore, Switzerland, Thailand, and Southern Africa.

The UK sections of Midland & North Western, Plymouth, Scottish, Western, York & North East and Minor Railways Sections were joined by the new UK London and South East section, inaugurated in March 2018 bringing the total number of sections across the world to 21. The new section give members living and working in the south east of UK an opportunity to meet and learn now that the Presidential Programme lectures are held internationally.

The geographical sections vary considerably in size (from around 40 members up to several hundred), and in levels of activity. Each has its own organising Committee, elected officers and programme of events. They report annually to the Council on their work. In 2018 highlights included:

Australasian Section: Technical meetings and visits in Adelaide

French Section: Conferences on "Railway solutions on regional lines" and "Digital continuity and BIM in signalling"

China Section: Hosted a technical workshop on "Big data - based railway health management and maintenance" in Beijing

Hong Kong Section: Technical visit to Hong Kong international airport automated people mover

India Section: Annual seminar on the Future Railway Mobile Communications System (FRMCS) in Delhi, technical visit to see a fibre-optic based acoustic sensing system at Chandil station, and a webinar on CBTC concepts

Indonesia Section: A one-day seminar on the "Implementation of safety for operation and maintenance of automatic people mover systems" was held in Tangerang

Irish Section: Technical visits to Poolbeg power station in Dublin, Luas Cross City and a technical paper on training and competence in Belfast

Japan Section: Seminars were held on "Strategic drivers of change in the signalling industry" and "Railway undertakings in Europe"

London & South East Section: Technical visits to London Underground Northern Line extension and London Transport Museum depot

Malaysia Section: Co-hosted "Women in Rail Malaysia" at the Malaysian Houses of Parliament

Midland & North Western Section: Technical visit to the Rail Accident Investigation Branch (RAIB) in Derby

Minor Railways Section: Technical visits to Nene Valley Railway, Dartmouth Steam Railway, Severn Valley Railway, Didcot Railway Centre and Swindon old panel and Gloucester Warwickshire Steam Railway **Plymouth Section**: Technical visit to Plymouth waste incinerator and associated electricity & steam generation plant

Netherlands Section: The Section celebrated its tenth anniversary with several meetings and presentations including a technical visit to Voest Alpine Railpro

North American section: Third annual CBTC conference and technical visits on "communication based train control and beyond"

Scottish Section: Tour of Glasgow Central station for Younger Members and two technical visits to NATS (formally National Air Traffic Services) at Prestwick

Singaporean Section: Took part in in CAFEO36 - Engineering rail connectivity & fostering excellence in engineering education in Singapore

Southern African Section: Participated in the Africa Rail Conference 2018

Swiss Section: Hosted the IRSE Convention in addition to technical visits to Bartholet Aerial Ropeways and Linth-Limmern power station

Thailand Section: Took part in the 56th Kasetsart University Annual Conference and Rail Expansion Asia 2018

Western Section: Seminars on the "Digital railway" and "Listening for trains-distributed acoustic sensing"

York & North East Section: Participated in the North Eastern Railway Engineers' Forum

The Council wishes to record its thanks to the Officers, Committee members and all others involved in the operation of the local sections, for the excellent work they undertake in organising technical meetings and other events. Council also very much appreciates the help and support given by many companies in facilitating and supporting the events organised by the sections all over the world.

Charles Page continues his excellent work in the role of Local Section Coordinator, supporting the sections and the IRSE providing guidance for local sections on the General Data Protection Regulations (2018).

Younger Members

The Younger Members Section is committed to engaging with younger members across the world and provide opportunities for networking, sharing knowledge and developing any members 35 years old and under. However, events are open to all and we greatly appreciate the many members who help out with presentations and sponsorship throughout the year. Keith Upton continued as the chairperson in 2018 with only minor changes to the remaining committee members.

This year the Younger Members Section undertook significant changes to the way in which they communicated with the younger members. This was largely to comply with GDPR but also helped to slim down their mailing list to only those who are interested in receiving messages about the younger members. However, as always, the mailing list is open to anyone and you don't have to be under 35.

The Younger Members Section also made changes to its terms of reference to bring it up-to-date and to add additional roles for voting members, one who has responsibility for the study days and one who has responsibility for the mentoring scheme. These additional roles will help to spread the responsibility of these important aspects across the committee.

The annual seminar took place in November and was held at the National College of High Speed Rail in Birmingham, UK. This event sold out with almost 50 in attendance to the seminar and just over 25 to the technical visit. This was an excellent seminar on the theme of communications. The technical visits to the Birmingham New Street station control centre and Power Signal Box also proved an excellent and informative visit.

The Section is committed to supporting the preparation for the IRSE exams, and so they provided four exam study events during 2018, kindly supported by Signet Solutions, SNC-Lavalin Atkins and Peter Woodbridge, David Nicholson and Andrew Love (to name a few). The first event was a conference call in February to talk through the process for entering the exams, apart from some technical complications, this was a successful event. Later in February they held the annual exam review day, including a talk about how to pass the exams. This was again a successful, well attended event. Next, they had their sell out study days: the first was a Module 2, 3 and 5 study weekend at Signet in Derby in April and the second was a Module 1 and 7 study day in Birmingham (sponsored by SNC-Lavalin Atkins).

The younger members are also involved in the next steps for the IRSE Exams and the mentoring schemes and are about to take on the organisation of the Technical seminar live recordings. Showing that the Younger Members Section are still involved in the wider aspects of the IRSE.

The Younger Members Section has a lot more exciting plans for 2019 and hope that many new faces will join, as well as the older ones, at events near you soon!

Photos from just a few of the wide variety of events arranged by the Younger Members Section

Annual General Meeting

The IRSE's 105th Annual General Meeting, chaired by the retiring President, Peter Symons, was held at the Institution of Engineering and Technology, London on Friday 27 April 2018.

A Special Resolution was voted on which agreed changes to the Articles of Association concerning nominations to Council. Previously the invitation to corporate members to make nominations included the names of those nominated by Council, which was perceived as discouraging members from making nominations. The changes voted in no longer required this.

After conducting the formal business of the AGM, Peter commented on the Annual Report for 2017 (published on 1 April 2018), and the Treasurer, Andrew Smith, commented on the Accounts for 2017.

Peter Symons announced that the ballot for the election of members to Council had resulted in Pierre-Damien Jourdain (Alstom, France), Bogdan Godziejewski (Mott MacDonald, Netherlands), Cassandra Gash (Melbourne Metro Rail Authority, Australia), Paul McSharry (Kilborn Consulting, UK) and Xiaolu Rao (Systransis, Switzerland) joining Council.

Announcements and presentations were made to the recipients of the Dell Award, the IRSE-Signet Award and Merit Award (for more details see the Awards section of this Report).

The Chairman announced that Council had elected Ray Legg (Australia) as Honorary Fellow of the Institution in recognition of his major contributions to the work of the Australasian section and rail industry over many years.

This was followed by the inauguration of the new President, Markus Montigel. Before presenting his Presidential Address, Markus paid tribute to Peter for his leadership of the IRSE during the past year. The address covered the theme "The Winds of Change" as described in the introduction to this report.

IRSE Council 2018 – 2019	
President	Markus Montigel
Vice Presidents	George Clark, Daniel Woodland
Members of Council from the class of Fellow	Peter Allan, Steve Boshier, Ian Bridges, Bogdan Godziejewski, Yuji Hirao, Pierre-Damien Jourdan, Andy Knight, Jane Power, Gary Simpson, Philip Wong
Members of Council from the class of Member	Rob Burkhardt, Martin Fenner, Cassandra Gash, Ryan Gould, Lynsey Hunter, Paul McSherry
Members of Council from the class of Associate Member	Firas Al-Tahan, Xiaolu Rao
Co-opted Past Presidents	Charles Page, Andrew Simmons, Peter Symons

Annual Dinner

The 54th Annual Dinner was held at The Savoy on Friday 27 April 2018 following the AGM and the inauguration of new President Markus Montigel. It was a sell-out event again with 351 diners.

President Markus presented the toastmaster with an IRSE engraved Swiss cowbell to assist his 'call attention' in the busy room.

The guest of honour was Gery Balmer, Vice Director of the Swiss Federal Office of Transport. He spoke about transport integration in Switzerland and compared the role of the state between Switzerland and the UK.

The President's charitable cause was to support Soroptimists International (SI) raising money for their club in Lviv in the Ukraine which helps an orphanage in that city. SI were represented by two of their members from Epsom. The charity is close to the President and his wife's heart as they adopted their son Michael from this country. Michael himself made a special guest appearance at the dinner, enchanting the attendees with an oboe solo.

A collection taken at the dinner raised £3676 for SI.

The dinner relied on generous sponsorship once again and on this occasion we were grateful to Mott McDonald for providing this support.

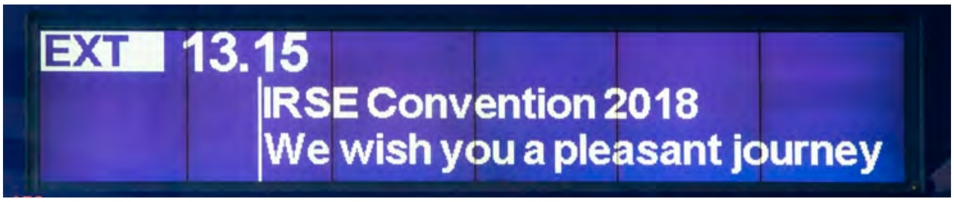
Members' Luncheon

On Wednesday 13 June 2018 the Institution held the 20th Annual Members' Luncheon at the Union Jack Club, near Waterloo Station in London where Members and staff gathered to reminisce and to exchange news. The President, Markus Montigel, paid tribute to Francis How, who after three years as Chief Executive would be retiring from the Institution on 1 August. Markus spoke about the "Winds of Change" and how they were impacting on IRSE and the sector .

Francis formally announced his retirement and went on to update those present on the activities of the Institution, changes in the IRSE office in London, awards made to young engineers during the past year, forthcoming events including the convention in Switzerland. He then introduced Blane Judd as the incoming Chief Executive, who gave a short speech outlining his background as a Chartered Engineer working in the safety critical environments of power and nuclear decommissioning engineering. Blane also spoke of how he had worked on protection, interlocking and communication systems and also his work in conjunction with the railways sector with possessions where rail and power lines crossed. He finished by saying how much he was looking forward to working with all at the IRSE.

International Technical Convention

President Markus Montigel and the Swiss Section organised and hosted the IRSE's 2018 International Technical Convention from 28 May to 1 June. The event's theme was "Safety in long railway tunnels". It offered a week of activities for Members and guests combining thought-provoking presentations with fascinating site visits across Switzerland.



Markus' opening address was attended by over 250 Members and guests, all of whom he presented with a convention tie and scarf proudly sporting the new IRSE logo.

Delegates visited the 57-km Gotthard Base Tunnel, the 23-km Ceneri Base Tunnel further south, and the new 6-km Albula Tunnel to the east, which was still very much under construction.

Leading figures of the Swiss railway sector gave a series of presentations in advance of the scheduled site visits. Hans-Peter Vetsch introduced the safety principles for the Gotthard Base Tunnel (GBT), which include the automatic inspection of trains before they enter.

Markus Spindler and Patrick Sonderegger then presented the design principles that aimed to make the GBT's signalling and tunnel control "safe and easy to use". These include a high degree of automation to keep trains separated to provide passenger escape routes, and monitor trains that slow unexpectedly. Peter Müller and Erwin Achermann's talk about the tunnel control and automation systems (TAG) focused on the concept of checklist-based and automated emergency responses in the GBT, whilst Stefan Koller described the wayside train monitoring system (ZKE) of Swiss Federal Railways (SBB).

Gilbert Zimmermann spoke about the project to build a new, parallel tunnel alongside the Rhaetian Railways' 114-year-old Albula Tunnel and the associated geological challenges the builders face. Pierre-Damien Jourdain presented ERTMS deployment worldwide. Finally, Oskar Stalder spoke about the Gotthard mountain route, which opened in 1882 and is now a scenic alternative to the GBT.

At the final dinner, President Montigel thanked the organising committee for all their hard work in organising the week's events and visits, the sponsors for their generous contributions, and in particular Ian Harman, David Street and Francis How, as this was their last convention acting in their official roles as convention coordinator, hotel coordinator and CEO, after many years of successful events.

International Technical Committee

The IRSE's International Technical Committee (ITC) has 18 fully participating and ten 'correspondence' members from many parts of the world, including Japan, USA, the UK, Netherlands, Italy, Germany, Switzerland, Belgium, Finland, France, Australia, Spain, Singapore and Canada.

The ITC's primary purpose is to provide thought leadership and disseminate learning on strategic or technical topics relevant to train control and communications systems in the railway environment, thereby providing value not only to IRSE members but to the wider rail industry. Its particular strength lies in its international membership at senior level, enabling engineering principles and practices from a diverse range of countries to be brought to bear upon the subjects that ITC debates.

During the year, the ITC held four meetings, in London UK, Lugano in Switzerland, Berlin in Germany and Amersfoort in the Netherlands. The ITC produced a bumper crop of eight papers, all of which have been published in IRSE News and one in ePub format as a trial. Papers can also be found on the IRSE website at **irse.info/itcreports**.

The meetings are hosted by members in their country and minutes are produced for each meeting. An annual report is produced for the Council summarising the ITC activities during the year.

Publications and communications

In the IRSE's five year Strategy published in 2015, the Institution committed itself to improving how it communicates with the wider rail industry, as well as its members. We continue to raise our profile through greater and better use of social media, and this year implemented the development of a new IRSE website, which aligns with the re-branding of the Institution.

IRSE News

IRSE News is published monthly, its purpose being primarily to inform IRSE members worldwide about industry news, technical developments, and the work and activities of the IRSE and its Sections. Papers that comprise the Presidential Programme are published in IRSE News, together with a wide range of other internationally sourced educational papers and articles. During 2018 we have continued to work closely with Paul Darlington who is the managing editor to develop the publication in line with the new brand and image.

Proceedings

The Proceedings provide a summary of the Institution's activities and have been produced annually since the very first issue in 1913. A hard copy of the Proceedings is supplied to the British Library and to the library of the Institution of Engineering and Technology.

Website

The website provides details of Institution events, Sections, information about the governance and operation of the IRSE, material for members taking the IRSE professional examination, how to become a member, as well as a wealth of information relating to professional development. Members (and registered non-members) can update contact details, book events, order publications, and pay their subscriptions on-line. We also advertise industry vacancies that may be of interest to IRSE members and non-members. Towards the end of the year we put in place plans to develop a more modern site, that will help support members through improved functionality and content.

E-communication

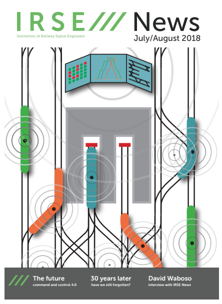
A monthly email bulletin is sent to all members, containing information about upcoming events and other topical information. We conducted some cosmetic changes to the way that the information is presented to make it a more useful communication tool.

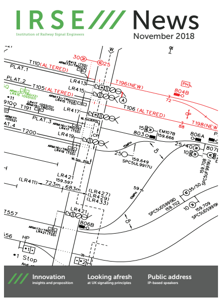
Publications

The IRSE publishes a range of books on railway train control and communications systems, which provide a useful source of educational material for those relatively new to the profession, as well as providing a valuable record of the development of signalling. The Council endorsed, in 2018, the editing and modernisation of the Metro Signalling Handbook which will be carried out during 2019.

Library

Members of the Institution are permitted to use the library of the Institution of Engineering & Technology in London, and there is also an archive collection of publications available on request at the IRSE's London offices.





IT Systems

The three major IT components that support the Institution's operations are the Membership and Licensing Database, the Websites, and the London office IT systems.

Throughout 2018 we have been developing our ability to use the vast amounts of data available to us through the Customer Relationship Management (CRM) system purchase in 2016. As we begin the development of the new website in 2019, we will be linking many of the functions of this system so that members can take full benefit from this software in managing their data.

To minimise the risk of data loss, the Institution will be migrating to a new IT system in 2019. The change reduces risk and also cost of managing our own server stack, in favour of a fully hosted solution by a UK based data centre.

Collaboration

The IRSE has both formal and informal working relationships with a number of organisations in the UK and, either directly or through its Sections, with organisations in other parts of the world. In China and South East Asia in particular, the IRSE's Sections are forging closer links with other engineering and educational organisations, and with governments. This is to be welcomed.

In late 2016 the decision was made by the IRSE's governing Council to close our existing Company Affiliation Scheme, as it had become evident that it was providing little tangible value either for the companies who participated, or for the IRSE. Towards the end of 2018 a new Industry Partnership Scheme was developed and work will start in 2019 to build this into a new and engaging service to employers of IRSE members.

An important element of our five-year Strategy is to strengthen our engagement with external bodies, including not only rail industry companies, but also other relevant organisations. The Institution enjoys good working relationships with, and support from, many companies, but our ambition is to grow this further for mutual benefit. This year collaborative events included:

- A seminar on the White Paper published in December 2017 on "Making a success of the Digital Railway". The seminar took place, with the support of WSP, in London in January
- Joint seminar with INCOSE on Systems engineering: requirements management held at the University of Birmingham in April
- Joint course with IET on railway signalling & control systems in June
- Joint seminar with IMechE in London on traffic management systems in June
- Joint seminar with IEEE in London on ethics of engineering in July

During 2018 we entered into a collaboration arrangement with VDEI (Verband Deutscher Eisenbahningenieurer, the Assocation of German Railway Engineers) on the technical paper in Darmstadt. Meetings were held with the Tunnelling and Underground Construction Academy who provide signalling and telecommunications training for the new Elizabeth Line (often still referred to as Crossrail). Engineering UK which does a lot of work on encouraging young people into careers in science, technology, engineering and mathematics have agreed to work with the IRSE on raising our profile as a career opportunity.

In the UK, two organisations are of particular significance for the Institution as a whole:

Engineering Council

The UK's Engineering Council is responsible for the regulation of engineers, particularly in the UK. The IRSE is a licensed body of the Engineering Council and is thus licensed to register Chartered Engineers, Incorporated Engineers and Engineering Technicians.

The Royal Academy of Engineering

The Royal Academy of Engineering is the lead representative organisation in the UK for matters relating to government policy on engineering, including education. It works in close collaboration with all the licensed engineering institutions (of which the IRSE is one). It has two major work-streams, 'Engineering the Future' which deals with engineering policy issues, and 'E4E' (Engineering for Education) which deals with education policy issues in so far as they have implications for the supply of engineers and technicians for the future.

The IRSE is a signatory of the Academy's Diversity Concordat. We benchmark ourselves regarding diversity measures using resources provided by the Academy.

Finances

This year sees the first presentation of our accounts since we changed to our new accountants, HPH. After a fairly significant alteration last year in order to meet the requirements of Financial Reporting Standard 102, Accounting and Reporting by Charities: Statement of Recommended Practice (SORP) there have been some further modifications this year, including a complete re-write of the introductory notes, which are not reprinted here and a new table showing the cash flow for the combined charity and IRSE Enterprises.

The financial results are shown on pages 16 to 20. They are extracted from the consolidated accounts for the IRSE and its wholly owned trading subsidiary, IRSE Enterprises Limited. The term 'Consolidated' at the top of a set of tables refers to the two companies combined, and 'Charity' to the IRSE alone. As far as possible, these extracted results use the titles and the format of the consolidated accounts.

From the Consolidated Balance Sheet on page 16 it will be seen that the total value of the Institution is about £200,000 less than at the end of last year. This has arisen largely as a result of two factors, the fall in the UK stock market affecting the value of our investments and the final writing-off of the value of the new membership database; as software it is only counted as having value for three years.

Thankfully the 2018 Convention returned to generating a surplus for IRSE Enterprises, as will be seen in note 8, which offset an overall reduction in licensing income, but even here there was a reduction in the net profit as a result of the reduction in value of investments. Otherwise, the variations in Enterprises from 2017 have arisen from the ASPECT conference only occurring in 2017 and our Past President David Weedon agreeing to temporarily act as Licensing Registrar while Paula Persson project managed the re-branding and new website exercises.

From the Consolidated Statement of Financial Activities on page 17 it can be seen that overall the total income was almost the same as in 2017, although the sources have changed with an increase in subscription income, but no exceptional income as achieved through some consultancy work in 2017. Our total costs fell by almost £50,000, partly through the completion of the integration of the new membership database, but also through the lack of the consultancy work. Meanwhile, the lower part of the table reveals the impact of the reduction in the value of our investments, with a fall in value of £118,978 against an increase last year of £195,162. (Our budget for 2019, agreed towards the end of the year, should see our costs fall to be in line with our expected income.)

Consolidated accounts (extract)

THE INSTITUTION OF RAILWAY SIGNAL ENGINEERS
CONSOLIDATED BALANCE SHEET AS AT 31st DECEMBER 2018

	Notes	Consolidated 2018 £	Consolidated 2017 £	Charity 2018 £	Charity 2017 £
Fixed Assets					
Tangible assets		9,382	79,972	9,381	79,971
Investments	1	1,493,734	1,626,032	1,103,927	1,249,480
		1,503,116	1,706,004	1,113,308	1,329,451
Current Assets					
Stocks	3	46,846	48,337	42,125	47,791
Debtors	4	176,349	234,629	310,305	360,191
Investments	5	207,707	206,739	207,707	206,739
Cash in hand		461,043	523,307	154,123	68,527
		891,945	1,013,012	714,260	683,248
Creditors: amounts falling due within one year	6	(414,400)	(547,018)	(231,770)	(234,814)
Net current assets / (Liabilities)		477,545	465,994	482,490	448,434
Total assets less current liabilities		1,980,661	2,171,998	1,595,798	1,777,885
Creditors: amount falling due after more than one year	7	(268,273)	(253,016)	-	-
Net assets		1,712,388	1,918,982	1,595,798	1,777,885
Funds	2				
Unrestricted funds		1,675,701	1,882,222	1,559,111	1,741,125
Restricted funds		36,687	36,760	36,687	36,760
Total charity funds		1,712,388	1,918,982	1,595,798	1,777,885

THE INSTITUTION OF RAILWAY SIGNAL ENGINEERS
CONSOLIDATED CASH FLOW STATEMENT AS AT 31st DECEMBER 2018

	2018 £		2017 £	
Net cash (used in) operating activities		(110,864)		(107,922)
Cash flow from investing activities:				
Purchase of tangible fixed assets	(1,947)		(22,272)	
Purchase of fixed asset investments	(266,101)		(159,924)	
Sale of fixed asset investments	279,421		181,248	
Interest received	5,168		16,175	
Dividends received	32,059		22,753	
Net cash provided by / (used in) investing activities		48,600		37,980
Change in cash and cash equivalents in the year		(62,264)		(69,942)
Cash and cash equivalents at start of year		523,307		593,249
Cash and cash equivalents at end of year		461,043		523,307

THE INSTITUTION OF RAILWAY SIGNAL ENGINEERS
CONSOLIDATED STATEMENT OF FINANCIAL ACTIVITIES AND INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER 2018

	Notes	Unrestricted £	Restricted £	Total 2018 £	Total 2017 £
INCOME AND ENDOWMENTS FROM:					
Charitable activities:					
Donations and legacies	9	1,763	-	1,763	15,163
Other trading activities:					
Non-ancillary trading income	10	590,739	-	590,739	568,481
Other activities	10	452,035	-	452,035	454,301
Investments:					
Investment Income	11	36,749	353	37,102	38,928
Total Income		1,081,286	353	1,081,639	1,076,873
EXPENDITURE ON:					
Raising Funds	12				
Other activities		9,714	-	9,714	41,821
Investment		8,067	-	8,067	7,758
Non-ancillary trading		562,274	-	562,274	552,248
		580,055	-	580,055	601,827
Charitable activities	12				
Awards		31,802	300	32,102	46,985
Promoting best practice		557,098	-	557,098	567,016
		588,900	300	589,200	614,001
Total Expenditure		1,168,955	300	1,169,255	1,215,828
Net Expenditure before (loss) / gain in investments		(87,669)	53	(87,616)	(138,955)
Net (loss) / gain on investments		(118,852)	(126)	(118,978)	195,162
NET INCOME / (EXPENDITURE)		(206,521)	(73)	(206,594)	56,207
RECONCILIATION OF FUNDS					
Total funds brought forward		1,882,222	36,760	1,918,982	1,862,775
TOTAL FUNDS CARRIED FORWARD		1,675,701	36,687	1,712,388	1,918,982

ANNUAL MEMBERS' REPORT WITH SUPPLEMENTARY MATERIAL

The tables set out on pages 15 to 19 are extracted from the full audited accounts of the Institution for the year ended 31 December 2018. They constitute supplementary material to this Annual Members' Report. Section 426A of the Companies Act 2006 requires the following statements to be made in respect of the supplementary material:

1. This annual report is only part of the company's annual accounts and reports prepared under the Companies Act.
2. A full copy of the company's annual accounts and reports may be obtained upon request from The Institution of Railway Signal Engineers, 4th Floor, 1 Birdcage Walk, Westminster, London SW1H 9JJ.
3. The auditor's report on the annual accounts was unqualified.
4. The auditor's statement under section 496 of the Companies Act (whether the Trustees' Report is consistent with the accounts) was unqualified.

A P Smith
Treasurer

Approved by the Trustees on 13 March 2019.

M MONTIGEL
President
Director and Trustee

G CLARK
Vice-President
Director and Trustee

THE INSTITUTION OF RAILWAY SIGNAL ENGINEERS
NOTES TO THE CONSOLIDATED ACCOUNTS
FOR THE YEAR ENDED 31st DECEMBER 2018

1 Fixed Asset Investments (Group)

	Equities £	Government Securities £	Total £
Market value			
At 1 January 2018	1,463,159	162,873	1,626,032
Additions	231,045	35,056	266,101
Disposals	(264,543)	(14,878)	(279,421)
Revaluations	(120,299)	1,321	(118,978)
At 31 December 2018	1,309,362	184,372	1,493,734

2 Movement in Funds (Group)

	At 1.1.18 £	Net movement in funds £	At 31.12.18 £
Unrestricted funds			
General Fund	873,642	(182,290)	691,352
Scholarship fund	75,956	276	76,232
Alan Fisher / Frank Hewlett Fund	423,017		423,017
General Development	307,000		307,000
Future ASPECT Conference	10,000		10,000
International Convention	27,500		27,500
Textbook Preparation	7,500		7,500
IRSE Enterprises - General Fund	157,607	(24,507)	133,100
	1,882,222	(206,521)	1,675,701
Restricted funds			
Dell Bequest	24,382	(397)	23,985
Thorrowgood Bequest	12,378	324	12,702
TOTAL FUNDS	36,760	(73)	36,687

The company holds 20% or more of the issued share capital of the following company:

Company	Country of incorporation	Share class	%age owned
IRSE Enterprises Limited	England and Wales	Ordinary	100

	Share capital and reserves	Profit for year
IRSE Enterprises Limited	£121,007	(£24,505)

3 Stock

	Consolidated 2018 £	Consolidated 2017 £	Charity 2018 £	Charity 2017 £
Stock	46,846	48,337	42,125	47,791

4 Debtors

	£	£	£	£
Trade debtors	104,214	151,025	-	1,288
Other debtors	4,507	9,292	3,257	8,042
Pre-payments and accrued income	23,453	60,376	-	-
VAT	44,175	13,936	23,041	13,936
Amounts owed by group undertakings	-	-	284,007	336,925
	176,349	234,629	310,305	360,191

5 Current Asset Investments

	£	£	£	£
National Savings	207,707	206,739	207,707	206,739
	207,707	206,739	207,707	206,739

6 Creditors: amounts falling due within one year

	£	£	£	£
Trade creditors	33,969	34,863	22,500	25,853
Deferred income and accruals	210,911	325,958	177,658	176,914
Other taxes and social security costs	-	6,650	-	-
Other creditors	169,520	179,547	31,612	32,047
	414,400	547,018	231,770	234,814

7 Creditors: amounts falling due after one year

	Consolidated 2018 £	Consolidated 2017 £	Charity 2018 £	Charity 2017 £
Deferred income	268,273	253,016	-	-

Representing the proportion of licence fees receive which will be credited to Income after more than one year.

8 Activities of IRSE Enterprises

	2018 £	2017 £
Turnover		
Donations	180	-
Proceeds - Conventions and Conferences	149,025	91,696
Proceeds - Dinner	51,947	40,536
Proceeds from Technical Visits and Seminars	37,829	36,710
Licences - Fees Received	229,343	229,336
Licensing - Appraisal Fees	20,367	75,330
Licensing - Assessing Agents Fees	84,101	83,320
Licensing - Technical Publications	17,947	11,553
	590,739	568,481
Cost of sales		
Opening Stock	546	4,913
Costs - Conventions and Conferences	113,750	126,784
Costs - Dinners	32,668	28,542
Costs - Technical Visits and Seminars	18,160	18,543
Costs - Engineer’s fees	13,738	13,403
Licensing - IRSE Administration Charges	146,746	191,341
Costs - Appraising Engineers	65,773	69,248
Costs - Accreditation	10,427	8,249
Costs of Young Members’ Seminars and Visits	810	162
Closing stock	(4,721)	(546)
	397,897	460,639
GROSS PROFIT	192,842	107,842
Other income		
Dividends receivable	8,029	4,133
Bank interest receivable	312	67
	8,341	4,200
	201,183	112,042
Expenditure		
IRSE Admin Charges	17,318	20,359
Telephone	4,918	4,669
Post and Stationery	15,779	8,874
Officers’ expenses	33	502
Accommodation and Refreshments	3,260	3,992
Computer costs	31,487	10,015
Sundry expenses	2,820	2,741
Licensing - Treasurer’s, Chief Executive’s and Registrar’s Fees	69,479	31,738
Investment Manager’s Fees	3,346	3,071
Auditor’s remuneration	2,750	2,875
Donations	45,029	22,050
Profit / loss on sale of fixed asset investments	11,122	363
	207,341	111,249
Finance costs		
Licensing - Bank charges	2,064	2,412
Net figure	(8,222)	(1,619)
Gain / Loss on revaluation of assets		
Gain on revaluation of investments	(16,283)	60,187
NET PROFIT	(24,505)	58,568

9 Donations And Legacies (Group)

	2018 £	2017 £
Donations	1,763	15,163
	1,763	15,163

10 Other Trading Activities (Group)

	£	£
Subscriptions	408,709	381,376
Advertising	10,323	11,815
Booklets and text books	7,072	5,478
IRSE ties, badges & cufflinks	51	173
Examination Fees and materials	22,823	11,774
Sponsorship of charity event	557	-
Proceeds from members' lunch	800	1,035
Consultancy Income	1,700	42,650
	452,035	454,301
Trading income:		
Turnover of trading subsidiary - Note 8	590,739	568,481

11 Investment income (Group)

	£	£
Equities and government stocks	24,030	18,620
Interest receivable	4,731	16,108
IRSE Enterprises Ltd	8,341	4,200
	37,102	38,928

12 Analysis of Expenditure

	Staff Costs £	Depreciation £	Other £	2018 £	2017 £
Raising Funds					
Other Activities	2,198	363	7,153	9,714	41,821
Investment	-	-	8,067	8,067	7,758
Non-ancillary trading - Note 8	97,910	36,269	428,095	562,274	552,248
Total raising funds	100,108	36,632	443,315	580,055	601,827
Charitable Activities					
Awards	8,792	1,451	21,859	32,102	46,985
Promoting best practice	208,798	34,454	313,846	557,098	567,016
Total charitable activities	217,590	35,905	335,705	589,200	614,001
Total Expenditure	317,698	72,537	779,020	1,169,255	1,215,828

13 IRSE Charitable Expenditure

	£	£
Raising donations and legacies		
Fund raising dinners	3,729	4,014
Consultancy	1,360	32,880
Charitable activities		
Proceeding: editing and printing	7,173	3,832
Newsletter: editing and printing	96,438	78,131
Booklets and textbooks	3,540	3,326
IRSE ties, cufflinks and badges	45	313
Prizes	1,272	215
Awards	13,602	27,279
Activities funded by country subscription supplements	9,268	13,149
Thorrowgood medals	-	24
Support costs		
Staff costs	219,788	188,361
Office rent and services	20,072	19,962
Fees and honoraria	51,388	37,056
Membership database	6,750	48,768
Other administrative costs	125,118	158,397
Investment manager's fees	8,067	7,758
Fixtures and fittings	36,269	36,140
Governance costs		
Auditor's remuneration	3,101	3,975
Total Expenditure	606,980	663,580

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Index of IRSE News Contents – May 2018 to April 2019

Summaries of IRSE Presidential Programme Technical Papers

Each year the President of the IRSE invites keynote speakers to produce papers and presentations on selected topics. The papers for the Presidential Programme for April 2018 – March 2019 had the overarching theme of *Winds of Change* selected by Dr Markus Montigel for his Presidential Year.

In 2018-19 the papers and speakers were as follows (a summary of each appears on the following pages):

Command and control 4.0 by Josef Doppelbauer in June 2018
(Published in IRSE News, July/August 2018 – Issue 246)

Insights and propositions on innovation of railways by Ulrich Weidmann on 26th October 2018
(Published in IRSE News, November 2018 – Issue 249)

The location and control of assets in Smartrail 4.0 by Steffen Schmidt on 26th October 2018 (Published in IRSE News, December 2018 – Issue 250)

The main line ATO journey by Andrew Simmons & Nicola Furness in December 2018
(Published in IRSE News, January 2019 – Issue 251)

Challenges in designing secure and resilient railway command and control systems by Stefan Katzenbeisser on 7th February 2019
(Published in IRSE News, March 2019 – Issue 253)

Human factors in aircraft cockpits, lessons learned by Michael T McNamara on 5th March 2019
(Published in IRSE News, April 2019 – Issue 254)

Command and Control 4.0

Josef Doppelbauer, Executive Director, European Agency for Railways
Presented in June 2018 in London
Published in IRSE News, July/August 2018 – Issue 246

Summary:
The paper explores the future possibilities for train control, using internet protocol and vehicle-to-vehicle communications. It also explores the challenge of migration from today's railway to one with new train control systems, the need for modal integration, and the nature of innovation and the challenge of innovation on railways.

Control, command and signalling are at the core of railway operations – they essentially determine safety and performance of the network. With the capabilities provided by new technology in terms of computing power, sensors, networking and connectivity, new possibilities arise – more and more functionality can be moved on board trains (thus reducing fixed cost in the infrastructure), vehicle-to-vehicle communications (including to non-rail vehicles) can enable mitigation of safety risks (e.g. at level crossings), while central traffic management remains significant for network-wide optimisation.

Insights and propositions on innovation of railways

Ulrich Weidmann, Professor for Transport Systems and Vice President Human Resources and Infrastructure, ETH Zurich
Presented on 26th October 2018 in Zurich
Published in IRSE News, November 2018 – Issue 249

Summary:
This paper does not summarise just a single project, but rather combines insights into innovation in the railway sector from around 30 years, which the author has gained as a researcher and practitioner. In part it is based on the research results of his group, but partly also reflects personal opinions. Innovation in rail has always spread slowly, according to consistent human standards, since the beginning. Important pioneering achievements go back to the late 18th to early 20th century. For example, steel wheel on steel rail technology was introduced ca. 1780, the steam locomotive ca. 1800, the mechanical interlocking ca. 1860, the electric train drive and the automated block ca. 1880, the diesel locomotive ca. 1910 and the high-speed railway around 1930. In these and many other cases it took about four decades from initial use to general dissemination and adoption.

In this paper the author explores why innovation happens slowly on railways, examining four "blockers" to innovation. He then moves on to consider what innovation needs to address in the next 40 years in order for railways to continue to be successful. In particular, he considers the need for more automatic train operation (ATO), better traffic management systems and, ultimately, the full automation of the rail system, with driverless trains and fully automated planning and timetabling, to more closely meet the needs of the railways' customers.

The location and control of assets in Smartrail 4.0

Steffen Schmidt, SBB
Presented on 26th October 2018 in Zurich, Switzerland
Published in IRSE News, December 2018 – Issue 250

Summary:
The programme Smartrail 4.0, which is driven by the Swiss railway sector, has the goal of making railway operation significantly cheaper and more efficient by means of modern technologies. Smartrail 4.0 is an open concept whose specifications are released for open use in the product market or in self-developed products after completion. Basic available technologies from different industry sectors are combined to develop requirements and concepts for new high-performance products and to develop innovative vendors in the marketplace.

Smartrail 4.0 will feature full digitisation with fewer trackside assets with possibly only switches and crossings left. The architecture will be simple, but powerful with a reduced amount of safety critical functions. Higher capacity will be delivered by a high performance and precise train control and dynamic optimisation, which blocks only the necessary minimum of track for each train movement.

Automation of the CCS (control command and signalling) asset lifecycle processes, especially data preparation and safety cases, will be a key feature, along with automation of scheduling and production planning. Higher grades of automation for both existing operation centres and train operation will contribute to less energy consumption.

Modular CCS vehicle architecture with high upgradeability will result in lower life cycle and safety cost, along with increased safety, by using a generic and redundant protection architecture. Cheaper and faster migration will also be possible with minimised loss of CCS investment capital.

If all 30 projects of Smartrail 4.0 succeed, the operating cost reduction will have a volume of several hundred million euros every year. All the so called “CCS game changers” will combine to achieve these goals. There are two key elements of the concept. Firstly, the methods, architectures and technologies for the localisation of trains on the track together with the function, logic and secondly the flexibility of the trackside safety system. This controls the safety of all types of movements and changes of the state of the trackside assets, such as switches. These are discussed in the paper.

The main line ATO journey

Andrew Simmons & Nicola Furness, Network Rail
Presented in December 2018 in London, UK
Published in IRSE News, January 2019 – Issue 251

Summary:
Automatic Train Operation (ATO) was first introduced in the 1960s on London Underground's Victoria Line. Since then ATO has been developed through a number of technology phases on Metro and People Mover Systems to allow driverless train operation operating on a moving block signalling platform. There have also been isolated main line applications such as ATO used on suburban lines in the Czech Republic.

It was clear from metro operations that ATO has the capability to enhance capacity/performance whilst also optimising traction energy, but for main line applications it was also apparent to Network Rail that the lack of interoperability for ATO systems was a factor that could prevent widespread application and/or increase infrastructure complexity. Network Rail considered that a long-term strategy to develop the concept of an 'interoperable' ATO was the most appropriate way forward, if the benefits of ATO were to be realised across main line networks.

This paper describes the main line ATO 'journey' from a Network Rail perspective. It includes an account of the European and GB projects in which ATO was developed (including Shift2Rail), the integration of ATO into the CCS TSI, the experience of developing it for application on Thameslink and Crossrail, and what happens next.

Challenges in designing secure and resilient railway command and control systems

Stefan Katzenbeisser, Technical University, Darmstadt
Presented on 7th February 2019 in Darmstadt, Germany
Published in IRSE News, March 2019 – Issue 253

Summary:
Traditionally, the development of new railway command and control systems has focused on safety aspects. There are well-proven methods that prevent accidents caused by system faults or human errors. Technical realisations typically follow the principle of redundancy, which assures that a second system is available if the first one fails, and the safety principle, which states that a system always fails in a way that does not cause harm. The assessment of a system with respect to its safety features is typically done by probabilistic analysis: average failure rates of systems can be determined by long-term inspection of components for failures, while failure rates of human operators are known from psychology. This allows computation of a residual error probability for a complex system. If the error probability is too high, it can be reduced by technical measures, such as the further addition of redundancy. Crucial to this process are various independence assumptions (individual system components fail independently) and the knowledge of failure probabilities for various components.

Despite being engineered for safety, recent reports have shown that railway command and control systems can be susceptible to cyberattacks (see for example irse.info/5o8n0).

In the domain of security, we face active attackers, which try to subvert systems and cause harm. In particular, an active attacker will not trigger random faults, but will always try to attack the “weakest” component to achieve his goal. Thereby, the above-mentioned independence assumptions are unlikely to hold in the domain of cybersecurity: if an attacker managed to penetrate one part of a system, he will likely also be able to break a second. Furthermore, it is notoriously difficult to assess probabilities for attacks, as the attacker landscape changes over time. A system that can be considered secure now may be completely insecure in the near future, if new attack technologies emerge or new vulnerabilities are found. The latter is in stark contrast to safety features, which remain valid over the entire lifetime of a system due to unchangeable laws of physics. Thus, the security of a system has to be re-evaluated periodically.

This paper explores the "attack vectors" (ways that attackers can penetrate a system), the steps in a security engineering design process to minimise the risk of an attack in a system, the problems of making a train control system both secure and safe, system architectures for ensuring resilience in the event of an attack, and business continuity management.

Human factors in aircraft cockpits, lessons learned

Michael T McNamara, President, Gannett Fleming Transit & Rail Systems
Presented on 5th March 2019 in Brisbane, Australia
Published in IRSE News, April 2019 – Issue 254

Summary:
The paper compares the treatment of human factors within the North American railway and aviation industries. The author's experience as a professional railway signalling engineer and a leisure aircraft pilot gives him a unique insight into former and current practices in both environments, and he proposes that lessons can be learnt from both railway and aviation safety regimes. Railways are very different from airlines and practices in the United States (US) and can be very different in other parts of the world.

Railways are a more mature industry than aviation, having been around for 150 years or so. Aviation was a wild experiment until about 80 years ago and only developed into the reliable transportation system that it now is after the second world war. Railway safety and aviation safety developed separately; there are very few people who have extensive knowledge of both, with aviation having experienced rapid technological change and railways benefiting from technology at a slower pace.

The three-dimensional aspect of aviation is an inherently more complex environment than the single dimension of a railway. But as railway engineers, we understand that the single dimension creates hazards itself; no train can swerve suddenly to avoid an accident. The steel on steel that creates efficient movement, also creates longer stopping distances; usually beyond a train driver's ability to see.

Summaries of IRSE International Technical Committee (ITC) Papers

The mission of the IRSE's International Technical Committee (ITC) is to provide a multi-national and independent perspective on Railway Control, Command and Signalling (CCS) topics. Membership is by invitation, and comprises industry experts from both suppliers and operators, drawn from more than a dozen countries around the world. It aims to inform and educate both IRSE members and the train control and communications community worldwide, principally by the production of reports on selected topics.

Listed below are ITC papers published during 2018 – 2019 with the abstract on the following pages:

Why do signalling projects fail?
Alan Rumsey
11th May 2018
(Published in IRSE News, May 2018 – Issue 244)

Improving the management of emerging and residual safety risks
Libor Lochman and Jean Baptiste Simonnet
1st July 2018
(Published in IRSE News, July/August 2018 – Issue 246)

Achieving high levels of signalling system availability – is there a role for secondary systems?
Alan Rumsey
1st September 2018
(Published in IRSE News, September 2018 – Issue 247)

ITC view on the residual risks to the Railway as at Q2 2018
Rod Muttram
1st October 2018
(Published in IRSE News, October 2018 – Issue 248)

Why do signalling projects fail?

Alan Rumsey
11th May 2018
(Published in IRSE News, May 2018 – Issue 244)

Abstract:
Why do signalling projects fail? The reason for asking this question is that, in recent decades, the frequency at which projects fail appears to be increasing rather than decreasing. There is a growing concern and frustration amongst some operators that signalling and telecommunications technology deployment is too slow, which leads to the unfortunate perception that the profession lacks innovation and is incapable of successfully delivering upgrades in a timely fashion. If this is indeed the case, then it is important to fully understand the root cause or causes of project failures.

For the purposes of this article, a project is considered to have 'failed' if it fails to deliver the anticipated business case benefits in the planned and contracted time frame i.e. the project is 'late'. In extreme cases, the contract may be cancelled, and the work never completed, or the contract may be re-bid resulting in additional delay. More typically, the actual project completion date is many months or years after the originally contracted completion date.

The paper explores a number of causal factors for project failure, including capability and competence, poor specification, system adaptation/innovation, systems integration, migration, commissioning, operational readiness, safety certification, project management, stakeholder engagement and procurement. The paper concludes with nine recommendations for success:

1. Focusing more on project output requirements and business case objectives, and less on ever increasing detailed technical and process requirements.
2. Encouraging early engagement between the client and prospective suppliers to build confidence and to ensure a common understanding of both the technical requirements and the delivery process requirements (including migration planning), and to flush out unrealistic expectations, prior to contract award.
3. Minimising and simplifying, where possible, external interfaces to legacy equipment with the contracting agency acknowledging their role in mitigating system integration risks.
4. Minimising, where possible, product adaptation/new development, and where this is required ensuring there is an allowance for the adaptation/development in the project schedule and cost.
5. Placing project delivery risks with the entities in the best position to manage the risks.
6. Adopting a co-located 'one team' method of working.
7. Simplifying 'process' requirements and ensuring that the process requirements contribute to, rather than constrain, project success.
8. Maximising access to track and trains (short-term pain for long-term gain).
9. Showing a willingness to change legacy operating and maintenance practices, consistent with characteristics of the new system.

Improving the management of emerging and residual safety risks

Libor Lochman and Jean Baptiste Simonnet
1st July 2018
(Published in IRSE News, July/August 2018 – Issue 246)

Abstract:
The increased role of control command and signalling (CCS) in railway traffic management creates opportunities but also threats that need to be solved to ensure that the railway system is not exposed to unacceptable risk, technically effective and commercially affordable.

There are emerging as well as residual risks in CCS technology and an insufficient knowledge of how to mitigate them (including cyber security) without threatening safety, decreasing the system performance and increasing overall costs. Currently there is neither a common sector approach to defining risks applying to CCS nor a common understanding on how and when to deal with those risks. A harmonised methodology needs to be gradually developed in order to help rail operators and suppliers to progressively move from extensive and subjective expert judgement.

This paper describes the EU approach to railway risk management, the "Common Safety Method for Risk Evaluation and Assessment", the management of new and emerging risks such as cyber threats, and the approach to managing residual risk.

Achieving high levels of signalling system availability – is there a role for secondary systems?

Alan Rumsey
1st September 2018
(Published in IRSE News, September 2018 – Issue 247)

Abstract:
Rail Operators are driving the signalling industry to take a more holistic view of rail transportation operations with signalling solutions that recognise not only the importance of achieving high levels of signalling system safety but also high levels of signalling system availability. They are looking to the signalling industry to provide solutions that not only exhibit ‘fail-safe’ characteristics but that also support degraded modes of working following equipment failures.

Meeting this challenge requires solutions that:

- Reduce the number and frequency of service-affecting failures in the primary signalling system;
- Reduce the time required to recover from service-affecting failures in the primary signalling system;
- Provide independent means to continue to move trains, in a degraded mode, pending recovery from service-affecting failures of the primary signalling system.

In this article, such independent means will be described as secondary systems. Other terms that have been used to describe such secondary systems include ‘auxiliary wayside systems’, ‘fall-back systems’, ‘back-up systems’, and ‘degraded mode of working’ systems.

In the paper, grades of secondary systems (GoSS) are defined. Consideration is given to improving the availability of the primary signalling system, reducing recovery times after failure, and the selection of the most appropriate secondary system (three scenarios are considered).
The paper also makes a brief reference to the Network Rail "COMPASS" system.

ITC view on the residual risks to the Railway as at Q2 2018

Rod Muttram
1st October 2018
(Published in IRSE News, October 2018 – Issue 248)

Abstract:
During the presentation day of the IRSE Annual Convention in Dallas on 26 September 2017, the IRSE International Technical Committee (ITC) presented three linked papers which are amongst the most important outputs of the Committee in recent times. For that reason, the authors decided to produce this article to summarise those papers in a form that is digestible to non-signalling specialists. The three papers were also published separately in IRSE News (January 2018, March 2018, October 2018.

People make far reaching decisions affecting safe railway operation but may not fully appreciate the implications and risks associated with proposals (which might appear superficially minor in nature) to change operational practice and/or the technical systems of infrastructure and rolling stock.

The three related papers cover a proactive approach to speed control, the need to recognise the importance of considering human factors and the methodology now used in the EU for railway risk analysis and management. They are primarily related to the main line railway (heavy rail) but a number of the messages and principles they outline are applicable to metros and light rail systems as well.

All ITC members are very experienced professionals. These three papers were prepared respectively by our current chair, Frans Heijnen, a former IRSE president, technical director of the ERTMS EEIG (European Economic Interest Group) and former vice president technology at Invensys Rail; by Rod Muttram, who as director, safety and standards led Railtrack's input to three of the four public inquiries into the Southall and Ladbroke Grove collisions before setting up the RSSB and then holding a series of vice president roles at Bombardier, and by Libor Lochman, executive director of the Community of European Railway and Infrastructure Companies (CER) and former director of the Railway Research Institute (VUZ) of Prague.

IRSE Examination Results – 2018

The IRSE is pleased to announce the results of the 2018 IRSE Professional Examination and to congratulate all those who have now successfully passed four modules. There are seven exam modules and to gain the full IRSE Exam it is necessary to achieve a Pass in four of them. Module 1 is compulsory, and candidates can choose a further three modules to suit their experience and specialism.

Congratulations to all of those named below and a thank you to all who supported candidates through study groups, sponsorship, the exam forum and other means, and not forgetting the examiners, support staff and volunteers who always spend a considerable amount of time making the examination the success it is.

The modules referred to in the table below are as follows:
Module 1 Safety of Railway Signalling and Communications (compulsory)
Module 2 Signalling the Layout
Module 3 Signalling Principles
Module 4 Communications Principles
Module 5 Signalling and Control Equipment, Applications Engineering
Module 6 Communication Applications
Module 7 Systems Management and Engineering.

Key:
P = Pass
C = Credit
D = Distinction

Successful candidates completing the exam by passing modules in 2018 are:

Name	Modules: results
F Al-Tahan	5: P
M Barker	1: C; 7: C
M Bowerman	1: D; 3 P; 5: P; 7: P
K Chang	1: D; 5: P
A Clapham	5: P
S Crowther	2: P; 3: P; 7: P
M France	5: P
C Hamilton-Williams	3: P; 6: P
I Hayes	1: P; 2: C; 3: P; 5: P
I Ho	1: C; 3: C
R Lee	1: C; 7: C

Name	Modules: results
R Martin	1: C; 2: C: 3: C
R Paolozzi	5: P
K Patel	2: D; 3: C
D Paxton	2: P; 3: C
T Shanmugaratnam	3: C
M Slade	1: C
T Stankowski	2: C; 3: P
A Steele	1: C; 7: C
D Westerman	5: P
K Wong	1: P; 3: P
T W Thomas Wong	1: P; 7: P

Candidates who have successfully passed modules in 2018, but not yet achieved the required four module passes for full exam completion are:

Name	Modules: results
V Aviomoh	6: P
A Azad	1: P, 3: P
K Banks	1: P, 5: P
M Baporia	3: P, 5: P
S-H Barbuta	3: P
A Belson	2: P, 3: P
E Bramble	2: C, 3: P
J Calderwood	3: P
E Campbell	1: C, 7: P
VP Challa	3: P
S N Cheng	2: C
P Chopra	5: P
A Courts	1: C, 3: P
J Darlington	1: P
S Dooley	1: C
M Duck	2: P
L Edwards	2: D
A Farish	1: P, 5: P
S Loveless	1: P
S Maddock	1: C
C Madinga	1: P
A McConville	1: P, 5: P
A Morrison	2: P
D Mui	2:C
M Navas Hussain	3: P
S Ni	3: P
A O'Connor	5: C
S Pamidi	2: P
K Pascal	2: C
Y Pathan	7: P
S Polana	3: P
T Ryan	1: C
S Saenthan	4: C

Name	Modules: results
J Farrell	1: C, 5: C
B Gabai	1: C, 5: P
S Gorman	5: P
U Gowrisetty	2: P
M Halligan	1: C, 6: P, 7: P
P Hobden	1: D, 2: D
R Hutchinson	2: D, 3: C
R Hyde	2: P
M Iqbal	3: P
C Jameson	1: P, 2: P
C Kerrigan	3: P
L Koen	2: P
P Kumar	2: P
G Larkin	2: P, 3: P
T Y Law	1: P, 2: C
A Laz	2: C, 3: C
K Lee	1: P, 2: P
M-A Lew	1: C, 7: P
A Singh	5: P
D Snelling	1: C, 5: P
M Tebele	2: P
T S Z Tsang	2: P
P Tully	5: P
S Walker	1: C
S Wallace	1: C
J Wallis	2: D, 3: C
B Wang	2: C, 3: P
C Welsh	1: C
J Whyte	5: P
K L Wong	2: P
W H Yang	2: C
S C Yuen	2: P
F Zhang	2: D, 3: P

Reports from Local Sections Non-UK

The following reports were originally prepared by the IRSE's international (non-UK) Sections as a means of reporting their activities to the Institution's Council. They have been edited slightly for the purposes of providing a permanent record as part of the Proceedings 2018-2019.

The international Sections in existence in 2018-19 (in alphabetical order) were:

Australasia
China
France
Hong Kong
India
Indonesia
Ireland
Japan
Malaysia
Netherlands
North America
Singapore
Southern Africa
Switzerland
Thailand

IRSE Australasia Section Incorporated Report: 2018 – 2019

Report produced by: Kaniyur Sundareswaran (Chairperson) & Les Brearley (Secretary)
Date: April 2019

1. Introduction

The Section has had a successful year in the past 12 months with the national technical meetings, local technical meeting and major conferences where the IRSE managed 'streams' of technical papers.

The Section received notification in early April that it has achieved national accreditation for the Graduate Diploma in Railway Signalling from Australian Skills and Qualifications Authority (ASQA).

Several actions have been taken to reduce the trend of decreasing membership including advice to members of the change in membership policy and encouraging members to pay their overdue subscriptions. However, there is still a significant number (about 50) who are unlikely to meet the 1st April 2019 deadline. This has been offset by the increased membership approvals in the last few months. Steps have also been taken to increase the number of IRSE members residing in the region also joining the Section.

Please note that the Local Technical Meeting information in Section 3.2 covers the period from January 2018 until December 2018.

Date of last Annual General Meeting:	15th March 2019
Were annual accounts presented at the AGM?	Yes
Were officers elected / re-elected at the AGM?	Yes
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	560 IRSE Australasian Section Inc members as of 23rd March 2019

2. Section Officers (at the time of writing report)

Chairman	K P Sundareswaran
Vice Chairperson	G Hartwell
Secretary	L F Brearley
Treasurer	P Szacsvay
Country Vice President	R Baird
Webmaster	W Millburn

3. Main Activities During Past 12 Months

During the year, there has been three national Australasian Section technical meetings of the Australasian Section (with one being combined with the AGM). In addition, 23 local technical meetings were held.

National Technical Meetings
These meetings are held in each state and New Zealand on a rotational basis. The AGM meeting (March or April) is held over three days. The other meetings are of two days duration:

Adelaide 20th – 21st July 2018 - This two-day meeting had a theme of *What's next for Rail Technology?* 115 Members and guests attended the Friday meeting with 53 attending the site visits on Saturday to Department of Planning, Transport & Infrastructure (DPTI) Control Centre and Australian Rail Track Corporation (ARTC) Project Office including the Advanced Train Management System (ATMS) lab demonstrations.

Sydney 16th – 17th November 2018 - The final national technical meeting for the year 2018 had a theme of 'Advanced Signalling to Deliver our Transport Needs'. Friday attendance was 132 with 46 attending the site visits to the new Sydney Metro Operational Control Centre, new Tallawong station and the Rolling stock maintenance facilities at Rouse Hill, Sydney.

Brisbane 14th – 17th March 2019 (inc. AGM) - A Younger Members' Society function was held on the evening of the 14 March hosted by WSP. There was a good attendance of approximately 45 people from various signalling organisations including younger employees from the company. This provided the added benefit of promoting the IRSE to these attendees.

The evening before the AGM a management committee "strategy meeting" was held, where new strategies were discussed, and the current strategies from the IRSEA strategy plan revisited.

The first meeting for the 2019 year started on the 15 March with the theme 'New Generation People and Technology'. This was a three-day meeting and included the 2019 AGM. There were over 165 people in attendance, with a significant portion of visitors, for the Friday Technical conference. The President Dr M Montigel was in attendance, he gave a presentation and presided over the Presidential Paper *Human Factors in Cockpits: Lessons Learnt in the Light of ATO* which was also live-streamed. Technical site visits on Saturday were attended by 50 people and included visits to the New Generation Rollingstock Maintenance facility at Wulkuraka, QR signalling installation at Chelmer and Network Management Centre at Mayne. A social day to St Helena Island on Sunday was enjoyed by members and partners.

Awards presented were:
Chairman's Award – Robert Baird

It was also noted that the HonFIRSE certificate and a plaque from the Australasian section have been delivered by post to Raymond Legg, on his request, as he was unable to attend the meeting physically. Ray was elected as an Honorary Fellow of the Institution in 2018 April.

Local Technical Meetings in 2018
Local technical meetings are held in the capital cities. Typically, they involve two 30-minute presentations followed by light refreshments and networking. Technical papers are not usually published. Note this information is for the 2018 calendar year which is the most recent detailed information available. These meetings have continued in a similar pattern in 2019.

Queensland:
20th February 2018, attendance 32. Moreton Bay Rail Link - Project Experiences and Beyond – Federico Nardi & Mohan Sankarasubbu (Ansaldo STS). Presentations and demonstrations: Electronic Train Graph Applications – Anthony McDonald (Ansaldo STS) and Toma Abe (Hitachi)
15th May 2018, attendance 47. Implementation of Requirements Management on HS2 MWCC North (N1 and N2) Packages - Tanya Galliara (Systra). Thameslink Traffic Management Integration: Understanding Key Learnings and Trade Offs - Jon Hayes (Systra)
5th December 2018, joint meeting with RTSA, PWI and RTTA, total attendance 81 Potential of Rail and is it being Realised – Steve Kanowski (QR)

South Australia:
6th September 2018, joint meeting IRSE, RTSA & PWI attendance 62. Train Detection Track Circuits and Axle Counters – Advantages and Disadvantages– Trevor Moore (ARTC). Train Detection and Asset Monitoring – using acoustic detection– Mark Foster (Wavetrain)

Victoria:
21st February 2018, attendance 40. Reflections on Aspect 2017 Singapore - Pesala Kahawita (Opus / WSP). Realising the opportunities Offered by New Developments in Technologies - John Gifford (Frauscher Sensor Technology)
18th April 2018, attendance 30. Optimise asset usage – selected aspects of Rail customer Service – Jacek Mocki (Motzky). Content is the Key - Rick Draper (Amtac)
16th May 2018, attendance 40. Implementing high capacity and high availability networks in rail applications - Ken Yip (Siemens Ltd). Vic Track's Network Transformation programme; delivering an integrated IP/ MPLS Network to support transport - Julian Williams (Vic Track)
20th June 2018, attendance 52. New Generations Object Controllers; Smart IO - Hatem Guirguis (Alstom). Clockface timetables for regional railways - Peter Burns (PYB Consulting)
18th July 2018, attendance approx. 50. Signalling on the Cranbourne/Pakenham Corridor - Adam Clark (LXRG) Principle Testing and Axle Counters - Richard Ogilvie (RCSA)
15th August 2018, attendance 45. 2018 IRSE Convention 2018 – Switzerland - Daniel Martin [MTM], Luis Evangelista [MTM] & Ron Lam [IRES]. Let's have a sensible discussion about proving - Richard Stephens (Wabtec Control Systems)
19th September 2018, Joint meeting with RTSA attendance, 65. Virtual Rail Infrastructure Inspection using Unmanned Automated Vehicle (UAV) - Dr Paul Reichl and Calvin Vong (Institute of Railway Technology). How Innovation is Improving Level Crossing Safety at Lower Cost - Gary Foster (Rail Safe Systems).
17th October 2018, attendance 60. Complex Train Control System Interfaces - Jordan Oustambasidis (UGL Pty Limited) Let's have a sensible discussion about power system availability, Alex McGrath (Level Crossing Removal Authority).
21st November 2018, attendance 40. Power Systems Protection - Oliver Eisenlohr*,* (LXRA). The Engineering Profession in Victoria: Opportunities and Challenges - Dr Collette Burke (Chief Engineer of Victoria).

New South Wales:
22nd February 2018, attendance 28. Resistance is Useless (based on the ITC Paper – Strategic Drivers of change in the signalling industry) - Peter Symons (President, IRSE and Technical Director, Tritun)
22nd March 2018, attendance 28. Overview on INCOSE & SESA - David Orr (Transport for NSW)
26th April 2018, attendance 39. The Digital Future – Railway Analytics and Smart Cities - Heather Moody (Siemens)
21st June 2018, attendance 100+ Joint meeting with PWI, NSW Designing Inland Rail - Brett Hillcoat (WSP)
26th July 2018, attendance 66. Signalling systems and Architecture of MTR South Island Line - Ella Peters (Metro Trains, Sydney)
23rd August 2018, attendance 25. Sydney Metro Signalling & Control - Oliver Fried (Metro Trains, Sydney)
27th September 2018, attendance 32. Cyber Security - Gabriel Haythornwaite (JB Cyber)

Western Australia:
5th April 2018, attendance 35. Do we have the Backbone to Support Emerging Technologies? - Malcolm D'Cruz (Rio Tinto Iron Ore) and David Lim (DXC Technology)
28th June 2018, attendance 38. Two Papers on Point Machines. M23A MKIII – Making a classic solution relevant to changing maintenance practices. The Digital Point Machine – both papers Richard Flinders (Siemens)
30th September 2018, attendance 25. Informal networking (BYO) event

New Zealand:
Local members attended some of the RTSA events below, however no IRSE branded local meetings were held during 2018:
Conference on Railway Excellence May 2018 (attendance 700+)- CORE is a biennial event organised by the Railway Technical Society of Australasia (RTSA), a technical society of

Engineers Australia, and in 2018 it was held in Sydney, in the month of May. Two streams of IRSE presentations (4 papers each) were organised and chaired by IRSE members, with an average of 40+ people attending these sessions.

ARIA Awards Dinner, Melbourne 5th July 2018. (attendance 400+) - An evening was held in Melbourne where the IRSE and the other rail engineering institutions of Australasia organise an event called the Australasian Rail Industry Awards (ARIA), where people were recognised for their contribution into the Industry. The IRSE presented an award for the Rail Signalling and Systems Engineering area, which was won by Trevor Moore of ARTC, based in Sydney.
AUSRAIL, Canberra November 2018 (attendance 700 approx.) - AUSRAIL is an event held by the Australasian Railways Association (ARA) and is a two-day conference with more than 120 exhibitors with a theme in 2018 of 'Rail- For a Better Future'. The IRSE participated with two streams of papers in the conference with a total of 6 papers presented. Average attendance at the IRSE papers was 40.
Insight into Railway Signalling Courses - In conjunction with ARA, IRSE delivers Insights into Railway Signalling course in the various states of Australia. In 2018 courses were delivered in Brisbane, Melbourne and Sydney. In addition, courses were delivered for organisations such as Metro Trains Melbourne (MTM), Rail Projects Victoria (RPV) and Level Crossings Removal Authority (LXRA). On average there is around 30 attendees per session.

4. Plans for the Next 12 Months

Events
The program of technical meeting, both national and local, will be maintained as follows:
National Technical Meetings

- The Section will be hosting its next Technical meeting for the year in a regional centre. The mid-year Melbourne meeting will be held in Ballarat, Victoria, which is a satellite town of Melbourne on 19th and 20th July 2019. The theme will be "Brownfields Rail Investment".
- The Section will be holding our third and final IRSE Meeting for the year in New Zealand, after quite a gap, on 1st and 2nd November 2019.
- The Section will be returning to Adelaide for the 2020 AGM and the first technical meeting of the year. It is expected that George Clark, IRSE President (2019- 2020) will be join the Section for the AGM and a likely Presidential paper will be presented there.

Local committees in each of the states are established now and committee meetings are taking place in a more regular fashion. Regular local technical meetings are being held in most of the states and the Section will continue with that value provision to its membership base.

IRSE will be holding three streams of presentations in the AusRail Plus conference to be held in Sydney from 3-5 December 2019.

The Section will continue with the Insight into Railway Signalling courses delivery in the major cities (one each in Adelaide, Brisbane, Melbourne and Sydney) and support any dedicated course requests for individual organisations.

The Section intends re-starting delivery of our technical seminars prior to the national technical meetings, with a seminar before the AGM in 2020.

Other Initiatives

With the receipt of accreditation notification from ASQA, the Section's focus now is to identify and appoint a Registered Training Organisation to deliver the post graduate diploma course by the third quarter of 2019.

At the strategy committee meeting is was decided to take a proactive approach to encouraging more women and younger members to be on the management committee (similar to Council). The Operations Committee (similar to Management Committee) is to investigate and develop some strategies.

The Section is looking at finding synergies with other local engineering organisations such as Engineers Australia, RISSB, Permanent Way Institution (PWI), Rail Track Association of Australasia etc and some of the sub-societies such as Railway Technical Society of Australasia, Systems Engineering Society of Australasia (which has connections with INCOSE) and possibly formalising MOUs for increased local collaborations.

The Section will continue its work towards improving the membership base – by sustaining existing members and enrolling new ones, both young and experienced signalling engineers.

Allan Neilson has taken up the role of providing inputs to IRSE News from an Australasian perspective.

The Section is making regular contributions to the local Track & Signal magazine.

Australia's first driverless metro is due to open in Sydney by the middle of 2019. We will start to see more of them in the coming years and so IRSE will organise more technical sessions on CBTC, including CBTC seminars and support skills development and currency of competency of our industry workforce.

The Section will continue to work in accordance to IRSE HQ and IRSE Australasian section strategy plan.

The Section will revisit and review the Australasian section strategy plan to take into consideration actions taken and ensure that the directions planned remains relevant.

The Section will ensure that its website development is completed, and it attains the full functionality desired of the Australasian Section website.

IRSE China Section Report: 2018 – 2019

Report produced by:	Yinghong Wen
Date:	7th February 2019

1. Introduction

Date of last Annual General Meeting	5th Dec 2018
Were annual accounts presented at the AGM?	Yes
Were officers elected / re-elected at the AGM?	Yes
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	89

2. Section Officers (at time of writing report)

Chairman	Bin Ning
Secretary	Yinghong Wen
Treasurer	Daming Jiang
Country Vice-President (if appointed)	Chaoying Liu; Weizhong Shi; Weizhong Huang
Webmaster (for updating IRSE website Local Section page)	Kexin Liu

3. Main Activities During Past 12 Months

IRSE China Section AGM (December 5th 2018)
IRSE China Section 2018 Annual General Meeting (AGM) was held in December 2018 in Beijing with the kind support of Beijing Jiaotong University. The president of IRSE China Section, Professor Bin Ning, gave a warm welcome to all attended IRSE members and presented the IRSE annual report to all members in terms of the main activities during the past 12 months and the plans in 2019. This was followed by the secretary, Prof Yinghong Wen, who gave a short report on the important notice of membership affairs, including membership subscription payment, website updating, social media communication method, etc.

Members also expressed the opinions and suggestions of the expected development of IRSE China Section. After the tea break, two technical reports were presented by Mr Weiqing Xue and Prof Zhongwei Xu, who are two members from industrial and academic field respectively. Members attending showed a great interest and had a lively discussion. The annual dinner followed the AGM in Jiayuan Hotel.

Fig. 1 IRSE China Section AGM and Annual Dinner

IRSE China Section Local Technical Workshop - Big data based railway health management and maintenance (June 30 2018)

IRSE China Section held a technical workshop about big data based railway health management and maintenance in Beijing on 30th Dec 2018. This workshop was open to individuals involved with rail signalling system and rail telecommunication system or who are interested in the topics.

Seven invited presentations were made on the workshop. A delegate from China Railway made a report in terms of “Maintenance system of Chinese railway signal system”, Prof Tao Tang from Beijing Jiaotong University gave the presentation of “Key technology of railway signal system PHM”, Mr Bassam Mansour from ICE KVMRT Malaysia gave the presentation of “Impact of digitalisation on railway asset management – towards digital railway”, Mr Kok Meng Wong from Rohde & Schwarz Asia gave the speech of “Jammer Analysis for Railway Signalling system”.

After lunch, Mr Jianyi Chen from China Railway Guangzhou Group Co., Ltd gave an report named “Maintenance and management of high-speed railway signal system”, followed by Mr Jiangtao Wang from Beijing FUNENC Technology Co., Ltd made an report named at “Intelligent maintenance management based on RAMS and big data”. Lastly, Mr Jin Ma from Frauscher Sensor Technology presented with the topic of “New maintenance concept by using continuous track monitoring along the entire network”.

The scheduled topics include, Maintenance technology of the rail telecommunication system; Rail telecommunication application technology; Rail signalling simulation technology and its application; Chinese Next Generation Train Control technology; Rail safety assessment and authentication in China. Members from China Railway Corporation, China Academy of Railway Sciences, Beijing Jiaotong University, and Chinese railway industry companies attended the workshop, and five delegates made the relevant presentations. This technical workshop was free to IRSE members and non-members, more than 50 delegates from China and other IRSE sections attended the workshop.

Fig. 2 IRSE China Section Local Technical Workshop

IRSE China Section Local Technical Visit (June 29 2018)

IRSE China Section was holding a technical visit on 29th Dec 2018. The technical visit lasted for one day, three institutes from academic and industry fields helped organise the visit. This technical visit was open to all IRSE member with free of charge, more than 30 visitors attended the technical visit. In the morning, visitors were invited to visit Beijing MTR Construction Administration Corporation and Traffic Control Technology Co., Ltd, followed by the technical visit to National Engineering Research Center of Rail Transportation Operation and Control System in the afternoon. Visitors showed great interest and got acquainted with the latest information on domestic rail transit.

Fig. 3 IRSE China Section Local Technical Visit

7th China Railway System Safety Framework workshop (October 28th 2018)

IRSE China Section helped to organise the 7th China Railway System Safety Framework workshop in Beijing. The topic of this workshop was the technical strategy of engineering safety evaluation of the Chinese railway signalling system. Delegates from China Railway, Beijing MTR Construction Administration Corporation, China Railway Test & Certification Center, London Metropolitan University etc. presented at the workshop. More than 100 international delegates attended the workshop, and each presentation was followed by a heated Q/A.

Fig. 4 7th China Railway System Safety Framework workshop

Domestic Railway Signalling Training Courses

In November and December 2018, IRSE China Section conducted two railway signalling courses. More than 120 engineers from China Railway Harbin Group Co., Ltd attended the courses. The course assists students with further development of engineering skills in railway signalling, control and communication systems including integration of many subsystems and diverse equipment in a professional manner. Students are introduced to Systems Engineering and learn how to transform an operational need into a set of requirements to system performance, produce the most suitable configuration and recommend system design, select the equipment, implement and then validate the system.

Fig. 5 Domestic Railway Signalling Training Courses

International Railway Signalling Training Courses (June 2018)

IRSE China Section conducted the 2018 Seminar on Urban Transit Operation Management and Planning for Vietnam with 21 participants from June 1st to June 14th. Invitees were officers engaged in urban transit operation, management or other related work. Training methods include both the indoor lectures and field study. The training contents include the model of China urban transit operation, maintenance management system of China's urban rail transit, certification system of China rail transit equipment and other related knowledge and field study visits to related laboratory, sites and corporations.

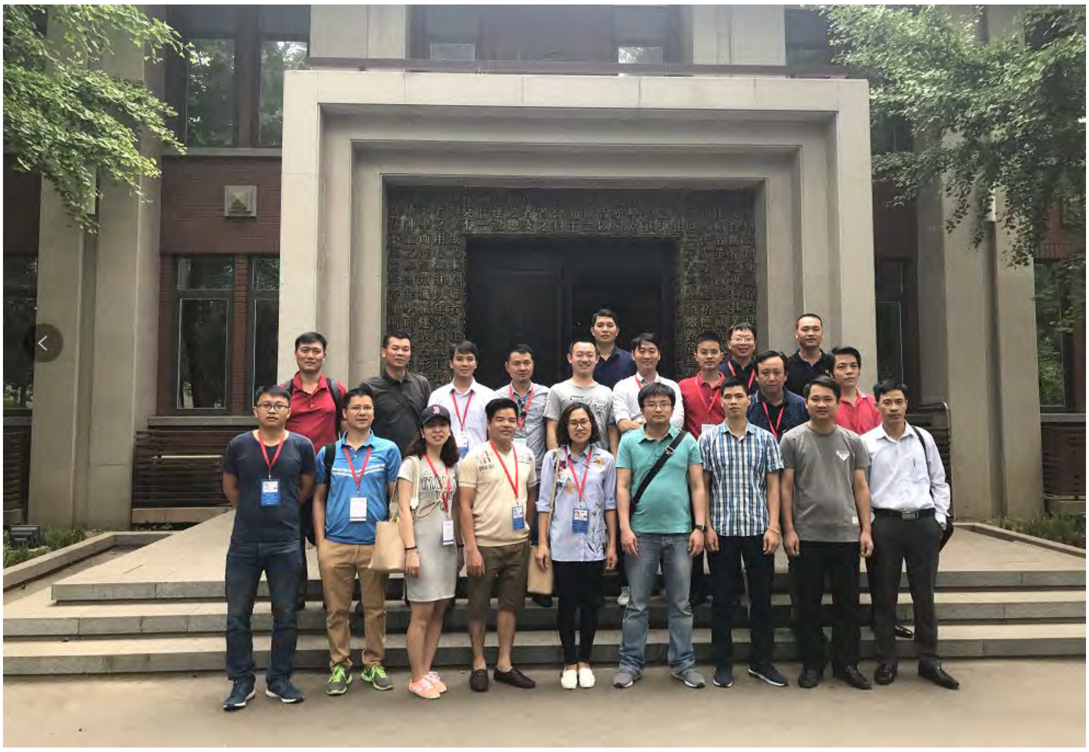


Fig. 6 International Railway Signalling Training Courses

IRSE Membership Application

In 2018, IRSE China Section considered and approved eight membership applications and submitted these to the IRSE Council.

Fig. 7 IRSE Membership Application

IRSE China Section also updated the application form and the membership routes flowchart in Chinese and submitted to the IRSE. The translated version has also been uploaded to IRSE China Section website to help member applicants fill in the English/Chinese application form.

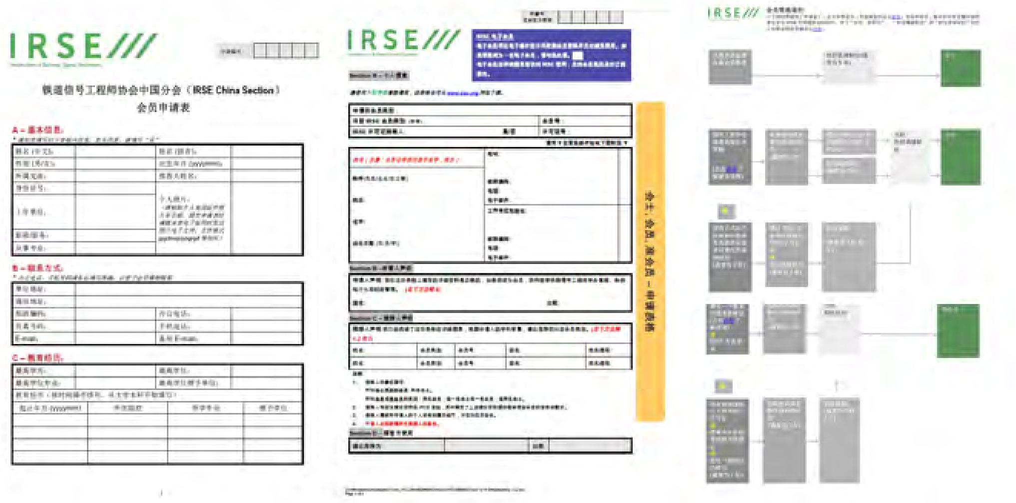


Fig. 8 Updated IRSE membership application documents

4. PLANS FOR THE NEXT 12 MONTHS

Annual General Meeting 2019

In 2019, IRSE China Section plans to conduct the Annual General Meeting according to the bye-law. The Annual General Meeting will be held in OCT, chaired by the President Bin Ning. The Annual Dinner will be held at Beijing, on October 2019, followed by the Annual General meeting. The IRSE China Section was to invite president Bin Ning to give an annual report of IRSE China Section to all members.

Executive Committee Meeting 2019

The Executive Committee Meeting is planned to be chaired by the president Bin Ning in June, held in Beijing Jiaotong University. The meeting aims to discuss the membership application to IRSE China Section, and recommend the outstanding member to the IRSE council.
The second Executive Committee Meeting is planned to be chaired by the President Bin Ning, held in Beijing Jiaotong University. This meeting is scheduled 3 weeks prior to the AGM, aims to the preparation of the AGM 2019.

Trainings and courses

The IRSE China Section will conduct a series of domestic and international trainings and courses in 2019 to assist members to develop their professional skills.
The courses will include but not limited to:
Signalling Principles
The course provides a thorough understanding of signalling principles and systems to ensure that you can apply this knowledge in a safe and cost efficient manner. Students will be able to understand and address the issues that may arise from combining multiple and diverse units of equipment.
Signalling Systems, Management and Engineering
The course assists students with further development of engineering skills in railway signalling, control and communication systems including integration of many subsystems and diverse equipment in a professional manner. Students are introduced to Systems Engineering and learn how to transform an operational need into a set of requirements to system performance, produce the most suitable configuration and recommend system design, select the equipment, implement and then validate the system.

Seminars and technical visits

The IRSE China Section plans to organise several technical meetings and seminars, which would be advertised on the IRSE China Section's website. The planned Seminars include:
IRSE China Section hosts workshop "Safety Authentication of Digital Railway" (October 2018)

IRSE China Section will host the local technical workshop "Safety Authentication of Digital Railway" in Beijing. China Railway Society will also be the associate organisation. In this workshop, domestic and European technical experts in the railway engineering safety authentication field are invited to present, and discuss the promoting issue of the equipment safety authentication in China. The workshop plans to last for one day, and open to all IRSE members. All related researchers and industrial companies are also encouraged to attend and communicate at the workshop.

IRSE China Section hosts workshop "Intelligent Maintenance of Railway Electrical Equipment" (November 2018)

IRSE China Section will co-host the local technical workshop "Intelligent Maintenance of Railway Electrical Equipment" in Beijing with the support of China Railway Society. In this workshop, the applications of cloud, internet of thing, big data and artificial intelligent technologies on railway maintenance will be discussed. The workshop plans to last for one day, and open to all IRSE members. All related researchers and industrial companies are also encouraged to attend and communicate at the workshop.

IRSE China Section hosts workshop "Intelligent Railway Command and Dispatching technology" (August 2018)

IRSE China Section will co-host the local technical workshop "Intelligent Railway Command and Dispatching technology" in Beijing with the support of China Railway Society. In this workshop, the current domestic and international railway command and dispatching methods strategies will be discussed and summarised, requirements of command and dispatching method suits for Chinese high-speed railway will be further discussed. The workshop plans to last for one day, and open to all IRSE members. All related researchers and industrial companies are also encouraged to attend and communicate at the workshop.

IRSE China Section hosts workshop "The Applications of Telecommunication and Signalling Technologies for the Next Generation Train Control System" (July 2018)

IRSE China Section will co-host the local technical workshop "The Applications of Telecommunication and Signalling Technologies for the Next Generation Train Control System" in Beijing with the support of China Railway Society, Southwest Jiaotong University, and Beijing Jiaotong University. In this workshop, the domestic and international technical experts are invited to present, and discuss the promoting issue of the telecommunication and signalling technologies in next generation train control system in China. The workshop plans to last for one day, and open to all IRSE members. All related researchers and industrial companies are also encouraged to attend and communicate at the workshop.

IRSE China Section hosts workshop "The Technology of Track Circus" (December 2018)

IRSE China Section will co-host the local technical workshop "The Technology of Track Circus" in Beijing with the support of China Railway Society, Beijing National Railway Research & Design Institute of Signal & Communication Ltd. In this workshop, the local railways bureaus are invited to attend and present, to share the experience and difficulties in the real worksites. The workshop plans to last for one day, and open to all IRSE members. All related researchers and industrial companies are also encouraged to attend and communicate at the workshop.

IRSE China Section hosts workshop "The Technology of Turnout Switching and Electric Relay" (November 2018)

IRSE China Section will co-host the local technical workshop "The Technology of Turnout Switching and Electric Relay" in Beijing with the support of China Railway Society Beijing National Railway Research & Design Institute of Signal & Communication Ltd and. In this workshop, the local railways bureaus are invited to attend and present, to share the experience and difficulties in the real worksites. The workshop plans to last for one day, and open to all IRSE members. All related researchers and industrial companies are also encouraged to attend and communicate at the workshop.

Publications and communications

The IRSE China Section website provides details of all events, news and membership application operation of the section. In 2019, the membership function will be further revised on the website. Members can update their personal information, contact details, and other booked events online.

A monthly email bulletin will be sent to all China Section members, containing information about upcoming events and other topical information. The IRSE China Section also plans to make use of social media channels like Wechat and Weibo.

Fig. 9 IRSE member communication

IRSE French Section Report: 2018 – 2019

Report produced by:	Mr ROCHFORD Hugh / Secretary
Date:	16/11/2018

1. Introduction

The local section is now two years old but no Annual General meeting is to be organised as such. Regarding financial matters, IRSE French Section has decided to organise free events (around four per year among which will be conferences and technical visits) each individually sponsored by companies who have members. All events are covered by an article in IRSE News as much as possible.
The French section has been increasing its number of members from 45 (minimum for the creation of the section) to 78 members of the IRSE today. It also attracted the interest of 200 other professionals, potentially future members of the IRSE.
Minutes of all meetings are written and available in native language.

Date of last Annual General Meeting	None yet
Were annual accounts presented at the AGM?	NA
Were officers elected / re-elected at the AGM?	NA
Have minutes of the last AGM been produced?	NA
How many IRSE members are in the Section?	78

2. **Section Officers** (at time of writing report)

Chairman	Mr SEVESTRE Christian
Secretary	Mr ROCHFORD Hugh
Treasurer	NA
Country Vice-President (if appointed)	Mr PORE Jacques
Webmaster (for updating IRSE website Local Section page)	Mr ROCHFORD Hugh

3. Main Activities During the Past 12 Months

Meetings
The French section has held 10 regular Committee meetings since April 2017. The committee meetings are well attended with physical or online presence of our 8 committee members, namely Christian SEVESTRE (Consultant ex SNCF), Jacque PORÉ (Alstom), Hugh ROCHFORD (SNCF Réseau), Jocelyn GALLOU (SNCF Réseau), Philippe LEBOUAR (SNCF Réseau), Gilbert MOENS (ex SNCF), Gilles PASCAULT (ANSALDO), Pierre Damien JOURDAIN (ALSTOM) and François Xavier PICARD (SNCF Réseau).
The agenda consists of decisions to be taken regarding the section's development (visiting major railway companies for IRSE promotion) and preparation of events (contacts and coordination of the event).

Events
The events attracted around 70 individuals at each conference (limitation of 50 for the technical visit), among which members and non-members.
Technical conferences:
The events focused on national and international signalling presentations such as:

- 2017/06/20 **Technical visit** of the French wide range control centre (CCR) in Gare de Lyon, interlocking and operating centre
- 2017/12/07 **Conference** on project and experience return of mixed traffic line built under Public Private Partnership, including the French certification body's views
- 2018/02/15 **Conference** on Formal Methods in safety proving

- 2018/04/09 **Conference** on Internet of the Things from the supplier's view
- 2018/06/14 **Conference** on Railway solutions on regional lines
- 2018/09/14 **Conference** on Digital continuity and BIM in signalling

All Conferences this year were hosted by **SNCF Réseau and ALSTOM,** the technical visit by **SNCF Réseau and SETEC**. Events end usually with an informal session around drinks and finger food. The interest and satisfaction of attendees is good and increasing in the number of attendees, experience shows that the answer rate is still high and fast (40+ persons willing to participate only two days after the invitation is sent).

As mentioned in the introduction, after each event, we plan to send an article to IRSE NEWS to increase visibility. We have experienced some difficulty in this term to have 2 of articles published in IRSE News, they were submitted to IRSE News and never published.

4. Plans for the Next 12 Months

Plans for the future mainly concern the events we will organise. The IRSE French Section will organise new events towards the beginning of year 2019:

- Conference on the future telecommunication for railways
- Technical visit in Belgium on the new Siemens Interlocking
- Conference on driverless suburban train
- Technical visit in the Parisian ATO Metro, OCTYS System
- Technical visit on innovation in point machines

Feedback of our events is always analysed during the meetings, and we already see the fruit of our efforts to promote contacts and discussion across the French sector.

IRSE Hong Kong Section Report: 2018 – 2019

Report produced by:	YF Sung
Date:	5th February 2019

1. Introduction

The IRSE Hong Kong Section conducted an election in the 23rd AGM on 15th June 2018. 31 members attended the event. The new Committee was reported to UK on the following day. There was a major change in the Committee. This year, other than the Chairman, three Vice chairmen were elected to facilitate the success plan in the coming years. The new organisation was put on the IRSE(HK) website too. Besides, IRSE(HK) launched two Basic Signalling Courses for MTR Academy in 2018.

Date of last Annual General Meeting	16th June 2018
Were annual accounts presented at the AGM?	Yes
Were officers elected / re-elected at the AGM?	Yes. Refer to the report submitted in June 2018.
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	218

2. Section Officers (at time of writing report)

Chairman	PANG Kwok Wai
Secretary	SUNG Yuen Fat
Treasurer	PANG Kwan Kin, Ken
Country Vice-President (if appointed)	LUK Kam Ming
Webmaster (for updating IRSE website Local Section page)	IRSE.org.hk

3. Main Activities During Past 12 Months

- Committee Meetings – Normally bi-monthly meeting and to be held in MTRHQs.
- Technical forums – To invite Signal experts of MTR, Consultant firms in Hong Kong and China to deliver technical papers.
- Technical visit to local or overseas railway lines and local major utilities
- Participated in IRSE Convention 2018 in Switzerland – 5 members were sponsored and attended.
- Technical visit to Beijing Jiaotong University and China Railway Signal and Communication Company in November 2018 – 4 Committee members were sponsored and attended.
- Provision of IRSE Exam study group for IRSE candidates – We provided 10 sessions.
- IRSE(HK) Committee Member presented an article to ASPECT 2017 in Singapore.
- IRSE(HK) collaborated with MTR Academy. Provision of two Basic Signalling Courses.

4. Plans for the Next 12 Months

- Committee Meetings
- Technical forums
- Technical visit to local or overseas railway lines and local major utilities
- Technical visit to the railway operators and suppliers in main cities of China
- Provision of basic signalling course and intermediate signalling course
- Provision of IRSE Exam study group for IRSE candidates
- Invite railway experts from China to give talks on new train developments

IRSE India Section Report: 2018 – 2019

Report produced by:	Anshul Gupta, Secretary IRSE Indian Section
Date:	4th March 2019

1. Introduction

The Indian Section of Institution of Railway Signal Engineers started working in the year 2009. Since then the Indian Section has progressed very well as a professional body for the advancement of Science & practice of Railway Signal Engineering & Telecom related matters due to collective efforts of all its members.

Now the membership extends to almost all the zonal Railway of the Indian Railways, various working and upcoming Metro Railways, and many International Signalling OEMs and System Integrators and Railway Signal Design companies working in India.

The Institution has furthered its objectives and principles by holding workshops; technical reviews all round from the year across length and breadth of the country. During the year, it has taken a new initiative of reaching a wider audience through a series of webinars. It has also guided certificate/ diploma course in one university. IRSE Indian Section, has also working closely with Indian Railways and Institution of Railway Signalling and Telecom Engineers (India) to start IRSE Licensing system-based licensing system.

Indian Railways has in principle agreed to use the license provided by IRSE, London as a prerequisite to work on the relevant Railway projects and also to develop its own licensing system guided by IRSE. Further, it is worth mentioning that an ambitious project of complete upgradation of existing signalling and telecom system has been approved at an approximate cost of USD 10-12 billion. In the first phase work is being taken up on about 1000 Rkms. This includes many modern systems like:

1. Provision of Electronic interlocking systems.
2. Provision of ETCS Level 2 – Baseline 3 MR2.
3. Mobile Train Communication system based on LTE rel 15.
4. Remote signalling health monitoring system
5. WiFi at all its stations
6. CCTV based, Artificial Intelligence powered Video Surveillance System for a secured rail journey at all its stations and on all its coaches of all the passenger carrying trains.

The timelines for these projects are 2-3 years. Thus, there seems a huge requirement of professionally competent Railway Signal Engineers to undertake the work in such an ambitious timeline.

Date of last Annual General Meeting	7th June 2018 at New Delhi
Were annual accounts presented at the AGM?	Yes for the preceding year
Were officers elected / re-elected at the AGM?	Yes,
Have minutes of the last AGM been produced?	Yes

2. Section Officers (at time of writing report)

Chairman	Mr A K Misra
Vice Chairman	Mr Nikhil Swamy
Secretary and Treasurer	Mr Anshul Gupta
Country Vice-President (if appointed)	Mr Arun Saksena
Webmaster (for updating IRSE website Local Section page)	Mr Ajai Singh

3. Main Activities During the Past 12 Months

During the year, Indian section had arranged the following activities:

- Annual Seminar along with AGM was held on 7th June on the topic of FRMCS project. Held in New Delhi on 7th June 2018.
- A seminar was held at Jaipur on 'Safety precautions to be taken while doing RE signalling works' on 17th Feb 2018. 40 delegates attended.
- A technical visit was organised at Tilayya station on 29th Mar 2018 to show recently commissioned Electronic Interlocking.
- Workshop was held at Kochi on 28th May 2018 on using IRSE licensing system on Indian Railways.
- First of its kind a Webinar was held on 28th September on CBTC under the guidance of IRSE. 30 professionals across world (India, Singapore, Australia etc) attended.
- Technical visit was made to Optical Fiber based Acoustic Sensing system installation at Chandil station on 15th Oct 2018.
- IRSE examination study sessions are held regularly at Bangalore by Atkins.

4. Plans for the next 12 months

28th & 29th June 2019	Convention – By IRSE & IRSTE, at Jabalpur
23rd July 2019	Technical Visit to Kota RRI.
27th April 2019	IRSE Members visit to Kochi Metro line having CBTC.
11th August 2019	Young Members visit to DFCCIL for modern signalling projects

IRSE Indonesian Section Report: 2018 – 2019

Report produced by: Toni Surakusumah
Date: March 11st 2019

1. Introduction

Date of last Annual General Meeting	2015
Were annual accounts presented at the AGM?	Yes
Were officers elected / re-elected at the AGM?	Yes
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	84

2. Section Officers (at time of writing report)

Chairman	Adi Sufiadi Yusuf
Secretary	Toni Surakusumah
Treasurer	Yunanda Raharjanto
Country Vice-President (if appointed)	
Webmaster (for updating IRSE website Local Section page)	

3. Main Activities During Past 12 Months

Activity	Date	Remarks
Safety APMS by IRSE	31st May 2018	One Day Seminar in Tangerang "Implementation of Safety for Operation & Maintenance Automatic People Mover System"

4. Plans for the Next 12 Months

Activity	Date	Remarks
General Meeting of Committee Election	The end of April 2019	We will reactivate the IRSE Indonesia Section, hold new Committee Election of IRSE and open new membership.
Trial Ride of MRT Jakarta Lines	March 20th 2019	MRT Jakarta is a new line in Jakarta and they invite some related institution to take trial ride before launching the commercial operation.
Book Donation	April, June, August, October 2019	We plan to take book donation for several universities, Railway Industries and Railway Regulator.
IRSE Campaign and open recruitment for student in University	April, June, August, October 2019	We plan to take lecturer at Stadium General Program in several universities (ITB, Tel-U, Itera, API Madiun, UP)
Focus Group Discussion of IRSE ASEAN SECTION	July 2019	The focus group discussion is held for initialising IRSE ASEAN Section.
IRSE Seminar	November 2019	The seminar takes the topic about the latest issue of signalling in the world.

IRSE Irish Section Report: 2018 – 2019

Report produced by:	Bernard Kernan, Secretary
Date:	12 Nov 2018

1. Introduction

2017 - 2018 was the fourth year in existence of the Irish Section of the Institution. The Section continues to be in a healthy state, with membership climbing into the high 80s and great interest shown in the many events organised throughout the year. There is an active and enthusiastic committee of eight members drawn from different railway administrations, suppliers and regulators and together they have run a wide-ranging and diverse programme of events throughout the year.

Date of last Annual General Meeting	31st Jan 2018
Were annual accounts presented at the AGM?	Yes
Were officers elected / re-elected at the AGM?	Ys
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	88

2. Section Officers (at time of writing report)

Chairman	Sean Burns
Secretary	Bernard Kernan
Treasurer	Huw Bates
Country Vice-President (if appointed)	Peter Cuffe (vice-chairman)
Webmaster (for updating IRSE website Local Section page)	Peter Cuffe

3. Main Activities During Past 12 Months

Annual dinner in Cork, 18th Nov 2017
The annual dinner was held in the Metropole hotel in Cork on Saturday, 18th Nov 2017 and was attended by approximately 80 members and guests both from Ireland and overseas. The event was once again an outstanding success, with an entertaining talk from the guest speaker, Lex Moscou from ProRail in the Netherlands, music from local musician, Brendan Kelly, and a piper and Irish dancers providing further entertainment.
Sponsorship from a number of suppliers helps to reduce costs and we were very pleased that many of the sponsors attended the dinner and expressed a wish to do so in future years. The committee also took the opportunity to recognise the achievements of Irish IRSE exam candidates who had successfully passed four modules.
The dinner included a raffle for prizes with the proceeds going to the local Merrymount University Hospital and Hospice.

AGM, 31st Jan 2018
The AGM this year was held in the Railway Record Society building at Heuston Station in Dublin on Weds 31st Jan 2018. In addition to the 28 members who attended, the committee was delighted to welcome the IRSE President, Peter Symons, to the meeting.
The Chairman's report highlighted the principal events held in the previous year and outlined the intended programme for the year ahead. Accounts were presented and the new committee was elected, consisting in the main of the previous year's committee with some roles alternated.
Following the meeting, the President then presented his paper entitled "Resistance is Useless", which subsequently generated a lively discussion about the future role of the signal engineer. The day concluded with a dinner in a nearby hotel which was much enjoyed by the committee and the President.

Visit to Poolbeg power station, Dublin, 8th Mar 2018
Following a committee meeting held in the morning, a technical visit was held on 8th Mar 2018 to the Poolbeg power station located in Dublin bay. The visit was facilitated by the national utility company ESBN and featured a technical talk on the issues of reliably providing power to a city the size of Dublin, followed by a comprehensive tour of the combined cycle gas turbine (CCGT) plant. The day concluded with a visit to the control centre where the members observed the plant being brought on line for the evening peak load.

Technical paper on training and competence, Belfast, 25th April 2018
On Weds 25th April 2018 a technical presentation on training and competence was given by Huw Bates of Translink, followed by a presentation on CPD from Judith Ward (IRSE). Both talks were universally agreed to be very informative and resulted in a very good Q & A session afterwards. Discussions on CPD, preparation for C.Eng. and possible licensing for IE contractors and staff were particularly useful. The meeting was hosted by Translink.

Golf outing, Carrickmacross, 11th July 2018
On Weds 11th July 2018 what has now become the annual golf outing was held in Mannan Castle golf course, followed by a meal afterwards in the clubhouse. The event was hugely enjoyable and well attended, with some fifteen golfers playing and a further ten individuals joining afterwards for the dinner.
Unlike previous years, the weather was benign and calm, although this was maybe not reflected in many of the scores that were returned. The committee extended its grateful appreciation to Michael Murphy and his colleagues at RIVVAL for their support and organisational efforts.

Operations of the CME, Inchicore, 19th July 2018
It was originally intended to hold a technical weekend visit to the DART system in Dublin on 16/17 June but due to the very high cost of hotel accommodation at that time the event was reluctantly cancelled. Instead, on Thurs 19th July some 25 members and colleagues attended the CME's premises in Inchicore for a technical presentation from the CME, Peter Smyth, on the latest technology in use by Irish Rail for train monitoring. Following lunch, the group was then taken on a tour of the various CME workshops. All attending found it a very stimulating and informative visit.

Technical visit to Luas Cross City, Thurs 13th Sept 2018
On Thurs 13th Sept 2018 approximately 25 members assembled in Dublin city centre for a trip on the recently completed Luas light rail extension from St Stephen's Green to Broombridge. Arriving at the new depot in Broombridge, the group was given two presentations:

- An operator's perspective on preparing for, introducing and operating a new tram service through the city centre, given by Dave Rooney the Transdev manager of the central control room;
- Items of archaeological interest found during the construction of the line, given by Emer Dennehy from TII's archaeology department

Following lunch, the group then travelled by tram to the upgraded control centre in Red Cow for a further view of the line extension. The technical visit was hosted by Transdev.

4. Plans for the Next 12 Months

The Section intends to follow a similar format for presentations and visits for the year ahead. The following is the outline programme that has been put together so far, with some dates and speakers yet to be confirmed:

Date	**Topic**	**Location**
1/12/18	Annual dinner	Belfast
7/2/19	AGM, followed by a technical paper on ETCS	Belfast
Mar/Apr 2019	Technical visit to Ringsend incinerator	Dublin
May 2019	Joint technical weekend with Minor Railways group	Midlands
21/8/19	Golf outing,	Carrickmacross
Sept 2019	Visit to refurbished Portrush station	Portrush
30/11/19	Annual dinner	Limerick

IRSE Japan Section Report: 2018 – 2019

Report produced by:	Yuji Hirao
Date:	19th September, 2018

1. Introduction

Date of last Annual General Meeting	1st November, 2017 (Japanese section was founded)
Were annual accounts presented at the AGM?	No. (Art 5: Members of IRSE JP shall not be required to pay an annual subscription to the Local Section. IRSE JP members who participate in technical and social events shall bear only the actual costs for each event.)
Were officers elected / re-elected at the AGM?	Yes
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	> 60

2. Section Officers (at time of writing report)

Chairman	Prof Yuji Hirao
Vice-chairman	Dr Masayuki Matsumoto
Secretary	Dr Takashi Kawano
Treasurer	Hideki Komukai
Country Vice-President (if appointed)	-
Webmaster (for updating IRSE website Local Section page)	-

3. Main Activities During the last 12 Months

Lecture meeting (25th January, 2018 attended by 41 members)
a. Report of the Inaugural meeting
b. Introduction of IRSE activities

Lecture meeting (16th April, 2018 attended by IRSE President and 60 members)
a. “Strategic Drivers of change in the Signalling Industry”, Presentation by IRSE President
b. Perspective on railway signalling development in Europe
c. RTRI’s research and development for innovation of railway signalling systems
d. Innovation of railway signalling systems by JR East

Lecture meeting (5th July, 2018 attended by 45 members)
a. Railway undertakings in Europe
b. Discussions on section’s activities from now on

4. Plans for the Next 12 Months

Four or five lecture meetings are to be held.

IRSE Malaysia Section Report: 2018 – 2019

Report produced by: Ir Sri Viknesh
Date: 12th November 2019

1. Introduction

Date of last Annual General Meeting	17 June 2019
Were annual accounts presented at the AGM?	No
Were officers elected / re-elected at the AGM?	Yes
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	88

2. Section Officers (at time of writing report)

Chairman	Ir Shahrizaman Zamhury
Secretary	Ir Sri Viknesh
Treasurer	Hazwan Rahman
Country Vice-President (if appointed)	Aniket Mukhopadhyay
Webmaster (for updating IRSE website Local Section page)	

3. Main Activities During Past 12 Months

Date	Activity	Participants	Remarks
17th April 2018	*Annual General Meeting*	*10 members*	
24th May 2018	*Committee Progress Meeting & Event Planning*	*4 members participated*	
24th May 2018	*Incorporation of IRSE Malaysia LinkedIn Page*	-	
29th June 2018	*Technical Workshop hosted by IRSE China on "Big Data Based Railway Health Management and Maintenance"*	*Representation by 1 member + paper presented*	
7th October 2018	*IRSE Evening Talk 1.0*	*30 pax – combination of members and non-member*	*2 paper presented*
8th October 2018	*Ministry of Transportation (MoT)Malaysia – IRSE Introductory Meeting*	*5 members of IRSE participated*	*Meeting with the Transport Minister*
1st November 2018	*IRSE – WIR Leadership Talk*	*100 pax – combination of members and non-member*	*Talk by Minister of Transport, IRSE Malaysia Chairman & WIR Malaysia Chairman*
12th December 2018	*Received Letter of Support and Appreciation from Ministry of Transportation (MoT) Malaysia for IRSE's contribution in human capital development within Malaysia rail environment*	*General*	*A major success for the local section to receive recognition by the Government*

Date	Activity	Participants	Remarks
28th December 2018	*Committee Progress Meeting & Event Planning*	*4 members participated*	*Meeting attended by Company Secretary for secretarial matters*
29th January 2019	*IRSE Evening Talk 2*	*Target – 50pax*	
30th January 2019	*UK-Malaysia Rail TVET Workshop*	*2 members participated*	*IRSE Malaysia invited to be observers*
28 Feb 2019	*IRSE Presidential Visit*	*6 members participated*	*Meet-up with the Minister of Transport & Dinner with the president*

4. Plans for the Next 12 Months

Date	Activity	Participants	Remarks
Mar 2019	*IRSE Committee Progress Meeting & Event Planning*		
April 2019	*IRSE Evening Talk 3*	*Target – 50pax*	
May 2019	*IRSE – Site Visit*	*Target – 20 pax*	
Jun 2019	*IRSE Committee Progress Meeting & Event Planning*		
July 2019	*IRSE Evening Talk 4*	*Target – 50pax*	
August 2019	*IRSE Seminar / Workshop*	*Target – 100 pax*	
Sept 2019	*IRSE Committee Progress Meeting & Event Planning*		
October 2019	*IRSE Evening Talk 5*	*Target – 50pax*	
November 2018	*IRSE – Site Visit*	*Target – 20pax*	

IRSE Netherlands Section Report: 2018 – 2019

Report produced by:	Ben van Schijndel (secretary)
Date:	13-02-2019

1. Introduction

Date of last Annual General Meeting	May 17, 2018
Were annual accounts presented at the AGM?	Yes (and approved)
Were officers elected / re-elected at the AGM?	1 officer no longer eligible 6 officers re-elected
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	212 members @1/1/2018 217 (incl. 5 YM)@31/12/2018

2. **Section Officers** (at time of writing report)

Chairman	Alwin van Meeteren
Vice Chair	*Wendi Brandt - Mennen*
Secretary	Ben van Schijndel
Treasurer	Wilbert Eijsink
Country Vice-President (if appointed)	*None*
Webmaster (IRSE website Local Section page)	Wim Coenraad via Secretaris@irse.nl For updates on Local Section Page.

3. Main Activities During the Past 12 Months

During the past year the Dutch Section celebrated its 10 year anniversary and has organised several meetings and presentations.

Date	**Subject**	**Attendees**
January 25-26	Day 1; Presentation Presidential Paper IRSE NL and consequences of BREXIT Day 2; visit of Amsterdam and Rotterdam Metro	75 members
March 8	Hyperloop Delft (TU)	47 members
May 17	AGM and Presentation Data Lab by ProRail	53 members
May 17	IRSE 10 years celebration dinner for members	42 members
July 3	RET training center	37 members
September 27	ProRail and Digital technology of the future	Young Members
September 27	Site Visit Voest Alpine Railpro	39 members
September 27	10 Years celebration BBQ	35 members
November 29	Simulation for Rail innovations	Young Members
December 6	Closing drinks 10 yrs celebration and celebration of Sinterklaas	61 members

Significant changes: New changes in the Board
The Section's much appreciated treasurer Mr Tom Spronk could not be re-elected anymore due to the fact that he was at the end of his period. Within the current board Mr Wilbert Eijsink is available and willing to follow up as treasurer; the Section not to fill in the vacant position as there are enough board members.

Position	Old	New or re-elected
Chairman	Alwin van Meeteren	Alwin van Meeteren
Secretary	Ben van Schijndel	Ben van Schijndel (re)
Treasurer	Tom Spronk	Wilbert Eijsink
Country Vice-Chair	Wendi Brandt-Mennen	Wendi Brandt-Mennen (re)

New Strategy process
During several 2016 board meetings and evenings spent together the new board elaborated a renewed strategy for the next 5 years, a process known as OGSM. This stands for a joint Objective, shared Goals and Strategy that are Measured and followed-up by an action plan per Strategy. Most board members are Owners of such a Strategy and have working groups around a specific theme.
In the first 'new-year'-meeting the OGSM strategy method was firstly introduced to the members. After discussion and (smaller) adaption the Section has presented this new strategy during the 2017 and 2018 AGM. All five strategy themes were presented by its non-executive board member to further adopt this item with AGM.

OGSM Outcome in brief:
Mission - To improve the safety and the increase of the capacity of rail-guided systems by the retaining and further development of the knowledge and practice of signalling.
Vision - By developing and bringing together professionals and knowledge in the field of the signalling, we propose and encourage them to realise solutions for the optimisation of the use of track.

The goals and strategies are defined in five major strategy items:

Strategy Theme	Goal	Realised actions in 2018
Knowledge Platform	Securing, deepening and broadening of knowledge by bringing together knowledge and collaborations with knowledge sources.	The above mentioned lectures, debates and project visits contributed to this Strategy theme
Network	Developing knowledge and acquaintances by increasing and simplifying access to knowledge and acquaintances.	Established a more vivid internet site, linked-in profile and new discussions were held
Involved Members	Increasing the involvement of its members by mobilising the knowledge of its members.	During the year the Section have actively motivated young engineers to join the IRSE by a no-pay induction program; this was very successful.
Opinion making	The interpretation of the developments in the industry so that it can be practically applied.	The Section was were cited several times by the professional press regarding the Presidential Visit, its 10 years existence, Brexit views. The big next step will be the ASPECT2019, which is currently being organised.

Image	Securing the continuity of knowledge of signalling by a relevant and contemporary knowledge platform	The Section held a survey in order to assess the current expectations of our members vis-à-vis IRSE. The new logo and website helped to improve the image of a modern organisation.

Other issues during 2018

During the year 2018 the Section has celebrated it 10 year anniversary. It was also happy to be invited by IRSE HQ to host a presidential paper and presentation. This was held on the 25th and 26th of January 2018 and was the ‘kick-off’ for our celebration year. This event was sponsored by the local companies that support the IRSE Dutch section.
Continued special attention was given to young (potential) members. A special program was executed with the goal to be more interesting to younger members.
Two special Young Member excursions and presentation were held during the year.
The Section has updated its website regularly with technical information and the presentations that were held during the year forward.
Made some major steps in organising the ASPECT 2019 in Delft. Full alignment with the Technical University of Delft, a lot of papers were submitted, technical visits are organised and a fun social program has been established.
Now the important step of sponsoring continues and the Section will work on this in early 2019.

4. Plans for the Next 12 Months

ASPECT 2019 is going to be the main topic in the Netherlands for IRSE Dutch Section. There will be a couple of meetings before already introducing this topic. Also regarding ASPECT the organising of two day’s local events/technical visits ((re)signalling (URBAN) projects in the Netherlands) will be interesting.
It is going to be an interesting year for all members of the IRSE Dutch Section.

Current Plans (further changes can be expected)

Month [planned]	**Subject**	**Date**
February	Inauguration speech (re) Prof Dr Rob Goverde MIRSE	Feb 28
March	Digital future for signalling ERTMS Lab – AI- Railcenter	March 28
April	Visit Harbour Rotterdam	
May	AGM + lecture ERTMS Strukton Wkd Utrecht	May 16
June	Visit Schiphol or Lelystad airport	
September	ATO	
October	ASPECT, Delft, the Netherlands	Oct 22-25
November	TBD	
December	Close-out IRSE-NL year	
Spring 2019	TBD Young Members	
Autumn 2019	TBD Young Members	
January 2020	*Presidential Paper incl Section visit*	*Jan 7*

IRSE North America Section Report: 2018 – 2019

Report produced by:	David Thurston
Date:	23rd December 2018

1. Introduction

The NAS has been busy this past year with an active AGM and mini conference as well as a strong showing at the annual Canadian meeting and CBTC Conference. The NAS expects to continue its activities with the addition of investigating a licensing scheme for North American rail properties at the behest of BNSF and Canadian Pacific for design staff and contractors.

Date of last Annual General Meeting	May 21, 2018
Were annual accounts presented at the AGM?	Yes
Were officers elected / re-elected at the AGM?	Yes
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	45

2. Section Officers (at time of writing report)

Chairman	David Thurston
Secretary	Ray Rizman
Treasurer	N/A
Country Vice-President (if appointed)	Bill Scheerer
Webmaster (for updating IRSE website Local Section page)	Rob Burkhardt

3. Main Activities During the Past 12 Months

There were three main events associated with the NAS in 2018. The first was the AGM held in Omaha, Nebraska in conjunction with the Railway Systems Suppliers, Inc. annual product show. The AGM also hosted a mini conference with various industry presentations of interest to the members. The conference was open to all and was well attended with approximately 85 present.

The next activity was the annual Canadian meeting held in Toronto, Ontario on November 30, 2018. This is more a conference with presentations for members and guests and is held immediately before the Toronto Railway Club holiday dinner. This year, over 90 were in attendance at the meeting.

The last activity was the annual CBTC conference held in Toronto on November 29/30, 2018 at the Fairmont Royal York hotel in Toronto, Ontario. This event sold out at 115 attendees and was considered a very successful event for IRSE.

The NAS Committee met via teleconference throughout the year.

4. Plans for the Next 12 Months

For 2019, the NAS plans to help organise the annual Canadian meeting as well as the annual CBTC conference in Toronto, Ontario. The AGM will be held in Minneapolis, Minnesota. As this year is a Rail Interchange Event (this is the North American equivalent to INNOTRANS), the traditional mini-conference will not be held.

The NAS will also advance the proposed licencing scheme for the North American Market. The Section anticipates that there will be additional interest from the major railroads and transit agencies for this.

There are several officers' positions scheduled for election as well, and this will be processed in the second quarter of 2019.

IRSE Singapore Section Report: 2018 – 2019

Report produced by:	M.P.White (Secretary of IRSE Singaporean Section)
Date:	15th November 2018

1. Introduction

2018 has been a successful year for the IRSE Singaporean Section, with 5 presentations held throughout the year at approximately bi-monthly intervals. These were all well attended and gave the opportunity to showcase the IRSE to non-members and inform them of the benefits of IRSE membership. In November/December 2017, the IRSE Singaporean Section hosted the ASPECT 2017 Convention and Joint Seminar with the Australasian Section.

Date of last Annual General Meeting	8th November 2017 (Our next AGM will take place on Tuesday 27th November 2018)
Were annual accounts presented at the AGM?	YES
Were officers elected / re-elected at the AGM?	YES
Have minutes of the last AGM been produced?	YES
How many IRSE members are in the Section?	61

2. Section Officers (at time of writing report)

Chairman	Robert Cooke
Secretary	Martin White
Treasurer	Ian Tomlins
Country Vice-President (if appointed)	Mark Appleyard
Webmaster (for updating IRSE website Local Section page)	Lim Chiau Khoon

3. Main Activities During the Past 12 Months

Presentations

The Section has held a series of presentations in the past year, approximately every two months. These are usually attended by approximately 50 to 60 people, both IRSE members and non-members. The following presentations took place in 2018:

- The Clapham Junction Railway Accident-Lessons Learnt, Presented by Martin White-LTA.
- 4LM Resignalling Project on LUL, Presented by George Clark-TfL.
- Reliability Improvement on Point Machine with Solid State Switch Control, Presented by Hashim Abdullah-SBS.
- Communication System & Interface with Signalling System, Presented by Martin Pang-LTA.
- Developing Specifications and Defining Performance Standards for the Unmanned Railway, to be presented on Tuesday 27th November 2018 by Robert Cooke.

ASPECT 2017 Convention & Australasian and Singaporean Sections Seminar

Members of the Section were on the organising committee for the ASPECT 2017 Convention that took place in Singapore from 27th November 2017 to 30th November 2017. By broad consensus, this Convention was considered to be a great success. In Addition, along with the Australasian Section, the Section hosted a joint Seminar in Singapore on 1st December 2017. The Convention and Seminar included a wide variety of papers being presented, technical visits and evening social events. It was the first time that the ASPECT Convention had taken place outside London.

Other IRSE Events attended by members of the Committee
Two members of the Committee (Robert Cooke-Chairman & Martin White-Secretary) attended the IRSE Annual Convention in Switzerland in May/June 2018. Robert Cooke also attended the Australasian Section Seminar held in Adelaide in July 2018.

4. Plans for the Next 12 Months

The Section plans to have a number of presentations in 2019 at approximately bi-monthly intervals. The programme and list of topics for these presentations is currently under review. The Section will be pleased to host a visit by the next President, George Clark if his plans in his Presidential year include a visit to this region.

IRSE South African Section Report: 2018 – 2019

Report produced by: Ryan Gould (Hon. Secretary)
Date: 12th September 2019

1. Introduction

The signalling industry in the Southern Africa Region has, in the past 12 months, experienced a decline in activity, especially with regards to the amount of new works planning and implementation.

The activities within specifically the South Africa signalling industry during this period has focused on the following:

- Progress relating to the renewal of the commuter rail network signalling installations in the Gauteng, Durban and Cape Town metropolitan areas. Meaningful further progress has been achieved during the past 12 months in the three regions, but with the extent of the progress varying from region to region.
- The planning and implementation of signalling changes to various selected freight rail corridors to either increase or in some cases decrease (typically associated with theft and/or vandalism) the infrastructure and capacity of the general freight network.
- Efforts to combat the occurrence and impact of a growing trend in theft and vandalism, especially in certain areas of metropolitan infrastructure. This is having a significant negative impact on the commuter and freight rail service quality.
- Essential train control system developments, enhancements, maintenance and repair to ensure continued train operations on existing commuter and freight rail networks.

The need to develop resource competency and capacity in the local industry to meet the needs of these initiatives remains a challenge to the industry and IRSE Local Section. There are signs of some initiatives making a positive contribution in this regard, but there is still a long road ahead.

The IRSE Local Section was granted Voluntary Association Recognition by the Engineering Council of South Africa (ECSA) in August 2018. This will enable IRSE Local Section members to claim continuous professional development (CDP) points from ECSA for attending the Local Section Technical Meetings. These CPD points form part of the requirements for re-registering with ECSA as a Professional Engineer every five years. The IRSE has been attempting to achieve this status since 2007.

Financial support from the local industry players for the IRSE Local Section remains a mixed bag, with good support from some industry players and limited to no support from others. The SA IRSE Section remains financially constrained.

IRSE colleagues from Botswana have recently approached the Local Section to explore options for them to become more involved in the activities of the Local Section and for the Local Section to possibly assist them with their intention to write IRSE exams. These options will be explored going forward.

Date of last Annual General Meeting	15 November 2018
Were annual accounts presented at the AGM?	Yes
Were officers elected / re-elected at the AGM?	Three of the appointed committee members retired as per local bye laws. The 2nd year of the 2-year term for the remaining 3 appointed committee members rolled over. The one member co-opted during 2018 stepped down.

	Two of the 3 retired members were nominated and re-elected. Two new members were also nominated and elected to fill 2 of the remaining 3 vacancies. Two younger members were later co-opted to the committee to facilitate exposure to and involvement in the committee as a developmental initiative.
Have minutes of the last AGM been produced?	Yes – but only focusing on key issues
How many IRSE members are in the Section?	Of the order of 60 – but the number continually varies

2. **Section Officers** (at time of writing report)

Chairman	Nikesh Hargoon
Secretary	Ryan Gould
Treasurer	Johan van de Pol
Country Vice-President (if appointed)	Graham Paverd initially. Graham notified the committee in mid-2018 that he wished to step down from this role. Louis Beukes was nominated to take over and he accepted the role in November 2018. The change was ratified by Council in February 2019
Webmaster (for updating IRSE website Local Section page)	Kobus van Niekerk

3. Main Activities During the Past 12 Months

- Seventh 2018 Technical Meeting (11 October): The topic was “In-Cab Train Control for Africa”, presented by Dr Bennie Steyn of Emitron.
- AGM and eighth 2018 Technical Meeting (15 November): The topic was “IRSE 2018 Exam – Feedback and Discussion”, introduced and led by Ryan Gould on behalf of the IRSE Local Section.
- First 2019 Technical Meeting (21 February): This meeting took the form of a discussion session with the topic “Moving Trains in a Signalled Area Without Signalling”, with the topic being introduced and led by Ronnie Watt of Gibb.
- Second 2019 Technical Meeting (20 April): The topic was “SIL4 is not Always SIL4”, delivered by Dr Markus Montigel, in his capacity as the IRSE 2018/19 International President.
- Third 2019 Technical Meeting (11 May): The topic was “Commissioning Johannesburg with Electronic Interlocking: The Joys and Challenges”, delivered jointly by Dirk Kruger of Siemens and Berend Ostendorf of Hatch Africa.
- Fourth 2019 Technical Meeting (9 May): The topic was “Level Crossings – A New Approach”, delivered by Jonita Delaney of Transnet Freight Rail.
- Fifth 2019 Technical Meeting (13 June): The topic was “Power Backup Requirements and Challenges Within a Freight Orientated Railway Signalling Environment”, delivered by Christoffel Jansen van Vuuren of Transnet Freight Rail.
- Sixth 2019 Technical Meeting (11 July): The topic was “Batteries and Standby”, delivered by Bert Els of Deltec.
- Seventh 2019 Technical Meeting (15 August): The topic was “In Motion Weighing and the Challenges Within the Railway Environment”, delivered by Dawid van der Spy of Transnet.

There are a further three Technical Meetings scheduled the to the end of 2019, of which the last meeting in November will serve as the 2019 AGM of the Southern Africa Section.

Following the initiative in 2018 for some South Africa IRSE members to sit for the IRSE exams, one of the younger members who was part of the group of seven in 2018, but who did not sit for the exam has decided to do so in 2019. This candidate will write the exam on the 11th of October 2019.
The SA Section continues to have the privilege of using the video conferencing system of GIBB to connect Technical Meeting venues in Johannesburg, Durban and Cape Town. This has enabled a wider participation in these events and is most certainly appreciated.

The initial indications are that, with having obtained ECSA recognition as a Voluntary Association and with the resultant benefit of getting Continuous Professional Development points for attending the IRSE Technical Meetings, the level of attendance of the IRSE members has increased significantly. We have in 2019 thus far had more members than guests attending. This is a meaningful turnaround compared to previous years. It is hoped that this will also encourage more train control system industry colleagues to join the IRSE.

The achievement in getting recognition as a Voluntary Association from the Engineering Council of South Africa (ECSA) has been a significant benefit to the IRSE Local Section. Accordingly, it is fitting to take this opportunity to thank the IRSE Local Section members that participated in driving this process to conclusion for their efforts.

4. Plans for the Next 12 Months

The current 2020 focus areas for the Southern Africa Section are captured below. These will however be reviewed and refined at and after the AGM in November 2019 and when the newly elected committee for 2020 is in place. Accordingly, these focus areas/plans may change later.

- To further understand and refine the processes required to fully and successfully implement and benefit from achieving ECSA recognition as a Voluntary Association.
- To ensure that the IRSE members are fully informed as to the procedures and actions that are required on their part to administer the necessary submissions to ECSA, so as to be eligible for CPD points.
- Identifying possible further approaches and enhancing ongoing efforts to encourage our guests and others in the train control systems arena to become IRSE members.
- Completing the current 2019 programme of events as planned. There are three further Technical Meetings set in September, October and November. The November Technical Meeting will also serve as the AGM for the Southern Africa Section.
- It is intended to organise a Technical Visit in either October or November 2019, but these arrangements are still to be finalised. A suitable venue for the visit has been identified.
- As an ongoing effort, further efforts will be made, and more innovative ways sought, to approach the captains of the railway and signalling industry in South Africa to promote the IRSE and to provide a better understanding of how the IRSE can contribute to the success of the industry.

IRSE Switzerland Section Report: 2018 – 2019

Report produced by:	Daniel Pixley, Chairman
Date:	13th January 2019

1. Introduction

This report covers the complete business year 2018 of the Swiss section.

Date of last Annual General Meeting	9-March-2018
Were annual accounts presented at the AGM?	Yes
Were officers elected / re-elected at the AGM?	Yes
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	61

2. **Section Officers** (at time of writing report)

Chairman	Daniel Pixley
Secretary	Dr Marco Lüthi
Treasurer	Rolf Seiffert
Country Vice-President (if appointed)	Rolf Seiffert
Webmaster (for updating IRSE website Local Section page)	Beatrice Müller and Dr Marco Lüthi

3. Main Activities During the Past 12 Months

Events

During the calendar year 2018, the section organised the four events as usual plus the IRSE Convention 2018 according to the following overview:

Date	**Topic**	**Type**
09 Mar 2018	Bartholet Aerial Ropeways – safety from the ground up	Technical Visit
09 Mar 2018	AGM in Sargans	AGM
28 May 2018 - 1 Jun2018	IRSE Convention 2018	Convention
24 Aug 2018	Linth–Limmern Power Station	Technical Visit
19 Sep 2018	Dinner Meeting at Innotrans in Berlin	Meeting
26 Oct2018	How to innovate the railway? Location and Control of Railway Things	Paper Session Presidential Programme

All events were well attended, generally by about half of the section members. At a number of events, members from other sections joined. The Section much welcomes this and would be delighted to increase this further. Interestingly enough again there was no substantial international participation at the meeting at Innotrans in Berlin. There remains potential here as we are sure there were a lot of other IRSE members at Innotrans. Reports of all events have been submitted to IRSE News. The selection of interdisciplinary subjects demonstrates once again one important element of the strategy of the section.

The traditional yearly Paper Session was held in Zurich as part of the Presidential Programme and the Section provided remote access by video link.

The IRSE Convention 2018 in Switzerland kept us very busy and was a great success.
The Section utilised doodle.com in organising events so that all participants could sign up and also see, who else was joining. Although for most events not mandatory, this was well utilised. This has proven to be a very light weight but powerful way to organise the Section's events.

AGM
On 9 March 2018 the 7th regular AGM was held together with a technical visit. The annual accounts 2017 and the budget 2018 were approved and all members of the committee were re-elected.

Participation at the international level
The Swiss section remains very involved also at the international level:
- With Dr Markus Montigel as the current IRSE president and Xiaolu Rao as new council member the Swiss section is well represented in the governing body of IRSE.
- Two active members of the Swiss section, Beat Keller from Siemens Mobility and Jens Schulz from the Swiss Federal Railway SBB, are member of the International Technical Committee (ITC).
- There have always been around half a dozen Swiss members participating in the past IRSE conventions. Of course this year as the Section organised the convention in Switzerland, the involvement was substantially higher.
- In 2018, motivated by the election of Dr Markus Montigel as IRSE president, 8 members joined the IRSE AGM and Annual Dinner in London.
- Companies becoming increasingly restrictive on travel has been compensated by the well-received possibility to join many IRSE sessions by video link.

IRSE Convention 2018
Most of the Swiss section was heavily involved in organising the IRSE Convention 2018 which was held in Lugano and Pontresina under the central theme “Safety in Long Railway Tunnels”. The convention was a huge effort and kept us very busy.
It was an exceptional opportunity to be able to host the convention in Switzerland under a Swiss IRSE president and to be able to visit three major tunnels in different stages of completion:
- The Gotthard Base Tunnel as the longest tunnel of the world that went into operation 2016.
- The Ceneri Basel Tunnel which is current being equipped and will go into operation 2020.
- The Albula Tunnel which is currently under construction and will open 2021.

The participants also got to know some outstanding achievements of Swiss railway engineering of the past, including the Albula and Bernina railway lines, which are now UNESCO World Heritage sites.

As expected, there was a very high interest and large number of participants. Based on the very positive feedback from the participants, sponsors, IRSE HQ and organising Swiss members the convention was a great success. The Section would like to take the opportunity and thank everybody that contributed to the success of the convention once again – the Sponsors, IRSE HQ, the Swiss IRSE members, additional volunteers and last but not least: Dr Markus Montigel who has been driving this for the last few years with a huge effort!

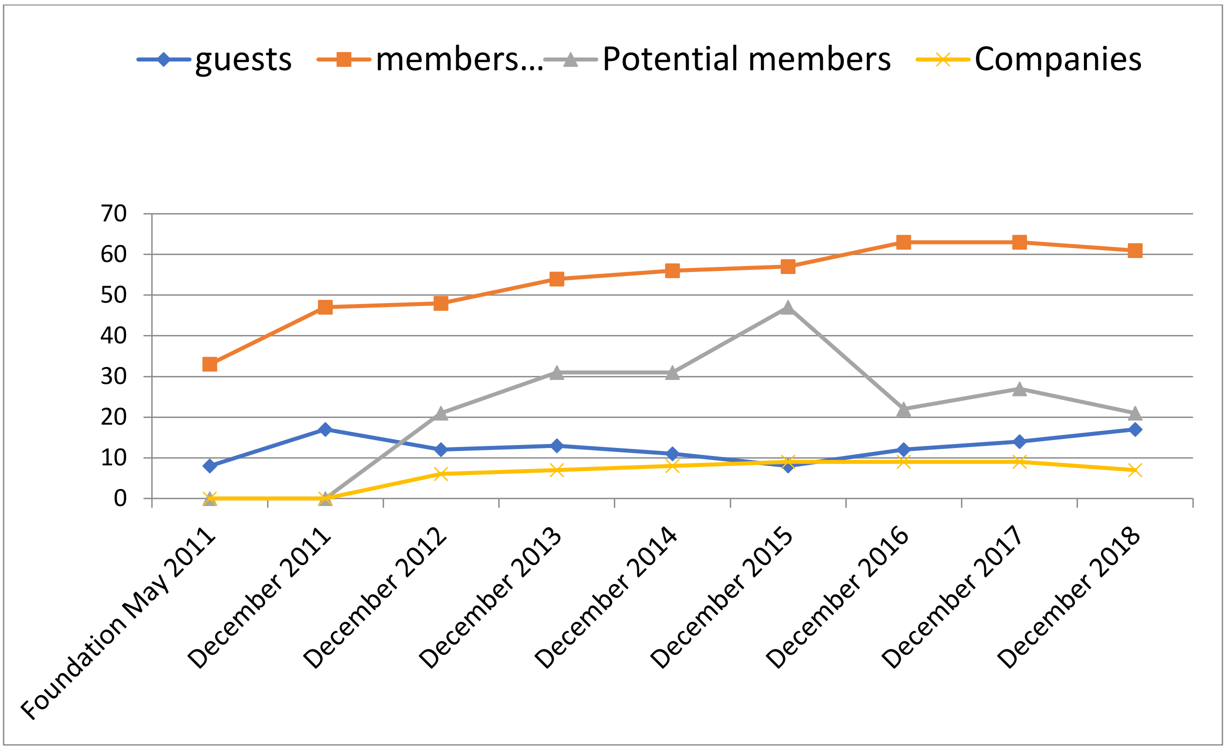
Committee
The committee met four times during the year and treated strategic subjects, the organisation of the events, membership and other matters. In addition to the standard tasks, all committee members were also actively involved in organising the IRSE Convention 2018.

Development of membership

The number of section members has been constant in the last years. In 2018 the number of members slightly declined by 2. The Section is very sad to report that Werner Welti, its long-time member and previous member of the committee, died on 8 Oct 2018. He was a very active member, both in the Swiss section and internationally.

There are a number of guests that have been actively participating in the section events, so the Section is hopeful they will join as members this year. Also, the Smartrail 4.0 programme of the Swiss railways is creating additional opportunities and interest for an IRSE membership. The potential to grow to 100 members remains, given the number of guests and prospective members. The largest obstacle remains filling in the application form in English correctly and completely.

The Section has therefore assigned a member of the committee with the specific experience to motivate and coach prospective members individually when filling in the application form. This has proven valuable and necessary.



4. Plans for the Next 12 Months

For 2019 the committee has set the following priorities for the Swiss section:

- Organise the usual 4 yearly events:
  Q1:technical visit and AGM
  Q2: paper session
  Q3: technical visit
  Q4: technical visit
  The events will be published on the irse.org web site as the dates are defined and the Section would very much welcome international participation.
  For 2019 the Section is starting to set up a few additional meetings without technical

visits as opportunity for the members to get together. It will then decide, whether these should become part of its standard programme.

- Dr Marco Lüthi has been elected as CEO of the Sihltal Zürich Uetliberg Railway and will therefore unfortunately be resigning from the committee of the Swiss local section. The Section therefore needs to renew the committee.
- It remains the Section’s goal to grow the number of members and develop membership.
- The Section plans to improve the communication between members of the Swiss section by taking advantage of state-of-the-art social media tools.

IRSE Thailand Section Report: 2018 – 2019

Report produced by:	Wichai Siwakosit / Vasuwee Euanchita
Date:	18-Sep-19

1. Introduction

Date of last Annual General Meeting	October 12, 2018
Were annual accounts presented at the AGM?	Yes
Were officers elected / re-elected at the AGM?	No. But two TS committee members have resigned from the Committee as they allocated out of TS.
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	44 members are living in Thailand

2. **Section Officers** (at time of writing report)

Chairman	Assoc Prof Wichai Siwakosit, Ph.D.
Secretary	Mr Vasuwee Euanchita
Treasurer	Mr Vasuwee Euanchita
Country Vice-President (if appointed)	Mr Paul Harland
Webmaster (for updating IRSE website Local Section page)	Mr Vasuwee Euanchita

3. Main Activities During the Past 12 Months

The Section has achieved three (4) activities in the year 2019 as below:

IRSE Thailand Annual General Meeting (October 12, 2018) at Kasetsart University
The AGM was held at Faculty of Engineering, Kasetsart University with 38 people attending the meeting. Opening speech by Dr Prapat Jongsa-nguan (Ex-Governor of Mass Transit Rapid Authority of Thailand and State Railway of Thailand and). Topics were presented by competent persons from railway business organisations:

- Capacity Increase by CBI by Walaiporn Leelawanneee (Bombardier)
- Stray Current in DC Railway Systems by Wachiraphan Phota, Didier Eginard and Alix Benameur (Egis)
- Fastening System Insulation by Louis Vandamme and Thomas Lorent (Pandrol)
- Automated People Mover with UTO CBTC NEOVAL Product by Issam Farissi (SIEMENS)

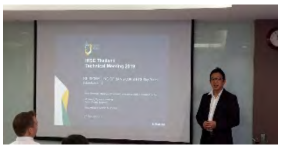
Rail Asia Expo (March 28 – 29, 2019) at Makkasan Airport Rail Link Expo Halls, Bangkok
Dr Wichai Siwakosit (Chairman of IRSE Thailand Section) chaired a technical conference on behalf of IRSE Thailand Section.

Source: http://railasiaexpo.com/RAILAsiaShowPreview-CountdowntoRAILAsia2019.php

Asia Rail Summit 2019 (June 27-28, 2019) at Le Bua Hotel, Bangkok
Dr Wichai Siwakosit (Chairman of IRSE Thailand Section) presenting the aspects of Thailand Public Private Partnership Law on behalf of IRSE Thailand Section.

A Joint Technical Meeting of Kasetsart University & IRSE Thailand Section and IRSE President Visit (February 27th , 2019)
The event was held at Bombardier Bangkok Office with 32 participants from railway business in Thailand. SIEMENS and Bombardier had technical presentations in MRTA Blue Line Extension Signalling System and Re-signalling of Bangkok's BTS Sky Train and respectively. Mr Markus Montigel, IRSE President joined the event during his Presidential IRSE World Tour 2019. He presented the topic "SIL-4 IS NOT ALWAYS SIL-4" and shared his experiences with theme of the year "WINDS OF CHANGE".



4. Plans for the Next 12 Months

Tentative Date	Activities	Target Group
3rd week of October 2019	IRSE TS Committee Meeting	IRSE TS Committees
November, 2019	IRSE TS Annual General Meeting	IRSE members and interested audiences in Thai Railway industry
3rd week of January 2020	IRSE TS Committee Meeting	IRSE TS Committees
3rd week of February 2020	Technical Talk#1	IRSE members and interested audiences in Thai Railway industry
3rd week of June 2020	IRSE TS Committee Meeting	IRSE TS Committees
3rd week of August 2020	Technical Talk#2	IRSE members and interested audiences in Thai Railway industry
November 25-26, 2020	Rail Asia Expo, a presentation by IRSE TS	Conference audiences

Expectations:
During the course of the next 12 months the intention is to progress further Technical Talks, potentially on a quarterly basis. Another area the Section are looking to explore is building the foundations of a 'Younger Members' section given that the rail industry in Thailand is attracting a high volume of resources from University and are seen to be proactive individuals.

Reports from Local Sections in the UK 2018-2019

The following reports have been received from the IRSE's UK Sections to report their activities over the Presidential Year 2018-2019. They have been edited for consistency and to provide a permanent record for the 2018-2019 Proceedings.

London & South East Section
Midlands & North-Western Section
Minor Railways Section (submitted in non-UK Section format)
Plymouth Section
Scottish Section
Western Section
Younger Members' Section
York Section

London & South East Section Report: 2018 – 2019

Report produced by: Mick Ward
Date: 11th September 2019

1. Introduction

As the chairman of a very young section, I welcome the chance to report our progress to council and to raise some issues for their consideration. As part of the process for establishing the section, it was agreed to allocate all members of the IRSE who leaved within London and the south-east of England to the new L&SE section unless the member was already a member of another section. The section was therefore formed with about 700 members. I would like to thank the members of HQ staff for the unwavering support of our section and also the committee of the Midland & North-Western Section who assisted me with guidance on how to run a section. I have relied heavily on Transport for London to provide free accommodation for our committee meetings and technical presentations and this is very much appreciated. Finally, I would like to thank the current and previous members of the L&SE Section Committee for their help in establishing and running the programme of technical presentations and visits which are detailed below.
Trevor Foulkes, Chairman L&SE Section

Date of last Annual General Meeting	21st May 2019
Were annual accounts presented at the AGM?	No due to unforeseen circumstances. However, this was our first year and we stated that we had not spent any of the £1500 up to this AGM.
Were officers elected / re-elected at the AGM?	Yes, all current members returned with no proposals from the membership for new members.
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	700+

Section Officers (at time of writing report)

Chairman	Trevor Foulkes
Secretary	Mick Ward
Treasurer	Adrian Vyse
Country Vice-President (if appointed)	Jerry Morling
Webmaster (for updating IRSE website Local Section page)	All updates now done by HQ

2. Main Activities During past 12 Months

These are the events from the Section's initial meeting up to the AGM and cover from May 2018 to May 2019 as reported at the AGM. In the majority of cases the Section has submitted a report to the IRSE News of its activities.

18th May 2018 - Technical visit to London Underground Northern Line extension
The 20 delegates were given a presentation on the history of the project and the difficulties the project had faced. The delegates were shown a Virtual Reality view of the new station. The visit concluded with a visit to the viewing platform.

21st June 2018 - Inaugural meeting
The Section had its Inaugural meeting on the 21st June 2018 where 40 members attended. The Section formally endorsed the Articles and elected the first Committee. This was followed by two presentations, one from Rod Muttram on *The Direction of Signalling in mid-2018* and the second by Vincent Louie and Konstantinos Banias on *IRSE Licencing and Professional Development*.

3rd July 2018 - Technical visit to London transport museum depot
17 members enjoyed a guided visit to the collection of vehicles, equipment and memorabilia that represent the history of London Transport from its origins through to recent days. The members had an explanation and demonstration of the cab and traction equipment that formed the Victoria Line, particularly the interaction of the train control system with the signalling system.

26th July 2018 - ElectroLogIXS - the production and introduction of a new interlocking
45 members listened to Ian Bridges on the introduction of Atkins' ElectroLogIXS electronic interlocking using the Atkins Signalling Method. Derived from EN50128. Peter Harbottle then told members about the telecoms elements of the system and finally Grace Nodes told members about the Atkins' level crossing in a box using the Newgate barrier machine.

27th September 2018 - Valise - the video balise
Close to 60 members listened to Richard Shenton and Rob Hill of RDS International talk about the video balise. The video balise uses live images from a camera on the train and compares them with a database of images taken at known locations and uses a match to fix the position of the train.

25th October 2018 - Future railway mobile communication system
Over 60 members listened to Pierre Tane of Kapsch CarrierComm (the provider of Network Rail's GSM-R Core and Radio Access Network) update us on the status of the work and plans to specify and develop the FRMCS system leading to the ultimate migration from GSM-R to Future Railway Mobile Communications System (FRMCS).

22nd November 2018 - Heathrow visit
19 members attended and saw the transit train at terminal 5 (which takes passengers to the B&C gates) together with its maintenance facilities. After which a reduced group had a trip on "pods" and a visit to their maintenance facility. It was a very interesting trip.

24th January 2019 - The Application of Digital Technologies on Thameslink
100 attendees listened to Tom Chaffin describe the design and delivery of telecoms solutions which have been implemented on the Thameslink Programme to enable a digital railway with 24 trains an hour European Train Control System (ETCS) operation with Automatic Train Control (ATO) through the centre of London. Stephen Brown then talked to members about the signalling private network that supports the signalling and ETCS controlled from 3 Bridges ROC.

28th February 2019 - 4LM - Modernising the oldest part of the Underground
The meeting was introduced by Clare Porter who talked about her role in LU.
Andy Ward and Amit Purohit gave an interesting talk on the 4LM project that included implementing CBTC and the stage-work needed to deliver the Resignalling. They went on to describe how a new point machine controller was designed to replace the existing hand points with the same operation. The novel point controller moved the points but gave no indication to the Shunter of the lie of the points so that current movement practice could be maintained. When the depot is finally signalled the controller will be replaced by a standard point controller.

20th March 2019 - Contactless payment and Ticketing on the underground
27 people came to listen to Kathryn Lowen, of Transport for London. Kathryn gave members an overview of the history of ticketing on the Underground and how TfL is at the fore front and pushed the adoption of contactless payment very early on. Members heard that Contactless payments represents more than 4million daily taps, 2.5 million daily journeys and have collected more than £3.5billion from cards from 137 different countries. Kathryn explained the whole process for a single trip to fare capping, bus hopper and night tube travels. Kathryn concluded telling us about some TfL projects including replacing equipment, improving the code and working with other transport networks such as New York.

9th April 2019 - Motor Industry Research Association in Nuneaton
9 members visited MIRA, where Nigel Skellern of HORIBA MIRA then gave members a very interesting and in-depth presentation on HORIBA MIRA's work as a testing ground with specialist testing facilities such as EMC and climate. This followed a site tour to see some of the testing facilities. This included passenger impact test facility and the large environmental wind tunnels where members witnessed a new variant of a popular Jaguar Land Rover (JLR) 4X4 undergoing snow endurance testing in driving snow. Finally, members were shown some historic videos showing testing of the original Issigonis designed Mini, the Austin/Morris 1800 (with 'hydrolastic' suspension) and the Ford Consul.
This was an extremely interesting and informative visit.

17th April 2019 - RAIB presentation
41 listened to an informative presentation on the work of the Railway Accident Investigation Branch and their concerns that deviances from established safety protocols are becoming more common.

Summary
In the Section's first year it has had 7 presentations and 4 visits.

3. Plans for the Next 12 Months

Below is the Section's current plan from the AGM in May. The Section still needs to plan some events in early 2020.

25/06/2019	Hackpartners
25/07/2019	Acoustic Monitors
01/08/2019	No meeting
25/09/2019	2nd Heathrow visit
26/09/2019	HS2 Asset Management, Command Control and Signalling (CCS)
28/09/2019	Great Cockrow Family Day

24/10/2019	Radio Innovations with AD Comms
28/11/2019	Brighton Mainline Resignalling
10/12/2019	The IRSE (joint with M&NW) at Milton Keynes with Blane Judd For the programme the talk will be titled “Beyond a 20/20 Vision” and will cover the IRSEs next five year strategy which will be for 2020 to 2025. 1715 at NR office
23/01/2020	Timetabling by Kris Alexander, Network Rail’s Programme & Support Services Director

Midlands & North Western Section Report: 2018 – 2019

Report produced by: Ian Allison

1. Introduction

The 49th year of the section has seen a busy, well attended and varied programme with a number of new venues visited with some particularly interesting technical presentations. It was also the first occasion that the Midlands & North Western Section held a joint meeting with the recently formed London and South East Section.

Section Officers (at time of writing report)

Chairman	Ian Allison
Secretary	Bill Redfern
Treasurer	Clive Williams
Vice Chairman	Paul Darlington
Webmaster (for updating IRSE website Local Section page)	All updates now done by HQ

2. Main Activities During the Past 12 Months

Technical Meetings:

Tuesday 18th September 2018 - *Liverpool Lime Street Completed* by Ian Fury, Steve O'Hare and Claire Hulstone of Network Rail.
This detailed the upgrade works undertaken in and around the station and covered all disciplines.

Tuesday 16th October 2018 - *How to change at Crewe* by Dave Gordon of Network Rail and Suzanne Mathieson of HS2 Ltd.
Held at the Holiday Inn Express at Crewe, this technical presentation detailed the proposals for the future interchange between Network Rail and HS2 in Crewe in the near future.

Tuesday 13th November 2018 - *Tubular Stretcher Bars* by James Dzimba, Professional Head of Switches & Crossings for Network Rail.
Held the Network Rail Headquarters at The Quadrant in Milton Keynes, this joint meeting was with the London and South East Section and detailed the development of the equipment now in use around the network and the issues encountered along the way.

Tuesday 11th December 2018 - *Innovations in the era of Industry 4.0*
Held at Signet Solutions Ltd in Derby and detailed the opportunities for product development and innovation going forward within Park Signalling Ltd and Unipart Rail.

Tuesday 15th January 2019 - *From Modular to Low cost Digital Ready* – The North Wales Coast Story by Andy Stringer and Gareth Meehan of Siemens Rail Automation.
Held at The Queen Hotel in Chester this presentation detailed this project through its relevant stages to final commissioning and the issues encountered along the way.

Tuesday 19th February 2019 - *ElectroLogIXS Introduction to Service* by Ian Bridges, formerly of Atkins. Held at the Atkins Offices in Crewe, this presentation detailed how the product was developed and introduced into revenue earning service within the UK market.

Tuesday 19th March 2019 - *Telecoms Innovations* by Tim Lane, Principal Strategy & Innovation Manager at Network Rail Telecom.
Held at Network Rail Offices at Baskerville House in Birmingham and detailed some of the ideas currently being developed for trial on the two test tracks that Network Rail manage in the UK.

Tuesday 9th April 2019 - *R&D to tech - 44 years as a Derby railway boffin* by Ian Mitchell, formerly of Delta Rail and now retired.
Held at Signet Solutions Ltd in Derby, this meeting included the Section's AGM and the presentation of the Chairman's Trophy. Ian's presentation included details of notable moments and points in his career over the 44 years aligned with specific products that were developed and delivered during this period of time.

Technical Visits and Annual Luncheons:

Tuesday 24th April 2018 - A well-attended party of members and guests visited the Health and Safety Laboratory (HSL) for a guided tour and presentations. Whilst also known as the HSE Laboratory or HSL Buxton, it is a large 550-acre research site in rural High Peak, Derbyshire, south of Buxton. This site is one of the world's leading providers of health and safety solutions to industry, government and professional bodies.

Tuesday 23rd October 2018 – A visit to the Rail Accident Investigation Branch (RAIB) in Derby for a guided tour and presentations. This is a British government agency that investigates rail accidents in the United Kingdom and the Channel Tunnel in order to find a cause, not to lay blame. Created in 2005, it is required by law to investigate accidents causing death, serious injuries or extensive damage. It also has authority to investigate incidents that could have resulted in accidents.

Saturday 16th June 2018 – The Section's Annual Luncheon with 40 members and guests visiting the Severn Valley Railway at Kidderminster for a leisurely luncheon and train ride to Bridgnorth and back, with an opportunity to view inside Kidderminster Town Signal Box and the Railway Museum next to the station. The event was sponsored by Siemens Rail Automation.

Saturday 29th June 2019 – The Section's Annual Luncheon for 2019 took place on at the Churnet Valley Railway in Staffordshire, which was sponsored by Haywood and Jackson Fabrications Ltd. Around 40 members and guests enjoyed a leisurely luncheon and train ride between Kingsley and Froghall and Cauldon Low, with site visits undertaken at signalling and telecommunications installations at Cheddleton and Leekbrook Junction.

Chairman's Trophy:

The 2018 Chairman's Trophy award was made to Bill Redfern, Section Secretary for the Midland and North Western Section for many years, for his outstanding contribution made to the Institution. This presentation took place on Saturday 16th June 2018 at Kidderminster Town Station. The presentation was undertaken by me on behalf of Peter Halliwell, immediate past Chairman of the Section.

The 2019 Chairman's Trophy award was made to Lee Clinton, Senior Operations Manager at telent. Whilst living in Warwickshire and having joined the IRSE recently, Lee has been working in Scotland on the RETB Next Generation radio network on the Far North and West Highland lines for a number of years. His continued outstanding contribution regarding telecommunication systems and the mentoring of younger engineers, along with his positive attitude has made him a well-known individual within the industry. This presentation was undertaken by me at the AGM that took place on Tuesday 9th April 2019 at Signet Solutions Ltd, Derby.

The Chairman thanks his fellow committee members of the Midland and North Western Section and the members of the Institution itself, for their continued support of the Section's activities. He also thanked the Section's supporters and sponsors who have provided our meeting venues during this programme and who have provided sponsorship monies for events.

Minor Railways Section Report: 2018 – 2019

Report produced by: Emma Haywood & Mike Tyrrell
Date: 15th September 2019

1. Introduction

The Section is celebrating its 10th anniversary this year with a full programme of events from March to November.

Date of last Annual General Meeting	22nd June 2019
Were annual accounts presented at the AGM?	Yes and to HQ in January 2019
Were officers elected / re-elected at the AGM?	Yes
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	The IRSE Membership database does not record Minor Railways Section membership, therefore the Section has no membership records and is unable to answer this question.

2. Section Officers

Chairman	Ian Allison
Secretary	Emma Haywood
Treasurer	Martijn Huibers
Visits Secretary	Mike Tyrrell
Webmaster (for updating IRSE website Local Section Page)	Mike Tyrrell

3. Main Activities During the Past 12 Months

The year started badly with the cancellation of the Section's technical workshop on the subject of *Planning and Maintenance of Signalling Cables*.
Technical visits were held as follows:
The GWSR at Toddington in March was well attended by 24 members and guests, despite the failure to publish the flyer in the IRSE News in time.
The AGM followed in June with an associated technical visit to the East Lancashire Railway attended by 49 members and guests.
This was followed by a Sunday technical visit to Manchester Tramlink attended by 13 members. A more social visit to the Fawley Hill Railway and Museum was attended by 34 members and guests. The library of the sections Guideline documents has been reissued so that they could be presented on the section's pages on the IRSE web site.

4. Plans for the Next 12 Months

There will be a Technical Training Workshop on Signalling Maintenance and Installation in October 2019 and numbers are stacking up well with only 2 places currently left to be filled. The Section's bi-annual Technical Seminar will be held in November at the Kidderminster Railway Museum with various speakers now booked on a theme of interest to minor railways members and it is a good way of publicising the IRSE and its publications. Applications are going well since the flyer was published in the September IRSE News. Plans for next year are well advanced for a technical visit to the Dean Forrest Railway in March and the AGM and technical visit to the Romney, Hythe & Dymchurch Railway. Plans are yet to be formulated on the training workshop for 2020 and autumn visit.

A sub-committee has been created to examine the ORR’s requirements for changes to the competency arrangements for minor railways staff and volunteers. Work continues on this subject, with the intention of producing a Guideline document on the subject.

Plymouth Section Report: 2018 – 2019

1. Overview

As a result of the 2017-2018 AGM being delayed and not held until 12th September 2018, it was October 2018 before the Section committee could look towards planning any 2018-2019 activities. (Refer to 2017-2018 Proceedings for details of events and causes of delays).
As it was too short notice for the remainder of 2018, events were all planned for within 2019. Details of these follow later in this report.
The major other item for discussion was the approaching 50th anniversary of the formation of the Plymouth section. There was confusion over the exact date as some IRSE presentations were initially held in Plymouth but were under the auspices of the Western Section. By reference to the minutes record of the section and the Proceedings booklets for those years, the secretary was able to clarify that the formal date of the 50th anniversary of the official formation of the section was not until 2020. However, it was agreed to be prudent to begin planning for this event.

2. Summary of Committee Actions

The Plymouth Section held only one committee meeting during the session, primarily to agree a programme of events. A draft list had been recorded at the previous AGM and members had taken some actions, but now it was necessary to agree a final list. The committee meeting took place on December 6th 2018, and minutes were produced.
In addition to the meetings, there had been extensive email communication as the majority of the committee travel away on business and it is not often that a quorum can be gathered in one place.

3. Technical & Social Meetings

Social
25th January 2019 - The annual Beer and Curry night. Despite the time of year that it was held there was the usual high turnout. The evening began at the Dolphin Pub before moving on to the Marina Bar and finally on to the Jaipur Palace Indian restaurant. It was an excellent evening with plenty of laughter and banter.

Technical
9th April 2019 - Cornwall Capacity Enabling Project by Paul Munday (Network Rail), Dave Helliwell (Amey) and Andy Scarisbrick (Atkins).
A joint meeting with the IET, held at the Babbage Building of Plymouth university. The presentation detailed the project undertaken to increase the number of trains per unit of time through the county. The meeting was jointly chaired by Andy Millar representing the IET and Richard Belli for the IRSE. The meeting was well attended by a combination of IRSE, IET and other interested persons.
An extensive question period took place at the end of the meeting, including discussion and explanation surrounding the non-signalling engineers' fascination with the apparently "antiquated" signalling equipment still in use in the county.

Cancelled Meeting
A further technical meeting had been agreed for February / March 2019, but unfortunately the speaker had to withdraw his offer.

Annual General Meeting
The Annual General Meeting for the 2018-2019 session for the Plymouth Section of the IRSE was held on 15th May 2019 at 17.30 hours at the offices of Atkins Global, Estover, Plymouth. Specific extracts from the minutes of the 2018-2019 AGM are as follows:

Introduction
Chairman Richard Belli opened the meeting by commenting that it was good to see such a high attendance, more than had been anticipated, and welcomed all there. He reminded members as to events of the previous year that had resulted in the previous AGM being held much later than the usual date, but commented that the Section had successfully held functions despite the difficulties. The functions held were the Beer and Curry social event plus the Cornwall Capacity Enabling Project lecture.

Attendance
A total of fourteen members attended the AGM as follows:- Richard Belli, Dave Came, Alastair Wilson, Tom McLarnon, Mick South, Pete Stiles, John Lovick, John Senior, Andy Billson, John M. Billson, John P Billson, Scott Brooksbank, Andy Millar and Michael Kingston.

Apologies for Absence
Apologies for absence were either received in advance or tabled at the meeting from members as follows:- Jim Easterbrook, Dave Smith, Andy Moore, John Fissler, David Gill, Trevor Lampen and Dave Chaffe.

Minutes of Previous AGM
A copy of the minutes of the previous AGM, held on 12th September 2018 at the premises of Hitachi Information and Control, were projected onto the screen for the attendees to read through.

Matters Arising from Minutes of AGM
The secretary advised there were two matters arising from the minutes as follows:
- Publication of an article in the IRSE News prepared by the Plymouth Section.
- Bye-Law changes.

These two items would be covered during the items yet to be discussed during this meeting.

Acceptance of Minutes of AGM
It was proposed by Tom McLarnon and seconded by Mick South that the minutes be accepted.

Secretary's Report
The Secretary's report for 2018-2019 was read to the meeting by the secretary .

Financial Report and Acceptance
The Secretary / Treasurer advised the meeting that there had been no income or expenditure activity in the period between the 2017-2018 AGM and this 2018-2019 AGM, thus the bank balance remained at £368.16, the figure presented at the previous AGM. A copy of the latest bank statement was tabled at the meeting.

Review of IRSE Plymouth Bye-Laws
A copy of VERSION 5 of the bye-laws was projected onto the screen for members to read. The secretary began by explaining that IRSE HQ has a set of bye-laws and those bye-laws dictate that local sections must also be governed by a set of bye-laws, and the headings of the various paragraphs are laid down in the HQ bye-laws.

He further explained that the reason to review the Plymouth bye-laws followed the decision at the 2017-2018 AGM when the existing committee was re-elected en bloc, with no changes to personnel, but with the proviso that the words of the laws be reviewed at this the following AGM. The reason for needing a review being that the current laws stipulate that two members of the committee must retire each year, to be replaced by newly elected members.

Suitable modifications to the IRSE Plymouth Bye-Laws were discussed and agreed. For full details of the changes and reasons refer to the full minutes of the AGM.

Election of Officers
The meeting was advised that committee member Allan Morgan was no longer working at Bombardier Transportation, but there were no further confirmed details and he had not contacted the IRSE locally.
Following the agreement of the laws governing the section as above, it was proposed that the committee again be voted in en-bloc. However, it was pointed out that it was highly likely that Allan Morgan would not wish to continue, and a new member should be elected just in case. John Lovick agreed to serve, proposed by Mick South, seconded by Pete Stiles.
The committee was then re-elected en-bloc, but including John Lovick, proposed by Pete Stiles and seconded by Alastair Wilson.

The committee voted in was:
Richard Belli (Hitachi) (Chairman)
John Senior (Atkins)
Mick South (Retired)
Tom McLarnon (Retired)
Andy Billson (Rail Signalling and Power - RSP)
John Lovick (Atkins)
Allan Morgan (Pending)
Dave Came to continue as Secretary / Treasurer

AOB
Application for financial grant from HQ - The secretary advised the meeting that further to information presented during the above meeting, there had been progress on the application for a grant from HQ. Following communication with the treasurer of the IRSE, it transpired that time was running out if the section wished to apply for a grant. Two sections had already applied and were under consideration, but this would not preclude Plymouth being successful. The secretary / treasurer circulated the committee by email in order to obtain a consensus as to whether this section should apply for a grant. A positive majority was received in return and subsequently the secretary / treasurer contacted the treasurer of the IRSE and applied for a grant. The application was acknowledged and the section will be advised as to success of this application following consideration at HQ.

Urgent need for a committee meeting - Mick South suggested that in view of the forthcoming 50th anniversary of the section, and subsequently the amount of work that could be involved, the committee should meet as soon as possible in order to put the wheels in motion. This was agreed by all. Committee members to advise the secretary of their availabilities and suggestions for a location to meet.

Events programme for 2019-2020 - Discussions took place on likely subjects / locations for technical papers and visits. During this discussion Andy Millar advised the meeting that the IET was very keen for further joint meetings. The IET would provide the lecture hall and refreshments and the IRSE would organise topics / speakers and speakers' expenses should there be any. It was also agreed to involve Andy in committee communication relating to topics and potential visits.

The list of suggested visit locations and presentation topics is included in the full version of the minutes of this AGM.

Scottish Section Report: 2018 – 2019

Scottish Section Chairman's Report 2018 - 2019

On behalf of the committee, I would like to extend a warm welcome to all members present this evening and thank all those members and guests who have supported the section throughout this session.

This session has been my fourth and final session as Chair and due to work commitments, it has been the most difficult. Managing to maintain communication with the Committee and attend events whilst working on a remote project has been tough and I would like to extend an apology to the Committee for what was a bit of a haphazard year behind the scenes. Thankfully the programme of events still managed to progress as planned.

Session 2018/19 has seen a successful year concluding with a very well attended family day. Sloans has continued to be the home of our lecture programme which has seen another year of varied topics including welcoming the Chief Inspector of the Rail Accident Investigation Branch. A number of topics have already been identified for the 2019/20 session which should provide the new Chair with a good start to their stewardship.

Our Annual Dinner continues to go from strength to strength, maintaining its popular position within the Scottish Railway social calendar. Over the next few years the Committee must continue to support Peter Allan in the sterling job does in putting on the event and put in place succession plans for when Peter eventually wishes to hand over the reins. We have already secured our lecture topic for this year and Andrew Haines, Network Rail Chef Executive, will be joining us to deliver the After-Dinner Address.
Uptake of the IRSE Exam within the Scottish Section membership remains consistent with a mixed bag of results this year. Frazer Howie continued his role as Lead Invigilator and Study Group chair this session and he has already begun the process of registering applicants for this October. A point of note that the IRSE Exam format will be changing in the near future – further information will be distributed through the usual channels in due course.

As I step down as Chair I'd like to reflect on the past four years leading this section. I have made a few changes to the way the section is run and presented, for what I believe is to the betterment of the section, however there is still a lot of room for improvement. Engagement with the section has been steady however attracting younger members has been a struggle. This a problem that the Committee cannot solve alone and the local industry must also do its part to incentivise its staff meet their Professional Development requirements through the IRSE and the local section.

I agreed to take on the Chairmanship for two years longer than planned due to a shortage of volunteers to take on the role. I have been pleased to hear that three individuals have shown interest in becoming the chair going forward which would ensure that a two-year stewardship can be returned to. This will ensure the Committee remains fresh and engaged. It's been great having such a young Committee however the addition of a couple of senior engineers would be beneficial to the Section is driving events and encouraging support.

On a personal note, despite the struggle over the past 9 months with workload and a bit of lethargy, I have thoroughly enjoyed my time as chair. It has opened so many doors and put me in front of so many people. To the Chairs of the future, I say make sure you enjoy it – especially the Dinner.

Finally a short note to mark the passing of former IRSE President and founder member of the Scottish Section Robin Nelson earlier this year. Robin was a lifelong railwayman, a dedicated supporter of the IRSE and an all-round decent man. Our industry and discipline are worse off with his loss.

Western Section Report: 2018 – 2019

1. Introduction

The 2018-2019 season saw an attempt to vary the section's activities. A social event in early January was well-received by the few who attended: more social activities are being planned for friendlier times of the year. A presentation slot was replaced with a section debate on the subject of 'The Digital Railway'. This debate was successful in bringing the section engineers to the fore of its activities and will hopefully pave the way for similar section activities going forth.

Date of last Annual General Meeting	3rd October 2018
Were annual accounts presented at the AGM?	No
Were officers elected / re-elected at the AGM?	Yes
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	411

Section Officers (at time of writing report)

Chairman	Adam Allen
Secretary	Sam Loveless
Treasurer	Andy Scarisbrick
Country Vice-President (if appointed)	
Webmaster (for updating IRSE website Local Section page)	

2. Main Activities during the past 12 months

October Lecture: 'Command, Control and Communication' – Clive Burrows, First Group
The session focused on the development and progress of the Rail Technical Strategy (RTS), a 30-year plan covering an extensive list of rail-centric topics. Broader themes discussed by the speaker include High Level Output Specifications (HLOSs), technical knowledge gaps, digital services, including the concept of "Mobility as a Service" (MaaS); hierarchies and mapping in terms of investment and vision, the key capabilities and portfolio of technologies required to achieve the RTS strategic vision, and the various challenges associated with integrating these into the existing railway. The presentation was met with a warm response and a brief Q&A.
Attendance: 21 Members, 4 Guests

November Debate: 'The Digital Railway as an Engineering Concept'
This event saw a departure from the normal lecture format, with the local members/attendees instead invited to engage in a structured debate on the Digital Railway, a timely topic in the UK rail industry.
The debate established that, based on the declared understanding of the word 'digital', the attendees were overall not satisfied with the term 'digital railway', preferring something along

the lines of the term 'interconnected railway', in line with the idea that the aim to have each part of the rail network talk to each other as much as possible.
The discussion covered topics such as connectivity, asset reliability, current contractual arrangements with TOCs/FOCs and stock and crew issues. It was agreed that knowledge transfer between the customers and the railway was ideal, but asset data is not yet up to scratch.
The tail-end of the debate centred on two subjects relating to ETCS: the lack of an established methodology/methodologies, and the indecision over whether to develop signalling engineers or systems engineers to meet the requirements of ETCS work.
Attendance: 20 Members, 1 Guest
A report of this event was published in issue 254 of IRSE NEWS (p.31).

December Lecture: 'Technology Change and Associated Training' – Sam Loveless, Siemens
This session was meant to be a presentation on mainline ATO, however the speaker withdrew at the last minute. In his absence, the section secretary agreed to present a paper previously delivered elsewhere.
The paper presented on technology change that occurs during the lifecycle of a typical infrastructure project, where it is now possible that the technology delivered as part a given solution could be rendered obsolete by the time the project reaches operational service, notably software and specialist hardware. It surmised from this that a given engineer had to be trained in such a way that they could better adapt to, and incorporate, these changes throughout their career. The paper then looked at available data to determine that the rail industry was not currently thinking in these terms, with the consequence that the perceived skills shortage is the industry is growing rather than decreasing.
The following Q&A focused on the issue of training, with resultant themes of company-specific approaches and the need for personal CPD to be encouraged arising.
Attendance: 12 Members, 1 Guest

January Social: Pub Quiz
The first western region social in some time was held at the GW pub opposite the Swindon railway station. A small number of people attended a pub quiz, consisting of a mixture of general knowledge and signalling related questions. The event was enjoyed, though improvements are to be made in the future to improve attendance.

February Lecture: 'Cloud Computing' – Gary McGuire, Siemens
This was a joint presentation with the IET.
This presentation examined the idea of putting industry functionality into the "cloud", with some emphasis on resilience and scalability. The development of ideas against new and existing regulation were discussed, as was an early trial of operations control technology in Switzerland. The discussion then moved onto data prediction, modelling and the concept of the 'digital twin'.
The following Q&A covered customer concerns, the alterations required in business models, the need for specialist connectivity services, built-in security requirements, transmission reliability and server location.
Attendance: 17 Members, 6 Guests

March Lecture: ElectroLogIXS (Introduction to Service) – Ian Bridges, Balfour Beatty; Grace Nodes & Peter Harbottle, Atkins
ElectroLogIXS was introduced as a solution the UKs problem of limited interlocking products being available. The speakers guided the audience through the underlying issues and standards that were used to guide the development of the product. The solution was developed so that more systems engineers could be used to compensate for the lack of signalling engineers available.
A verbal, slide-assisted tour of the technology, from the I/O cards to the non-vital communications, was delivered alongside an explanation of the 'Atkins Signalling Method':

this is predicated on configurable standard equipment suites, allied to formal device definitions and checksum-based configuration deployment.
The final topic of the presentation was Atkins' 'Level Crossing in a Box': a new barrier machine (to MCB-CCT specifications) that arrives on site as one ready-to-install piece of kit; many interesting facts about its development were presented.
The following Q&A covered weather-proofing, limitations, interfaces and obsolescence.
Attendance: 29 Members, 6 Guests

May Lecture: Cornwall Capacity Enhancement Project - Paul Mundy, Network Rail; Dave Helliwell, Amey; Andy Scarisbrick, Atkins
The final session of the season was deferred from April at the request of the speakers. This covered the title project from its GRIP 1 to 3 origins as 'Totnes to Penzance' in 2014, through to the commissioning of the various stages in 2018.
The timeline and complexities of the project were described, including gradient issues, convoluted GRIP 4 designs and single line bottlenecks from St Germans to Liskeard. A decision was made to split the project into three sections, each with a different set of technological and geographical challenges. The technology changes (predominately alterations as much of the existing signalling infrastructure was retained) to each section were described, with most solutions working well and only a couple of areas that would have been done differently in hindsight.
Unusual risks that occurred during the delivery of the project included the liquidation of MCB, who were sub-contracted to help deliver the location case designs, and the presence of a badger set near various signals. Of the commissionings, the east section of the project was relatively stress-free, whilst the west section suffered from the onset of storm Callum, including flooding at Roskr signal box. Despite the delays this caused, the commissioning was completed on time.
Post-commissioning concerns included early issues with axle counter resets, due to the variation in methodology from previously used axle counters in the area, and issues with the Westplex TDM system, exacerbated by late TENE design.
The presentation was concluded with a brief Q&A session.
Attendance: Currently unavailable

3. Plans for the Next 12 Months

It is intended that the 2019-2020 season takes a similar shape to the season just gone. A backbone of talks will be supplemented by another debate on a topic to be decided prior to the start of the season. A social event will be organised in line with feedback received, and a grant has been requested from HQ to introduce the first technical visit/workshop the section has hosted in recent years. Finally, to address concerns raised by Western Section committee members, it is planned to host a CPD day with the co-operation of local engineering companies and HQ staff.

York Section Report: 2018 – 2019

Report produced by: Ian Puckrin
Date: 15th September 2019

1. Introduction

York Section has continued its activities through the year with a variety of topics discussed during its lecture programme.

The Annual Dinner was more popular than ever helped by the guest speaker, Rob McIntosh, route director for Network Rail LNE Region.

The annual meal was held on 23rd March 2019 at the York National Railway Museum and attracted just under 150 guests.

The Annual General Meeting was held on the 11th April 2019, the Section welcomed Richard Storer to take up the chair for the year 2019/20 and Rhiannon Jones and Becky Radnage onto the committee as new members. Besides the formal AGM items, Richard entertained the attendees with a presentation on continuous improvement in the field of signalling assets.

Date of last Annual General Meeting	11th April 2019
Were annual accounts presented at the AGM?	Yes – Commentary provided by T Kornas, treasurer
Were officers elected / re-elected at the AGM?	Yes – Nominations for offices have been received but not yet elected. Nominees are: Chair – Richard Storer Secretary – Tony Pinkstone
Have minutes of the last AGM been produced?	Yes – There was a lack of minutes from the previous meeting available due to the computer failure of the secretary. This was declared to the meeting.
Is your page on the website up to date with contact details etc?	Yes

2. Section Officers

Chairman	Richard Storer
Secretary	Tony Pinkstone
Treasurer	Anthony Kornaas

3. Main Activities During the Past 12 Months

The usual September East Railway Engineers Forum was held at the National Railway Museum where a variety of Railway subjects were presented. This event continues to be popular, the event in Sept 19 was attended by 6 of the serving York section committee, and many more York section members

A series of Section Lectures followed during the autumn and winter period held at Network Rail, York Regional Operating Center Auditorium, speakers as follows:

18/10/2018 – David Gordon (NR Senior Program Manager) HS2 Network Rail Interfaces

15/11/2019 – Paul Darlington– What Follows GSM-R?

05/12/2019 – Ian Puckrin + Guests - Signalling Maintenance – Why do Engineers Engineer?

17/01/2019 – Bruce MacDougall – High Capacity System Principles and Seamless Transition to Communications Based Train Control (CBTC)

21/2/2019 – Paul Clark, Signalling Systems North of the Border

07/03/2020 – Ian Allison Unipart, New Technology to make signalling systems safer

The Lecture programme was followed with the Annual Dinner on 23rd March 2019 where the speaker was Rob McIntosh, Network Rail Route Managing Director, LNE Region.

4. Plans for the Next 12 Months

Dates for the 2019/2020 events are:

24/10/2019 – Becky Radnage – Resilience – focusing on the effects of mental health

14/11/2019 – David Jones (NR LX Engineer) – Obstacle Detection at level Crossings (at GSH)

05/12/2019 – Rhiannon Jones & Guests - Signalling Maintenance – Plan v's Actual!

15/01/2020 – Tony Kornas – Engineering Safety and Safe by Design

12/02/2020 – Mark Marridge, Arentis – Operational applications of HD Video

05/03/2020 – Craig Donald, NYMR – Maintaining and Replacing Level Crossing Equipment and level Crossings on the North Yorkshire Moors

The Annual Dinner will be held on 12th March 2020.

The York Section's principal aim is to promote the IRSE as a diverse and welcoming institution, which has purpose, helps support junior signal engineers and allows experienced signal engineers to spread best practice.

Younger Members' Section Report: 2018 – 2019

Report produced by:	Keith Upton
Date:	25th November 2018

1. Introduction

Principal objectives of Younger Members:
Communication with the Institution's Council, Committees and Sections to contribute to and improve the benefits the Institution provides for Younger Members.
Communication with the Younger Members of the Institution through regular use of the Institution's publications, the web site, email and social media
Communication with other engineering institutions
Organisation of specific events aimed at Younger Members.
Encouraging and supporting those members undertaking the IRSE professional exam.
Promoting and overseeing the IRSE self-service mentoring scheme alongside the relevant IRSE committees.

The Section's aim is that its events are free of charge and it will only generally advertise events that have a reduction for younger members. Therefore, the Section relies on sponsorship and contacts (which can be a challenge)!

Date of last Annual General Meeting	22nd February 2018
Were annual accounts presented at the AGM?	No
Were officers elected / re-elected at the AGM?	Yes – all members of committee were re-elected
Have minutes of the last AGM been produced?	Yes
How many IRSE members are in the Section?	470 in UK; 881 across world; 290 on approved GDPR mailing list

Section Officers (at time of writing report)

Chair:	Keith Upton
Secretary:	Vivich Silapasoonthorn
Treasurer:	Kevin Gardener
Webmaster (for updating IRSE website Local Section page):	Michael Bastow

2. Main Activities During Past 12 Months

The Section's annual seminar took place on 1st-2nd November and was held at the National College of High-Speed Rail in Birmingham. This event sold out with almost 50 in attendance to the seminar and just over 25 to the technical visit. This was an excellent seminar on the theme of communications. The technical visits to the Birmingham New Street station control centre and Power Signal Box also proved an excellent and informative visit.

Four exam study events were held during 2018, kindly supported by Signet Solutions, SNC-Lavalin Atkins and Peter Woodbridge, David Nicholson and Andrew Love (to name a few). The first event was a conference call in February to talk through the process for entering the exams, apart from some technical complications, this was a successful event.
Later in February we held our annual exam review day, including a talk about how to pass the exams. This was again a successful, well attended event.
Next, we had our sell out study days: the first was a Module 2, 3 and 5 study weekend at Signet in Derby in April and the second was a Module 1 and 7 study day in Birmingham (sponsored by SNC-Lavalin Atkins).

Articles in IRSE News:

January 2018

- IRSE exam module 2,3,5 workshop

April 2018

- IRSE ASPECT - a YM View; Meet the Bursary Winners
- Scottish section - younger members Christmas social

3. IRSE professional exam 2017 - results

May 2018

4. Visit to North Pole Depot

June 2018

5. Alex Patton - encouraging engineering - ASPECT paper
6. Annual Seminar article
7. Rebranding feedback from YMs (Colin Williams and Keith Upton)

October 2018

- Mod 1,7 Study Day

Other

- Updating mailing list to comply with GDPR
- Involved in next steps of IRSE Exams
- Involved in mentoring scheme
- Involved in organisation of technical seminar live streaming

3. Plans for the Next 12 Months

- Study days – Conference call – late Jan/early Feb; exam review – late Feb; mod 2,3,5 study day – April; mod 1,7 study day – July.
- Glasgow SPT – early 2019
- Romford ROC – early 2019
- Resonate trial at TVSC – 2019
- Braunschweig visit
- Switzerland Visit – seminars and tech visit
- Hitachi ITS Visit
- VMS site

Committee changeover – Keith Upton stepping down; Kevin Gardener likely to be next chairperson

IRSE News

Institution of Railway Signal Engineers

May 2018

Presidential address
winds of change

Track safety
keeping staff safe

Unmanned railways
successful specification


Starting
fresh or
stepping
up...
BST
Basic
Signalling
Technology
IST Signalling
the Layout /
Control
Tables
RRI
Appreciation
SSI
Appreciation
Track Circuit
Bonding
Design
ERTMS - UK
Application
Level
Crossing
Design
AST
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Are you listening?

In the olden days, the role of the engineer (think I K Brunel) was pivotal in a project. Indeed, until relatively recent times the chief S&T engineer was at the centre of decision making, inspiring a certain amount of dread and awe in lesser mortals and others outside the railway undertaking. Why do I mention this? Well, there is a great article in this edition of IRSE News titled "Why do projects fail?" which I heartily recommend that you read and inwardly digest.

In my view, one of the underlying and disturbing trends we are seeing is that the project managers, accountants, etc. hold sway, and sometimes make 'courageous' decisions without fully understanding or considering the consequences – for instance to maintain an unrealistic completion date or come in 'under budget'.

Cutting out scope is a classic project management solution to meet an end date. However, unless carefully chosen, the scope removed could be very detrimental to the project objectives that justified the business case in the first place.

The dividing up of a contiguous project into "chunks" that allow for contestable packaging is another trend, claimed to deliver value for money for the client. However, unless this is done sensibly, arbitrary work packaging can lead to 'artificial' system interfaces which add to complexity both in the project delivery phase and, potentially, in the operational life of the system.

As we know, whether it is a green or brown field project, there are numerous interfaces to be managed, and the complexity of system integration and operational readiness is seldom truly appreciated outside of the project. For politicians and some others, once the tunnel is bored or the track is laid it is 'job done' and the provision of the operating systems is then the cause of any project delay!

You could argue it was forever thus. Nevertheless, project outcomes would undoubtedly be better if properly qualified professional signalling system engineers (and by signalling I mean control of traffic movements in the widest sense) are in positions of authority on both the client and supplier sides from the start of the project (requirements phase, business case), as well as throughout the project lifecycle.

To return to my original point, I think there are many people who influence projects but do not have sufficient regard for competent engineering advice. So I would add one more item to the conclusions of the article, namely ensure that you have competent engineers at the heart of your project team, and listen very carefully to their advice.

Peter Symons, Past President

Cover story

For three decades Singapore has been at the forefront of introducing high performance, high reliability metro systems.

The initial lines were GoA2 systems such as these shown at Jurong East on our cover, but most recently the Singaporean Land Transport Authority has successfully procured and delivered GoA4 unmanned mass transit services.

In our article this month Robert Cooke explains some of the challenges of specifying unmanned railways, and the additional considerations that need to be taken during their adoption.

Photo Land Transport Authority.

In this issue

Presidential Address: Winds of Change

Markus Montigel
CTO, systransis, Switzerland

The inauguration of our new President for 2017-18, Markus Montigel, took place during the Annual General Meeting of the IRSE held in April. Markus presented his views and plans for the year ahead, which IRSE News is pleased to share with you.

Figure 1 –Build a wall or a windmill when the wind changes? [7]

It is an exceptional honour for me to serve as your president and to write this address. As with my predecessor, Peter Symons, my term will be devoted to the future of signalling. The IRSE's definition of signalling includes telecommunications, automation and associated technologies, i.e. whatever enables the safe and efficient control of a railway, [1].

If you had asked me three years ago which ground-breaking innovations in railway safety and control I expected to see in the next few years, I would probably have come up with little of significance. However, much has changed in my perception in the last three years: The railway – and the transportation system as a whole for that matter – could soon face some of the most dramatic reshaping ever.

At the border of a new age?

Between June 2015 and October 2016 I participated in the SBB project now called 'Smartrail 4.0' [2], leading to revelations I would not have thought possible and creating an entirely new view of how railway safety and control could be achieved.

In a broader context, autonomous driving has become a widely discussed subject, first on roads and now also on rails. It has become topical for mainline railways to think about Automatic Train Operation, see [3]. Such visions are supported and enabled by the progress (and promises of further progress) of modern IT, including the appearance of seemingly new technologies such as Big Data, the Internet of Things and Deep Learning.

At the same time, cyber threats – long believed to be rather imaginary in the so-called closed networks of the railway safety domain – have become real, leading to the need for new Cyber Security products and the challenge of integrating requirements for both safety and security into railway systems.

If these changes materialise they are likely to revolutionise the transportation system as a whole. Under the title "New-Rail-Deal, Big Mix or AUTOnomy – scenarios for the railway in the year 2040" [4], German research claims that there is a credible outcome in which there is practically no role left for the railway in the overall transportation system!

All this would affect not only the technology of safety and control, but the business models of the entire transportation system in a way that is hard to foresee today. These insights must motivate the railway industry to increase their innovation efforts, creating dynamics which were not there three years ago and representing the beginning of something new. This cannot be a gradual change which takes many decades, which is what usually happens in the railway domain, and other people seem to share my opinion, for example as in [5] and [6].

"Winds of Change"

Reflecting on all this, I have chosen "Winds of Change" as my theme for my IRSE Presidential Year. The main aims of my term are:

- To reflect on the possible mechanisms at work.
- To demonstrate some elements on which these big changes could probably be based.
- To prepare the IRSE, i.e., ourselves, for this future.

This theme manifested itself in my mind one day quite suddenly, and it became considerably more interesting when I investigated its origins. It appears to be based on an old Chinese proverb:

风向转变时,有人筑墙,有人造风车.

When the direction of the wind changes, some build a wall, some build a windmill.

Build a wall or a windmill when the wind changes? This is indeed a complex question with profound depths, and it perfectly reflects our age-old struggle between providing safety in a vast, heterogeneous and complex system, and at the same time being cost-effective and efficient by harvesting the benefits of modernity.

According to [8], the prices of public transportation in Switzerland have increased by about 60% since 1990, compared with 20% in road transportation (general price increase of consumer goods: 30%, see figure 2). And this, it seems, is just the beginning. Bus operators will soon be allowed to offer services between, for instance, Zurich and Bern for a fraction of what the rail ticket costs. Bus operators are even starting to attack the rail transportation market directly [9]. Does the added value of the rail service really justify such high prices? Moreover, what could happen when the bus drivers would be replaceable by robots? And what will happen to safety standards, if such cost pressures are exerted on the railway?

In the light of this situation, I have the impression that the railways' struggle described above might soon become a struggle for their existence! It is our task and responsibility to reduce the cost of signalling and create additional benefits from it. Expressed in more direct terms, railways must change or else! This sounds frightening, and it is.

Build walls or windmills?

Am I the windmill-building type when the winds of change blow? Yes, I feel very lucky when I see the possibilities of the exciting times we live in, despite the worried impression I may have given in the previous paragraphs. I see myself as an innovator.

Most signal engineers, however, usually seem more on the defensive (wall-building) side to me. I am not generally

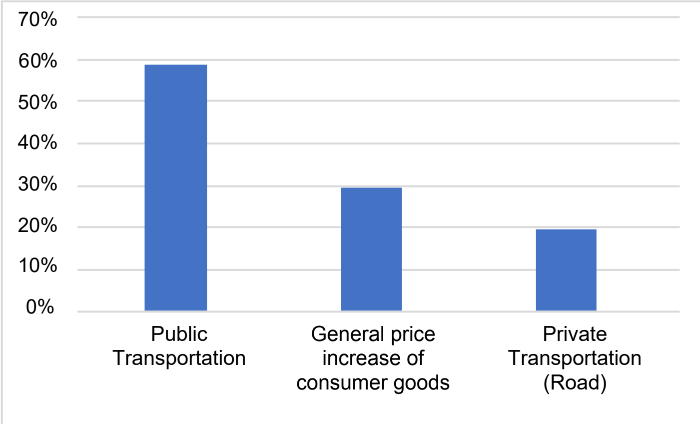

Figure 2 – Comparison of price increases in Switzerland 1990 – 2016.

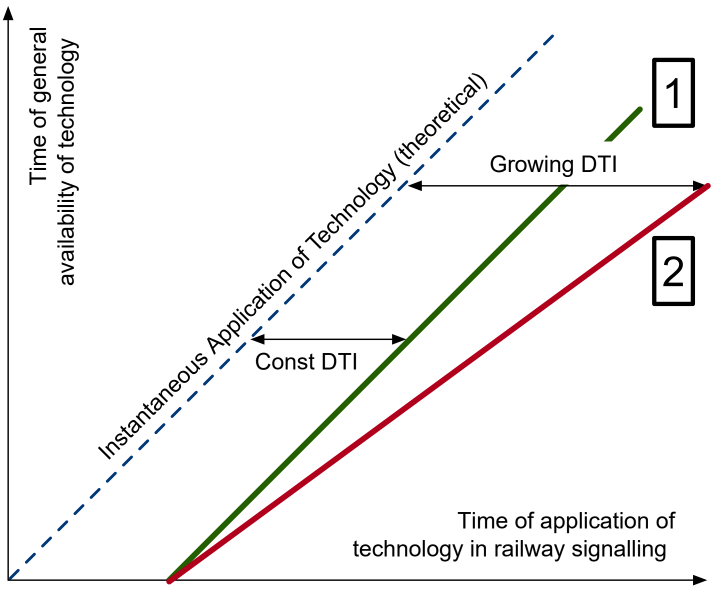

Figure 3 – Distance to Innovation (DTI) in Railway Signalling: is it 1 or 2?

criticising this strategy – it has proven its merits by successfully developing the culture of high safety standards on the railways. And if you think about the cyber security issue, isn't this of necessity about building walls? I can well understand that perceiving today's situation and its extrapolation into the future could increase this defensive reflex even further.

So, which recommendation is the appropriate one for a president of the IRSE to make, who is always supposed to balance things carefully? Quite simple: **Build both! Build windmills on top of the walls!** The elevated windmills will catch stronger winds and hence be more efficient at no additional cost, because our walls are usually very strong – strong enough to sustain a modern, elegant windmill!

What does this mean in railway terms? We must use our very expensive safety systems to create additional benefits at marginal costs, for instance by using their excellent sensing and communication methods to create functionality which increases the efficiency of the overall system, such as modern traffic management systems that optimise capacity and the flow of trains.

How fast to innovate?

How fast should the windmills be built? The speed of innovation in a specific domain such as railway signalling, compared with the speed of innovation of technology in general, is crucial.

In the past decades, railways often seem to have struggled with innovation. May I refer you to the article "Why is innovation so difficult in railways" [10] of the IRSE International Technical Committee (ITC), which generated a month-long heated debate before it could be published!

If innovations are introduced into the railway domain with only a modest time delay, the domain is healthy (see curve 1 in figure 3). In this case, the so called (temporal) Distance To Innovation (DTI) is constant. However, if we behave in a manner as depicted by curve 2 in figure 3, then our domain is not healthy, as we will progressively lose sight of modern technology. It would cost more and more to modernise the infrastructure, meaning that investment backlogs accumulate, to the point where the existing system becomes completely unmanageable and would need to be abandoned. Moreover, in general efficiency is lower in a domain with higher DTI, leading to even less funding being generated for the much needed innovation.

The DTI of railway signalling in general, and even of an individual railway, is hard to quantify. Worryingly however, there seems to be little evidence for railway signalling following the trajectory indicated by curve 1 in figure 3. For instance, GSM-R is already four generations behind the development of general technology, let alone the typical technology on which interlockings are based in most countries. We need to look at ourselves in the mirror: The technological step of ETCS began some 25 years ago and is still not truly 'business as usual', let alone fully implemented. Would this happen in a truly 'healthy domain', as defined above?

Contrast this picture with the initial development of railways, which applied modern technology almost immediately in their early history. Examples include the electric motor (1834) in the first electric locomotive (1837, DTI = 3 years), the telegraph (1837) as safe signal telegraph (1844, DTI = 7 years) and mechanical interlockings (1856) based the idea of the Arithmometer (1851, DTI = 5 years) [11].

Today, I personally think we are much closer to exhibiting the behaviour of curve 2 and therefore, if I am correct, it is absolutely crucial to increase the speed of innovation in our domain.

To change stepwise or with a Big Bang?

Another age-old question in this context is whether to renew stepwise (in an evolutionary manner) or with a 'Big Bang' approach. Should the walls be renovated stone by stone and many new small sections of the wall be rebuilt where and when circumstances call for it? Or should large segments of the wall be torn down in one go and completely be rebuilt at once? And how should we proceed with the windmills? Do we adapt the walls to support windmills when they are being renovated, or perform this in a second round of activity?

In my perception, a respectable majority of signal engineers would vote for the stepwise evolutionary strategy. In [12], ÖBB supports this view by stating: "One of the misconceptions is that digitalisation signifies large, disruptive changes like autonomous driving or other hyped technologies (though we will be waiting a long time for a truly significant change in rail digitalisation)."

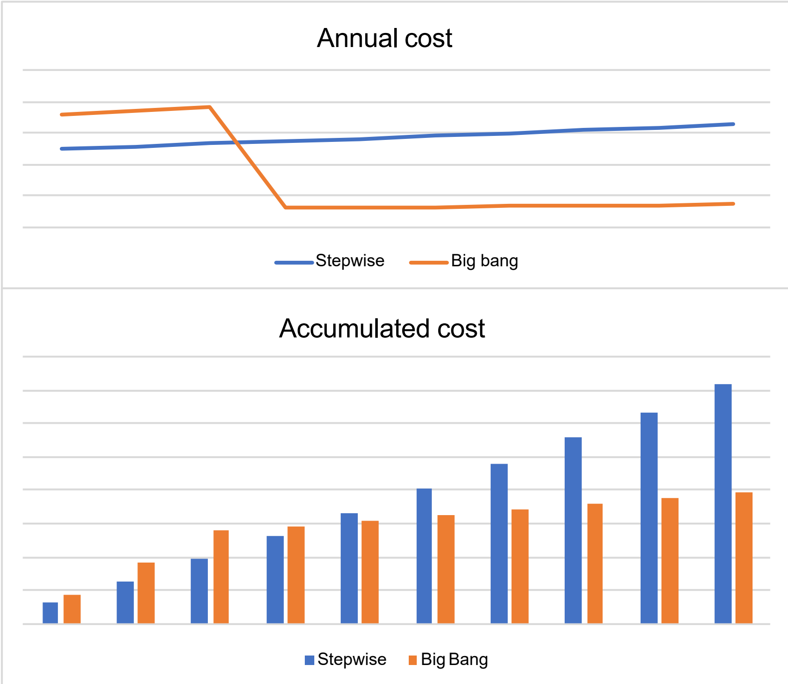

Figure 4 – Annual and accumulated cost in Stepwise and Big Bang Approaches (qualitative).

SBB's CEO, on the other hand, seems of different opinion: "We would like to make a Quantum Leap with the railway." [6]. It is the very nature of quantum leaps that they have nothing gradual in them. The Danish re-signalling project is also representative of the Big Bang approach.

Who is right or wrong cannot be said in general terms – it depends very much on the circumstances. In my perception, however, there is a too conservative tendency in signalling, with not enough courage to take larger steps. Much of the risk aversion that we see in our industry stems from problems discussed in [14]. Several independent unpublished studies by railways have reached the same conclusion: Big Bang can save up to 50% of the cost. A qualitative model of this is shown in figure 4. While the initial investments are higher, they drop substantially after the innovation is in use, because of the higher degree of uniformity, the lower maintenance cost and the fact that every newly introduced system doesn't have to be compatible with all other legacy systems, see [13].

Admittedly, the risks with Big Bang are higher, but so are the opportunities and benefits, and so again we arrive at the question: do we build walls or windmills in the future?

There remains the question of the business case, of course. Where to find the additional initial investment required for a Big Bang approach? There are two important preconditions for this:

- The industry structure and governance must allow for strategic budgeting over several years (if not decades).
- It must be possible to make business cases for the overall systems, not just for individual parts.

If these preconditions are not fulfilled, they must be made to be fulfilled, otherwise the benefits illustrated by figure 4 cannot be realised. It is to no avail if neither the walls can be renovated nor the windmills built because each does not generate a positive business case when considered separately. And we need to make this clear to the stakeholders and investors!

Vademecum "Winds of Change"

You may disagree with some or much of what I have said, but don't you also find some grains of truth worth considering? I have prepared the 'Vademecum Winds of Change' in the green panel opposite, a check list to see whether you, your project, the industry and the IRSE is on the right track with the "Winds of Change". It fits neatly in the pocket of every signal and telecommunications engineer.

Conclusion

We could see quite dramatic changes in signalling, railways and the transportation system as a whole. This prospect alone demands hard work from us: We must find an appropriate balance of 'walls' (maintaining the tradition of high safety standards) and 'windmills' (harvesting opportunities and increasing efficiency) in times of uncertainty.

"Winds of Change"

1) Have we thought hard enough about building more and efficient windmills?
2) Is a gradual change the right thing to do, or do we have the courage for more?
3) Application of modern technology:
   a) Do I get sufficiently engaged with modern technology by attending IRSE events and reading technical papers?
   b) Do I support suppliers enough to persuade them to apply modern technology to signalling?
   c) Do I support the railways enough to make them want to apply modern technology to their operations?
   d) Are we ready for "digitalisation" and "4.0": data/sensor/actors/communication methods?
4) Are our architectures modular in a way that they will support future innovations?
5) Have we observed and learned the lessons of the pitfalls in "Why signalling projects fail?" [14]
6) What does the common sense of an IRSE signal, telecommunication or automation engineer tell us about what we are presently doing to help the future prosperity of railways?
7) Do I communicate courageously and clearly enough to the decision makers that I have access to?

We cannot leave it to 'others' to do it. **All members of the IRSE and players in the rail industry are summoned to master this task together.** There are so many fine minds in this industry: we can and will succeed, but this requires clear communication to the leaders of this industry and to governments.

Many of the topics discussed in this paper will also feature in my Presidential Programme, which will, as in previous years, again be 'on the road' throughout 2018-19. We are planning live streaming of the events, so that you can join from anywhere and even participate in the discussions live. I sincerely hope you will make this idea a success by using this new service.

For me, the IRSE's main purpose is: **To serve as the worldwide leading organisation for innovative exchange of know-how and experiences in the field of Signalling, Automation and Telecommunication at the interfaces between railways, suppliers, government and education on 'neutral ground'.**

I am planning to devote my term as president to this. Let me finish with a citation from the Inaugural Address of president John F Kennedy, Washington, DC 20 January 1961, whose optimism impressed me greatly whilst on a visit to the JFK Museum in Dallas during the 2017 IRSE Convention:

"All this will not be finished in the first one hundred days. Nor will it be finished in the first one thousand days, ..., nor even perhaps in our lifetime on this planet. But let us begin."

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About Markus

Dr Markus Montigel Dipl Ing ETH FIRSE is the founder and CTO of systransis Ltd based in Rotkreuz Switzerland. systransis is involved in the innovation of computer science in the field of railway safety and automation.

Markus studied computer science at ETH Zurich university and gained a masters of computer science degree. He was also awarded a medal for an excellent doctoral thesis and a PhD.

He has been an assistant professor for computer science, University of New Orleans and a lecturer of computer science and student advisor, College Studies for Telecommunication and Media, St Pölten, Austria. Other roles include project manager and system engineering manager, Transport Automation Division, Alcatel Austria, and assistant lecturer Institute for Traffic Planning and Transport Systems, ETH Zurich.

Track worker safety

Wim Coenraad
Movares, Netherlands

Rod Muttram
Fourth Insight, UK

Mark Prescott
Network Rail, UK

This Presidential paper, the first Wing Lecture, was given in London on 15 March 2018. The focus is heavy rail; many of the principles also apply to metros, but the prevalence of tunnel and elevated infrastructure for those systems pose particular risks and issues. The IRSE International Technical Committee (ITC) may consider a supplement for light rail and metros at a later date.

Working on or near the track, with on-going train traffic, do not mix; at least, that is the predominant opinion nowadays among many railways. Increasing frequencies and speeds of trains combined with societal risk aversion tend to enforce regimes where track workers and train traffic are separated—in time, in space or by physical barriers. Currently, in some countries (e.g. the Netherlands) working on or near the track is only allowed in possessions, and even adjacent tracks are not allowed to be in service. This imposes such restrictions on the possibility of performing maintenance and repair activities without disruption to traffic that ProRail's newly-appointed CEO has publicly voiced his concerns that we are "going over the top" in our safety concerns and should be more pragmatic.

Whilst in the past the use of signalling systems to provide warnings of approaching trains for track workers was deemed too expensive, current practice seems to be that announcement and warning systems and devices need to provide at least the same level of safety as control and command systems for trains. At least to some degree changes in technology are making such systems more practicable and affordable.

Intelligent infrastructure is a primary source of risk reduction for track workers, but there will always be a need to go on to the track for some tasks, such as maintaining switches and crossings.

Functions and practices

The function of a track worker protection system is to ensure persons working in or near a track cannot be harmed by trains.

Preventing conflict between workers and trains can be achieved by **warning** workers of approaching trains in their own or neighbouring tracks, by **protecting** workers and their workspace from trains, or by simply ensuring that train traffic is stopped when work is in progress, by taking **possession** of the track, line or station.

In some cases it is not only regular trains, scheduled or unscheduled, that pose risks; engineering trains and other "yellow fleet" vehicles moving inside the work area are also potential causes of hazards. Further, a whole system approach is necessary to avoid hazards from uncontrolled vehicles (for example the accident at Tebay in England on 15 February 2004 [1]), and other hazards such as electrification.

Most infrastructure managers use different types of track worker protection equipment in conjunction with pre-defined procedures. The range (as well as the combination) of the measures to be implemented and used depends on national rules and the local situation.

Recent CEN Standard EN16704 [2] defines a hierarchy of measures and the conditions under which they should be used. This is intended to harmonise working practice in this area across Europe. It is relatively new and local working practice does not yet necessarily align with it.

The following regimes for working on or near the track have historically been common:

- Out of service (total possession).
- Physical barriers between work areas and open tracks.
- Controlled admission (of trains and work vehicles) to track otherwise under possession.
- Assured warning of approaching trains by a technical system.
- Personal observation (by an individual worker or a lookout).

Technical systems can be used to support track worker protection based on personal observation or assured warning, depending on their properties and deployment. In most cases evacuating the danger zone is required when a warning is issued. Of course this does not apply when all or part of the railway that constitutes a work zone is out of service (usually referred to as 'under possession').

'Controlled admission' is a term used to describe a system where work trains, engineering vehicles etc. are allowed to enter or leave a possession, usually requiring some form of cooperation between the person in charge of the possession (PICOP), the signaller and the drivers of the vehicles concerned.

Traditionally, track workers kept an eye on oncoming traffic or were assisted by lookouts, and stepped out of the track or moved to a safe haven when they saw a train approaching. This of course

Worksites can be complex, noisy, exposed areas with many people carrying out difficult tasks. Protecting their safety is paramount.
Photo Network Rail.

required a line of sight (and attention) to be able to spot an approaching train, and it is incompatible with the use of some personal protection equipment such as hearing and eye protection, and the use of noisy equipment. Nowadays this method of working is largely considered unacceptable. Remnants of this practice can be observed when track workers wave to the driver of a train to acknowledge they have seen him approaching.

More recently mobile technical warning systems typically use sirens and flashing lights to warn a track gang of an oncoming train. Activation can be manual by a lookout, or automatic through some form of train detection. Usually these mobile systems need to be installed prior to the works, which requires a degree of planning—and some other method of protecting the installation crew.

Where the installation of mobile technical warning systems is too cumbersome or their use is too frequent, they can be installed permanently. Typical examples of such locations include bridges, cuttings and tunnels

Temporary speed restrictions are used mostly to allow train traffic to continue on adjacent tracks, ensuring workers will have enough time to reach a position of safety, and are protected from pressure waves etc. Usually when train speeds and frequencies increase, this practice is no longer allowed

In some countries (such as the Netherlands) the view is that working on or near the track while trains are running is no longer acceptable, and track work is only permitted when traffic in an area (a station or yard), on a track or even on an entire line is stopped. Work is only allowed with the track blocked under possession.

Often such a blockage can be agreed between track workers and signallers as a kind of contract. The making of this contract between people presents a risk of human factors error, and is one reason why this method of working cannot just be assumed to be completely safe.

Possession

A possession may or may not require boundary protection measures such as the blocking of signals protecting routes into the area under possession, and ensuring that turnouts are locked in a diverting lie away from the possession area. The area under possession can take the form of a station area, a track on a multiple track line, or a complete line. If only one track is blocked in a multi-track section, other protective measures such as barriers may also be needed.

Possession management

Taking possession of a station, track or section of line is the most used way of separating track workers and trains physically. It requires a system to manage the possession, typically arranging for traffic on the tracks to be suspended, after which the authority for the possession is handed over to the PICOP. The PICOP is in charge of allowing engineering trains to enter his area under possession and to move within it if the work needs that. After the works have finished and the tracks are verified to be safe for the passage of regular trains, the PICOP hands the area under possession back and train traffic can be resumed.

It requires a means of identifying the tracks that are under possession and the possession boundaries, both for the parties handing over authority to the PICOP and the workers in the field. It also requires means to prevent trains entering the area under possession without authority.

Advanced systems of possession management can allow pre-defined areas to be taken, for example by use of lineside key switches ('lockouts'), or even allow possessions to be planned and managed using timetabling, traffic management and interlocking functions. Such management systems allow more time to check and verify planned possessions and use pre- programmed scripts to set and lock boundary protection measures, and remove them.

Use of preprogrammed possessions and scripted actions reduces the risk of human error, but may increase the integrity requirements (SIL level) of the timetable planning and traffic management systems that implement them. This is an area where we need to apply some common sense; if we are replacing very low integrity human processes then the the cost of over-specifying systems to high levels of integrity may mean that possible improvements are priced out. We must avoid the situation where 'the best is the enemy of the good.'

Worker warning and alerting systems

Lookout operated warning system (LOWS)

Systems that allow a lookout to warn the track gang under protection can range from horns and whistles to remote controlled personal warning devices such as headsets (which can be required when ear protection needs to be used) and preinstalled sirens and flashing warning lights. These systems are only delivering or distributing a lookout warning in effect, and so they suffer from the same potential human error rate in terms of missed alerts, although they may somewhat improve the rate of observation of warnings. The send part of the system sometimes includes a form of hold-down switch, such that if the device is put down or dropped, or if the lookout totally loses concentration, an alert is sent (see the functional requirements in EN 16704-2-1).

Far left, lookout operated warning system (LOWS) transmitter unit.

Left, signal controlled warning system (SCWS) warning unit.

Photos Schweizer Electronic.

Automatic train-operated warning system (ATWS)

Remote controlled personal warning devices such as headsets and pre-installed sirens and flashing warning lights can be operated by some form of approach warning such as wheel sensors, by automated or autonomous proximity sensing, or by conflict detection based upon geo-location of trains and individuals working in or near the track.

In some cases elements of the signalling system with a warning function, such as level crossings, can be used to alert track workers as well, if the warning times and locations to be protected happen to coincide. Fully automatic systems cancel the warning as the train leaves the area, Semi-automatic systems can save detectors and cables by only fitting the approach side of the site/track and having the warning cancelled manually. Of course, this also has some human factors risks. (Again, see the functional requirements in EN 16704-2-1).

Signals and signal controlled warning systems (SCWS)

In many cases signals and features of the signalling system can be used both to block tracks and to warn track workers. Austrian Railways (ÖBB), Swiss Federal Railways (SBB) and Infrabel all have SCWS (for example the Thales FieldTrac 6392). Network Rail and Deutsche Bahn both have systems in development to meet the requirements of EN 16704-2-1 for their specific needs. This reflects the pressure on available possession time. On the ProRail network, signals warning of approaching trains are used in locations where lines of sight are obscured, such as on bridges, in tunnels and near overpasses.

Speed restrictions

Speed restrictions, usually for trains on tracks adjacent to work zones, can be in the form of temporary signs advising reduced maximum speeds. They can be enforced by ATP, using additional balises, by inhibition of less restrictive speed codes in continuous ATP, or by movement authorities with reduced speed profiles.

In most situations a speed restriction alone would not now be considered a sufficient risk reduction measure.

Safety fencing

Fences can be used to prevent workers from accidentally stepping on to a live track. Implementations vary between safety chains on sticks or simple high visibility mesh, to robust fences and railings that will resist a worker falling against them. Several quickly deployable safety barrier systems are available. The requirements for such barriers can be found in EN 16704-2-2.

Mobile enclosures on wheels

A coach-type enclosure allowing access to the track and equipment installed in it allows work to be carried out without requiring a multi-track possession. The mobile workspace can be driven on to a work site. It prevents the workers from leaving the protected area while at the same time using the signalling system to prevent conflicts with other trains (it is no different from any other train from the system's perspective). This method is particularly suitable for work on assets on-track, such as reprogramming of balises.

Implementing possessions and boundary protection

In station areas on Prorail, shunting areas can be configured to provide protected work zones. If the shunting area is activated, a well-defined area of the station's interlocking is isolated.

Once the shunting area has been released (by the signaller) and accepted (in this case by the PICOP), no routes can be set into or within the shunting area. This creates a work zone with boundary protection.

Train alerting systems

In most cases, alerting a train to ongoing work in its path is not a very effective way to safeguard track workers, but it can be used as a supplemental risk reduction measure where traffic is not stopped in or near work zones, for example for engineering trains.

Signs, flashing lights, stop boards etc are used in situations where a train is to be warned that it is approaching a work zone, or an engineering train moving inside a work zone is approaching the limit of that work zone. Where a modern ATP system is fitted it may be used to enforce stopping points, low running speeds, etc. In the USA, at least one manufacturer sells a system which issues warnings to drivers and workforce as a backup to more conventional methods such as lookouts.

Train emulation

Track worker protection systems can use the signalling system's inherent functions that prevent conflicting train paths or moves by allowing the workers to emulate the occupancy of a train. The simplest form is a track circuit operating device (TCOD). The TCOD when placed between the running rails connects them together electrically, emulating a train and occupying the track circuit.

TCODs can be locked in place to prevent mistaken removal. More recent

Remote disconnection device trackside (RDD) installation.
Photo Network Rail.

implementations can use remote control to start and stop the track shunting function. Thus the devices can be installed and left in place prior to a series of possessions, optimising the available work time.

Clipping and locking points

Traditional point clamps and locks can be used to lock points in a position leading away from the workzone or possession.

Hand held terminals

Hand held terminals (HHTs), employing either specific hardware and software or mobile phone apps linked into a central control system, can be used to allow the PICOP to control the taking and handing back of an area under possession.

The HHT can, at least to a degree, use its own location information to check that the area to be placed under possession corresponds to its actual location. When this is deemed either insufficiently secure or insufficiently precise, tags such as RFID or barcode labels may be added, or use can be made of ones already in place for asset identification.

Emulating trains with communications based signalling

In communications based signalling systems such as CBTC, and also in ETCS Levels 2 and above, the principle of using a TCOD to emulate a train can be extended to portable equipment emulating an on-board unit.

Evolution

Many railways approaching the limit of their network capacity, are hoping for capacity increases promised by ERTMS and CBTC systems or are nearing 24 hour, 7 day per week operation. The increased use of the infrastructure is bound to increase the need for maintenance while at the same time decreasing the time available for doing it. This issue is a potential vicious circle, and must be addressed.

The general trend seems to be to enable track workers to establish a safe working zone themselves, and to delegate the authority to authorise movements such as engineering trains into, out of and within the area under possession to a PICOP.

The tendency is to plan the required possessions into the timetable as much as possible, minimising signaller or dispatcher involvement in decision making, and to implement technical systems that minimise the time wasted in handover and handback. An example of such practices can be seen in the use of HHTs as part of the ERTMS system in the Netherlands and in current developments in Denmark and for Positive Train Control in the USA.

Where possession cannot be used for whatever reason, many railways have or are bringing in SCWS as the most acceptable alternative form of control.

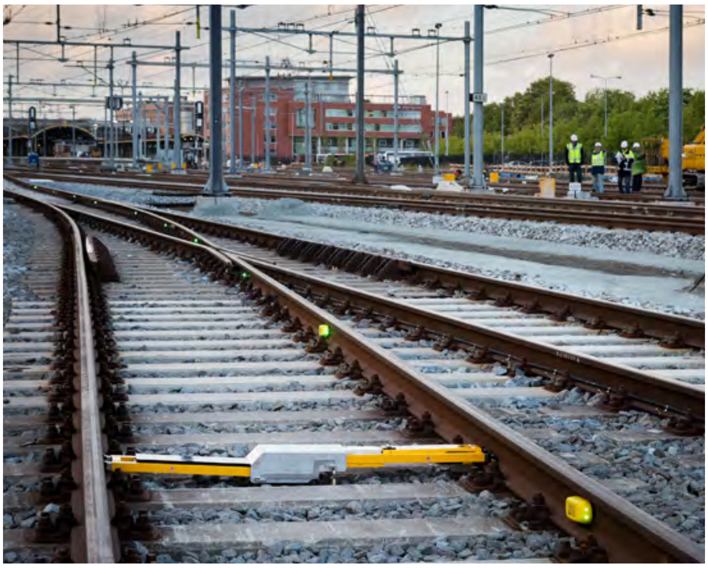
Strategies

Prevention is preferred

EN 16704 includes a hierarchy of measures with full separation preferred, signal controlled warning systems as second choice, followed by automatic warning systems and only then systems requiring human vigilance.

In line with existing strategies for dealing with occupational hazards, Prevention is the guiding principle. It follows then that stopping train traffic when workers are active is the preferred option. This can be done through taking possession of a line or station, or where this is not possible

Track circuit operating device remote control devices used to set up a protection area.
Photos Dual Inventive.



by taking possession of one or more tracks and ensuring a physical barrier prevents personnel from entering the area under possession.

Where prevention is impossible, the second best option is to control the hazard either by reducing the probability, or by mitigating the consequences. Such practices include the use of warning systems, speed reductions and safe havens where workers can remove themselves from the path of an approaching train.

The following are some examples of developments in progress or recently completed, the list is by no means exhaustive.

ATOS (Japan)

In Japan, in their conventional traffic control systems, route setting for shunting and track worker management and protection is excluded from interlockings because of the complexity that would be needed; these functions are carried out locally at stations (it is too complicated to control them from the control centre). This means that there is little or no benefit from introducing conventional traffic control systems into Tokyo metropolitan commuting lines, due to the numbers of station staff that would need to be retained.

In JR East's new autonomous decentralized transport operation control system (ATOS), maintenance workers themselves request access with the support of the system, and maintenance work and train collision prevention are realised by the system, and as a result safety and efficiency have improved.

The difference between conventional traffic control centres and the specific features of ATOS is that its automatic route setting for trains covers all stations including large ones. The dispatchers interrupt or change the route setting for trains in the event of traffic disturbance, but they do not need to be involved in route setting for shunting nor track worker management and protection because these functions are carried out by the interlocking systems and workers themselves.

TMS (Denmark)

In Denmark the ETCS based signalling system that is currently under development and test will provide a more advanced means of defining and managing possessions.

The traffic management system (TMS) allows the use of planned possessions integrated into the daily online production plan (OnPP). It provides interfaces to control room users for setting up, modifying, negotiating and handing back possessions jointly with other task owners.

The TMS supports the HHT control room user in cooperating with the PICOP to start a possession properly through a messaging infrastructure, sending and receiving notifications to and from the PICOP. The control room user must approve a possession started by a PICOP, or can request a possession themselves. The TMS also supports possessions not associated with an HHT, issuing the necessary route controls or points movements. It also supports setting up emergency temporary speed restrictions.

Railroad worker protection system (USA)

Of the various PTC implementations in the USA (there are essentially four different PTC solutions), some require an HHT and vehicle-mounted terminal based solution for Railroad Worker Protection, interfacing to a maintenance workstation which is integrated into the office system which is the heart of the PTC wayside. This allows the rapid and secure handover and handback of possessions and line blocks in a similar way to the Danish ETCS based system above, but in the USA the principle of a handover and handback between worker and dispatcher seems to be still preferred over a higher level of timetable planning. This probably reflects the predominantly freight nature of US railroads with less repetitive timetables.

Austria

Like a number of other European railways, ÖBB has reacted to the pressure on capacity and reduced availability of possession time by opting to develop a more comprehensive and widely deployed SCWS.

UK

In addition to reducing the need to visit track through intelligent infrastructure, Network Rail has endorsed a Track Worker Safe Access Strategy. This targets the reduction of the national risk profile of track workers being struck by trains through development and deployment of enhanced protection and warning systems. These must be of a high reliability and remove the opportunity for human error. The deployment of this risk reduction strategy is planned as a phased approach over a number of years.

Network Rail's safer trackside working programme (STW) is designing and developing new protection and warning systems. These will be both tactical short-term solutions, to give some early reduction of risk, and longer term sustainable solutions aligned to deployment of digital railway technologies.

This strategy for sustainable risk reduction is built on the following principles: - Highly reliable train blocking systems and technical activated warning systems with:

- Low human error failure modes.
- Low installation failure modes.
- Low operator competence.
- Low hardware costs.
- Low installation costs.
- Low system maintenance costs.
- A large number of installations, to maximise geographic coverage and availability to track workers to gain maximum impact to the risk profile.

Tactical systems

Remote disconnection device

The RDD (remote disconnection device) concept was developed by staff simultaneously at Manchester and London Bridge Delivery Units. The RDD is designed to mimic the signal disconnection facility available in solid state interlockings (SSI), allowing the process to be used in traditional relay signalling architecture. This provides additional protection for a line blockage beyond that provided by a signalman's reminder appliance.

A signalling technician activates the RDD from a terminal, using Control Agent software, on the instruction of the signaller, after he has put the primary protection in place. This is in line with the existing Rule Book process. The RDD remote control switch is cut into the existing track circuit of the existing relay signalling architecture. This technology is being prepared for trial on Network Rail infrastructure this year.

LEWiS

LEWiS (lineside early warning system) is a retrofittable SCWS. LEWiS will be deployed at tactical locations on the network, typically at critical junctions. LEWiS is composed of two key components: an SSI message interpreter known as the Interlocking Monitor and a portable sounder with visual beacons known as the Warning Device.

The Interlocking Monitor units are left in situ in a signalling location case or adjacent weatherproof enclosures. When the track worker team want to use the system, they connect the portable Warning Device to the Interlocking Monitor via a plug coupler.

The Interlocking Monitor is programmed to 'listen' for specific SSI telegrams via a connection at the data link monitoring test points. These trigger telegrams are selected to give sufficient warning time for a team of workers to move to a place of safety at a predetermined fixed warning

Above LEWiS interlocking monitor and right LEWiS warning device. *Photos Network Rail.*

area. The device will also warn if there has been a critical error with the device, to provide the users with an indication that the device cannot be relied on.

LEWiS is a primary protection system and replaces the need for traditional distant lookouts. The warning unit weighs less than 5 kg, is non-metal and free standing, and designed to meet noise and light emissions in accordance with BS-EN-16704-2-1.

LEWiS will be trialled on Network Rail infrastructure during 2018.

Strategic systems

In order to deliver its asset management strategy Network Rail needs access to the track to perform maintenance and enhancement activities. Digital Railway facilitates the optimisation of capacity and in some cases the reduction in train headways. Consequently, it has been necessary to provide both a highly reliable protection system and a highly reliable warning system in order to enable the maintaining of assets without compromising safety.

The Traffic Management Protection System is a high integrity protection system that removes human error failure modes, reliance on signalmen and safety critical communications. Protection will be able to be established via a mobile application integrating with the Digital Railway Traffic Management System. It will introduce new possession management rules and make more efficient use of track access.

The strategic signal controlled warning system (SCWS) is a new high integrity, highly reliable system that can be deployed over whole lines of Route. It provides an automated warning system for trackside workers of the approach of trains towards a site of work. The objective is to reduce the reliance on lookouts during open line working and remove human error modes associated with lookouts. In essence, portable warning units will triangulate their position and communicate with a main control unit connected to Control Centre signalling equipment. The control unit will interface with the interlockings via EULynx data protocol and build a model of the state of the railway. It calculates the warning criteria to allow workers at the portable field unit to reach a position of safety. Network Rail will let a contract in 2018 to undertake feasibility studies, product development and deploy prototypes.

So where is technology taking us?

The introduction of communications based signalling systems in rapid transit and ETCS level 2 or above (or similar systems such as PTC) on main line railways offers the potential to use the centralised knowledge of the positions and speeds of trains for better management of possessions and in automatic track worker warning systems.

Systems that use individual warning devices as well as those that use collective warning devices can be activated on the basis of issuing movement authorities that overlap the warning zones. The logical extension of this is to treat track workers as a special kind of train—one that can “drop out of the sky” when a possession is given and taken, and “evaporate into thin air” once more when the possession is given up and taken back. The possession zone itself can then be treated as a special movement authority, for a “train” that is stationary for most of the time (although there is no fundamental reason why it should be).

Special care must be taken that track workers’ auto location processes have enough resolution to prevent them either locating themselves on an adjacent track, or entering such a track mistakenly. A number of current implementations use RFID tags attached to infrastructure elements and readers to mitigate this hazard, and Sudhir Prabhu has suggested this solution [3]. Although it would be possible to implement such logic in an ETCS radio block centre, the required standardisation and incorporation of such functions in the ETCS specifications through the European Railway Agency might be prohibitively cumbersome. An ATWS trackside system would have to be able to emulate an ETCS on- board EVC to a sufficient degree, be registered in the RBC to be able to start a communication session etc. to be able to take and give up a possession.

The hand held terminal approach as described in the Danish example would offer a more pragmatic approach, but on the other hand potentially imports a required SIL into the TMS, which is undesirable in other ways.

There are certainly many initiatives in process, and the new EN 16704 attempts to introduce a logical structure and a more standardised approach, albeit its first issue has a few obvious challenges. It will interesting to see how things mature and develop over the next few years.

Acknowledgements

The authors gratefully acknowledge the contribution made by Sudhir Prabhu (University of Birmingham) to this paper.

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Specifying the unmanned railway

Robert Cooke
Land Transport Authority, Singapore

Robert's article s was originally presented at the IRSE's flagship ASPECT conference in Singapore last year. This is the third of our articles based on papers from the conference, and we plan to bring you more during the coming year.

Unmanned trains were first launched in Singapore in 2003 with the aim of providing a fast, efficient high-performance mass transit solution and setting the standard for the islands future mass transit lines. The paper will examine key elements of the unmanned system that system designers need to consider from an operations and technical perspective.

Introduction

Specifying any modern signalling system is difficult as modern communications based train control (CBTC) systems consist of complex sub-systems such automatic train control (ATC), computer based interlocking (CBI), automatic train supervision (ATS) and radio all sitting on a modern fibre based transmission network. The days of one person fully understanding every part of the system in detail are long gone.

Adding unmanned operation (GoA4) to the mix provides further complexity. This pulls in new external interfacing systems and adds complexity to those that already exist. If all cities had the same operating concept after a few systems had been rolled out it would become straight forward, but alas this seems a long way off and every city has its 'must have' features – much to the frustration of suppliers who must adapt their baseline solution to each new client. Each supplier's system has subtle differences, so what should you ask for to ensure that a fair comparison can be made? Where will the supplier innovate and where should the client insist on innovation. Some examples follow, but the scale of the challenge means this paper can only highlight some key features, due to the complexity of the modern CBTC system.

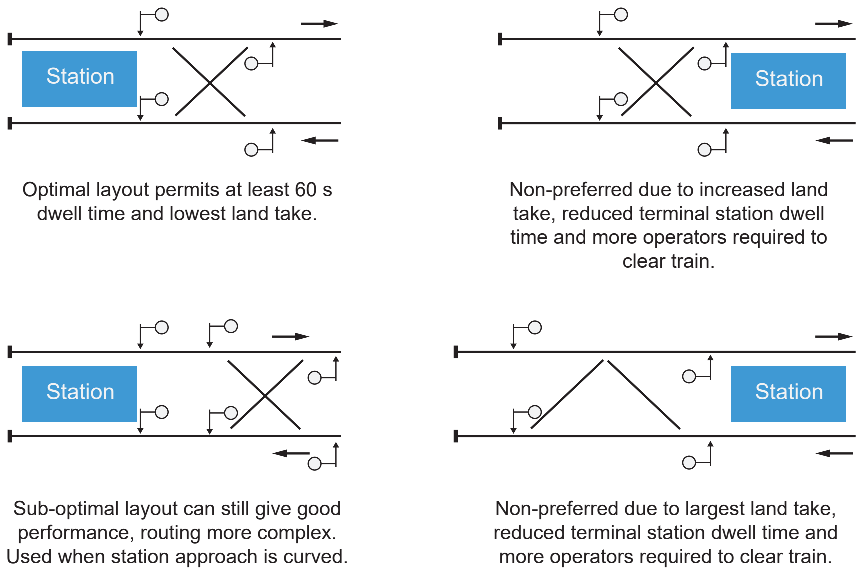

Figure 1 – Terminal station layouts.

Specifying the system

Line concept – performance planning

Whether the line is a greenfield or brownfield site, there will be physical constraints that determine the performance of the line regardless of the signalling system supplied. Decisions should be made as to what the signalling system can realistically achieve.

New lines

For new lines, generally there is more flexibility but even new lines will be faced with challenges. When building new lines through existing cities, piled foundations, existing lines and services all place constraints on the design. Whilst many services can be diverted, the potential impact of settlement on properties can severely restrict the alignment. Efficient track maintenance calls for a 'Hornby' style of track design, where only standard turnouts are used to minimise spares. As such points and crossings may only be permitted on straight track.

Existing lines

For existing lines, there will already be information on the performance and the pinch points should already be identified. Depending upon the existing system, if the terminal station performance is constraining the line it is likely to do the same when a CBTC system is applied (see figure 1). Thus, decisions need to be taken as to whether layouts need to be improved and if so whether the alignment will permit such changes to be undertaken economically and with an acceptable level of disturbance to the existing customer base. However, if not done before or during the resignalling such changes may prove very costly to make once the signalling system has been commissioned, unless a framework agreement has been agreed for future works.

Rolling stock

The performance of any system will depend greatly on the performance of the rolling stock. For CBTC systems the train performance characteristics are very detailed and slight variations in traction, braking and system reaction times can have a significant effect on performance. For new lines where existing stock cannot be measured the signal engineer must work closely with their rolling stock counterpart to agree the parameters that the rolling stock will be designed to. Some of the essential characteristics are listed below:

- Emergency brake rates defined for specific levels of adhesion (surface and tunnel).
- Service brake rates.
- Brake blending.
- Tractive effort curves.
- Jerk rate.
- Traction cut off delay.
- Brake build up delay.
- Train mass (empty and maximum passenger load expected in service).
- Rotating mass (to ensure braking on different gradients).
- Number of passenger doors (to determine realistic passenger dwell times).
- Door opening/closing times to determine available. passenger exchange time.
- Train length.
- Number of motor cars.

In the planning stage, it will not be possible to define these exactly, but good estimates need to be used to undertake a line simulation to determine capacity. During the feasibility study phase of a new line undertaken by a contractor, they must undertake simulations and be expected to justify the rolling stock and signalling characteristics used. Once the line has been designed an in-house simulation using a suitably configured CBTC signalling simulator should be used to determine the raw line performance before pinch point management commences. Every alignment will have one or more pinch point that determines the maximum capacity. As long as they are not at terminal stations then suppliers would be expected to adopt strategies to eliminate them and achieve the desired headway.

Terminal station design

Terminal stations and any station where scheduled reversing moves will occur must be carefully designed to ensure that the performance of the overall line is not constrained. For Singapore where cut and cover construction techniques are used for station construction the station box size is critical and so terminal stations are island platforms. The best performance is achieved when a scissors crossover is placed in front of the station and trains enter alternate platforms with a minimum of 60 seconds dwell. This is not always possible and so other point arrangements may be provided. Staggered crossovers on the approach to the station are still effective but performance will not be as good as a scissors crossover. Placing the scissors crossover further away from the station is also an option but requires additional short routes to allow departing trains to safely approach a crossover that is in use by an arriving train. Reversing behind the station is possible but this effectively turns the terminal station into a through station for the train. It restricts the available dwell time which for short trains may be manageable but for six+ car trains ensuring that all passengers have alighted before sending the train to the siding becomes challenging for station staff. The unmanned train will have to have effective automated announcements on the station approach to ensure that all passengers are aware that they are approaching the terminal station and need to alight.

Specifying performance and determining supplier capability

The tender phase for any CBTC signalling system is critical. Each supplier's system will behave differently and they will have different approaches for pinch point management. For the unmanned railway ensuring maximum available passenger exchange time as part of a long dwell time is a major safety and operational factor that contributes to the effective line operation. For Singapore dwell times are defined as follows:

- 28 s for non-interchange stations
- 45 s for interchange stations
- 60+ s for terminal stations

For the unmanned railway, it is not acceptable to compromise on the passenger exchange time and a safe system is one where passengers have finished entering the train as the doors start to close. Additional doors help and for the Thomson Line cars will be equipped with 5 sets of double leaf doors, providing 25% increase in access to the train. Queue lines also help to give space to exiting passengers whilst marshalling the boarding passengers, an approach which works well here in Singapore.

Supplier comparison

During the tender phase, each potential supplier needs to demonstrate the capability of their system to achieve the desired headway. Great care needs to be taken to ensure that the suppliers are using the same baseline. Firstly, a baseline is required. This should already have been done in-house and the various pinch points identified. For the suppliers to make simulations that can be compared they must be given a baseline train. Whilst the real rolling stock characteristics may not be available for a new line it is reasonable to use the characteristics of a comparable train from another project if the train type is similar. Next there needs to be a clear definition of what simulations should be submitted. The following three simulations allow a real comparison of performance to be achieved.

- Minimum journey time accepting headway impacts.
- Adjusted journey time eliminating headway pinch points.
- Terminal station reversing headway.

The minimum journey time accepting headway impacts is an important measure as outside of the morning and evening peak it is unlikely that the operator would need to run at such a headway. The adjusted journey time using profiles that are of lower performance to allow closer train spacing at pinch points is needed to assess the overall increase in journey time. If the increase is too much then this may impact the fleet size calculations. The terminal station study is useful to determine how the route release, route setting times of a system affect the terminal station. This is a complex calculation and providing the suppliers with a template to fill out provides both assistance to the supplier and easier analysis for the client when comparing. The above examples should be tailored to a particular project's need. If for example coast is used as energy saving is considered more important than journey time, then simulations with coast should also be submitted.

The method of pinch point reduction is also an important factor. Is it switchable? A new line may well not need its ultimate capacity from day one of operation as rolling stock is progressively purchased to meet the increasing ridership. As such, pinch point solutions may not be needed

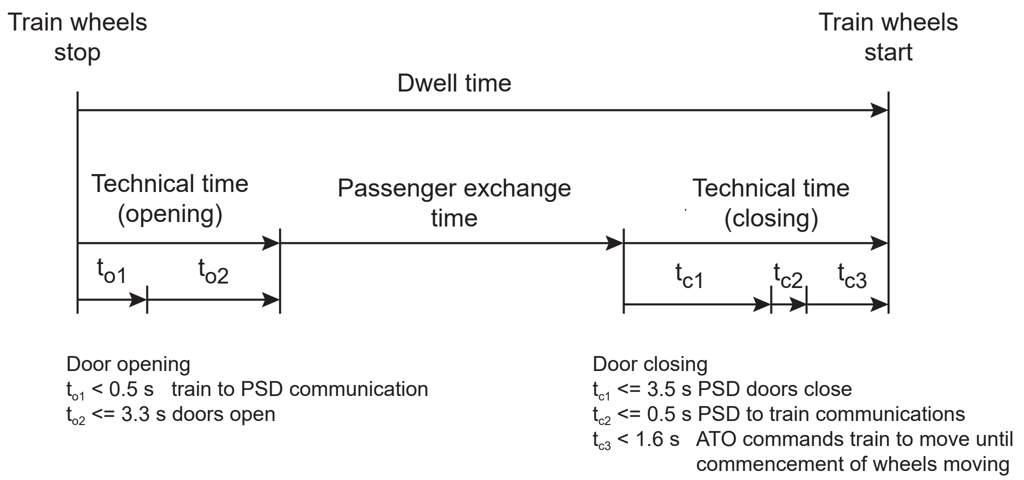

Figure 2 – Technical and passenger exchange time.

initially and so should be switchable or dynamically applied depending on the timetable. Whatever approach is used the dwell times must be preserved for the unmanned operation.

Understanding the role of the train operator

When specifying the unmanned system, the roles performed by the operator must be automated but these go beyond the basics of train operation and announcements. Automatic driving is not new and so the automation of the driving from station A to station B is not a new challenge. The other duties performed by the train operator can be more challenging and it is the degraded modes, where a train operator would step in, that require the most thought.

What are the key functions?

Enhanced automatic driving

Whilst automatic driving is not new, with automatic train operation (ATO or GoA2) an operator can intervene when the train stops incorrectly. There are three features that directly replace the operator as follows:

Jog – This allows automatic realignment in the platform either forward or backwards within defined safety limits. It is essential that a train is properly aligned with platform screen doors (PSDs) otherwise the passenger exchange cannot be undertaken efficiently and there is a risk of doors closing on passengers. The automatic train protection (ATP) system supervises this process to ensure that the train is aligned within +- 0.5m of the stopping point ensuring full use of the train door opening.

Creep – This allows the control centre operator to command a train with a failed ATO to move at slow speed to the next station, enabling operator intervention without having to enter the track to access the train - minimising both delay and risk to the operator. Creep does not have the same stopping accuracy as ATO and as such, the station stopping point is not used to prevent misalignment with the PSDs, which may prevent access to the train. At the station, the train is stopped before reaching the normal platform stop mark to ensure that the rear of the train stops just before the platform, where staff can safely access the train from the station back of house area without the PSDs causing obstruction.

Close stabling of trains to within 3m of another train – This is required due to limited land being available for depots so close stabling of trains makes for efficient spacing. This is challenging for must suppliers and requires the issue of traction inhibit to the rolling stock and careful consideration of the potential position of a non-reporting train ahead that has been put into sleep mode. Whilst the ATO can drive the train to the desired stopping point there is always a residual collision risk. The key is to ensure that the collision risk is at a speed that is below that where the coupler would sustain damage, i.e. at a normal coupling speed.

Automatic platform management and platform screen door operation

For an unmanned train both the train and PSDs must be opened and closed automatically. Door closing warnings must be given and the door closing co-ordinated to reduce the risk of entrapment between the train and the PSDs. Entrapment between the PSDs and the train is a hazard that once the train commences movement has a very high risk of fatality. PSD doors are designed to eliminate any potential standing area between the train and PSD as it closes, such that if a passenger does not move then the PSDs are unable to close preventing the movement authorisation being issued to the train. The main preventative measures are as follows:

- Ensuring that straight platforms are used minimising the gap between PSDs and the train. For older railways with curved platforms additional detection systems would need to be considered.
- Careful train design to ensure minimal gap between the train and PSD at torso level.
- Ensuring that passengers have sufficient time to alight and board the train.

This last point directly relates to the dwell time. The dwell time is split up into three phases as can be shown in figure 2.

This is an area of the design that cannot be left to the suppliers and must be carefully specified. The two technical times for the opening and closing of the doors if left to the suppliers without any requirements may prove to be very long. Unlike earlier relay based systems, the sequential processing of CBTC systems can result in delays. To open doors, the train borne ATO must establish that the train is stationary, transmit the command to the train and the PSDs and the doors then must open. Depending on the supplier this can be a slow process and would typically involve the following sequential steps:

1. ATP proves the train is at rest and berthed correctly and issues door enable to the ATO
2. ATO issues a command to the track side signalling to open the doors.
3. Radio propagation delays
4. ATC processes the door open command and passed to the computer based interlocking
5. The computer based interlocking outputs the door open command to the PSD controller
6. The PSD controller processes the command and commences door opening.

The door closing process is the same except that the PSD closed and locked status must then be transmitted to the ATC on the train to permit the train to move.

Without innovation, this process can take 4-5 seconds before the doors commence opening. This is an area that industry has not perceived as important and some suppliers claimed improvements were not possible. By studying the process and introducing new communications channels, so that the trainborne ATC can communicate directly to the PSD controller, improvements can be made. For the ATP, the concept of assured stopping allows the train to be declared at rest as if the traction is disabled, brakes are applied, train is braking at a known brake rate and is at very low speed, there comes a point where it is impossible for the train not to stop as it takes a finite time for the brakes to release, thus the train stationary status can be achieved earlier than waiting to measure the speed as 0 km/h.

The scope for reducing time during the closing period relies on efficient communications between the PSD controller and the trainborne ATP to indicate that the PSDs are all detected closed and locked. This is less complex than the opening sequence and the closing time is dominated by the closing time of the PSDs which must be carefully controlled to minimise the kinetic energy of the doors to prevent injury should someone obstruct the doors. Once the doors are closed the time taken for the train to move will depend on the holding brake applied. The higher the level of holding brake applied the longer the brakes take to release, as such this requires careful co-ordination with the rolling stock provider.

Other key roles of the operator

The system will also have to perform other key operator roles and some of the more complex are as follows:

Train Wake Up and Sleep – These functions are normally performed in the depot, Train wake up is a complex process whereby a remote command from the ATS system, sent to the train ATC system, is used to power-up the rest of the ATC system as well as all other train systems. During the power-up the train data management system, part of the ATC, will communicate to the train systems and perform its own start-up tests of the ATC system as well as integrated tests of the train systems to determine that the train is healthy and ready for unmanned operation. The health status achieved is reported back to the operations control centre (OCC) to permit the operator to intervene in the event that a train does not achieve the desired state. Sleep is used at the end of the service day; once the train is stabled the ATS issues the command sleep to the trainborne ATC system and this is then used to shut down all the train systems and partially shut down the trainborne signalling equipment (except for the radio communications and wake-up equipment).

Emergency detrainment – There must be a mechanism to allow the passengers to be able to escape from the train safely in the event of an emergency on the train. The general principle is always to get the train to the next platform where evacuation and incident management can be performed more easily than in a tunnel, but there may be occasions when evacuation is required in the tunnel. The trains are equipped with end detrainment doors that can be lowered to provide a ramp down on to the track. Use of the ramp must be carefully controlled to ensure that all trains in the vicinity are stopped and that the traction current has been discharged from the third rail, thus minimising the risk to passengers on the track. In the event of loss of communications between the train and the trackside an evacuation zone is automatically applied around the train by the trackside on the basis that the train is of unknown status.

Fault reporting – With no operator on-board all alarms must now be monitored by the OCC. This increases the workload of the OCC and as such the alarms must be carefully designed. The criticality of alarms across systems must also be consistent to allow the operators to know the comparative importance of different alarms. For this the potential impact on safety/service is assessed to rank the alarms. Alarms are sent back over the redundant signalling communications network and critical alarms for signalling, communications and train systems are also sent back via the non-signalling communications system (TETRA) back to the ATS. The ATS must combine the two sources of alarms ensuring that there is not duplication presented to the operator. Whilst double failures in the redundant signalling communications system should be exceptionally rare, losing critical alarms such as fire alarms for an unmanned train is considered highly undesirable. TETRA can carry data in addition to the voice communications but the capacity is limited. Only critical alarms are transmitted via TETRA back to the control centre providing a diverse path. For a new system this has a relatively low cost overhead as currently there are no suitable frequencies available that could provide the bandwidth for both signalling and voice data comms channels.

System interfaces

System interfaces for the unmanned railway are more complex to permit automation of interface functions that would traditionally be done by an operator. Figure 3 shows the interfaces of a CBTC system. Note that in Singapore locomotives are equipped with CBTC (ATP) and this allows safe running at speed, enabling efficient access to work sites after the traffic day has ended. There are three interfaces that require attention

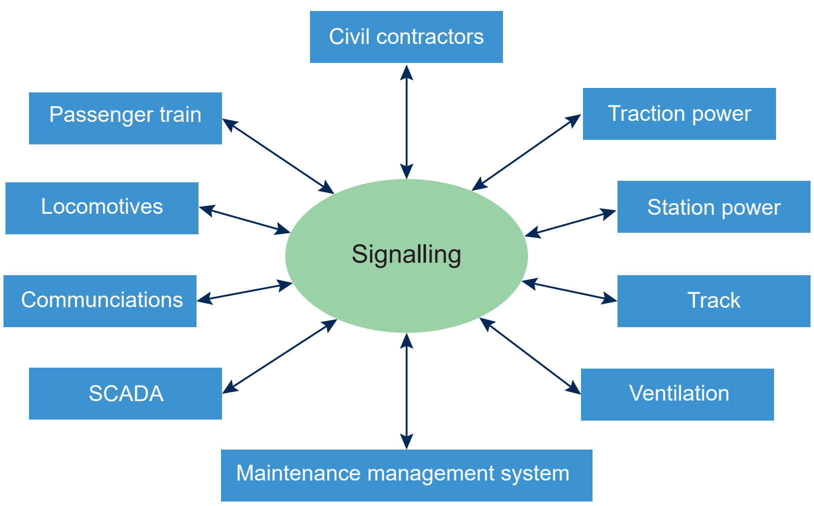

Figure 3 – External system interfaces.

for the unmanned railway and these are considered in more detail below.

Passenger train interface

As has already been discussed above, replacing the train operator requires the signalling to perform many functions requiring the most complex interface of all the external systems. This is an area where specifying requirements requires great care. The requirements for the signalling specification must be mirrored in the rolling stock specification. How much to specify? Too little and there may be problems with the two suppliers converging to a common design; too much and there is the risk of non-compliance due to systems operating differently but meeting the same overall ops and safety requirements as well as the risk of stifling innovation.

There will however be functions where the operations concept is clear and so such requirements can be defined in detail. The more difficult part is defining input/output between systems as different suppliers configure their systems differently and care must be taken not to favour a supplier specific solution. Some key issues that need to be considered for the train interface include, ventilation, location of equipment including cubicles, defining brake rates for both surface and tunnel conditions, mode transitions, mode selector switch combinations, consist formation and valid/invalid consist formations, etc.

Whilst many of these issues are not unique to the unmanned railway when added to the unmanned railway requirements the interface becomes very daunting especially if one of the interface contractors has not supplied an unmanned system before. At the Land Transport Authority of Singapore (LTA), we are looking to develop a skeleton Interface specification that covers most of the fundamental requirements for the interfacing parties on the basis that if they have an alternative solution that meets/exceeds the safety and operational requirements it can be proposed, but if not accepted then a backstop design solution exists.

Train announcements also need to be either remotely made or triggered as well as standard train arrival and interchange information which is triggered on the train. The signalling system will be required to provide triggers based on location, dependent upon the complexity of the message to ensure that the message is completed prior to the train stopping to give passengers time to prepare to alight. With some stations requiring complex messages and some only simple messages the signalling must be able to have the triggers set individually for each station to station run in order to ensure messages are not broadcast too early or late.

Power interface

During a passenger initiated evacuation in the tunnel the signalling must stop trains and discharge the traction supply to the third rail. The interface needs redundancy but also needs to be fail safe, such that in the event of total failure of the interface the traction can be discharged. Similarly, if the traction is discharged trains should not be permitted to enter areas without traction. Determining the extent of traction discharge for an evacuated train needs careful consideration.

The system must ensure that all traction is discharged in areas where the passengers could realistically end up. As shown in figure 4, the presence of cross passages and crossovers mean that passengers could stray onto the other line, especially if there is smoke in the tunnel. Whilst we would expect that passengers would leave the track at the first station we also assume that some might try and exit at the other end of the station and that introduces the next traction section. So, the principle is to discharge the traction on both tracks on the section where the incident train is located and both adjacent sections on each side of the stations adjacent to the stations.

Integrated supervisory control system (ISCS)

The ISCS system is used to set tunnel ventilation in an emergency and the provision of accurate location information is essential as there are no train operators to report where they are. With CBTC permitting multiple trains on a single train detection section this further complicates the train location determination for the operator. The signalling therefore provides the position of all trains to the ISCS system to allow effective ventilation control during an incident, ensuring a smoke free path for passengers to evacuate through.

System architecture

Most suppliers can supply systems in a variety of architectures for both trainborne and trackside systems, varying from completely distributed to totally centralised systems. For the unmanned railway, consideration must be given to how the system reacts to a complete loss of redundancy. Whilst such events should be very rare they cannot be ruled out. Any incident should minimise the number of affected trains. Any failure that results in the loss of communications to the train from the signalling will trigger the evacuation process, stopping trains in the vicinity and discharging traction current.

At this point the operator must quickly decide whether the system can be recovered or whether to commence evacuation as the trains commence load shedding. Under such circumstances the affected area should be as small as possible to minimise the number of trains without power. A totally centralised architecture is unacceptable due to the difficulty in managing so many trains back into service or in the event of an extended shutdown the logistical challenge of evacuating passengers quickly before the batteries drain completely. Evacuation is to be avoided if possible as evacuating in tunnels that can be at over 40°C is a serious undertaking.

Suppliers want to minimise the equipment count and once the location of reversing crossovers is considered, then zones covering 2-3 stations tend to be the best compromise. For a service running at 90 second headway the failure of a zone covering 2-3 stations could affect up to 20 trains which is still a significant incident for operators to manage.

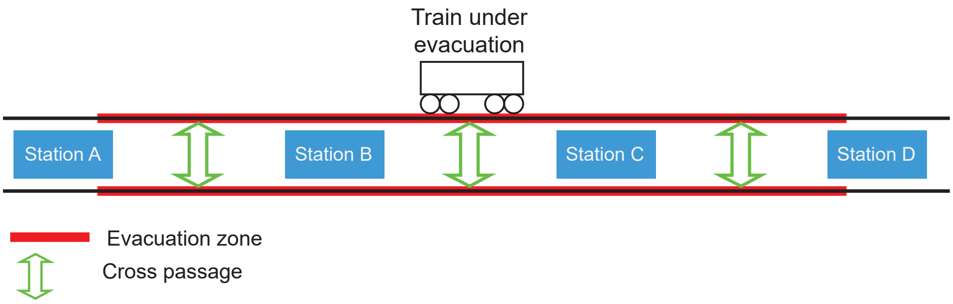

Figure 4 – Emergency evacuation area.

Seen at Gali Batu depot, this is one of the new fleet of driverless trains that have been introduced on Singapore's world-leading metro system.
Photo LTA.

When the implications of failure even for an optimised architecture can affect 20 trains, then the design of the power supply, zone controllers, interlockings and data networks and radio communications systems must ensure that there is true redundancy and eliminate all possible single point failures.

For future lines the provision of diversity, additional stand-by systems in addition to the standard redundancy, are being investigated for key systems to increase the robustness of the system. Experience has shown that interconnection between redundant systems can have systematic faults that bring down both systems, so diversity in design can assist in reducing the impact.

For the trainborne equipment all systems that if failed would immobilise the train must be redundant. Designing out single point failures on the train interface can be challenging and a variety of interface circuits maybe required to cope with the different train circuits, such as emergency brake release, door enable and control, service brakes, traction inhibit, creep etc. I/O redundancy also needs to be done at each end of the train with mode selector, door controls etc. This is generally easier if ATC equipment is placed in both end cars. Main processor redundancy however is achieved on an end to end basis making the redundancy arrangements complex.

Supplier' system vs authorities system requirements

Suppliers ideally want to sell you their system off the shelf, but most clients have their own specific needs that need to be met. The clash in needs of the client specifications and off the shelf solutions needs to be managed to achieve a balance between prescriptive and performance based specifications and ensure that innovation is not stifled.

Whilst unmanned systems are becoming more common they are not standardised and as such each operator will want to keep a common operating concept across lines; only updating when there are improvements that can be made to safety, performance or operability. As such most contracts need to be both prescriptive and performance based. This of course poses a dilemma for suppliers in terms of the compliance during the tender process, as a fully compliant bid may well be significantly more expensive than the supplier baseline solution.

For the Authority, this poses a problem where justifying a higher price bidder to the tax paying public is not easy. Often the criticality of an unmanned feature may not be obvious to a supplier who is so often far removed from the operating railway. Undertaking a rigorous technical evaluation of tenders and then only opening the price for those that reach the required technical compliance certainly helps. Having an appropriate weighting between price and quality can then be used to ensure that the best value for money solution is adopted.

Operator information

The signalling system is one of many systems that supports unmanned operation and the interfaces mean that the operator is often dealing with multiple systems during an incident. Whilst suppliers must provide detailed manuals and training on how their systems work, it is important to provide the operators with a complete picture of the railway. The four systems with the most complex interfaces are the signalling, rolling stock, communications and ISCS.

For these systems, a unified set of manuals is produced in addition to the system specific manuals. All four suppliers provide the information with collaborative editing to produce the 'Operational Modes and Principles' document, which is formed from the following volumes:

Volume 0	Table of Contents
Volume 1	Operations Concept
Volume 2	Normal Mode Operations
Volume 3	Emergency Mode Operations
Volume 4	Degraded Mode Related to Mainline and Depot Operations
Volume 5	Degraded Mode Related to Trains
Volume 6	Degraded Mode Related to Signalling System
Volume 7	Degraded Mode Related to Platform Screen Door
Volume 8	Degraded Mode Related to Communication System
Volume 9	Degraded Mode Related to ISCS
Volume 10	Degraded Mode Related to E&M Services

The manuals are developed in tandem with the system design, the theory being that they are developed from the individual system designs, however in practice as they are developed they tend to identify issues with the design that are not obvious to the individual system designer and so can identify changes in the design stage prior to testing thus saving additional time in the design and testing process. Once complete the manuals are signed off by all four suppliers.

Conclusion

Unmanned railways are complex and must be specified very carefully to ensure that a safe and efficient operating concept is achieved. Suppliers will try to supply their baseline product with as few bespoke elements as possible and so 'must have' features need to be carefully specified. The suppliers need to be told up front that the omission of any features will mean a technically non-compliant bid that may be rejected. Innovation may need to be client driven in some instances where no supplier has an obvious solution to improve reliability or performance.

Interface management and definition must be an integral part of the process from specification, design process, testing and operator manuals to ensure the both the operability of the system and understanding of the system by the operators.

Reducing maintenance backlog

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Finnish Transport Agency

The following article was originally published in Signal and Draht, issue 5 of 2017. It is republished here with permission and an update on current progress provided by Juha.

The Finnish transport network (roads, railways and waterways) has been suffering degradation as a result of decreasing funding for routine annual maintenance. It has been calculated that the maintenance backlog for the Finnish transport network is around €2.5 billion.

Programme to reduce maintenance backlog

In order to reduce the maintenance backlog of the transport network in Finland, additional funding of €600 million has been granted for the period 2016-2018. Further funding amounting to approximately €100 million is to be transferred annually from new transport infrastructure projects to basic renovation of transport systems including private roads between 2017 and 2020. Figure 1 describes the need for additional funding levels to stop the degradation of the transport network.

Around €223 million has been granted for railways out of the total of €600 million, in addition to which €101 million from new transport infrastructure projects has been designated for the railways.

Great emphasis has been on railway signalling systems in the maintenance backlog programme. Altogether, €124.2 million has been granted for renewing signalling systems between 2016 and 2020.

Finland's interlocking and signalling systems

In order to understand the problems of the Finnish signalling system maintenance backlog, here is a short review of Finnish interlocking systems. From Figure 2 it can be seen that there are many different kinds of interlocking system. One of the biggest issues for maintenance is that there are some unique interlocking systems. The know-how for them is very limited and, because of competition in maintenance, no company wants to invest in training professionals to look after them, for example for a five-year period of time.

Spares and supplier availability are also an issue for maintenance of some of the interlocking systems. If the system life cycle is coming to its end, there may be no production of new equipment to repair current systems. Also, suppliers are no longer interested in the old systems when it comes to supporting maintenance or making changes to functions or track layouts.

The Finnish Transport Agency (FTA) has made a survey regarding the remaining life cycles of Finnish interlocking systems. Figure 3 describes the situation, where green means that everything is fine for a certain period of time, yellow means that

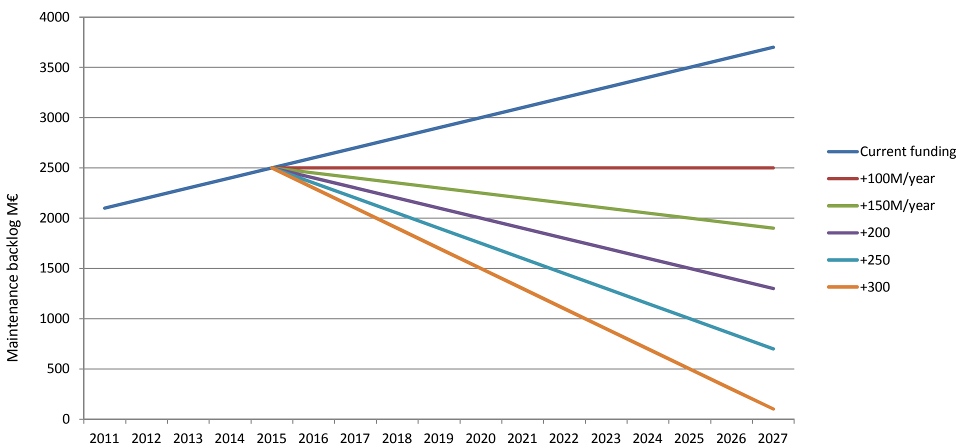


Figure 1 – Changes in maintenance backlog for different levels of funding.

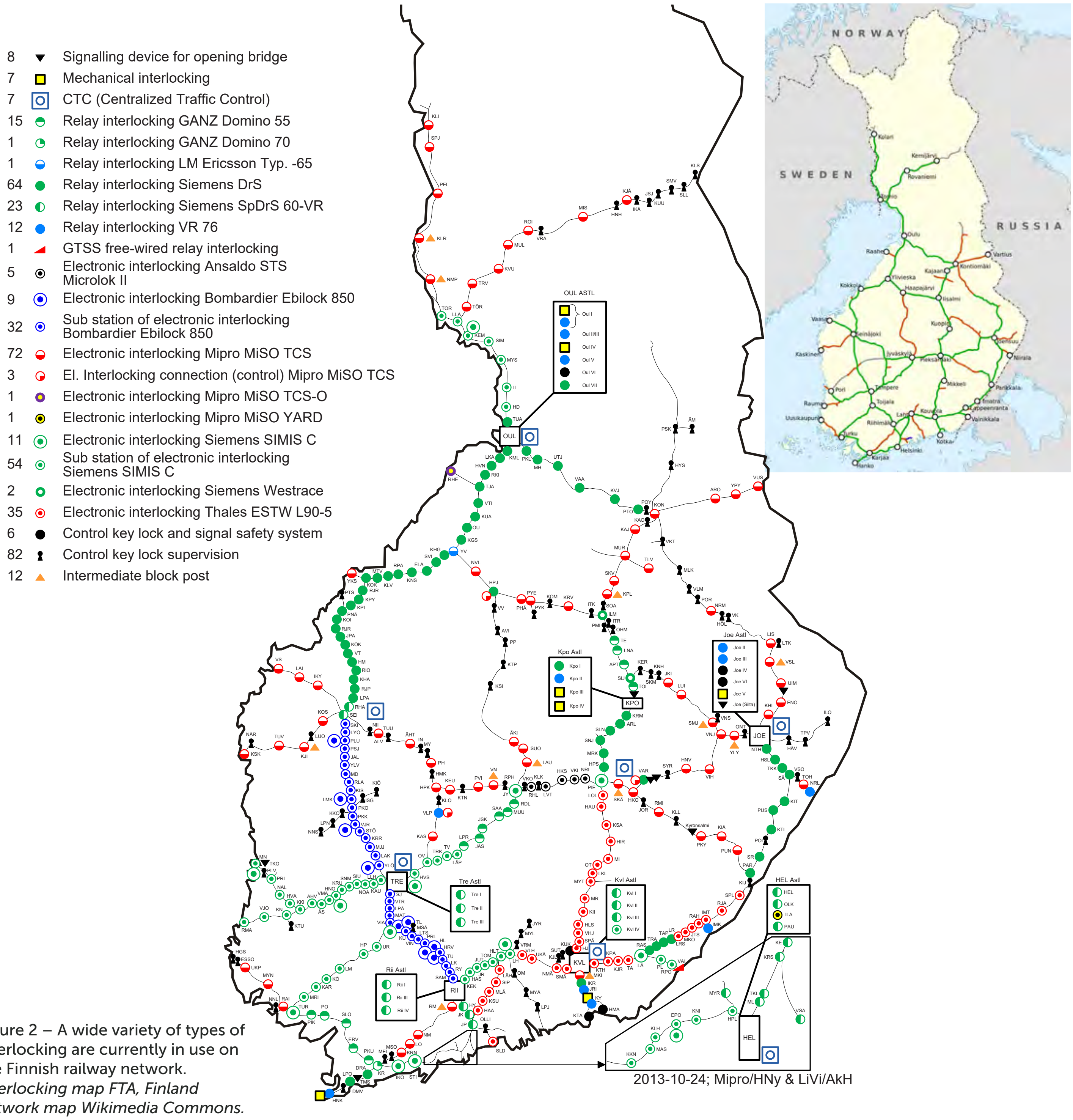


Figure 2 – A wide variety of types of interlocking are currently in use on the Finnish railway network. *Interlocking map FTA, Finland network map Wikimedia Commons.*

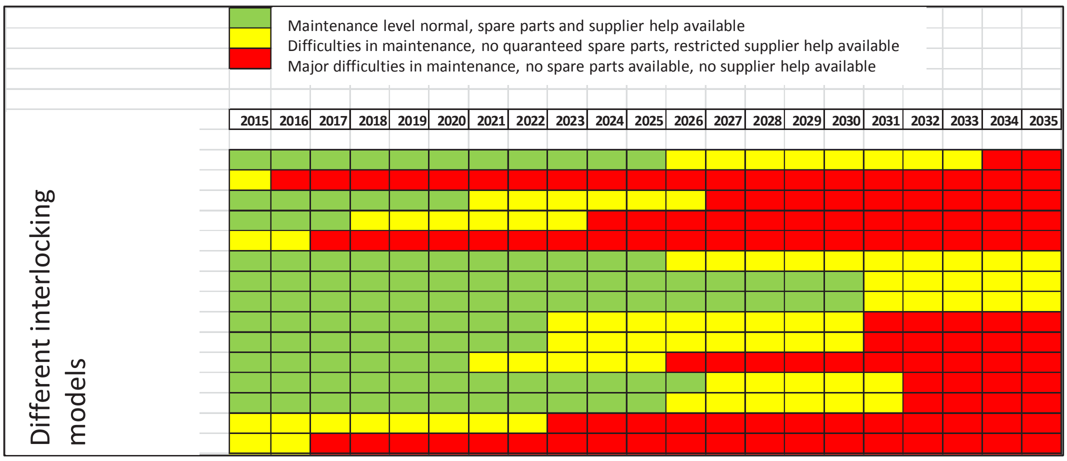


Figure 3 – Lifecycle estimation for different interlocking models in use in Finland today.

there are going to be some difficulties in getting new spare parts or supplier support and red means that no more spare parts are available and that the supplier does not provide any support for maintenance or modifications.

Around a third of the interlocking systems are relay-based, and the rest are computer-based from several periods starting from the early 1990s up to 2016. Age is not a basis for renewing systems. Some relay interlockings are fully functional, have the possibility of being modified and spare parts are available for them, so those still have a long life cycle left. On the other hand, some computer-based interlocking systems are in need of urgent upgrading or renewal.

As Finland's signalling is still based on visual aspects (and will remain so in the near future) we have both bulb and LED–based signal lamps. It is a requirement for newly-built systems to use LEDs, and thus the need for bulbs is decreasing, but still much needed throughout Finland.

Digitisation

Digitisation is a big thing around the world now. The Finnish railway sector also has a strong desire to digitise for the benefit of railway maintenance. More and more predictive maintenance is required to keep the focus of maintenance personnel on doing the right things at the right time. For that, continuous information is needed from trackside elements to interlocking systems for passage on to higher level ones. Interlockings are a key part of this controlling and monitoring of the outdoor equipment.

In the procurement of the new interlocking systems, the FTA, as an infrastructure manager, has taken this into account by requiring an easy interface for providing this information to its own systems, where it is forwarded for use by the maintenance contractor.

Modern traffic control

Train traffic control is becoming more and more automated. In the past, we used to have dispatchers in every station handling the trains, and later the dispatchers moved to centralised traffic control centres, but were still doing manual work (for example setting the routes), the main difference being that the traffic areas were larger. Nowadays, Finland is moving towards more automated traffic control, where computers control the trains according to train numbers and pre-determined schedules. So, there is no longer any traditional dispatching to be done. As Finland is digitising the higher-level systems at a faster rate all the time, this also sets requirements at the interlocking level. If an interlocking system cannot be modified to make it comply with the requirements set by the digitised new world, it must be renewed at some point.

Another example concerning modern traffic operations (apart from controlling trains) are track works. In theory, protecting track work could also be automated. Whenever a company wants permission to work trackside, it must submit a reservation request for a certain location. That request is then handled and approved by a coordinator responsible of scheduling track works and train traffic. Once the request has been approved, the system has to generate track blocking or request automatic blocking (within the functional rules of the interlocking system). That will then remove the possibility of human error failing to provide the correct protection of the track work at the right time and in the right location.

Date	Process
25 February 2016	Market information.
7 March 2016	The public procurement notice was issued. six applications to tender were received.
22 April 2016	The invitation to tender was sent to four tenderers..
16 - 19 May 2016	During the tendering period a presentation meeting concerning the invitation to tender was arranged for all tenderers. At that meeting, the FTA presented the material in the invitation to tender to all tenderers separately. The purpose of that was to make sure that every tenderer understood what the customer wanted.
20 June 2016	Three offers were received for the procurement part one and four offers for the procurement part two.
1 July 2016	The purchase decision was published.
9 September 2016	Contracts signed.

Table 1 - Procurement process timing.

Renewal programme

The locations for the maintenance backlog signalling system renewals were selected according to the survey made by FTA.

Locations

The most critical locations were suggested for funding, and out of the original €600 million funding the following were selected:

- Vainikkala yard.
- Kotka/Kotolahti and Mussalo yard.
- Riihimäki-Tampere line section.

These three with Niirala yard added to them (already decided on before the maintenance backlog funding) are to enter service by the end of 2018.

In addition to these, the following received funding from the additional resources for big investments:

- Ylivieska yard.
- Kotka/Hovinsaari yard.
- CTC Eastern Finland.

These three are to enter service at latest at the end of 2019.

As the funding was decided in January 2016 for the first three, time became the most important factor for the procurement. The first thing was to arrange market information about the upcoming procurement. It was a great success with participants from more than 15 companies interested in different kinds of tasks related to the projects. The additional three locations are still pending.

In general, for these projects one procurement was arranged with two parts as follows:

1. Vainikkala, Kotka/Kotolahti and Mussalo and Niirala yards.
2. Riihimäki-Tampere line section.

Both procurement parts also include an option. For procurement part one, there is an option for renewing the signalling on the line from Kouvola to Kotka and Hamina. For procurement part two, the option is to renew the signalling on the line from Tampere to Seinäjoki. One company was only allowed to get one part. The decision was to be made by the winning company and it was required to indicate in its tender which part it would prefer if it were to win in both parts.

Very tight schedule

The whole procurement process was carried out during spring 2016. The very busy schedule was as shown in table 1.

This kind of busy schedule sets high demands on both the buyer and the tenderers. In the end, it can be said that there was barely enough time. The quality of all offers was very high, and they were highly comparable. The comparison basis was:

- 40% for quality, divided into:
  - 10% for life cycle control management plan.
  - 10% for standard time schedule.
  - 20% for a test for key personnel offered.
- 60% for price, divided into:
  - Price for basic content.
  - Price for option.
  - Price for yearly maintenance.
  - Price for small and large modification.

Details of the locations

Procurement part one

Vainikkala

- Internationally important railway operating location.
- One of the most notable railway operating locations on the border between the European Union and Russia.
- The only railway operating location on the border between Finland and Russia with regular passenger traffic.
- Unique current interlocking system.
- More than 30 tracks of mixed main and shunting routes.

Kotka, Kotolahti and Mussalo

- The Kotka railway yard consists of seven parts that form three larger entities in the railway operating location.
- The railway operating location of Kotka functions as a stopping point and terminal for passenger traffic and as the harbour's railway yard for freight transport.
- Several interlocking systems currently including unique and very old technology.
- More than 20 tracks of mixed main and shunting routes.

Niirala

- Railway operating location on the border between Finland and Russia.
- Daily freight traffic between Finland and Russia.
- 15-track railway yard of mixed main and shunting routes.
- Currently very old technology.

Option Kouvola-Kotka/Hamina line

- 35 km double-track line and 36 km single-track line.
- Freight and passenger traffic.
- Mixed interlocking base currently.

Procurement part two

Riihimäki-Tampere line

- 110 km double-track railway.
- Two larger stations (maximum ten tracks).
- Main railway route in Finland with heavy mixed traffic of freight and passengers.
- Interlocking equipment of the railway yards of Riihimäki and Tampere is not included.
- Relay interlockings are the technical interface in Riihimäki and Tampere.

Tampere-Seinäjoki line

- 160 km single-track line.
- Tampere and Seinäjoki not included.
- Important corridor for passenger traffic from south to north.
- Relay interlockings are the technical interface in Tampere and Seinäjoki.

Current situation

Procurement part one

The Niirala railway yard's new signalling equipment was taken into use in December 2017, a couple of weeks earlier than planned. At the moment FTA in conjunction with the supplier is monitoring the reliability, availability and maintainability values set in the contract. The Kotka and Vainikkala railway yards are currently under construction despite quite heavy winter conditions in Finland. The estimated schedule for commissioning is for both locations is later this year. Kotka first after summer and Vainikkala, the border station, will be the last taken into use around the end of the year 2018.

The FTA requires all new schemes to use LED signals. *Photo Simon Toikkanen.*

Procurement part two

The line between Riihimäki and Tampere is almost complete on-site and the final factory acceptance tests are ongoing. The on-site commissioning activities will begin around March and will last the rest of the year. The planned take into use date is just before Christmas 2018. In this commissioning there is a lot of coordination work to be done between the project and operators as the railway section is the busiest mainline in Finland with mixed passenger and freight trains. Final construction works are also in progress during the Finnish winter conditions with roughly half a meter of snow and 0 to -20 degrees Celsius outside.

General

Despite the very tight procurement schedule we can say that so far it has been a success. Both parts are on schedule and there has been only a small amount of negotiations related to additional works. This year will show how well the contracts work out in the end.

Additional funding locations

The Hovinsaari signaling renewal has just been procured and the Ylivieska signaling is under procurement. The CTC Eastern Finland was also successfully procured and contract just signed in January 2018.

Requirements

The FTA has a collection of requirements called "The Finnish interlocking requirements" (FIR). The FIR includes technical, functional, operational and Reliability, Availability, Maintainability and Safety (RAMS) requirements combining over 4500 items. These are fulfilled with project-related requirements such as design documents, including track layouts, route tables and other functional and operational designs.

A basic high-level requirement in Finland is that if there are main routes included all system functions must fulfil SIL4. The maintainability of the signalling system and availability of spare parts must be assured for at least 25 years.

More detailed requirements include country-specific functions, such as visible signal pattern and aspects and how to generate a route and what the monitoring conditions are. Also, requirements for shunting work are included in the FIR basically containing operation with buttons outdoor inside a specific local operating area for setting shunting routes.

RAMS requirements are more or less adopted straight forward from the Euro-interlocking documentation with only minor parameter settings done in Finland.

Buyers' contribution

The FTA has a strong willingness to contribute to suppliers' work to achieve all these requirements. For example, the buyer has arranged preliminary factory acceptance testing where Finnish interlocking specialists are sent to suppliers' premises to help interpret the requirements. This has been found to be a very beneficial way of working. The supplier can show the experts from a demonstration operating panel if their interpretation is correct. There is also an opportunity for the experts to point out the often challenging parts before the software is frozen for a release.

In the maintenance backlog projects, the supplier sits at the same table as the final construction designer. The benefit from this is quite major, for example when designing cable routes and final layouts for equipment rooms.

Through these buyers' activities the FTA wants to make sure that no difficult surprises will occur later on during the system build phase or, even worse, during commissioning.

In general, in these projects the FTA wants to create an atmosphere in which we can work together towards the same goal. The management of the whole project is as open as possible when working under the contract. In this way, decision making is not too heavy but remains flexible.

Future plans

The FTA takes the maintenance backlog problem very seriously and is working on preventive matters. One very important step is to start educating the people working on signalling systems. Brand new educational facilities will be opened for all track work and maintenance works in Finland during 2017. A strong focus is on signalling systems. Education is to be planned and controlled by the infrastructure manager. That leads to better understanding of the current systems and by that to wider range of experts working on modification projects.

Digitisation will be used to steer the maintenance work to be more preventive rather than reactive. The interlocking and CTC systems play key roles in that, as they are the interface between the equipment and maintenance. There are several improvement projects going on which using applications and available data from the signalling systems is to be taken into use to help the process of planning maintenance.

For example, with these the FTA wants to be in a position in future where at least for signalling systems the maintenance backlog would not be so big. That is also a huge cost-driver with less need for large investments and more focus on sustainable maintenance of current equipment.

Summary

The signalling system renewal project is historically large by Finnish standards. By this kind of investment, the infrastructure manager can assure a high level of RAM for years to come. Simultaneously, the FTA is putting a lot of effort in preventing the maintenance backlog having an impact on the usability of the Finnish railway network. The signalling systems are also seen as a key part in digitising the railways and thus are in constant need of renewal and modification.

An aerial view of Helsinki central railway station taken in January 2018.
Photo Shutterstock/Karavanov_Lev.

Industry news

ERTMS and TMS for Norway by 2034

NORWAY: The Norwegian national rail administration Bane NOR is planning the procurement of a new signalling system based on the European Rail Traffic Management System (ERTMS) standard. The goal is to renew most of the existing signalling systems on the railway network by 2034. The project includes signalling systems, onboard equipment and a national Traffic Management System (TMS).

The modernisation programme will increase the attractiveness of rail travel through improved passenger service as well as delivering environmental, social and economic benefits to Norwegian society. The renewal project is also driven by the need to replace older signalling equipment that is harder to maintain and less reliable.

A NKr 600m (£59m, €63m, $78m) contract has been awarded to Thales for a new TMS system based on Thales's ARAMIS TMS which has been substantially enhanced to provide a cyber-secured, cloud ready platform with a fully adapted human machine interface.

The TMS will replace three existing systems and Bane NOR say it is crucial to provide a state of the art system to make the most of their existing infrastructure, deploy more trains on the network and deliver an efficient, high-capacity railway system to improve train punctuality, enhance passenger safety and comfort and facilitate the mobility of people and freight throughout the country.

The project will be rolled out over the next 17 years, and the contract includes support, maintenance and cyber-security services. The Thales TMS will have an interface with the existing systems during the migration period, ensuring a smooth transition to the new system.

Bane NOR has also announced plans for ERTMS signalling to be supplied by Siemens worth NKr 5.5Bn (£510m, €579m, $717m) and in addition Alstom has a contract for the delivery of onboard equipment for the trains worth NKr 2Bn (£185m, € 210m, $259m). The new systems will be delivered over a period of ten years.

Norway's 4000 km rail network will benefit from a massive investment in ERTMS and TMS. *Photo Shutterstock/Thor Jorgen Udvang.*

The supply will include system development, design and build for around 400 vehicles owned by Norske Tog, Cargonet, Flytoget, Bane NOR and a range of other companies with a smaller number of locomotives and plant. The 14 companies involved will now enter into individual contracts with Alstom for ERTMS equipment for their vehicles.

First ATO passenger operation on London's Thameslink

Govia Thameslink Railway (GTR), working with Network Rail and Siemens, have claimed to achieve a world-first by running ATO (Automatic Train Operation) over ETCS (European Train Control System) on a mainline railway in passenger service.

On Saturday 17 March, southbound 8-car Thameslink train 700019, destination Three Bridges, brought itself to a halt automatically at London St Pancras International at 13.53 having transitioned into ETCS Level 2 Full Supervision and then ATO on its approach from Kentish Town.

With the driver checking the platforms, closing the doors and then selecting ATO again, the train with its in-cab signalling then continued under automatic control through Farringdon, City Thameslink and London Blackfriars. It finally transitioned out of the system on its exit from London Blackfriars, as it headed towards Elephant & Castle.

The run followed nearly two years of on-track testing and has paved the way for further runs. The runs will not only help build industry confidence in the system but also facilitate the commencement of driver training in readiness for the increase in services.

The system will allow a high intensity Thameslink service of up to 24 trains per hour each way with 70% more seats through the centre of London, linking new communities and cutting journey times for thousands of passengers.

Working with Network Rail and Siemens, GTR has run nearly 200 night and day shifts of testing since April 2016 when it began proving ETCS dynamically at Network Rail's ETCS National Integration Facility at Hertford North in April 2016 and has had to demonstrate to the regulator that it has made the necessary amendments to its Health & Safety Management System to allow for the trains to operate in both ETCS & ATO in passenger service.

ATO will initially operate between St Pancras and Blackfriars in May 2019 (22 tph), being extended to London Bridge in December 2019. Under ATO, the driver presses a button and the system takes over. The driver still undertakes safety checks, closes the doors and selects ATO again.

Why do signalling projects fail?

Photo Shutterstock/eteimaging

Prepared on behalf of the International Technical Committee article by Alan Rumsey

Why do signalling projects fail? The reason for asking this question is that, in recent decades, the frequency at which projects fail appears to be increasing rather than decreasing.

There is a growing concern and frustration amongst some operators that signalling and telecommunications technology deployment is too slow, which leads to the unfortunate perception that the profession lacks innovation and is incapable of successfully delivering upgrades in a timely fashion. If this is indeed the case, then it is important to fully understand the root cause or causes of project failures.

For the purposes of this article, a project is considered to have 'failed' if it fails to deliver the anticipated business case benefits in the planned and contracted time frame i.e. the project is 'late'. In extreme cases, the contract may be cancelled, and the work never completed, or the contract may be re-bid resulting in additional delay. More typically, the actual project completion date is many months or years after the originally contracted completion date.

When a project is late, there are inevitably financial and reputational implications for the parties involved in implementing the project. In addition, to minimise schedule and budget impacts, it often becomes necessary to reduce the originally contracted scope, with potential consequential reductions in the anticipated business case benefits. In an attempt to maintain the schedule, there is an increased risk of 'cutting corners', leading to errors, omissions and rework that further delay project completion.

Clearly, not all projects do fail, and many are successfully delivered on schedule and within budget. 'Greenfield' projects on new rail lines, for example, are typically implemented more successfully than 'brownfield' projects on existing operating rail lines. Projects that simply involve the replacement of equipment 'in-kind' are typically more successful than projects that involve the introduction of new generations of technology. Project complexity is therefore seen as an important factor in influencing project success.

It could be argued that the principle reason for project failures is simply a lack of experience, expertise and competence within the parties responsible for implementing the project (on both the supplier-side and on the contracting agency-side). This could include technical, process-related, and project management-related competences.

With respect to technical competence, as systems increasingly become computer-based, communications-based, software-based and information technology (IT) based, and as these enabling technologies continue to evolve at an ever-increasing rate, some contracting agencies are now beginning to look more to their IT departments, rather than their traditional signalling and telecommunications departments, to take on the leadership role when delivering state-of-the-art control and communications projects.

It is certainly clear that for any project to be delivered successfully the project team on both the client-side and the supplier-side must be appropriately staffed with qualified personnel with the necessary expertise and experience in the technology being implemented. It is a sad reality that often there is a shortage (in numbers) of the specific talents needed to deliver all the complex system developments and projects that the profession is working on today.

As such, it is not unusual, particularly on the client-side, to increasingly rely on consultant organisations to provide the necessary expertise. There are also many railway professionals who have worked exclusively in either a client role or a supplier role. As such, those working in a client role may not fully appreciate all the implications of changes to software-based, real-time, safety systems, while those working in a supplier role may lack experience with the practical realities of operating and maintaining a rail transportation system.

There is also a tendency to suggest that a real or perceived lack of technical expertise and experience on the supplier-side can be mitigated through 'better' and more rigorous processes, and high levels of project oversight, on the client-side. While appropriate processes can certainly contribute to project success, unfortunately they cannot replace competent resources. At the end of the day it is people that deliver successful projects.

While a lack of sufficient competent resources can certainly be an important reason why projects fail, this article suggests that it is not the only factor, or even the dominant factor, in project failures.

There are three basic and highly interrelated elements of any project, namely scope, cost and schedule. These are the key elements of any project, and this article suggests that one of the principle reasons projects fail is when

there is a failure to appropriately balance these three elements when viewed within the context of the delivery risks inherently associated with complex signalling and telecoms projects.

All too often, the full complexity of a project is not recognised (or acknowledged) until after contract award, when the project schedule and cost have already been fixed. If the project scope is the priority, then this clearly should drive the project schedule and cost. It is not unusual, however, for the project schedule i.e. the timeline for completing the project, to be constrained by external political factors unrelated to the realities of the project delivery.

In this case, if the project schedule is the priority, then often either the project cost must be increased, or the project scope reduced. The project cost, i.e. the total cost required to implement the project scope within the defined project schedule is, however, also typically constrained by available funding. A competitive procurement environment, where lowest cost is the primary selection criteria, can also lead to unrealistic project cost expectations.

To successfully deliver a project therefore, the primary challenge becomes one of optimising the project scope to be compatible with the project schedule and cost constraints, and with consideration and management of the inherent project delivery risks which follow. If this is not done it will inevitably result in project failure, regardless of the competency of the project participants.

Project delivery risks

In this section, some of the inherent risks associated with the delivery of any complex project are described. Each of these risks, if not mitigated, can lead to late project delivery and cost overruns.

Specification/scope risks

The risk here is that project scope is poorly or ambiguously defined by the contracting agency in the contract specifications, or the scope is not consistent with the key business case objectives. This risk includes both under-specifying and over-specifying the project requirements. Mitigating this risk rests with the contracting agency and their consultants, and is discussed in more detail later in this article.

Adaptation risks

The risk here is that the level of adaptation to service-proven products, or the level of new product development required to meet the requirements of the contract specification, is underestimated by the contracting agency and supplier, and thus inadequately reflected in the project schedule and project cost.

This risk is closely related to the above specification/scope risk, and realistically can only be mitigated through early interactions between the client and supplier organisations prior to contract award, and prior to finalising the project scope, schedule and cost.

Systems integration risks

The risk here is that there is inadequate interface definition and interface management with respect to the system's internal and external interfaces. While the supplier is responsible for the internal interfaces within their scope of supply, it is the external interfaces to the infrastructure, to the trains, and to other legacy systems that are typically more complex and of higher risk.

The contracting agency must play a critical role in risk mitigation both in the specification of, and the management of, these interfaces. This can be particularly challenging if the contracting agency does not have access to the relevant interface information (which can then require direct information exchange between two suppliers under two separate contracts), or if the necessary interface information simply is not available, is not up-to-date, or cannot be trusted.

Design risks

The risk here is of a failure to develop detailed designs that are consistent with contract requirements and the contracting agencies' expectations. While mitigating this risk rests primarily with the competence of the supplier, the contracting agency can also influence this risk, both positively and negatively, through the specification requirements and the method of working during project execution.

Migration, commissioning, and operational readiness risks

The risk here is two-fold. There is a risk that the migration plan and implementation schedule is unrealistic given track access constraints, level of effort required, or the dependencies on work to be performed by others. There is also a risk that the migration plan and implementation schedule result in unacceptable levels of impact to passenger service during implementation.

Given that control and communications projects are inherently tightly linked to rail operations, the client organisation, through its own in-house expertise and knowledgeable staff, is inevitably in the best position to mitigate this risk although all too often an attempt is made to contract-out this risk to the supplier.

Safety certification risks

The risk here is the level of effort required for safety certification is underestimated by the contracting agency or supplier and inadequately reflected in the project schedule and project cost. While mitigating this risk again rests primarily with the supplier, the contracting agency can also influence this risk, both positively and negatively, through the specification requirements and the method of working during project execution. The contracting agency is also responsible for managing the safety certification of those elements of the project that are external to the supplier's scope, such as external interfaces and operating and maintenance readiness.

System availability risks

The risk here is a failure to achieve and sustain an acceptable level of signalling system reliability/availability when the system is cut-over into revenue service. This could be a result of inadequate or incomplete system test & commissioning (which is primarily a supplier responsibility), but could also be a result of insufficient attention to maintainability and maintenance training (which is typically a joint supplier/contracting agency responsibility).

Project management risks

The risk here is ineffective project management by the contracting agency and/or supplier, because of a lack of sufficient resources to complete the project on schedule, or a lack of competency as discussed earlier in this article.

Stakeholder engagement risks

Finally, the risk here is insufficient, untimely, ineffective, and/or unconstructive stakeholder engagement that negatively influences project outcomes. Many major re-signalling projects are not stand-alone projects, but rather are just one component of a highly integrated transportation system upgrade programme, comprising multiple projects, collectively focused on satisfying specific long-term business needs.

For example, the system upgrade programme could include not only the re-signalling project, but also new train procurement, major control centre upgrades, trackwork upgrades, network electrification upgrades, maintenance and storage facility upgrades, etc. Successfully implementing such an upgrade programme has been described as akin to solving a huge logistical puzzle.

The number of internal and external stakeholders that can influence a project may be very large. Stakeholders include not only signalling and telecoms professionals, but engineering professionals from other disciplines responsible for enabling works and interfacing systems, operators, maintainers, procurement and contract managers, funding agencies, regulatory agencies, independent safety assessors, and various public advocacy groups.

Politicians, who may not fully appreciate the complexities of re-signalling an operating rail transportation system, can also apply pressure to deliver the benefits of the re-signalling project quicker and at a reduced cost. Stakeholder risks can be mitigated in part by the contracting agency through early stakeholder engagement and education, and by ensuring, where possible, that any stakeholder, who has the authority to make changes or veto decisions, is also accountable for the consequences of these actions with respect to schedule and cost impacts.

Optimising signalling project scope to mitigate project delivery risks

As noted earlier, one of the primary factors contributing to project failures is a failure to optimise the project scope to be compatible with the project schedule and cost constraints, when viewed in the context of the above inherent project delivery risks. The discussion on project delivery risks also clearly indicates that the responsibility for mitigating these risks is a shared responsibility between the supplier and the contracting agency, and it is particularly important that this reality be recognised by all parties when optimising the project scope.

The scope of any project can be summarised in terms of:

1) The geographic area and complexity of the project.
2) The performance/functionality to be provided.
3) The operating and regulatory environment in which the work is to be undertaken.
4) The procurement/delivery model adopted.

Complexity of rail network

The complexity of the rail network to be signalled/re-signalled is typically a given, with little opportunity to reduce the complexity of the rail network as part of the signalling project. Indeed, there are often changes to the rail network being implemented in parallel with the project, with changes to track alignment, new tracks being added, changes within interlockings areas, etc.

The project may also be implemented in parallel with new train procurements and other system upgrades. The complexity of the rail network (including legacy equipment the project is required to interface to) is however a major factor in influencing the implementation strategy and migration plan for the project which in turn are major factors in influencing the project schedule and costs.

With a complex rail network, it is not unusual to implement the project in phases. While this is a perfectly appropriate migration strategy, care must be taken to ensure that the more complex and higher risk issues are not being pushed into the later project phases simply to maintain schedule in the earlier project phases.

Insufficient attention to migration planning early in the project lifecycle (i.e. prior to contract award) can be a significant factor in subsequent project schedule and cost overruns.

Performance/functionality to be provided

The project functionality, as well as the safety, availability, and operating performance levels to be provided, should be driven by the desired business objectives (such as enhanced safety, increased capacity, higher levels of automation, improved system availability, reduced maintenance requirements, etc.) and should be consistent with the anticipated concept of operations and maintenance after the implementation of the project.

Although the benefits of top-down requirements development and requirements management are well recognised, there are unfortunately too many examples where this approach is not followed. Rather than adopting a true business case-driven approach to requirements development, focused on the desired project outputs, all too often clients and their consultants will develop procurement specifications by building on specifications from prior similar projects (without consideration of any lessons-learned from those projects), supplemented by a wish-list of additional client-specific requirements drawn from various, and often numerous, project stakeholders.

With this approach, it is inevitable that specification requirements, and resulting system architectures, will become increasingly complex, with no improvement in specification quality. The volume (number of pages) of typical system procurement specifications is certainly increasing, not only in terms of technical requirements (what the project must deliver), but also in terms of process requirements (how the project must be delivered and contract-deliverable documentation).

The specification requirements must also be balanced against the capabilities of currently available, and service-proven, products such that the level of product adaptation and new product development is clearly understood early in the project life cycle and appropriately reflected in the project schedule and cost.

When developing specification requirements, the challenge is balancing long-term needs with short-term wants. The long-term needs relate to the business goals that justified the project in the first place i.e. they are something that must be delivered, and include not only functional requirements but also the overall system performance requirements (the project 'outputs'), including safety integrity requirements. If this requires product adaptation or new product development, then so be it, but this must be factored into the project schedule and cost.

The short-term wants on the other hand relate to preferences of the various stakeholders; things they would like to have but that don't necessarily relate directly to the business goals. This is where the problem of over-specification and unnecessary product adaptation can occur. There is an argument, however, that clients should not hold back on including such requirements, and should use such requirements to encourage innovation and attracting new players into the market; relying on the industry to push back if the requirements are unrealistic.

In a competitive procurement environment, however, there is a real danger that suppliers will promise more than they can realistically deliver, with the philosophy that at the end of the day it is better to have an unsatisfied client than no client at all. This risk can be mitigated, at least in part, though early contractor engagement, prior to contract award, to flush out unrealistic expectations.

When over-specifying the project requirements occurs, at the functional and detailed design levels as well as at the engineering process level, there is a resulting risk that demonstrating compliance with thousands of individual requirements during project execution (the 'paper project') can take on a higher priority than delivering the fundamental business objectives.

Major projects also often represent fundamental changes to operating and maintenance practices, specifically when there are major changes to signalling technology. A lack of attention by the client to organisational transition planning, and operating and maintenance readiness can also be a factor in project failures.

Operating and regulatory environment

The operating and regulatory environment can also be major schedule and cost drivers on complex signalling projects. On 'brownfield' re-signalling projects, for example, the operating environment and the need to maintain operations during project implementation inevitably results in constraints on track access and access to rail vehicles.

If these constraints are not fully understood early in the project life cycle, and balanced against project delivery needs, schedule and cost overruns become inevitable. It is particularly important that contracting agencies recognise their role in mitigating this risk.

Regulatory requirements, and other process-based requirements that impose constrains on 'how' the project is to be delivered can also result in schedule/cost overruns if not factored into the implementation schedule early in the project life cycle.

Procurement/delivery model

Delivering complex projects typically involves multiple entities (the client, suppliers, installers, consultants, etc.) all linked through multiple contracts, where each entity takes on specific responsibilities with respect to project delivery.

There is a danger in attempting to place all the project delivery risks with a single entity, especially if that entity is not in a position to manage all of those risks. This approach will inevitably lead to project failure.

A preferred approach is to fully understand all of the project delivery risks, and place each risk with the entity that is in the best position to manage it. A consequence of this approach, however, is that the method of working between the various entities becomes critical, which in turn requires a contracting strategy that encourages a collaborative and co-located 'one team' approach to project delivery, with shared milestones and processes, rather than a confrontational 'blame-based' approach.

A contracting strategy that recognises that successfully project completion should take precedence over total contract compliance i.e. the contract should support, not constrain, successful project delivery. Again, a prerequisite of such a collaborative delivery model is that the project schedule and cost is realistic given the project scope.

Conclusion

In summary, while there can be many reasons for signalling project failures, this article concludes that one of the primary factors is a lack of consistency between contracted project scope, project schedule and project cost, when all of the project delivery risks are considered.

One solution is to simply acknowledge up-front that complex projects will indeed cost more and take longer to implement than desired. The preferred solution is to remove, as much as possible, the unnecessary complexities in the project scope that contribute to project delivery risks, by:

1) Focusing more on project output requirements and business case objectives, and less on ever increasing detailed technical and process requirements.
2) Encouraging early engagement between the client and prospective suppliers to build confidence that there is a common understanding of both the technical requirements and the delivery process requirements (including migration planning), and to flush out unrealistic expectations, prior to contract award.
3) Minimising and simplifying, where possible, external interfaces to legacy equipment with the contracting agency acknowledging their role in mitigating system integration risks.
4) Minimising, where possible, product adaptation/new development and where this is required ensuring there is an allowance for the adaptation/development in the project schedule and cost.
5) Placing project delivery risks with the entities in the best position to manage the risks.
6) Adopting a co-located 'one team' method of working.
7) Simplifying 'process' requirements and ensuring that the process requirements contribute to, rather than constrain, project success.
8) Maximising access to track and trains (short-term pain for long-term gain); and
9) Showing a willingness to change legacy operating and maintenance practices, consistent with characteristics of the new system.

IRSE

Institution of Railway Signal Engineers

News from the IRSE

Francis How, Chief Executive

Subscription renewal and your contact details

We will soon be writing to all IRSE members with details of your subscription renewal for 2018-19. Subscriptions are due to be paid by 1 July, and we very much hope that you will continue to be a member of the Institution by paying your subscription promptly.

Most importantly, in order that you can renew and continue to receive mailings from us, please check that the contact details we have for you are up-to-date. You can do this by going to **www.irse.org**, logging in and clicking on **Manage your Record** under the **Home** tab. In particular, if you are receiving IRSE News in the post from us but are not receiving the monthly e-bulletin, it probably means that your email address on our system is out of date. You will need to contact us if you need to change the email address we have for you (email us at **irseonline@irse.org**).

We are in the process of updating our procedures for managing the information we hold about IRSE members, licence holders and others, to meet the requirements of the EU General Data Protection Regulation (GDPR) which comes into force on 25 May 2018. We are sending all members an information sheet about this (e-members can view it online at **irse.info/r1xav**).

London and South East UK: New Local Section

I am very pleased to announce that IRSE Council approved the formation of a UK London and South East Section of the IRSE at its meeting on 15 March. As we have progressively moved our Presidential Programme technical meetings to locations outside London (and to other parts of the world), the need for a Local Section to serve the needs of members living in London and the south east of England has become ever more apparent.

Trevor Foulkes, a former telecom engineer, is proposed as the chair of the new Section, and Vivich Silapasoonthorn of TfL as the secretary. The inaugural meeting will be held in Central London on the evening of 21 June, featuring a series of short thought-provoking presentations by members of the new Section.

Amendments to Bye-laws

IRSE Council has approved an amendment to the Institution's Bye-laws, which means that if someone has not paid their subscription within four months of the due date, their membership can be terminated. Previously someone could remain a member (although not receiving any mailings or bulletins) for more than one year after the subscription payment was due.

The amended Bye-law is clause 4.3, and the full Bye-laws can be viewed/downloaded on the **About** page of the IRSE website.

Proposed Industry Affiliation Scheme

The IRSE is developing proposals for an 'Industry Affiliation Scheme' (replacing the old Company Affiliation Scheme which was discontinued in 2016), so that companies and organisations can be affiliated to and support the IRSE. This is intended to be available worldwide, and we are planning to go live with it later this year.

Annual Lunch, London

The 20th IRSE Annual Members' Lunch will take place at the Union Jack Club, Sandell Street, Waterloo, London, SE1 8UJ (near Waterloo station) on Wednesday 13 June 2018.

A three course lunch with wine and coffee will be served at 13.00 hours and tickets for the event can now be purchased. Please note that the Lunch is for IRSE members only.

This event is for all members, regardless of age or employment status. It's a great way of networking and meeting up with both current and former colleagues in an informal social setting. Our President, Markus Montigel, will be speaking. For more information, and to book, please visit the IRSE website (**irse.info/v5pba**).

IET Railway Signalling and Control Systems Course (partnered by IRSE)

The IET Railway Signalling and Control Systems (RSCS) is a four day training course delivered by a host of expert lecturers who have worked on railway systems around the world. This year it takes place from 18– 21 June in London. This course is delivered every two years, and this year for the first time the **IRSE is the official course partner** with the IET for delivering the course.

The course features a technical peer-reviewed programme which is developed by an expert committee, covering the core aspects of signalling and control systems from the basics to in-depth design. The programme aims to provide attendees with the most up-to-date contemporary training on signalling and control systems, and is ideal for people at any stage of their career who need to understand the basics of signalling and also for those wanting to learn more about current developments. It contains material relevant to both national rail networks and metros. For more information and to book your place, visit **irse.info/v7lpm**.

Presidential Programme 2018/19

The first paper of the Presidential Programme 2018/19 will take place on the evening of 13 June in London. Dr Josef Doppelbauer, executive director of the European Railway Agency (ERA) will present a paper on ERA's view on "Command and Control 4.0". This will lay the basis for the rest of the year and the application of cutting-edge concepts and technology in railway signalling. Subsequent papers will include: Big Data, location detection in "Smartrail 4.0" of SBB, autonomous driving in London, cyber security, and a contribution on 'ATO in aeronautics' to obtain another industry's view. The president invites you participate in the papers either in person or by video link.

Markus would be pleased to receive your comments at **president@irse.org**. As his personal contribution to "Winds of Change" he has also opened Twitter account **@irse_president**, where you can follow his activities during his Presidential year.

Midland & North Western Section

Technical visit to Derby power signal box

Ian James Allison

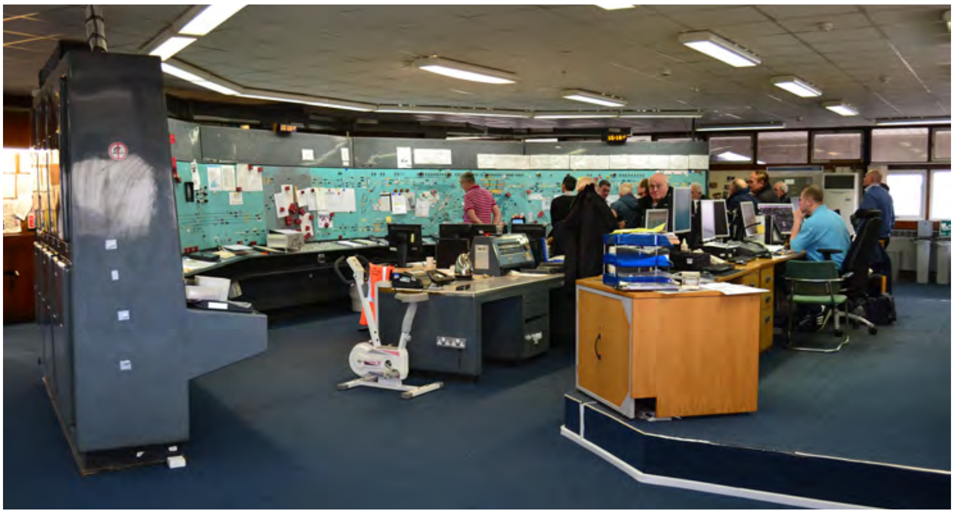
The afternoon of Thursday 22 February 2018, saw some 25 members and guests of the Section visiting the power signal box (PSB), located off London Road in Derby.

This visit included some of the staff who had been involved with the original commissioning or who had worked at the location during its lifetime. Commissioned in 1969 under the watchful eye of Tony Howker, then of Westinghouse, the Westpac Mark 3 geographical relay interlockings will finally be decommissioned in October 2018 for this area of control, after some 49 years of continuous service.

The Derby Resignalling is taking place this year and it is a £200million investment to improve the railway in and around Derby station. Although the station itself was modernised in 2013, the current track layout has not been improved for nearly fifty years. The new track layout has been designed to remove the bottlenecks which currently force trains to have to wait for vacant platforms outside the station itself. Between 22 July and 7 October 2018, Network Rail will be closing various sections of the remaining PSB area of control in stages to achieve the following activities:

- Installation of a brand new 320-metre Platform 6 at Derby station, on the site of the carriage sidings.
- Removal of the current Platform 5.
- Replacement of 17 km of track.
- Installation and commissioning of 79 new sets of points.
- Installation and commissioning of 55 new signals and nine new gantries.
- Renewal of Spondon Level Crossing from MCB-CCTV (manually controlled barrier with CCTV) to MCB-OD (obstacle detection).

The existing Westpac interlockings at Breadsall, Derby, Spondon and Melbourne Junction will be replaced with three new Siemens Trackguard Westlock interlockings. The remote interlockings at Duffield and Ambergate, to the north of Derby, will be re-controlled and the existing Westronic Time Division Multiplex (TDM) systems will be replaced with Controlguide Westronic 1024 TDMs. All equipment will be controlled from the new Derby Westcad workstation at Derby ROC (rail operating centre). Automatic Route Setting (ARS) is expected to be added to the Derby Westcad workstation six to nine months later.



Two views of the Derby PSB. Top the M&NW Section visitors. Above a detail of the panel in use. *Photos Ian James Allison.*

Network Rail operations manager Lucan Hawes greeted the members and guests of the Section and provided an interesting, enlightening and amusing commentary to two separate groups over a period of two hours on the operating floor of the PSB, explaining the current interfaces with the Derby ROC and the NX panel for the remaining area of control. This included the Derby station area, the route from London towards Sheffield, and the branch line to Matlock from Ambergate South Junction. The previous area of control for the West lines from Derby, beyond the Sunny Hill loops and Burton on Trent towards Birmingham had previously been recontrolled to Derby in 2015, however, the NX panel still remains although decommissioned and out of use in the PSB.

An enjoyable afternoon of memories was had by all those who attended this technical visit. Grateful thanks must go to the duty signallers, Lucan Hawes and Derek Whittle of Network Rail and Tony Kornas of Siemens Rail Automation for making this technical visit possible.

Technical meeting: Delivering the Rail Technical Strategy – FuTRO

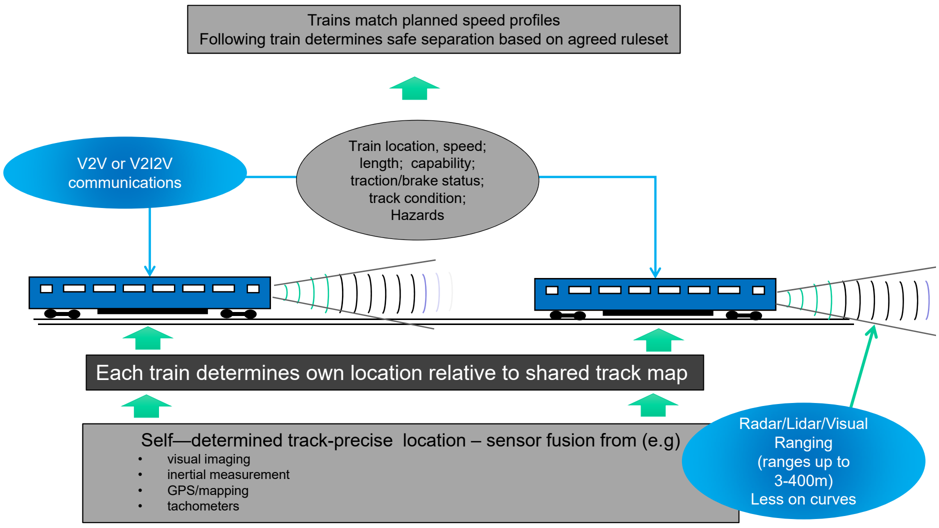
Ian Mitchell

The Midland and North Western Section met at the offices of Resonate in Derby on 8 March 2018 to hear an update on the UK Rail Technical Strategy by Clive Burrows of FirstGroup.

Clive's current role is that of group engineering director for FirstGroup. His role is international and cross-modal.

The Rail Technical Strategy was defined some years ago with the goals of reduced costs, increased capacity, cut carbon emissions, improved customer satisfaction, and maintained levels of safety. These improvements are essential if the railway is to complete with other modes and contribute to society. The pace of innovation is accelerating in areas such as smart motorways, electric road vehicles, autonomous cars and new transport concepts such as Hyperloop. The concept of 'Mobility as a Service' could totally change the relationship between transport providers and users – in future someone wishing to travel from A to B could book a multi-modal journey on a smartphone including a segment on a train without dealing directly with the railway undertaking.

Several of the key capabilities identified in the technical strategy relate to control command and communications, such as running trains closer together, services timed to the second and optimum energy use. A research programme known as FuTRO (Future Train Operations) has been established to tap into university and industry capability in these areas. Three academic projects within the programme have been recently completed and detailed results are available on RSSB's SPARK website.



A 'thought model' for closer running, presented during Clive's talk.

Safecap+ is a tool for entering and analysing railway junction schemas. The tool aims to be extensible and configurable and may be applied in a number of contexts such the analysis of control table for junction signals, assessment of capacity impact of signal positioning and train detection circuit boundaries, and also for conducting semi-automatic or automatic changes to schema topology or control tables. The project was led by the University of Newcastle and Siemens are making use of the tool to validate signalling designs.

DEDOTS aims to develop algorithms to increase the capacity at bottlenecks on railway networks, such as busy junctions and stations. The focus is to control speeds of trains that approach to junctions, so that they arrive at junctions not only at the right times but also at the right speeds. University College London and the University of Birmingham collaborated on this and a follow-on project is planned for a practical trial of the algorithms on a Connected Driver Advisory System (C-DAS)

DITTO has developed scheduling algorithms to minimise congestion related reactionary delays, and train-following rules to avoid inefficient acceleration and braking when one train is following another. These rules take account of the type of signalling system, e.g. fixed block or moving block, and frequency of updates to movement authorities. The Universities of Southampton, Leeds and Swansea worked on the project, and some of the results are being used on the Beijing Metro.

Clive also explained the concept of 'closer running' by managing train separation via direct train-to-train communication, instead by a centralised interlocking or radio block centre. This could be achieved using the same location technology as existing ETCS and CTBC solutions, or sensor techniques such as radar, lidar and image processing that are being developed for autonomous road vehicles.

Finally, however autonomous and connected our trains become in future, we must not forget the human, and there will never be 'one size fits all'. Across the network there will be applications where full Unattended Train Operation is appropriate and others where manual driving will remain with technology in a 'drivers assistant' role.

Clive ended his presentation by saying that in preparing this talk he was disappointed that he found it possible to re-use some of his presentation slides from five years ago. There is a real need to increase the speed at which the railway industry takes research concepts through to realisation. There are tangible signs of progress, for example the new fleet of trains to be built by Bombardier in Derby for FirstGroup's South Western Railway will come with ETCS and C-DAS onboard, but most Network Rail projects such as the Derby resignalling under way just outside the meeting venue are still just 'lights on sticks'.

In the Q&A discussion it was noted that train-to-train communication could be facilitated by the new 5G telecommunications standard that allows for direct mobile-to-mobile communications, to facilitate the 'internet of things'. Finally, Paul Darlington gave the vote of thanks on behalf of the IRSE, and also thanked Resonate for sponsoring the meeting.

RSSB has produced a brochure summarising the results of the FuTRO research projects described above. This is available on the web at the SPARK Rail Knowledge Hub www.sparkrail.org, together with more detailed information on these and other projects. IRSE Presidential Programme papers will also be available on SPARK.

The Midland & North Western Section invites you to join us for a Technical Visit and Annual Luncheon on the Severn Valley Railway, Worcestershire, Saturday 16 June 2018

With the kind assistance of Siemens Rail Automation and the Severn Valley Railway (SVR), the committee of the Midland & North Western Section have agreed to return to a location of previous successful technical visits and luncheons. We have secured places for up to 50 members and guests to travel on a dedicated train and seek support from the whole of the Institution and the S&T Industry to make this yet another successful and enjoyable family event.

The programme is as follows:

10:30	Arrive and assemble at Kidderminster Town (SVR) station.
10:45	Opportunity to visit the Kidderminster Town signal box and railway museum in groups.
12:05	Special Luncheon Train departs Kidderminster Town station.
13:15	Special Luncheon Train arrives Bridgnorth station.
14:15	Special Luncheon Train departs Bridgnorth station.
15:30	Special Luncheon Train arrives at Kidderminster Town station and end of visit.

The choices for the three-course meal per individual for this event are shown on the menu opposite.

The cost of the technical visit, including train tickets and luncheon (excluding beverages) is £45 per adult and £35 per child (aged 5-15). All children attending must be supervised individually by an adult.

All individuals attending the technical visit MUST bring with them a railway industry high visibility vest to wear on the technical visit, and stout shoes or boots for walking on ballast and uneven surfaces. The SVR reserves the right to refuse access to the technical visit for individuals not complying with these instructions and any Health and Safety Briefing instructions.

To confirm your attendance, please send an email detailing individual names and meal choices of those individuals planning to attend, to **acw-57@ntlworld.com** and **ian.james.allison@btinternet.com**. All payments can be made either via internet banking sort code 09 01 51 account 09065506 (preferred method of payment), or cheques made out to "IRSE Midland & North Western Section" and sent to the Section treasurer Clive Williams, at: 4 Mill Rise, Kidsgrove, Stoke on Trent. ST7 4UR. All payments should be received no later than Friday 1 June 2018 unless previously agreed with the Section Treasurer. For any further details, please contact Ian James Allison on +44 (0) 7794 879286.

Please note that the Institution and administrations whose sites are visited on technical visits cannot accept any responsibility for injury, damage or other difficulty which may arise. Individuals are therefore advised to ensure that their own insurance covers all appropriate eventualities.

The 2010 Annual Luncheon special train at Highley Station. ***Photo Ian James Allison.***

MENU

Starters

Crisp breaded Camembert

Tricolore of fresh fruits

Thai crab cakes

Chef's homemade soup

Main dishes

Roast beef, Yorkshire pudding, horseradish sauce

Roast leg of pork, apple, sultana & cinnamon compote.

Poached chicken fillet, sage & onion duxelle, bacon wrap

Lightly poached fillet of salmon

Vegetarian main dishes

Cauliflower cheese tartlet

Champagne and mushroom risotto served in red pepper basket

Desserts

Severn Valley Eton Mess served in a brandy snap basket

The famous duo 'Choco – Loco' platter with shortbread biscuit

Fresh exotic fruit salad

Baked vanilla cheesecake and summer fruit & orange compote

Cheese Selection includes biscuits, celery and grapes, homemade Bewdley ale chutney

All main dishes are served with seasoned roast and baby new potatoes with a seasonal medley of vegetables. All desserts are served with freshly whipped vanilla cream. Special dietary requirements can be catered for on request.

Younger Members' Section

Visit to North Pole depot, west London
Mark Wilcox

On 7 December 2017, Hitachi Rail Europe hosted a technical visit for 20 IRSE Younger Members at their state-of-the-art North Pole Train Maintenance Centre (TMC) in West London.

It was facilitated by Mohammad Sekanderzada and kindly hosted by Mark Wilcox (ETCS signalling engineer) and Ben Helliwell (support engineer).

The event started with a presentation about Hitachi's rail businesses in the UK with a specific focus on the Super Express Train. This fleet forms part of the wider Intercity Express Programme and is now in service with the Great Western Railway (GWR). It includes the standard UK AWS/ TPWS systems, the legacy BR-ATP system used on the route and ETCS Baseline 3 onboard system.

This was followed by a tour of the main maintenance building at North Pole TMC.

The 800003 looking grand in GWR livery.

The depot was originally designed and built to service the Eurostar trains, but has now been given a complete overhaul to equip it with the facilities to maintain the Super Express Train. There were plenty of opportunities to ask questions about the depot operations as well taking a closer look at the bigger items of kit. Two items of particular interest included the double headed wheel lathe, capable of cutting two axles simultaneously, and the heavy lifting road, which can lift an entire nine car train. Several Super Express Trains were on site, including the nine car bi-mode train in Virgin Azuma livery. The first Class 802 test train for the West of England project was also on site, as well as the 800003, looking grand in GWR livery, which recently had the privilege of hosting Her Majesty the Queen.

The group then had the opportunity to board one of the five car bi-mode GWR trains, allowing for a 'behind the scenes' preview of the driving cab and catering facilities. Unfortunately there was no Pullman Dining car on this unit, as it was being prepared for entry into service, but there were more opportunities for photographs. There were a lot of questions on the bi-mode technology, which allows the Super Express Train to switch from on board diesel generators to 25kV overhead electric traction seamlessly at line speed. Interestingly, this can be controlled automatically from ETCS eurobalises installed on the railway.

The event turned out to be a great success, with very positive feedback from attendees. The Younger Members wish to thank Hitachi Rail Europe for facilitating the interesting visit.

Younger Members viewing the under-carriage of the new 9 car bi-mode train in Virgin Azuma livery.

One of the class 800s on the Great Western Main Line between London and the West. Photo Hitachi.

Industry news

Alstom acquires on-board connectivity company

[RGI] EUROPE: Alstom announced on March 6 that it had signed an agreement to purchase onboard connectivity and infotainment supplier 21net from the Innovacom fund and other investors. The transaction was expected to close within a month.

Founded in 2001, 21net has its headquarters in the UK and subsidiaries in Belgium, France, Italy and India. It employs 50 people and recorded turnover of €16m (£14m, $20m) in 2017. In 2016 21net won a contract to provide wi-fi on SNCF's TGVs, and it has worked with Alstom to equip the NTV fleet in Italy. 21net uses multiple technologies including satellite, cellular and trackside antennas.

"This new acquisition, one year after that of Nomad Digital, will reinforce Alstom's digital offering and expertise", said Jean-François Beaudoin, Senior Vice-President for Digital Mobility at Alstom.

Automated people-mover for Frankfurt airport

GERMANY: Frankfurt Airport operator Fraport has awarded a consortium comprised of Siemens, Bögl Group and Keolis Deutschland a contract to build a fully automated people mover. The trains will be equipped with Siemens Trainguard MT communications-based train control system, have large doors, spacious aisle, internet access and a top speed of 80 km/h.

Operating 24/7 at two minute headways, the 5.6 km guideway transit system will connect Terminal 2 with the multi-billion dollar Terminal 3, which is currently under construction, as well as Frankfurt Airport long-distance station at Terminal 1.

The system, Siemens' 'Airval' turnkey solution, will have two tracks and three stations. It will run on rubber tyres, use a central rail guidance system and be designed and developed at the German manufacturer's competence centre in Toulouse, France.

As well as delivering trackwork equipment, station platform doors, a communication system, depot equipment and the power supply system, Siemens will deliver 12 two-car trains.

The people mover is scheduled to begin service in 2023, from which point Siemens will take over the operation and maintenance of the system for five years with an option to extend service for another five years. During peak times, it is expected to carry more than 4,000 passengers per hour per direction.

In order to bring IRSE News readers the latest global signalling, telecomms and train control information, we have teamed up with the Railway Gazette International (**www.railwaygazette.com**) to supply brief summaries of major news in our industry. We will of course also publish items of news from other sources when we receive them.

In IRSE News next month …

- French ATP in the UK
- STEM – reaching out to the next generation
- Level crossings – the next generation

and all of our normal news and features.

So, what did you think?

This May 2018 issue of IRSE News is the first in our new format. We hope it is clearer, easier to read and a little less dated than our previous layout. Do you agree? What do you enjoy about IRSE News, what would you like to see change? Email us at **irsenews@irse.org** and let us know.

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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Advertisements are accepted on the basis that the advertiser and agency (if any) warrant that the contents are true and correct in all respects.

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Membership changes

Admissions

We have great pleasure in welcoming the following members newly elected to the Institution:

Companion

van Dongen	L	Dutch Railways	Netherlands

Fellow

Bonvoisin	D	RATP	France
Pouchin	B	Siemens	France

Member

Gharios	A E P	SCLE SFE	France
Hardy	C L	Siemens	UK
Hirai	T	Daido Signal	Japan
Houston McMillan	D C	Metro Trains Melbourne	Australia
Itoh	S	Daido Signal	Japan
Midgley	A	Network Rail	UK
Pitz	D	Alstom	France
Turvill	A K	Network Rail	UK
Usami	Y	Daido Signal	Japan
Wai	A H	MTRC	Hong Kong
Yoshitomi	Y	Daido Signal	Japan

Associate Member

Berridge	A	Network Rail	UK
Chan	P	Land Transport Authority	Singapore
Gunti	P B	Cyient	India
Gurijala	A	Volker Rail	UK
Hall	A	Siemens	UK
Halligan	M J	SNC-Lavalin	UK
Jansen Van Vuuren	C	Transnet Freight Rail	South Africa
Kok	M H A	Land Transport Authority	Singapore
Lianghiruntawon	P	Bombardier	Thailand
Lynch	D	Iarnród Éireann	Ireland
Saenthan	S	Amey	UK
Sorokin	M	Aecom	UK
Tallo	R	Jacobs	UK
Timmins	D	Ove Arup	UK
Von Abo	C	Transnet	South Africa
Watts	E J	Network Rail	UK
Wong	G W A	Downer	Australia

Accredited Technician

Bandarchi	T	Siemens	UK
Rudall	C	Network Rail	UK

Affiliate

Azad	A	Network Rail	UK
Banala	S K	Siemens	UK
Barbuta	S H	Network Rail	UK
Bathla	S	Siemens	UK
Bhuhi	A	Network Rail	UK
Bowerman	M J	Network Rail	UK
Bray	E N	WSP	UK
Chabaoui	A	Siemens	UK
Chan	A	Siemens	Australia
Chu	Y F	MTRC	Hong Kong
Chung	W S	SNC-Lavalin	UK
Dhepe	P	Siemens	India
Duck	M	Alstom	UK
Gilbert	T A	Siemens	UK
Halebeedu Manjunath	J	Siemens	India

Affiliate (contd)

Inamdar	K C	Siemens	India
Jacob	A	Iarnród Éireann	Ireland
Kambale	A	Siemens	India
Killilea	R	Iarnród Éireann	Ireland
Kothia	H	Transport for London	UK
Mohamed	M	WSP	UK
Morgan	P	Iarnród Éireann	Ireland
Natola	M	Network Rail	UK
Naveesh	J	Siemens	India
Okamoto	S	Daido Signal	Japan
Pick	J	Opus International	Australia
Samse	A	Siemens	India
Sethw Ghani	S H	Rapid Rail	Malaysia
Thomas	S	Iarnród Éireann	Ireland
Toms	R	Balfour Beatty	UK
Wang	X	Ansaldo	China
Wong	L H	UGL	Australia
Wong	M F A	MTRC	Hong Kong
Wong	M L W	Network Rail	UK
Wu	Y	Network Rail	UK
Zanvar	B R	Siemens	India

Transfers

Member to Fellow

Das	D J	Metro Trains Melbourne	Australia
Munakata	K	Daido Signal	Japan
Sealy	N P	Amey	UK

Associate Member to Member

Kakinada	V	Thales	UK
Kouse Abdul Hameed	M A	Wabtec	Australia

Affiliate to Member

Mahmoud	J	WSP	Australia
Srivastava	A K	Aecom	UK
Walsh	R	Iarnród Éireann	Ireland

Accredited Technician to Associate Member

Bent	W D	Siemens	UK

Affiliate to Associate Member

Ssuuna	A	Siemens	UK
Upton	K	Atkins	UK

Engineering Council registrations

Congratulations to members Ashley J, Feeney M, Ford N, Hoarau A, Rudall C, Lulek C and Luveniyali M who have achieved final stage EngTech registration. Also to member Longley C who has achieved final stage IEng registration and member Robb D who has achieved final stage CEng registration.

Re-instatements

De Klerk G, Dunham M, Gadenne R L, Mulugeta T and Rigby M S.

Resignations

Hopkins D.

Deaths

It is with great regret that we have to report the death of members Both D J, Roome M N, Rose J and Wati S.

Current Membership: 5402

IRSE News

Institution of Railway Signal Engineers

June 2018

STEM education
encouraging future engineers

Women in rail
past and present

Level crossings
reducing risk in the UK

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Where are the future engineers?

Its not only in the UK that we see a shortage of engineers but it's a growing global issue. In the UK alone there is an estimated annual shortfall of up to 59,000 engineers and the transport sector is a major portion of that number. Its great to see that at the IRSE we have a thriving Younger Members Section and a competency development scheme which all helps those who are already interested in Engineering as a career.

One aspect of how we address this issue is featured in this edition of IRSE News (page 4) – the STEM initiative – which in the UK seeks to engage with children in schools and other events to showcase what engineering is about and how exciting it can be as a future career. Furthermore, 2018 is the "Year of Engineering", an exciting opportunity to celebrate the great contribution that engineering makes to the UK and encourage young people, especially those from under-represented backgrounds, to join the profession. Led by the Department for Transport, the government will be supporting events and campaigns across the UK during 2018 which gives young people inspiring, hands on experiences, of modern engineering and eliminates misconceptions among parents and teachers about engineering careers. This could not have come at a more crucial time as we have seen a 24% drop in the number of apprenticeships offered across the professions. To further promote apprenticeships and reverse this trend, the Strategic Transport Apprentice Task Force (STAT) which is an alliance of transport sector companies, with government support, has been established.

Its not just about young people but also that of gender; 92% of the engineering population in the UK are male and at the apprentice level the figure is only slightly less. In order to ensure innovation and creativity, the railway sector needs to tap into the whole population, reflecting the diversity of the people it helps move around the country. I think the article in this edition which tells the story of Women in Signalling is very interesting and relevant as we seek to promote our profession to a wider community.

To meet the transport challenges of the future, of which signalling, traffic management and communications systems are key foundations, I believe we must build a workforce where a diverse group of people can shine, be creative and step up to find solutions to the complex issues we face. We have been presented with a once in a generation opportunity to promote and celebrate the best of engineering, overcome the preconceptions about the discipline, demonstrate the social impact and value that engineering plays in society, addressing under-representation, and inspire more young people to become engineers and to shape the future of the profession.

George Clark, Vice President, IRSE

Cover story

Our front cover shows Rhyl No 2 signal box in Wales, UK. Dating to 1884, and similar in design to the No 1 box on the other side of Rhyl station, the signal box was shut in 1990. Both signal boxes are Grade II listed buildings, and so despite being out of use they cannot be demolished. No 1 signal box shut in April 2018, along with six other mechanical signal boxes, when control for the route transferred to the Wales rail operations centre, 180 miles (290 km) away in Cardiff. Siemens Rail Automation commissioned their digital modular signalling solution at significantly lower cost than conventional UK signalling. Bidirectional signalling is also provided, hence the LED signal seen to the east of No 2 signal box in the photo.

In this issue

Regular features

From the IRSE sections

A word with Markus Montigel

Markus Montigel took over as President of the Institution at the Annual General Meeting held in London on April 27. Paula Persson met with Markus to learn more about him, his background, and his plans for the profession.

Can you provide a short biography to inform our IRSE members a little about yourself, your professional background, and the history of your involvement with the IRSE?

As a child, I was always enthusiastic about trains. I had a model railway and I played with it incessantly. It was also my hobby to make imaginary 'travels' around Switzerland using railway timetables. This highlights that railway was already an important, even emotional subject to me.

My degree was in Computer Science which led to the question: where can I apply my theoretical knowledge? The answer was railways. Therefore, I joined the Institute for Traffic Planning and Systems (IVT/ETH Zürich) where I undertook my doctorate in the subject: Formal Proofs of Interlockings in 1994. I then entered the Rail Industry with the desire to apply my research. For three years (from 1995-1998) I worked with Alcatel (now Thales) in Vienna, Austria. Here I was able to continue my passion for innovation and the exploration of new development areas. During this period I designed the interface between RBC and interlocking for the ETCS pilot project in Switzerland, which was the first of its kind at the time. I always liked it when my work took place on the boundary of research and the actual railway world, so I could actually see the newly developed elements at work, which motivated me much more than just to research in the 'ivory tower'.

After my time with Alcatel (Thales) I went on to further my research in computer science at the University of New Orleans, Louisiana, between 2001-2003. During this time in the USA, I still kept in touch with European Rail and was invited to consult for the Siemens Maglev project in Shanghai. Later, in preparation to bid for the 35 km Lötschberg Base Tunnel project in Switzerland, Thales asked if I would deliver a Driver Advisory and Decision Support System for the project as that functionality would be essential to win such a bid. Therefore, it was in 2003 that I set up my own company: systransis, specializing in this kind of system. In December 2007, the Lötschberg system was put into operation for the first time on a main line railway, and after 10 years of almost flawless commercial operation, everyone agrees that it is a system which proves highly beneficial to the railway in terms of punctuality, capacity, passenger journey experience and energy efficiency. I managed systransis as the CEO for 13 years in total. In time, my company grew to over 30 employees. During that time, the company worked on various projects, such as the Gotthard Base Tunnel, delivering tunnel specific safety functions. In December 2016, systransis was bought by Siemens. However, I have stayed on there as the chief technology officer.

The IRSE first became firmly imprinted on my mind as an engineer working in Vienna. The IRSE held an annual convention in Salzburg in the mid-1990s, in which I didn't participate. However, after the conclusion of the convention, I was invited along with one other young engineer to tour signalling installations in the UK for two weeks. This was an eye-opening experience for me as I learned that there wasn't just one possible set of principles for railway safety but several. This realisation helped me to broaden the scope of my understanding of signalling principles and the common core; the foundation of how to achieve safety in rail operations. During these two weeks, I was made to fill out the IRSE application form, a rather difficult task for an inexperienced non UK person! But they took me on, and I became a member of the IRSE. At the time (mid-1990s) there were not that many members of the Institution in Switzerland and Austria. So, much of my contact with other members in those early days was at the IRSE ASPECT conferences. By the time I returned from the United States in 2003, there was what I would describe as a loose group of IRSE members in Switzerland, who met for professional gatherings. In time, it became evident that we needed to form an official Swiss Section instead of just being members of some organisation no one really knew, far away in London. We needed our own local identity. This took some years to come to pass, but finally, in 2011, the Section was founded, and I was given the great honour of being appointed as the first Section's chairman until 2015. In 2012 I was elected an IRSE Council member, and in 2015 I was also appointed to the Management Committee.

What are your unique areas of expertise that will benefit the Institution and be of interest to our readers?

Although I understand the safety principles of signalling, interlockings and ETCS quite well, I am not a 'hard-core' signal engineer with detailed knowledge of all the bits and pieces. IT will become ever more important for signalling and train control in the future. To have an intimate understanding of both worlds, especially about how to further automate and optimise the train traffic, seems valuable for the Industry. My area of expertise is in these high level operations which are often termed as the 'glue' of overall systems. I often endeavour to develop systems that others deem to be impossible. An example of this would be the Lötschberg project which not a small number of people deemed unlikely to ever be completed, especially by a company of – at that time – only three employees. However, 'impossible' is a word that I don't like to use. Often a different approach is what is required to be successful. Innovation is about inspiration and quality, not quantity.

What is your vision and mission for the IRSE? What would you like to achieve with your Presidency, and in which direction would you like to steer the organisation?

I like to regard the IRSE as a neutral place where individuals can exchange their experience and innovative ideas without their company 'hat' on. It needs to be an informal platform where critical thinking is permitted and no one feels obliged to defend the particular interests of their affiliation. Such interactions are highly valuable as they sometimes even bring people together from within the same company. Working on different projects, some are not aware that they have colleagues within the same company who are IRSE members.

My mission for the IRSE is that it be the thought leader in its field. "Winds of change" is the title of my Presidential Address. This is pertinent for us because the world is changing and it's not changing slowly, and I am not sure if our industry is changing fast enough with it. Therefore, our approach cannot simply be: 'business-as-usual.' The organisation needs to be able to harvest the energy that is coming; not try to defend against it. No one really knows what is going to happen next in this industry. Perhaps things won't change that much at all but continue on as normal. The important thing is that we are prepared for whatever is going to happen. These thoughts are further developed in my Presidential Address.

Change, and the strategic drivers behind it will be the theme of the Presidential Programme of lectures for 2018/19. My aim is to contribute to the preparation of all of us for this unknown future.

One of my further missions for the organisation is to direct more young people into membership. Therefore, we have to ensure the Institution is modern, attractive and relevant to young people, which are where the re-brand, a new website and increased engagement in social media come in as important projects which occur within my term as President.

Our readers will want to know about the uniqueness of Swiss railway; especially tunnels. What can the rest of the world's railways learn from Swiss rail?

When many people think of Switzerland, they think of Swiss time pieces. This has not just been a highly successful marketing ploy to sell watches; the concept of precision is intrinsically built into the Swiss mentality. Precision time keeping is a fundament of the Swiss approach to how our railway system is planned and managed. Every railway employee of the Swiss Railway is devoted to making our railway run like clockwork. This philosophy also extends into the development of new projects comprising several dozen billion Swiss Francs over many years; the project will be finished on the completion date announced years earlier. This is because the railway in Switzerland is part of the Swiss identity, not just a transportation system. In essence if the railway fails in Switzerland, it's as if the Country has failed. The opposite is also true; success of the railway means success for Switzerland, almost always leading voters to affirm the generous subsidy of railway projects by the government.

Compared with other Western European countries, trade unions play a rather minor role in Switzerland. Automation has played a very important role for the last 40 years leading to a high degree of automation and a lower number of employees working on the railway. This has resulted in the very high efficiency of the system.

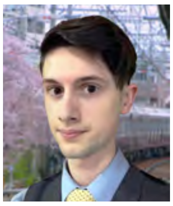
The railway in Switzerland is an integrated transport system where service to the customer is planned from door-to-door. This service is specialized so that customers can easily plan how to get from 'A to B' more easily rather than having to join separate travel lines together. This is the policy of the Swiss Federal Office of Transport, which is the governmental authority responsible for public transport in Switzerland.

The IRSE has recently held an event in London for the release of our Digital Railway White Paper. Our readers would be interested to hear your comments about that.

Publishing the White Paper is a good example of the IRSE exercising a leading role. It has shown its leadership qualities in how it constructively criticizes some 'inconvenient circumstances' about how digital railway has developed. Many points made in the paper are pertinent not only in a UK context. The issue underscores a more widespread difficulty of the Industry to follow through with innovation. Most people say that innovation has to take place gradually but slow can mean expensive. It can also mean that the Industry remains in an intermediate position for decades; always lagging behind the latest technological developments. The alternative is a more fundamental approach with management having the courage to make decisions for the long-term, sometimes for a future period of 10 or more years, which would probably allow investment in available funds in a more strategic and efficient manner.

The Lötschberg Base Tunnel.
Photo Markus Montigel.

Encouraging engineering: reinvigorating the S&T approach to STEM



Alexander Patton
Siemens Rail Automation, UK

This article is the latest in our series of presentations from the ASPECT conference held in Singapore late last year.

In 2016, Siemens graduates in the UK developed a model railway layout using low-cost commercial off-the-shelf (COTS) components as found in school electronics kits. The custom Raspberry Pi-based control system allows young people to interact with features of a modern railway such as train detection, automatic train operation/protection, passenger information systems and even simulate the trackside for office testing.

During brief demonstrations, young people take control and direct trains around the layout, experiencing how modern signalling and train control systems (S&TCS) prevent collisions and increase capacity. Activities in which students can signal their own section of railway range from 30-minute challenges to day-long classes. Control software can, depending on experience, be written in Scratch, a drag-and-drop language, or Python, another language popular in schools. With more time, students and graduates can attempt a simulation of almost any signalling discipline. From a minor scheme change to an introduction of traffic management, virtually anything is possible by modifying the Raspberry Pi and the STEMRail Python software.

This article describes the technical solution and gives examples of how the challenges of the signalling industry can be used in an interactive approach to teaching programming, electronics and computing to young people. It is hoped the lessons learned will encourage further innovation in youth engagement.

Background

Engineering skills shortages are widely documented throughout the world. The global rail industry, worth €169bn in 2016, [1] sees no exception to this trend. The rail industry must make every effort to engage young people in our profession for the sake of both business sustainability and social responsibility. STEM events (to encourage careers in Science, Technology, Engineering and Mathematics) are a critical part of this engagement, as they offer the opportunity to change students' perspectives and encourage a more diverse group to discover the rewards of an engineering and technology career.

Every year, people travel far enough by main line rail to reach the sun and back– 10,000 times. [2] Cities are set to add another 2.5 billion people in the next 30 years. [3] To meet the needs of our changing world, integrated transport systems of the future will be highly reliant on information technology, and the rail industry will need a new generation of IT competent engineers. By exposing students to computer-based signalling, young people can be both educated and inspired to take on the great transport challenges of the coming decades.

Raspberry Pi

In recent years, the UK has seen significant efforts to engage young people in STEM. One of the strongest examples is the Cambridge-based Raspberry Pi Foundation. The Raspberry Pi is a pocket-sized Linux computer costing as little as USD$5. It was designed as a toy for young people to learn basic computer science. However, its flexibility and ease of use led to it becoming one of the best-selling computers in history, and schools around the world have begun integrating them in to their computing curriculum.

The Raspberry Pi natively supports Python, the world's most popular programming language. Python is considered easy enough for children to learn, but powerful enough for professional application. As a result, it has rapidly become the introductory computer language of choice for secondary schools and universities worldwide.

The power of the Raspberry Pi lies in its 26 digital input/output (I/O) connections, which can be directly controlled from the Python programming environment. This means that the Pi is not simply a toy, but a fully featured control system platform.

Model railways

Although model railways are seen as playthings, they were once used as simulators to introduce young people to the world of rail. Britain's National Railway Museum in York is home to the world's oldest working model railway. Built in 1912, the model was originally part of a railway signalling school, and was a particularly useful tool, as it presented to the student the entire signalling system, from the trackside to the signal box. The school could therefore stimulate learners visually, audibly and kinaesthetically while providing a full, detailed system overview.

Vision

By taking inspiration from historic signalling schools and implementing modern technology like Raspberry Pi, it was felt that a new method of STEM engagement could be developed. In

October 2015, graduates at Siemens Rail Automation in the UK were asked to refurbish and signal a model railway so that it could be taken to schools and events. In response, the author developed the vision of a project known as STEMRail. The model railway control system would allow young people to interact with features of modern railways such as:

- Colour-light signals.
- Axle counters and balises.
- Automatic Train Protection (ATP).
- Automatic Train Operation (ATO).
- Passenger Information Systems (PIS).
- A signalling IP network.
- A signaller's panel featuring movement authorities.
- Trackside I/O simulation for office testing.

The S&TCS architecture and functionality would mimic on a small scale the state-of-the-art systems used on urban railways. Inspirations included Thameslink ATO over ETCS L2, the SATLOC low-cost signalling project and the Victoria Line's former track code-based ATO. This detailed realism would be presented in a simple manner by using Python exclusively for all software and by using physical components found in school electronics kits. Sitting alongside the railway would be a raft of interactive activities drawing connections between educational topics and rail signalling. Graduates would be able to run an interactive Raspberry Pi class in a school, and then directly show students how their work fits in to a real-world engineering challenge.

Technical solution

Because STEM events happen throughout the year, a stage-based migration from line-of-sight driving all the way to fully automated operation was used. At each event throughout the year, new functionality was unveiled, and lessons learned fed back in to the design process.

The layout was donated by Wiltshire College in Chippenham, UK. It consists of an outer ('UP') loop and an inner ('DOWN') loop running along an oblong viaduct, with a crossover at either end of the main station. The track gauge is 16.5mm (OO scale). Up to four three-car electric multiple units (EMU) can run simultaneously under ATO, manual control or a mix of the two.

System architecture

The STEMRail architecture (Figure 1) was designed in such a way that a presenter can use the model S&TCS to visually demonstrate real engineering challenges across the railway system. The railway is divided in to two zones: the inner and outer loops. Train location within each zone is monitored by axle counters. Intermittent position updates, where necessary, are provided by balises. Both report to a zone controller, which runs on a Raspberry Pi. The zone controller also controls lineside signals and point machines. Each of the zone controllers is connected to the signalling network. The control centre Raspberry Pi hosts the core systems, including the interlocking, radio block centre (RBC), ATP and ATO. A serial link connects the RBC to the wayside communication-based train control (CBTC) base station. The base station transmits movement commands to individual trains. To further capture students' imaginations, a speaker provides passenger announcements at the main station. Finally, a personal laptop can be used to run the development workstation and trackside simulator.

Trackside, there are at least 58 3.3V objects used to control the railway, including signal aspects, axle counters and balises. In theory, one Raspberry Pi could both run the control software and handle all of the I/O with an I2C multiplexer. However, distributing the system across an IP network provides many more opportunities to demonstrate how IT affects modern S&TCS.

Train detection

Train detection and position reporting is at the heart of all S&TCS. To fulfil the STEMRail vision, the train detection method needed to closely resemble a real-world system, but also contribute to students' STEM learning. Track circuits are difficult to implement on a model railway, because the rails are used to deliver traction current. However, three methods were identified that could meet STEMRail requirements:

Figure 1 – STEMRail architecture.

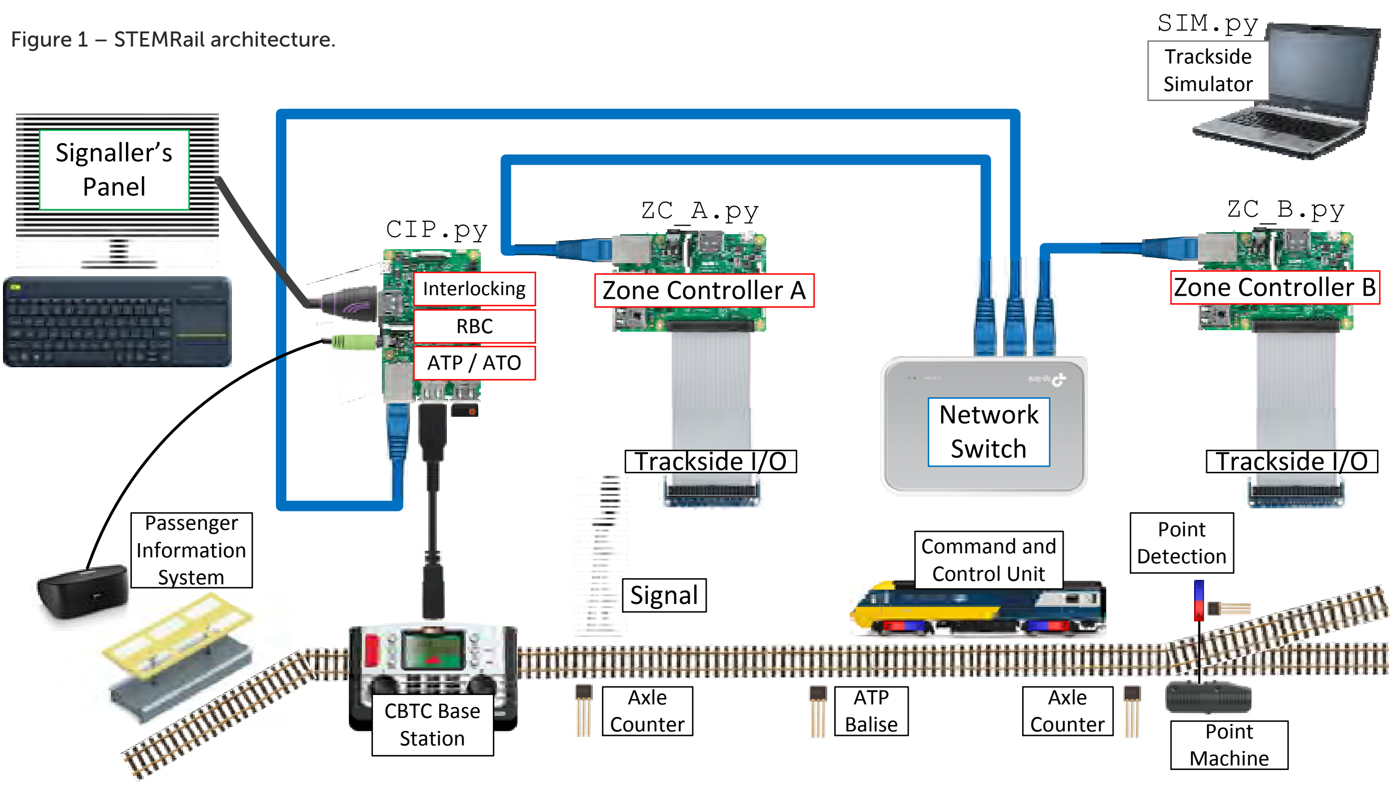


Figure 2 – Hall effect sensors are placed at braking distance before each signal.

1. Hall effect sensors – These sensors detect magnetic field strength. Magnets placed beneath a train can be counted in the same way an axle counter counts train wheels.
2. Optical sensors – Also similar to axle counters, optical sensors count disruptions to an infrared beam.
3. Radio frequency identification (RFID) tags – readers placed under the track work like balises used for ETCS and CBTC systems. An RFID tag placed on a train's undercarriage can hold identifying data.

Option 3 offered a high-tech solution, but was rejected for cost reasons. Options 1 and 2 were both low-cost, but the Hall effect sensors have several advantages. They are included in the UK high school and A-level Physics curriculum, they can detect the difference between magnetic poles, and they are far less prone to tampering by children.

As a result, Hall effect sensors were placed between each of the track sections. Hall effect sensors were also placed at braking distance before each signal. These act as balises, both to protect against SPADs, and to inform the ATO system when a train is approaching the end of a fixed block (figure 2).

Software

The control software is divided in to three programs:

- CIP.py – Central Interlocking Processor:
    - Performs the interlocking and RBC processing.
    - Hosts the vital communications server.
    - Handles all control system user-IO through a graphical user interface (GUI).
- ZC_A.py and ZC_B.py – zone controllers (One for the outer and one for the inner loops):
    - Monitors the states of the track sections.
    - Illuminates the correct colour-light aspect for signals under its control.
    - Sends/receives network messages to/from the CIP regarding track occupancy and signal state.

Each program was written in Python 3. This section focuses primarily on the CIP, which holds the most logic.

The CIP was written with object-oriented programming (OOP). OOP is a method of organising code in to a 'system of systems', and demonstrates to the student how complex software development projects can be broken down in to 'classes' or sub-programs written by different people. OOP is an abstract systems engineering concept, but the model railway helps to visualise the basic principles such that students feel less intimidated when they come across it later on (which is increasingly likely in the digtal economy!). Each software 'class' can correlate directly with a generic class of physical objects on the railway such as a train, signals or point machines.

The CIP code consists of three parts: Initialisation, Main Loop and Objects. Initialisation builds the objects based on the interlocking data. First, track section objects are generated. The generic TrackSection 'class' expects information like that from the interlocking data file shown in figure 3 in order to generate a unique TrackSection object.

It also automatically fills some default initial parameters. State is always set to 'occupied' when a new track section is generated. The flag which marks the section as routed defaults to false.

The process is the same for other railway elements. A signal object is generated for each signal and loaded with information such as a list of track sections and points protected, the direction of travel and the identity number of the next signal. Train objects are not generated during initialisation, but rather on demand when a user registers a train with the RBC.

After initialisation is complete, the Main Loop cycles indefinitely. It does only two things:

1. Calls upon the Vital I/O object to process inputs from the signalling network.
2. Waits 200ms to call upon the Vital I/O again, thus allowing users to interact with the GUI.

Thus, two types of events drive any state changes in the CIP: either a network input triggers the Vital I/O object or a user input triggers the GUI object. Either of these events starts a chain reaction where objects call other objects until the railway state stabilises, ending the cycle. Between each cycle, outgoing messages from the previous cycle are sent out, and incoming ones are stored to be parsed.

ATO/ATP

Once a train is registered, the RBC continuously derives its location from track occupancy sequence and balise notifications.

The RBC attempts to issue a movement authority (MA) up to three sections in advance. This is calculated by inputting a train's location and direction to the RBC's 'look ahead' function. For an MA to be issued, the section must be routed, unoccupied and not protected by a red signal. MAs always end at an ATP balise.

Target speeds are issued using Digital Command and Control (DCC), the model railway industry's internationally standardised train control protocol. The DCC controller (compared to a CBTC

```
<TrackSection>
        <ID>1</ID>                    ...   ID number (0 to 999)
        <name>A1B</name>              ...   Name (e.g. AC)
        <speedlimit>65</speedlimit>         Speed limit
        <pointsID>2</pointsID>              ID number of the point machine within the section (if applicable)
        <nextup>2</nextup>            ...   ID number of next track section, UP direction
        <nextupR>15</nextupR>               ID number of next track section, UP direction, reverse points
        <nextdown>0</nextdown>              ID number of next track section, DOWN direction
        <nextdownR>X</nextdownR>            ID number of next track section, DOWN direction, reverse points
        <drawing>                     ...   Instructions on how to draw the track section on the screen
                <line>
                        <start>(150,1000)</start>
                        <end>(300,1000)</end>
                </line>
                <line>
                        <start>(100,900)</start>
                        <end>(150,1000)</end>
                </line>
        </drawing>
</TrackSection>
```

Figure 3 – The generic TrackSection 'class' expects information from the interlocking data file, as shown in the example above.

base station in Figure 1) modulates the 12V DC applied to the rails to send coded signals.

A train is progressively slowed as it approaches the end of its MA. When the ATP balise at the end of an MA is triggered, the target speed is immediately set to 0. Should a train pass a signal at danger (SPAD), an emergency brake command is given, and the GUI is prompted to issue an alarm.

Trains can be driven manually using the dials on the DCC controller, but the CIP can issue a command to override the manual controls in the event ATP is triggered. Unregistered trains lack ATP, and must be driven with caution. They are only used to sweep a reset axle counter.

Signalling network

The signalling network is built around an unmanaged switch. Static IP addresses are assigned to the CIP and each of the zone controllers. It was desirable for students to tangibly 'see' the network communications travelling across the system in real time. Thus, Telnet, a simple, human-readable protocol, is used to exchange text-based messages. This makes it easy to introduce children to digital telecoms.

When an input state changes on a zone controller, it sends a message to the CIP, e.g.:

$clear;occ;clear;clear;clear;clear;occ;occ;clear;clear;NA;NA;NA;NA;NA;NA*

The first character '$' sent over Telnet instructs the CIP to expect a track occupancy update. The CIP then awaits the state of track section ID 0. c-l-e-a-r. The ';' character then tells the CIP to expect the state of the next track section. This repeats until the '*' character signals the end of the message.

When signal aspects need to change, the CIP broadcasts a signal update message to all zone controllers, e.g.:

#2;1;2;0;2;1;2;0;0;2;0;0*

The principle is the same. '#' represents a signal update message. 0, 1 and 2 represent red, yellow and green aspects respectively.

When a connection between a zone controller and the CIP is broken, the CIP automatically occupies all relevant sections, and the affected zone controller sets all of its signals to red.

User interface

The GUI consists of a track layout, a control panel and a diagnostics window. Figure 4 shows the track layout display.

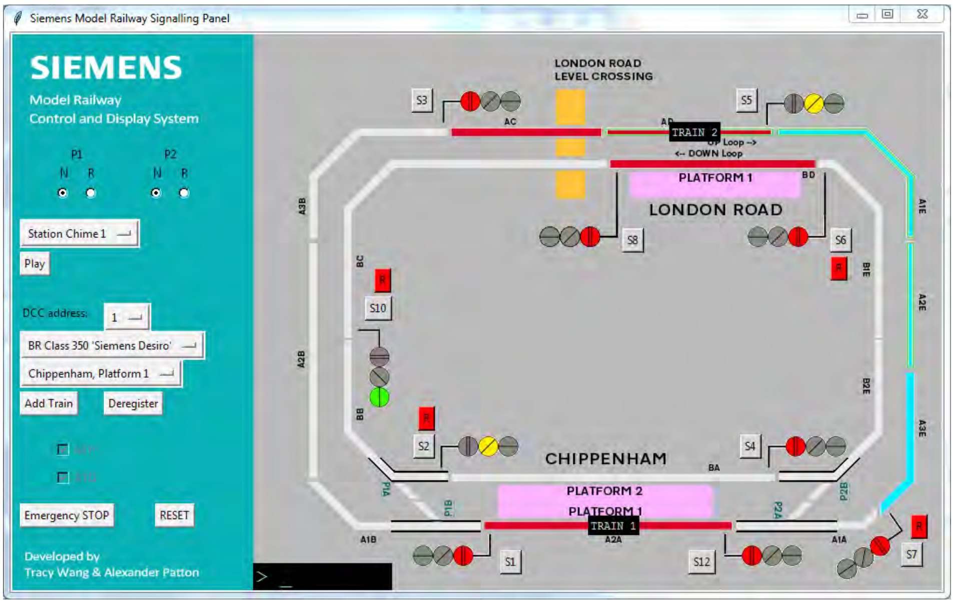


Figure 4 – The graphical user interface track layout display.

The control panel features manual points setting, train registration, an emergency stop, and manual operation of the PIS. The PIS automatically plays a "mind the gap" announcement when a train opens its doors at Chippenham station. It also automatically warns passengers waiting on Platform 1 when an approaching train is routed to run fast through the station without stopping. Additionally, announcements regarding train departures, unattended luggage and the smoking ban can be manually set to attract children's attention.

A diagnostics window shows network messages as they are sent and received. This allows the students to physically see how the CIP and zone controllers communicate.

Simulator

To minimise the number of treks taken through the splendid British winter to go "trackside" (the model railway is located in an annex to the main office building), a Trackside Simulator (SIM.py) was developed to replicate the functionality of the zone controllers. The Trackside Simulator places a copy of the track layout GUI on top of the zone controller logic. All axle counters and balises are displayed geographically and can be triggered with a click.

STEM activities

General demonstration

Numerous STEM activities have been delivered using STEMRail technology as a tool. These activities can target different age groups and be deployed at different types of events. Often, STEMRail is demonstrated at a fair, and engineers only have a few minutes to engage a visitor. It is important to consider how the students will be introduced to rail signalling. Young people, particularly children, should be regularly engaged to keep attention, and posing questions is a good way to do this. One approach is to use dialogue to relate to the audience's experiences:

"Have you ever been on the Underground? Was it crowded? Oh it was terrible, was it? What would you do to fit more people on the trains? What do you think might happen if you run trains closer together?"

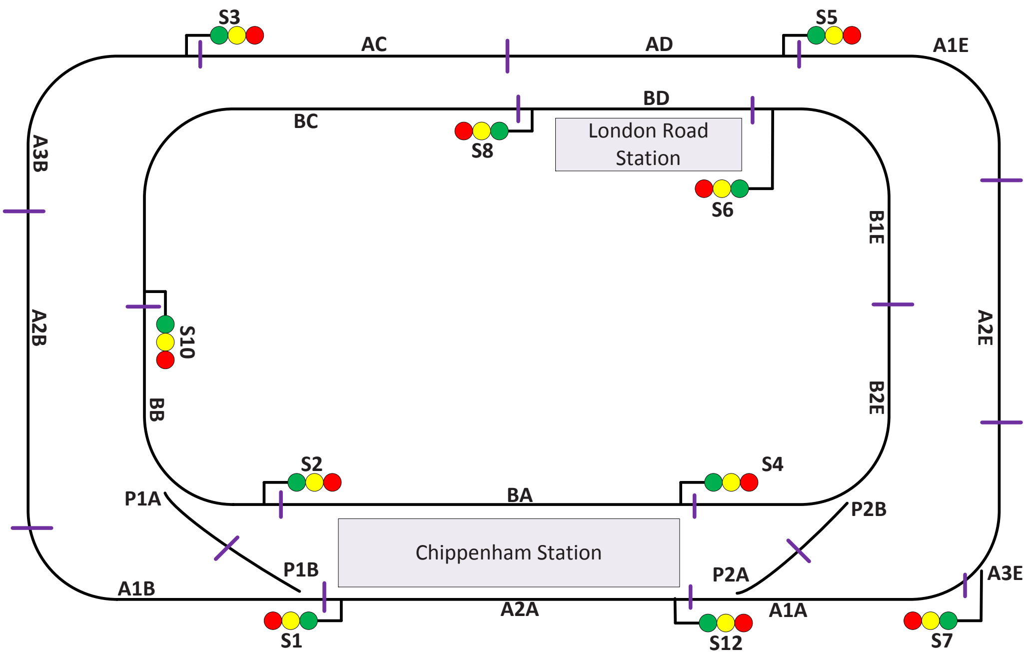
From experience, these questions pique interest and lead to good discussions. British students often ask:

"Why not make trains longer/taller/wider? Why not use GPS to locate trains? Why not run the trains faster? Why is my train delayed in autumn?"

A good demo is to challenge a student to crash a train by racing past a red signal – what child doesn't love a bit of destruction? While they can turn the speed up all they want, once the SPAD occurs, the train will screech to a halt and an ominous alarm will play.

Day class

In one example of a more in-depth activity, Siemens graduates held a day long STEM intervention for twenty 14-year-olds attending a technical college in Swindon. Students were split in six groups. Half of the groups were 'A' groups and half were 'B' groups. 'A' groups needed to construct a circuit to control LED lights, and 'B' groups needed to construct a circuit with buttons.



STEMRail has a layout designed to demonstrate many of the concepts of railway signalling and control that may not be familiar to younger people or those outside the industry.

'A' groups then paired with a 'B' groups and agreed on two IP addresses. The two groups had to agree a common communication protocol that resulted in the correct light being displayed based on the count of the buttons.

After having effectively built a basic signalling system, the students interacted with STEMRail and gained a perspective of how their work fits in to a larger engineering project.

Advanced activities

STEMRail also provides opportunities for interns and graduates, because it effectively simulates a real engineering project lifecycle. Layout changes and enhancements to functionality are possible. The system is fully documented, and can be passed on to future years. During the STEMRail project, the inner loop was commissioned by 2015 graduates, and the outer loop by 2016 graduates. Now, a new year of young engineers is further expanding upon its functionality.

Conclusion

Since 2015, the STEMRail project has demonstrated at events across the United Kingdom how a Raspberry Pi microcomputer can transform a model railway in to a tool for engaging young people. It is one way railway signalling engineers can share an insight into their industry and inspire the next generation. Although data from busy events can be difficult to capture, feedback from event organisers has been strong. At a recent STEM event where STEMRail technology was a major feature, 30% more students developed an interest in engineering, with the greatest growth amongst girls.

Future developments could make this project more accessible to a wider range of students: Creating a Lego [4] version would make it easier to transport, while modularising components would give students more freedom to experiment and learn within a shorter time. In future, the interface will be made more user-friendly, and reliability issues will be addressed. Eventually, technology found in optical mice could be applied to measure distance travelled, and moving block working could be implemented.

Acknowledgements

Sincere thanks are extended to:
Colin Morris for sponsoring and steering the development and to 2015 Siemens RA graduates for giving up their evenings to solder, wire and install countless signals and axle counters.

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[4] Lego is a plastic construction toy manufactured by the Lego Group, a company based in Billund, Denmark.

The IRSE is committed to equality, diversity and inclusion within our industry, including working to encourage a new generation of engineers to join us. Science Technology Engineering and Maths (STEM) activities like those Alex describes are a key part of that work. Such activities also count as part of your continuing professional development. If you'd like to be more involved in this sort of work, more information can be found at irse.info/i23ah.

Reducing the risk at automatic level crossings in Great Britain

Paul Darlington and David Fenner

Great Britain's level crossing safety record is one of the best in the world and overall the risks are well managed. However, level crossings are still one of the biggest sources of railway catastrophic risk and every incident has the potential for significant danger to both users of the crossing and trains.

Risk control should, where practicable, be achieved through the removal of level crossings and replacing them with bridges, underpasses or diversions. This is easier said than done though, as the specification is often driven by the need to address equal access for disabled users and infant buggies, and this may require ramped access which demands land take and can create a visually intrusive structure. In many cases there is simply not the land available. Many road crossings have property or road junctions nearby making it challenging or very expensive to provide the necessary vertical separation between road and rail whilst still providing access to these facilities.

Crossings connect communities and closing them even with diversions will, understandably, be resisted by local communities. Where removal is not possible, the risks need to be reduced as far is reasonably practicable and this is an area where innovative technology at an affordable cost can help to reduce risk.

The risk reduction measures have to take into account all the users of crossings, with 'equal access for all' being a key requirement. Users of crossings may be mobility impaired (with the population getting older). They may have hearing and sight impairments and their first language may not be English. Users may

Newcastle Road automatic half barrier crossing, Nantwich. Only a single barrier to stop road traffic and pedestrians.

be old, young, short or tall, and mobility scooter users and horseback riders will have a different angle of view of crossing signs, signals and approaching trains compared to pedestrians.

Fully closed crossings

The classic highway level crossing originally consisted of gates controlled by a local operator which were closed to road traffic when a train approached. Such crossings were made safer with the provision of interlocking, so that protecting signals could not be cleared until the road was fully closed by the gates being operated and locked. Approach locking will ensure that the gates cannot be opened until a train has travelled over the level crossing, and the train detection equipment has proven the train to be clear, thus removing the risk of opening the crossing too soon as a result of human error. The crossing operator also has to check that the crossing is clear and that nobody is trapped inside the gates before the signals are cleared. Gates are still found at a number of level crossings, but they have largely been replaced by lifting barriers with the same controls.

Remote operation of level crossings became possible with the introduction of CCTV technology, with an operator still responsible for checking the crossing is clear even though it may now be several miles away. Such crossings are not without risk though, and the operator has to be trained and monitored, along with the asset condition, to make sure the safe observation of the crossing is not affected by – signaller error (workload), poor equipment (picture quality), or poor contrast – which needs to take into account user clothing and the background in varying lighting conditions. There is a limit to the number of crossings that can be operated by one person via CCTV; the creation of larger signalling centres and the desire to reduce the number of signal boxes has triggered the development of obstacle detection equipment.

Recent developments and next steps

The use of radars and lidars to "sweep" the crossing and to check it is clear is now accepted technology and has been installed at many crossings. The concept has been a major success in fully automating the operation of full barrier crossings. The crossings are known as obstacle detected, or simply 'OD', crossings. New methods of obstacle detection are now being evaluated by Network Rail both for the next generation of automated OD crossings and to assist the signaller in checking a CCTV image prior to operating the 'Crossing Clear' function. To provide assistance to the signaller, video analytics techniques are being investigated to give a prompt to re-check the screen if something is detected within the barriers. The challenges for all forms of obstacle detection include ensuring that the camera or sensor operates reliably in all light conditions, including fog and falling snow. It must also not be 'fooled' by harmless obstacles such as paper or cardboard or even falling leaves.

Changes to society, such as a Sunday markets, new housing developments, amended school bus routes, or even satellite navigation algorithms, can change the risk profile of a level crossing. Currently it can be difficult to identify such changes in use without expensive traffic surveys, and they only provide a snapshot in time. Video analytic based systems may provide benefits, such as generating data on the use of the crossing both vehicular and others to feed into automatic risk analysis systems. This will enable the identification of any changes of use of the crossing automatically, subject to data protection and privacy requirements. The use of 'big data' systems is an area which may become more important for railways to help manage assets and risks, and to target interventions and resources.

The introduction of Light Emitting Diode (LED) technology has improved the light output and reliability of illumination associated with level crossings. LED lighting was first introduced for the barrier boom lamps fundamentally to improve reliability, as the vibration when the barriers were raised or lowered affected the life of the traditional incandescent lamps, especially as this vibration occurred at the same time as the lamp was being turned on or off. The benefits of LED have also been successfully migrated to the road traffic signals (wig-wags) replacing the traditional 36-watt incandescent lamps.

The sharp on-off of an LED compared with the rise-fall of a traditional lamp may require changes to the flasher drive, along with the need to alter the proving circuitry as LEDs require significantly less current. The reliability of LED technology is now so good that there may be more failures caused by proving circuitry rather than a failure of the LED itself. It is an area where the re-evaluation of the safety benefit of lamp proving complexity against cost may be required, with the opportunity to invest the savings in other safety measures.

Automatic Half Barrier (AHB) crossings

AHB crossings were introduced in the 1960s by British Rail following their introduction in other parts of the world. There have been a number of changes to the design, but currently the speed of trains over the AHB crossing should not exceed 100 mph (160 km/h) and such crossings shall have no more than two running lines. Trains should not arrive at the crossing in less than 27 seconds after the amber lights of the road traffic signals first show, with at least 95% of trains arriving within 75 seconds and 50% within 50 seconds. There is no limit to the amount of road traffic but the carriageway on the approaches to the crossing should be sufficiently wide to enable vehicles to pass safely, with the road layout, profile and traffic conditions such that road vehicles are very unlikely to become grounded or 'block back' and obstruct the railway.

A good road profile is particularly important at an AHB as should the crossing become occupied by a stationary road vehicle, there is no mechanism to detect the crossing is not clear and stop an approaching train. An emergency telephone is provided to alert the signaller if the crossing is occupied, but a train may only be 27 seconds away and the only means of stopping it is by radio message from the control location. This is why only half barriers are provided, so as to not trap vehicles or pedestrians inside the crossing barriers.

So long as they are used correctly AHB crossings are efficient and, compared to other types of crossing, are closed to road traffic for a relatively short period of time. This allows road traffic to keep moving with minimum disruption from the railway. Unfortunately, AHBs are prone to misuse, with the risk of road traffic 'weaving' around the barriers when they are down. Pedestrians approaching the crossing on the right-hand side, when the crossing is in use, will be met with no barrier and only the flashing light and audible alert to stop them. The problem can be worse at 'skew' angled crossings with a longer time required to walk over

Figure 1 – AHB crossing with a large skew angle making a long walk for crossing pedestrians.

Figure 2 – 'standing red person' signal (centre) supplementing road lights.

the crossing (see figure 1). AHBs are therefore not suitable where there is a high volume of pedestrian users without other mitigations such as a 'standing red person' signal to supplement the road lights. (see figure 2)

There are over 400 AHB crossings in use on the Network Rail network, and their use on higher speed and often busier lines, together with the potential for misuse, means that they present the highest risk of all crossing types. So, what can be done to reduce the risk of AHBs, while retaining their benefit of not inconveniencing road users too much?

AHB plus

As long ago as 1983 the Oppenheim committee investigated the pedestrians' use of level crossings and their report made a recommendation concerning the use of pedestrian signals, but the introduction of such signals has not been widely adopted across the network. This is discussed in Ed Rollings' ASPECT 2015 paper, irse.info/qncdt.

This is now starting to change with products now readily available, and the introduction of low current LED signals has assisted their cost effectiveness. The 'standing red person' signal is particularly useful in reducing risk when installed for pedestrians approaching a AHB crossing in the opposite direction to road vehicles exiting the crossing.

An additional measure for AHBs could be the use of red controlled LED road studs across the whole of the carriageway, see figure 3. These would deter vehicles and pedestrians from entering the crossing once a train has passed the strike in point, though a legislation change will be needed to allow their use. Road studs are not currently supported by the Department for Transport, although another option may be to provide LED studs just on pedestrian walkways to supplement the 'standing red person' signal.

A method of reducing the risk of vehicles weaving around the AHB barriers could be to provide a raised 'median strip' or central reservation in the area that separates the opposing lanes of road traffic. Such strips have been provided at level crossings in a number of countries around the world. The problem though is that a 'misuser' could still cross to the other side of the road before reaching the strip. The strip would also possibly require road widening and introduce a hazard to cycles and motorbikes. The option is not favoured by the road authorities

A more practical way of reducing the risk of weaving at AHBs would be to provide full barriers, along with the use of an obstacle detection device to raise the barrier if a person, or a vehicle, was trapped inside the barriers. This would be known as AHB plus and a number of configurations are currently being evaluated.

The first option would be to 'stagger' the position of the additional exit barriers so that a narrow gap was available to pedestrians between the ends of the barriers. A simpler 'vehicle only' obstacle detection device could then be used to lift or stop the descent of the exit barrier if a vehicle was detected during the closure cycle, as shown in figure 4. This should reduce the window of opportunity to weave around the barriers as both are closed except when a departing vehicle is in the way. Another

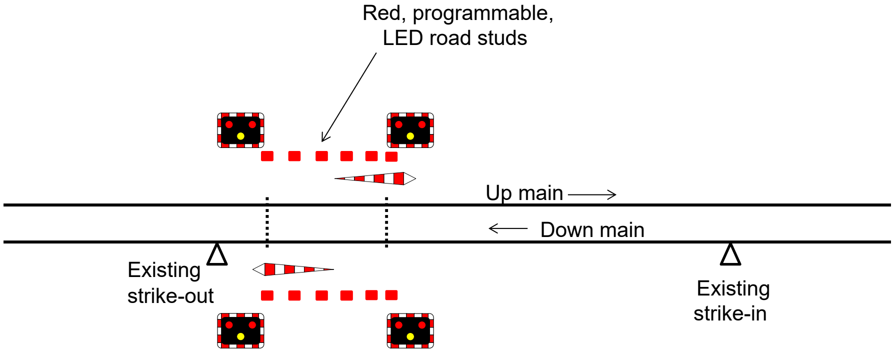


Figure 3 – The use of programmable LED road studs could offer safety benefits.

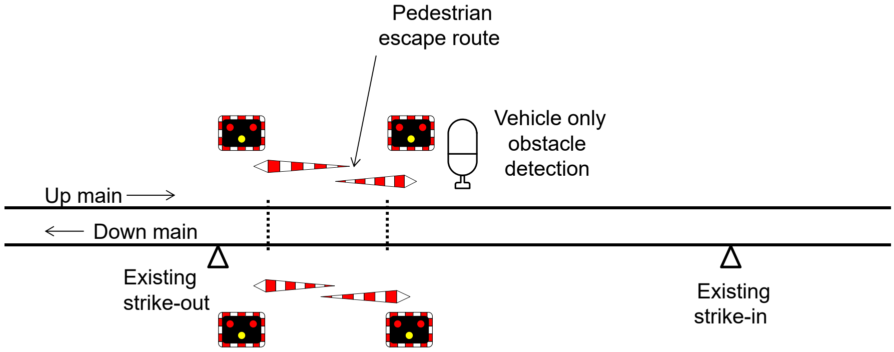
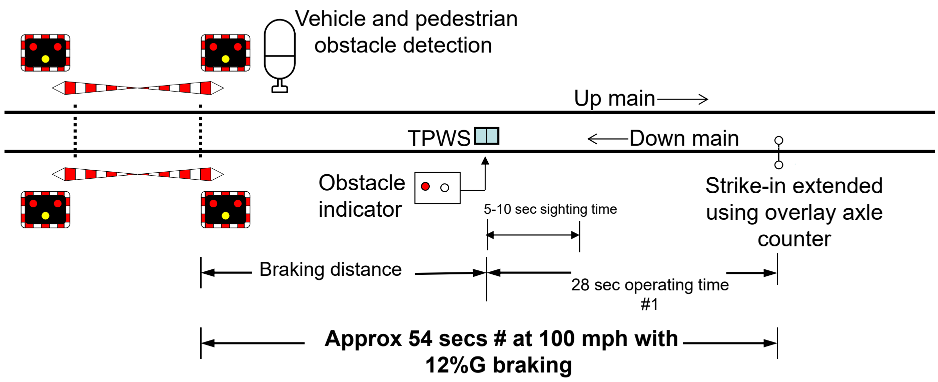


Figure 4 – One way in which full barriers could be used.



Time, to be calculated for each site, dependent upon gradient between TPWS and the crossing. Example based on gradient of 1/66F.

#1 Does not include allowance for "another train coming" controls. This will not affect train arrival time but will affect position of strike-in equipment.

Figure 5 – Full barrier operation enhanced by the use of TPWS.

option would be to align the barriers and have an obstacle detector for both pedestrians and vehicles.

A further safety enhancement could include the provision of a TPWS trigger to stop a train before it reached the occupied crossing. The time factor would need to be calculated for each site. The strike in point and probably the level crossing cycle time would need to be extended to provide (for example) around 54 seconds at 100 mph (160 km/h)with 12%G braking although it may be acceptable to simply confirm the level crossing is clear when the train first approached and thus isolate the TPWS but this leaves the possibility of a collision with a car entering the crossing during the closure cycle. An allowance would also need to be included for 'another train coming' controls, or with the crossing now protected with full barriers is the 'another train coming' facility required? An indication to advise a driver that their train TPWS had been triggered by a level crossing obstacle detection device would also need to be considered via a lineside indication. This is shown in figure 5.

ABCL and AOCL

Automatic Barrier Crossings Locally Monitored (ABCL) and Automatic Open Crossings Locally Monitored (AOCL) were introduced to automate the operation of crossings on predominantly rural lines with lower line speeds and train frequencies than for an AHB. They are used on lines where remote monitoring of the crossing is or was challenging or where the road situation approaching the crossing cannot be designed to meet the requirements of an AHB and a reduction in train speed is acceptable. ABCL crossings appear, to the road user, similar to an AHB crossing with a single barrier on both sides of the railway. Both AOCL and ABCL crossings are protected by road traffic light signals along with an audible warning for pedestrians.

As with AHB the barriers on an ABCL only extend across the entrances to the crossing leaving the exits clear. The crossing equipment is normally initiated automatically by an approaching train. However, unlike an AHB, the operation of the crossing equipment and the absence of an obstruction on the crossing are monitored by the driver of an approaching train, hence the term locally monitored. Train drivers are required to stop their trains short of the crossing unless they have received an indication (in the form of a white light) to confirm that the crossing equipment is functioning correctly and have observed that the crossing is clear. This requirement gives rise to a maximum approach speed of 55 mph (90 km/h) but in many cases where visibility is not good the approach speed may be significantly lower.

Figure 6 – AOCL+B crossing installation at Wraysholme level crossing in Cumbria, UK.

Another view of Newcastle Road, Nantwich. Pedestrians with a dog walk across the AHB crossing with no barrier on the right hand side to prevent access when a train approaches.

AOCL crossings are similar but, as the name suggests, they are open with no barriers and with only the flashing lights and audible alert to stop users entering the crossing. Following a number of serious accidents with vehicles entering the crossing just as a train approached the crossing and with no time to stop, several AOCLs on the main rail network have been retrofitted with entrance barriers. As far as users are concerned they now appear to be the same as ABCL crossings but are known as AOCL+B (figure 6). The reason for this is because the barrier is a 'bolt on' to the existing AOCL circuitry, and there are subtle differences in failure modes and how they operate under local control compared to an ABCL, hence the different designations.

With the lower line speed and local monitoring, along with trains being able to stop if the crossing is occupied by a stationary road vehicle, both ABCL and AOCL+B carry a lower risk than AHB. However, the risk of road vehicles weaving around the entrance barriers is similar, therefore the addition of exit barriers will further reduce the risk profile. Such a crossing is known as Automatic Full Barrier Crossing Locally supervised, AFBCL.

An AFBCL is fundamentally a locally monitored crossing with elements of an OD system to determine if lowering of the exit barriers can commence, and therefore the crossing must be clear of standing pedestrians for the exit barriers to start lowering and with the entrance barriers already down. This will extend the closure cycle time by circa 6 seconds so strike in etc will all have to be moved. If the OD system is active from the beginning all barriers could be lowered simultaneously with the exit barrier stopped only if something then encroached.

The Drivers White Light is only given if all the barriers are fully down and in the unlikely event of a trapped user (vehicle or pedestrian) the train driver is able to raise and re-lower the exit barriers using a Drivers Release Unit (DRU). Ardrossan Princes Street in Scotland was the first AFBCL monitored crossing, commissioned 28 January 2018 as reported in the March issue of IRSE News.

ETCS

A new challenge or opportunity for level crossing engineers is the implementation of the ERTMS, and in particular how the operation of level crossings is integrated with ETCS.

Reducing the variation in road closure times not only minimises the economic impact of unnecessarily delaying road or rail traffic at a level crossing but it influences risk, as large variations in closure times have been known to increase the risks because of impatient road users. If the variance in closure times is reduced, impatient road users should be less inclined to ignore, or weave around, barriers.

Systems to provide constant warning times at crossings for large variations of train speeds have had mixed success, especially where train speed may be varying during the approach. ETCS level 3, with its constant ability to report train location and speed, along with the opportunity to manage the train speed, could reduce the amount of variations in the warning times and replace the trackside strike in equipment. It is an area that requires further development, and one that is very important for Great Britain given the number of crossings that may exist on routes to be fitted with ETCS. Some of these benefits may even be extended to the large number of private and footpath crossings that have otherwise not been covered in this article especially if used in conjunction with other technical developments in local supply of electricity and internet-based communication (Internet of Things). The problem, given the huge number of crossings involved, is justifying the business case for the safety benefit delivered against cost.

Level crossings in the future

Autonomous road vehicles are just around the corner (no pun intended) and will be capable of being connected to the environment in which they operate. So, could the automatic level crossing of the future communicate directly with approaching vehicles and warn drivers that the level crossing ahead has a train approaching? Could the level crossing system of the future actually take control of a road vehicle and bring it to a stop safely before reaching the crossing?

The collection of real time data about crossing use will be key to the management of level crossings, both in asset management and in real time terms. Could 'big data' from the road system be linked to the rail traffic management system, such that the railway operation may be modified if say children or a slow-moving vehicle approached the crossing?

Many thanks to Ed Rollings, former head of level crossings engineering and Ken Vine current head of level crossings engineering at Network Rail for their assistance with this article, which is based on an earlier article published in Rail Engineer magazine.

What do you think, could these ideas be used in other railway administrations around the world to reduce the risk associated with level crossings? We would welcome comments and feedback on the ideas discussed.

Collaboration brings the new Eurostar to Ashford International

Mark O'Neill
Amey Consulting, UK

Charles Bache
Network Rail, UK

The new Eurostar Class 374 Velaro trains were officially introduced into service from Ashford International on the 3 April by the Secretary of State for Transport, the Rt Hon Chris Grayling MP, with local dignitaries in attendance. A new plaque was unveiled at Ashford International Station to commemorate the occasion.

Project background

The new Siemens Class 374 high speed Velaro train was introduced by Eurostar to replace the ageing Alstom Class 373 Trans Manche Super Train (TMST), that has been in service since the opening of the Channel Tunnel in 1994. The TMST was specifically designed for operation on the national networks of the UK, France and Belgium, and included the UK train protection systems of AWS/TPWS, as well as the French TVM 430 cab signalling system, KVB ATP, crocodile warning system, and the Belgian TBL ATP system.

The new Siemens Class 374 has ETCS on-board, with ETCS Specific Transmission Modules (STMs) for TVM 430, with KVB and TBL also installed. However, there is no AWS/TPWS on-board, so the train was unable to call at Ashford International station, leaving the people of Kent with an International station but no service.

Kent County Council and Ashford Borough Council approached Network Rail and asked them to provide a signalling system at Ashford International, compatible with the new Eurostar, to allow them to stop. KVB was selected as the train protection system, being already proven and in use with the lineside signalling at St Pancras International station.

An Ashford Project Governance Board was quickly established with all major stakeholders in attendance, to

Secretary of State for Transport, Rt Hon Chris Grayling MP and Ashford MP Damian Green welcomed the Velaro Eurostar into Ashford International to much press interest. *Photo Network Rail.*

successfully steer and deliver a business case, third party funding stream, and an integrated delivery programme, which ensured a realistic budget and timescales were set from the start. Chaired monthly by Ashford Borough Council, representatives from Kent County Council, Department for Transport, The Office of Rail and Road, HS1 Ltd, Eurostar, Southeastern, Network Rail south east route and Network Rail infrastructure project signalling southern, set out to ensure the international status was reinstated at Ashford.

Network Rail and Amey collaboration

Network Rail Infrastructure Projects and Amey integrated themselves alongside Network Rail High Speed Ltd and Network Rail Works Delivery Signalling to undertake the installation and testing works. Network Rail Signal Works Testing also partnered with Amey's testing staff to develop and deliver robust plans for a successful and on-time commissioning. French signalling consultancy Systra were subcontracted to provide independent checking of the layout plans and control tables and to manage the production of the data. Safety specialist AEGIS was sub-contracted to produce the safety case and EMC work, with human factors specialists CCD undertaking the ergonomic studies.

KVB history

The system was introduced by SNCF after a derailment and head on collision at Argenton sur Creuse that killed 43 people in 1985. The driver failed to deal with a temporary speed restriction located within successive permanent speed restrictions and the train derailed towards the adjacent track as another train was approaching. This accident occurred a month after the crash at Flaujac that resulted in 35 dead. There was another accident shortly afterward in 1985 due to an overspeed at Novéant where a train derailed at 118 km/h on a set of points, the driver failing to deal with a 30 km/h speed restriction. SNCF looked to install a national ATP system after these accidents and reviewed the available systems operating in Europe, similar to the BR response after Clapham. SNCF selected the Ericson EBICAB ATP system from Sweden as it was the most modern and easiest technology to implement.

A licence was given to Alstom to develop the EBICAB system to SNCF standards and the resulting system was named KVB (Controlle de Vitesse a Balise). Note that the K is used for Control in the French signalling alphabet – like W for points in Britain!

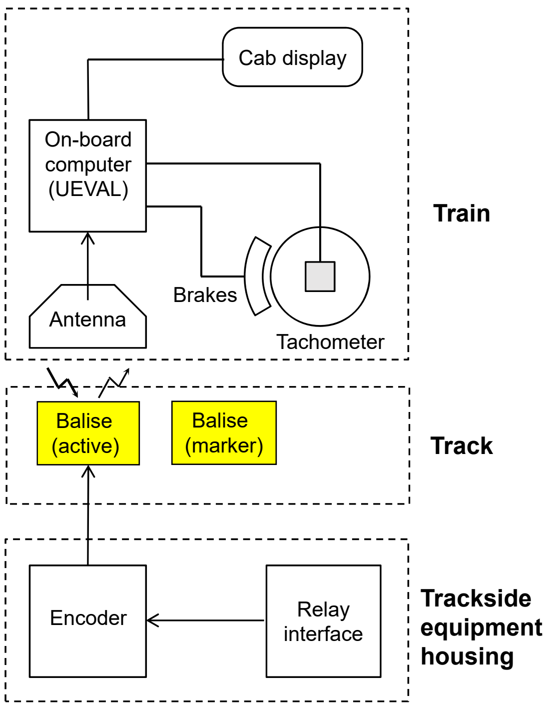


Figure 1 – System architecture and key subsystems.

The initial deployment was at the most dangerous signals and speed restrictions, but a further accident at Melun in 1991, where 16 people were killed, resulted in the acceleration of a nationwide installation programme.

System types

Two versions of the system exist; an older version using individual balises for different messages and a new version using only one balise for all messages (maximum of 8). The new system is termed SN (Sol Numerique or 'digital'). The advantage of the new digital technology is that the updated encoder and balise have greater capacity and only two balises are required to deliver the maximum 8 messages: one balise for information and one as a location marker. The older technology used a number of balises depending on the amount and type of information required.

The newer digital technology was chosen for the St Pancras application and used at Ashford.

System architecture

The main components of the system are shown in figure 1. The system provides continuous supervision of the driver's speed and braking, in accordance with the line speed and signal aspect/routing information provided by the trackside balises. As the trackside balises are positioned at defined locations only (i.e. signals, line speed changes, etc.) the train only receives updated information intermittently.

Balises

The balises send fixed or variable information to the on-board equipment concerning the line speed, gradient, distance and signal aspect. Three types of balise exist: active, passive and marker.

An active balise gives information that can vary according to the encoder inputs. This variable information is normally associated with signal aspects, routing information or point position. Consequently, active balises are normally used at signals or speed restrictions that are dependent on the route set. The encoder is attached to the balise via a plug coupled cable, up to a maximum of 1500 m in length.

A passive balise gives information that is always fixed, such as permanent speed restrictions or end of fitted area messages. As the information does not vary, a passive balise does not require an encoder connection, but is pre-programmed with the necessary information via a fixed plug.

A marker balise is also a fixed message balise that contains a fixed marker message. This balise is used along with an active or passive balise to determine the direction of the train.

Location of balises

A signal balise pair (or information point) is located adjacent to each signal. The signal information point consists of an active balise whose message depends on the aspect/route information given by the signal, and a marker balise. The active balise is normally placed adjacent to the signal, with the marker balise 3.5 m ahead (note: the active balise must be a minimum of 6.5 m from the signal replacement joint).

An information point is also provided at each speed restriction or change of speed profile. This consists of a passive balise giving details of the speed profile and a marker balise 3.5 m ahead (unless the speed restriction is different depending on the route, when an active balise would be used).

The speed restriction balise is normally located directly adjacent to the speed board. Where the speed board is located on the signal post, then the signal balise will be programmed with the speed restriction information field.

Where a reduction in speed occurs, then a warning information point is required to provide braking details on the approach to the speed restriction. Again, this consists of a passive balise and a marker balise 3.5 m ahead. Where a balise is provided for other means (i.e. a signal balise) near the advanced warning balise, then the warning information can be programmed into this balise.

Functionality

The system provides the following functionality:

- Supervision of train speed against the line speed.
- Supervision of braking to a speed reduction.
- Supervision of braking to a signal with a standard overlap.
- Supervision of braking to a signal with a reduced overlap.
- Passing signals at Danger.
- Shunting movements.

The balises send fixed or variable information to the on-board computer concerning the line speed, gradient, distance and signal aspects. The on-board computer uses this information to calculate the required speed curve and compares it to the current train speed. If the driver goes 5 km/h above the speed curve, then the over speed lamp lights on the display and an alarm sound is given (a 2 second 'toot'). If the driver then brings the train speed within 5 km/h of the speed limit, the warning light is extinguished. This is shown in figure 2.

If the driver goes 10 km/h above the speed limit then the emergency brake is applied and both the emergency braking lamp is lit and the FU (Freinage Urgence – Emergency Brake) indication is displayed in the main display. The emergency brake will then bring the train to a halt.

When approaching a line speed reduction, the KVB on board computer calculates a braking curve after passing the warning information point as shown in figure 3.

A warning information point is not required for an increase in line speed, as shown in figure 4.

When approaching a signal at danger the driver's braking is not supervised to a stop, but to a release speed of 30 km/h at 200 m before the signal. This allows the driver to approach the signal at a low speed and pass the signal if it has cleared from danger to a proceed aspect as the train approaches., Updated information on the line ahead is received when passing the signal balise. Figure 5.

The Southeastern Class 395 Javelin trains will receive a 00 in the auxiliary display to warn the driver that they are approaching a signal at danger (see display section).

Due to the release speed functionality, the balises provide a train stop function when the signal is at danger. Consequently, an overlap is still required as a driver could theoretically pass a danger signal while at 40 km/h (note: 30 km/h is the release speed dictated in the Eurostar driving procedures, but the system will only intervene when the driver is 10 km/h above the release speed i.e 40 km/h). The guaranteed overlap distance at 40 km/h is 120 m for Eurostar and Javelin trains.

Where an overlap length of 120 m is not available (as in figure 6), a specific balise termed the PROX balise is located 125 m in rear of the signal. This changes the drivers release speed to 10 km/h if the signal is still showing danger (intervention at 15 km/h). The corresponding guaranteed stopping distance for this lower release speed is 50 m.

If a driver is authorised to pass such a signal, to prevent the train being tripped and emergency braking activated, the driver must press the 'BPFC' button on the on-board display panel. The pressing of this button, which must be carried out while the train is at standstill, allows the train to pass the signal and continue to proceed on sight, supervised to a maximum speed of 30 km/h.

The driver can also enter shunting mode if required to undertake authorised shunting movements. Again, the train needs to be at a stand and the driver must press the 'BPMV' button on the on-board display panel. Shunting mode supervises the train speed to a maximum of 30 km/h and for a maximum distance of 3500 m (after which shunting mode must be entered again). The shunting mode functionality in not in use in the UK application.

On-board equipment

The train borne equipment consists of a vital computer, an antenna, speed and distance sensors, brake interface and cab display unit/input device (i.e. for train length, braking characteristics, etc.). The on-board antenna constantly sends a tele-powering signal at a frequency of 27 MHz, modulated by a 50 kHz

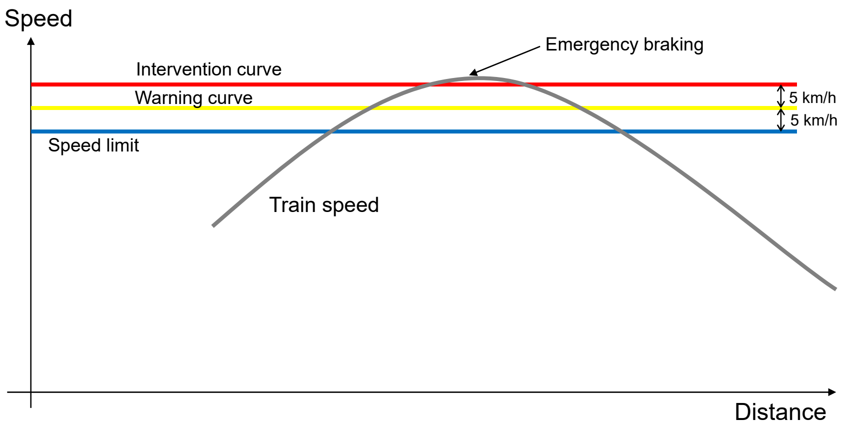


Figure 2 – Speed supervision concept.

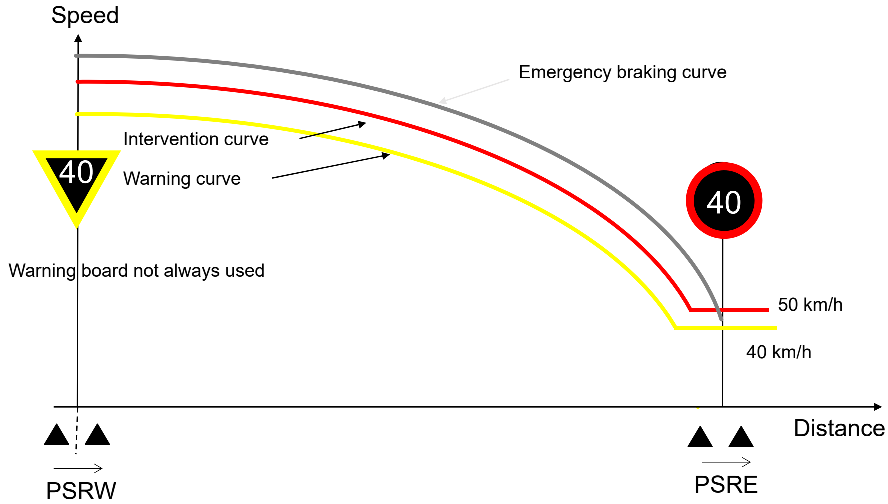


Figure 3 – Braking supervision towards a speed restriction.

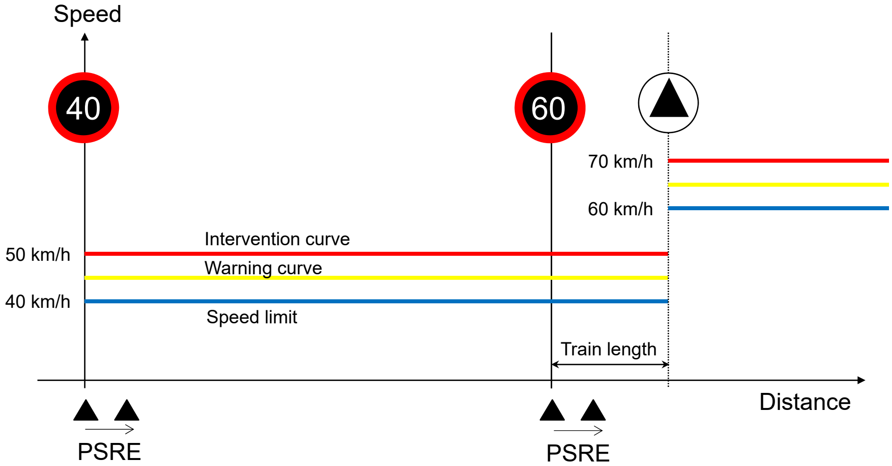


Figure 4 – Speed supervision for a speed increase.

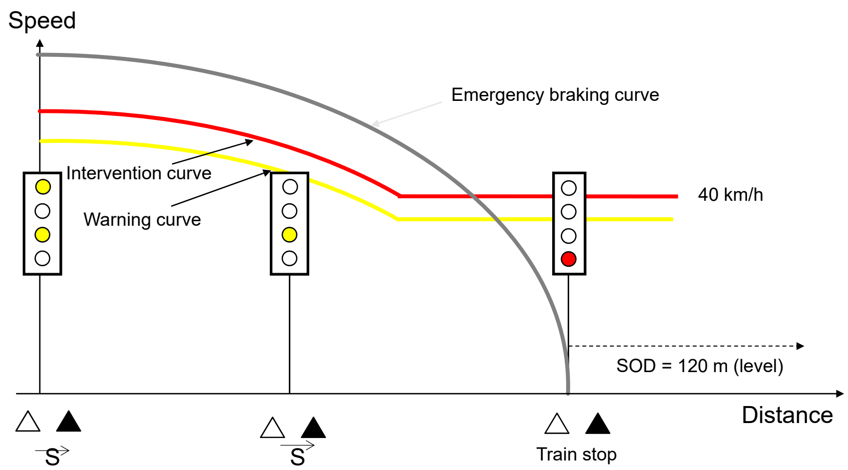


Figure 5 –Braking supervision for a full overlap (>120 m).

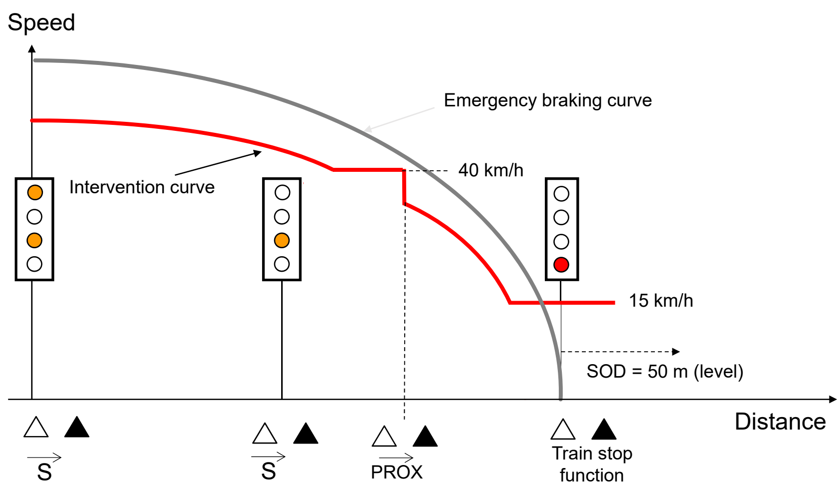


Figure 6 –Braking supervision for a reduced overlap (<120 m).

square signal of cyclical ratio 1/8 that synchronises the transmission of the message. The balise uses the energy of the 27 MHz signal as a power supply and sends its message back in the form of 4.5 MHz pulses at a speed of 50 Kbits per second. A bit in the '0' state corresponds to a 4.5 MHz pulse and a bit in the '1' state corresponds to the absence of 4.5 MHz pulse.

The balise sends a 256 bit message consisting of 8 start/synchronisation bits, 172 message bits and 76 check bits for the check sum and cyclic redundancy code. The first 4 bits of the 172 bit message represent the type of balise, with the remaining 168 bits representing the information fields of the message (i.e. signal information, speed restriction information, etc.). Different information fields are provided for different message types.

Display philosophy

The ATP system does not provide cab signalling information. The SNCF/Eurostar philosophy is for the driver to follow the lineside signals and indications, and not consider the ATP background safety system (i.e. the driver should not rely on a system designed to monitor their behaviour). This allows the driver to behave in accordance with training and experience, relying only on the lineside signals and route knowledge.

A limited amount of information was provided on the original display to let the driver know when they had received a warning indication at a signal or speed restriction, but SNCF have now upgraded the display to show only the minimum amount of speed supervision information. This upgraded version is provided on the Eurostar trains.

However, the system on board the Southeastern Class 395 Javelin train was provided prior to the SNCF upgrade, and has more indications than the Eurostar.

Display

The driver display panel (figure 7) has a number of indications and buttons. There are two displays on the panel: an auxiliary display provides warning information, and the main display execute information as shown in figure 8.

The input device allows the driver to input information regarding the train characteristics, but is not used on HS1.

The Eurostar display only provides an auxiliary indication (000) after passing a PROX balise approaching a signal at danger, when the release speed is 10 km/h. The main display on Eurostar only shows FU for emergency braking.

On the Southeastern Javelin trains, an additional indication is provided to alert the driver to a warning signal (i.e. 00 indication in the auxiliary display).

The buttons in use on HS1 are the override (BPFC) to allow the driver to pass a signal at danger with the signaller's authority. The other buttons are not used. On the Southeastern Javelin trains, a green 00 indication is provided on the main display when passing a signal at danger under 30 km/h supervision. This indication is not provided on Eurostar.

The PANNE indication lights are used to indicate either a trackside (SOL) or on-board (ENGIN) failure of the equipment.

The balises provide distance 'linking' information to the next information point for signals and speed restrictions, so if a balise is not encountered where expected, a 'panne sol' trackside failure will be indicated by an audible warning and the indication lamp flashing for 10 seconds.

When a trackside balise failure is indicated, the system resets and no train protection functionality is available until the next balise is encountered. As a trackside failure is not indicated back to the signaller or maintainer, any failure indication is notified immediately to the signaller by the driver.

The various driver indications for Javelin and Eurostar trains are shown in figure 8.

Encoder unit

The encoder unit (figure 9) takes inputs from the signalling system and transmits this information to the active balises.

The unit can drive up to four balises and is made up of a number of cards, with the card type dependent on the power supply used and the input method used for the signal information (i.e. the input card for a relay input is different from the input card for direct connection to the signal lamp).

The cards used for St Pancras and Ashford are:

- Location B: UCS card – The main CPU Card. This holds the BCC coding plug that contains the site data.
- Locations C, D, E, F: ECI cards – Input Cards. Each card can take up to 10 relay contact inputs (maximum of 30 inputs between 4 cards – one card per signal is normally used).
- Location G: SBI card – Output Card. This drives up to 4 balises maximum.
- Location K: AHT card – Power Supply Card. The 110V AC power supply card is used at St Pancras. This card

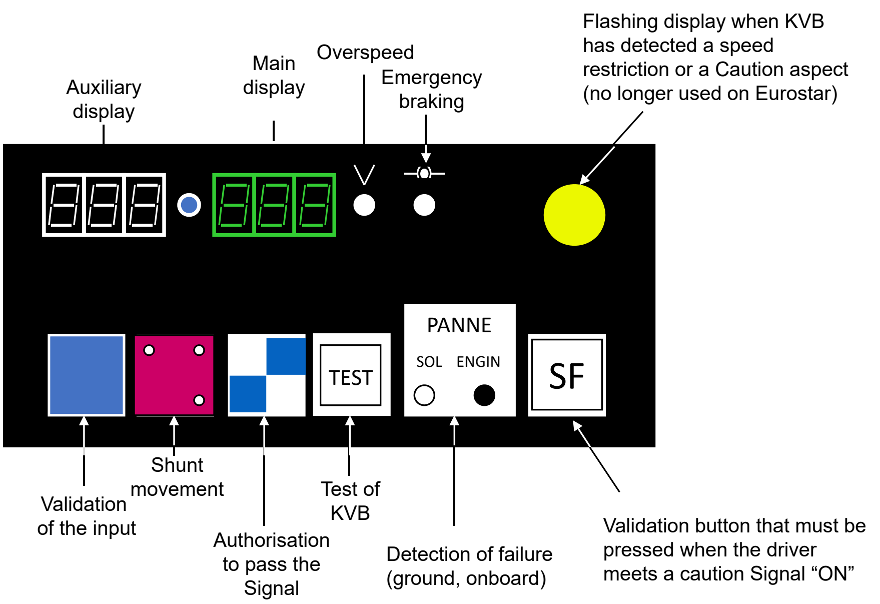


Figure 7 – Driver display panel indications and buttons.

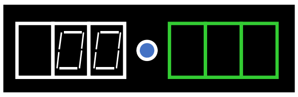
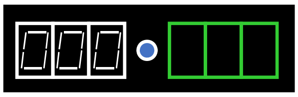
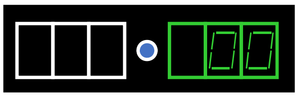
Display	Description
	Supervision of the announcement of a signal at danger with approach speed of 30 km/h. Used at St Pancras when approaching a red signal with an overlap greater than 120m.
	Supervision of the announcement of a signal at danger with approach speed of 10 km/h. Used at St Pancras by both Eurostar and Javelin trains when approaching a red signal with an overlap less than 120 m. Indication appears after PROX beacon has been passed.
	Proceed on sight supervision. Used at St Pancras when passing a red signal with a subsidiary aspect for a call-on movement. Only provided on the Javelin.

Figure 8 – Cab displays for class 373/4 Eurostar and class 395 Javelin trains.

provides up to 10VA and is required for providing the 5V DC for the internal electronics and 24V DC for the feed for the relay inputs.

Upgrade to ETCS level 1

The SN digital encoder can be upgraded to ETCS level 1 with the addition of a 'CERB' card in slot location A. This card connects to the UCS card and can:

- Convert the input information from the UCS card into the ETCS message format.
- Control up to 4 Eurobalises.
- Manage Ethernet links to other encoders.

The CERB card provides a simple upgrade path to ETCS level 1.

Interfacing KVB to Network Rail principles

The main technical challenge facing the design team was to interface the system with UK SSI. This was achieved by installing lamp proving relays in series with the SSI outputs to each lamp, following the method 3 arrangement adopted for TPWS which doesn't require any alteration to the SSI data.

The lamp proving relays were inserted between the output fuse and terminal, allowing the new wiring to be cut in with minimal impact to the existing installation. There was exactly one year to complete the project, between contract award in March 2017 and the first train in March 2018, so a simple solution with minimal impact to the existing signalling was the main goal.

The GECR lamp proving relays were used to feed repeat relays located in a dedicated location case or REB rack. This was necessary as the BR941A type relay does not have back contacts, and the KVB principles state that the both back and front contacts of all signal aspect relays are input into the KVB encoder to determine that all the inputs are working correctly.

Standard modular locations and REB racks were also designed to allow for quicker design and installation.

Testing

The testing process and certificates used on the CTRL project at St Pancras were different to NR testing practice. Therefore the testing team had to develop a new set of testing specifications and testing certificates that matched Network Rail testing principles.

Most of the testing was undertaken off track using the KVB testing tool and the relevant encoder. The fixed data balises were pre-installed with the required data plugs and then tested in a depot environment prior to installation and checking on site. A final test at the balise was all that was required to ensure a message was being transmitted.

Figure 9 – Encoder unit.

Conclusion

All parties worked closely together to make this unique project successful. Close collaboration was the only way to introduce a novel system and meet the tight schedule, which required the combined team to go from option finalisation to completion of the wiring design in only 7 months.

The use of specialist sub-contractors also ensured that skilled staff worked on the tasks required, with Systra managing the data production and independent verification of the design, AEGIS producing the safety case and EMC documentation and CCD undertaking all the ergonomics studies.

The residents of Kent can now look forward to continued access to Eurostar services to Europe and Ashford remaining part of the European High Speed network.

IRSE
Institution of Railway Signal Engineers

The history of women in railway signalling and telecommunications

Paul Darlington

From the earliest days the railways were dominated by men with masculine characteristics defining and shaping the industry. Railways developed along military lines, with roles, grades and personnel clearly defined.

The term 'railwayman', was associated with a man and his family supported by the railway. As well as an income, the railway company may have also provided a home, education, community, training and welfare. Daughters often married into other railway families with sons following their fathers into the railway.

Things have changed tremendously since Victorian times, although according to various sources in the order of less than 20 per cent of the roles in the UK rail industry are filled by women, and in some countries, it is less, 9 per cent according to a survey by the Association of American Railroads [1]. Engineering roles are even worse with only 4 per cent in some companies.

Diversity should not be seen as just simply political correctness or as a threat to career progression, as more diverse organisations have, for example, better safety records and increased profits. Good organisations are therefore adopting diversity as a business strategy and devising initiatives aimed at positioning rail as an attractive career choice for both male and female young people.

2018 has been declared as the Year of Engineering in the UK, with various initiatives to encourage all young people to consider a career in rail. Some say the problem is not a lack of women wishing to work in rail, but the problem is simply that there are not enough young people of either sex choosing rail engineering as a career. However, with such a historically small number of women choosing engineering and rail, there is potentially a large untapped resource of engineering talent to deliver tomorrow's railway.

International Women in Engineering Day takes place this month on 23 June. This is an international awareness campaign to raise the profile of women in engineering and focuses attention on the career opportunities available to girls in engineering. It celebrates the outstanding achievements of women engineers throughout the world, so we thought what a great time to look at the history of women in rail and signalling and telecommunications.

The history of women in rail

There is evidence that some women were present in the creation and operation of the railways. Helena Wojtczak in her book "Railway Women" [2] says that in the 1851 census there were three women listed as 'railway labourers' in the UK and in the 1850s Elizabeth Holman worked for the Great Western Railway as a 'navvy' by pretending to be a man.

In general women were hired by rail companies to perform duties stereotyped by femininity. Examples

Women in rail then and now.
Left, cleaning carriages at around the time of the First World War. *Photo National Railway Museum/Network Rail Media.*
Right, Jennifer Gilleece Jones, Network Rail senior telecoms project engineer.

included women working as cooks, kitchen assistants, cleaners, housemaids, waitresses, laundrywomen, stores women, cloakroom attendants and chambermaids. By the turn of the 19th century nearly half of the women employed by the railway companies worked in hotels and catering.

The working conditions for women were even worse than for men. They were often given the lowest status jobs, with little possibility for development, and were paid less than men. Railwaymen's status and conditions slowly improved but women were initially excluded from joining unions.

Some women were involved in railway operations as level crossing operators, often looking after the crossing gates if their husbands or fathers were involved in other railway work. The role had a safety responsibility but women working in this area were often unpaid, with a tied house the only reward.

Only at the start of the 20th century were women employed in increasing numbers which included train construction. The National Railway Museum in York [3] say that by 1914 about 900 women worked in UK railway workshops as skilled trimmers, French polishers or sewing machinists producing the finely upholstered and polished hardwood interiors of railway coaches.

Women and war

By necessity, the outbreak of wars has always created new opportunities for women as men were called on to fight. This occurred as long ago as the American Civil War and offered women job opportunities in a male dominated industry [1]. The same happened at the outbreak of both world wars. Within a month of the outbreak of the First World War of 1914-18 over 100,000 men working on railways in the UK had enlisted. By 1918 the number of women carrying out clerical, telephone and telegraph duties had risen tenfold. In Britain's railway workshops the number of unskilled women labourers increased from 43 in 1914 to 2,547 by 1918 [3].

Although throughout the war women faced opposition from railwaymen attempting to prevent women from being trained – even threatening to strike during wartime. The common assumption was that women were too weak both mentally and physically and lacked the skills and physical attributes to work in rail.

According to the National Railway Museum in York [4] some people disapproved of women working, saying it was "unfeminine and immodest". Women were also criticised for wearing men's trousers despite the fact some tasks were impossible or dangerous to do in a long skirt.

Until April 1915 women were paid two-thirds less than their male counterparts until the railway unions finally admitted women and demanded that companies should pay them at least the minimum male wage. As the war progressed women took on the better paid but more hazardous posts, e.g. track maintenance platelayer, shunter and guard, even the position of railway police officer was opened to women in 1917.

When the war ended the female workforce quickly began to dwindle in numbers. Male casualties as a result of the war meant that there were some vacancies open to women, working in the traditionally female identified clerical and domestic positions, but in general the women who had filled men's roles during wartime were dismissed to make way for the returning armed forces. This was a similar situation both in the UK, USA and around the world. By the 1920s only a handful of women were working in the rail industry.

At the outbreak of the Second World War in 1939, the National Service (Armed Forces) Act made all men in the UK between 18 and 41 liable for conscription into the armed forces [5]. However, in 1938 a Schedule of Reserved Occupations had been drawn up, exempting certain key skilled workers from conscription. The intention was not to repeat the mistakes of the First World War, when the indiscriminate recruitment of too many men into the military had left the country short of the necessary workforce for industries, such as mining and rail.

Australia and New Zealand introduced similar schemes. The reserved (or scheduled) occupation scheme was a complicated one, covering five million men in a vast range of jobs, which included railways and dockworkers, miners, farmers, agricultural workers, schoolteachers and doctors.

Engineering was the industry with the highest number of exemptions, but the government frequently reviewed the situation as the need for men to join the armed forces grew greater. As the men went off to fight at the front, women began to fill some of the reserved occupations as in the First World War, which included railways. Women took on engine cleaning, maintenance, track work, signaller and train driving roles.

Women worked in factories making ammunition, weapons and aeroplanes. Skilled women could earn a relatively better wage than in a domestic role, but men doing the same work were still paid more. It was not unheard of for unskilled men to receive more money than skilled female workers.

In 1943, women at the Rolls Royce factory in Glasgow went on strike. This was seen as being highly unpatriotic in a time of war and during a street demonstration; eggs and tomatoes were thrown at the female strikers. However, the protesters stopped when they found out how little the women were being paid. The women returned to work on the same pay as a male semi-skilled worker, but still not the same as a male skilled worker [5].

Once the war ended, yet again most women were forced to leave any uniformed job to make way for men returning from war, although some women remained in signalling design and equipment production.

There were situations reported in which rail managers were keen to keep on war widows, especially those with dependents. However, union officials often applied pressure until these women were dismissed and replaced by, often untrained, men.

Women in rail: an uphill struggle

After the Second World War 1939-45 there was nothing stopping women from applying for work on the railways. However, as far as recruitment drives and posters were concerned, roles for porters, engineers, technicians etc. were considered 'male-only' roles, to be filled by men.

There was an effort, in the 1960s and 1970s, by British Rail, to employ women as guards and signallers due to staff shortages. However this, again, provoked opposition from railwaymen and so the idea was dropped.

By the 1970s, women in rail were, again, generally confined to cleaning, catering or clerical work. Even then women were hindered from career progression and promotions. In catering and cleaning, women were generally prohibited from supervising or managing men.

In 1977, Karen Harrison applied for a job with British Rail and faced an immediate struggle, even with recruitment officers who, upon discovering her gender, attempted to dissuade her from becoming a train driver, and instead encouraged her to apply for clerical work. However, Karen persisted, and became the first female train driver in the UK rail industry. [6]

Harrison described her railway career as "Ten years of hell, ten years of heaven. It's a bit tough when you're only a teenager and you're hit by this gigantic tidal wave of hate. To a lot of the men, I was the proverbial xxxx in the swimming pool".

She however rapidly advanced through the ranks of her trade union, having joined the train drivers' union, ASLEF, on her first day on the railway. Karen became the first woman to hold various positions in ASLEF, culminating in 1995 when she was elected to the highest position a lay member can hold: presiding over ASLEF's annual conference during which time she was an active trade unionist and political campaigner.

Signalling and telecoms engineering

Women have held various roles in S&T engineering over the years. One example where women have made a significant contribution is with the construction of signalling equipment at the railway engineering works in Chippenham. A variety of companies were involved in railway manufacturing at the Chippenham site, until in 1935 Westinghouse Brake and Signal Company Ltd fully took over the site. The signalling side of the business remains at Chippenham and is now owned by Siemens Rail Automation.

Until the First World War of 1914-18, the personnel of the factory were exclusively male, which was generally the case in all aspects of manufacturing. When the men were 'called up' to serve on the front-line women were at first used to replace the office staff, but it was not long before they were brought onto the factory shop floor initially to do some of the lighter jobs, and then making an important part in the production of ammunition material and signalling equipment.

When that war ended most of the women in the factory gave up their benches to the returning soldiers and went back to their homes. Not quite all the women left the factory though and a few stayed on in the relay department on coil-winding and similar jobs. When a copper-oxide rectifier production facility system was installed, women were introduced in increasing numbers to handle the small components at various stages of production. In fact, the production of rectifier elements and units was nearly a 100 per cent a woman's job. When the plastics department was formed once again most of the personnel were women.

At the commencement of the Second World War in 1939 women entered almost every manufacturing shop in the factory as men were called up. They became welders, drivers, machinists, fitters, plastic moulders and painters, as well as coil-winders and assemblers in the relay shop. This included working night shifts in various parts of the factory.

Unlike the end of the First World War, the rapid development of the factory in the 1950s meant overall there were more opportunities for women. The factory had to be hugely agile during this period, creating signalling and braking equipment in a fraction of the time previously acceptable in order to replace war damaged equipment.

The workforce was around 3,500 in 1955 of which 1,125 were women, and at 32 per cent was probably far better than some other industrial sectors of the time. However, evidence suggests that by and large the women weren't given the opportunity to carry out senior management and engineering roles. The unfairness and closed opportunities created a situation of wasted talent in

One railway company's story is recorded in the remarkable body of photographs and documents that make up the Westinghouse Brake & Signal Co archive.

Top left, in the 1890s the workforce was entirely male as shown in this photograph of the Chippenham site in the days of Evans O'Donnell.

Top right, the pressing need for War work and the large numbers of young men fighting away from home meant that the factory, by now Saxby & Farmer, had no choice but to recruit and train capable and dedicated women.

Left, despite the remarkable contribution made by women during the Second World War, by the late 1940s a view of the works laboratory showed one lone female worker.

Photos WB&S archive/Siemens Rail Automation.

By the 1980s women were working in a range of skilled roles, but it would be another decade before female engineers started to be a common sight.
Photo WB&S archive/Siemens Rail Automation.

a group of people without whom the company simply would not have been able to operate, let alone prosper.

Switchboard operators

A key role within signalling & telecommunications was the switchboard and telegraph operator, without whom the early voice and telegraph networks could not operate, and these roles have always been predominantly been carried out by women. For many years the telephony licensing requirements in many countries and technology did not allow direct connections between internal railway telecoms networks and public telephone networks. The switchboard operators carried out this role, and when an internal railway telephone dialled 999 it was the railway switchboard operator who directed the call to the correct emergency service area, as the location where a call originated could be many miles from where the call 'broke out' onto the public telephone network.

There were also strict restrictions on connecting calls which could be many miles away from the switchboard onto the public network, but it was not unknown for S&T maintenance personnel to have a girlfriend or wife on the switchboard who could 'overlook' the restrictions. In quiet times, to relieve the boredom of waiting for calls to arrive, there are stories of the female operators connecting the station supervisors telephone to, for example, the local Chinese restaurant!

The train enquiry bureaus that existed up and down the rail networks were largely staffed by female employees who were key to the railway customer interface for many years.

IRSE

In 1923 the IRSE gained its first women member when Miss Elsie Louisa Winterton of Reading was made an Associate Member, the equivalent of the Member grade today. Elsie entered the service of the railway, joining the Great Western Railway (GWR) at Reading. In 1917 Elsie was appointed as a draughtswoman in the Signal Department of the GWR in Reading, as by this time many of the men were serving in the armed forces.

After the end of the First World War and the return of the men from the forces Elsie, unlike many others, was not laid off. Between 1915 and 1924 she attended classes at University College, Reading where she gained prizes and a distinction in many subjects including applied mechanics, machine construction, and mathematics.

One area where women did dominate was in switchboard operation. Euston reservation centre in 1954.

Manchester switchboard in the 1940s.
Photos Sam Hallis.

IRSE firsts:
Above, Elsie Winterton takes centre stage at the 1925 IRSE trip to Brussels.
Right, our first female president, Claire Porter.

After her marriage, as was usual at the time, Elsie left work and also the IRSE. Unfortunately, shortly after the outbreak of the Second World War, her husband fell very ill and died, leaving Elsie a widow to bring up their two small children on her own. She was taken back on the staff of the GWR Signal Department at Reading.

Elsie also developed severe asthma and eventually retired from the railway as a draughtswoman at the age of 65 in 1962, but even after 37 years' service to the GWR she received no pension. Eventually she was granted a small ex-gratia pension and she died in 1984 aged 87 years.

It took another 76 years from the time Elsie joined the Institution before a lady member achieved the distinction of becoming a Council member, as in 1997 Claire Porter (Henley) was elected to serve as an ordinary member of Council. Claire took an active role within the institution on various committees before serving as president in 2011 – 2012.

Today the Insitution has many female members, with a number serving as chairpersons of Sections and several women members on Council.

Modern women in rail

The industry in the UK slowly began to change as a result of the 1975 Sex Discrimination Act which made discrimination at work based on sex or marital status illegal. The number of women management trainees at British Rail rose from none in 1975 to 20 in 1981.

Sexist stereotypes and restrictions have now hopefully ceased being an accepted barrier to women wanting to enter previously male-dominated industries, and the rail industry in particular has been making strides in the desire to increase gender diversity.

Digitalisation and industry modernisation have also created an immense number of roles where gender has become irrelevant. The steady introduction of computers, smartphones, technology and mechanisation has meant that physical strength is no longer needed as it was, so roles are open to a wider range of people. As a result, the rail industry, once bound by 19th Century propriety and traditions, is now more open for women.

Some companies, such as Network Rail, have introduced flexible working policies, [7] which help overcome a significant barrier for women in the workplace and to fulfil their potential. There are also families where the male takes the role of 'house husband' with the women working full time in her chosen career [9].

Network Rail plan to increase their take-up of female employees across the business to 20 per cent by 2020 and by 50 per cent by the end of 2024 and to have gender balanced recruitment of apprentices and graduates.

The industry is also engaging with schools and colleges to encourage young people – girls and young women in particular – to choose science, technology, engineering and maths (STEM) as worthwhile subjects at school and in higher education.

According to Women in Rail, [8] lack of self-confidence is the most commonly cited insecurity for women in business, and the rail industry is no different. In workshops up and down the country, Women in Rail is aiming to challenge this issue and to support women who choose to work in rail.

With change transforming rail's physical and digital infrastructures, alongside an aging male workforce and increasing shortfall in skilled railway workers, now is potentially the most opportune time for companies to embrace the benefits of diversity.

Many thanks to Colin Porter, Mark Glover, Claire Beranek, Jennifer Gilleece Jones and Marie Kipling who have all helped with this article.

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Industry news

New York Transit Challenge results

Ian Mitchell

In IRSE News 242 we reported on the international competition being run by New York Metropolitan Transportation Authority (MTA) to identify innovative solutions to increase the capacity and improve the reliability of New York City's subway service.

The results of the competition have now been announced. In the signalling category, which focused on strategies to dramatically accelerate CBTC deployment, two key innovations were identified, and for each innovation two applicants were awarded a share of the $1 million prize money.

Revolutionise signalling deployment using ultra-wideband

Two applicants submitted innovative solutions to revolutionise the deployment of subway signalling using Ultra-wideband (UWB), a next generation wireless technology. It is claimed that the implementation can be done much faster than MTA's current plan for signalling deployment, eliminating the need for cumbersome and costly wayside equipment. UWB technology is utilized by other industries globally and is currently being tested in other transit systems.

Key features

- Rapid implementation: removes the need for expensive, cumbersome equipment currently required by the signalling system, and MTA has the ability to begin UWB installation immediately.
- Precision: an UWB-based mesh network provides centimetre-accuracy location for cars in tunnels.
- Reduction of wayside equipment: reduces maintenance effort and maintains safety.
- Cost-effective: can be implemented at a fraction of the cost of the current signalling technology.

The Judges selected **Robert James** and **Metrom Rail** because their proposals of Ultra-wideband technology provide substantial benefits relative to the current technology of subway signalling and communications.

The MTA has been exploring and will continue to robustly test UWB for train location, and will further research how the applicants' technology could supplement MTA's current signalling system.

Onboard sensors and cameras for train positioning

Like the technology used in autonomous vehicles, next generation train positioning solutions employ sensors and cameras, lending themselves to the concept of a completely train-centric signalling system with little to no equipment on the tracks. Train location technology historically has involved the use of complex wayside equipment, which is both time consuming and costly to deploy and maintain. Two applicants have focused on moving most, if not all, of the wayside equipment onto the train itself and making use of onboard sensors and cameras.

Key features

- Rapid implementation: solution could be implemented in approximately one-third of the time of the current plan.
- Reduction of wayside equipment: reduces maintenance effort and maintains safety.
- Cost-effective: the equipment would cost nearly 60 percent less than the current configuration.
- Modernised technology: leverages advances in video and sensor technology.

The judges selected **Ansaldo STS** and **Thales Group** to receive this award because they each proposed innovative onboard systems that would more efficiently and accurately perform necessary train positioning actions, as well as maintain a high degree of safety, reduce delays, and mitigate costs.

In light of these awards, MTA plans to begin testing video and sensor-based systems for integration with future signalling systems.

More details of these awards and the winners in the other categories (for Subway Cars and Communications) are at **irse.info/iuv2f**


Photo Shutterstock/oneinchpunch.

The New York Transit Challenge – do the prizewinners really have a solution for modernising older metros?

Alan Rumsey

Alan Rumsey is a member of the IRSE's International Technical Committee, with many years experience of CBTC signalling for metros in North America and around the world. Here are his views on the outcome of the Metropolitan Transit Authority (MTA) competition.

Photo Shutterstock/Agdvaldez.

The MTA website (**irse.info/yxpe6**) states that the objective of the recently completed New York Genius Transit Challenge, in the signalling category, was to either "dramatically accelerate the current deployment of CBTC or similar technology", or "identify alternate solutions that offer technological advantages or can be deployed faster than CBTC solutions." In either case, any proposed solution was required to be "capable of being implemented in a rapid timeframe, scalable throughout the system, and cost-effective."

In announcing the results of the transit challenge, the MTA panel has clearly selected as winners those candidates who took the second approach. Both winners proposed innovative 'train-centric' train positioning technologies with the goal of utilizing these technologies to eliminate or significantly reduce the need for wayside signalling equipment. With this approach it was claimed that a completely train-centric signalling solution could be developed and deployed in a significantly shorter time, and at a fraction of the cost, of currently available signalling technologies.

If this claim is indeed valid, then clearly these new innovative technologies should be embraced by the signalling profession at-large, and their deployment endorsed and promoted by the IRSE.

However, while exploiting the benefits of evolving new technologies should always be encouraged, when embarking on a major operationally-critical, network-wide signalling upgrade programme is it prudent to proceed down a path that depends on first developing a new, software-based, safety-critical, signalling solution? Is this MTA initiative indeed a dramatic technical breakthrough that will accelerate the deployment of lower-cost signalling technologies to subway systems not only in New York but also elsewhere in the world, or is this simply a political distraction that will only further delay the modernisation of one of the worlds largest and busiest subway networks? More specifically, does new train-centric train positioning technology really address the root-cause of the New York-specific constraints that are currently driving the CBTC deployment schedule?

Currently available service-proven CBTC systems are already required, by definition, to include train-centric train positioning solutions. It is therefore not immediately evident how the proposed 'next generation' train positioning solutions, in and of themselves, will facilitate the elimination of wayside equipment for interlocking protection, movement authority determination, train service management, support to degraded modes of working, and other such functions that are currently being performed within wayside or central office signalling equipment. While a completely train-centric signalling solution, with little to no equipment on the tracks, may be conceptually feasible, how long will it take to fully develop, validate, and safety-certify such a solution, prior to actual revenue service deployment, and is such a solution even capable of satisfying New York's unique operating requirements and constraints?

In last month's IRSE News, the IRSE's International Technical Committee (ITC) addressed the question "Why do signalling projects fail?". Drawing on world-wide experience and lessons learned the ITC concluded that the primary factors that drive the implementation schedule, and cost, for re-signalling projects is not the technology per se, but rather: the complexity of the rail network; the signalling functionality to be provided; the operating and regulatory environment in which the signalling work is to be undertaken; and the procurement/delivery model adopted.

So, in the New York case, it is important to fully understand these constraints, and to understand how the innovative technologies, in and of themselves, will significantly reduce the system deployment times.

The New York subway network is certainly highly complex with 665 miles of track, 36 separate lines, and approximately 6,500 trains operating on the network. The MTA operates multiple train services on this rail network with a given service typically operating along several lines, and where a given line can support multiple services. Trains are typically not dedicated to a specific line or service and are often rerouted from one line to another in the rail network to support service delivery. Any signalling solution therefore must recognize this network complexity and be capable of being deployed while supporting this operating concept.

In addition, until such time as all 6,500 trains operating on the subway network are equipped with any new signalling technology, the complete signalling solution has to support 'mixed-mode' operations, with one system to protect and control the movement of equipped trains, with a second system to protect and control the movement of unequipped trains, and – most importantly – with complex interfaces between these two train protection systems, operating under different signalling principles. New York currently also has a functional requirement to retain track circuits for broken-rail detection. Have these practical constraints truly been considered when claiming rapid implementation of the proposed innovative technologies? If any of these constraints could be relaxed for a completely train-centric signalling solution, then surely these constraints could also be relaxed for a CBTC solution.

With respect to the operating environment, in the New York case the rail network operates 24 hours a day, 7 days a week, which imposes constraints not only on track access but also access to trains. If the new technology solution were indeed completely train-centric, then clearly track access requirements for wayside equipment installation would indeed be reduced. However, given the above interoperability, mixed-mode, and broken rail functional requirements, how realistic is it to assume a solution that is completely train-centric? Even with a completely train-centric solution, track access would still be required for multi-train testing to fully commission and safety certify the signalling solution, and to train the operators in the new system functionality.

Finally, to date the MTA has been seeking multiple sources of supply with an ability to competitively procure interoperable signalling equipment through traditional procurement methods. MTA has also been sequentially implementing CBTC on a line-by-line basis. It is unclear if any alternative delivery models and migration strategies have been considered by the MTA, for either a completely train-centric signalling solution or a conventional CBTC signalling solution. For example, to reduce the deployment time for signalling system upgrades many transit agencies (London, Hong Kong, Copenhagen, San Francisco, for example) are now awarding multi-line re-signalling contracts and adopting collaborative and incentivised 'one-team' methods of working with signalling suppliers, with delivery risks being managed by the entity in the best position to manage those risks.

New York was one of the first transit agencies to recognise the safety and operational benefits of modern computer-based and communications-based signalling technologies, awarding one of the first radio-based CBTC contracts in 1999. The future of New York's signal modernization programme, and MTA's 'train-centric' technology initiatives, will I am sure be followed with great interest by the IRSE, and I look forward to further updates on progress in future editions of IRSE News.

What do *you* think? Do you agree with the MTA's judges? What do you think about Alan's response?

Are these really are the key innovations for the next generation of mass transit railway signalling? Can they make a fundamental difference to the cost and timescale required to replace the legacy signalling on a complex network such as New York's?

Let us have your thoughts to share via the Feedback column of IRSE News. Email **irsenews@irse.org**.

Polish GSM-R contract awarded to Nokia

POLAND: State-owned railway operator PKP Polskie Linie Kolejowe S.A. (PKP PLK) has signed a five-year contract with Nokia, together with its partners Herkules, Pozbud and Wasko, to deploy a nationwide GSM-R and mission-critical backhaul network. Nokia's largest-ever GSM-R contract, will provide PKP/PLK with one of the biggest state-of-the-art railway communications networks in Europe.

Nokia will provide installation, commissioning, third-party integration, first-line care and maintenance for 13 800 km of the GSM-R network, plus more than 11 000 km of optical fibre-based backhaul network infrastructure with IP Multiprotocol Label Switching (IP/MPLS) and dense wavelength division multiplexing (DWDM) optical network equipment. Herkules, Pozbud and Wasko will be responsible for civil works, including construction work for laying the fibre cabling.

Railstaff Awards 2018 nominations open

UK: The RailStaff Awards is a ceremony to show appreciation for the people who deliver the railway in the UK. Often these are stories of lives saved, careers turned around and adversity conquered. In 2017, the awards saw over 1,000 people in attendance, 1,500 nominations and 35,000 votes.

Nominations are now open for the 2018 awards which will be presented at the NEC, in Birmingham Thursday 29 November. Anyone can nominate a person in the rail industry for an award Categories which include: Apprentice of the Year, Graduate of the Year, Control and Communications Engineer of the Year, and Lifetime Achievement Award.

The organisers are keen to increase the nominations for younger people and control and communications engineers who have made valuable contributions to the industry. You may nominate colleagues at **irse.info/5scwr**

EU funding supports ETCS on LGV Sud Est

[RGI] FRANCE: The European Union is to provide €117m (£103m, $140m) from the Connecting Europe Facility to support the installation of ETCS Level 2 on LGV Sud-Est between Paris and Lyon, under a financing agreement signed on 25 April.

According to SNCF, LGV Sud-Est is now Replacing the analogue TVM300 signalling system by ETCS Level 2 and GSM-R is expected to increase the capacity of the route from 13 to 16 trains/h at peak times.

The work forms part of SNCF Réseau's programme to update the 37-year-old line, which has a total cost of €607m (£535m, $728m) at 2016 prices. Of this, the installation of ERTMS accounts for €130m (£115m, $156m), while €340m (£300m, $408m) will fund the replacement of interlockings and traffic control systems.

Many of the original interlockings dating from 1981-83 will be replaced, and a single traffic management and control centre will replacing the current facilities covering the Greater Paris, LGV PSE and Lyon areas.

IRSE ///
Institution of Railway Signal Engineers

News from the IRSE

Francis How, Chief Executive

Subscription renewal

Annual subscription renewals are being sent to all members, and renewal payments are due by 1 July. Please pay promptly, in order that you continue to receive IRSE News, e-bulletins and other information from us. We very much hope that you will continue to be a member of the Institution, so as to benefit from the many events, publications and other information that we produce.

You can renew by logging in on the IRSE website and navigating to **Manage your Record** under the **Home** tab.

Annual General Meeting (2018)

The Institution's Annual General Meeting was held on 27 April 2018 at the Institution of Engineering and Technology in London.

Around seventy people attended the meeting, which was chaired by Peter Symons, performing his last duty as IRSE President before handing over to Dr Markus Montigel. Peter thanked everyone for making his year a success, and in particular Francis How. He reflected on the enjoyable, vibrant, exciting visits he had made to a number of Sections, which included the new Japanese Section. He commended the annual report and commented that the rebranding strategy placed the Institution in an excellent position for the future.

As happens each year, the formal business of the meeting included the approval of the minutes of the previous AGM, approval of the Accounts for 2017, announcement of the Council members for 2018-19 and the appointment of the Institution's auditors for 2018-19.

IRSE Council 2018-2019

President

Markus Montigel

Vice Presidents

George Clark	Gary Simpson

Members of Council from class of Fellow

Ian Bridges	Pierre-Damien Jourdain
Peter Allan	Bogdan Godziejewski
Jane Power	Philip Wong
Daniel Woodland	Yuji Hirao
Steve Boshier	Andy Knight

Members of Council from class of Member

Rob Burkhardt	Ryan Gould
Martin Fenner	Lynsey Hunter
Cassandra Gash	Paul McSharry

Members of Council from class of Associate Member

Firas Al-Tahan	Xiaolu Rao

The newly elected members of Council were welcomed namely Pierre-Damien Jourdain (Alstom, France), Bogdan Godziejewski (Mott MacDonald, Netherlands), Cassandra Gash (Melbourne Metro Rail Authority, Australia), Paul McSharry (Kilborn Consulting, UK) and Xiaolu Rao (Systransis, Switzerland). Thanks were given to Alan Rumsey, David Weedon, Simon Eastmond and Helen Kellaway who are stepping down from Council.

The Dell Award, given annually to a member of the Institution who is employed by London Underground Ltd (or its successor bodies) for achievement of a high standard in the science and application of railway signalling, was presented to Mohammed Akram, who in his thirteen years with LUL has worked on a variety of projects including, currently, the Four Lines Modernisation Programme.

The IRSE-Signet Award, presented annually to the candidate who achieved the highest marks in any single module of the IRSE Exam, was given to Robin Lee of Park Signalling. Robin is presently engaged mainly on testing and documenting track-worker safety products for Network Rail. He obtained a Distinction (86%) in module 2 of the Exam.

Mike Tyrell, long-time supporter and Secretary of the Minor Railways Section, and who has also faithfully maintained the IRSE's telephone system in the London office for many years, was presented with a Merit Award for his services to the IRSE.

Ray Legg, a long-standing key member of the IRSE in Australasia, and who has also made a very significant contribution to the rail industry during his career, was made an Honorary Fellow of the Institution.

Peter then inaugurated Markus Montigel as our President for 2018-19. Before presenting his Presidential Address, Markus paid tribute to Peter for his leadership of the IRSE during the past year. Markus then delivered his Presidential Address, which was published in the May edition of IRSE NEWS. The presentation used the new typeface and branding for the first time and it was noticeable how the IRSE name was more prominent than before.

Institution's Annual Dinner

The AGM was followed by the Institution's Annual Dinner in The Savoy, next door to the IET. Over 350 members and guests attended the Dinner, which was sponsored this year by Mott MacDonald. The President's guest of honour was Gery Balmer, Vice Director of the Swiss Federal Office of Transport.

A highlight of the evening was Michael, the twelve year old son of the new President, who played 'Scarborough Fair' on his oboe to a standing ovation from the audience. Michael has only been playing the oboe for 7 months and also plays the piano. Music is one of his talents and passions, and the performance was a great joy for him because he wanted to help the IRSE to support Soroptimist International.



Highlights of this year's AGM and Annual Dinner.

Soroptimist International is a global volunteer movement working to educate, empower and enable opportunities to transform the lives of women and girls. They were represented on the evening by colleagues from Epsom and District, Diana Porter and Sally Curtis. The after-dinner collection raised over £3600.

Planning for the 2019 event will commence very soon and Peter Halliwell, who does an excellent job in organising the dinner, for which the IRSE is most grateful, would appreciate feedback on how the event could be improved – in particular from those who don't attend but might in other circumstances, such as price, date, venue, time etc. You may contact Peter at **peter.halliwell@hotmail.com**.

Annual Lunch, London

The 20th IRSE Annual Members' Lunch will take place at the Union Jack Club, Sandell Street, Waterloo, London, SE1 8UJ (near Waterloo station) on Wednesday, 13 June 2018.

A three course luncheon with wine and coffee will be served at 13.00 hours and tickets for the event can now be purchased. Please note that the Luncheon is for IRSE members only.

This event is for all members, regardless of age or employment status. It's a great way of networking and meeting up with both current and former colleagues in an informal social setting. Our President, Markus Montigel, will be speaking. For more information, and to book, please visit the IRSE website **irse.info/rh1dc**.

IET Railway Signalling and Control Systems Course (partnered by IRSE)

The IET Railway Signalling and Control Systems (RSCS) is a four day training course delivered by a host of expert lecturers who have worked on railway systems around the world. This year it takes place from 18 - 21 June in London. This course is delivered every two years, and this year for the first time the IRSE is the official course partner with the IET for delivering the course.

The course features a technical peer-reviewed programme which is developed by an expert committee, covering the core aspects of signalling and control systems from the basics to in-depth design. The programme aims to provide attendees with the most up-to-date contemporary training on signalling and control systems, and is ideal for people at any stage of their career who need to understand the basics of signalling and also for those wanting to learn more about current developments. It contains material relevant to both national rail networks and metros. For more information and to book your place, go to **irse.info/loirb**.

Africa Rail 2018

The IRSE Southern Africa Section is partnering with the Africa Rail 2018 event to be held in Johannesburg on 12 - 13 June. This annual conference brings together all railway stakeholders in Africa to network, share ideas and promote business interests. Key speakers from southern Africa governments and from industry will be participating. In 2018 the focus of the event is on skills development and, for the first time, the IRSE will be running a workshop at the conference, which will be geared to that theme. For more information, visit **irse.info/nqjp6**. IRSE members can obtain discounted tickets for the conference.

Traffic Management Seminar, 26 June, London

This Seminar will explore the challenges and opportunities associated with implementing advanced traffic management systems. Designing these systems to maximise capacity and performance, and to respond effectively to changing operating conditions (without adversely affecting safety), requires Rolling Stock and Signal engineers to work together – which is why this event is being organised jointly by the IRSE and the IMechE. Join us for a thought-provoking and informative day. For more information, go to **irse.info/wyxnd**. There are discounts for IRSE members.

Looking for a Proceedings Editor

The IRSE's current Proceedings Editor, Stephen Clark, is planning to retire from the position later this year and so the Institution is seeking a replacement.

Stephen would therefore be interested to hear from any IRSE members who would be prepared to take on the Editor's role – support would be provided as required through a transition period covering the preparation and publication of the 2017-18 Proceedings. Following migration of the Proceedings from a printed journal (paper or CD) to an on-line publication over the past two years, the Editor's task has become somewhat simpler and less time-consuming. The role is subject to an annual honorarium awarded by Council.

If you would be prepared to consider taking on this task, and would like to discuss the activities involved, please contact **stephen.clark@irse.org** for details.

Swiss Section

IRSE SWISS SECTION

Aerial ropeways: safety from the ground up

George Raymond

Safety management was the focus of 26 IRSE Swiss Section members and guests on 9 March 2018 as we examined a cousin of the railway: the aerial ropeway. Ropeways are the core business of Bartholet Machinenbau AG, which we visited in the eastern Swiss town of Flums. IRSE's Marco Lüthi organised the event; our lead host was Placi Wenzin, Bartholet's chief technology officer.

Anton Bartholet founded the company in 1962. The Flums site is known as BMF or in English as Bartholet Ropeways and employs about 400, including some 40 apprentices and 30 engineers. The company can also call on another 45 engineers. It designs ropeway systems and fabricates most system components itself, most noticeably the small and large wheel assemblies that hold the cables on which passengers' lives depend.

Great variety

Helicopters help install ropeway towers, and drones help make the videos on **www.bmf-ag.ch** that show ropeways in all their variety. Vehicles range from simple T-bars for skiers to chair lifts to enclosed gondolas. In some designs, multi-person chairs are fixed to the cable, and a conveyor brings skiers up to speed so a chair can swing around and scoop them up. In other designs, chairs or small gondolas momentarily detach from the moving cable so people can board or alight.

In most aerial ropeways, the cable that carries the vehicles also moves them. On some large aerial tramways, however, such as the one completed in 2016 in the French city of Brest, the gondola rolls along fixed cables while smaller cables pull. Brest's gondolas pass above and below instead of beside each other to save ground space.

Some ropeways climb mountains, while others move horizontally, especially in cities but sometimes in scenic areas. Cables pull vehicles, and usually support them as well, but sometimes the vehicles roll on fixed guideways. Most systems transport passengers, but some carry freight or underlie white-water rides in amusement parks.

System integrator

In producing ropeway systems, BMF generally serves as system integrator. Mr Wenzin said that only two other companies worldwide possess his company's breadth of competency in aerial ropeways. This has let them build a growing number of installations throughout the world.

BMF also sometimes builds control systems, lift chairs or gondolas for other companies. An example is Gangloff, which among other work installs rides on cruise ships. Some 400 chairs and gondolas a year are built in Flums, most of them to plans from Porsche Design Studio.

Customers also profit from the sun with solar panels installed on ropeway towers, even if the aesthetics are sometimes controversial.

Standards

Mr Wenzin said that Switzerland has heavily influenced the EU standards for ropeways, which have become world standards. Standards were once more country-specific. China copied some standards and created some of their own. Unlike Europe, the US still does not require a safety bar on chair-lift seats.

Standards prevent customers from over-specifying ropeways – and from writing specifications that qualify only

A gondola ropeway in the Lenzenheide ski region in eastern Switzerland in March 2016. The gondolas detach from the moving cable momentarily while people board and alight. *Photo BMF.*

Top left: Daniel Candinas explains the fabrication of large cable wheels in Flums in halves that then go to the destination country, where his company supervises the safety-critical task of welding of the two halves together.

Top right: Fabrication of the cable wheels on which passengers' lives depend.

Above left: Wheels for a ropeway tower, including the cable catchers that keep the haul rope from falling to the ground in the rare event it slips off the wheels. The wheels' rubber liners need changing every 5 or 6 years.

Above right: One of up to 400 ski-lift chairs built every year in Flums, mostly to plans from Porsche Design Studio.

Photos George Raymond.

one competitor. Customers are better off when experienced specialist firms write the call for tenders. Standards specify interfaces that allow mixing parts and assemblies from different makers.

Quality for safety

Mr Wenzin said quality and thus safety assurance are a permanent focus of Berthelot Ropeways. Ten people, including technical documentation writers, lead quality assurance.

A proof of safety underlies design, production, installation, operation and maintenance. Handbooks prescribe how to buy, process, check and test components. Tests are typically non-destructive. Mr Wenzin stressed the need to keep in mind a component's designed purpose. Quality checks are particularly critical for potential single points of failure, such as cables and wheels. The company checks conformity with all standards – and has a process ready to deal with non-conformity.

A safe ropeway requires standards, experience, calculation and the four-eye principle. All work is subject to internal and external audits, along with audits of suppliers. But Mr Wenzin warned that overly complex safety checks can hamper oversight.

Standards and documentation must be translated into the customer's language, for example Chinese. No documents are stored on paper.

The manufacturing and quality assurance process is particularly demanding for large cable wheels. Wheels are typically fabricated, welded and painted in Flums in halves that then go to the destination country, where engineers from Flums either weld the two halves together themselves or supervise this safety-critical work.

Certification

Because hazards can arise in design, manufacturing and operations, all these phases are subject to certification. An ISO 9001:2000 certificate and qualification in welding according to DIN 18800-7 are in place. Mr Wenzin said that Switzerland lacks engineering firms like the Notified Bodies in Austria who are authorised to check his company's work. The Swiss Federal Office of Transport performs checks, but it is not a Notified Body under EU law.

Maintenance and return of experience

A well-maintained 50-year-old ropeway is safer than a poorly maintained 2-year-old ropeway, Mr Wenzin said. Traditionally, a ropeway's buyer takes over operation and maintenance after training. Ski areas like to maintain their lifts themselves because employees have less to do in summer. But ropeways in cities have less down time and thus seek to outsource maintenance. Increasingly, Mr Wenzin's company tries to gain maintenance contracts so it can benefit from a return of experience.

Emergency responses and redundancy

A critical part of a ropeway's documentation specifies how to react in case of problems. Such documentation must also be certified. Much redundancy is built into a ropeway, including diesel generators for backup power and sensors that warn if a cable is about to fall off a tower's wheels.

A cable could become stuck. In this case, the ropeway system typically foresees several ways for passengers to escape, including rescue by a second vehicle and means of descending safely to the ground. The last resort is rescue by helicopter. Safety is never absolute. For example, unlike nuclear power plants, ropeways are not built to withstand aeroplanes. For Mr Wenzin, requiring "safety" 'in every case' is saying a lot".

In case of fire, the objective is to return vehicles to a station as fast as possible. In this respect, a ropeway is more like a plane than a train in that safety requires the system to continue operating. An exception on the railway is a long tunnel like Switzerland's new Gotthard Base Tunnel, in which passengers' survival during a fire requires that trains also continue to run. Safety in long railway tunnels was the central theme of IRSE's Convention 2018 in Switzerland on 28 May to 1 June.

Midland & North Western Section

Technical visit to Buxton Health and Safety Laboratory

Paul Darlington

The afternoon of Tuesday 24 April 2018, saw 16 members and guests of the Section visiting the UK Health and Safety Laboratory (HSL) in Buxton. The centre provides industry research, consultancy and training, to tackle often complex health and safety related issues, as well as undertaking incident investigation to identify common health and safety problems. HSL is part of the Health and Safety Executive (HSE), the safety regulator for the UK.

The old track bed of the Cromford and High Peak Railway runs through the site although this part of the route has been shut for over 100 years and access is now only possible by road. The site extends to over 500 acres and the facilities include a railway constructed to investigate explosions on trains, as well as collision impact assessments using smaller gauge tracks and drop tests.

Four hundred people are based in Buxton and the wide range of specialists include: medical doctors, psychologists, explosives engineers, toxicologists, ergonomists, fire engineers, occupational hygienists, process safety engineers, microbiologists, mathematicians, material scientists, and personal protective equipment experts.

The specialist teams provide health and safety solutions to industry and governments around the world, and combine significant scientific, medical and technical expertise to help all industries manage risk and protect people from illness and injury.

Investigations over the years have included a number of railway incidents in the UK including, Potters Bar, Ladbroke Grove and Grayrigg, along with incidents in high hazard installations such as oil storage facilities. The HSE said that over the last 30 years their investigations have increasingly included incidents at amusement parks, fun rides, and bouncing castles, as the active leisure industry has grown.

One of the UK's largest dedicated human factors teams operate from the site and the technical visit included a human factors laboratory. The investigation facilities are extensive with many specialist tools and analytical systems available. The discussion with an investigator included the work he had done in the rail industry, including failures of trackside warning systems and signal passed at danger investigations.

The objective of human factors is to design systems, jobs and organisations that match human capabilities. The aim is to optimise the interactions between people, equipment and working environment, and addressing human factors elements can improve organisational performance, efficiency, productivity and safety.

Next, we moved to a mechanical investigation laboratory and were shown high speed videos of explosive and rail vehicle collision testing. There is a wide range of assets from various industries, including leisure, on site. As in some cases the assets may involve legal cases that may go on for many years, items have to be kept securely at Buxton, before being returned to the owner.

Its not just about investigation after an incident. The risk management expertise that has been gained through the research, investigation and regulatory work at Buxton enables a great understanding of the immediate and root causes of failure. This is available to all businesses and industries to help manage major accident hazard risks. See **irse.info/wrimc** for an overview of the site

The Section would like to extend a thank you to Lorraine Gavin, Tony Wynn, and Paul McCann of the HSL for the interesting and informative visit to the laboratory.

Younger Members' Section

Annual seminar and technical visit: Homogeneous transport systems

Keith Upton, Section Chair

The Younger Members (YM) annual seminar and technical visit is the key event in the YM's calendar, and it has migrated around the country each year. In 2016, we took the bold step of heading to Glasgow and it was a great success. So, in November 2017 we decided to travel a bit further South and take our event to Newcastle.

There are many regional transport programmes happening in cities across the UK and so the theme "Homogenous transport systems" sought to highlight these programmes. Newcastle is a prime example where Nexus (the Tyne & Wear Passenger Transport Executive) is over half way through an £350 million 11-year upgrade programme. This seminar was a chance for YMs to look outside the traditional signalling boundary and understand the railway as a system.

I opened the event, thanking everyone for attending and discussing how the seminar will be a chance for attendees to not only hear some great talks but also get to know each other better! The seminar had an informal feel, meaning that everyone had the chance to talk to everyone else.

The day was jam packed with presenters and we must say a big thank you to all the presenters for supporting the event:

- Raymond Johnstone, Nexus, asset renewal programme.
- Dr Hongsin Kim, University of Birmingham, Swiss approach to service timetabling and capacity management.
- Colin Robey, UK Tram, An insight into the world of light rail.
- Glynn Hutton, VMS Signalling, Intelligent transport systems (ITS) used in rail applications.
- David Nicholson and Vish Kalsapura, Atkins & Network Rail, Digital Railway: reasons, technology and process.

The range of presentations provided food for thought for all attendees. There were a few messages that came across the board and provided challenges for YMs who are at the beginning of their career. The key challenge presented is to look outside the railway boundary and to know the whole system; including the environment, pedestrians, roads, disruptive technology, process and many more. These boundaries and interfaces need to be defined as early as possible to ensure a successful railway and overall transport system.

Raymond Johnstone started our seminar by taking us through Nexus and the incredible asset renewal programme that they are undertaking. This was the first time that Nexus had presented to the IRSE. Nexus is a closed metro system, but they also run on Network Rail infrastructure on the line towards Sunderland. There are 120 track-km, 60 stations, 5 level crossings and over 80 000 assets. It is incredible to see how much Nexus have done in seven years: 37.1 km of new track, 25 stations refurbished, five level crossings upgraded, 50 new sets of point motors, 85 km of signalling cables replaced, 15 location cases rewired and this is only a selection of the outputs! The result is that signalling failures have reduced by 51% and points failures have reduced by 90%. An amazing result. Nexus is planning for the future and are already thinking about 2031/32 where they plan to have a new interlocking; perhaps another chance for the YMs to revisit Nexus and see the differences.

Dr Hongsin Kim then took us through the Swiss and Japanese approaches to railway complexity. This presentation was based on research that is being undertaken at the University of Birmingham, and Hongsin described the complicated research in a 45 minute slot. She started by reinforcing that we need to look at the functional view of the railway and understand the determinants that make up the railway (i.e. factors that influence something happening), then looking at how these determinants interface with each other. Only then can we start to understand and change the railway system! The Swiss and Japanese use different approaches; the Swiss start by defining the timetable, the rolling stock and finally the infrastructure. Whereas the Japanese look at the infrastructure and ask how they can keep it simple to save overall cost. There was so much in the presentation that I'm sure the YMs will invite Dr Hongsin back for a longer session.

Colin Robey then talked about UK Tram, who they are and what they do. UK Tram is the trade body for the light rail industry. Light rail has very few regulations compared to heavy rail and trams are technically a highways vehicle but are guided by rails (and so can't swerve out of the way like a highways vehicle can). Light rail vehicles don't use colour light signals but instead are run on line of sight, with point indications and indications at highway crossings. Colin raised a few challenges that can equally apply to the heavy rail industry: the technology is there to keep light rail and heavy rail trains apart so why are trams becoming more crash worthy (and therefore more expensive) instead of using the technology! Human factors can be more important than blindly applying standards. It was an interesting presentation looking at a different aspect of the transport system that the YMs may not have heard much about previously.

After lunch, the YMs participated in a workshop designed to get everyone talking with each other and thinking about the system as a whole. This was the same workshop from the Mod 1/7 study day and is further described in the October 2017 edition of IRSE News. There were some great discussions and all the attendees enjoyed the activity, as well as the chance to play with Brio (a wooden toy) trains!

Glynn Hutton then looked at ITS and how systems used on highways could also be used on the railway, from connected systems that tell a driver the speed to reach a traffic light at green to over-height bridge detection systems and urban traffic management and control. Glynn also looked at systems that are used on the roads that also affect the railway: over-height bridge detection systems can avoid bridge strikes, thereby reducing train delays (or potentially an

Attendees discuss potential signalling solutions for the Brio layout.

One group of YMs touring the Newcastle College Rail Academy.

accident) and level crossing signage helps road users understand a level crossing and to keep them clear. The aim of looking outside the railway boundary was exemplified by this presentation.

The end of the day was a chance for David Nicholson and Vish Kaslsapura to talk about the Digital Railway; the technology proposals and the process to get the railway to that point. Technology can help reduce disruption and release capacity. These technologies are available but is the industry ready? Therefore technology like traffic management is more about the business and process change with a bit of new technology. People, process and product all need to come together to form the system with data at the heart of everything that we do! Therefore, the interfaces need to be identified and managed well. This can be completed by adopting a systematic process and answering the six simple questions at each stage: what, when, why, how, where and who.

The seminar proved to be both informative and thought provoking. I personally learnt that, as a railway engineer, the railway shouldn't be kept in a box. Rather,to improve the railway, we need to look outside the railway boundary and embrace new ways of working and new technology. I hope the other YMs also gained something from the day and they can take it back to their day-to-day jobs.

Delegates reconvened the following day at Newcastle Central metro station where they met two employees from Nexus who guided us on the metro to the control centre. Along the way they talked us through the renewal programmes as well as the signalling used. En-route it was noted that the system is well used by the local community, and the newly refurbished stations look crisp and clean.

The signalling is generally two-aspect, with the occasional three-aspect signals for critical areas. There are signs to indicate that a signal is approaching, which are highway signs, as the original drivers on the metro were bus drivers and so requested standard highway signage. This is also obvious by the fact that a LOS (limit of shunt) is a no-entry highway sign.

For train protection, the metro uses electronic tripcocks with inductive magnets, which is the same system used on metros in Germany. Speed control is used at level crossings and Driver Only Operation exists throughout the network (using CCTV in the central area and mirrors at all other stations). Between Pelaw and Sunderland, the metro trains run on Network Rail infrastructure, and so the trains are controlled by Tyneside integrated electronic control centre The line is shown on the panel for Nexus signallers, however they have no control over the trains once they have been sent onto the Network Rail infrastructure.

Nexus is currently testing a new Railway Transport Management System (RTMS), which will replace the current control panel in 2018. This system uses IECC Scalable and is designed for two controllers. There are two fringes, one to Tyneside IECC and one to the depot, where a separate shunter's panel exists. During the visit, we had a chance to "test" the new system while it was in simulation. This was a great learning experience and a chance to see how the system reacted if (for example) you replaced a signal in front of a train.

We were also taken down to the equipment room where it was noted that there are varying technologies, some of which have obsolescence issues. The new RTMS is coming online soon, along with a new radio system, however a renewal of the interlocking is not due until 2031/2032. As with many older signalling systems, the issue of replacing obsolete (but essential) equipment will only get worse.

After an excellent tour of the Nexus control centre we were driven to the Newcastle College Rail Academy. Here, we saw the excellent facilities that can cater for many different practical railway courses. The academy has a hands-on approach to the courses and tries to show the students what it is like on the actual railway. For example, in the track workshop area the students have to wear full personal protective equipment and undertake a controller of site safety briefing, just as if you were entering Network Rail infrastructure.

After two excellent days, it was time to head back to Newcastle Central and for everyone to take their trains back home.

This seminar was free to attend thanks to the support of Nexus and the Newcastle College Rail Academy, who provided fantastic technical visits and the location for the seminar (as well as a great lunch and plenty of tea and coffee).

Past lives: Bengt J Sterner

With deep regret, we have to announce that our Swedish colleague Bengt J Sterner passed away on 28 March 2018, aged 82, after a long illness.

Bengt, born on 29 July 1935, was deeply involved in the transformation of signalling from relay to electronic technology.

He developed his career within the Swedish State Railways (SJ) and was always focussing on innovations in the signalling field. Called a legendary signalling expert by Swedish colleagues, he had two major stages in his professional life, in Sweden and internationally.

Firstly, Bengt was a member of the team that introduced software diversity in safe electronic systems for railway signalling. In the beginning of the 1970s he introduced a 3D geographical model to represent the railway network and developed the basics for a formal language, called remarkably STERNOL, for specifying interlocking algorithms. These ideas were used by the supplier L.M. Ericsson to develop a compiler for translating the functional specification into computer code. These developments led to the implementation of the first computerised interlocking of the Type 85 in Sweden for Gothenburg (Göteborg) station.

During the 1980s Bengt, as the development assistant to the chief signal engineer of SJ, took active part in the development of the new Swedish ATP system, called ATC. Bengt was truly an inventor and he was granted a number of patents, all in the area of dual channel safe electronic devices. In the second part of his professional career, starting in the late 1980s, Bengt was more and more involved in the international UIC / ORE work and became the chairman of the UIC Signalling Sub-Committee 7A. He, together with leading signalling engineers from many European countries, prepared, within the study group S 1059, a proposal to set up a Specialist Committee with an accelerated method of working to prepare specifications for a pan-European train control/protection system in April 1990. He was also involved in IRSE work chairing sessions during ASPECT conferences.

Bengt J Sterner, 1935-2018.

In 1992, Bengt moved to Utrecht in the Netherlands to lead the System Requirements Specification group within the ERRI A 200 Specialist Committee. This work was based on the results of a detailed questionnaire regarding the technical and operational needs of European railways, carried out in 1991. The European Rail Research Institute (ERRI) was his second home for a number of years.

With a purely technically oriented personality, Bengt was able to attract several signalling engineers from around Europe to work under his leadership on the SRS for the European Train Control System (ETCS). He was result-oriented and rather difficult in daily life, but for all those involved in the SRS work it was clear that Bengt created this extraordinary teamwork to develop something revolutionary and far ahead of any other parallel developments. He is clearly the founding father of the ETCS and a leader to many of us. One of my A 200 colleagues told me that Bengt was the only person to 'read' him. He taught us to stay interested in new developments and to learn.

Bengt was always honest and very direct, which did not help him on a higher political level. Around 1996 we finalised our work with six volumes of the ETCS SRS, before others took the lead.

In the meantime, the signalling department of newly created Banverket, the Swedish infrastructure manager, moved to Borlänge, but Bengt after returning to Sweden decided to stay in his home in Järfälla next to Stockholm. He became a passionate translator of books related to Europe's future into Swedish.

During his retirement he was critically following the ETCS developments and helped others to develop new technical ideas in the signalling domain. For his achievements, he received the European Railway Award in 2009.

Libor Lochman, the executive director of the CER, the Community of European Railway and Infrastructure Companies, and a former member of the ERRI A 200 SRS group, remembered Bengt's work during the 1st UIC Global ERTMS conference held in Milan in March 2018. It was just a day before Bengt passed away.

Bengt J Sterner and his work will stay in our memories.

Bogdan Godziejewski on behalf of former members of the ERRI A 200 SRS group.

Feedback

Rebranding – Well you did ask!

I fully appreciate and support the desire to modernise our image and especially to attract new young members. I am also well aware that there are those who hold the view that our existing graphic logo is old fashioned in appearance and meaningless to perhaps the majority of people, even including some of our members. It does however possess a very important and I would claim overriding virtue. It is like no other; it is instantly recognisable and used on its own clearly identifies the IRSE, our Institution. Now we are to adopt a newer, cleaner type face for our IRSE initials and our name. I applaud that change as it looks modern and fresh (and we are still to be called the Institution of Railway Signal Engineers). What I cannot understand and, I submit, what no-one in the world would be able to guess at, even with research, is what the 3 three leaning pillars as the graphic that accompanies the logo are supposed to mean. I know what they are intended to represent because it is explained in the IRSE News article about the rebranding. But they are meaningless on their own. They have all the appearance of falling trees and give the impression that IRSE is about to fall over.

Ken Burrage, UK

Rebranding – It won't win any design awards ... but it's still a vast improvement

So the IRSE has chosen to update its branding and in my opinion about time too! I know there will be some among you who will be disappointed with the new look but personally I think it's a positive step in the right direction. Do I like it, yes. Do I love it, no. Sure it's not going to win any design awards, but then again, was it ever supposed to?

I'd suppose that the design is meant to inspire some visions of the future with the forward slashes meaning something or the other. This type of thing is common in marketing speak but lost on those of us without the artistic eye of Don Draper.

In this case then, a more appropriate response when looking for grounding and confirmation is to look at our contemporaries. The IMechE has simple yet effective trapezium that encompasses their name, it's meant to make them stand out and inspire visions of the future, they say. The IET only went and changed their name recently so we won't be looking there for much in the way of nostalgia. I guess what I'm getting at is we are modernising and in the same ball park as our fellow institutions so in my view I'd say the change is a success.

And, I almost forgot the most important part, pretty much any logo suggested was going to be better than the current one.

Colin Hamilton-Williams, UK

Rebranding – April fool?

I spent quite a long time trying to decide whether the article in the April IRSE News about the new IRSE logo was an elaborate April Fool or was actually serious. Regrettably, I have been forced to accept that it is real, and that Council really has spent a lot of time and money on this "re-branding" exercise. I am probably in a minority, but I do not see why a professional institution needs to promote itself like a supermarket chain, and I certainly don't see the point of replacing our existing tasteful, dignified and instantly recognisable logo with something so unmemorable. As to the somewhat patronising assertion that the present logo has meaning only to those who understand it, I would say it is better than one incorporating three – well, let's call them forward slashes – which mean nothing to anybody until it is explained that they represent three (appropriately sloganised) objectives of the institution, none of which is about safely controlling the movement of trains. I had better carry a crib sheet in case anyone asks me what they are there for. And I look forward to seeing IRSE material proudly branded with white slashes on coloured squares.

Alan Cribbens, UK

IRSE re-branding – IRSE for the 21st Century!

I am glad that the IRSE is taking the bold step to re-brand. I never understood the old logo (even when it was explained to me), I find it out of step in the current age and a bit weird plus everything about it (including the text) just looks dated. Maybe it is recognisable to many, but possibly not in a good way and why keep something for tradition's sake (which seems to be a bit of a railway trait!). The new logo follows a lot of other companies and professional institutions where the logo is simply the text. When it comes to online content and social media then the simpler the logo the better!

OK, people might not understand the three pillars (but you could say the same with some big multi-national companies that everyone has heard of – could you explain their logos?) but it is simple and reasonably distinctive, especially used with the IRSE colour. And I could almost definitely explain these three pillars better than the previous IRSE logo.

I've also heard someone saying that the three pillars represent other aspects of the IRSE and signalling. For example, whenever a design or change is implemented it should be produced, checked and approved, or the IRSE theme of inform, discuss, develop. The three pillars also remind me of a webpage address showcasing that the IRSE is leaning towards the future.

My hope is that this logo is accepted by members as representing the future of the IRSE and makes the institution more attractive to other younger members (like myself).

Keith Upton, UK

May issue

I would like to just note that, in my opinion, you have produced a really exceptional issue in the May edition of the IRSE News. The content this month has been especially relevant, interesting and educational and the new sharpened format and branding significantly improved on the previous. Congratulations to all involved.

Christopher J Cox, Denmark

MTA Transit Genius Challenge feedback

Following the report on the MTA Transit Genius Challenge in the March edition of IRSE News, I see from the competition website that two awards were made to signalling companies proposing train positioning technology using on board sensors and cameras.

It is good to see that this 'infrastructure free' approach is now being considered by major suppliers. However, for an innovation competition, it is disappointing to see the proposals being at such a low level of maturity.

The automotive industry continues to make enormous strides forwards in this area in very short spaces of time. Unfortunately, one of the MTA proposals is based on the technology that we presented at IRSE ASPECT 2009, nearly a decade ago. So to avoid being left behind, the rail industry must strive to work more collaboratively and more quickly with a 'whole systems' approach.

However, we are pleased that the UK Department for Transport is funding our cross-industry consortium to realise a dependable 'infrastructure free' solution which is the culmination of many years of 'state of the art' R&D. The system will be available for presentation at ASPECT 2019.

Richard Shenton
Director, RDS International Ltd, UK

Headway

How refreshing it was to read an article (Terry Macdougall, (issue 238, November 2017) on headway that takes into account the terminal station, for this is where the fundamental constraint actually lies.

The report prepared for the RSSB summarised by David Fenner (issue 225, 9/2016) discusses the issue of closer running in plain track. Just what is the point when trains have to eventually diverge and disperse? If they cannot achieve this more frequently than the plain line headway then this is the capacity constraint and improving the main line headway will not allow any more trains to operate. The report even suggests what is termed 'Motorway Driving' in which trains run at less than braking distance apart. The following train must eventually diverge. Are we really going to swing some points ahead of a train that cannot stop should the points fail mid-stroke? On a motorway a following vehicle merely peels off at an exit road, no points needing to swing to facilitate it.

Philip Wong Wai Ming's article (issue 226, October 2016) concerning Hong Kong talks about reducing running line headway when the constraint is the terminal stations. I fail to see how CBTC or any other technical system can improve this. We may be able to gain a second or two by faster point machines and earlier detection of clearance, but the headway time at the terminal will still be considerably more than the plain line headway of even the earlier systems. So CBTC whatever doesn't actually improve the throughput, as is so often implied.

When I was working on HKMTR we did some trials at Chater (now Central), feeding trains in at decreasing intervals starting at two minutes. The minimum headway came to about 110s, more or less as predicted. Interestingly if one fed trains in more frequently than this, at say 108s intervals (well within what the running line headway allowed), then the terminal headway increased. This was because the arriving train was signal checked on its way in, and then took longer to enter the platform. I suggested fitting an indicator at the penultimate station (Admiralty in this case) to tell the train operator exactly when to depart, to the second. Unfortunately this was rejected by the operating department as too much for the train operator to cope with, something with which I strongly disagreed. It would merely have replaced the Time Interval Clock (TIC) that he should have been observing anyway.

I actually maintained that we could readily operate a 110s service, well within the running line capability even with the signalling that we had then. I disputed the operator's need for 10s 'recovery' time. Why? Because the train stood in the terminal station platform for near the headway time, 110s. It gained a new operator ('stepping up'). It could commence closing its doors (a frequent cause of the need for recovery) a full 10s before departure time (as per the TIC or judging from the arrival of the incoming train) and be ready to depart the very second that the proceed code was received. In effect the recovery time was in the 110s stood in the platform. Unfortunately this was never taken up. I was told in no uncertain terms that one couldn't possibly run more frequently than every two minutes, and that was that. It would be interesting to know what is being operated today.

To summarise. Improving plain line headway will not allow operation of more trains. That can only come from attention to detail at terminals and diverging points. All the attention given to plain line headway is misplaced.

David Thornber, UK

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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Membership changes

Admissions

We have great pleasure in welcoming the following members newly elected to the Institution:

Fellow

Li	W	Beijing Jiaoda Signal Tech Co	China
Santini	A M	Metro North Railroad	USA

Member

Atwal	N	Melbourne Metro Rail	Australia
Cheng	C H A	Land Transport Authority	Singapore
Downing	B	Carillion Rail	UK
Hardy	C S	Siemens	UK
Huerlimann	D	Open Track Railway Tech	Switzerland
Lee	E	Land Transport Authority	Singapore
Onuoha	V I	Network Rail	UK
Shigeta	T	East Japan Railways	Japan
Tavakoli	S	Metro Trains Melbourne	Australia

Associate Member

Bahaldin	R	Ansaldo	Malaysia
Bergin	K	Iarnród Éireann	Ireland
Hambali	L	Ansaldo	Malaysia
Holmes	J	SNC-Lavalin	UK
Jaafar	N	Ansaldo	Malaysia
Khatri	P K	L&T Metro Rail Hyderabad	India
Murugan	S	Ansaldo	Malaysia
Othman	M F	Ansaldo	Malaysia
Pamidi	S	Thales	UK
Sayah	R	Mott MacDonald	UK
Shahrizaman	N	Ansaldo	Malaysia
Sowter	C	Network Rail	UK
Syed Abdul Rahman	S A	Ansaldo	Malaysia
Tralaksamee	C	Bombardier	Thailand
van Plateringen	G L	Movares	Netherlands

Accredited Technician

Jein	A	Iarnród Éireann	Ireland
Mohamed	O	London Underground	UK
O'Sullivan	G	Amey	UK

Affiliate

AB Sani	M Z	Ansaldo	Malaysia
Abdul Ghaffar	N N	Ansaldo	Malaysia
Ali	I	Network Rail	UK
Andersen	I-S	Network Rail	UK
Arun	G	Aurecon	Australia
Bolli	M	Suprexa	Switzerland
Cheng	S N	MTRC	Hong Kong
Cheung	T C	MTRC	Hong Kong
Hogg	M	London Underground	UK
Jaikaew	N	MHPM Co	Thailand
Lam	Y Y	MTRC	Hong Kong
Law	T Y	MTRC	Hong Kong
Ma	H M J	MTRC	Hong Kong
Ma	W H	MTRC	Hong Kong
Machap	S	Siemens	Malaysia
Mohamad Fadzlullah	M S	Ansaldo	Malaysia
Mohamad Shukor	M F	Ansaldo	Malaysia
Rafi	J M R	Ansaldo	Malaysia

Affiliate (contd)

Sawyer	A	SNC-Lavalin	UK
Suhaimi	A F A	Ansaldo	Malaysia
Tsang	T S Z C	MTRC	Hong Kong
Waters	A	Frequentis	UK
Wong	C K	MTRC	Hong Kong
Wong	K L	MTRC	Hong Kong
Zawiazalek	K	Metrotrains	Australia

Transfers

Member to Fellow

Halliwell	P J	RSSB	UK
Rodgers	S A	Jacobs	UK

Associate Member to Member

Dawes	A L	Siemens	UK
Murungu	L M	Network Rail	UK
Nesom	D M	Mott MacDonald	UK
Xaba-Nkuna	P S	Gautrain Management Agency	South Africa

Affiliate to Member

Dolby	M	Resonate	UK
Laver	A K T	Network Rail	UK
Wheeler	D F J	Amey	UK

Affiliate to Associate Member

Azizan	M Y	Ansaldo	Malaysia
Cleverley	L F T	Network Rail	UK

Engineering Council registrations

Congratulations to members Atesh T, Osman M, O'Sullivan G and Turner J who have achieved final stage EngTech registration. Also to members Lee C E, Elliott T and Vidyarthi A who have achieved final stage IEng registration and members Nock D and Tembo C who have achieved final stage CEng registration.

Re-instatements

Miftha M and Neacy G.

Resignations

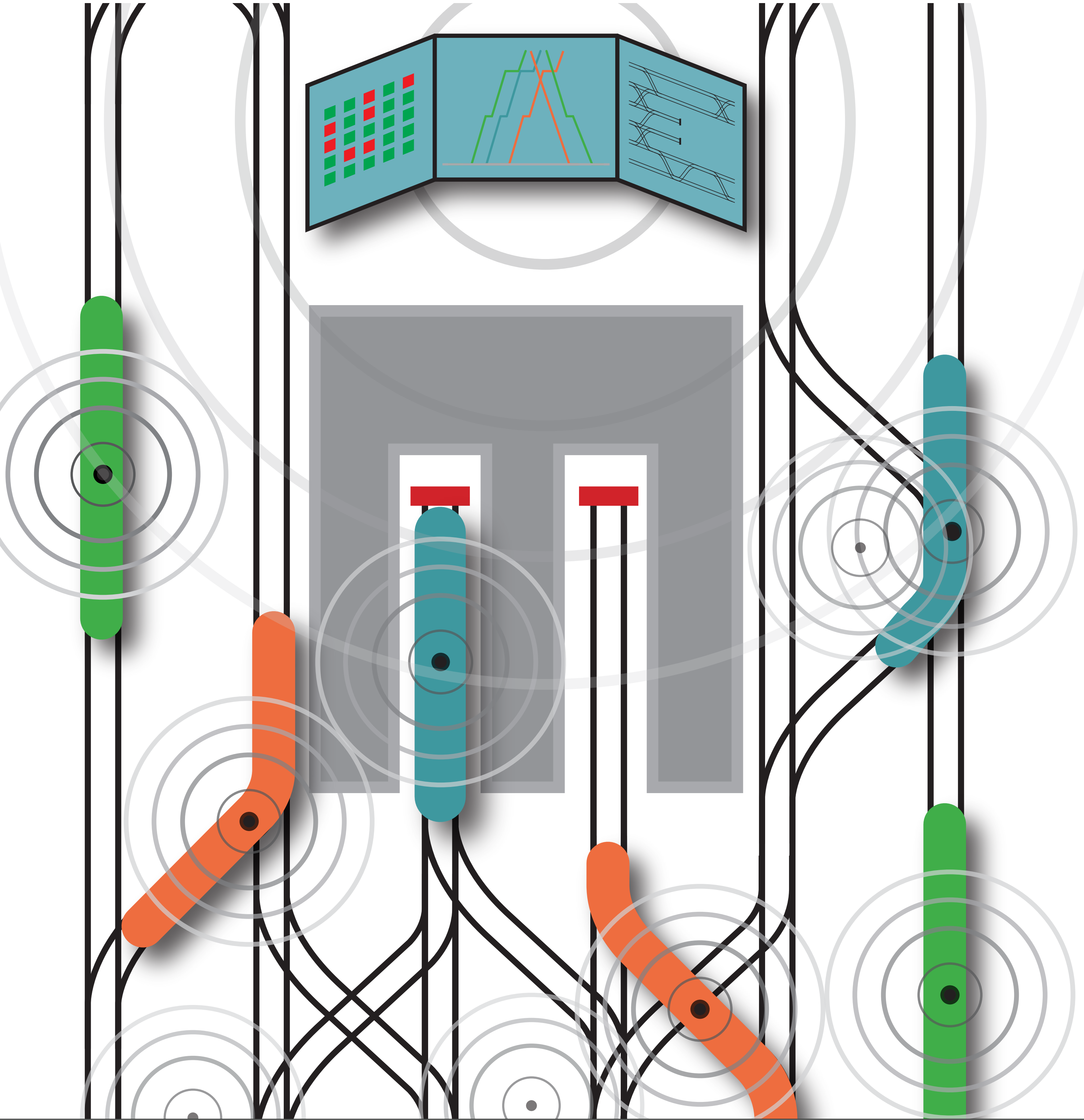
Hunt B, Luk G, Marwah M and Stojanovic M.

Deaths

It is with great regret that we have to report the death of members Fish M E and Sterner B J.

Current Membership: 5458

IRSE News
Institution of Railway Signal Engineers
July/August 2018



The future
command and control 4.0

30 years later
have we still forgotten?

David Waboso
interview with IRSE News

A professional home

In the last IRSE News George Clark, asked the important question "Where are the future engineers?" and talked about the shortfall of engineers within the transport sector. He described some of the initiatives being undertaken within the UK to tackle this. George talked about the need to build a workforce consisting of diverse and creative people to find solutions to complex problems.

In this month's edition Josef Doppelbauer has written about future 4th generation control, command and signalling systems harnessing capability of new technologies, not just within the railway sector but also from beyond.

Specialist technological areas such as wireless connectivity, big data, artificial intelligence, safety critical software, cloud computing, sensors, internet based interfaces and intermodal transport integration are mentioned within Josef's article. These areas, with their associated skill sets, are critical to future command and control systems for both main line and metro railways. With this mind, there exists a great opportunity for the IRSE to be the professional home for individuals that have these skills, or for young engineers that are potentially interested in developing their careers in these areas. In doing so, the IRSE can tap into these critical skills – many of which exist today and are flourishing outside of the railway transport sector.

Consider for example Transport for London (TfL), an integrated multi-modal transport authority covering metro, railways, trams, highways, buses, cable car and river boat services. Working within TfL, it is apparent that many skills sets are common across the transport sector, and not limited to railway application. Being a vertically integrated business across some sectors, it can be seen how individuals working in areas such as 4G wireless deployment in tunnels, cyber-security, development of passenger ticketing systems and CCTV data analytics can offer vital capability to future command and control applications. The IRSE as a professional engineering community can offer an interesting home to these professionals to benefit the whole transport sector, not just rail.

So how could IRSE attract those individuals and what would be they gain from joining an institution such as the IRSE? The IRSE White Paper on Digital Railway, published last year, naturally focused on the railway sector. Consideration should be given firstly to extending the scope of this digital white paper to cover the interfaces to the wider transport sector. Secondly the scope of 'Digital' should cover performance and reliability improvements for existing transport systems as this could bring benefits to passengers in shorter periods of time than other longer-term objectives. Being part of the IRSE will not only provide a professional home for these individuals, but more importantly will provide interesting challenges in an industry sector that they can easily relate to, and enable them to apply their digital engineering expertise in the transport community.

Harvinder Bhatia
Head of Central Engineering
Transport for London

Cover story

Signalling and train control is going through one of the fastest periods of technical change we've seen since the introduction of interlocking technology in the 1850s. As described in this month's presidential paper (page 2), advances in computing power, networking capability and data communications are opening up the potential to move towards radically different solutions to the basic architecture we have been familiar with for nearly 150 years. Our cover shows just one view of the future, with automated trains communicating with one another, switches and traffic management systems over high speed vital links. Whilst what the railway of the future will look like isn't clear, it is certain that change is happening.

In this issue

Command and Control 4.0

Josef Doppelbauer
Executive Director, European Union Agency for Railways
France

Josef Doppelbauer's paper on the future of the railway was the first in Markus Montigel's Presidential programme for 2018-9, and was presented by Josef in London in June.

Control, command and signalling are at the core of railway operations – they essentially determine safety and performance of the network. With the capabilities provided by new technology in terms of computing power, sensors, networking and connectivity, new possibilities arise – more and more functionality can be moved on board trains (thus reducing fixed cost in the infrastructure), vehicle-to-vehicle communications (including to non-rail vehicles) can enable mitigation of safety risks (e.g. at level crossings), while central traffic management remains significant for network-wide optimisation.

At the same time, interoperability must be preserved (or even enhanced), while advances in artificial intelligence will make possible new forms of automation. With these developments, the silos separating transport modes should disappear and a scenario becomes likely in which all modes become part of a single shared transport system, where journeys are procured digitally using whatever combination best fits the customer's needs and preferences at the intended time of travel. In order to manage evolution towards such a scenario, a representative architecture that describes the key interfaces is necessary.

Introduction

This article is about the future.
It appears to be common knowledge that accurate prediction of the future is impossible. However the opportunities offered by technological progress, the consequences of current and foreseeable decisions, as well as the constraints and restrictions arising from applications within the framework of the shared system, can be captured, and consequential areas of attention and action can be devised. We are not entirely in the hands of developments outside our control, condemned to wait and see; to a certain extent, we can be in control of our destiny.

Despite all advances in communications technology and digital connectivity (the increasing 'virtualisation' of the world), physical transport of people and goods will remain essential. Mobility is not just movement of people and goods, it is shaping society and economy. However mobility brings with it a number of negative side effects such as pollution (including noise), congestion, and safety risks. Today, climate change remains one of the most serious challenges for humanity; transport contributes significantly to greenhouse gases and, unlike some other sectors, the emission situation with transport has not improved over the past couple of years.

Rail on the other hand is a transport mode that is energy efficient, providing high capacity at comparatively high speed, and a significant fraction of rail transport already operates with cleaner electrical energy, so a shift to rail could be an effective strategy to clean up transport [1]. Rail is also the safest mode of land transport [2].

The good environmental properties of rail stem from the low coefficient of friction at the wheel-rail interface, and the lower aerodynamic drag per passenger-kilometre and tonne-kilometre. However, the low friction and the resulting long braking distances of trains have made it necessary to introduce elaborate systems for signalling, train protection, and traffic management, in order to dispatch trains and to avoid derailment and collision hazards. These control, command and communication systems ensure the safe movement and operation of trains on the railway, and so they have a major impact on the performance of the rail system as a whole. The train separation they impose drives route capacity, and speed restrictions determine journey times.

In the 19th century, rail was a major driver of technical innovation, especially in the area of control, command and signalling. Today though, advances in technology are mainly in the fields of information, computing, and communication. Technology in these fields is progressing exponentially in accordance with "Moore's Law" [3].

Furthermore these technological advances can be combined and integrated – innovation by combination, as seen in smartphones (Figure 1). So we are currently witnessing a major transformation of the world, with potentially fatal consequences for rail [4]. In the transport sector, the automotive industry is investing enormous amounts of money in development of autonomous vehicles [5], including truck platooning [6] to improve the efficiency of road freight transport, all based on advances in broadband connectivity, computing power, and artificial intelligence.

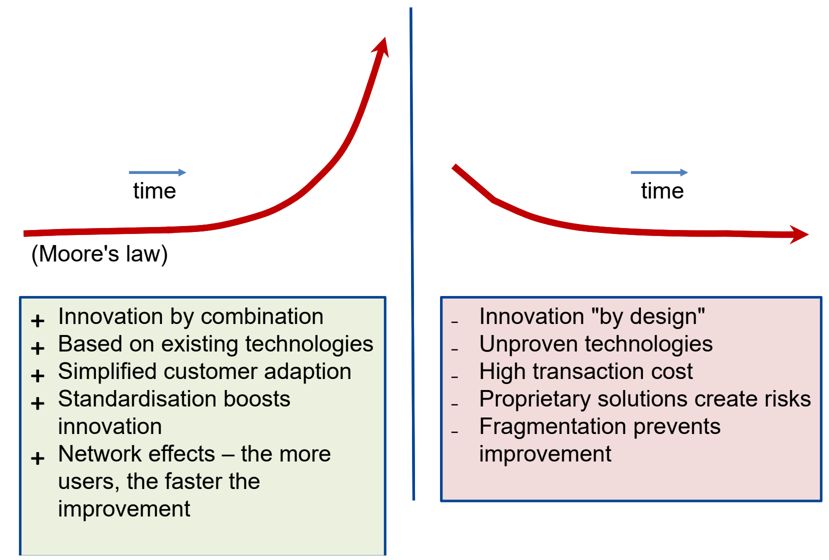


Figure 1 – Combinatorial innovation (left) leading to improvements on an exponential scale, in comparison with the approach often followed in rail (right). Innovation "by design" also means that use of the so-called Vee Model, often called for in safety assessments (as for example in CENELEC EN 50128), is required.

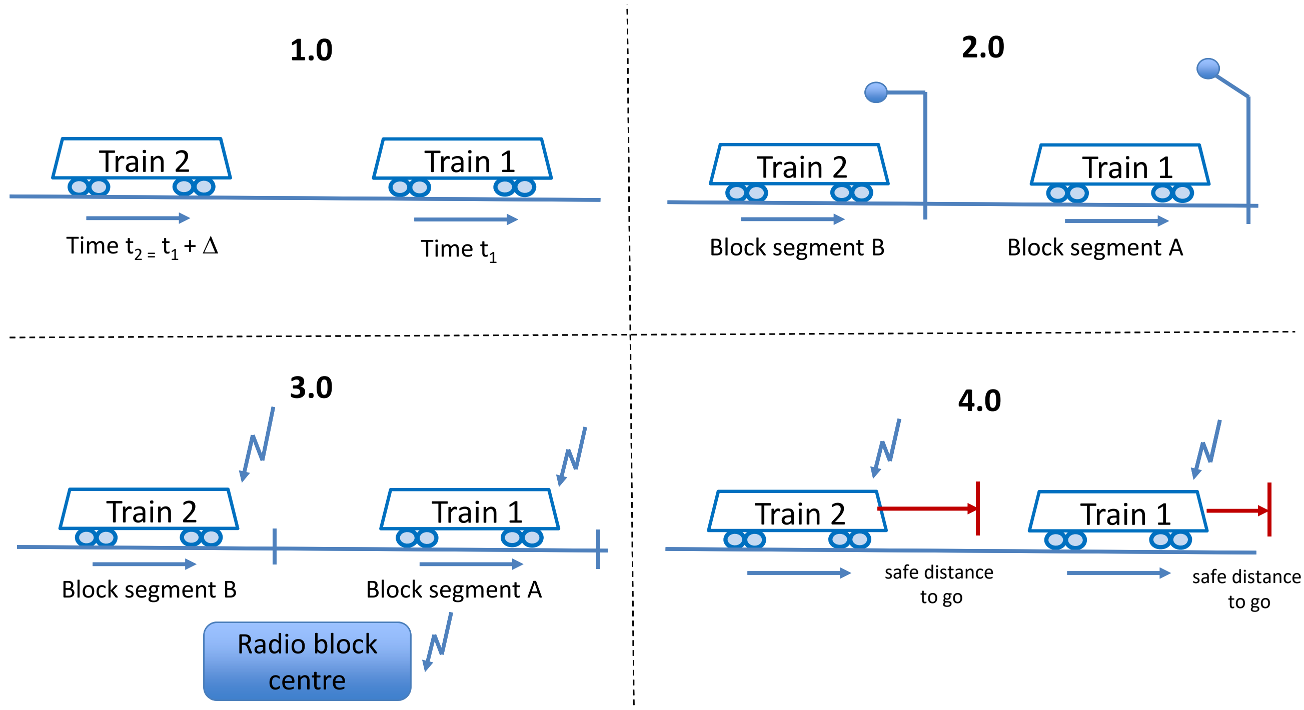


Figure 2 – Four generations of control, command and signalling and their basic principles. The first generation ("1.0", upper left) is based on separation of trains in time. The second ("2.0", upper right) is based on separation in space, by (electro-)mechanical signals. The third ("3.0", lower left), is communication-based signalling, still based on block sections. Finally the fourth generation ("4.0", lower right), has universal geographic safety logic enabled by vehicle-to-vehicle communication.

These new technological capabilities are a threat to rail in its classical form, because they help create cheaper and more convenient alternatives, but they can also be a massive opportunity for rail to become more cost effective and more attractive for users. In the area of control, command and signalling specifically, we have seen time separation; then space separation (the absolute block principle); and finally track to train communication, as in ERTMS. With the new technological capabilities, a fourth generation of railway traffic management system ('Command and Control 4.0') will become possible (Figure 2). In this article, some of the conceptual possibilities, their necessary consequences, and potential issues will be discussed.

From a user's perspective, for both mobility and logistics services, instant updates available for example via smartphones make it possible for the user to be advised of options in real time and to decide on the spot the most suitable way to travel from A to B, taking into account attractiveness and flexibility, and highlighting quality, hassle-free, reliable and safe travel. In freight, intermodality will play a key role in decarbonising transport, drastically reducing the pollution and congestion caused by long-distance road transport. One of the critical questions for rail will be whether it will ultimately be at the core of the multimodal transport chain (the 'backbone'), for integration between the various modes of transport will be critical. In other words, we are confronted with a need to transform the rail industry; just making the current status quo better will not be sufficient.

The interoperability vision

Before we come back to the impact of technology evolution, I would like to briefly discuss some structural issues with rail. Almost all transportation systems

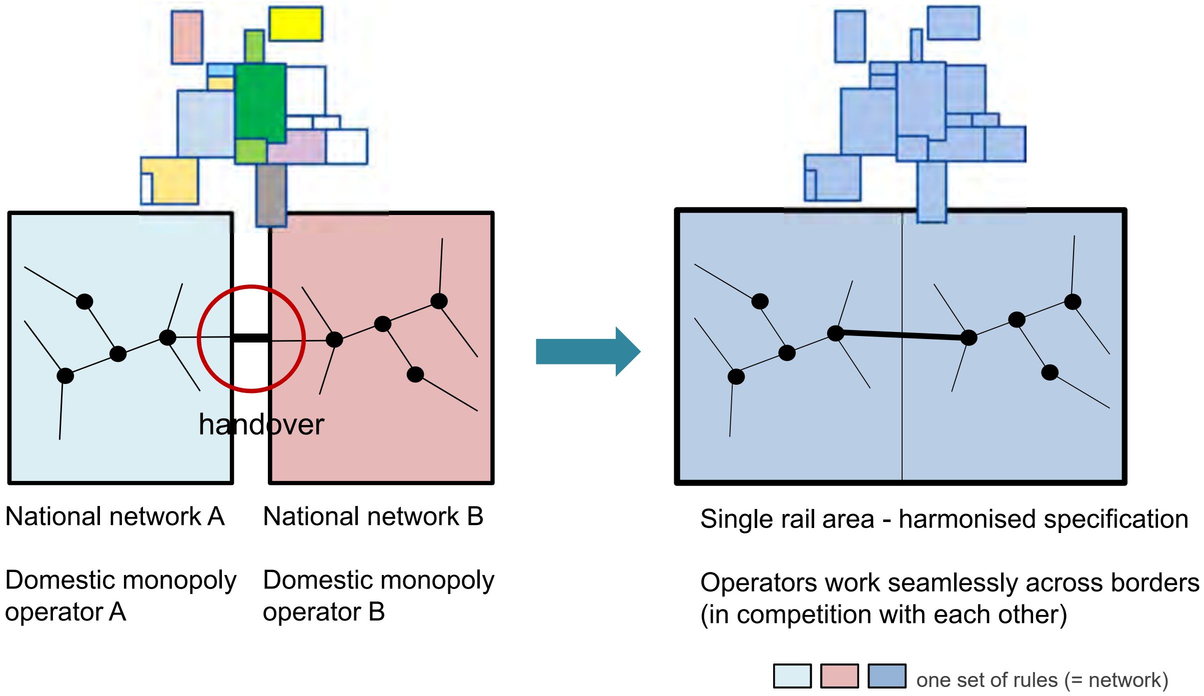


Figure 3 – The interoperability vision for rail: fragmented national systems (left) versus single rail area (right).

have rules which are globally valid: roads (apart from the issue of driving on the right or the left); aviation; and maritime. Rail is the exception. Historically, technical and regulatory requirements and operational rules on the railway have been fragmented, mostly along national borders (see Figure 3). Control, command and signalling is one of the areas where there is the greatest diversity; although all signalling systems are based on the same block principle, every infrastructure manager adapts this principle to its own operations concept, resulting in different technical specifications for both mobile and fixed equipment. As a result, even with the introduction of the European Rail Traffic Management System ERTMS [7] full interoperability across national borders has yet to be achieved.

The consequences of this diversity are high costs for operations, maintenance, and investment, lack of opportunity for economies of scale, and being locked into a thirty to fifty year cycle of obsolescence. This fragmentation is a major competitive disadvantage for rail against other transport modes; it needs to be rectified if rail is to play the role of the backbone of the future multimodal transport chain, both in order to remove barriers for seamless transport across borders and to improve return on investment for innovation. Creating a Single European Rail Area has therefore been one of the policy objectives of the European Union.

Within such a legal framework, it is important to apply principles that are well established in other transport modes, such as ‘user first’. This means that it should not be for the infrastructure manager to define restrictions on rolling stock that it allows on its network, but for the railway undertaking (as the user) to demand capabilities from the network that it needs in order to fulfil its core purpose of supporting optimum operation of trains. (Ultimately, this principle should lead to the definition of categories of trains, to be matched with categories of infrastructure capabilities, with appropriate system version management linking them). The new legal framework of the Fourth Railway Package in Article 23 of the Interoperability Directive [8] reflects this principle.

In order to make railway operation more economic, the infrastructure needs to be made cheaper and more efficient. To optimise the financial viability of the assets used generally, there should be a shift from fixed cost (in the infrastructure) to variable cost, with most of the intelligence moved on to the train. This reduction of fixed cost is obviously more important on routes having less dense traffic, as in rural areas. The mobile assets should then be able to roam freely in an integrated rail area. Needless to say, in such a single, global railway area operating rules should also be global.

Operational procedures are based on the need for efficiency but, more importantly, on the necessity for safe operation. This constitutes another structural problem for rail, with severe consequences for the cost and complexity of introducing new technologies. Railway safety results from the combination of functional and technical safety of assets, control of route-train compatibility, and operational rules. Any change in one of these will have an impact on the other two which must be considered in the authorisation procedure, making this repetitive procedure complex, time consuming, and expensive. In line with the interoperability vision and the ‘user first’ principle, technical and functional safety needs to be encapsulated and follow a universal design logic [9], whereas operational procedures should mostly be covered by the railway undertaking’s safety management system in order to ensure conformity with the system’s operational rules [10]. This aspect is crucial; if this deadlock situation is not resolved, rail will essentially become decoupled from the mainstream of technology.

The railway system of the future and how it will be operated

The exponential development of technology mentioned above means that, within a couple of years, computing power will continue to drastically increase, digital storage will be practically unlimited, broadband connectivity will be available at unrestricted bandwidth, a variety of sensors will collect information on virtually every aspect, big data-based algorithms will enable the effective processing of enormous amounts of data, and artificial intelligence will compete with human brains on decision making. It is unlikely that railways will survive if they remain in a closed corner, using expensive niche technology, decoupled from and outpaced by the tide of mainstream development.

Even though this article is mainly about control, command and signalling, to assess the impact of new technology we need to consider the entire rail system and its integration with the overall transport system. Starting from basics, localisation (that is, determining the positions of trains) is a key factor in rail operation.

Currently rail-specific coordinate systems are used; for example, ETCS uses balise-based coordinates.

In the future, rail should rely on a coordinate system that is used by the rest of the world too. All data should be expressed in these coordinates. (These data could then be used by third parties, such as shippers, to trace a train via Internet maps). As will be discussed below, geographic localisation will also become the basis for the new universal safety logic.

The obvious source of localisation information is satellite positioning, complemented by other means such as balises and tags in places where satellite positioning does not work such as tunnels. Complementary to localisation, information on train integrity (completeness) can be provided by position sensors plus appropriate connectivity.

By definition, railways remain constrained by tracks, meaning that tracks remain the essential element of a railway system. Even on the well proven rail/wheel interface, technology could bring about a change. Mechatronically controlled wheels could provide an alternative to the constraints of conicity.

As for problems with the track itself: inspection of the track for damage and defects can impact availability. Sensors on railway vehicles could turn every vehicle into an inspection vehicle. With big data algorithms operating on location-correlated datasets, deteriorating infrastructure can be detected and maintained appropriately.

Track switches and crossings will remain essential elements of the future railway system; changing direction, splitting and merging of routes will always be required for rail operation. The reliability of switches will therefore continue to determine the performance of the rail network. However sensor technology and wireless connectivity will increasingly facilitate continuous monitoring of switches, including weather conditions, and condition-driven maintenance.

From a safety perspective, switches must not move under a running train, and switch locking must therefore be provided. Whether switches will best be centrally controlled from an interlocking or train controlled (route protection versus train protection) will most probably evolve over time. In any case, with precisely known train location and train speed the efficiency of releasing switches can be maximised.

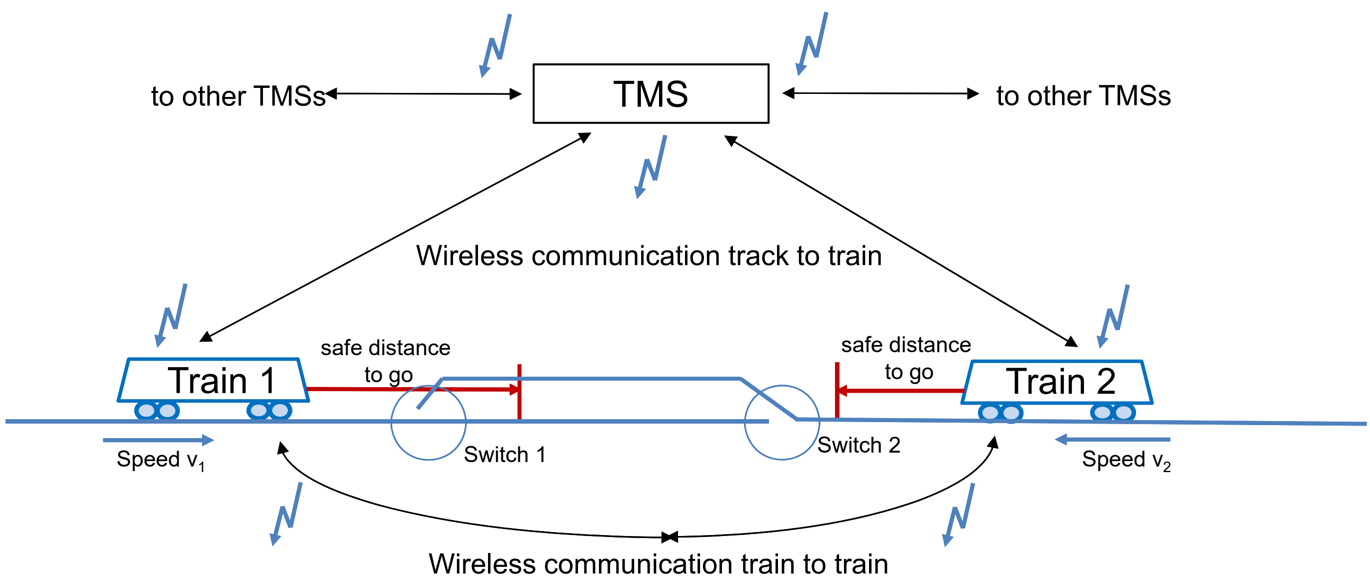
I fear that road level crossings will also remain, at least on secondary lines; however, control of these devices will shift more to the vehicles. Vehicle-to-vehicle communication (including rail to road) and integrated traffic management between road and rail will offer additional mitigation for safety hazards at level crossings.

From a control and command perspective, the future railway system will look as shown schematically in Figure 4. Immersed in a wireless communication network, each train will calculate its safe distance to go continuously and adjust its speed accordingly, on the basis of its physical location (as expressed in geographical coordinates), and of information derived from various sensors (such as speed and health check), communicated from track to train from the traffic management system (TMS), or communicated from train to train. This will be the new universal, dynamic and geometric safety logic of 'Command and Control 4.0'.

In other words, in Command and Control 4.0 we will see a risk-based approach to controlling train movement. Each train's speed envelope is to be calculated based on knowledge of location, track topography and switch positions, traffic ahead (known through wireless communication), and other relevant information (such as wind, rail adhesion or snow) and additional factors that might inhibit safe speed.

'Safe software', meaning software that conforms with Safety Integrity Level SIL 4 according to CENELEC EN 50128, should be used only where justified by the need to maintain proportionality of cost and risk in comparison with all the other elements of the system that ensure safety. Other functions can be provided

Figure 4 – Schematic representation of trains operated under Command and Control 4.0. TMS is traffic management system. Each train calculates its own 'safe distance to go' (shown in red).



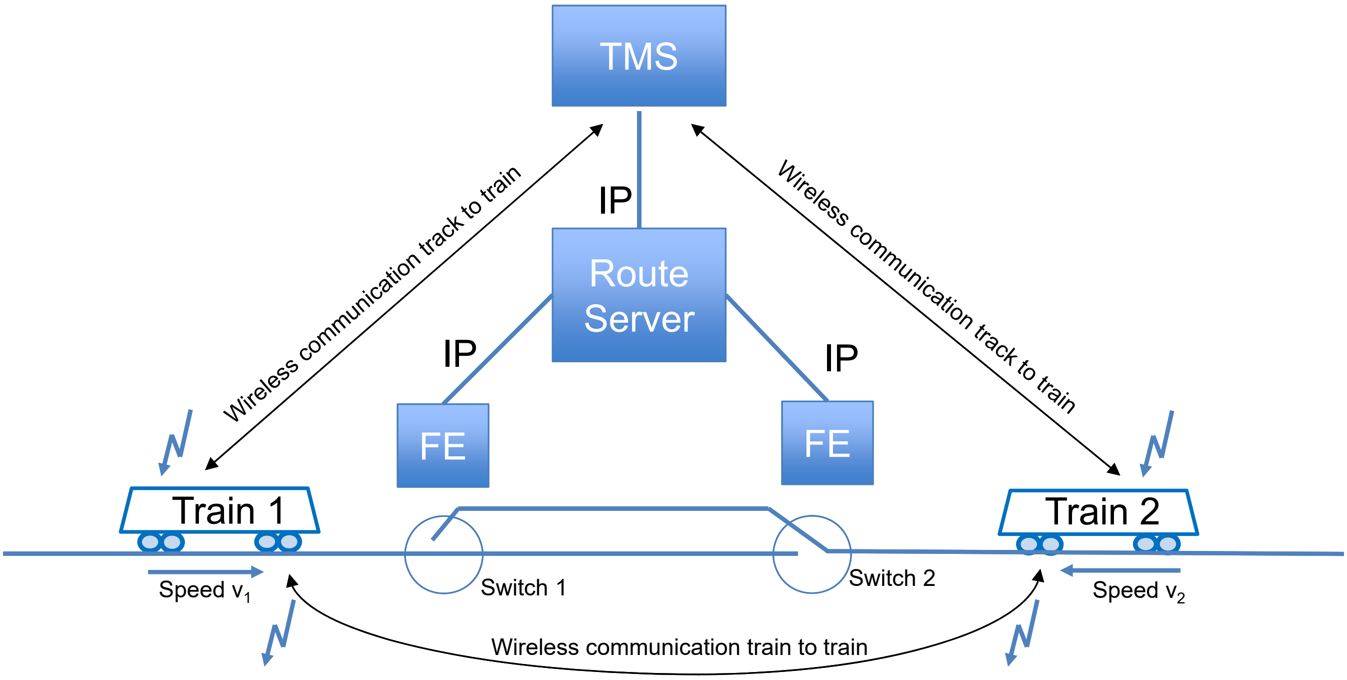


Figure 5 – Architecture of a future Command and Control 4.0 system. Smart wayside objects (field elements, FE) have open interfaces and powerful degraded modes. On the train, clearly only one interface is necessary, the communication interface between the rail vehicle and the external world.

in the form of applications that are 'safe enough' without achieving SIL 4. In all cases, the tolerable safety levels must be balanced between the elements of the rail system, and consistent with other modes of transport. In addition, technology might further be used for risk reduction by taking into account information for example about evolving degradation of equipment.

One of the key questions to be resolved remains the optimum distribution of functionality. On the basis of intelligence on each train and on bidirectional communication, both TMS-to-train and train-to-train (see Figure 5), there are several possible control loops. The innermost of these loops can be considered to be individual train protection (for example against collisions and derailment, but possibly also against obstacles), based on sensor fusion and the known weight, length, speed, and position of the train.

The next level can be collective action by a number of trains in close vicinity, the highest level in turn being centralised traffic management. More complex track layouts, as in larger stations, may possibly require station-wide control – the function currently performed by signal boxes or interlockings could be taken over by a 'route server', a function that does not necessarily have to be local to the station, but could equally be an 'interlocking in the Cloud'. The expected increase in computing power will permit calculations to be done on line that today have to be done off line because of long response time. In any case, there must be quick reaction to external events at local level, while retaining responsiveness to emergency commands from the centre. (Please note the similarity of this architecture to the way in which vertebrate animals – including humans – control their movements: local sensors and reflexes in the limbs, coordination by the spinal cord, and finally high-level management by the brain).

In this future configuration there is no need to keep the distinction between routes (in stations) and blocks (between stations). The route server will obviously combine the functions of the current interlocking and the radio block centre (RBC).

The only essential field elements in the track that will remain will be switch controllers and level crossing controllers. The controllers for these devices will have to be connected via an Internet based interface (that can ultimately be wireless) to the route server and the rest of the world (see Figure 5). Signals and track circuits or axle counters will no longer be needed, except in the transition period or as fall-back in degraded situations.

A number of sensors of various kinds will complement the basic system, each sensor being connected to the Internet (thus becoming an application of the 'Internet of Things'). In such an arrangement, with the ability to handle large amounts of data efficiently, additional asset management functions such as predictive maintenance can be integrated. Used intelligently, by this means system reaction can collectively be anticipated, and reliability and punctuality of the service improved. In an extreme case such sensors might include, as in a recent proposal from China, devices for supervising the brain activity of the driver, able for example to detect fatigue.

Naturally, with an architecture as shown in Figure 5, gradually more and more tasks can be automated – avoiding human factors, including language. Automation has a long history in rail so generally speaking, further automation should be achieved more easily on the railway than the roads, as fewer variables need to be controlled than for autonomous cars in cities for example. Automation will again contribute to better reliability, because driver behaviour is stochastic; with automated train

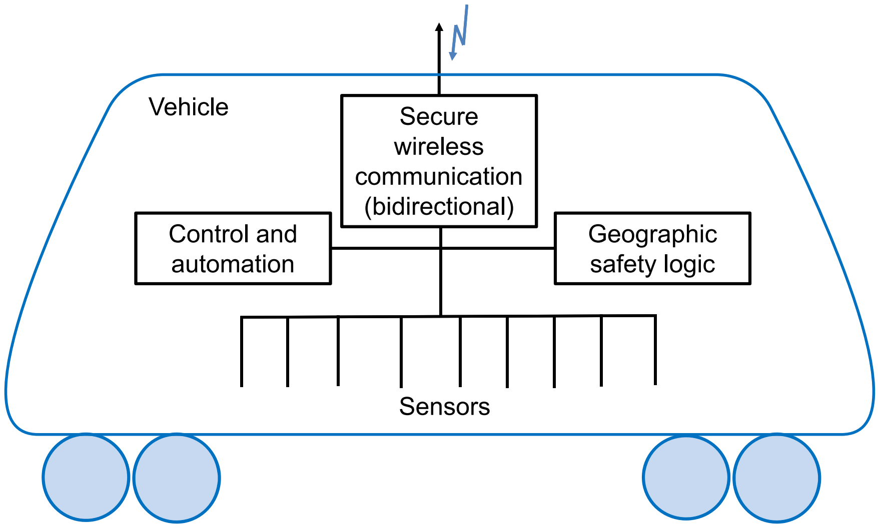


Figure 6 –Representative architecture of the on-board system with Command and Control 4.0.

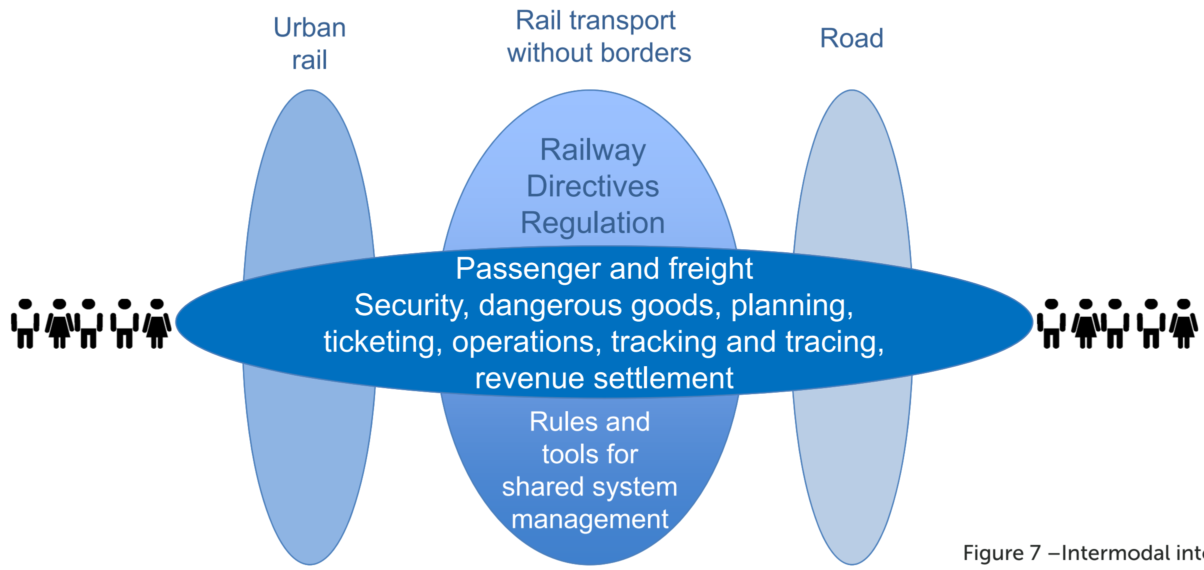


Figure 7 –Intermodal integration between main-line rail, urban rail and road.

operation (ATO) no big variations are to be expected (and in addition, the working environment will be healthier and safer). With advances of artificial intelligence (AI) an unprecedented variety of opportunities might open up here. Autonomous systems will evolve from recipients of a 'movement authority' to vehicles able to calculate their own safety envelope (risk based). A more detailed representation of the system on board is shown in Figure 6.

Command and Control 4.0 will allow for highly automated (re-)scheduling and precise real-time control, enabling real-time traffic management. Interruptions and disturbances (such as door closing problems) can be taken into account, and cascading of interruptions can be avoided. In turn, this will enable the reduction of buffers in the timetable; the more accurately the position of a train is known, the less buffer is needed, leading to an improvement of line capacity. It will no longer be necessary to resort to the worst case assumption, unless accurate information is lacking.

Collective action after first solving problems locally will help increase the efficiency of the rail system. For road, such systems already exist (an example being Waze [11], the world's largest community based traffic and navigation app, with which drivers of vehicles share real-time traffic and road information in order to find the best route for each), and integration across modes could be an interesting option. (Note that such intermodal integration will rule out having a specific, dedicated wireless network for rail). With the architectural possibilities of the new command and control architecture, level crossing closures could be factored into the calculation of car journey times, possibly preventing risk-taking on the part of car drivers.

New arrangements may arise, in turn, for the relationship of infrastructure managers, train operators (railway undertakings), and traffic management, ultimately with a central, European instance in charge of overall optimisation ('Eurocontrol for rail').

Digitalisation will promote multimodality and integration between industrial sectors. With vehicle to vehicle communication, a vehicle-centred approach to safety, and the need for rail to become the backbone of the multimodal transport chain, intermodal integration in the transport ecosystem and in the area of traffic management will become relevant (Figure 7). Interoperability across all sectors is also desirable in order to make possible sharing of components and functions (sensors, network interfaces); this should be particularly attractive for the rail sector, as it could profit from the higher volumes in for example the automotive

Innovation	Locality	Soft/hard	Comment
From **steam** traction to **diesel** traction	largely local	soft	Provided sufficient fuel is available, both steam and diesel locomotives can run anywhere on the network.
Electric traction	network	semi-soft	Diesel and steam can continue to run under catenary. Unless trains have batteries ('fuel on board'), electric traction depends on the provision of an adequate energy supply infrastructure
Air conditioning in passenger coaches	local (to coach)	soft	Practically no impact on the network, apart from weight and electromagnetic compatibility.
New materials for car bodies	local	soft	Passive safety? Fire safety?
Self-steering trains – no moving parts in switches in the infrastructure	local + network	very hard	Saves maintenance cost for switches in infrastructure massively. BUT ALL trains need to be converted – a 'normal' train can no longer run once the first switch is converted
Automated train operation (ATO)	largely local	semi-soft	ATO has existed for quite some time in closed (urban) rail networks
Universal geographic safety logic	local + network	semi-soft	Migration necessary, including regulatory framework

Table 1 – Some examples of innovations in rail, categorised by their location and impact ('soft' or 'hard' – this concept relates to the time delay for an innovation to take hold). Note that moving most of the functionality on board the train will help in making innovations local.

sector. Shared technology could, in turn, lead to shared regulation between modes and sectors.

Migration

The cost of the railway system needs to be systematically reduced by eliminating costs caused by existing diversity, and the performance of the rail system needs to be improved by introducing new capabilities, that is by innovation. In order to achieve this goal it is necessary to define a consistent vision of the future target railway system, and the evolution to it.

In the European Union, the joint undertaking Shift2Rail fosters research and innovation in the railway sector [12]. Its innovation programme IP 2 should support rapid and broad deployment of advanced traffic management and control systems, by offering improved functionalities and standard interfaces, based on common operational concepts, without impacting the ERTMS core.

In a shared network such as rail, for every innovation it is necessary to consider whether the change can be kept local to one element or whether the entire network needs to be changed. Likewise, the consequences of introducing a new capability can either be 'soft' or 'hard'; some examples are shown in Table 1.

The railway system has to remain in service, it cannot be stopped for the duration of a system upgrade. Also, the connected nature of rail infrastructure only allows compatible evolution; the cost of either building a new system in parallel, or of taking out of service the existing system, are prohibitive. On the other hand, a migration that involves the coexistence of old and new will have an impact on the safety concept.

A fourth-generation control and command system architecture as described above, specified in a modular way with common interface specifications, must deliver 'migrateability' followed by continuous upgradeability. As the railway system will remain a system shared between many actors, migration needs to include technical, operational, and regulatory aspects. Naturally, the evolution toward the new generation should be based on ERTMS. The 2016 Memorandum of Understanding on ERTMS in particular contains the compatibility definition that will be essential: "A compatible onboard can safely operate on any compatible section of infrastructure, with acceptable performance." [13].

On the hardware side, the following scenario leading towards Command and Control 4.0 seams feasible: the existing lineside and on-board equipment can be migrated from control by existing interlockings to control by new control mechanisms by changing the path of control from the current system to the new one. Object controllers for trackside equipment and virtual on-board balises are examples of tools that allow this migration to happen. The system needs to allow mixed traffic of both fitted and unfitted trains.

The importance of software will be predominant in the future, as the amount of software will grow exponentially. Migration of the software side is more difficult: it firstly requires modularity and concentration and, if it cannot be avoided, isolation of SIL 4 functionality, strictly limiting what has to be SIL 4 to the smallest possible amount; and secondly an evolution of the mechanism for authorisation, from certification of the product to certification of the design organisation. Functionality and safety levels must be flexible enough to be appropriate for the risk and the economic burden associated with each type of service. In the future, testing of new solutions should be possible in 'light tower implementations', for example in closed systems (metros) or on secondary lines. Thereby, a staged authorisation system could be introduced, as is known from sectors such as pharmaceuticals.

Definition of manageable software modules with precise interfaces will be paramount not only for SIL4. A train operating system with clear application programming interfaces (APIs) will be necessary, either defined by industry, or imposed by standards and regulation. Such an API will enable an ecosystem of developers to provide added-value functions that are not necessarily developed for the railway market by the historical rail suppliers, such as mobility services, real time information, and multimodality.

Conformity with standards (drafted by industry actors) confers a presumption of conformity with the essential requirements. Where deemed by the regulation to be in the public interest, third-party verification of conformity with the essential requirements is required.

Open interfaces will also make it possible to avoid supplier lock-in.

Challenges

The most important challenge for rail is obviously its low speed of innovation, leading to a dramatic disadvantage in the competition with other modes of transport. The new concepts presented here can be seen as a positive response to the innovation challenge, but there are also some intrinsic issues that need to be resolved.

Apart from the need to carefully manage migration in a shared system, with a new safety logic based on geography, independent of track layout and operational rules, there is the fundamental need to know securely where the trains are. Secure and precise localisation and secure communication therefore are the critical conditions for Command and Control 4.0 to work. Cybersecurity will be a design requirement of the system, with a modular design allowing for easy upgrades. As there are cybersecurity threats related to 'GPS spoofing', it might be necessary to build an additional cellular network for secure localisation in parallel with GPS. In other words, even if functions can be moved into the Cloud, safe operation has to remain solidly rooted in physical reality.

Another challenge is related to the capabilities of artificial intelligence: to what extent should we permit programmes to reprogramme or upgrade themselves?

Summary and conclusion

Exponential progress in technology (computing, communication, localisation, sensors, big data, artificial intelligence and so on) will allow optimisation of command and control for railway operation. Shifting functionality to the vehicle will allow a reduction of fixed cost by reducing the number of physical assets on the track. Interoperability considerations demand standardisation of vehicle-to-ground and vehicle-to-vehicle communication interfaces, supporting the 'user first' principle whereby this standardisation should not stop at the boundaries of rail since interaction across modes will become more and more relevant.

A new safety logic based on geography, independent of track layout and operational processes, will be necessary in order to provide 'migrateability' (and the ease of upgradeability required for cybersecurity). This new logic will, at the same time, provide an opportunity to leave behind the legacy of national rules for signalling.

Confining the 'safe' SIL 4 part of the software and introducing a staged approach will make authorisation more efficient. With these measures, innovation in rail might receive a significant push.

There is however the need to break with some traditions in rail. In the spirit of "building windmills on top of the walls" [4], state-of-the-art technology and components should be imported from other sectors into rail, instead of re-inventing the wheel. 'Mainstreaming' rail on the technology side could make the sector more attractive for suppliers outside the circle of classical incumbents. In addition, opening up markets and mobility of assets could enable increased levels of private financing for rolling stock; as the number of vehicles of a certain type will increase as compared to today, suppliers will rely less on customisation. Globalisation of rail technology, regulation, and standardisation can lead to huge efficiencies (and to a level playing field in competition with other modes of transport): the technology challenge to rail can equally turn into an opportunity.

I also draw an important conclusion for today's existing '2.0-world', on its way to ERTMS through legacy system replacement ('ERTMS Deployment') programmes. The exponential progress of technology could not be anticipated at the time when ERTMS with its different levels was conceived 25 years ago. However the ERTMS deployment philosophy must be reviewed, in order to take the evolving technology opportunities best into account. In particular the vision of reducing the number of physical assets in the track significantly requires a rethink of the acceleration towards Level 3 from the current ERTMS Level 2 planning. In view of the long duration foreseen for the deployment of ERTMS in Europe it could be a very interesting economic option to upgrade and redefine ERTMS Level 3 to a '4.0 Level'. Railways could then – as far as is feasible – migrate directly to a system in the described way without producing sunk costs for technology investments now which would need to be migrated (and paid for) again to a 4.0-system in the future. Some railways are already thinking in this direction [9]; the European Union Agency for Railways will continue to monitor and carefully steer this development.

Acknowledgements

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What do you think?

Do you agree with the view of the future that Josef has described in his article? Do you think that something else will happen, or that we are already heading down a different route? Do you think that we need to exploit technology to do things differently in the future, or is our current approach good enough? Perhaps you think that disruptive technology we can't currently imagine is just around the corner. We'd love to hear from you, email us at irsenews@irse.org.

30 years later, have we still forgotten the driver?

Forty years ago this November, Tony Howker presented his paper "Have we forgotten the driver" to the IRSE in London. Since then this paper has been referred to in more technical papers than any other in the IRSE's history, and has continued to sow ideas and challenge our way of working despite the huge technological changes we have seen since 1988.

To celebrate that anniversary IRSE News is pleased to republish the original paper, in a slightly edited form, together with a commentary from past president John Francis who outlines quite why the paper was so influential at the time it was published and has remained so since.

We have recreated the figures that illustrated the original. We have also removed a section that outlined then-current technology advances, which 30 years on are less relevant.

The themes of the paper, however, continue to be important for the rail industry today, in particular in seeking to consider how 'driveability' can be ensured in an increasingly complicated environment. It is fascinating to consider how much – and how little – has changed since 1988.

Introduction

John Francis

Some Technical Papers become noteworthy in the affairs of the Institution. "Have we forgotten the driver" by Tony Howker is one such Paper. Since its publication in 1988 it has become one of the most referenced Papers by other authors and presenters within the IRSE. It has also inspired the use of the phrase "Have we forgotten" to prefix "The Customer" and "The Signaller" amongst others. The production of such a Paper can only be achieved if the author fully comprehends the subject and has a clear understanding of the end users perspective, attributes ably demonstrated by Tony.

With the subject being core to our profession, Tony revisited it during 2006 in "Have we forgotten the driver? – the sequel", examining what had changed in the intervening 18 years. Despite a further 12 years having now passed, the original Paper continues to inspire examination and debate of how we signal our railways. By way of example the "Low cost signalling" Paper published in January 2017 by Andy Stringer and Graham Christmas referred to and drew inspiration from Tony's original Paper of thirty years ago. Even as recently as the January 2018 IRSE News Richard Barrow, in his article "Developing a standard for driveability of lineside signalling" added the subtitle "Have we forgotten the driver? – part three" in reverence to the subject.

In 30 years much can change, sometimes but not always for the better. Tony's Paper reproduced here raised a range of issues emerging from the evolving railway that warranted examination. It is encouraging to be able to record that some of these have been addressed in the ensuing years but readers can reflect for themselves on its content, and draw their own conclusions on what has changed.

Firstly and importantly, drivers have for some time now been recruited from outside the industry, most having no railway knowledge. Thus route knowledge is now gained from printed diagrams, videos and simulation backed up by a significant increase in the amount of lineside signage. None of this signage is illuminated other than by reflection from the train headlamp, except for emergency indicators approaching emergency speed restrictions. This signage has included a proliferation of differential speed boards and additional identifiers for a variety of purposes on signal posts and structures. As far as signals are concerned new fitments are mostly of the LED type.

Sighting requirements have led to an increase in the size of signal structures, compounded by the demands of health and safety, working at height and structural regulations. Thus, for a variety of reasons, it is hard for drivers to miss a signal.

Some things have not changed, indeed they may have got worse. There are still large distances involved between protecting signals and vehicles where permissive working is allowed and, more often than not, remodelled layouts result in signals being placed further out which is detrimental both to permissive working and to platform reoccupation time.

During the period immediately before the Paper there had been a relaxation of certain features aimed at reducing the complexity of interlocking, something highlighted in the Paper. Resulting from this diminution were a number of subsequent incidents which led signal engineers to reconsider their position on features such as flank protection and automatic train protection. Similarly civil engineers revised their stance on the provision of single lead junctions.

The Paper was keen to remind signal engineers that drivers are human and thus care has to be taken to avoid misleading them or setting traps for them. There had been a prevalence amongst engineers and managers to presume that drivers would always stop at red signals, the consequences of not doing so rarely being considered in the design of track layouts and the conflicts that might arise there from. The degree of protection afforded to drivers in the event of error on their part could be said to have been lacking, especially in light of the possible results of such error on modern layouts. It discussed some of the nuances of aspects a driver can receive, pointing out that the driver may not actually be aware of the subtleties associated with certain indications.

The pendulum, in swinging back, has travelled a little further with features such as double red approaches to some conflicts, the provision of overlaps to signals at the end of loop lines and the fitting of junction route indicators in certain locations where in fact there is only one forward route. The changes have all been determined by the explosion in the number and size of Standards, a moving feast having been created. Signalling Principles have metamorphosed through various guises to become what are known today as Railway Industry Standards whilst a range of new legal obligations, mandated since the turn of the century and derived from European Directives, flow through to dictate how signalling is designed and implemented.

Adherence to minimum sighting times has seen the installation of many more Banner Repeaters, some of which are of the 3-aspect type – a variety which did not exist in 1988 and which I think Tony might suggest was an unnecessary enhancement. Another new signal is the Preliminary Routing Indicator (PRI) which is often provided in preference to a splitting distant. These are liked by drivers as they support route knowledge by giving early advice of the route set ahead in conjunction with clear signals, allowing the driver to drive to his knowledge avoiding both approach control and the likelihood of misrouting.

The Paper highlighted the flaw with displaying one red and one white light for stop in position light shunt signals. This has since been remedied by the fitting of twin red indications, thereby removing the potential for wrong side failure and, no doubt, preventing incidents of such signals being passed at danger when the hitherto single red indication failed.

In the years following the Paper some serious accidents (10 or more with names we all remember) occurred on Britain's railway that subjected signalling to scrutiny and which saw calls to close the control loop between the signal engineer and the driver – a theme that had been strongly advocated in the Paper. Sadly cost has so far been used to prevent nationwide fitment of ATP but TPWS, initiated as a cheaper alternative, has prevented many SPADs and mitigated the outcome of many others.

In explaining the principles behind various types of ATP the Paper opened the debate for its need. Whilst a range of intermittent solutions have been deployed on main line railways since, the development of ETCS has opened up the opportunity to apply a continuous system that is now seeing widespread adoption and which offers the ability to abolish lineside signals whilst closing the control loop at the same time. As we move forward with further implementation of in-cab signalling we must continue to understand how best to serve the driver.

One feature not aired in the Paper was that of driver to signaller communication. This has advanced to a nationwide fitment utilising GSM-R which has made such communication simple and universal. It has provided a medium for clear understanding to be achieved between parties, enhancing safety particularly for the driver who no longer has to leave the train whilst, as a bonus, reducing delays resulting from incidents, failures and errors. It is also an adjunct to the signalling system as it allows for messages to be passed and emergency stop commands to be transmitted in a parallel and diverse way.

At the heart of the Paper is the relationship that should exist between the signal engineer and the driver. We are reminded not to forget the human element and to always remember the driver when making changes to the railway. Judging by the continued reference made by subsequent authors Tony's Paper achieved its objective of advancing this relationship. The record shows that safety has improved and this is in no small part attributable to the attention paid by signal engineers to the driveability of signals and the application of new protection mechanisms during the last thirty years.

About the author …

Anthony (Tony) Howker has a remarkable record of contributing to industry and the profession since joining the Westinghouse Brake & Signal Company in London as a student signal engineer in 1958.

Tony's career with Westinghouse saw him work on some of the largest resignalling projects carried out in the UK in the 1960s and 70s. During this time he developed a relationship with the footplate fraternity that allowed him to gain a significant insight into the role of the driver. Further projects followed overseas in such diverse locations as Hong Kong and Dublin.

Moving to Australia for 12 years, Tony worked on many resignalling and ground-breaking computer-based centralised traffic control schemes in the region before returning to the UK as engineering director and then managing director. Senior roles with BR and Railtrack followed before a return to Westinghouse.

Since retirement Tony returned to Australia to live in Melbourne from where he has continued to undertake consultancy work. A Past President of the IRSE, Tony has played a major role in the affairs of the Institution for decades, and continues to do so.

Tony seen being presented with the IRSE Australasian Section's Chairman's Award by Glenn Miller in 2017, recognising his outstanding contribution to the industry over many years.

Have we forgotten the driver? (1988)

Anthony C Howker

Many years ago, as a young man, the Author remembers asking the question "What does a signalling system do?" and receiving the answer "It allows trains to run safely". Nowadays, somewhat older, when asked the same question by other young men, the reply is that "A modern signalling system allows trains to run safely and provides a management tool to run the railway efficiently". Modern signalling systems are essential to the railway business. Both answers assume one important fact. When signal engineers present the end result of their endeavours to the train driver/operator, they usually assume that the instruction/information presented will be acted upon correctly. Signal engineers carry out their work based on their own knowledge and perception, and have to remember to view the end results of their labour from the vantage of those who use the signalling system, namely the signalmen and the driver. There is no doubt that the lot of the signalman has been improved, but it is suggested that the locomotive driver who relies upon the signalling system for his instructions and safety could well argue that signal engineers have not given the same consideration to his lot and wellbeing. There is a danger of designing signalling systems and equipment for signalling's sake and forgetting the driver. Certain areas of signalling have been picked out for comment: there probably should be more, but maybe these few will give rise to discussion!

Lineside signals

The Author must quickly reassure his driving friends that they have not been neglected so far, but that if care is not taken, they are in danger of being forgotten in the future. Undoubtedly care has to be taken of the men who rely on the signalling for their instructions and safety. Over a long period of time they have been given:

- A simple reliable and safe system.
- Signals and their supporting structures positioned for convenient viewing.
- A reduction of external influences such as lighting, advertising, sunlight etc. upon the signal instruction.
- Segregation of 3 and 4 aspect signals (but not too well in some places!).
- Where necessary added controls to prevent over-reading of signals.

And conversely, every attempt is made:

- Not to put signals on viaducts or in tunnels etc.
- Not to mix semaphore and colour light signals.

However, can it be said that sufficient care has been taken? This is debatable.

Are there still areas of potential danger to which signal engineers should be looking? The answer seems to be yes.

It is a well-known fact that many safeguards and improvements in railway signalling have been brought about through hindsight as the result of accidents. How many accidents have been prevented by initially providing the correct safeguards cannot be quantified. Developments in signalling have unfortunately contributed at times to making the railway both less efficient and less safe. The question from the footplateman's point of view is whether there are any features in present day and future signalling systems which reduce his capacity to handle his train safely and efficiently. It has to be remembered that the main task of the driver is to run his train safely and punctually whilst observing speed restrictions and obeying signals.

The signal engineer must never forget that the real nature and purpose of a signal is to tell a driver whether he may proceed and the state of the line ahead. There are rules governing the actions a driver must take on observing signals but the human element must not be forgotten and signals that can be misunderstood or which camouflage a potential hazard must not be provided.

There can be no doubt that replacement of semaphore signals has improved the driver's working environment in bad weather, and has reduced certain incidents common to this type of signal e.g. passing a signal inclined a few degrees from stop. There would be few advocates of a return to semaphore signals amongst the driving fraternity. The number of types of signals and their many displays have been reduced over the last 30 years, but the higher speeds and varying circumstances of today have again led to an increase in the types and their aspects. Many older style signals, both semaphore and colourlight, still remain in service and drivers are therefore required to understand a number of generations of signalling.

The following shows some new signals and indications introduced in recent times:

- Retro-reflective Distant Board.
- Retro-reflective Level Crossing Warning Board.
- Advance Warning Board for permanent speed restriction.
- Various miscellaneous instruction boards on lightly used lines.
- Position light shunt signal with 2 red lights for Limit of Shunt.
- Point indicator comprising a single yellow light.
- Point Indicator comprising 2 white lights in a position light shunt signal head.
- Fibre-optic displays.
- Flashing single/double yellow for turnout.
- Flashing green for full speed on lines signalled for speeds in excess of 125 mph.

Enginemen have managed to handle their trains accurately for more than a hundred years using their route knowledge. The instances where they have not done so are usually due to a momentary lapse brought about by tiredness, illness, disorientation or misunderstanding. It is these instances which must be guarded against. Today, where multiple aspect signals have replaced semaphores and manned wayside signal boxes have disappeared as well, there is less trackside geography to assist a driver in remembering where he is. At a junction, the significance of various heights of dolls emphasizing the speed and direction has been lost.

All the above are factors which signal engineers probably took little notice of –it was progress and drivers always knew where they were. After all, they had been driving up and down that stretch of line for years, firstly as firemen and later as drivers. It is the future driver who has to be thought about now!

Consider in detail various examples:

Junction route indicators

Normally each junction route indicator is positioned according to the direction of the junction in relation to the main or higher speed route. Both British Railways Signalling Principles and the Rule Book Section C lay down this requirement, and where only one route is available no route indication is given. But then there are exceptions included which are the exact opposite of the rules, as for example in Figure 1 where there is a straight route ahead to a branch but no speed restriction, and also at the end of a reversible signalled line where only one route is available.

Were the driver and his understanding of signalling systems really thought of when the principles were drawn up?

The caution aspect

The theme of considering the driver's viewpoint of signalling was first brought forward in a paper read to the IRSE by R S Griffiths and T S Lascelles in 1930. One of the topics included in that paper was the use and effectiveness of the distant signal. The distant at caution can mean that a signal ahead is at danger or that a diverging route is set. In the former case, the point at which the train will be finally stopped depends upon the number of signals and the conditions within the station and the block section beyond. Often delay is forced upon a stopping train whose driver will not know whether he will be halted at the home signal, or be able to run straight into the platform at which he is booked to call. With today's widespread installation of multiple aspect signals, this quandary is largely being removed. However, it still lingers on many lines sixty years after being pointed out. To make matters worse for the driver, the operator has allowed many places where delay occurred regularly in this manner, to be provided with an exemption to section C6.14 of the rule book. By authorising home signals to be cleared early, the strength of the original rule becomes lost.

When re-signalling individual locally controlled layouts, the opportunity has often been taken to install a 3 aspect home signal enabling the driver to receive better information at this point about the line ahead. This has usually meant that the distant signal becomes a repeater for the home, such that either a yellow or green on the home signal allows a green to be displayed at the distant location. This does much to improve the progress of traffic but a driver must take special care to ensure he places the correct interpretation on any distant he passes, dependent upon the particular location. Nowadays, the first signal a driver sees on approaching a station could be a traditional distant with its inherent ambiguity or a repeater that carries more precise information. The danger of course is that the function of a repeater becomes confused with that of the traditional distant by a driver exposed to both, resulting in a train passing a starting signal at danger.

The flashing yellow

At high speed junctions (and nowadays not so high) the addition of flashing yellow aspects has gone part way towards fulfilling the previous role of the splitting distant. However, the driver can be led into a trap if he thinks of it as just an early warning device or for the turnout route.

When flashing yellows were first applied, they were a straightforward means of telling a driver that the geographical turnout route in advance was cleared (e.g. Wootton Bassett - Bath Line or Badminton Line for down trains). However, over the years signal engineers have not thought the whole thing through and certainly did not consider the different interpretations that an engineman could put on the display.

Quite often the flashing caution signals apply to more than one route (slow speed ones at that) and this totally negates the original concept of high speed trains with good braking characteristics not having to reduce speed unduly –as illustrated in Figure 2 – flashing aspects when the home signal is set for Platform 1 or Platform 2.

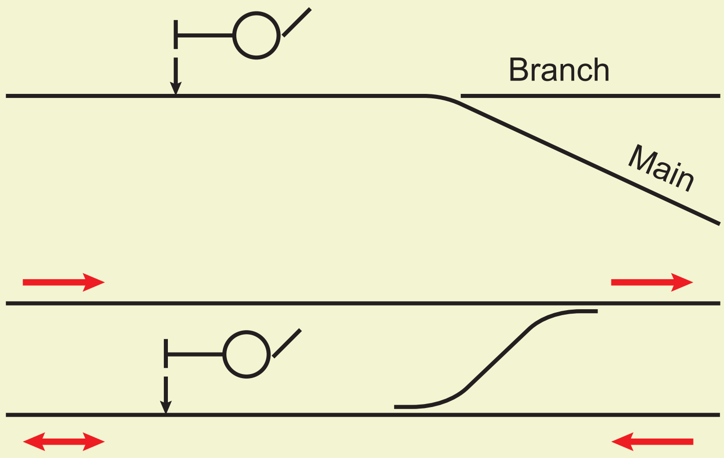


Figure 1 – Route indicator exceptions.

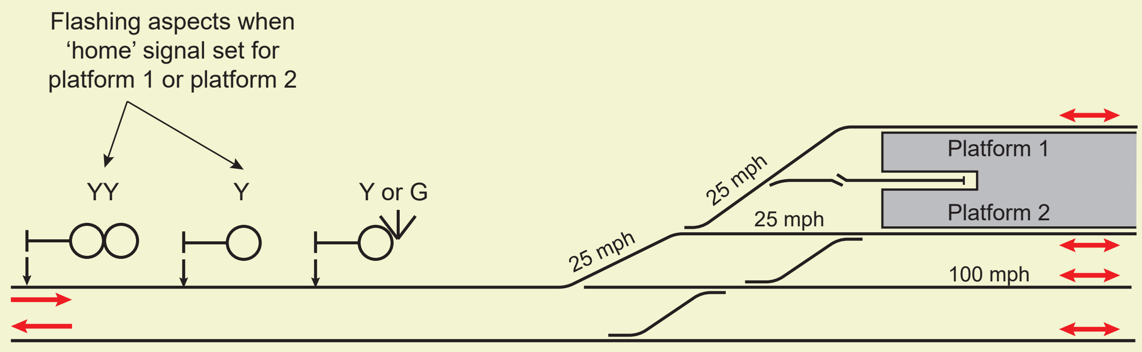


Figure 2 – Flashing aspects reading to more than one road.

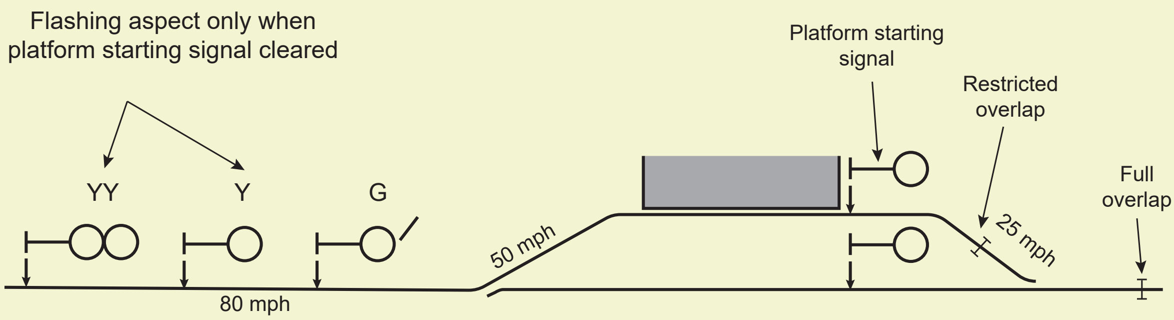
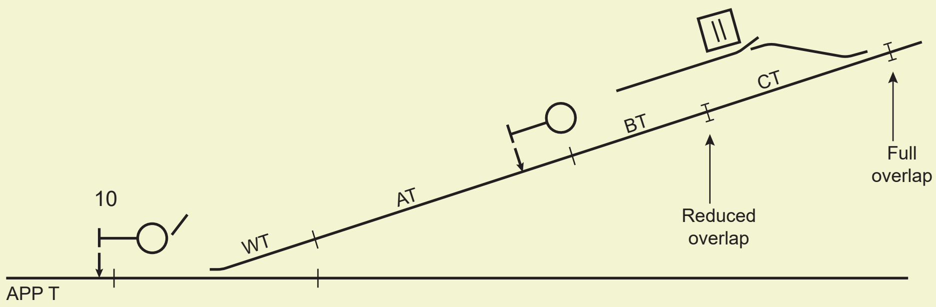


Figure 3 – Flashing aspects only when full overlap used.



FOR 10(1M) WT.AT.BT.CT.CLEAR. APP T OCC FOR t SEC & GF'N'
FOR 10(1W) WT.AT.BT.CLEAR. APP T OCC FOR t SEC

Figure 4 – Double meaning of delayed yellow.

The use of multiple aspect signalling has not however generally improved the information presented to a driver on the approach to a junction or turnout. He is still often only presented with caution aspects followed by an approach released junction signal. He therefore can surmise the direction he may be taking but is given no definite information until the last minute. The use of flashing yellows at higher speed junctions is an attempt to rectify this situation but here again the junction signal initially displays a caution aspect which may or may not require the train to be halted at the next signal. If the junction signal cannot be cleared until after the train has passed the previous signal then a standard aspect sequence (i.e. without flashing aspects) is seen. Similarly, if the junction signal has a restricted approach route (i.e. delayed yellow) then the same applies. At some busy locations, drivers therefore find that they rarely see the flashing aspects, leading some of them to quip that the feature only appears to work at weekends (i.e. when traffic is lighter and routes can be set earlier and further) (Figure 3).

It is interesting to note that a driver being stopped at a red signal, in 4 aspect territory, beyond a turnout that has a flashing aspect sequence will not actually receive the usual steady double yellow he could expect elsewhere.

The delayed yellow

The delayed yellow is a particularly curious kind of caution aspect because it can carry a number of varying meanings dependent upon location and circumstances:

- A preceding movement has now cleared and the route is set to the next signal with a full overlap.
- The route is set with a reduced or no overlap at the next original ('warner' route, nowadays known as restricted approach).
- The route has been approach released for turnout.
- The route is set for a short dead end platform or a bay.
- If a driver is stopped, or almost brought to a stand, at a red signal which then clears to a single yellow, what meaning should he then attach to it?
- Is the driver ever told – years ago he was, but not now. Has this been forgotten? Does the driver know the difference between the two examples shown in Figure 4? Probably not but does it matter?

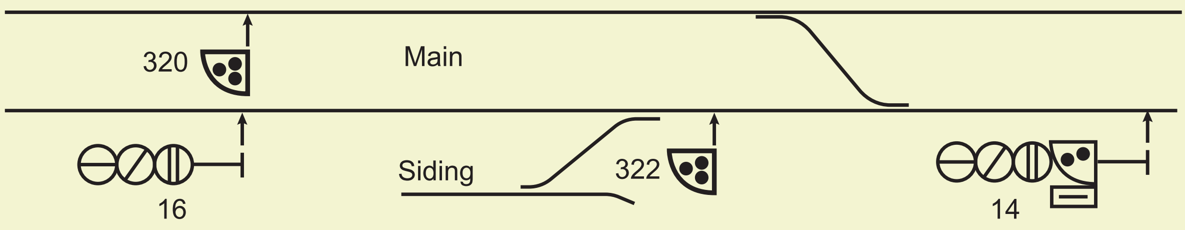


Figure 5 – Subsidiary with dual meaning.

Subsidiary and shunt signals

Because these are not main line signals signal engineers appear to have totally forgotten the driver, and in some circumstances could well be accused of providing signals that could be misunderstood or camouflage a potential hazard.

It is standard now not to provide distinguishing signs on subsidiary signals to qualify the meanings of the off indication. In the past calling-on, shunt-ahead and warning signals, whilst having an identical off indication of two white lights at 45° were qualified by an illuminated letter (C, S or W) in order that a driver knew the exact meaning of the proceed indication. Nowadays a draw-ahead signal is provided which, when illuminated together with a route indicator, carries the equivalent meaning of the old call-on signal. If a route indicator is not illuminated with this signal, then the equivalent meaning of the former shunt-ahead signal is conveyed. There is no equivalent to the warning signal, the delayed yellow being standard instead (at least in semaphore days there would be a W or a signalman would exhibit a green flag from the box!).

The rule book used to state that when a subsidiary signal was cleared with a route indication, the driver understood that the line was occupied. Without a route indication, no qualification one way or the other was given. This was because the signal was used under various circumstances, sometimes when the line was occupied, and sometimes when it was not. The new rule book no longer makes the distinction. Will the driver know the difference?

By way of example, take the arrangement depicted in Figure 5. Signal 14 has both main and draw-ahead routes to signal 16 and draw-ahead routes to signals 320 and 322. Both routes to signal 16 operate 322 as a pre-set shunt, the subsidiary move including a stencil route indication. The routes to 320 and 322 are displayed by the same signal but without route indications. The three draw-ahead routes from 14 signal can be tabulated as follows:

To 16	Two white lights plus route indication. 322 is pre-set, line occupied.
To 320	Two white lights only. Line may be occupied.
To 322	Two white lights only, line may be occupied.

Neither the second nor the third routes inform destination and the route to 322 is shorter than the other two. Overruns at 322 in these circumstances can be fairly common when the shunt-ahead route is set, especially where drivers are regularly called-on from 14 to 16 and the shunt route is less commonly used.

Signal spacing often leads to signals being positioned some way in the rear of the point work they read over and the vehicles they may be protecting. The philosophy of bringing trains to a stand before a subsidiary signal is cleared is obviously to stress the low speed nature of the intended move and to ensure the driver has his train under control. Nowadays there are often large distances between the signal where the train is arrested and the vehicles to which it may be allowed to travel, ample distance in fact for the enforced stop to be forgotten and a higher than safe speed attained.

Section C6.7.2 of the rule book permits a driver to proceed when a subsidiary signal only is displayed, even though a route indication normally illuminated with it has failed. This makes it perfectly feasible for a driver expecting to be routed to a line that does not normally have its destination displayed to find he has in fact been called-on. He may be able to see or know that the line he expected to travel over is clear, whereas of course the route he is taking is not only different but occupied.

A ground position light shunt is normally only fitted with route indicators under special operating circumstances (standard signalling principle no 13). A driver is therefore not given details of where he is being shunted or whether he is likely to meet vehicles ahead. For some shunt routes the whole route may be required to be clear, whereas for others a part or all of it may be occupied.

Considering Figure 5 again and signal 322, a driver arriving at this signal by reversing from the siding will not know from the off indication of 322 whether the line is occupied ahead or not. The rule book covers the way in which the driver should proceed past a shunt signal with care, but the human being is prone to cut corners and any discrepancies which exist with shunt signal displays are liable to help a driver to mislead himself.

If 322 is cleared in pre-set mode by 14 then the controls are proved to be off for 322 before allowing 14 to show a proceed aspect. The proceed indication of 322 is no longer lamp proved and hence a route may therefore be set by a shunt signal that is out, or has only one white lamp lit.

Consider now the driver who has just brought his train to a stand at a main signal at stop which then changes to display a route indication together with just one white light of the subsidiary. What will his reaction be?

It is well known that an incomplete signal must be regarded as a stop signal (rule book section C6.7) but what are the chances that the driver, realising one lamp has failed, will know that the route is correctly set and decide to move forward? Remember the same section in the rule book permits a driver to pass a particular type of incomplete signal. To say the above scenario has not occurred, or will not occur, would be a lie. No accident can directly arise from it and the driver may or may not report the failure. Now take the same situation, but omit the route indication.

In this case, one white light is illuminated in the subsidiary head beneath or alongside the main red aspect. The driver in this instance would perhaps be a little less inclined to accept this as an indication to proceed. Sooner or later a driver will do so, and again no direct danger will ensue The danger is however that this driver could subsequently be faced with a stand-alone position light signal, the red stop light of which has gone out leaving only the white pivot light illuminated. The route may or may not be set from this position light signal, but the driver could be influenced through his previous experience, to move forward not realising the subtle difference between the two situations. Additional pressures such as late running or hurrying to book off may act as a multiplying factor in the driver's thought process.

Is it safe therefore to have a stop indication comprising half of the proceed indication? Reports on the accidents at Crewe in 1973 and at Carstairs and Rutherglen in 1975 make interesting reading in relation to position light shunt signals.

Apart from the case mentioned of the pre-set shunt there is another type of signal that signal engineers assist the driver to pass when in an incomplete form. This is the route indicator made up of a number of lamps. The theatre indicator with its mutilated figure is checked to see if it is still decipherable, in order to clear or maintain the main aspect. The junction route indicator is tested to ensure at least four lamps are lit before the main signal may clear. Even then a further lamp is allowed to fail after clearing. So drivers are already permitted to accept incomplete signals.

Finally before leaving shunt signals it must not be forgotten that position light shunt signals have been installed in positions where they are not shunt signals at all, namely:

- Point indicators where the two white lights at 45° carry another meaning.
- Limit of shunt indicators comprising two horizontal red lights.

Approach control (approach releasing)

Approach control was devised to ensure that a driver braked his train for a turnout, and as such has been an effective arrangement (although often under attack in the railway press!). Pitfalls do exist when considering the human component, the driver. Many drivers, through familiarity know when an approach controlled signal will clear, and fall into the habit of forgetting the significance of the delay. This sometimes leads to instances where, when the route has not been set, the train slips past into derailment or collision. Has a trap therefore been set, day in and day out, for the occasion when familiarity or inattentiveness leads to human error? Is there a more secure means available to us to ensure trains brake for turnouts? The recent accident at Colwich had a driver's misinterpretation of junction signalling and approach control as a contributory factor.

Overlaps and flank protection

The Colwich accident also highlights another area of study relevant to the signal engineer's relationship with the driver. An overlap can often form part or all of the flank protection, especially today with the simplified layouts being designed by the civil engineer. Often those layouts do not permit the degree of flank protection once possible. A comparison between types of double junction is a good case to examine. Figure 6 shows both the traditional layout and its modern counterpart.

With the conventional double junction arrangement a movement from the branch to the main required that the junction points for movements in the opposite direction be set also to the branch to provide flank protection. Thus any overrun or runaway from the opposite direction could not fail to be directed parallel to the signalled move. With the modern layout no means are available to divert an unauthorised converging movement away from the legitimate route. True, an overlap exists against overrun, but there is no positive means of ensuring the train is stopped. Also, as simultaneous movements on to and off the branch cannot be made, another point of conflict is introduced whereby an overrun may result in a collision. The new configuration must surely then be less safe, as was highlighted by the accident at Haughley Junction.

The simplification of so many layouts and the widespread introduction of reversible operation means that trains travelling in opposite directions are no longer segregated to the same degree. Opposing movements now cross paths and approach one another without comprehensive means of directing them apart during both normal and emergency situations. Figure 7 represents the layouts at a typical station before and after modernisation.

In the original layout very little confliction between up and down trains was possible. In the modern version the thicker lines show how much of the new layout is available for potential head-on or sideways collision should one train overrun. The layouts being provided today have increased the dangerous consequences of a driver mismanaging his train.

Only a small fraction of trains passing signals at danger turn into incidents, but it is likely this figure will increase

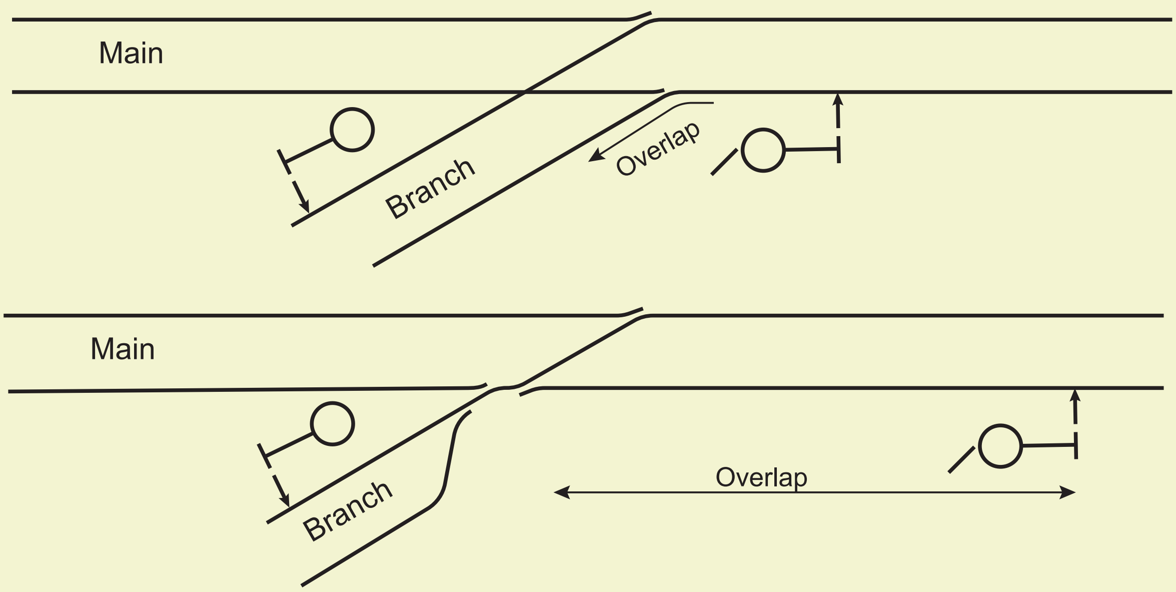


Figure 6 – Comparison of junction layouts.

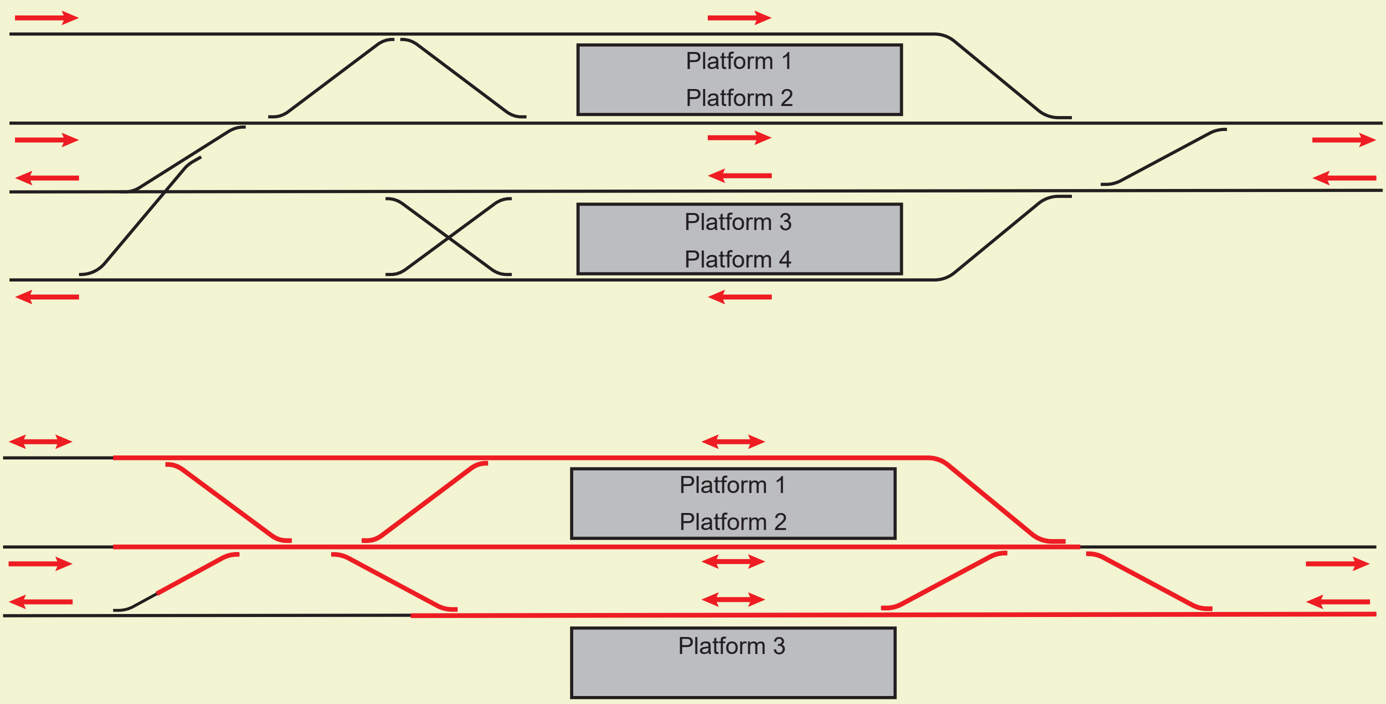


Figure 7 – Comparison of layout before and after modernisation.

as layouts are simplified in the manner described, unless there is a move to monitor rather than assist the driver. The number of incidents occurring from overruns must be directly proportional to the number of conflicts available within the overrun area.

Bearing in mind the higher speeds and dangerous cargoes of many freight trains, should the feature of not normally providing overlaps on freight only lines be reviewed? The particular circumstances which contributed to the collision between an oil tank train and a coal train at Lindsey in 1982 included a signal provided with a negligible overlap on a freight only line. It has long been procedure that where operating constraints exist due to physical features, overlap lengths are reduced, often with reference to lower speeds. What is an overlap to a driver? It is a stretch of line beyond a signal the length of which he does not always know. It is provided as extra stopping distance should he overrun but he is not allowed to make use of it.

This now brings us to the point made so forcibly by the President in his Presidential Address –Our Blind Spot –because the driver may have been forgotten, he might not be able to observe and obey the signal aspects presented to him. Systems are still being designed that do not complete the control loop –there is endeavour to control for both safety and management, using the most sophisticated technologies, yet very little is done about enforcing that control. Should not the loop be closed with some form of Automatic Train Control? There are plenty of methods!

Historical development

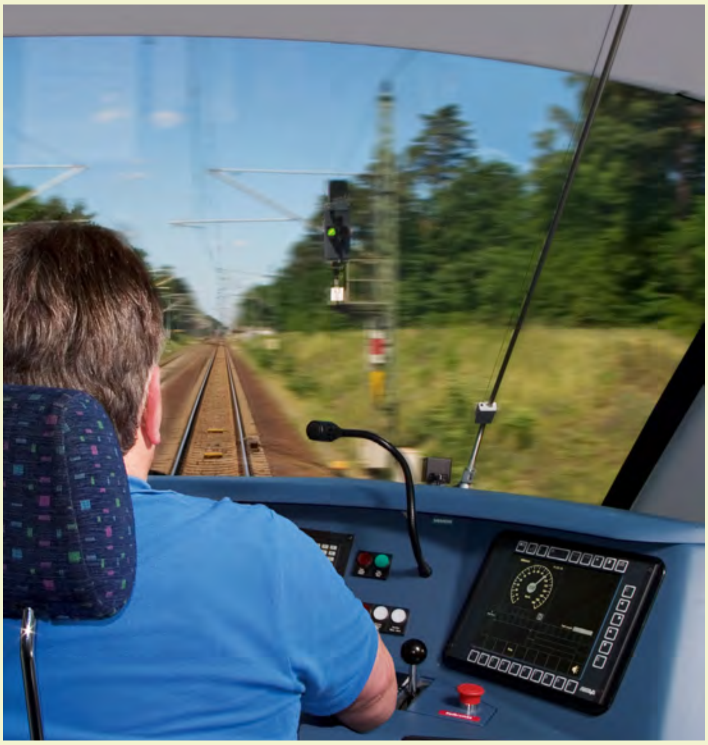
Automatic Train Control developments were concerned with two related but distinct objectives. These were firstly to ensure that the driver was aware of the lineside signal aspect, especially where this was warning him of the need to commence braking, and secondly to stop the train which was overrunning the limit of its movement authority. Historically this meant ensuring the driver acknowledged a distant signal at caution and stopping a train which passed a stop signal at danger.

The latter could be achieved by a relatively simple mechanical device and several railways installed such trainstops at stop signals. These consisted of a lineside lever or similar projection which engaged with an actuator on the braking equipment of any train which passed irregularly. The lever was withdrawn, typically by lowering, when the associated stop signal was cleared. Once the train-mounted actuator had been tripped on passing a signal at danger, it was generally necessary for the driver to climb down and physically reset the actuator before the brakes could again be released.

If a train which trips past a signal at danger can be stopped within an overlap provided beyond that signal, then the trainstop affords absolute protection against overrun accidents. To achieve this the overlap must be sufficiently long for a train travelling at maximum speed to be brought to a stand within it by an emergency brake application. An acceptable overlap length is limited by headway and other considerations. The use of simple trainstops, as the sole means of achieving absolute protection, is therefore limited in practice to railways with relatively low speeds and high braking rates. The majority of the London Underground lines use trainstops in this way, as do various urban metro systems around the world.

On main line railways it was apparent that except in slow speed areas, trainstops could not alone give absolute protection. Sufficiently long overlaps were impractical and trainstops fitted to existing stop signals would act much too late to prevent collisions. It was essential that the driver commenced braking at the appropriate warning signal (the distant signal in British practice). The most likely reason for failure of the driver to act on a warning signal was simply that he had missed it altogether because of bad visibility or distraction and it was therefore desirable to repeat the signal aspect, or some corresponding warning of it, into the cab.

True enforcement would have proved difficult as the required action is service braking aiming to stop at the stop signal ahead, taking into account widely varying train performance. Modern techniques make such enforcement feasible but earlier systems were generally limited to requiring a driver's acknowledgement of a restrictive aspect.



30 years ago when this paper was written, cab signalling was becoming commonplace on metro systems but was rare on main line railways. Today well established systems exist, for example ETCS (left) and CTS (above), but is roll out of on-board safety systems for main line as complete as we may have hoped in 1988, especially bearing in mind how much technology has changed in that time?
Photo left Siemens.

The Great Western Railway installed their electro mechanical warning system at almost all their distant signals from 1906 onwards but such comprehensive coverage was not repeated elsewhere. In Britain there was Raven's Electrical System on the North Eastern Railway and the Reliostop System of the Great Central. The British Railways Automatic Warning System (AWS) is an enhanced version of the same basic concept but uses magnetic coupling developed from Strowger-Hudd equipment of the early thirties. Its introduction throughout British Railways was hastened by the post-war disasters at Harrow and Lewisham.

A more elaborate magnetic system by Integra employs a variety of sequences and dispositions about the track, of different polarities of permanent and electro-magnets to provide a number of different cab signal aspects.

In North America and elsewhere, coded track circuits employing low rate switching of track circuit current, were detected on the train and used to drive a cab signal. This sometimes extended to a simple trainstop function whereby running past a signal at danger on to a track circuit not coded for a proceed aspect, would invoke an emergency brake application.

Incorporation of permanent speed restriction enforcement was difficult and generally incomplete. BR AWS was introduced as advanced warning of major speed restrictions following a serious accident at Morpeth and has been extended to temporary restrictions largely as a result of an accident at Nuneaton. On London Underground the clearance of a series of trainstops by timed occupation of track circuits to prove speed reduction of trains entering terminal lines, was introduced following the Moorgate accident when a train ran through a terminal platform at full speed into the tunnel end wall. Such arrangements are known as Moorgate Control. Systems which gave more comprehensive cab indications could cover a limited number of restrictions, particularly where the lineside signalling used speed- rather than geographically-based aspects.

Conclusion

Have we forgotten the driver? The Author thinks that there is a danger that this may be so in the past and could be so in the future.

Surely the time has come to consider a more positive form of AWS/ATC. Can it be honestly believed that the driver needs no help both at high speed and in suburban operation? The Author thinks not.

What do you think?

How much of what Tony described in 1988 is still relevant? Where have we made real progress in making the railway safer and the driver's job more straightforward? Where are we still not delivering the progress that was discussed 30 years ago? Email us at **irsenews@irse.org**.

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Improving the management of emerging and residual safety risks

Prepared on behalf of the International Technical Committee by

Libor Lochman

Jean Baptiste Simonnet

The increased role of control command and signalling (CCS) in railway traffic management creates opportunities but also threats that need to be solved to ensure that the railway system is not exposed to unacceptable risk, technically effective and commercially affordable.

There are emerging as well as residual risks in CCS technology and an insufficient knowledge of how to mitigate them (including cyber security) without threatening safety, decreasing the system performance and increasing overall costs. Currently there is neither a common sector approach to define risks applying to CCS nor a common understanding on how and when to deal with those risks. A harmonised methodology needs to be gradually developed in order to help rail operators and suppliers to progressively move from extensive and subjective expert judgment.

It is essential to manage CCS risks in the railway system

Railways are becoming busier more than ever – on many sections, capacity is squeezed to the limit. The impact of operational constraints, and especially technical failures, affects far more customers than in the past. The reliability and availability of traffic management systems is therefore an increasingly significant factor that railway manufacturers and operators have to manage.

Even if the design of safety critical technical systems in most cases prevents a single failure from creating a safety related hazard, degraded mode operation can lead to severe operational consequences and to a high difficulty to maintain a relevant safety level. In order to be competitive, the challenge for railways is to achieve a pragmatic mitigation of new/emerging risks, as well as effective control of residual risks through a holistic approach to safety (and security) management.

Common understanding and optimised practice for the identification and mitigation of risks will have a direct positive impact on cost and value for the railway customers. The current practice should therefore change and evolve towards a more harmonised approach that will contribute to an improved rail performance. Harmonisation helps to reduce diversity and impact of technical failures in a cost effective way; it also allows identification and anticipation of degraded modes that can lead to severe consequences. Furthermore a harmonised approach enables pragmatism in the definition and implementation of a mitigation strategy for emerging risks, as well as for the monitoring of residual risks.

The general principles defined in the European Common Safety Method (CSM) can assist a global risk management of the railway system performance. The approach, set by the European Railway Safety Directive through a common safety method for risk assessment should help to establish a harmonised strategy to manage safety risks. At the same time, specific focus on CCS residual risks and emerging risks is needed as well as wider consideration of 'non-safety related risk' (e.g. operational risk), in order to achieve comprehensive and predictable management of the performance of the railway system.

A comprehensive framework to manage safety risk in the EU/ Europe

The European Union has developed a comprehensive approach to safety, providing common methods for the assessment, monitoring, supervision and surveillance of safety risks thus enabling railways to achieve high levels of safety, and when reasonably practicable, improve it further. Figure 1 shows a flow chart for CSM risk assessment.

Within the European safety management framework, the CSM for assessing risks provides a detailed methodology for assessing safety risks related to any change within the railway system. It provides guidance for safety hazard identification, analysing the risk impact from those hazards, defining relevant and suitable safety requirements and measures and accepting/ managing residual risk.

The framework to manage safety risk is not limited to the European Union. In order to achieve efficient international transport, the authorisation of rolling stock (and all its subsystems) must be recognised on an international scale. To do so, EU assessment methodologies were transposed in recent years in the Convention concerning International Carriage by Rail (COTIF), and therefore

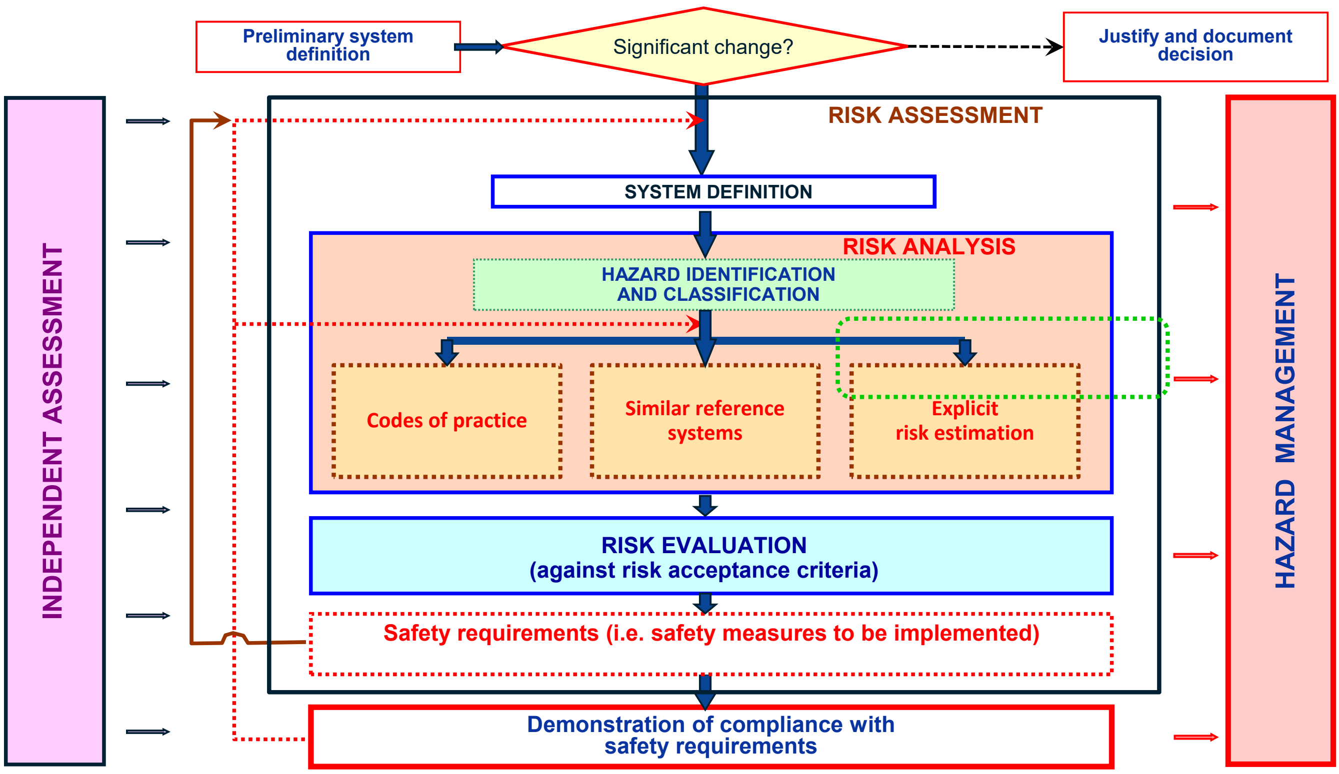


Figure 1 – Flow chart for the common safety method for risk assessment.

risk based approach for railway safety applies in wider Europe, not only in the EU.

The application of CSM enables harmonised methodology helping the design of modern and resilient railway technology with many benefits, more than just safety:

1. As a common tool used by all railway actors, it enables mutual recognition of results of risk assessments and the exchange of information between stakeholders.
2. It enables traceability of decisions and provides companies with criteria to help them take decisions consciously and safely. This way, it supports the 'corporate memory' of market actors.
3. It facilitates logical and rational thinking. In particular explicit risk estimation and targets promoted for a safe design of system can reduce the level of subjectivity often associated with risk assessment.
4. For new systems and innovations to be commissioned, it helps Authorities and Certification Bodies taking decision based on objective evidence and therefore ensuring an equal treatment of all Railway Undertakings, Infrastructure Managers and Entities in Charge of Maintenance.

Dealing with CCS risks in Europe

In order to achieve a high performance and resilient rail transport system, the holistic approach to risks should be further refined. For signal engineers, the need to manage risks throughout the CCS system design, commissioning and use is generally fairly well understood – although not always well documented. Residual risks that CCS cannot control or those considered acceptable as well as emerging risks do however require more attention.

There are some residual CCS risks that are considered acceptably low (e.g. unidentified software bugs remaining in certified products). The economic impact of these risks can be mitigated by avoiding single point failures or by an active management of manufacturing quality. The level of risk needs to be monitored in service in order to make sure that associated constraints and assumptions are respected. Action will have to be taken where the level of risk appears to be increasing.

Residual risks that CCS cannot control are in particular linked to human factor intervention in traffic management/ operation or to external causes (object on track, track failure...). Interaction with the public, such as delays in boarding/ alighting trains or incidents involving the public also has high economic impact. These risks need to be managed by other railway disciplines than the design and maintenance of CCS. A co-operative approach is essential to ensure no risk is overlooked.

Risks are also emerging, for example with cyber-attacks or change in road usage at level crossings (Figure 2). Scarcity of expertise to maintain the rail system in working order is also an emerging risk for the safe integration of new components with legacy systems. Emerging risks should be addressed through the relevant financial, time and expertise provisions when planning CCS projects and programme.

Even if the common safety methods do not explicitly address economic issues, they provide processes needed to identify, assess and manage new and changing risks. Therefore, when applied in a pragmatic way by applicants, assessment bodies and authorities, the common safety methods should enable maintaining and even continuously improving, on a cost effective basis, the safety and performance of the railway system.

Figure 3 gives some examples of changes at CCS boundaries affecting safety risks.

Figure 2 – More use of a level crossing by heavy road vehicles is an example of a how a residual risk could be increasing even when there are no changes to the railway.
Photo Shutterstock/Peter Moulton.

Managing emerging risks with CSM

The European safety framework, in particular the common safety method for risk acceptance, can improve traditional conservative approaches. The harmonised risk-based approach enables an explicit estimation that can facilitate the introduction of innovative solutions. It can also help mitigating emerging risks by an application of relevant operating rules designed to manage degraded mode with a sufficient degree of safety confidence.

The application of CSM not only provides safety but can also help to ensure cyber-security by design.

CSM supports CCS system upgrading ('significant change'), and cost effective management of safety and performance improvement over time.

Safety management systems help to focus on, and to manage, in-service risks. Complemented by an occurrence reporting system on a global scale, safety management enables large scale data collection for further improvement of designs and maintenance regimes. Thus the risk based approach encourages change from 'compliance with predefined criteria' to the active in-service management of system safety performance.

The growing complexity of the railway system, in particular CCS, is an issue that requires better common understanding, attention and efforts by all actors. In addition to the common safety method, the move towards more standardised technology and design methods can be a great opportunity. Standardisation will not only increase the number of competent experts but also provide a larger number of systems implemented, thus accelerating industrial maturity, and consequently reducing the risk of failures together with the cost to design CCS components and operate trains.

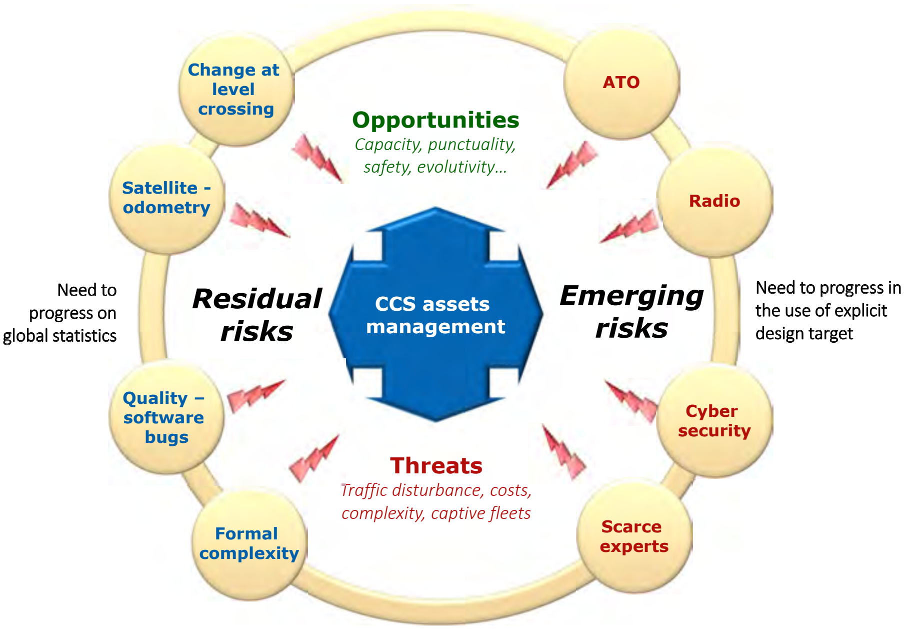


Figure 3 – Examples of changes at CCS boundaries affecting safety risks.

How to deal with residual risks

The European common safety method acknowledges that some residual risk cannot be eliminated but can be considered sufficiently low to be tolerated without further mitigation. Furthermore, there is no obligation set by European safety authorities to further reduce risk when one of the following risk acceptance principles is fulfilled:

- If the system implementation complies with established design standards and rules.
- If it is equivalent to a reference system.
- If explicit risk estimation demonstrates that the system meets design targets.

The CSM is certainly not a panacea, but it does provide an effective framework for progressing towards harmonised practices for safety risk mitigation and management. It will need to be applied intelligently and probably complemented with discipline-specific material to achieve its full potential. There is indeed still a space for further progress to be made, in order to reduce subjective judgements and preconceived ideas about hazards and how best to mitigate the associated risks.

For a safe management of residual risks, monitoring data is essential. Collecting the necessary quantitative and qualitative data is today still a challenge, especially with the wide range of legacy systems in operation for rail, or with decentralised systems in which several components contribute to a single functionality. With the growing technical knowledge and industrial maturity, explicit risk estimation methods can help to minimise cost through rationalised design and systematic approach to operation consequences, while improved priority settings for risk mitigation which will generally optimise the performance of CCS systems. The European approach to a common safety management system offers a practical and promising perspective of continuous and comprehensive monitoring of safety in operation, thus enabling constant improvement to the commercial viability of rail transport.

Conclusion

More work needs to be done to ensure common understanding, mapping and management of CCS risks (spreading best practice). Knowledge of designers and assessors should be developed to minimise time, subjectivity and paperwork for setting cross-accepted targets, enabling a sufficient mitigation of technical threads matching with operation constraints. However, the EU rail safety management regime, used sensibly, can already help to design, implement and operate CCS systems that address both current and upcoming challenges in a modern and agile way. It should help railways find the right balance between cost, assurance of performance, and flexibility.

The residual risks of signalling single point failures and the cyber threats (noting that the latter can jeopardise whole network operation or even be a threat for safety integrity) require further analysis and improvement. Improvements in technology, including the quality and integration of ERTMS assemblies, is therefore necessary in order to reduce economic impact caused by failures.

The move to greater automation of train movements, if systems are properly designed, integrated and commissioned, will enable further reduction of residual risk as a technical system can deliver higher safety than human operation. Automation and artificial intelligence can also optimise human intervention for sensitive decisions impacting operation, thus would allow to rationalise safety as well as security management and therefore, even in case or degraded operations, will reduce cost as well as improve rail system performance and resilience.

ERTMS in Europe has been designed and implemented according to the CSMs. It is deemed to be a sufficient solution, even without 'legacy' fallback CCS, for managing residual safety risk for operation under full supervision. The move from rules helping to commission legacy CCS to the risk base approach promoted by CSM has today often led to increased administration burden. However the move to explicit risk estimation as described in the CSM is a unique opportunity to move forward with innovation boosting rail capacity and performance. Further work is needed to simplify assessment and safety demonstration processes, but the CSM can today allow the use of ERTMS as a reference system for a safe CCS thus enabling complementary functionalities to be easily integrated in order to deliver responsive and robust traffic management applications supporting rail punctuality and recovery after incidents.

About the authors ...

Dr Libor Lochman has been executive director of the Community of European Railway and Infrastructure Companies (CER) since 1 January. He graduated at the Transport University in Zilina and has a doctorate in electronics from the West-Bohemian University Plzen. He has a strong background in control-command and signalling systems. Prior to his role as CER deputy executive director and leader of technical affairs (2007-2011), he acted as director of the Czech Railway Test Centre, a facility for testing European rolling stock, infrastructure and signalling components, in Prague (2000-2005).

Jean-Baptiste Simonnet has been senior technical advisor at CER since 2012. He graduated from the Grenoble Polytechnical Institute in 2000, and worked as Programme Management Officer in the defence and aeronautic industry, steering the design, certification and support of safety critical systems. In 2007, Jean-Baptiste joined SNCF and acted as project buyer for new-build train tenders and contracts. As CER senior technical adviser, Jean-Baptiste covers a range of technical issues notably safety and ERTMS regulations.

What is your experience of applying the European CSM for risk assessment? Have you adopted the explicit risk estimation approach, or an argument based on compliance with existing standards and rules? Do you have any interesting example of issues that have arisen from residual or emerging risks?

Let us have your thoughts to share via the Feedback column of IRSE News. Email irsenews@irse.org.

Remember that all published ITC reports can be found on the IRSE website.

Recent topics have covered major topics including why signalling projects go wrong, driver advisory systems and reducing the number of accidents involving human factors.

Just visit www.irse.org, and look for **International Technical Committee** under the **Knowledge** tab.

International Technical Committee visits first UK main line ATO system

Clive Kessell and Rod Muttram

The recent running of the first test train across the Thameslink central core in London using ETCS Level 2 with Automatic Train Operation (ATO) superimposed was reported in January 2018 of IRSE News. On the morning of the IRSE AGM on 27 April the International Technical Committee (ITC) were invited to ride through in a cab and witness the ATO performance for themselves.


IRSE ITC members from many countries attended the visit.

The Thameslink Project

The key elements of the Thameslink project are:

- Lengthening platforms to accommodate 12 car trains.
- Closure of the Moorgate spur to enable platform lengthening at Farringdon.
- Addressing the conflicting paths at the south end of Blackfriars station.
- Remodelling the approaches to London Bridge station to eliminate as far as reasonably possible all the flat junctions for Thameslink trains.
- Provision of a new station at Kings Cross/St Pancras to cope with both domestic and international travellers.
- Connecting the Thameslink route to the East Coast Main Line (ECML) via the new Canal Tunnels.
- Provide a signalling system that can cope with 24 trains per hour (tph).

All of these except the last have now been completed allowing an increase in capacity to 16 tph by December 2018.

ETCS and ATO

Thameslink has a modern but conventional signalling system, however extensive analysis and modelling revealed that to achieve the intended 24 tph, optimised braking and acceleration rates would be required with trains closing up consistently to the shortest possible separation. ETCS was identified as the solution along with the development of ATO.

The development has been a 10-year joint exercise between Network Rail and Siemens. Siemens are both the supplier of the Class 700 train fleet and the signalling system. Govia Thameslink Railway (GTR) are the designated operator and who will take responsibility for the train borne equipment, with Network Rail the system integrator on behalf of the Department for Transport.

An initial modelling of the core route from just north of St Pancras International through Blackfriars and on to London Bridge, led to a system integration laboratory being set up with all the infrastructure and train borne elements present to allow integration testing.

The laboratory includes a Trackguard Westlock computer-based interlocking, a Radio Block Centre (RBC), European Vital Computer (EVC), dynamically programmable track balise to represent balises encountered on the simulated route sections, underfloor train antenna to read the track balises, three GSM-R base stations, simulated train odometers to measure distance travelled with a speed probe unit to simulate wheels going round, a doppler radar to measure speed independent of wheel rotation with transmitters to simulate movement, and a Class 700 cab complete with ETCS, ATO and GSM-R cab interface equipment.

This provides a simulation of the system performance with the ability to 'drive' trains through the core section using video images of the track layouts and routes. A trial system was then set up in 2015 on the Hertford Loop test track using the Class 313 ERTMS test train.

Having verified the ETCS with its bolt on ATO package, the next stage has been to transfer the control of the whole central core section onto a new ETCS capable work station at Three Bridges ROC (Railway Operating Centre). In December 2017, the 'Canal Tunnel' link to the ECML was provided thus completing all the routes for the extended Thameslink service. This enabled initial testing of both ETCS and ATO to take place overnight on the central core using a Class 700 train. In December 2017, the Canal Tunnel link to the ECML was brought into use thus completing all the routes that would make up the extended Thameslink service.

Enhancements to the GSM-R infrastructure have been made to give improved resilience in case of a base station failure. Some problems with radio interference have been experienced noticed, and this is being investigated to identify and eliminate the issues.

Facilities in the system integration lab have allowed extensive pre-installation testing. Top, a driver's eye view of Farringdon station created by the simulator. Above left, Rod Muttram takes the controls of the simulated train. Above right, a balise reader(inverted) in its test rig.

The 115 strong Class 700 train fleet all came fitted with ETCS and ATO equipment with two units being used specifically for integration testing. This has allowed further ETCS and ATO testing to take place through the central core.

The control centre and trackside are software version 2.3.0d whereas the train is at the latest version 3.3.0 software. Both work together confirming the interoperability requirements, however once the ECML ETCS goes live, both ETCS infrastructure and train borne equipment may require upgrading to whatever the latest software version is at the time.

The GSM-R connection between ground and train is circuit switched meaning a continuous connection between the control centre and the train once log in has occurred. However, like the ETCS equipment, upgrading to packet switching (GPRS) may be required once the East Coast line ETCS goes live to provide sufficient data capacity.

ATO Operation

The class 700 trains can operate in four possible modes:

- Level 0, meaning no supervision with both ETCS and TPWS/AWS isolated and would only be used in an emergency situation should failures occur.
- Level NTC (National Train Control), which is the normal UK standard for train operation employing both TPWS and AWS plus lineside signals.
- Level 2, using ETCS for a line equipped with ETCS wayside equipment.
- ATO for trains equipped with both ETCS Level 2 and ATO equipment.

Another feature known as L2 Inhibit will be available to allow trains to be driven in the ETCS area in NTC mode, i.e. using lineside signals and TPWS/AWS. This will be used on Sundays and late evenings for when drivers are not trained on ETCS operation and to maintain driver competency for manual operation when required.

ATO operation can itself exist in three classifications:

- Standalone where acceleration and speed are maximised and station dwell time is minimised.
- Timetable based where the ATO drives to the timetable.
- Trackside driven where the ATO receives updated trip time and dwell time commands as the train journey progresses.

The Thameslink central core ETCS operation commences just south of Kentish Town on the Midland line, at the entrance to the Canal Tunnel on the ECML through to Elephant & Castle on the line down to Herne Hill and to just east of London Bridge Thameslink platforms.

At the start of ETCS capability, the train passes over a group of balises that triggers GSM-R registration and session management to establish secure communication between the RBC and the train EVC equipment. The train identity is established with the location to allow transmission of the initial movement authority (MA). The driver has to acknowledge Level 2 supervision after which the train can be driven to the limits of the MA. If the driver fails to acknowledge ETCS, the train will stop.

Once in ETCS L2 full supervision mode, ATO operation can commence, this being offered by a flashing yellow button on the driver's console, which when pressed, starts the ATO mode with the yellow light on continuously. The train then proceeds 'hands off' and will continue until the next station stop with the acceleration, speed and braking controlled by the train equipment in accordance with the ETCS MA. A double set of balises and the

Typical British spring weather as the test train approaches Blackfriars station.

train odometry equipment will ensure a stopping accuracy of ±0.5 metres.

Once stopped at the station, the ATO drops out and the doors are released automatically. With station duties completed, the driver closes the doors and re-presses the ATO yellow button, whence the train will move off and proceeds to the next scheduled stopping point.

At full operational capacity, it is likely that a train following closely behind the preceding one will be stopped at a signal or ETCS block marker before the station stop. If this happens, the ATO remains active and the train will move again once the MA is extended.

The core section has (and will continue to have) lineside signals. Both the MAs associated with ETCS and ATO operation are commensurate with these signals and the system does not permit trains in ATO mode to pass a red signal. An MA will not be given from the RBC until the signal aspect changes. This is to avoid driver unease and contrasts with some systems where ETCS operation can allow red signals to be passed in order to get capacity benefits.

ATO is not mandatory and it is possible for trains to transit the central core by manual driving to ETCS MA limits. It is likely that on Sundays and late evenings when the traffic density is lower, drivers will use this method to keep familiar with ETCS operation.

In the daytime and especially peak hours, drivers will be expected to use ATO. Another decision taken to optimise familiarity is the process of accepting ETCS supervision before commencing ATO; both could happen simultaneously but introducing them sequentially is judged a safer option. The driver can disengage ATO at any time by either pressing the ATO yellow button, or moving the Power Brake Controller (PBC) or pressing the emergency stop button

It was observed that ATO appears little different to manual driving but with all movements optimised. The acceleration rate is identical to normal driving and the braking rate is only 80% of the full-service brake application. The ATO is underpinned by an electronic representation of the infrastructure known as the Track data base (TDB). The information will need to be updated to take account of any permanent way alterations or changes to the route's speed profile but will eventually be downloaded to the entire fleet via an ATO server.

Adhesion issues are duly considered and low adhesion conditions can be implemented; the Class 700 has automatic sanders which were witnessed operating under acceleration as we left Blackfriars. The core section contains some steep gradients in the City Thameslink station area and descending towards London Bridge station.

Training and Traffic Management

Currently eight drivers are fully trained in ATO and they in turn are training the driver managers. When complete, all of the drivers employed by GTR will be trained, consisting of a day in a classroom, another day on a simulator and then out on a test train with an instructor. The training simulators are located at Hornsey and Three Bridges, these being the main depots for the Class 700 fleet.

To ensure the best possible train regulation and adherence to the working timetable, in parallel with ETCS and ATO provision, a Traffic Management System is being supplied by Hitachi and will cover the majority of the future Thameslink routes. The timetable will be downloaded into the TMS at the start of each day, whereupon the TMS constantly reviews train movements against the timetable with the intended ability to transmit revised trip and dwell times out to each train before entering the central core ATO area.

TMS will detect timetable conflicts and late running to then offer the optimum pathing plan to the signallers so that potential disruption is kept to a minimum. Once a new or revised train plan is agreed, the routes can be set either by the signaller or automatically where the TMS is interfaced with the ETCS/ATO. The latter will require the integrity of the data to be guaranteed before being contemplated.

So far, timetable data for a few days ahead has been compiled from Luton to Crystal Palace and is being tested within the TMS for conflicts and errors. TMS will become a subject for further articles in due course.

Conclusion

The Thameslink ATO project is not going to solve the challenge of providing ATO on main line railways, since it has only a single type of train (the Class 700) with all trains having the same stopping pattern through the central core. It does however give a useful insight into the application of ATO on the main line and the interfaces needed between conventional signalling and ETCS/ATO operation.

It will permit 24 tph operation when the final Thameslink timetable becomes live in late 2019. From May 2018, an enhanced Thameslink timetable of 18 tph will be implemented giving new route destinations. Driver training for ETCS and ATO will start this year with routine ETCS and ATO usage beginning in early 2019. Eyes from across the world will be watching how effective the ATO will be. The project is a UK first and one that we should be proud of.

Thanks are expressed to David Thomas, Philip Powley, Jim Doughty and David Harris from the Thameslink Programme team and to Scott Wilson and Selina Clarke from the Thameslink publicity group for explaining the technical features and enabling the visit to take place.

A cab ride video showing the train operating in ATO during the committee's visit can be viewed at irse.info/90bkf.

A word with David Waboso


Photo Network Rail.

Paul Darlington
and Judith Ward

IRSE News recently met up with David Waboso CBE to discuss how IRSE members can support the Digital Railway strategy for the main line network of Great Britain, and how it will change the railway for the better. David joined Network Rail in June 2016 as managing director of Group Digital Railway for Network Rail, the infrastructure manager.

As managing director of the group, David oversees the cross-industry Digital Railway programme. Currently he is the President of the Association for Project Management, as well as being a Chartered Engineer, and is Fellow of the Royal Academy of Engineering, the Institution of Civil Engineers and the Institution of Railway Signal Engineers.

Prior to joining Network Rail, David was the capital programmes director at London Underground Limited, where he led the upgrade of both trains and infrastructure to CBTC digital signalling. He has worked on infrastructure and train control projects for over thirty years and has previously held senior positions at the Strategic Rail Authority, The Nichols Group and Bechtel Corporation.

Digital Railway is the rail industry's improved plan to tackle the capacity problem by accelerating the digital modernisation of the railway. The GB railway carries twice as many passengers as it did just two decades ago but demand by freight and passengers is set to rise dramatically in the years ahead.

ETCS with ATO

The International Technical Committee recently witnessed a world first with the running of a test train across the Thameslink central core in London using ETCS Level 2 with Automatic Train Operation (ATO), see page 23 for their report. We asked David what has contributed to the success and what is the next step/challenge in the programme.

He quickly answered that it was a huge success through a combined team effort, with the Department of Transport, Office of Rail and Road (ORR – the independent safety and economic regulator for Britain's railways), the Network Rail project team, suppliers of both fixed equipment and trains, sub-contractors, train builders and the train operator GTR, all committed to making it a success. David also made special mention and expressed thanks to the wider workforce who had been involved in this achievement.

He stressed that the support from government, and throughout the whole of the rail industry, to introduce in cab signalling and its associated control systems is better than it has ever been. "We now just need to get on with it and deliver".

The Network Rail/Crossrail ETCS interface system is also now a well-established project and 'on track'. Another recent success is the ETCS high-density level 2 testing at ENIF (ETCS National Integration Facility at Hitchin). Working with ProRail, Network Rail have demonstrated the successful integration of ETCS equipment from a number of suppliers to control two trains under ETCS full supervision movement authorities. The system featured in April 2017 IRSE News.

The Cambrian Line ETCS in Wales, which is now working reliably, together with Thameslink and Crossrail ETCS, are what David refers to as the phase one schemes. Western traffic management went live in June and the Thameslink core will be carrying 20 trains per hour in October.

Control Period 6 (2019 to 2024) is likely to feature the provision of large Traffic Management (TM) and Connected Driver Advisory Systems (C-DAS) systems to provide relatively 'quick wins'.

Over the past nine years, the number of asset failure incidents causing delay has decreased whilst the delay per incident has increased from 27 to 37 minutes per incident, with secondary delays currently accounting for 70 per cent of the total. TM should make a big difference.

The plans for various TM systems are already making good progress, and one example where TM may possibly make a difference is at the Castlefield Junction, near to the newly opened Ordsall Chord linking the north and south of Manchester. It is a congested route with more train paths planned. The logical answer is four tracking through Oxford Road and Manchester Piccadilly platforms 13 &14. This would be a major civil engineering scheme, both in cost and disruption to the city. David admitted that TM would not provide the capacity that two additional lines would, but it may provide enough and would be a betterment in getting rail traffic through the city, and at far lower cost than the civil engineering alternative –"software is cheaper than lots of concrete". It's a similar concept that the highways agency is adopting for the SMART motorway schemes to avoid building additional motorway carriageways.

CP6 will also see a significant amount of ETCS deployment, with train fitment and signalling renewal synchronised. The business case for throwing away a signalling system that is not life expired just doesn't work, and retrofitting trains has to be avoided wherever possible, although some retrofitting of trains will be required – and which has already commenced.

The current programme for the next phases of ETCS are planned to be: East Coast, as it has a lot of digital-ready trains ordered and is due for resignalling, Crewe resignalling –with its interface to HS2 and ATO trains, Transpennine –with its 'bendy railway' causing signal sighting problems for line speed enhancements, and Wessex, which has a big resignalling programme and new trains planned.

ETCS for Crewe will require the Class 390 Pendolino retrofitted with ETCS equipment, along with other stock, but the Class 390 fleet was originally designed for ETCS so that should make things easier.

Network Rail has worked closely with DFT, and railway franchises will now include requirements for driver training, ETCS cab fitment, together with C-DAS and TM. Within Network Rail no signalling scheme will be permitted to go ahead unless it fits within the Digital Railway programme and is made 'Digital Railway Ready' with interlocking capacity and

interfaces, additional block sections, and designed to make the recovery of the lineside equipment easy.

The volume of signalling renewals required is currently around 1,500 signalling equivalent units (SEU) per year and will stay at this level until 2024, after which it will ramp up to 5,000 per year by 2028. The cost of replacing this amount of signalling is unsustainable and there are not the signalling resources and engineering access to do it without innovation and new ways of working. So, no change is not an option.

Telecommunications will be the glue that binds the Digital Railway together and is therefore hugely important. Investment in telecoms will be required to ensure capacity is available as GSM-R was not originally designed for ETCS data, and its circuit switched architecture limits capacity. Options for packet data enhancement or replacement are being evaluated. Every GSM-R failure for ETCS will be like a track circuit failure, so high availability is essential.

Supply chain

David was very keen to make the point that a very different way of working with suppliers is required. The traditional procurement process can stifle the innovation and collaboration required to make the necessary transformational changes required, so a more dynamic partnership approach is required.

He acknowledged that introducing disruptive technology is challenging and that delivering the digital railway needs innovative procurement and delivery. This will require early contractor involvement and outcome-based whole-of-life contracts to promote better cross-industry collaboration. Larger system contracts will also be required to facilitate risk taking and efficiency.

There needs to be a better 'whole of life' relationship between the infrastructure manager and system suppliers. Train operators and other industries have established this with design, build and maintain relationships, and the Digital Railway programme must do similar. Suppliers will be encouraged to take greater responsibility in what they provide, and to make systems always available and delivering their designed functionality, for which they will get rewarded.

Network Rail needs to get smarter with its specifications. They must be performance and output based and incorporate intelligent requirements. They must not be too prescriptive, as that stifles innovation and new ways of delivery. However, the requirements must allow interworking between suppliers, systems, and maintain safety, together with backwards compatibility where appropriate.

The traditional funding mechanism for railways has been for large capital projects to deliver operating cost reductions. Many engineers will recognise this as being measured on how much they spend on capital (capex) while reducing operating expenditure (opex). This may change for some assets and services to a model based on lower capex, but increased opex, similar to what is done in other industries such as telecommunications.

Automated design, robotic installation, self-assurance and more offsite testing are needed to drastically reduce the amount of rework and cost, as well as the need to shut the railway as often as at present. David said he would welcome seeing papers from IRSE members on such subjects.

System Engineering.

David commented that signalling engineering has to be looked upon as a system to make trains move safely and smoothly through the network, rather than simply traffic lights to stop and start trains and keep them apart. We discussed that IRSE objectives laid down in 1912 say that 'signalling' is "the whole of the apparatus, electrical, mechanical or otherwise, methods, regulations and principles whereby the movement of railway or other traffic is controlled". We agreed that the definition, while dated in the use of "'apparatus", is as good now as it was over 100 years ago, and what great foresight the founders of the IRSE had when they added "or otherwise" to "electrical and mechanical", and years before software and data over radio were first used in engineering.

We asked David what he thought current S&T engineers need to do to upskill, embrace and work in the Digital Railway? He was clear that people are at the heart of the programme and we will all need to adopt new technologies and ways of working, and he advocated informal and formal technical discussion with peers as a good starting point. He spoke highly of companies who organised technical briefings and 'teach-ins' and added that IRSE News was one of the best interesting technical magazines (and he had a copy in his brief case) with many relevant articles.

Going forward there will be a virtual network of material and facilities for people in the industry, which will also embrace social media and digital platforms such as video streaming, as well as formal training for engineers utilising current facilities who want to progress through the industry and embrace the opportunities that the DR programme will deliver.

Europe and Australia

David said it is important that Network Rail learns from experiences around the world and he explained that he had personally visited digital railway schemes and is talking with experts both in Europe and Australia and was encouraged from what he had seen and heard. This included projects involving the retrofitting of trains with cab signalling systems and the establishment of control centres similar to the Network Rail Railway Operating Centres.

Knowledge sharing and professional development is essential for everyone to benefit and it is an area where the IRSE plays a valuable role throughout the world.

Autonomous vehicles

The technology for autonomous road vehicles and trains is similar, and most of the intelligence required for autonomous driving is embedded into the railway ETCS infrastructure and the centralised control architecture that is in constant communication with all trains. Railways must embrace the capabilities of ETCS and TM if it wants to survive against the greatly intensifying competition from fully autonomous self-driving cars, lorries and buses.

But the threat is also an opportunity, as there may be things we can learn from the emerging autonomous road vehicle industry, with their greater R&D capability. They could also learn from us, and in particular the safety aspect as rail has traditionally provided a higher level of safety than road.

Autonomous road vehicle technology is being developed on the basis of full autonomy with no or little centralised control, which is something long distance freight railways around the world are also developing. David said he would welcome a joint conference to provide insight and debate between the two industries, and he suggested this is something the IRSE may want to consider and he offered his support.

David related that 20 years ago when working for Eddie Goddard in LUL, he wrote and delivered an IRSE paper called "Managing the Interface – System Delivery and the Challenges facing the Signalling and Railway Industry". He spoke with pride when reflecting on the reception he received when the paper was delivered, which made all the work in researching and writing the paper worthwhile. Reading the paper again today, it is clear where the principles come from that David is embedding within the DR programme today, such as the client/supplier relationship, risk management, performance specifications, interfaces and early integration. So, who will be the IRSE member to write a paper today that will set the standards in 20 years' time?

Industry news

UK Digital Strategy launched

UK: On 10 May 2018 the secretary of state for transport, Chris Grayling and Mark Carne, chief executive Network Rail, announced the Digital Railway Strategy for Great Britain's rail network.

With cab based digital signalling already proven on the Thameslink core through London Bridge and on Crossrail, they announced that a line of route deployment will be put in place. Funding has been confirmed for the early development phases of converting the East Coast Main Line to ETCS, and the secretary of state announced that the TransPennine route upgrade will be the ETCS intercity railway in the country.

The big renewal planned for Crewe will be ETCS enabled and will smooth the path for HS2 operating on the classic network, and the ETCS enabled renewal at Feltham will lay foundation for ETCS on the Wessex route. On all other routes traffic management will be implemented in the next five-year control period, known as CP6.

The CP7 five-year control period will focus on further regional deployments of ETCS, for example, the whole track 40 miles from Waterloo will be ETCS within 10 years, providing the potential for a metro style service into Britain's biggest commuter station.

In CP8 the regional routes will build out a national network so that within 15 years 70% of journeys will be ETCS signalled and Traffic Management enabled, in time for the arrival of HS2 in Manchester in 2032.

After the announcement Chris and Mark were joined by Sir Peter Hendy, the chairman of Network Rail and David Waboso, managing director of Group Digital Railway to answer question from suppliers, technical press and our own chief executive, Francis How; who commended and welcomed the announcements when questioning the panel.

It was clear from the debate that there is a commitment from Government and Network Rail to role out ETCS across the network. It was confirmed that all new rolling stock will come factory fitted with ETCS capability, and that all signalling infrastructure from now on will be designed ready for ETCS; for example, with additional block sections and with the ability for easy recovery of signals and lineside equipment.

Chris Grayling and Mark Carne at the launch of the GB Digital Railway Strategy.

Mark Carne said that the Digital Railway represents a way to achieve a step-change in the number of services without expensive and disruptive heavy engineering work. It will allow trains to run closer together in greater safety and with more reliability. A more flexible railway will be provided which, when married with traffic management, will dramatically reduce knock-on delay – currently the largest single cause of train disruption.

GB railways are already the safest railway in Europe, but Digital Railway will make it even safer by virtually eliminating the risk of signals passed at danger – which today represents 20% of total passenger accident risk. For railway workers it will mean less work out on track and better protection when they are.

The strategy will provide additional capacity and increased connectivity across the railway network, supporting and stimulating economic growth, jobs and housing. The capacity improvements are for freight as well, which the government acknowledge is vital for growth in the economy.

Chis Grayling said that this is the chance for GB rail to lead the world in developing and using the Digital Railway technology which has the opportunity to open up significant new export opportunities, together with interesting career choices for rail engineers.

Signalling contract awarded for Kuala Lumpur LRT3 line

MALAYSIA: A joint venture between Siemens and Rasma Corporation is to provide the signalling and train control system for a new driverless light rail line in Kuala Lumpur. The 38 km line will include 26 new stations and a new maintenance depot. Siemens' will also provide an intrusion preventive system (IPS) to provide greater cyber security and platform screen doors.

The fully automated Light Rail Transit 3 Line (LRT3) will connect Bandar Utama and Klang. The line will become part of the existing Klang Valley network and will improve connectivity in the western part of the Greater Kuala Lumpur/Klang Valley area. The new signalling is due to be completed in 2021.

ProRail tests 'crossing aid' to boost safety at level crossings

NETHERLANDS: A new level crossing aid that has been trialled in the city of Haarlem to assist less mobile pedestrians who use level crossings.

A display sits next to the level crossing barrier and indicates whether a pedestrian can cross in sufficient time or not depending on the displayed symbol.

If a green symbol is shown a passer-by has plenty of time to cross, but if a white train is displayed it means that it won't be long until the level crossing if activated as a train is approaching.

This installation works alongside – not instead of – the flashing lights, warning signs and barriers.

More passenger information for Downtown Line

SINGAPORE: Bombardier Transportation has announced the launch of its software solution installed on the Singapore Downtown Line's existing Train Control Monitoring System (TCMS). The technology maximizes passenger comfort and the system's operational efficiency by displaying real-time passenger load information on LCD screens at station platforms. The system has entered service following the completion of comprehensive testing by Singapore's Land Transport Authority (LTA).

The software solution features an onboard system designed to detect passenger weight load from the vehicle's braking system and then transmit the information to the passengers waiting at the next stop. LCD screens at the platform use a series of colours to indicate the capacity of each car: green represents a high probability of available seating, yellow for partially full and red for full. The implementation, the first of its kind in Singapore, seeks to better distribute passenger load while also improving the trains' efficiency and reliability.

Driverless railways hit the 1000 km mark

WORLD/CHINA: The total length of fully-automated driverless metro lines in the world now exceeds 1000 km (621 miles) report the International Association of Public Transport (UITP). The milestone was reached at the end of March with the opening of the Pujiang Line in Shanghai, China.

The UITP says there are currently 63 metro lines operating at Grade of Automation 4 (GoA4) in 42 cities in 19 countries, making a total of 1003km (623 miles). The world's first GoA4 metro line opened in 1981 in Kobe, Japan. It took another 29 years to reach 500km, but only a further eight years to double that figure.

The UITP says fully-automated driverless metros have a proven track-record for safety. "With adequate redundancy built-in, fully-automated metros are generally safer as human factors in safety-critical decisions are reduced," the UITP says.

Safety regulator approves autonomous trains for Rio Tinto

AUSTRALIA: In the Pilbara iron-ore mines in Western Australia, mining company Rio Tinto has been granted accreditation by Australia's Office of the National Rail Safety Regulator (ONRSR) for the autonomous operation of trains

The AutoHaul project involves automating the company's railway which links 16 iron-ore mines in the Pilbara hinterland with four ports on the coast. Trains started running in autonomous mode, with a driver on-board to monitor the train, in the first quarter of 2017.

At the end of the first quarter of 2018, approximately 65% of all train paths were operated autonomously, more than 1.86 million train miles (3 million train-km). By the end of 2018 the company says that the network is planned to the world's first heavy-haul, long-distance autonomous rail operation, delivering both safety and productivity benefits.

100 Gbps wireless data transmission achieved

JAPAN: The Nippon Telegraph and Telephone Corporation (NTT) has successfully demonstrated for the first time in the world 100 Gbps wireless transmission using a new principle, Orbital Angular Momentum (OAM) multiplexing, in combination with already widely used Multiple-Input Multiple-Output (MIMO) technology.

The aim is to achieve terabit-class wireless transmission to support demand for wireless communications in the 2030s. OAM multiplexing is a physical layer method for multiplexing signals carried on electromagnetic waves, using the orbital angular momentum of the electromagnetic waves to distinguish between the different orthogonal signals.

The results of the laboratory environment experiment revealed the possibility of applying the OAM principle to large-capacity wireless transmission, at a level about 100 times that of LTE and Wi-Fi, and about 5 times that of the planned 5G standard.

This is expected to contribute to the development of innovative wireless communications technologies for the next-generation of systems such as connected vehicles, virtual-reality/augmented-reality (VR/AR), high-definition video transmission, and remote surgery.

5G in the UK

UK: BT and EE could be the first companies in the UK and Europe to have a live 5G network. At a recent strategy and earnings presentation BT announced that they would launch 5G services within 18 months, at the end of 2019 via its EE brand. This is ahead of the dates for commercial launches set by European operators including Telefonica and Deutsche Telekom, who have publicly committed to launching their 5G services in 2020.

It would also be ahead of the UK government's projected commercial roll-out for 5G in the UK, which also aims for 2020.

BT and Huawei have already announced that they would deepen their collaboration, with an agreement in March to conduct live trials of 5G New Radio and the joint development of core 5G network technology and customer premises equipment.

At the 5G spectrum auction at the beginning of April, BT & EE secured 40MHz of 3.4GHz spectrum, adding to its existing 255Mhz for a total of 295MHz of spectrum. BT also has the advantage of having the most extensive fixed network in the UK, which will provide backhaul for 5G.

It appears that it's consumers who should initially benefit from the 5G launch, as BT has said that in the first instance, it will focus on improving mobile broadband, although 5G will eventually benefit industry with support for innovative new business and operational models.

Another case of forgetting the driver

UK: On 2 March 2018, the driver of the 12:35 hrs Manchester to London passenger service had stopped his train at Stafford to attend to a fault. While on the track and working on his train, he saw a train approaching at speed on the adjacent northbound line and had to take evasive action, lying down on the track next to his train, to avoid being struck. The driver was not injured but was badly shaken by the incident.

There had been a miscommunication between the signaller and driver on the protection arrangements, which in part was because drivers are not normally expected to know the numbers of all the signals and points on the routes they drive over.

The incident demonstrates the importance of signallers and drivers reaching a clear understanding when a driver needs to arrange protection to get down onto the track and examine their train. It is vital that in such communication:

- signallers explain to drivers the names of which lines are blocked and which lines trains are still running on. This is because drivers may not be able to identify lines from the numbers of the signals and sets of points that a line is blocked, and
- drivers check the status of each adjacent line with signallers if they do not fully understand the information that the signaller has given to them.

Full details are contained in the Rail Accident Investigation Branch safety digest at **irse.info/8rui0**.

IRSE///
Institution of Railway Signal Engineers

News from the IRSE

Francis How, Chief Executive

Subscription renewal

Members will by now have received your subscription renewal letters, and renewal payments are due by 1 July. Please pay promptly, in order that you continue to receive IRSE News, e-bulletins and other information from us. We very much hope that you will continue to be a member of the Institution, so as to benefit from the many events, publications and other information that we produce. You can renew by logging in on the IRSE website and navigating to **Manage your Record** under the **Home** tab.

End of an era

Our 2018 Convention in Switzerland was highly successful, and you will be able to read about it in a future edition of IRSE News. It was also significant in that it is the last IRSE Convention that Ian Harman and David Street will be involved in organising. Ian has been our Convention Coordinator for several years, and David Street, who arranges Convention accommodation and meeting rooms, is retiring (sort of!) after more years in this role than we can remember. On behalf of the Institution I would like to thank both Ian and David for their untiring work in ensuring the smooth running of our Conventions. We are truly grateful.

Our next Convention will be in 2020, and we hope soon to be able to announce the country in which it will take place.

ASPECT 2019 – save the date

IRSE Council and the Netherlands Section have agreed to hold ASPECT 2019 in Delft, Holland from Tuesday 22 to Thursday 24 October 2019. The University of Delft will be the venue. There will be an introductory day on 22 October, followed by two days of technical papers. We are also intending to arrange technical visits on Friday 25 July, and social/networking events will also be arranged for the evenings. We will launch the call for papers in October.

CBTC Conference: call for papers

The sell-out success of the IRSE's "CBTC and Beyond" conferences in Toronto in the last two years has led us to decide to hold the conference for a third year. We are now calling for papers for the 2018 event.

This year's CBTC conference will be held on 29 – 30 November at Fairmont Royal York, in the heart of downtown Toronto. We encourage you to attend this year, and right now we welcome proposals for papers and presentations on the following or related topics:

- Papers providing project updates, specifically (but not only) for Canadian CBTC projects currently being implemented or planned.
- Papers related to the application of CBTC on LRT, and commuter rail transit systems.
- Papers providing lessons learned in implementing CBTC in a brownfield environment.
- Papers on actual CBTC revenue service operating and maintenance experience.
- Papers looking to the future; what are the user business needs? What research & development is currently underway on new/improved technologies to further improve operating performance while reducing life cycle costs?

Please submit your abstract to **ykimiagar@gfnet.com** by 28 September.

Change of Presidential succession

As you probably know already, as well as having a President (elected annually), we also have two vice-Presidents, who will become the Presidents in the next two years. George Clark (director of engineering at Transport for London), our senior vice-President is due to become our President in April 2019.

Gary Simpson (chief engineer, telent Technology Services Ltd), our junior vice-President, was due to become our President in April 2020. However, for a variety of reasons, Gary has reached the conclusion that he cannot realistically take on the role, and therefore has decided to step down as our second vice-President. The IRSE Council discussed this at its meeting on 13 June, and approved a proposal that Dr Daniel Woodland (professional head of signalling and train control at Ricardo Rail) be co-opted as our junior vice-President in place of Gary – and therefore due to become our President in April 2020. Daniel is a Fellow of the Institution, a Council member (having also served on a number of IRSE committees), and a chartered engineer. He is also an honorary senior research fellow at the University of Birmingham.

Finally ...

At the end of July I shall retire from the role of chief executive of the IRSE. It has been an honour to serve the Institution for the past three years, and to work with four Presidents (Andrew Simmons, Charles Page, Peter Symons and Markus Montigel) during that time. Under the direction of the Council, I think we have moved the Institution forward, particularly in terms of becoming more international, how we are perceived by the wider rail industry, and in communicating with you (our members) and externally. Together we have done good work in delivering the IRSE's Strategy 2015-2020.

As you will know from an announcement in IRSE News earlier this year, Council has approved the appointment of Blane Judd as my successor. Blane has solid previous experience in running both engineering institutions and trade associations. He brings with him fresh ideas and insights that I am confident will prove valuable for the ongoing growth and success of the IRSE. Please make him welcome, and support him as he moves into the role of chief executive on 1 August.

IRSE membership feedback

First year of membership survey

With many thanks to Hilary Cohen, IRSE administration manager, we have undertaken a 'first year of membership' survey of new members to the IRSE. This has received a respectable response rate of 16% from over 350 new members.

Photo Shutterstock/Andrey Popov.

Over 50% of the responses said that the reason why they joined the IRSE was for their career development, 20% as they had an interest in the industry, a further 20% as a requirement or with encouragement from their employer, and 10% in order to take the exam.

Some members commented that they would have 'ticked several boxes' as it was a combination of their own career development, encouragement by colleagues in the industry and a strong interest in the industry which attracted them to become members.

Only three members responded that unfortunately they couldn't participate in any organised events during the year, with many indicating they had attended the ASPECT Conference, local Section events and technical visits.

12% said they found the IRSE website difficult for subscription payment and this is something that will be reviewed.

Many commented that the IRSE News is a very useful source of information and a hard copy is convenient to pick up and read, and that this was easier than remembering to log on and read on line. This is an interesting response in the on-line era. The new members thought IRSE News is very colourful and graphical, and said they like reading what is going on/being developed in other countries. There were many comments saying that they enjoyed reading IRSE News and that it had broadened their knowledge and understanding of signalling and helped them keep abreast with the latest developments in the industry. It was also felt that features on the current state of the rail industry as a whole, as well as a focus on signalling, would be good.

Overall the technical information received from the institution was felt to be good but adding videos to the web site was one suggestion, along with technical papers improvements with better electronic logbook cloud systems. "The IRSE should be a lot more 'on line' as it feels like an old-school organisation in some areas", was one comment. Members would like to see more IRSE news on social media platforms with better access to resources online for career development, along with better communication about Younger Member events.

Meeting and connecting with other professionals through conventions, publications, and personal communications along with the ASPECT conference and technical visits was an important benefit of becoming an IRSE member. Members also appreciated downloading the IRSE exam materials as a great help.

Younger members events fill up very quickly and some commented it has been difficult to get a place in the past, so more events/more places are needed, along with more STEM outreach activities.

The IRSE would like to thank everyone who has responded to the survey and that we welcome all feedback. Many of the comments and feedback support what we have planned in such areas as website development and modernising the institution, however the feedback will be further analysed and will feed into our plans for the future. If you have any other suggestions for improvement why not visit your local Section and get involved or contact us at **hq@irse.org**.

What do you think?

The views of all of our members, not just those who have recently joined the Institution, are very important to us.

If you would like to share your view about any of the content in IRSE News, or any of the activities or approaches that the Institution takes, we'd love to hear from you. Just email us at irsenews@irse.org.

Don't forget the IRSE's purposes of **Inform, Discuss, Develop**.

IRSE/INCOSE seminar

Requirements management

Karl King

On 19 April 2018 the IRSE and the International Council on Systems Engineering (INCOSE) Railway Interest Group held their second joint seminar on Systems Engineering at the University of Birmingham in the UK. The specific subject discussed was Requirements Management for Train Control and Communications Systems, exploring the complexities of specifying, developing and managing the requirements of projects within the industry.

Above, the seminar was well attended. Left, determining the optimal solution during a breakout session.

The event was jointly sponsored by WSP and Frazer-Nash Consultancy and supported by the University of Birmingham, who provided the venue. It followed on from the first highly successful seminar held two years ago on the general principles of systems engineering. The topic of Requirements Management is both highly relevant at the current time within the industry and is also the foundation of which all systems engineering is built upon.

The event once more took the form of a seminar featuring presentations on requirements management good practice supported by case studies from industry, as well as a breakout session to stimulate discussion on what makes a good requirement.

The event opened with a presentation from Michael Morua of Frazer-Nash Consultancy who gave an overview of the definition of what a requirement actually is and how it is important to develop and manage them correctly. Tanya Galliara from Systra Scott Lister then presented the first case study on Requirements Management for the HS2 Mainline North Programme. Baney Young from Network Rail gave on update on Network Rail's current developments in their approach to Requirements Management, followed by her colleague Kevin Gedge on the company's use of Goal Structuring Notation to manage requirements on the Northern Hub project.

Adam Rixon from WSP then led the breakout session by splitting the attendees into groups to determine an optimal solution to a non-railway problem based on a set of requirements. This exercise focused on what makes for a 'good quality' requirement set, highlighting that some types of requirement are, in practice, more useful than others for achieving the desired outcome. The exercise stimulated considerable discussion during the feedback session after lunch, not least about the extent to which standards and process-based statements do (or do not!) make for good requirements.

The third case study was presented by Frans Heijnen who described the EULYNX project, which is very much a requirements-focussed one aimed at improving the potential for integrating different suppliers' products into a signalling and control system. Andrew Woods from Siemens Rail Automation presented the final case study, on an equipment supplier's experiences of managing and delivering the requirements of projects during stages 5 to 8 of Network Rail's GRIP (governance of railway investment projects) process.

Bruce Elliott from Altran closed the event with a summary, presented with a dash of humour, illustrating how requirements management can cause projects to fail rather than succeed in delivering them on time and to budget.

The event was very well attended (indeed, over-subscribed) by an excellent cross-section of the industry, and all the sessions generated a great deal of healthy discussion. It was widely agreed that the industry now needs to embrace requirements management more fully and systematically, and that this will be essential for the successful delivery of complex projects in the future. The IRSE and INCOSE hope to hold a further Seminar on aspects of systems engineering in 2019, and possibly even make it a regular annual event to maintain the momentum towards better systems engineering within the railway industry.

Midland & North Western Section

Technical meeting: Smart motorways

Peter Halliwell, Section chair

What do motorway signalling and railway signalling schemes have in common? Quite a lot really. Both are about seeking to safely and efficiently manage traffic through a network. Both are seeking to maximise the capacity of that network, function by providing information to be read, interpreted and acted upon in a timely manner. Both are supervised by operators in a control centre, with elements of automated and operator-controlled working.

My programme as chairman of the Midland & North Western Section for 2017/18 started and finished with items associated with signalling road traffic on motorways. The year commenced with a visit to the M6 junctions 16 to 19 Smart Motorway Project to see how the construction project is managed and learn a little of Smart Motorway history and design (see IRSE News 239 December 2017). It finished with a talk on 10 April from Neil Young, a scheme designer and, Richard Goodwin, an engineering manager, both from Highways England's design contractor Jacobs. They explained the history of schemes to improve capacity on motorways, the signalling arrangements, the technology and the design philosophy.

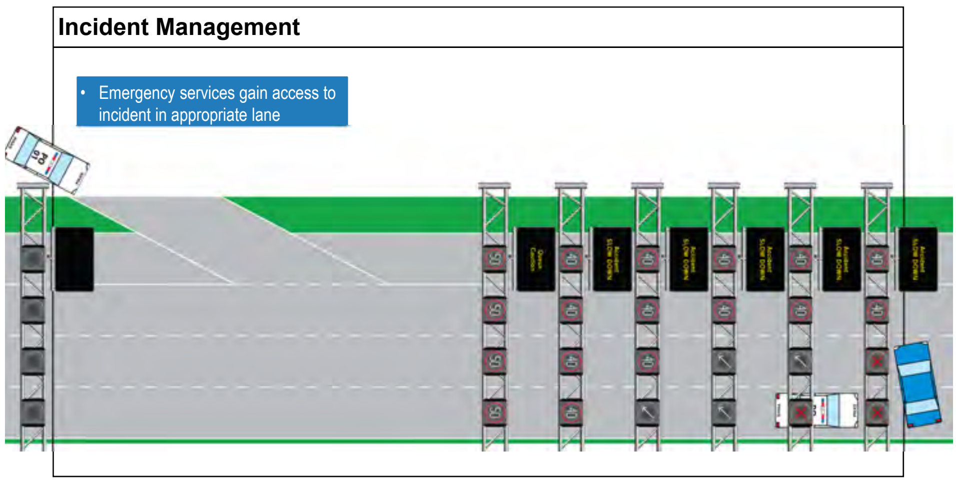
The Smart Motorways programme is one of a number of intelligent transport systems (ITS) deployed on the highways network. They are covered by an EU directive, the ITS directive of 2010. Other ITS systems include real time passenger information, ramp metering (controlled access to motorways through traffic lights on slip roads), traffic control centres (which supervise Smart Motorways, via CCTV, and manage incidents) and automated toll collection. The provision of remotely controlled signs with variable messages dates back the late 1960s. It was enabled when the first dedicated roadside communications network was established with emergency telephones every mile along the road.

MS4 sign on the M25 between junctions 24 and 25.
Photo Highways England under a creative commons licence, irse.info/z2bhy.

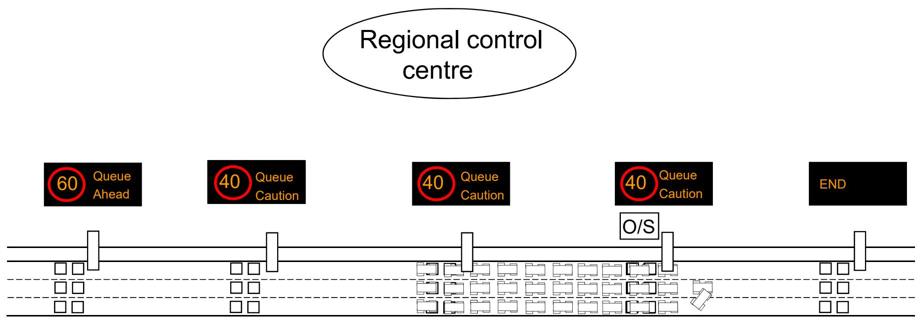
These could then be used to send coded messages to lineside matrix signs which could convey a range of messages to drivers: lane closures, fog warning, advisory speeds etc. These systems, which either operate with a single sign in the central reserve or with signs for each lane from overhead gantries, were mandatory where lane closure was notified but only advisory for control of speed.

The next big step came in 1995 with the introduction of variable mandatory speed limits (VMSL) signs on which were used as part of a pilot of controlled motorways between junctions 10 and 15 on the M25. It was the provision of the red ring around the numerals which was implemented as part of the Traffic Signs Regulations and General Directions Regulations 1994 that enabled the change. This pilot was studied and evaluated and the next step in 2006 was the introduction of the use of the hard shoulder as a running lane – Dynamic Hard Shoulder Running (DHSR), introduced as a pilot scheme on the M42 between junctions 3a and 7. The pilot was quickly confirmed as a success delivering a 27% increase in capacity and a personal injury accident rate reduction from 5.1 to 1.8 accidents per month. The national managed motorways programme was started in 2009. Understanding the implications of how DHSR operated and drivers' understanding of when the hard shoulder was to be used and when not, led to changing the proposal of All Lanes Running (ALR) with Emergency Refuge Areas (ERAs), with the programme recast from Managed Motorways to Smart Motorways. The first Smart Motorway scheme was on the M25 between junctions 23 and 27. In 2016 the first accelerated delivery on the M6 scheme was between junctions 10a and 13. The junction 16 to 19 scheme started in December 2015 and is scheduled to be completed in March 2019.

Initially the schemes were designed based on individual VMSLs for each lane suspended over the motorway on gantries. The latest configurations are based on single combined signs which incorporate the VMSL, free text and informational images, on a sign known as an MS4 sign.



Signs on the approach to an incident in lanes 3 and 4 showing arrangements for emergency services vehicles access to the incident from a manually operated DHSR arrangement. The operator only sets the signals at the incident and the rest are set by algorithms.
Graphic Jacobs.



Graphic showing how the speed sensors have detected the queue and illuminated MS4 signs according to the traffic flow. Operators can override the MIDAS outputs and set the signs as required but they cannot change the algorithms which determine the MIDAS generated sequences. O/S refers to an 'occupied sensor' which detects stationary traffic.
Graphic Jacobs.

To operate a Managed or Smart Motorway VMSL signs are supported by signs to give text advisory messages and speed cameras to enforce the variable speed limits. There are two different modes of operation: incident management seen on Managed Motorways and queue protection and congestion management seen on Smart Motorways. The key differences between these modes is that incident management is set up by an operator, with queue protection and congestion management an automatic system which sets the variable mandatory speed limits. When an incident occurs the control centre operator will close the lanes on the approach to the incident. This causes the signs on the approach to extend the lane closure, direct the approaching traffic to open lanes and to apply reduced speed limits on the approach to the incident. For each incident location and lane block combination the scheme designer will design the sequence of approaching signs. These can then be overridden by the operator as traffic builds back and to create access for the emergency services.

An automated queue protection and congestion management feature supports ALR. To operate the system needs to measure traffic density and speed, which is enabled by a system called motorway incident detection and automated signalling (MIDAS) located at the regional control centres. The MIDAS system detects the speed and flow of traffic and sets the signals on the approach automatically by algorithms, in much the same way as aspect sequences operate.

The first Smart Motorway schemes managed traffic detection through induction loops set in the carriageway, more recent schemes now employ CCTV cameras to record and assess the traffic. The induction loops are accurate and reliable once set up, they are well understood but they are expensive and need to be renewed when the motorway surface (the blacktop) is renewed. CCTV systems are cheaper, and safer, as they are located in the verge, however they are more complicated to set up and currently less accurate at measuring the traffic; one particular problem is occlusion where heavy goods vehicles in nearside lanes can obscure traffic in outside lanes.

The philosophy of safety by design is applied as required by the CDM regulations. Originally single matrix signs were located in the central reservation. Now everything is designed to locate systems on the outside of the carriageways. ALR central reservations have solid concrete barriers which are more resilient than traditional crash (ARMCO) barriers. Central drainage is minimised and no vegetation is planned.

Nationally there are seven regional control centres. Those covering M&NWS are at Quinton in the West Midlands and Newton-le-Willows in the North West.

The talk was fascinating in allowing us make comparisons and identify similarities and differences between motorway traffic control design and railway signalling design. There are many parallels in the intentions and functions in managing road and rail traffic. The main differences are in the design, checking, realisation of the central and field equipment, and the testing and commissioning.

Road vehicle drivers are required and expected to drive at all times such that they are able to stop and negotiate any hazards they encounter. The most significant for high speed roads is fog and there are still occasionally serious multiple vehicle accidents. VMSR can mitigate this and is designed and constructed to be highly reliable. The signalling system for motorways, whilst giving mandatory signals, does not employ the level of fail-safe design required on the railway which is understandable in the context.

Thank you Francis!

Charles Page

Francis at the launch of the IRSE Digital Railway White Paper, 2018.

As we welcome our new chief executive, Blane Judd, we also say goodbye to Francis How who has ably filled this challenging role since August 2015.

Formally the role of the chief executive is described as being: "responsible for directing and managing the resources of the Institution in order to implement the decisions of Council in an efficient manner and in compliance with company and charity law. The role is accountable to the Council. The CEO is also the focal point of contact for other Institutions and external organisations, including the UK's Engineering Council and the Royal Academy of Engineering, government agencies, the chief officers of other professional bodies, and the scientific, engineering and technology community. The CEO is also responsible for ensuring that the legal requirements of the Institution's Articles of Association, the Registrar of Companies and the Charities Commission are met."

We are sure Francis would have had a much easier job if that was all he had to do. To the outside world he has been the constant face of the IRSE throughout this period, building links with industry and academia, with government and other technical institutions. In reality he has also been at the centre of almost everything the Institution does. He has been the patient, willing and tireless 'Go To' person for every query or challenge. Many members may be unaware that he was actually engaged on a part time basis of 2½ days a week. In practice he has made himself available wherever and whenever he could help.

Francis has been a long time member of the IRSE, throughout his distinguished career. First with British Rail/Railtrack, then with Atkins and latterly as the technical director of the Railway Industry Association. He was a Thorrowgood scholar and then served on Council for many years. Ultimately he became the President of the Institution 2012-2013, when ASPECT and the subsequent Convention were held in London during our successful centenary year.

Francis is widely respected for his professionalism and technical knowledge. However, for those who have dealt with him most closely it is his unfailing courtesy, tactful diplomacy and commitment to the aims of the Institution that will also be remembered.

His quiet and effective style has been particularly evident in the way he has guided the operation of our key committees, particularly the Management Committee, as well as Council. He undertakes a final check of IRSE News and its not unknown for him to identify items that the team of editors have missed. Francis has been the constant and steadying hand that ensured that everyone knew their role, that meetings were properly organised and minuted, as well as seemingly being the most regular and willing nominee for actions.

As a Past President himself he has been particularly well placed to help advise candidates as they plan the many details of their Presidential year. He has used his wide network of contacts to help track down high quality authors for those elusive last gaps in the program, and to locate willing hosts for conventions and technical visits. He has used his diplomatic skills to navigate the inevitable tensions of committee work in a volunteer based Institution.

Francis has also played a vital role in drawing younger members into the running of the Institution. He has encouraged them to take responsibility, and helped them develop their capabilities in their IRSE roles. He has given quiet encouragement and engendered self-confidence within many of our rising engineers in our industry. In the process he has avoided micro-management and has been a leader for younger engineers to look up to and learn from.

As our chief executive he has overseen a period of strong growth in both our membership and the reach of the Institution. During his tenure there have been an unprecedented number of new local sections formed. These have included new sections in France, Thailand, China, Japan, and most recently a new UK based section – London and South East. These all required the

With Charles at the Beijing Convention.

creation and review of new articles for each local section, a task that was also managed by Francis. He has overseen two ASPECT Technical conferences, including the first ASPECT outside of the UK, held in Singapore in 2017. He has also been the quiet hand helping the various Presidents organise their year in office including three International Conventions, in Australia, China and the USA.

A number of major initiatives were progressed or launched during his tenure. He was instrumental in the original Strategic Planning process and has consistently worked to implement the initiatives therein. He has helped steer a number of complex projects, including the introduction of our new CRM system and the new Website (coming next year). Anyone who has been involved in delivering software based projects will appreciate the breadth of such a task. He has also managed the updating of the IRSE brand image, something that was very necessary but also potentially very controversial. Council firmly believes the successful result speaks for itself.

In deciding to move on to other opportunities, including a much delayed retirement, Francis has kept the interests of the IRSE at heart throughout. Ever the consummate professional, he actively contributed to the recruitment of his replacement and ensured an orderly hand-over of responsibilities.

So now Francis' time is his own, and we wish him all happiness and success in whatever lies ahead.

Charles would like to thank the other members of Council who helped with this article.

Above, at the controls during an IRSE staff visit to the Great Cockrow railway, Chertsey, last year.

Left, we'd also like to thank Pauline, Francis's wife, for all of her involvement, support and patience during his time as chief executive of the Institution. The photo on the left was taken at the Annual Dinner in 2016, from left to right, past president Claire Porter, 2016 Thorrowgood Award winner Tom Corker, Pauline and Francis.

Photos Colin Porter/IRSE.

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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Membership changes

Admissions

We have great pleasure in welcoming the following members newly elected to the Institution:

Fellow

Coineau	D	Academic	France
Katiyar	A	NHSRCL	India
Le Marchand	A L A	Thales	France

Member

Castles	M J C	Ricardo	UK
Clancy	M	Siemens	UK
Fraser	A	Hatch Associates	USA
Lindeboom	J	Movares	Netherlands
Peyrol	P	Egis Rail	France
Phuak	H S	Land Transport Authority	Singapore
Van Der Vlugt	J	Movares	Netherlands
Wainwright	M R	BHP Billiton Iron Ore	Australia
Wheeler	R	Engineering Training Centre	UK
Zhu	B	Ansaldo-STS	Australia

Associate Member

Arise	V	Dedicated Freight Corridor	India
Atsuta	K	West Japan Railway Co	Japan
Deviker	C	Dedicated Freight Corridor	India
Fielding	J	Network Rail	UK
James	Z	Network Rail	UK
Kammara	G	EXEN Eng Solutions	India
Marquis	G R	Network Rail	UK
Mbongwe	M C	Metrorail	South Africa
Ng	F W Y	Network Rail	UK
Peacock	N	Network Rail	UK
Schimmel	R	Alstom	Netherlands
Swarnkar	K C	Dedicated Freight Corrridor	India
Syed	A P	WSP	India
Tang	L Z R	Land Transport Authority	Singapore
Wright	N	MPEC Technology	Thailand

Accredited Technician

Donegan	D	Babcock	UK
Medepalli	V C	Cyient	India
Morgan	D	London Underground	UK

Affiliate

Ang	A	Land Transport Authority	Singapore
Bello	T	Hitachi	UK
Beune	H E	B-Solution	Netherlands
Butler	L	Student	UK
Choow	K F	Land Transport Authority	Singapore
Chua	J	Land Transport Authority	Singapore
Drysdale	R M	Network Rail	UK
Erdem	A	University of Birmingham	UK
Foley	F	STT Solutions	Ireland
Hicks	P W	Opentraintimes	UK
Leung	C H S	Alstom	Hong Kong
Leiva	E	Siemens	UK
Narahari	A K	Wabtec	India
O'Connor	S J W	Retired	Australia
Rahman	A	London Underground	UK

Transfers

Associate Member to Member

Heaton	J E	KeolisAmey Docklands	UK
McNulty	M A	Network Rail	UK

Affiliate to Member

Fiori	J	IDG	UK
Meghanathan	N	Thales	UK

Accredited Technician to Associate Member

Stevens	T J	London Underground	UK

Engineering Council registrations

Congratulations to the members listed below who have achieved final stage registration at the following grades:

CEng

Wood	S	Network Rail	UK

IEng

Darlington	J T	Atkins	UK

EngTech

Donegan	D	Babcock	UK
Morgan	D	London Underground	UK

Reinstatements

Ben Hassine A, Dakin P, Hardcastle A G, Josh G T, Pye R J and Williams B A.

Resignations

Brett J, Gooday M J, Rake S M, Redeker F R, Simpson A, Smith A, Stutzbach J W R, Van de Voorde W, Walser J, Watton M E and Welsh D W.

Deaths

It is with great regret that we have to report the death of members Sales R J, Harris D F and Rayers F G.

The current membership number is lower than that last reported, because of the change to membership termination rules as reported in a previous edition of IRSE News.

Current Membership: 4845

IRSE News

Institution of Railway Signal Engineers

September 2018

Convention
Switzerland 2018

Availability
keeping services running

Train protection
is enhancement necessary?

INTO THE FUTURE

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As many of you know, I come to the IRSE by way of a career in another safety-critical sector: power generation and transmission. When I began my engineering training, most communication and protection systems were analogue. Over time, we began to adopt digital systems capable of disconnecting faulty equipment from the power transmission network in milliseconds.

Joining the railway sector as it pursues digitalisation is thus, to me as an engineer, an exciting prospect. When I started my apprenticeship, the engineering profession was trying to attract more young people and we still are today. The engineering profession's focus on education in science, technology, engineering and mathematics (STEM) is still as strong. But IRSE President Markus Montigel speaks of "winds of change" and invites us to learn from the past rather than live in it.

He challenges us to build both walls and windmills to harness the wind. This is familiar to one who has built many walls (usually around substations) and windmills, well technically wind turbines, throughout my career. But I have also built professional relationships in many fields of engineering, including the railway sector. These include the National Skills Academy for Rail, Crossrail, HS2 and the National High-Speed Rail College and at network operators, train operators, signal manufactures, regulators and training institutions throughout the world and I will draw upon my connections to further the work of my predecessors. I led a campaign in the UK to recognise the significant contribution that Engineering Technicians make to the success of so many areas of the engineering profession and I know that to be true in the rail sector. I plan to promote that message more widely.

I have worked in professional engineering institutions long enough to know that every sector has its own language and key concepts. Already, I have been introduced to APS, TPWS and ERTMS, to name a few. All too often, we shroud in mystery the routes to professional qualifications, such as (in the UK) CEng, IEng, EngTech and ICT Tech. To reduce the confusion, I want us to work to simplify and standardise on key messages that each of us can use when communicating the benefits of being professionals. Anybody can say they are an engineer, but only competent professionals who voluntarily commit to regulation and registration, and are confident enough in their abilities and ethics, can become members of a licensed professional engineering institution like the IRSE.

The global presence of railways presents a massive opportunity for us to engage with like-minded professionals. With over a million route kilometres, the world needs ever-more-efficient digital signalling to safeguard freight, rolling stock, infrastructure and of course passengers, staff and the public. The IRSE has already developed an international profile; I look forward to working with the central team and you, our members, to build on the foundations laid by my predecessors Francis, Colin, Ken, Ray and those before to enhance our global impact as a key player in railway signalling and telecommunications. Collectively we have the power to harness energy from the winds of change and drive the IRSE towards greater things.

Blane Judd, Chief Executive

Cover story

Our front cover this month shows a train leaving Pontresina before ascending through the valley to the Bernina Pass and on to the highest summit of the Eastern Alps of Switzerland at Piz Bernina (4,093 m). Pontresina was the second location of this year's successful IRSE Convention and a full report of the event can be found on page 2.

Pontresina and St Moritz each have two completely different electrification systems meeting at the stations. At Pontresina 11 kV AC powered trains entering the station on the line from Samedan use platforms 1-3, while 1,000 V DC powered Bernina trains use platforms 3-7. Platform 3 has a catenary that can be switched from AC to DC, and a special signal to display to train crews the type of current being used.

Photo Paul Darlington.

In this issue

Regular features

From the IRSE and its sections

IRSE
Institution of Railway Signal Engineers

IRSE Convention in Switzerland, 28 May – 1 June 2018

Wim Coenraad and George Raymond

IRSE President Markus Montigel and the Swiss Section hosted this year's International Technical Convention in late May and early June. The week was filled with activities for members and guests, as described here by Wim and George, with photos by Paul Darlington.

Monday 28 May: Markus welcomes his guests

About 250 members and their guests assembled at the Hotel de la Paix in Lugano, Switzerland, to hear IRSE President Markus Montigel open his Convention. This year's Convention theme was Safety in Long Railway Tunnels. Over the next four days, we were to visit the 57-km Gotthard Base Tunnel, completed and in operation, the 23-km Ceneri Base Tunnel further south, where trackwork is complete and systems are being installed, and the new 6-km Albula Tunnel to the east, still very much under construction.

After breaking his own guideline on shutting off mobile phones during presentations by accepting a call from Saint Peter (no less) about the weather expected for the week, Markus introduced the programme and Switzerland's Ticino region. He presented to attendees the Convention tie and scarf, arguably the first such items to sport IRSE's new logo.

At the 2017 Dallas Convention, Rod Muttram had cited the Swiss Cheese Model, likening the holes in Swiss cheese to missing safety barriers that must not be allowed to align. The President reminded Rod about this vivid image (warning, the Swiss have long memories!) and presented him with a huge piece of Swiss cheese.

Tuesday 29 May: paper session and the Ceneri Base Tunnel

The first full Convention day opened with a paper session. Hans-Peter Vetsch introduced us to the safety principles for the Gotthard Base Tunnel (GBT). This is based on the automatic inspection of trains before they enter and the minimisation of maintenance-intensive and fault-prone equipment in the tunnel. Emergency stations are located one third and two thirds through the tunnel. An early warning system keeps faulty trains in the tunnel from blocking others. A system ensures spacing so that a train with dangerous cargo cannot prevent a passenger train from reaching the next emergency station or the exit portal.

Receiving the safety briefing at the Ceneri Base Tunnel.

The GBT consists of two 57-km tubes, 178 cross passages and two emergency stations. As in all modern tunnels, the safety concept revolves around enabling passengers to rescue themselves. In the event of an emergency, ventilation systems aim to remove smoke and keep one of the two bores smoke-free. Arrival of emergency helpers within 45 minutes and evacuation of passengers within 90 minutes is the target, with evacuation by trains only. Side tunnels are for ventilation. The control system immediately blocks all approach routes – in both directions – and prevents trains from entering the tunnel. The aim is for all trains to reach the exit portal or, failing that, to get passenger trains to the next emergency station.

Hans-Peter Vetsch also addressed risk perception and management, pointing out that according to a 1990 study, whereas sharks kill about 10 people worldwide yearly, falling coconuts kill 150. Yet we worry more about swimming in shark-infested waters than about lounging under palm trees. “You have to accept the residual risk, otherwise you will never be finished with a tunnel”, he said, but added that “if you don’t know the history of previous accidents, you will make the same mistake twice.”

GBT signalling and tunnel control

Markus Spindler and Patrick Sonderegger then presented the design principles for the GBT’s signalling and tunnel control, which aim to “make it safe and easy to use”. This is achieved by a high degree of automation to keep trains separated so as to provide passenger escape routes and monitoring trains which slow unexpectedly.

As would be visible in the cab of our train the following day, the control system monitors the speed of trains as they move through the tunnel. If a train’s speed drops below the expected threshold, the tunnel operator makes enquiries and if warranted, raises an alarm. Applying a ‘safe haven’ principle, the control system keeps a passenger train far enough behind a dangerous-goods train to ensure that dangerous goods never lie between the passenger train and the next emergency station or the exit portal.

The ERTMS specification has the option of reversing a train that has stopped short of an incident out of a tunnel. Switzerland had this function placed in the ERTMS specifications for use in its long tunnels. The reversing requirement also dictated the GBT’s signalling architecture, which employs four interlockings, for the north and south halves of each tube. But late in the project, objections arose. Enough track length might not be available to reverse all freight trains out of the tunnel. And an error by the driver when reversing would trigger an ERTMS brake application, blocking the train or seriously delaying its evacuation options. Reversing out of the tunnel was thus ultimately declared unsafe and the option is not used.

A driver’s eye view of the Gotthard Base Tunnel.

The safety concept is now as follows: in case of an incident, all trains try to continue and leave the tunnel. If a train cannot continue out of the tunnel, the passenger train behind stops at the next emergency station or, at worst, the next cross passage. From there, the passengers move to the other tube. The ventilation system keeps pressure higher in the healthy tube and smoke out. A rescue train then evacuates the passengers from the tunnel. Drivers of freight trains are expected to leave their train and reach a place of safety, using breathing masks if necessary.

Mobile door

During maintenance work in a tunnel section, a train can drive in ERTMS ‘shunting’ mode up to 40 km/h. Mobile doors mounted on railway vehicles seal the tunnel section to protect workers from the wind generated by trains passing in the other tube. The next day, in the Erstfeld workshop, we would see such a vehicle and wonder how such a door would be deployed within the confines of a tunnel.

The eight-year GBT signalling project was delivered with an eight-year warranty. This introduced some requirements and issues related to the continuity of teams, the stability of products and standards, and the management of stakeholders and system releases.

Swiss smurfs

Those of us old enough to remember the Interesting Signals column in IRSE News of old were thrilled to observe the special “smurf” signal (blue dwarf signal) at ERTMS stop marker boards in places where the maximum speed is below 160 km/h. This modified shunt signal was in response to driver anxiety about passing shunt signals at danger under ERTMS cab signalling.

Tunnel control system

Peter Müller and Erwin Achermann’s talk about the Tunnel control and automation systems (TAG) focussed on the concept of checklist-based and automated emergency responses in the GBT. In long tunnels, designing for safety requires more attention to system availability under the motto “stay available and bring everybody out”. This has given rise to new interlocking elements such as directional route locks that keep trains out of the tunnel once an alarm has been raised. The main functions of TAG are prevention, early detection, risk containment, event management and return to regular state.

Wayside train monitoring system

At the Tuesday paper session and in a more detailed presentation on Wednesday in Erstfeld, Stefan Koller described the wayside train monitoring system (ZKE) of Swiss Federal Railways (SBB). Part of Switzerland’s safety strategy is ensuring that only healthy trains enter the long Swiss tunnels. This is one reason why 200 wayside train defect monitoring systems are found across the Swiss network, monitored by operators in centres at Erstfeld and Luzern. For ongoing tracking of a wagon’s condition, SBB is encouraging wagon owners to install RFID tags on their wagons. In return, the wagon owner gets free access to SBB's data on the wagon.

In other talks at Tuesday's paper session, Gilbert Zimmermann presented the state of the RhB's Albula Tunnel after 114 years of service, the project to build a new, parallel tunnel, and the geological challenges its builders are facing. Pierre-Damien Jourdain updated us on ERTMS deployment worldwide and Oskar Stalder introduced us to the Gotthard mountain route, which opened in 1882 and is now a scenic alternative to the GBT. The scene was thus set for the week's site visits.

Ceneri Base Tunnel

On Tuesday afternoon,we visited the north portal of the 23-km Ceneri Base Tunnel (CBT), planned to open in 2020. Built south of the GBT on the same line by many of the same teams, the CBT will further shorten transit time and eliminate the last steep grades of the Gotthard route, allowing a single locomotive to pull most freight trains unaided. At the CBT's north portal in Camorino, half the group visited the two tunnel tubes and one of the connecting cross-passages, and the other half inspected a technical building and a sample track section. Placement of a Golden Sleeper the day after our visit marked completion of track installation in the tunnel. Just inside the tunnel's north portal are two 160 km/h turnouts connecting the CBT to both Locarno to the west and Bellinzona and the GBT to the north. The turnouts are equipped with swing-nose frogs and multiple hydraulic point machines.

Inside the Ceneri Base Tunnel.

Members reflect on their 1-km walk through two tubes of the Ceneri Base Tunnel.

Wednesday 30 May: old and new Gotthard tunnels

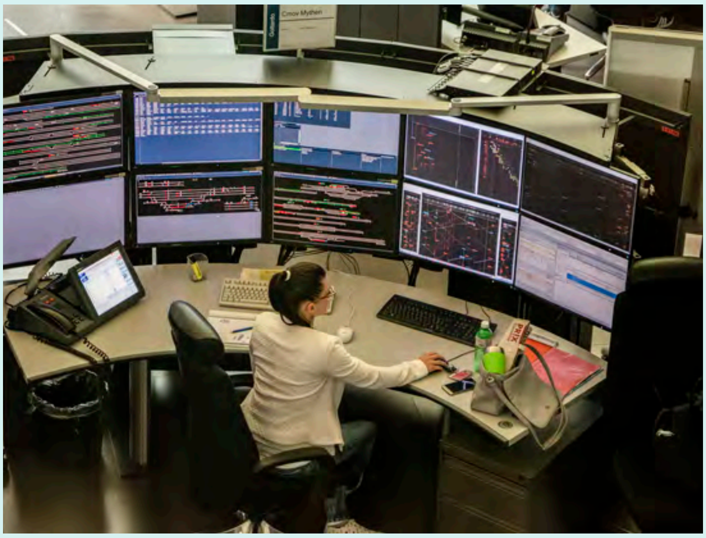
An early bird would have seen us walking through the streets of Lugano to Paradiso station, where a special train took us to Biasca, at the GBT's southern portal. There we toured the Gotthard line control room that houses the tunnel's operators and traffic controllers. Virtual reality headsets let us glimpse SBB's trial applications of virtual and augmented reality in training and maintenance.

Expo Biasca

At an exhibition in Biasca created just for the Convention, stands presented railway technology and operations in the GBT and Switzerland. At one stand, Lego trains illustrated the tunnel's operational and evacuation concepts. Hans Peter Vetsch expanded on his earlier explanation of tunnel safety and evacuation concepts and escorted us through an evacuation drill.

Departing Lugano-Paradiso station aided by one of our excellent guides.

Arriving at the impressive Gotthard control room.



A controller in the Gotthard control room monitors traffic.

A heritage locomotive outside the Biasca exhibition.

Refreshments at Biasca.

Members inspect the cab of the special train through the GBT to Erstfeld.

Erstfeld

We then re-boarded our special train to ride north through the GBT to Erstfeld. At the request of members in his cab, our driver slowed for a closer look at one of the intermediate emergency stations. This let us verify first hand that the control centre does indeed monitor train speed as upon detecting the unplanned speed reduction, a control-centre operator contacted the driver.

After a musical lunch in the Erstfeld workshop, where we enjoyed our President's regional menu, we saw a snow plough and the puzzling mobile GBT tunnel door on its support vehicle. A more in-depth presentation and demonstration of the ZKE system followed lunch.

We then rode a special train with panoramic windows south over the Gotthard mountain route. IRSE legend Oskar Stalder narrated the splendid scenery and spectacular contortions of the Gotthard mountain route, which among other feats passes Wassen church three times, the church where Oskar was baptised and married. The route's summit is the 15-km, original Gotthard tunnel of 1882. The Gotthard mountain route remains a wonderful alternative to the faster but (normally) monotonous 57-km ride through the GBT.

Enjoying the spectacular views from the panoramic car as we travelled over the older Gotthard mountain route.

Thursday 31 May: from Lugano to Pontresina

Members and guests travelled from Lugano to Pontresina (Switzerland) for the Convention's final two nights. A spectacular coach journey, mostly in Italy, brought us to a delightful lunch in the restaurant La Brace in Forcola and on to our Swiss Bernina Express train in Tirano (Italy).

Between Lake Como and Tirano, our coaches' route often paralleled the Italian State Railways' line, along which we observed the searchlight-type signals common in Italy. Such signals can display any of several colours (such as red, yellow and green) through a single lens. Originally, a mechanism inside the signal head swung a filter into the light beam to show the required colour. Nowadays, such mechanisms are giving way to LEDs that display the right colour without moving parts. Members said that Australian searchlight signals are undergoing the same transformation.

The Italian town of Tirano, 429 metres above sea level, is the southern terminus of the Bernina line of Switzerland's Rhaetian Railway (RhB). Our metre-gauge train made a dramatic ascent through countless curves to Bernina Pass, passing the Morteratsch glacier and the highest peaks of the Swiss canton of Graubünden. With 55 tunnels and 196 bridges, the route is the highest railway across the Alps but makes no use of racks despite grades up to 7%. We crossed the tree line, admired the rough high alpine landscape, and reached the small lakeside station of Ospizio Bernina, the route's highest point at 2253 metres above sea level. We then descended to Pontresina, whose 1805 metres still left us slightly short of oxygen as we walked up to our hotels.

During dinner, Rod Muttram presented Markus and his guests with slices of their large piece of Swiss cheese from Monday and confirmed that he had indeed found a configuration where none of the holes overlapped.

Below, ascending to the Bernina Pass, one of the highest railway routes across the Alps.

Friday 1 June: old and new Albula tunnels

Inside the RhB's new Albula tunnel.

The last day of the Convention took us to Preda and inside the RhB's new Albula tunnel, which is under construction, and to the Albula Railway Museum in Bergün. To reach Preda, our train rode northwest through the original 5.8-km Albula tunnel, which connects the Albula and Engadin valleys on the Albula line connecting Chur and St Moritz. At 1820 metres above sea level, the Albula tunnel is among the highest in the Alps.

Opened in 1904, the original Albula tunnel now needs major work. To avoid a long closure, RhB decided to build a new, parallel tunnel, some 30 metres to the northeast. It is about 80% bored and will open in 2021. Cross-passages will connect the new tunnel to the old one, which in 2022 will be refitted as an escape tunnel usable by road vehicles.

We were welcomed by the RhB's Gilbert Zimmermann, who presented the history of the tunnel and the current project. Building the original tunnel was difficult. Then, as now, the harsh winters confined work to the warmer months. On 29 July 1900, 1192 metres southeast of the Preda portal, workers broke into a watery zone that filled 500 metres of the tunnel with cold, mud-like slurry.

This stopped work for 15 months. The original contractor went bankrupt. In 1901 RhB took construction into its own hands. Tunnelling from both ends under a bonus system, workers were able to regain part of the lost time and broke though on 29 May 1902, allowing the tunnel to enter service in July 1904.

In 2012, after 108 years, the tunnel's walls and drainage system needed major work. Instead of renovating the old bore, RhB decided to build a new single-track tunnel some 30 metres to the northeast. This cost about the same as renovation, avoided a long closure of the line and allowed converting the old tunnel into an escape and rescue bore for the new one. The new tunnel will also be wider to facilitate train evacuation.

Three days earlier, Hans-Peter Vetsch had reminded us that those who ignore history will make the same mistake twice. When work on the new tunnel began in 2015, the RhB were perfectly aware of one bit of history: the exact location of the slurry zone the original tunnel builders had encountered in 1900. To avoid a second slurry inrush, RhB's contractors, working from the existing tunnel at night, opened a cavern in the mountain on the new tunnel's path, just southeast of the slurry zone. From there, workers drilled numerous holes 60 metres long, parallel to the future track. Through these holes, they pumped salt water, which freezes at a lower temperature than the mountain's fresh water. This let them freeze a mass of rock extending some 2.5 metres outside the excavation profile. Once the frozen material was removed from the centre, a 1.2-metre-thick, highly reinforced shotcrete lining had to be installed within seven days.

In an emergency, 12 cross tunnels roughly 440 metres apart will let passengers escape into the old tunnel, which will be provided with lighting, a communication system and ventilation. The new tunnel's cross section will be larger to ease evacuation, but it will still be a single line. The portal stations will still offer passing loops, however. An extra block section will increase capacity.

Members inspect the construction of the new Albula tunnel.

The project is under pressure to break the tunnel through by September 2018. The IRSE therefore are most grateful that RhB stopped work for the day so that members could ride into the tunnel.

Because of the geotechnical makeup of the mountain and particularly the slurry zone, RhB decided to blast and excavate the tunnel instead of using tunnel boring machines. We were able to walk along a section of the excavated tunnel and see drilling and rock-crushing machines, the conveyor system that removes spoil, and one of the cross-passages. Despite robust ventilation, the smell from the previous night's blasting was still strong and must be very strong when work is taking place. How would it have been 120 years ago? Outside the tunnel, the spoil is sorted by size, quality and degree of contamination by the blasting that produced it. Some rock goes into the tunnel's concrete or track ballast; much of the rest will underlie a re-vegetated hill.

We then rode the most spectacular part of the Albula line. Preda is 5.2 km from Bergün as the crow flies and 417 metres higher. To keep the grade below 3.5% and minimise tunnel time for the tourists for which the line was mainly built, engineer Friedrich Hennings devised an alignment involving three spiral tunnels and numerous stone viaducts that lengthened the line to 12.6 km. It crosses over itself twice.

Albula Railway Museum

The Albula Railway Museum is next to Bergün railway station. Built in 1912 for the Swiss army, the building opened as a museum in July 2012. The 1300 square metres of exhibits guide visitors through the history of Graubünden's railways.

Our guided tour included a talk by Gion Caprez, an RhB driver. Some 600 exhibits from more than a century of railway history pay tribute to pioneering achievements in Graubünden. Decommissioned signalling panels, telephones, station clocks, historical documents and engineering plans illustrate the history and importance of the spectacular route between Thusis and Tirano, which in 2008 was designated a UNESCO World Heritage site.

"Crocodile" locomotive 407 ran through the Albula valley for more than 50 years and is now on display. A simulator in the locomotive lets visitors drive through the valley. Historical photos, texts, models and 3D animations show how engineers routed the railway through the Albula's mountainous terrain. A 1:45 model railway presents buildings, viaducts and tunnels of the RhB in the 1950s. The detail extends to the size of the boulders next to the line.

Gala farewell dinner

The Convention's final event was a gala farewell dinner in the Pontresina convention centre. After a busy week of site visits and networking, it provided a chance to relax and to thank all those who had contributed to the Convention's success.

Between courses, the Cor masdo da Puntraschigna or Mixed Choir of Pontresina provided entertainment. Led by Urs Conrad, the choir continue an old tradition of area authors, composers and choirs who write and perform songs in German, Italian and Romansh, the area's local language. Romansh is mostly spoken in the Swiss canton of Graubünden, where it has official status alongside German and Italian.

President Montigel thanked the organising committee for all their hard work in organising the week's events and visits, the sponsors for their generous contributions, and in particular Ian Harman, David Street and Francis How, as this was their last Convention after many years of successful events.

Top and above, the Albula Railway Museum contains many historic signalling systems and demonstrations.

All set for the Gala farewell dinner.

Thank you David Street

Ian Harman

The 2018 Convention marks the end of a chapter in the history of IRSE Conventions, in that our long standing (and long suffering!) Hotel Co-Ordinator David Street has decided that 2018 is the time at which to retire and to end his 30 year association with IRSE Conventions.

For many years, David Brown Travel had arranged the hotel accommodation and some of the travel aspects of IRSE Conventions. David Street started to get involved in making these arrangements as part of his duties with David Brown Travel – and thus began his long association with the Institution.

When David Brown sold his company in 2009, David Street decided to set up his own company DS Travel Management to deal with bespoke travel arrangements of his customers, including the IRSE and the Conventions.

David has become a well known and very friendly face at IRSE Conventions, not only negotiating contracts on behalf of the IRSE with the Convention Hotels, but also dealing with the many details that surround the meals, accommodation, transport to and from venues, and the seating plans for gala dinners, as well as being a fount of knowledge about all things 'Convention'. His intimate knowledge of the way that the Institution runs Conventions, and the preferences of those Members and their Guests who have been regular attenders, has been crucial in the smooth running of these events.

David has been a great support to me over the few years that I have been involved with Conventions, and I also know that my predecessor Roger Penny found David's help and knowledge invaluable in the running of the Conventions during his period of tenure as Convention Coordinator.

Many thanks to David, Liz, Ian and Linda.

We must also not forget Liz Bambury, David's long suffering (with Conventions!) partner, who has always been there to help out, and to provide support and encouragement to all of us when the going gets a little bit tough (as it does sometimes), and to help with filling the delegates bags, and anything else that needs doing.

David has always been energetic, keen to make Conventions succeed, and conscious of all of the details that make a Convention work at a practical level. I don't think I have ever seen him sit down and eat a complete meal at a Convention gala dinner – he has always been flitting around making sure the everything is working as intended, and that everyone's needs (apart from his own!) are being met. I fear that David has had more experience with unintended cold collations of food than he would have wished for!

David now intends to spend his well-earned retirement with Liz and the grand-children, and he has even threatened to take up cycling, and to get Liz to teach him golf. Whatever he chooses to do, I wish him and Liz well for a long, happy and contented retirement.

Footnote by Francis How: I, and I am sure many Presidents over the years, echo Ian's words about David. He has been absolutely invaluable and we shall miss him. And I also want to make mention of Ian himself, who is stepping down from the role of Convention Coordinator after several years in that unenviable position. Ian – we are also very grateful to you for all that you have contributed to our Conventions, for your diligence in keeping the organising committees on track, and for keeping smiling however challenging the circumstances. Only you, David and a handful of others really know what goes on behind the scenes to make Conventions successful

IRSE
Institution of Railway Signal Engineers

Achieving high levels of signalling system availability – is there a role for secondary systems?

Prepared on behalf of the International Technical Committee
by Alan Rumsey

Rail Operators are driving the signalling industry to take a more holistic view of rail transportation operations with signalling solutions that recognise not only the importance of achieving high levels of signalling system safety but also high levels of signalling system availability. They are looking to the signalling industry to provide solutions that not only exhibit 'fail-safe' characteristics but that also support degraded modes of working following equipment failures.

Meeting this challenge requires solutions that:

1) Reduce the number and frequency of service-affecting failures in the primary signalling system;
2) Reduce the time required to recover from service-affecting failures in the primary signalling system; and
3) Provide independent means to continue to move trains, in a degraded mode, pending recovery from service-affecting failures of the primary signalling system. In this article, such independent means will be described as secondary systems. Other terms that have been used to describe such secondary systems include 'auxiliary wayside systems', 'fall-back systems', 'back-up systems', and 'degraded mode of working' systems.

Primary signalling system

The primary signalling system is defined as the fail-safe system designed to deliver the primary mission of moving trains safely and reliably from origin to destination. This could be a conventional wayside signal system (with or without enforcement), a cab-signalling system (providing automatic train protection (ATP) and automatic train operation (ATO) functions), a CBTC system, or an ETCS system (at various levels).

A generic signalling system solution would comprise the following elements of equipment that:

- Determines train location (which could be track-based, or train-based).
- Establishes and protects a 'safe route' for a train, such as interlockings and other wayside signalling equipment (typically located at trackside, in signal equipment rooms, or at central office locations).
- Establishes movement authority limits for individual trains, based on train locations and route status.
- Provides movement authority enforcement and other safety-related or operations-related functions (which could be track-based, or train-based, or a combination of both track-based and train-based equipment).
- Provides control and supervision functions at the central office.
- Links the various components of the signalling system using data communications.
- Powers all wayside, train-borne and central office equipment.

Secondary systems

The different terminology used to describe secondary systems can, unfortunately, create some confusion and misunderstandings as to the true purpose and intent of these systems. In this article, the following different 'grades' of secondary systems (GoSS) are defined.

GoSS 0: At the lowest grade there are no secondary systems, and degraded mode working following a service-affecting failure of the primary signalling system is managed solely through strict compliance with operating procedures, with control centre personnel responsible for issuing verbal movement authorities, and train operators responsible for complying with these verbal movement authorities. The primary signalling system would typically include facilities to override the 'fail-safe' signalling protection in order to move trains following a failure of the primary signalling system.

GoSS 1: At the next grade, degraded mode working following a service-affecting failure of the primary signalling system is still managed through strict compliance with operating procedures, however non-vital secondary systems are provided to assist control centre personnel in issuing verbal movement authorities and/or to assist the train operator in complying with these verbal movement authorities. The intent of such systems is to reduce the risk of human error, and to reduce the operational impact of the primary signalling system failure.

GoSS 2: At this grade, secondary systems begin to duplicate certain safety functions performed by the primary signalling system but do not provide the same level of safety protection as the primary system. Specifically, a GoSS 2 solution would include an independent and vital secondary means of train location determination. The intent of such systems is to reduce, but not eliminate, reliance on operating procedures during degraded mode working.

Vancouver's SkyTrain system, a GoSS 0 system.
Photo Shutterstock/Meunierd.

GoSS 3: In addition to a vital secondary means of train location determination, at this grade secondary systems would also provide an independent vital means for establishing movement authorities (MAs).

GoSS 4: At the highest grade vital secondary systems would provide the same level of safety protection as the primary signalling system by independently establishing train location, creating movement authorities, and enforcing movement authorities for trains that are not protected by the primary signalling system. Such secondary systems are essentially an alternative signalling system. The intent of such systems is to provide an equivalent level of safety for degraded mode working as would be provided during normal operations. A GoSS 4 solution is also required if there is a need to support 'mixed mode' operations i.e. when there are some trains operating on the line that are protected by the primary signalling system, and other trains operating on the line that are not protected by the primary signalling system and therefore have to be protected by secondary systems.

Clearly, the higher the 'GoSS', the more complex the signalling solution.

The extent to which secondary systems are required to continue to move trains in a degraded mode pending recovery from service-affecting failures of the primary signalling system, should be fundamentally driven by the:

a) Frequency and operational consequences of service-affecting failures in the primary signalling system.

b) Time required to recover from such failures.

Clearly, if the primary signalling rarely failed, if the operational impacts were minor, and if recovery to full service could be accomplished rapidly, there would be a limited business case for secondary systems. Other factors that may influence the level and complexity of such secondary systems could include the:

c) Grade of automation (GoA) of the line, i.e. whether or not there is a train operator onboard the train.

d) Safety and operating performance levels required during degraded mode working.

Improving the availability of the primary signalling system

As noted above, minimising the frequency and operational consequences of service-affecting failures in the primary signalling system are key business case requirements for any signalling system solution, and there are essentially two approaches to achieving high levels of signalling system availability.

The first approach is to focus on achieving the lowest practical hardware failure rates for individual components and items of equipment that form the specific signalling solution (for example, reliable track circuits, track switch status indications, relays, signals, power supplies, cable connections, etc.).

This has been the traditional approach within the signalling industry through on-going design improvements, and more recently through remote condition monitoring of signalling equipment in support of pro-active predictive maintenance strategies. The advantage of this approach is that it leads to relatively simple signalling system architectures.

The disadvantage of this approach is there remains a relatively high number of single points of failure i.e. single failures that can be service affecting.

The second and complementary approach is to focus on eliminating or minimising single points of failure within the signalling system solution; an approach that has become more practical with the introduction of computer-based and communications-based technologies. Single points of failure can be eliminated or minimised though appropriate levels of equipment redundancy and diversity such that the failure of a single component, device, power supply or communications channel will not render the system unavailable or an operationally critical function non-operative.

This includes all elements of the primary signalling system as defined above, including communication equipment and equipment power supplies. The advantage of this approach is that it theoretically leads to much higher levels of systems availability. The disadvantage of this approach is increased systems complexity with associated increases in system cost.

Regardless of the approach adopted, the goal should be to keep the signalling solution as simple as possible to meet the specific business case needs and operating/maintenance practices. This includes not only the system architecture, but also the system software which increasingly is the dominant component of modern signalling systems.

There is an argument that while modern software-based signalling systems may ultimately exhibit high levels of system availability, the time required to achieve

Sheppard West station on the recently opened Toronto-York Spadina Subway Extension (TYSSE), a recent example of a CBTC GoSS 2 solution.
Photo Toronto Transit Commission.

this level of system availability during in-service operations in and of itself justifies the need for secondary systems.

The counter argument is that poor system availability during initial operations is more a consequence of an inadequate/incomplete test & commissioning process, and a lack of operational and maintenance readiness, rather than an inherent characteristic of software-based signalling systems, and that more effort should be expended in these areas before incurring the capital and ongoing maintenance costs of secondary systems.

Reducing the recovery time after a service-affecting failure

Reducing the time required to recover from a service-affecting failure in the primary signalling system requires consideration of many factors including the time:

- Required to identify the nature of the failure.
- To travel to the appropriate site.
- At the site to diagnose and troubleshoot the failure.
- To replace the failed components.
- To test the repaired unit/subsystem.

Design characteristics of the primary signalling systems that can reduce the time required to recover from a service-affecting failure would include real-time condition monitoring, remote and local diagnostic provisions, and equipment access which can be improved by minimising track-based equipment and centralising critical systems wherever possible.

The effectiveness of maintenance support systems, training of maintenance personnel and the physical location of maintenance personnel and spare parts, also influence the recovery time.

Selecting the appropriate secondary systems

Given that knowledge of the location of trains is an essential prerequisite for issuing movement authorities to trains, this section will focus on secondary means of train location determination, following a failure of the primary means. There are three specific scenarios that can be considered:

Scenario 1: The primary train location determination equipment is track-based (for example, fixed block signalling systems utilising track circuits or axle counters as the primary means of train location determination). In such a scenario, any secondary train location system, if required, would likely be train-based, with secondary train location information communicated to central control via a train-to-wayside data communications link;

Scenario 2: The opposite would apply, with the primary train location determination equipment being train-based (for example, moving block CBTC or ETCS Level 3 systems). In such a scenario, any secondary train location equipment, if required, would likely be track-based (track circuits or axle counters);

Scenario 3: movement authorities are established by track-based train location determination equipment, and movement authority enforcement is achieved by train-based train location equipment (e.g. 'distance-to-go' and ETCS Level 2 signalling systems).

Discussion on each of the above three scenarios are provided below:

Scenario 1

Examples of Scenario 1, where the primary train location equipment is track-based (track circuits or axle counters), would include traditional fixed-block signalling solutions. These solutions typically do not include any secondary systems, as defined herein, i.e. are GoSS 0 solutions, relying on achieving acceptable levels of system availability through highly reliable components/equipment. Degraded mode of working following service-affecting failures in the primary signalling system is by means of strict compliance with operating procedures, utilising facilities within the primary signalling system to override the fail-safe signalling protection (e.g. to allow a train to pass a restrictive signal aspect).

In the UK, however, Network Rail has recently embarked on a research project that is attempting to develop new secondary systems that will enable trains to continue to move safely should its existing fixed-block signalling system fail, and to support a more rapid recovery to full service. The goal is to mitigate up to 70% of the operational delays currently caused by signalling system failures.

Following a failure of the primary signalling system, this secondary system, referred to as 'COMPASS Degraded Mode Working System (DMWS)' [1], is intended to allow the control centre (Rail Operating Centre) to independently determine a train's position, monitor its speed and travel direction, and verify that a safe route is correctly set, without the need to deploy line-side personnel. Based on this independently determined information, the control centre would then authorise appropriate train movements verbally or via a text message to the GSM-R cab radio.

Although described in some public-domain documents as an 'alternative signalling system,' or as a 'back-up train control system', COMPASS DMWS is in fact not viewed as an alternative signalling system, but rather an independent non-vital source of train and infrastructure status information, to support and supplement degraded mode operating procedures. As such, using the terminology of this article, COMPASS DMWS would be defined as a GoSS 1 solution.

In scenario 1, the primary train location system is track-based, and as such a track-based failure would impact every train operating over that section of track and would typically require maintenance personnel to be dispatched to the site to correct the fault and restore service. The proposed secondary train location system in COMPASS DMWS is currently anticipated to be train-based using the Global Navigation Satellite System (GNSS) and GSM-R train-to-wayside communications.

The COMPASS DMWS research project is currently in the feasibility demonstration stage, with prototype equipment. Key challenges that remain to be addressed, prior to any full-scale operational deployment, include:

- Operation approvals: will such secondary systems deliver the anticipated operational benefits?
- Safety approvals: will such secondary systems mitigate existing hazards, or introduce new hazards, associated with degraded mode working, specifically if the secondary systems are not fail-safe?
- Costs: will the life cycle costs of installing/maintaining such secondary systems support the business case for their deployment?

Scenario 2

Examples of Scenario 2, where the primary train location equipment is train-based, would include the newer generations of moving block signalling technology such as CBTC systems or ETCS Level 3 systems. To date, most of the industry discussion on secondary systems for such signalling systems has centred around CBTC deployments on passenger-carrying metros [2,3], but the issues raised here would equally apply to ETCS Level 3 deployments for passenger trains and freight on main line rail lines.

Since the initial installations in the 1980s, CBTC technology has been widely deployed around the world, in both 'greenfield' (new start) and 'brownfield' (re-signalling) applications. The technology has been implemented on light-rail systems, metros, and commuter rail systems, with grades of automation from GoA 1 (ATP only) to GoA 4 (fully automated/unattended). CBTC technology is available from multiple suppliers and is service-proven and safety-proven, with substantial operating and system availability experience. However, there is no 'industry standard' CBTC solution, and CBTC systems have been deployed both with and without secondary systems, and with a variety of different secondary systems.

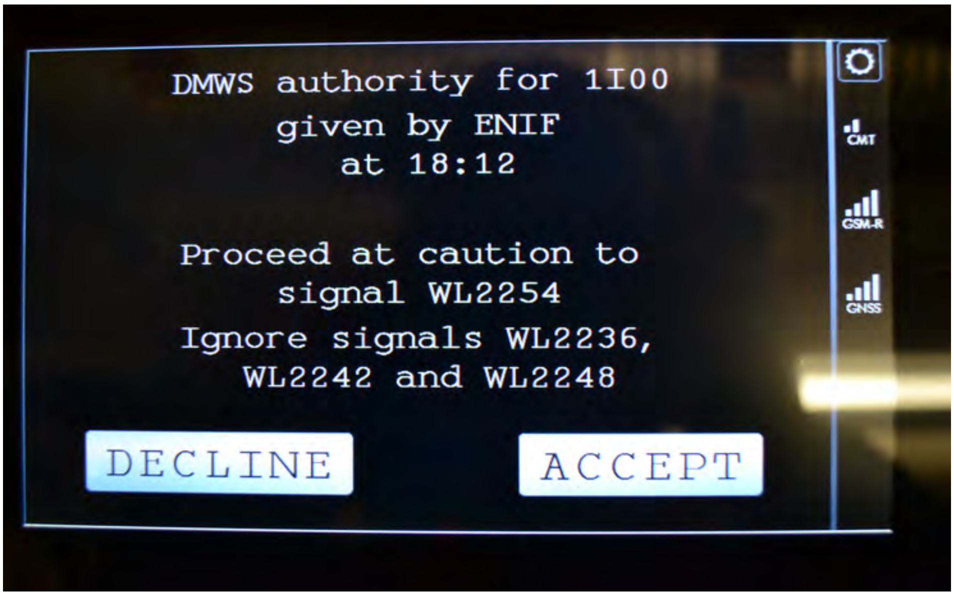
For example, one of the first greenfield, inductive loop-based CBTC systems on the SkyTrain system in Vancouver, Canada, operating at GoA 4, had no secondary systems. Using the terminology of this article, this was a GoSS 0 solution. On the other hand, one of the first brownfield, radio-based CBTC systems, on the Canarsie Line in New York, USA, operating at GoA 2, was a GoSS 4 solution, primarily to support mixed mode operations, with track-based secondary train detection (track circuits) and secondary train protection (wayside signals and train stops).

There are also many examples of CBTC GoSS 2 and GoSS 3 solutions, with (for example) track-based secondary means of train location determination (track circuits or axle counters).

As such, with each new CBTC application, there is typically a renewed debate on the secondary systems required for that application.

Experience would suggest that a conservative approach was adopted in the early deployments of CBTC in brownfield (re-signalling) applications, at a time when there was limited operational experience with the technology. These early deployments typically included complex secondary systems. Today, with over 30 years of operating experience, the clear trend now is to minimise and simplify secondary systems wherever possible.

It should be noted that most CBTC systems inherently incorporate features and functions to assist control centre personnel during degraded modes of operation, specifically for the movement of trains with a total failure of train-borne CBTC equipment, and to work around blocked tracks, for example. Also, with high-capacity, bi-directional, data communication links between control centre equipment, wayside equipment, and train-based equipment, CBTC systems inherently provide control centre personnel with a high level of information on train and infrastructure status.



Network Rail's COMPASS degraded mode working project is one example of a system that offers some train movements in failure conditions.
Photo Clive Kessell.

GoSS 4 on New York's Canarsie Line.
Photo MoskFPS/Wikimedia Commons.

Currently, GoSS 0 solutions, with no secondary systems, have been limited to greenfield CBTC applications operating at GoA 4 (Unattended Train Operations), where the emphasis had to be on achieving the highest possible levels of availability of the primary signalling system, given the absence of onboard staff to support degraded modes of working. (Indeed, it could be argued that it is the presence of a train operator on board the train that has driven the need for secondary systems.)

With such a GoSS 0 solution operating at GoA 4, while service-affecting failures can still occur, the frequency of such failures, and the recovery time from such failure, is such that the operational impacts are assessed to be acceptable. An analogy can be drawn here to traction power systems which are also designed to include high levels of redundancy with no secondary systems. In the event of a service-affecting traction power system failure, there is no other option but to suspend service until power can be restored. This is also assessed to be acceptable if the frequency of such failures is sufficiently rare.

Today, GoSS 4 solutions, with secondary systems providing an equivalent level of safety as the primary signalling system, are generally restricted to those CBTC applications where mixed-mode operation is a mandatory requirement. To avoid the cost and complexity of a GoSS 4 solution, the focus now is to avoid mixed mode operations whenever possible by ensuring that all trains operating on a CBTC-equipped line (including maintenance-of-way trains) are CBTC-equipped.

This also includes during the migration phase where there is a preference to dual-equip the train (so it can operate in CBTC-equipped and non CBTC-equipped territory, rather than dual-equip CBTC territory with GoSS 4 secondary systems. An analogy can be drawn here with traditional track circuit-based signalling systems where it is assumed that all trains operating on a signalled line will shunt the track circuits. If there were a need to operate a train on the line that did not shunt the track circuits, special operating procedures would apply. Similarly, if there were a rare need to operate a non-equipped train on a CBTC-equipped line, special operating procedures could similarly apply.

Similar issues will arise when main line railways move away from traditional fixed block signalling systems. With early ETCS Level 3 deployments, it may not be practical to avoid mixed-mode operations. As such, a 'Hybrid Level 3' solution is currently being jointly developed by Network Rail in the UK and ProRail in the Netherlands in which track-based train detection (track circuits or axle counters) would be retained to support mixed-mode operation of Level 2-equipped trains with Level 3-equipped trains [4]. This would essentially be a GoSS 2 solution, given that there would be no independent equipment to replace the functionality of the Radio Block Centres (RBCs) or train-based ETCS equipment.

Any train not equipped for either ETCS Level 2 or 3 operation would not be permitted to run on a Hybrid Level 3-equipped route unless, in addition to track circuits or axle counters, lineside signals were also retained (a GoSS 3 solution). However, the primary intent of Hybrid Level 3 is simply to allow certain trains to start operating in Level 3 mode on what essentially is still a Level 2 line i.e. all trains would either be Level 2 or Level 3 equipped.

When mixed-mode operations are not required, the primary debate for secondary systems with CBTC is, today, focused primarily on the need for, and specific configuration of, GoSS 2 solutions, with secondary means of train location determination, to support a more rapid recovery to full service following an infrequent failure of the primary CBTC system. A similar debate should be anticipated for ETCS Level 3 deployments, even when all trains operating on the route are equipped for ETCS Level 3 operation.

Operational risk assessments, that consider both the frequency of CBTC system failures, the operational impact of these failures, and the time to recover from such failures (drawing on operating experience from existing in-service CBTC applications) generally indicate that the highest operational risk relates to failures that result in a lack of train location reporting from a single train.

While such failures are 'fail safe', recovering from such failures requires train location reporting to be re-established, which typically requires train movements in a degraded mode to re-initialise train location reporting. Such train movements can be achieved solely through strict adherence to operating procedures, utilising features and functions available within the primary CBTC system (GoSS 0 solution), or can be supported by independent systems to determine a train's position (GoSS 2 solution); typically track circuits or axle counters. (There are currently no known examples of a GoSS 1 CBTC solution, as defined herein.)

If track circuits or axle counters are deployed as a means of secondary train detection, then there is also a tendency to use these devices for other purposes, for example to drive wayside signal aspects and as input to interlockings (i.e. GoSS 3 solution). This again can further increase the complexity of the secondary systems. It has been suggested that secondary systems can increase the cost of a CBTC re-signalling project by as much as 30%.

Experience has shown that migrating to CBTC is significantly simplified if axle counters are used as the means of secondary train detection, and axle counters are now increasing being deployed in CBTC re-signalling projects as an alternative to track circuits. The primary argument for retaining track circuits is that track circuits can detect broken rails. However, numerous studies have shown that the ability of track circuits to detect broken rails in a timely fashion is extremely limited, and a more holistic approach is being taken to the issue through, for example, more pro-active preventive maintenance regimes focused on the prevention of broken rails.

In summary, the current 'standard CBTC solution' that has evolved over the past 30 years typically includes, as a minimum, secondary train detection systems utilising either track circuits or axle counters. Indeed, there are some CBTC products that have been specifically developed and designed as a GoSS 2 solution, with secondary train detection an inherent element of the system architecture.

On one side it can be argued this reflects the appropriate due diligence of signalling professionals and political decision-makers. On the other side, it could also be argued this has evolved based primarily on subjective and emotional considerations, rather than on a thorough risk assessment and quantitative cost-benefit analysis.
As such, the debate on the need for secondary systems with CBTC can be expected to continue. At least, perhaps, until such time as a GoSS 0 solution, with no secondary train detection, is actually implemented on a brownfield re-signalling project. Similar discussions should also be anticipated with the deployment of ETCS Level 3.

Scenario 3

Examples of Scenario 3, where movement authorities are established by track-based train location determination equipment and then enforced by train-based train location equipment, would include fixed-block distance-to-go cab-signalling systems and ETCS Level 2 systems.

An ETCS Level 2 system, for example, is not a stand-alone signalling solution and is generally deployed as an overlay with existing track-based train detection equipment and existing interlockings equipment providing the basis for establishing movement authorities that are then communicated to and enforced by train-borne ETCS Level 2 equipment. The availability of the complete signalling system solution is therefore constrained by the reliability and failure recovery times, of the existing track-based train detection equipment and existing interlockings. As with scenario 1, these underlying train detection and interlocking subsystems typically do not include any secondary systems, as defined herein, i.e. are GoSS 0 solutions, relying on achieving acceptable levels of system availability through highly reliable components/equipment.

Depending on the success of the COMPASS DMWS research project referenced earlier in this article, such non-vital DMWS secondary systems could potentially also be deployed as an element of an ETCS Level 2 GoSS 1 solution such that in the event of a failure in the underlying track-based train detection and interlocking subsystems, control centre personnel could independently determine a train's position and verify that a safe route is correctly set, in order to verbally authorise appropriate train movements. Such a solution has not however been deployed to date.

Summary

In summary, today only those signalling solutions that utilise train-based technology as the primary means of train location determination, such as CBTC solutions, are being regularly deployed with a secondary means of vital track-based train detection, either with or without a secondary means of movement authority determination (GoSS 2 or GoSS 3). Secondary systems are included even though CBTC technology has been specifically designed to eliminate or minimise single points of failure through high levels of equipment redundancy and diversity, and even though this technology has been specifically designed to eliminate or minimise track-based equipment such that in the event of a failure in the primary train-based train location detection equipment there is no requirement to deploy line-side personnel for failure recovery.

Similarly, today, the only signalling solution that has been deployed together with an alternative secondary signalling system providing secondary vital train detection, movement authority, and movement authority enforcement (GoSS 4), is CBTC technology. Such deployments are primarily to support 'mixed-mode' operations either during normal revenue service operations, or during the introduction of CBTC on a complex rail network before all trains operating on that network are CBTC-equipped.

The factors that have resulted in secondary systems being incorporated within CBTC technology solutions may also apply to the future deployment of ETCS Level 3 solutions.

Signalling technology solutions that rely on track-based train detection as the primary means of train location determination typically do not include any secondary systems (GoSS 0), even though the operational impacts and recovery times in the event of a track-based train detection failure can be significant. With such systems, the traditional approach has been to focus on achieving the lowest practical hardware failures rates, with regular preventative maintenance together with remote condition monitoring. The COMPASS DMWS initiative referenced in this article could potentially support more rapid failure recovery, as a non-vital GoSS 1 solution.

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Key token signalling with a 21st century twist

Grahame Taylor
Tern Systems Ltd, UK

IRSE News June 2010 featured TERN – Token Exchange using Random Numbers and a demonstration to the IRSE Minor Railways Section on a visit to the Ravenglass and Eskdale Railway. Grahame now provides an update on the principles of key token signalling and the development of the Ternkey project.

It's a favourite (and infuriating) trick of some writers to start any technical article with a statement of the blindingly obvious. Here goes! Key token signalling has been around for a long time. Maybe some members of the IRSE didn't know that, but it's more likely that they did – another obvious statement.

This article examines the Ternkey project which takes the principles of key token signalling and propels them into the digital age. It is a deliberate use of a traditional physical authority – a key with an engraved tag attached – at a time when in-cab signalling and automatic control occupies the energies of the mainstream signalling industry.

The challenge that gave rise to the project was the need to supply train control equipment for a single line steam railway that had five passing loops. However, there was no lineside cabling nor many trained ground staff and all but one of the loops was out of use. Despite these hindrances, the railway did have ambitions to run more trains and a reliable service thus generating more revenue. This it could not do without reinstating the unused passing loops.

Thus the remit was to build a system that would give a Line Controller the operating flexibility of opening loops at the touch of a button to allow trains to pass in order to reduce train and passenger delays. Straight away, after several cab rides, it was obvious that in-cab signalling was a complete non-starter. The steam locomotive environment involves heat, cold, weather, water, dust – lots of dust – vibration and usually at least two people in a cramped space, one of whom wields a hefty shovel loaded with coal. Key tokens appeared to be the only way forward.

A new approach

Installing pairs of conventional key token machines was not an option due to the lack of cabling, key token machines and technical skills.

Even if it had been possible to use conventional machines, however they were linked, there was still the issue of operating flexibility. There are other locations where equipment has been made to work using digital networks, but heritage machines do not lend themselves to being linked in a coordinated structure that allows a whole branch to be controlled by one person.

A new system architecture and new token machines were required. Given that this equipment did not exist, it meant that just about everything had to be constructed out of Components Off The Shelf (COTS) and built using Suppliers And Manufacturers Unknown to the Railway Industry (SAMURaI to coin a new acronym) with the controlling software written from scratch. As a result, the project has been complex with every stage and element presenting possible show-stoppers.

The up-side, of course, is that there has been an opportunity to start from a completely blank piece of paper. It meant designing and building unconventional key token machines based entirely on an operator's needs, allowing a Line Controller the chance to actually manage a train timetable whilst at the same time dealing with passenger enquiries and crises. It meant devolving the issuing of key tokens to drivers under instruction from the Line Controller, using machines that guard against unsafe acts.

The overall architecture:

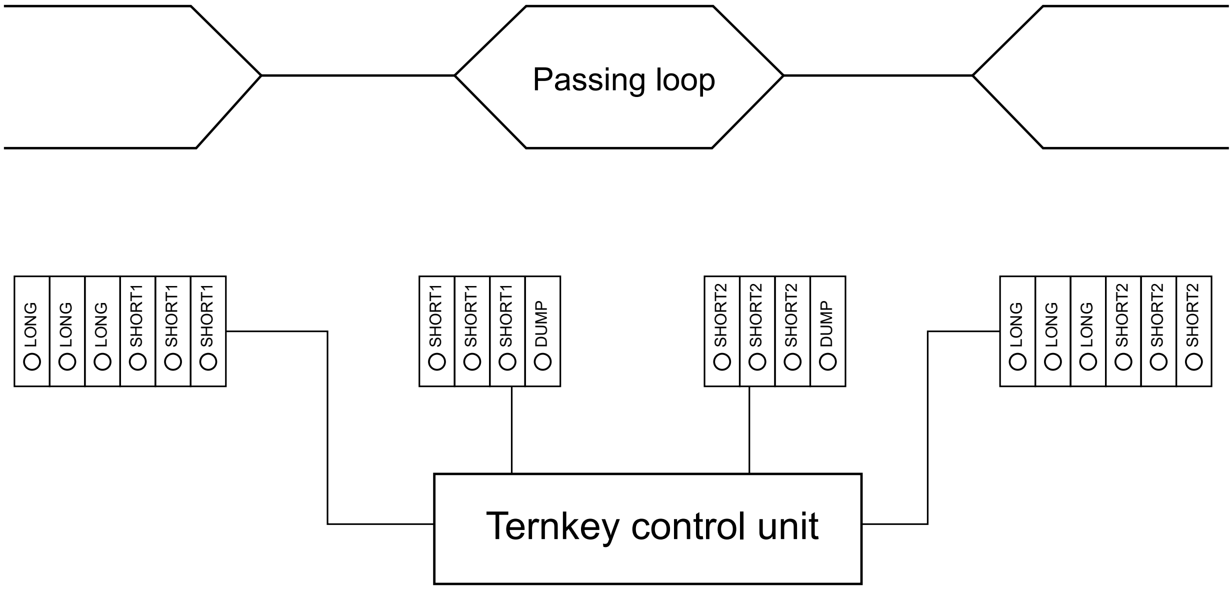
At each end of a single line there is a Ternkey (TK) machine. Each TK communicates via a network to a server program which, in turn communicates with both a controlling program and an audit program.

The controlling program contains all the rules associated with a layout. The audit program monitors the system and its Ternkey transactions, comparing the system inputs and the control program outputs. It is also the second opinion without which no token can be issued.

For a simple single line layout, each TK will hold a number of locks into which keys can be inserted or removed. The number of locks depends on the intensity of the train service and can range from just two to twelve. Each lock is twinned with a corresponding lock in the other TK unit. Each pair of twinned locks has a uniquely cut key.

Herein lies the difference between a conventional key token machine and a TK unit. The former relies on the detection of polarity – an electrical 'one-trick-pony'. Polarity is either + or - . That's it, there's nothing else to detect.

The TK system counts and accounts for keys. That is, the number of captive keys can be counted and the position of the keys in the machines can also



A very simple arrangement of Ternkey machines with three long tokens covering the whole railway, three short tokens covering each of the two single line sections and two long token 'dump' locks in the short token machines. If there is a short token out in either of the single lines, then a long token cannot be issued. If a long token is out, then neither of the short tokens can be issued. If a long token is locked into a dump lock, then short or long tokens can be issued.

be detected. Both the number of keys and the position of the keys has to be consistent – a digital 'two trick pony'.

It is this ability of the system to identify the state of specific locks that allows the management of short, long or very long sections in real time. It is also the basis of the patent granted in 2017.

The components

The locks are simple and robust. The key barrel looks similar to a front door rim lock. This is because it is a front door rim lock. They are the archetypal Component Off the Shelf, made in their millions and all to the same dimensions no matter the manufacturer. They also have the happy property of securely capturing keys once they are rotated past vertical. Those in use in the production models are at the top end of the market in that they are high security locks beautifully manufactured by DormaKaba – but they are door locks nonetheless.

These barrels, completely unaltered, are built in to the front cover of an aluminium extrusion and drive an assembly of components precision manufactured by a firm in Kidderminster more used to working in the aerospace industry. A key is retained in the lock when the rotor behind the rim lock is unable to rotate because of a solenoid plunger forced by two limit switches and gravity into a deep socket in the rotor.

The key can be released when a relay is energised via the audit program that completes a circuit to the solenoid, and when the controlling program energises that solenoid circuit. The solenoid pulls a plunger clear of the rotor so allowing it to be turned. The limit switches detect the new position of the solenoid plunger and thus the possibility of the key being turned. As a point of principle, if the key can be turned, then it is assumed that it has been turned.... and withdrawn.

Other 'key' principles that guide the Ternkey project include

- Whatever happens, the Line Controller is in control – not the drivers.
- The system is a train control system using voice communication with authorities confirmed by the possession of unique key tokens.
- COTS must be treated with caution.
- The construction of the Ternkey units must be modular to allow rapid exchange and off-site repairs.

The sequence

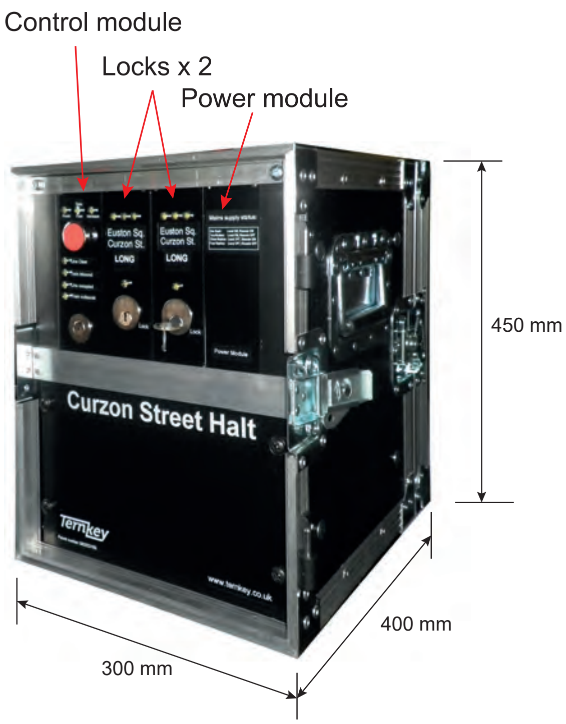
The sequence leading to the solenoid pulling the plunger clear of the rotor is initiated by a driver, standing by a TK machine, contacting the Line Controller to seek permission to obtain a token. If the Line Controller agrees, the driver presses a button on the TK unit. The control program checks that the request is in line with a set of route rules and polls each TK unit asking for a declaration of keys. These are coordinated in the control program which then asks the audit program for its opinion. If the audit program is happy, it causes the relay in the appropriate lock to pick. The control program is then informed that the audit program is content, so prompting the control program to cause the solenoid plunger to lift. The driver can then turn the key and withdraw it from the lock. The transaction is completed by the driver confirming the type of token obtained after which the Line Controller authorises the movement.

Five seconds after the solenoid plunger is lifted, everything is cancelled, the plunger drops and the position of the keys – or rather the state of the rotors – is polled. If the rotor has turned because a key has been withdrawn within the five seconds then the plunger just comes to rest on the rotor body and cannot drop into the socket. If the number of keys between the machines is out of balance then no more keys can be issued. If the key was never taken out, then this too will be detected as the plunger will drop back into the rotor socket and the system will revert back to a balanced state so allowing keys to be requested. When a key is returned to its twinned lock in the other TK machine (or even if it is returned to its original machine) there is an immediate system poll and a balanced state resumes.

This then is the simple option (viewable in a basic video at **www.ternkey.co.uk**).

The long section dump

However, as the software has been written to cater for up to twelve TK units, it is possible to control a line with five passing loops all with a single control program.



The Ternkey unit, left, and a detailed view of the front panel.

The rules become a little more complex, but not outrageously so. They can cater for long and short sections and for complete possessions. They can cater for the hitherto unknown facility – the long section dump. This is a lock located at an intermediate machine that will accept a key from a long section. It would be used if a train with a long token cannot complete its journey and has to stop at a short section machine. Once the long section key is returned to the dump lock, the system again becomes balanced and short tokens can be issued to trains that would otherwise be delayed until the ailing train cleared the long section.

All the above resulted from the original commission. Prototype units covering one single line ran for a year using a closed network. These were replaced and production units ran for another year, again covering one single line and running in shadow mode.

Demonstration units

In the meantime, demonstration units that have a minimum specification have been built. They do not have the touchscreen displays that were fitted to the original units but each just rely on a single large button for the initiation of token requests. Information on the state of traffic is indicated by LEDs along with basic health status reports.

The point of constructing them is to demonstrate a number of possibilities. Firstly, that the system can be portable. They are nominally powered by mains power charging the standby battery, but the battery has the capacity to run for about ten hours before the solenoid will not pull.

The system can be transferable from one railway to another by simply altering the labels on the locks and the tags on the keys.

Exhaustive testing can be completed on or off site as there is no interface with existing systems.

The demonstration units have been assembled from the three basic Ternkey building blocks – a control module, a power module and standard locks. Fitted into a standard 19" rack that's all that's needed to control a single line.

Not only, but also....

It has been observed that what has been built is basically just a mechanism to allocate unique work authorities. Yes, it was designed for a conventional railway, but there are other possibilities where the holding of a physical authority might be preferred over an electronic equivalent:

- Think perhaps about long possessions where the progress of single engineering trains is still painfully slow.
- Perhaps there could be a change from sudden death switch-overs from old to new signalling schemes with an interim planned use of TK units?
- And, as train running is just a process, it could be possible to substitute the word 'electricity' or 'power' for the word 'train'.

The future....

The Ternkey project has come a long way from its origins in 2014 and indeed from much further back. It is a descendant of equipment designed to increase productivity on the Redmire and Eastgate branches in the late 1980s. TERN, at that time, stood for Token Exchange using Random Numbers. As the project has shown, concept is one thing. Design and build is another. Testing, commissioning and real life working is yet another. There are hurdles yet to overcome. For it to be used for signalling a working railway would probably require an independent safety case assessment.

Key token signalling has been around for a long time - but this is not to imply that it is due to be relegated to a dusty chapter of history. The use of physical tokens of authority – key tokens – now has a bright future in the railway industry fired on by the almost limitless possibilities of digital technology that can give an unprecedented level of operating flexibility to our minor railways – and maybe others.......

A video demonstration of the system can be seen at **irse.info/qwvar**

What do you think?

Could Ternkey be used for a conventional minor railway, tramway or other applications where a physical authority key is preferred, such as electrical isolation or hostile working? Would you be able to assist Grahame with taking it forward?
Let us know what you think at IRSE News, **irsenews@irse.org** or contact Grahame at **gt@gftaylor.co.uk**.

Do we need to enhance our train protection?

David Fenner

Train Protection & Warning System (TPWS) is a train protection system used throughout the UK passenger main line railway network and in Victoria, Australia. David Fenner discusses its history and success, together with why ERTMS is required for safety as well as capacity improvements.

TPWS has greatly reduced the risk of signals being passed at danger. However, it has number of limitations, and while it provided a relatively inexpensive stop-gap prior to the widescale introduction of ATP and ERTMS, the installation of the much more capable European Train Control System is now required to further improve safety.

Brief history of train protection in Britain from pre-nationalisation to TPWS

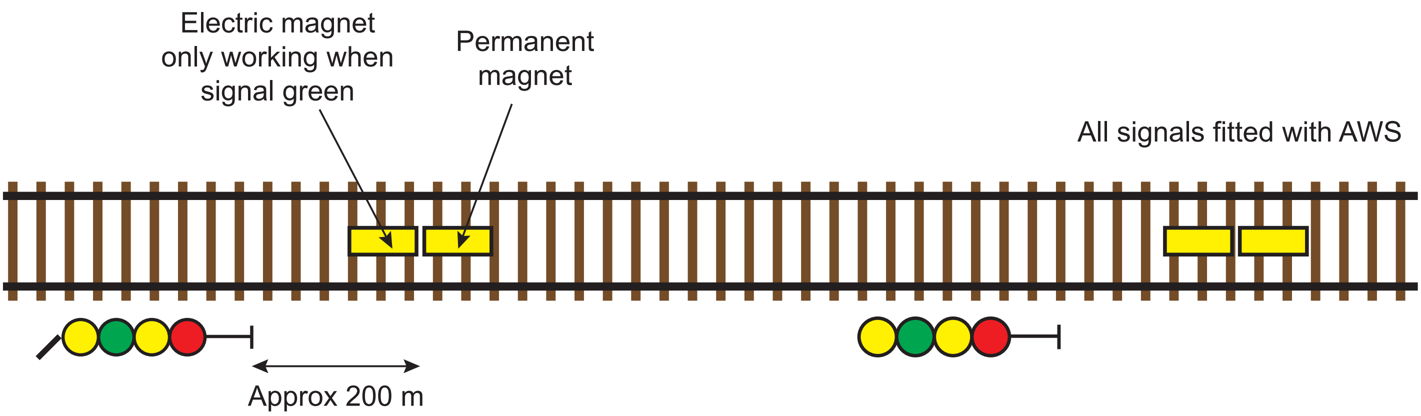
For more than a century railway people have been trying to find ways of ensuring the train driver never makes a mistake either by misreading a signal or by not observing or responding to a signal. Train stops were an early example as was the Great Western Railway Automatic Train Control apparatus. In addition to these systems there has been a steady improvement in the design and placement of signals as the significance of human factors associated with the train driving task has come more to the fore.

Work was in progress prior to World War II to develop a system of ensuring drivers were aware of the approach of a distant signal. The system eventually became AWS, the system we are now familiar with, but implementation was greatly accelerated by the serious rail accident at Harrow & Wealdstone in 1952.

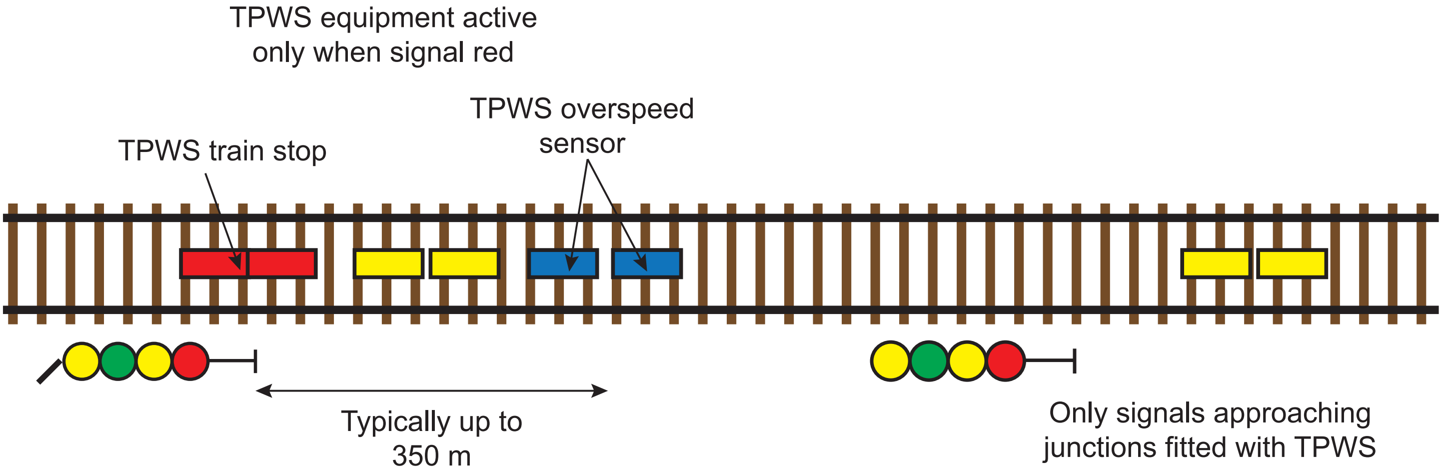
AWS and improvements in signal visibility arising from implementation of colour light signals in the second half of the 20th century reduced the number of accidents but a few caused by signals passed at danger (SPAD) continued. Toward the end of the century the demands for Automatic Train Protection were increasing, especially after each accident where a SPAD had occurred. Two experiments with ATP were conducted by British Rail around 1990. The first involved high speed trains operating from London to Bristol and the other on the suburban routes from Marylebone. Whilst the original plan was to select the best ATP system the actual outcome was evidence that a pure ATP system linked to the existing signals was not a good use of scarce financial resources.

The toll of the accidents that did occur was insufficient to justify the money to be spent. As a result, a project was established to try and find some affordable solutions to both reduce the number of SPAD events and to limit the consequence of those events. The Drivers Reminder Appliance (DRA) was one such outcome together with a still greater appreciation of human factors issues. The other was an enhancement to AWS to provide a train stop and overspeed

Trackside equipment for UK AWS and TPWS. On the left is the primitive technology used to send one bit of data, permanent magnet on the left, electromagnet to the right. Right a TPWS train stop antenna or 'toast rack'.



Operation of AWS:
1) Signal green: train responds to both magnets, sounds bell to driver, no action required.
2) Signal NOT green: train responds to one magnet. Sounds horn to driver. If driver does not respond to horn brake applied after 2 - 3 seconds. If driver responds, no action by system.



Operation of TPWS:
1) AWS as before.
2) If train speed less than overspeed when signal red no action, if overspeed then brakes applied for minimum 1 minute.
3) If train (front end) passes train stop when signal red then brakes applied for 1 minute.

function that would override the driver on approach to a red signal if the speed was excessive. Hence TPWS was born.

The rail industry was working toward an implementation plan for TPWS but too slowly for the supervising authority, The Health and Safety Executive. The Railway Safety Regulations 1999 were therefore enacted requiring fitment of TPWS within 5 years alongside other programmes intended to reduce risk. Fate again took hold with another serious accident caused by a SPAD at Ladbroke Grove in October that year.

TPWS was successfully implemented within the timescales required and together with a greater focus on 'professional driving' has so far prevented further serious accidents arising from SPAD events. TPWS however has limitations and can not prevent all possible SPAD or overspeed causes of accident scenarios.

Limitations of TPWS

Brake performance

TPWS relies on there being a significant difference between the braking profile of a well driven train and the best braking performance the train could actually deliver. After consultation with a few train operators it was decided that a well driven train would slow on approach to a red signal using a braking profile not exceeding a 6%g rate of deceleration; this sets the minimum speed at which a train should be tripped if a potential SPAD was detected. The protection offered then depends on the distance available to the accident location, the best brake performance the train can deliver and the actual speed. Different trains have different brake capability which is sometimes exacerbated by the tendency of the emergency brake to be guaranteed to function but not necessarily at the maximum possible deceleration rate. The result is that TPWS will never be able to stop every train prior to it reaching the possible point of collision and this is true even without consideration of poor adhesion conditions, that would make matters worse.

TPWS was originally expected to minimise collisions for trains travelling at up to 75 mph (115 km/h) but following the inquiry in to train protection instigated after the Ladbroke Grove (and Southall) accidents selective fitment of additional overspeed detectors were intended to increase protection to 100 mph (160 km/h) at critical locations. However the provision of additional overspeed sensors further from the signal slightly increases the risk of a false intervention.

There are also some trains operating on the network where the best brake performance is not much better than 6% g so the margin for some types of trains is even smaller. Finally, the low brake rate of freight trains and the relatively long

TPWS antennas in the foreground as a train approaches Manchester Victoria station.

delay in making the brake fully effective is why freight locomotives have a different timer setting to reduce the trip speed at which TPWS will intervene.

Limits of fitment

Whilst TPWS tackled the cost of fitment to the rolling stock by effectively upgrading the AWS equipment, it had limited impact on the cost of trackside fitment. Here however cost was contained by limiting fitment to signals where an accident was more likely, namely those protecting a junction. This leaves some signals unfitted but where in exceptional circumstances an overrun could result in a serious tail end collision. Some of the most significant of these locations have subsequently been fitted as a result of signal risk assessment but such assessment cannot account for the most unexpected of scenarios.

Equipment reliability

The basic TPWS equipment is simple and thus reliable but as a system that must be active to initiate a brake application it is not fail safe. A further risk that could still result in an accident is failure or isolation of the equipment at the wrong time.

Remaining risks

During project inception there was an assessment of both the frequency and outcome of SPAD-related accidents. In the 1980s and 1990s there were around 600 SPADs per year with an actual consequential collision on average every 15 months, not all resulting in fatality. It was estimated that TPWS could reduce the fatality count by around 70%.

In practice better driver training and management has reduced the number of SPAD by around 50% and TPWS seems to have reduced the accident rate by more than 70% but just one accident with significant numbers harmed could change the record.

Unfortunately TPWS may have increased the risk to track working staff with the addition of many thousands of TPWS overspeed and train stop loops all placed in the 4-foot requiring maintenance. The risk can be managed via safe systems of work but it is a risk that cannot be eliminated.

Finally, other countries with similar 'first generation' ATP systems have had accidents despite the system being in place. Is it reasonable to expect the UK to be different?

Public expectation

If, or more likely when, another serious accident happens as a result of driver error there will be a significant questioning of the industry about why we have still not implemented ATP. After all it was being discussed before the major accident at Clapham in 1988 and after the Ladbroke Grove accident in 1999. And yet here we are nearly 20 years later and still TPWS is the best available on the vast majority of routes.

Furthermore, if we do have a serious accident a few years from now, the regulators and the public are likely to point to the progress achieved in reducing road accidents as a result of increasing use of autonomous vehicles or improved accident avoidance functionality – the USA is mandating automatic emergency braking for cars sold after 2020.

Justifying enhanced protection

Implementation of TPWS to comply with the 1999 Regulations cost the industry over £800 million (approximate year 2002 prices). Other than the reduced rate of SPAD accidents the system can claim no other benefit and some would argue incurs further unaccounted costs in terms of railway system performance. Other ATP systems based on lineside signals are in a similar position and because of increased complexity cost even larger sums of money.

What does current technology offer?

Modern systems of signalling based on in cab guidance and supervision of the driver, such as ETCS or CBTC systems offer a significant number of additional benefits whilst also enhancing train protection.

Lineside signalling is heavily constrained by the human factors issues associated with ensuring the driver never misses a signal and equally never ignores a signal thinking it is for a different line. Additionally, the driver must always correctly interpret the signals meaning, respond appropriately and be given sufficient warning to keep the train under control. Signal positions are therefore significantly constrained and with that the capacity of a line especially on multi-track routes and approaching major stations.

Putting the signal indication in the cab removes these constraints, although it will impose a few new ones.

The removal of lineside signals has obvious benefits of reduced equipment at the trackside but it also significantly reduces the complexity of interlockings by removing the elements that operate those signals (aspect controls) and especially in the case of junction speed supervision the tailored elements that ensure the train has been brought under control before the signal is fully cleared. These will over time make a significant difference to the infrastructure cost of train control in Great Britain.

Within ETCS the Radio Block Centre (RBC) contains information, much previously not available, about the train location, its movement and other data which could provide enhanced performance either by export to traffic management systems or by enabling additional trains to occupy a given section of line without extra trackside train detection (ETCS Hybrid Level 3). There are also potential benefits on rural lines where better level crossing protection arrangements could be developed. As we approach ETCS level 3 there is also the opportunity to reduce and possibly even remove lineside train detection, another major cost saving.

What are the primary obstacles

One of the major obstacles to ETCS fitment is that the signalling benefits suggested above can only accrue when all the driving vehicles that use the route have been fitted with the necessary onboard equipment and of course the drivers have been fully trained. Some benefits can be obtained when the majority of trains are fitted since it is possible to conceive of ways to operate the fitted trains differently to unfitted units but overall the policy needs to be working towards 100% rolling stock fitment. Fitment during manufacture of a new vehicle is relatively simple and cost effective when built in to the design.

The problem is that retrospective rolling stock fitment is cumbersome, expensive and has a tendency to reduce train reliability, to which needs to be added the fact that the major financial benefit rests with the infrastructure operator and the retrofitment cost naturally rests with the rolling stock owner and operator. Not a scenario that is likely to generate enthusiasm.

Alignment of work packages can be significant but as many trains roam over several lines complete alignment is a significant challenge. This makes even a medium term business case difficult.

The other significant obstacle is the culture change such signalling will bring to the industry and this change will be felt in many areas. It is obvious the drivers and their managers will be significantly affected but so too will dispatch staff on station platforms. However, the change is not limited to just them, as signal engineers will have to adjust many of their practices, electrification engineering may be less constrained by signal gantry locations but still be affected because of the location of Ends of Authority. No doubt this list is not exhaustive and other parts of the industry may well be influenced.

So, what is the plan?

The good news is that after several false starts the Digital Railway is at last becoming a reality. Two ETCS schemes will go-live in 2018: the first on the Thameslink core through central London; and second, on a stretch of the new Elizabeth Line (Crossrail) linking to Heathrow. Traffic Management schemes will become operational on three Routes this year: Western; Anglia; and Wales.

More broadly the Digital Railway Programme, now led by David Waboso, is beginning to take shape. A series of initial business plans have been completed and show a positive return for deployment of digital train control. This is based on the key customer benefits of capacity, performance, journey time, more efficient whole of life cost and of course, safety.

The business case work shows that Traffic Management, integrated with crew and stock and connected driver advisory systems, provides significant performance benefits and can be rolled-out relatively quickly across large parts of the network. It is quicker and cheaper to deploy than ETCS and can be done with minimal intrusion on the signalling system

Bringing together track and train fitment is a pre-requisite for ETCS roll-out to achieve critical mass. The plans for Control Period 6 (Network Rails investment is managed in five-year 'control periods, the next is CP6 which runs from 2019 to 2024) plans start to synchronise these key elements and as 'DR-ready' re-signalling and train procurement increases, the marginal additional costs for DR deployment decrease.

Based on this there is now a target CP6 plan, linked with Network Rail's re-signalling plans and DFT's franchising processes, to introduce digital technology on routes that when completed in CP6/CP7 will account for 70% of all passenger journeys, including:

- Introducing Traffic Management on key routes where performance improvements are needed including the South East Route
- Replacing lineside signals with in-cab signalling (ETCS) at Moorgate and between Kings Cross and Peterborough.
- Deploying TM and ETCS as part of the Transpennine Rail Upgrade programme to increase capacity and reduce journey times between Manchester and York.

The bigger picture is that almost two thirds of Network Rail's signalling infrastructure is due to be replaced in the next 10-15 years. The inexorable rise in conventional signalling costs as well as the closures required on a hugely busy railway, is simply unsustainable.

At the same time nearly half of the entire train fleet is due to be built in the next few years, either to replace old rolling stock or the 3,000 additional carriages that are being introduced to cater for the growth in demand.

Grabbing these two 'generational' opportunities present an unmissable chance to reduce the long-term cost of running the network by transforming how we re-signal and switch to in-cab technology.

Clearly harmonising track and train fitment will require a high degree of cross industry and government co-ordination.

Much will also depend on the appetite of the supply chain and here there are grounds for optimism. Digital Railway's Early Contractor programme has brought suppliers – from within and outside of the rail industry – into the heart of the programme to help solve problems and drive out cost. One of the tangible outputs so far has been a welcome move in the direction of a more collaborative approach to procurement.

Under this progressive procurement model, future contracts are likely to focus on outcome based specifications and whole of life relationships that are centred on partnership working between railway operators, infrastructure, routes and the supply chain.

So during CP6 we will start to see the implementation of a full functional train protection system that also offers the ability to reduce the cost of the railway and improve the capacity and performance at critical locations.

What do you think?

Are AWS and TPWS still perfectly adequate for the UK railway or is full train protection the best solution? What has your country or railway done to ensure safety whilst increasing capacity?
Email us at **irsenews@irse.org**.

Industry news

Driverless heavy-haul freight in Australia

Australia: Following approval by The Office of the National Rail Safety Regulator in May, on 10 July Rio Tinto completed its first iron ore delivery using a driverless train. Full commercial operation is planned for late 2018.

Monitored from the Rio Tinto's Operations Centre more than 1 500 km away in Perth, the fully-loaded autonomous train with three locomotives carried 28 000 tonnes of ore over the 280 km between the Tom Price mine and the port of Cape Lambert in Western Australia.

Each locomotive has been equipped with an onboard module which sends automatic reports on its position, speed and direction of travel to the control centre. The locomotives and all public crossings are also fitted with cameras allowing constant monitoring from the control centre.

Deployment of the ATO over ETCS Level 2 technology to support Grade of Automation 4 (unattended) operation is the result of six years of development by Rio Tinto and Ansaldo STS under the mining company's A$940m AutoHaul project.

Automation is being introduced on much of the 1 700 track-km network with 200 locomotives which Rio Tinto uses to transport ore from 16 mines to four port terminals in the remote Pilbara region. The average round trip is about 800 km and takes around 40 h, including loading and unloading.

London's 4LM system successfully operated

UK: Staff at Transport for London (TfL) recently successfully operated the new Thales signalling system supplied under the Four Lines Modernisation (4LM) programme.

It follows extensive testing by Thales and the TfL project team, and means that customers will benefit from the new signalling on the first section of the Circle and Hammersmith & City lines. The trial involved staff operating six out-of-service trains under the new signalling system between Hammersmith and Latimer Road.

The rollout of the new signalling system in stages is part of the Four Lines Modernisation programme, which will see reliability, capacity and customer information improved on the Circle, District, Hammersmith & City and Metropolitan lines – some of the oldest sections of the Underground network – by 2023. The lines will have more capacity than they currently provide due to an increase in train frequency from 28 to 32 trains per hour in the central London section.

The new control centre for all four lines at Hammersmith has also been completed and is now operational, replacing some of the oldest equipment on the Underground network – including a signal box at Edgware Road that was built in 1926.

IRSE
Institution of Railway Signal Engineers

News from the IRSE

Blane Judd, Chief Executive

Subscription renewal

If you have not yet renewed your membership subscription, please do so now in order that you can continue to receive IRSE News, e-bulletins and other information from us. You can renew by logging in on the IRSE website and navigating to "Manage your Record" under the **Home** tab.

Logo trademarked

Both the new IRSE logo and the old one have been trademarked to prevent misuse. Other organisations may only display the IRSE logo on their websites and on printed materials with the explicit written permission of the IRSE.

Revised Code of Professional Conduct

The IRSE's Code of Professional Conduct, with which all members are required to comply as a condition of membership, has been revised to incorporate material drawn from:

- The revised Statement of Ethical Principles produced by the UK Royal Academy of Engineering and the UK Engineering Council in 2017.
- The UK Engineering Council's Guidance for Institution Codes of Professional Conduct issued in 2017.
- The UK Engineering Council's Guidance on Whistleblowing issued in 2015.

As the Code of Conduct was being updated, the opportunity was also taken to clarify some of the wording to reflect the IRSE's Diversity, Equality and Inclusion Policy (**irse.info/djkeh**).

You can find the new Code of Professional Conduct on the **About** page of the IRSE website (**irse.info/0h74w**).

Railway Safety and Control Systems MSc/PGDip/PGCert

The University of Birmingham (UK) and University of York (UK) are jointly offering an MSc / Diploma / Certificate in Railway Safety and Control Systems, starting in September.

The three pathways of this programme focus on risk and safety systems design; risk and safety systems operation; and communication and control systems (including signalling). The last of these is closely aligned with the IRSE's professional Examination, and offers a qualification equivalent to that of taking part or all of the Exam. The course includes systems engineering and theory and practice in railway control systems.

The programme is available to study to PGCert, PGDip (all taught modules) and the full MSc, which includes a research project. The project may be taken at the University of Birmingham, University of York, or in industry, subject to appropriate academic co-supervision. Distance-learning students attend Birmingham only for the taught elements. The part-time and distance-learning modes usually take 2-3 years to complete the full MSc. Individual modules may be also taken for continuous professional development.

For more information and to enquire about places still available, visit **irse.info/5yhsr**.

CBTC Conference: call for papers

The sell-out success of the IRSE's "CBTC and Beyond" conferences in Toronto in the last two years has led us to decide to hold the conference for a third year. We are now calling for papers for the 2018 event.

This year's CBTC conference will be held on November 29 and 30 at Fairmont Royal York, in the heart of downtown Toronto. We encourage you to attend this year, and right now we welcome proposals for papers and presentations on the following or related topics:

- Papers providing project updates, specifically (but not only) for Canadian CBTC projects currently being implemented or planned.
- Papers related to the application of CBTC on LRT, and commuter rail transit systems.
- Papers providing lessons learned in implementing CBTC in a brownfield environment.
- Papers on actual CBTC revenue service operating and maintenance experience.
- Papers looking to the future; what are the user business needs? What research & development is currently underway on new/improved technologies to further improve operating performance while reducing life cycle costs?"

Please submit your abstract to **ykimiagar@gfnet.com** by 28 September.

Network Rail Apprentices of the Year

Francis How presented the IRSE awards for Network Rail's "Apprentices of the Year" at HMS Sultan, near Portsmouth, on 22 June. The awards went to Andrew Hughes for Signalling, and to Carl Burns for Telecoms. Both have done extremely well to win these awards, and we congratulate them on their achievements – and wish them well in their future careers.

Francis How presents Carl (left) and Andrew with their awards.

London & South Eastern Section

London & South Eastern Section is go!

Trevor Foulkes

The inaugural meeting of the London & South East Section took place on 21 June 2018 at the University of Westminster.

The chair of the new Section, Trevor Foulkes, welcomed forty members to the meeting. He thanked everyone who had helped get the Section going and particularly Judith Ward for her work in supporting the process. Following the endorsement of the Articles and the election of the Committee, the programme for the forthcoming year was presented.

This was followed by two interesting presentations: "Where is Signalling going in mid-2018?" by Professor Rod Muttram and "IRSE Licensing and Professional Development" by Vincent Louie and Konstantinos Banias

Rod painted a picture of ridership starting to fall due to a number of factors, and the potential for new competition from the automation of other modes; all of which will potentially challenge the available funding. He also noted that the number of suppliers to railways is reducing as companies merge with one another. He suggested the way forward is to become more efficient by introducing new technology in a professional manner, moving to ETCS Level 3 as fast as possible, adopting ATO, developing lower cost fall-back systems and self-learning interlockings.

Rod was followed by Vincent and Konstantinos, who shared their professional history and explained how they have migrated into signalling. They explained how they had applied the IRSE professional development and licensing policy and recommended keeping records in a way so that the evidence could also be used to support other licensing regimes such as those used in Australia.

The speakers look on as Trevor welcomes everyone to the meeting.

The question and answer session explored the degree to which automated vehicles are already in use at London's Heathrow Airport, how to get better capacity and early thoughts on how the IRSE development and licensing regimes may be amended in the future.

The well attended and interesting first meeting was well received and bodes well for the future of the Section. IRSE members in the London area are recommended to consult the IRSE website to find out more of the future programme of presentations and technical visits, and how to register their interest.

The next L&SE section meetings are "Valise - The Video Balise" on 27 September and "Future Railway Mobile Communication System" on 25 October. Details on the presentations and how to register for them will be found in the Events section of the IRSE web site. If you would like to contact the committee on any aspect of the Section then please email londonse@irse.org.

The new Section's first meeting was well attended by a diverse and lively group of attendees.

Midland & North Western Section

Annual technical visit and luncheon

Paul Darlington

On Saturday 16 June 2018, the Midland and North Western Section returned to the location of previous successful technical visits and luncheons, the Severn Valley Railway (SVR). Some 62 members and guests travelled on a dedicated train for yet another enjoyable family event. Andy Stringer, Siemens Rail Automation Delivery Director West, did a superb job with coupling duties and firing the locomotive throughout the trip.

The day started at 10.30 with the opportunity to visit Kidderminster Town signal box. After tea and coffee in the refreshment room, 12 members and guests were escorted along the platform and to the signal box by the SVR's S&T Engineer, John Philips. The signal box was commissioned in 1987 and is an authentic recreation of a typical GWR medium-sized signal box. Having split into two groups, one group went up to the operating floor, where the duty signalman explained and demonstrated the equipment with the departure of a service train from platform one towards Bewdley, along with the arrival of a light engine into platform two to haul our train.

John Philips escorted the other group into the locking room below and explained the operation of the mechanical and electrical locking, with both groups swapping around before leaving to join the luncheon train in the platform. An area of interest within the signal box was the recently commissioned interface with the Network Rail West Midlands Signalling Control Centre at Saltley, enabling fully signalled through working between the two networks.

Departing at 12.05, the luncheon train was adorned with the familiar and appropriately nameboard 'The S&T Engineer' on the steam locomotive hauling the train, GWR Collett 5700 class 0-6-0PT 'Pannier Tank' No.7714. However, before the luncheon train departed Kidderminster, Ian Allison, chairman of the Section, presented the Chairman's Trophy, (which was selected by the previous chairman, Peter Halliwell), to Bill Redfern in recognition and appreciation for all his work as secretary for the Section. Bill has been the secretary for several years and is often the one committee member who attends every meeting around the country and throughout the year.

Above, the S&T Engineer special.

Below, the happy fireman: Andy Stringer took on coupling duties and fired the locomotive throughout the trip.

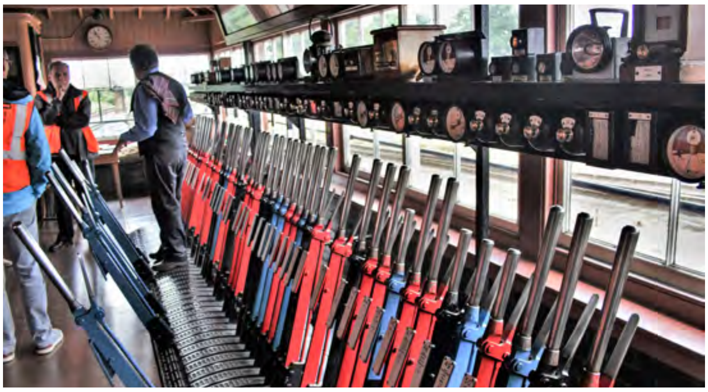
A typical view of the Severn Valley Railway and its signalling.

The Severn Valley Railway 16-mile (26 km) route runs along the scenic Severn Valley from Bridgnorth to Kidderminster, crossing the Shropshire/Worcestershire border and following the course of the River Severn for much of its route. It is the sixth-longest standard gauge heritage line in the United Kingdom and one of the most comprehensively signalled heritage railways in country. The whole route is signalled using Great Western style lower quadrant signals, apart from the connection at Kidderminster to Network Rail, which uses a colour light signal.

A delicious meal was served on the trip to Bridgnorth and an hour stop allowed members and guests to visit the workshops, watch the shunting run around moves, visit the well-stocked railway book shop, or for the more energetic to climb one of the seven sets of steps to admire the views from Bridgnorth High Town. Bridgnorth is in fact two towns consisting of High Town and the Low Town. As well as the steps the two towns are connected by the steepest inland funicular railway in the United Kingdom.

On the trip back to Kidderminster the dessert course was served, which included the appropriately named Severn Valley Eton Mess, followed by tea and coffee. Many complimentary comments were received to confirm an enjoyable day was once again had by all those who had attended the luncheon. For a few keen members and guests, the technical element of the visit continued upon arrival at Kidderminster, with a chance to visit and operate Wrangaton Signal Box, which is part of the Kidderminster Railway Museum. The demonstration signal box is fully functional including local signals and points and simulation of the fringes. The signal box came from Devon and the lever frame it contains came from Bersham Colliery Sidings near Wrexham.

The Midland and North Western Section would like to thank Siemens Automation for their kind sponsorship of this event, Ian Allison and Graham Hill for organising the event on behalf of the Section and the SVR and John Philips for their hospitality and allowing the technical visit to take place. The Section looks forward to welcoming members and guests to our next Annual Technical Visit and Luncheon in 2019, when we plan to visit a different venue.



Top, Ian Allison presents Bill Redfern with the Chairman's Trophy.
Middle, the magnificent Kidderminster Town signal box.
Above, members and guests take their seats on the special train.

Minor Railways Section

Visit to Nene Valley Railway, 17 March 2018

Charles Weightman

The Nene Valley Railway is the final seven miles of a 47-mile-long 'cross country' branch from the London and Birmingham Railway at Blisworth. It has the distinction of being the first railway into Peterborough and was opened in 1845.

The River Nene rises on the borders with Oxfordshire and throughout its distance to Peterborough, the valley is rich in ironstone, which was worked until the mid-1960s. It is likely that the ironstone was the impetus to build the railway, and that it gave the London & Birmingham Railway a route to the sea. It is believed that the area of the present Peterborough NVR Station is on the site of the original terminus and wharf, before the arrival of the Great Eastern Railway in 1846.

The signal box is called Woodstone Wharf and has yet to be commissioned but with the installation of the external signalling equipment at an advanced stage. The upper part of the structure is of Great Eastern origin and was recovered from Welland Bridge (Spalding) and which became redundant when the former GN & GE Joint Line between Spalding and March was closed in 1982. The lower portion of the signal box is of brick construction and has been built higher than the original structure.

There is also a large attached room at the west end (also in GE style) which will eventually be a relay room. The lever frame is of 40 levers, manufactured by Evans O'Donnell and identical to those still in service at Maidstone West and Gainsborough Lea Road. (The cast of the makers name is clearly seen in a photograph). The mechanical interlocking has yet to be fitted.

The party joined a large Scandinavian rail car, the warmth of which was appreciated as the outside temperature was dropping fast. This car was noticeably wider than the British gauge. The Nene Valley is noted for the amount of northern European rolling stock, this is best appreciated when seen coupled to UK stock. Shuttles are run with the immaculate continental stock.

Peterborough station on the Nene Valley Railway.
All photos Ian James Allison.

A taste of 1950s Sweden in Northamptonshire. The Y7 railcar that the IRSE group travelled on.

The next stop was at Orton Mere, which is a station with an active passing loop. At the east end of the station is the junction with the Fletton Branch, which is the connection with Network Rail. As the use of this connection is only exceptional, the single line is protected by the use of a token (train staff). Also on this spur is the remains of a signal erected to test drivers eyesight.

The signal box at Orton Mere is a Midland Railway structure, which has been raised

Top left, Orton Mere signal box.
Top right, Woodstone Wharf from the outside, with the relay room visible to the right of the signal box.
Left, the Evans O'Donnell 40-lever frame.
Above, ex-GWR loco 5619 is currently on loan to the Nene Valley Railway.

on to a base of concrete blocks. The structure was recovered from Maxey Crossing, when the East Coast Main Line (ECML) north of Peterborough was re-signalled in the mid 1970s. The crossing is very unusual in that the road crosses six running lines, two of the Midland Railway and four of the Great Northern Railway (ECML). The GNR had a separate signal box with each company having its own gates. The crossing still exists but is now a CCTV type controlled from Helpston Gate box.

The lever frame is a Midland Railway, tappet type interlocking. The external equipment includes a now very rare 'Z' plate economical facing point & lock mechanism. The loop points at the east end of the station are power worked with the signals reading through the points in a facing direction being mechanically operated semaphore signals. In the event of a loss of point detection they do not 'self revert' to danger, so the signals are supplemented with points indicators which, in the event of a loss of detection display, a flashing red LED signal.

The railcar then moved on to Wansford Station, which is the headquarters of the line, where lunch was taken. After lunch the railcar continued through Wansford Tunnel, to the site of Yarwell Junction. Here there is a newly built platform which marks the end of the line. The track bed of both routes can still be seen, with the route turning to the southwest the original Nene Valley Railway to Blisworth (of 1845).

As a through route the line was closed beyond Oundle in 1964, but remained until 1972, when the whole of the remaining Nene Valley closed. The line bearing to west went to Rugby. This was opened in 1879, was closed beyond Nassington Quarry in 1968 and completely in 1971.

While at Yarwell Junction it was possible to walk the lineside (a proper path) to view the western portal of Yarwell Tunnel. This is highly decorated which highlights that the line was very early to be built. Wansford Station buildings are highly decorative and built of local limestone.

The signal box at Wansford is a standard London North Western structure and is built partly on a bridge which crosses the River Nene. The signal box controls the whole of the station area and a four gate capstan operated level crossing. This crosses the former Great North Road. The signal box used to control a branch which turned off east of the bridge and went to Stamford East Station (GNR). This branch was opened by the Great Northern Railway in 1867 and closed in 1929. The lever frame in Wansford SB, an LNW tappet type of 40 levers, opened in 1907, closed in 1971 and re-opened with the line in 1974. The line is worked by staff and ticket with short or long section working according to whether Orton Mere SB is open.

The railway runs through delightful countryside, mostly meadows around the river. There are a number of stops along the way enabling walks to be taken beside the river. There are workshops and much of interest to see at Wansford. The Section would like to thank the volunteers and staff of the Nene Valley Railway for a memorable visit.

Below, the group pose in front of the railcar.
Bottom, signal gantry at Wansford.
Below right, Wansford box and level crossing.

'IRSE News' news

David Stratton retires as our Presidential Paper editor

Bob Barnard

The Presidential Papers published in IRSE News and then subsequently forming an important part of the Institution's Annual Proceedings are intended to be a record of key developments in signalling and telecommunications, to broaden the understanding of our members around the world about changes occurring in our industry, and to provide a reference for newcomers to the industry in the future.

The high standard of IRSE News is maintained by the efforts of a small number of people like David Stratton, who for the past 13 years has edited the Presidential Papers for publication. Maintaining the standard of this published record is a demanding task, and the work that goes on behind the scenes is not always understood. Some authors present a well-argued paper in good time, even when English is not their first language. In such cases, David's work may be correcting a few typographical errors. At the other end of the spectrum, one or two authors may start out fondly imagining that they can get away with a hastily modified and adapted version of a company Powerpoint presentation full of lists of bullet points. In such cases, David's work is more demanding, requiring significant liaison with the author to obtain a written paper, and then sometimes needing to make major modifications very close to the publication deadline.

Older UK members may well have come across David, who worked in Manchester as a research & development engineer and team leader in the company that he joined as AEI-General Signal, and which (via various name changes) became Alstom. David developed and documented safety-critical products as diverse as Reed FDM remote control, audio frequency jointed and jointless track circuits, before becoming the leader of GEC's team engineering their version of British Rail Solid State Interlocking. Once SSI was established in service in the UK, David supported the transfer of the technology and its application overseas (for example in Belgium and France).

Later, he worked on re-specifying parts of the functional behaviour of SSI as part of Alstom's Smartlock 400 successor product to SSI.

Writing and editing documents and specifications having formed a major part of David's work, he has carried on with similar activities on a voluntary basis from his home in Cheshire in his retirement, editing papers for Signal und Draht, editing material for European signalling textbooks, and co-writing and editing the book "25 Years of SSI" telling the inside story of an influential development project in the words of those who participated in it.

David will however remain on the editorial team as assistant editor, helping to proof-read IRSE News each month.

If you would like to join the IRSE News editorial team and help with editing the Presidential Papers please contact us at irsenews@irse.org. The role is interesting, helps with a member's CPD and is subject to a honorarium payment from Council.

York Section

Annual Dinner 2019

The York Section Annual Dinner will return to the National Railway Museum, York on Thursday 21 March 2019 at 1900 for 1930 for what is becoming a major social event.

The Guest of Honour will be Rob McIntosh, Network Rail's route managing director for the East Coast Main Line, Midland Main Line and the eastern TransPennine routes, a senior industry figure with a strong local connection.

Full details will be published nearer the time.
Any enquiries should be made to Ian Moore on ianmooreirse@hotmail.co.uk.

The magnificent, record-breaking, Mallard at the National Railway Museum - venue for the York Section Annual Dinner.

Feedback

MTA Genius challenge - a response to Alan Rumsey

As one of the co-winners of the New York Metropolitan Transportation Authority (MTA) Genius challenge, I read the article on "The New York Transit Challenge – do the prizewinners really have a solution for modernising older metros?" by Alan Rumsey in IRSE News issue 245 June 2018 with great interest. I take the opportunity of the related call for opinions to address some of Alan's concerns.

We never proposed to embark on redesigning a signalling system.

As can be verified on MTA's website, our proposal is a reimplementation of targeted CBTC functions, namely the localisation and the signal aspect cancellation. It remains compliant with IEEE 1474. Similarly, it does not promote any 'train centric' approach beyond the one defined in usual CBTC architectures. It clearly follows the first proposed MTA objective to "dramatically accelerate the current deployment of CBTC or similar technology", not the second one highlighted by Alan.

It is why this concept is attractive to MTA and suppliers alike. It capitalises on other expenditures incurred to develop, deploy and certify a software system able to cover the challenging use cases in particular mixed mode of operations.

CBTC technology has a significant impact on cost and schedule.

In the frame of re-signalling projects, CBTC overlays additional constraints and precise sensors on top of pre-existing infrastructures that are difficult to access or adapt. These additions mechanically translate to schedule dependencies (i.e. delays) and high ownership costs (i.e. maintenance). These are problems for transit agencies of the scale of MTA, and any operator of the technology in general.

The video-based train localisation system is attractive because it reduces these constraints while retaining the required safety and accuracy.

- By replacing RFID balises with cheap signs, it relaxes required tools and works. Furthermore, the use of video camera simplifies the geographical survey of the line, a traditional schedule buster of CBTC projects;
- By replacing the cancellation aspect on signals by a safe display of the information on a head up display, it removes the need for replacing signals. We can switch them off as CBTC trains approach.
- By replacing the speed and acceleration sensors by a device that measures distance directly, it eliminates most of the bias and failure modes related to the use of indirect sensors (e.g. wheel locks, gravity offset, ...), thereby reducing the effort required for train fitment.

Just on signals, the savings for MTA is in hundreds of millions of US dollars, just in equipment. The solution will also add a layer of resilience to signal failures and can offer a way to remove signals without any schedule constraint.

At such impact levels, I do not believe looking at past technological choices is a distraction. This is especially true for MTA, indeed an early sponsor of CBTC technology. This point is further strengthened by initiatives such as the 'Autonomous train' program in France. One of the stated objective of this initiative is to design a train location system that does not require modification to existing infrastructures. When multiple mature customers around the world share a common interest in a topic, it is a strong sign that there is value for them there. We must listen.

The proposed invention follows a holistic approach.

I read with great interest the report of IRSE's ITC on "Why signalling projects fail". I cannot agree more on the need for a holistic approach to systems design. In fact, the proposed innovation matured because it started solving seemingly unrelated problems. This is a clear characteristic of holistic topics.

To take the example of broken rail raised by Alan Rumsey, a high-resolution camera can contribute to the monitoring of rail and track condition. Multiple articles and patents exist on the topic. Track circuits have been so far the "less bad" option available. The proposed innovation offers a non-intrusive way for MTA to introduce and gain confidence in a viable alternative. In any case, this technology offers valuable infrastructure monitoring capability to MTA (e.g. platforms, tunnel geometry, etc.).

The invention offers promising answers to other difficult train control problems. I can only enumerate a few: remote driving, obstacle / passenger detection, train collision protection under restricted manual mode, service vehicle fitment, etc.

To go back to the conclusions of the ITC report, one can only agree that contractual environment and technological complexity contribute heavily to the failure rate of projects. It is a challenge faced by all engineers around the world. I do believe, however, especially in signalling, that the report underestimates how well targeted innovation can have a strong holistic impact.

Inventors created the business of signalling.

If we want to ride the "wind of changes", as described by Marcus Montigel in his presidential address, I believe we need to go back to this scientific, problem-solving, undaunted spirit.

So, Alan Rumsey asks if prize winners really have a solution for modernising older metros. My answer is yes, we do.

Alexandre Betis
Head of CBTC Solutions at Ansaldo STS
France

Traffic management – do we have the right specification?

Traffic Management is a key feature of 'The Digital Railway' (DR) here in the UK but have we really got the right and complete specification? In many ways this is not just a question for signal engineers but for many sections of the rail industry including commercial staff in the Train Operating Companies (TOC), timetable planners, engineers in the DR team, and operations staff of both the TOC and Network Rail (NR).

To be honest my immediate concerns have been triggered by the frankly appalling customer experience following the recent timetable upgrade that occurred in May this year.

First a brief history to assist those unfamiliar with the London main line rail system. In the late 1980s a section of disused tunnel through central London was reopened facilitating the introduction of a through north/south rail link giving direct access between Bedford and

Gatwick Airport and Brighton as well as local services between Luton and Wimbledon and Sutton.

The route was christened Thameslink. The route rapidly became popular with rail users with the result expansion of the system and importantly an upgrade of the service frequency through the central core became a politically desirable objective. Enhancement of the frequency was constrained by complex and heavily used flat junctions just south of the core area and in particular around London Bridge. The Thameslink project commenced with platform lengthening and major works at London Bridge to provide additional tracks and a new station. This work was finally completed in January 2018 with the intention of introducing a new significantly expanded timetable with several new destinations in May.

As a person whose career was in signal engineering I would claim to be a fairly tolerant 'customer' often using some of my knowledge to work around travel difficulties when journeys I make hit a snag. But as a 'customer' of the railway on the Great Northern route between Kings Cross and Cambridge the service has fallen apart since the new timetable was introduced with the intention of enhancing the train service and introducing new routes across London. We knew a few weeks before introduction that there would be some toning down of the initial aspirations to give time for the timetable to bed in. We never expected the meltdown that actually occurred and as of mid-July (eight weeks later) is still happening.

A few examples from personal experience include:

- Checking the web to confirm a train is apparently running on time 20 minutes prior to departure at a local station only to find it is cancelled on my arrival at the station.
- Two occasions when a cross-London train has arrived at Finsbury Park only for staff to announce there will be a 20 minute wait until the relief driver arrives, so the train is then running significantly out of course with potential for further delay.
- Announcements of station calls at Kings Cross station, confirmed by the information boards, only be contradicted by the platform staff and train crew who are adamant three of the stops will be omitted.
- Other examples of late running trains subsequently skipping stops resulting in hour long intervals at admittedly less important stations.

Traffic management is about a lot more than making train timetable decisions. *Photo Shutterstock/Lena Maximova.*

- Delays of 15 to 20 minutes are currently not uncommon, in fact I would almost say they are to be expected, even when trains are nominally departing origin on time.

Now admittedly this tale of horrors is based on a temporary timetable that is intended to overcome a shortage of fully trained drivers to operate the originally planned timetable. It does, however raise the question if this is a temporary timetable planned, albeit in a hurry, by professional planners will a TM system be re-planning in real time based on the rules they used? Will it have access to all the necessary data? Will that data be up to date?

My contact with 'real' customers of the railway suggests they have either lost faith in the service provided or are on the verge of doing so. They are modifying their travel patterns with potential negative effects on the railway. A genuine metro can perhaps afford some of this disruption because a train to the destination the passenger wants is very likely to arrive in the next 5 minutes or at most 10 minutes. Whilst this may be true for travelling in the core of the Thameslink network the frequency out on the limbs is rarely better than 15 minute intervals and often 30 minutes. This causes me to ask the following questions about the TM specification

- What commercial input is there in the TM short term decision process. In particular skipping stops at minor stations is probably acceptable on isolated occasions but if one particular station becomes a "regular" the impact could be more serious as passengers start to desert the station due to lack of faith in the service arriving. And be in no doubt if on time presentation at the core due to traffic density becomes the key factor in TM decision making, skipping stops on a slightly late train is the only real option to ensure delivery on time.
- Without stock rosters and train staff rosters, especially drivers, being part of the re-planning process, the amended plan is very likely to fall apart. These need to be kept as current as the actual progress of the trains because staff availability also changes.
- Information disseminated both by passenger information systems and Web-accessed systems must give the true picture ideally with last minute changes being very much the exception. Many people will check via the Internet their train is running before leaving home/office. Finding a different version of the truth at the station is at the very least dispiriting and ultimately leads to distrust and loss of custom.

People are perhaps more likely to tolerate a system where the trains are a few minutes late than a system which disrupts their journey by 30 minutes or more for the benefit of the others.

My final point is in fact a repeat of the title. Do we really have an adequate and complete specification of all the outcomes we wish to achieve with our new TM systems and are we sure we have access to all the necessary data to make them work? The railway industry needs to recognise that at this level it is a 'railway system' and all the parts and all the players have important roles to play to deliver the service the customers expect and which was advertised by us in the published timetable.

David Fenner, UK

Industry news

Recognising the industry's inspiring characters

UK: The RailStaff Awards is an opportunity to recognise outstanding employees, who go above and beyond, and to let them know just how much they are appreciated. The event takes place on Thursday 29 November 2018, NEC, Birmingham and nominations are now open at **www.railstaffawards.com**

Entrants, either individuals or teams, can be nominated by friends, colleagues in the industry, or by the travelling public. Nominations are filled with stories of lives saved, careers turned around, charities supported and adversity conquered.

Based on these written nominations, a public vote decides the shortlist and an independent panel of judges then has the difficult job of deciding which will win.

There are a number of categories, however the organisers are keen to maximise the nominations for the 'Control & Communications Engineer of the Year'. Visit **irse.info/yc7u9** to nominate. Nominations close on 5 October 2018 with voting from 8 – 19 October 2018.

Buenos Aires upgrade contract awarded

Argentina: UTE Green-Rottio has awarded Alstom a €5m (£4.4m, $5.9m) contract to provide signalling for the new 5 km viaduct of the San Martin line in Buenos Aires.

The 22-station San Martín line is one of the seven suburban train lines of the Buenos Aires metropolitan area. It currently transports around 170,000 passengers per day along a 76 km-long stretch between the Retiro and Dr Cabred stations.

As part of the deal, Alstom will provide its interlocking technology along with point machines, signals, local control post and track circuits.

Modernisation in Hungary

Hungary: The country's railways are being modernised as part of a global project in order to upgrade and develop the Budapest Kelenföld – Croatian border railway, in order to eliminate an important bottleneck along the Mediterranean corridor, and the National Infrastructure Developing Private Company Limited has commissioned Siemens to equip the 26-km-long two track Százhalombatta-Pusztaszabolcs line.

Siemens will provide its Trainguard 200 train control system, which includes the installation of European Train Control System Level 2 and one radio block centre as well as two Trackguard Simis IS electronic systems.

The project includes six Wayguard Simis LC railway crossings, power supply, assembly and telecommunications. The planned commissioning is expected by December 2020.

ETCS Hybrid Level 3 and ATO demonstrated

Andrew Simmons

Network Rail in collaboration with Govia Thameslink Railway (GTR) and Siemens demonstrated the combined operation of ETCS Hybrid Level 3 and Automatic Train Operation (ATO) at the ERTMS National Integration Facility (ENIF) near Hitchin between 2 May and 11 May 2018.,

The demonstrations were an extension of the previous ETCS Hybrid Level 3 testing carried out at ENIF in December 2017 which involved a very successful collaboration between ProRail, Network Rail, Siemens, Alstom, Hitachi and Thales, and also follows on from the first ATO over ETCS Passenger Train service through the Thameslink Core in March 2018.

The Network Rail Class 313 ETCS test train operating in ETCS Level 3 was followed by a Thameslink Class 700 train operating in ATO (Grade of Automation 2) over ETCS Level 2 was the basis of the demonstration. The ATO over ETCS Level 2 was the proprietary Siemens ATO system developed for Thameslink.

The outcome highlighted the significant reductions in headways that are possible with ETCS Hybrid Level 3 combined with ATO when compared with conventional signalling arrangements and also a step change enhancement from ETCS Level 2 with ATO. This performance improvement being possible with a reduction in lineside infrastructure compared with both conventional signalling and ETCS Level 2 arrangements.

The logistics and technical integration for the demonstrations were carried out over an eight week period, with constraints including the availability of the ENIF test track and also of the Class 700 test train. As a result of the restricted timescales, it was not possible to optimise the ETCS Hybrid Level 3 arrangements from those developed for the December 2017 demonstrations. Nevertheless, it was possible to show significant reductions in station run in/run out times compared to conventional signalling – even allowing for additional restrictions that are necessary for compliance with the safety case for two train operations at ENIF. In addition, it was possible for the invited guests on 11 May to witness the interworking of both ETCS Level 3 and ETCS Level 2 trains as defined by the ETCS Hybrid Level 3 concept.

It is arguable that we are fast approaching interoperable CBTC for main line railways. Evidence to support that statement includes the ERTMS Users Group's involvement in the development of an interoperable application of the ETCS Hybrid Level 3 concept utilising virtual blocks in order to minimise train separation, and the ongoing development of the ATO GOA2 specifications, which started in Shift2Rail and are now recognised by the European Union Agency for Railways.

Further testing of the interoperable ATO specifications are planned as part of the Shift2Rail programme in early 2019 at ENIF in order to validate the specifications before their inclusion in the Command Control and Signalling (CCS) Technical Specification for Interoperability (TSI).

A video of the demonstration of ATO and Hybrid Level 3 at ENIF can be seen using the link **irse.info/agulp**.

Past lives: Stanley Hall

Born on 9 April 1926, Stan (as he was universally known) joined the LMS Railway as a junior booking clerk at Keighley in 1943 and made his way up through the grade of station master (he was deputy station master at Kings Cross 1961 to 1963) becoming divisional operating superintendent for the West Midlands in 1970. During his divisional office career he chaired over 100 formal accident inquiries before going to BR HQ in 1977 as the signalling and safety officer from where he retired in 1982.

It is true to say that railways were his passion throughout life, with the interest in railway safety coming about through the many accident inquiries that he chaired. This brought him into contact with the signal engineering fraternity and led him to join the IRSE as an Associate in 1977, and he was made an Honorary Fellow in 2000. After retirement, he embarked upon his writing vocation where his career had made him uniquely qualified to write about safety on the railways. He also lectured widely on the subject of safety and acted as railway safety consultant on many occasions. His first book "Danger signals, a study of modern railway accidents", appeared in 1987 and his last one was "From Birmingham to the board, a railwayman's odyssey continues" which was published in 2015. In 2007, he was awarded the MBE for services to the railway industry. When he was not writing, he could often be found helping out at Keighley, on the Keighley and Worth Valley railway, where his career started.

Stan was known for his forthright views on all matters concerning the railway industry and these resonated with many in the industry. He was never sparing in his criticism of those he felt tried to do the industry down, the safety regulator and government included. This was particularly the case following the accident at Ladbroke Grove in London in 1999 when 31 people lost their lives. He was a good friend and colleague to many in the industry, whose wealth of knowledge and understanding and his calm analytical approach to the subject of railway safety was a help and support in times of difficulty.

Sadly, he suffered a stroke in 2014 which severely restricted his activities, and following a second stroke, he died peacefully on 29 June 2018. He was widowed in 2010, but leaves two sons, one of whom, Chris Hall, is a Fellow of the IRSE.

Colin Porter

Stanley Hall MBE FIRSE, 1926-2018.

Frank Rayers

Frank George Rayers HonFIRSE (known to many as FGR) was born in Frampton Cotterell, just outside Bristol, on 28 February 1932. His father was a headmaster and his mother a school teacher. The couple also helped run a newsagent's shop where the ready supplies of chocolate triggered a life long love. An energetic child, he often combined his hobbies of trainspotting and cycling, by cycling to distant railway stations to watch steam locomotives. Distance did not deter his enthusiasm, with destinations at places as far away as Birmingham or Southampton. He gained a place at Bristol Grammar School and was a bright and sociable pupil.

On leaving, his interest in railways continued as in the early 1950's he began a 5-year British Rail (BR) Western Region(WR) S&T apprenticeship at Reading. On completion of his training he joined in the Railway Modernisation programme team, headed by the new works assistant, Paul Jacobs. Soon Frank was involved in the WR, Birmingham Snow Hill and Plymouth resignalling schemes. Fellow apprentice colleague, Mike Page, was best man when Frank married Pat, who sadly died of cancer all too soon afterwards in the mid 1950s. Fortunately Frank re-found matrimonial happiness when he married Barbara English on 6 June 1964. Three years after their wedding they celebrated the birth of their first child, Mark. A daughter, Rachel, completed the family with her arrival in 1973.

After the death of his first wife, Frank understandably wished to make a fresh start. He was about to move to BR Southern Region when a chance meeting

Frank Rayers HonFIRSE, 1932-2018.

ended with him being appointed to help set up a signalling resource, including design, manufacture and installation work. This evolved into ML Engineering (Plymouth) Ltd. Frank continued his career with ML by heading up many of the teams that won projects for Western Region. He was instrumental in securing the company's first major supply and install contract at Stoke on Trent, in competition with the well-established Westinghouse and GEC companies. Major schemes followed throughout BR, also with metro style projects in Glasgow, Nottingham and Sheffield. Overseas railways awarded contracts to ML in Jordan, Australia, Indonesia, Greece and Malaysia in the years that followed.

It was in Australia that he met up with local entrepreneur, Ray Gallian, and they formed a joint venture known as Delairco - ML, or DML for short. Several major Australian signalling projects were undertaken successfully. Frank was Managing Director when the Plymouth company became involved with international takeovers mergers and acquisitions, and he later decided to turn his talents to consultancy. Ansaldo of Italy engaged him in Italian and Malaysian projects. Frank and Barbara took up residence in Kuala Lumpur where they lived for 7 years, enjoying a fantastic lifestyle and a busy social scene.

A long and diligent commitment to the IRSE began when he joined as a Technician in 1956, subsequently attaining the grade of Fellow in 1979. He supported the Institution serving on the IRSE Council and most of the IRSE committees. The highlight occurred when he became President of the IRSE for the year 1989/1990. This was at a critical stage when the UK signalling practices were under close scrutiny by the Inquiry into the Clapham Rail Disaster. During his Presidential year he hosted a memorable Convention in Holland. His daughter, Rachel, then aged just 16, will always treasure the look on her father's face when she turned up in Rotterdam as a surprise visitor to the IRSE Convention. In 2005 he was elected Hon FIRSE.

Family was a large part of Frank's life. His interests included a brief involvement with golf, playing tennis, sports car rallying and going for long walks on his beloved Dartmoor. He was famous for his fried rice and satay. Fascinated by the local moor and its history, he could identify all of the Dartmoor tors. This walking pursuit he combined with his love of visiting letterboxing sites on the moor. Frank and Barbara enjoyed taking part in pub quizzes and shared in amateur dramatic productions by Shaugh Players. Frank's frequent travels meant that he did not always attend as many rehearsals as perhaps he should have. His ad-libbing of his recollection of the script caused many fellow actors some consternation at times. As a proud supporter of their causes, his charitable interests included Dartmoor Preservation, the RSPB, the National Trust and the Red Cross,

With some health issues affecting him during his latter days, Frank could no longer drive. He treated this as a challenge for him to become a master of the local bus service timetable. On 24 May 2018, during a brief stay in Derriford Hospital. Frank passed away due to heart failure.

A service celebrating his life was held at Weston Mill Crematorium, Plymouth on Friday 15 June 2018. Several of Frank's favourite musical pieces, covering several genres, were played during a memorable tribute to a man whose charisma, his inspiring team leadership qualities and his devotion to family and friends were recalled fondly. Many people whose lives he influenced will miss him sadly.

Having had the pleasure of knowing Frank for over five decades, I am grateful to Mike Page, Julian Stiles and the Rayers family who have helped me cover his life-story.

He is survived by his wife Barbara, son Mark, daughter Rachel and three grandchildren, Callum, Frankie and Joby.

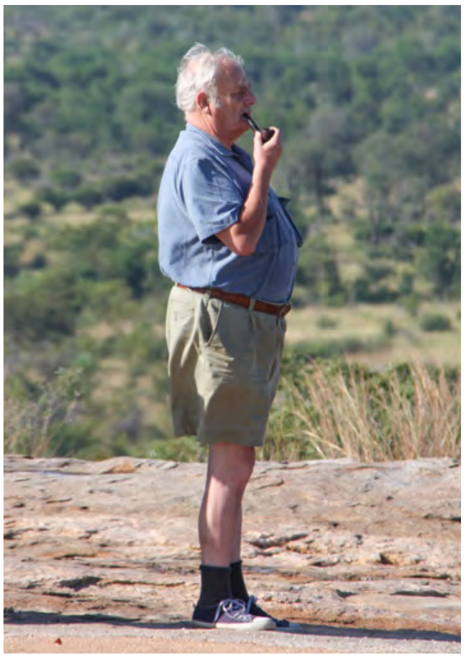
Alastair Wilson

Bob Woodhead

Bob Woodhead, who died on 25 June 2018, had become synonymous with the IRSE Southern African section for many years. Yet Bob was as English as they come. Born in Wilmslow in 1937, he was part of a railway family. His great great and great grandfathers had been employed in the rail industry dating back to Victorian times and his grandfather followed suit. His father was a civil engineer on the LMS railway, initially at Manchester. The family moved to Derby in 1945, thence to Watford in 1952, back to Derby in 1954, returning to Wilmslow in 1959. All part of Bob's father's promotional trail, Bob attended Bushey Grammar School, Regent Street Polytechnic and Loughborough College to study electrical engineering, completing his studies in 1959 thereby missing National Service

Bob started his railway career by joining Westinghouse at Chippenham in the Electrical Engineering Dept. A transfer to the Westinghouse London premises in York Way near to King's Cross saw Bob begin his association with project delivery contracts which took him to Spain and other overseas locations. During 1961-63, he was sent to South Africa to be Resident Engineer for a big CTC scheme in Swaziland. He later worked on projects in South Africa where he lived in a caravan in the Karoo, a semi-desert area in the then Cape Province. Returning to England in 1964, he was involved in the development of time division multiplex systems (TDM69), the Westronic S1 multi station CTC system and Westronic style F which was used on the Reading and Birmingham New Street projects.

Back to South Africa in the early 1970s for projects that utilised Westronic equipment, in 1975 he met software engineer Sandra van de Pol, marrying her in 1978. Looking for a change in career, they both came to England to work at GEC-General Signal at Borehamwood. This proved to be only transitory as they returned to South Africa after a year



Bob Woodhead, 1937-2018.

with Bob re-joining Westinghouse for a while, participating in an international Westinghouse team to develop the Westrace product. When Westinghouse pulled out of South Arica, Bob set up his own business primarily involved with the supply and repair of Westinghouse products used on South African railways. This continued until recent times

Bob fitted well into the international team activity. He had the ability to see what everyone else was doing then noticing the gaps and filling them himself. Nothing got overlooked in the planning process but he was at his most creative if a project deadline had been passed. He understood the strengths and weaknesses of South African Railways and gave useful advice as to what was feasible for them and what was not.

Establishing a South African (now Southern African) Section of the IRSE became a personal goal. After several false starts, the section was inaugurated in July 1981 with Bob becoming the Section Secretary, a position he fulfilled for many years. He also became Chairman at one period. During the planning for the convention in South Africa in 1998, Bob made it his business to know what was required of the section to ensure success. He enjoyed the fellowship of the IRSE and always encouraged younger members to use their knowledge and enthusiasm for the betterment of the railways. He was elected Graduate in 1961, Member in 1966, Fellow in 1977 and Hon Fellow in 2005.

Bob had several outside interests; he was a keen bell ringer and enjoyed visiting new towers when back in the UK, he had a superb model railway and always purchased new locomotives when in England, he had an affinity with classical music. His hospitality to visiting IRSE Presidents was superb and his breakfasts in the Kruger Park became famous. He will be much missed, especially by the Southern Africa Section.

Clive Kessell

Postscript. It is with much sadness that we report the subsequent death of Sandra Woodhead on July 18. She had been in poor health for some time and suffered a heart attack. Condolences have been sent to the family

Industry news

EU grant for Paris - Lyon ERTMS deployment

France: The European Union (EU) has agreed a €117m (£103m, $137m) million grant to help fund the deployment of ERTMS Level 2 on the Paris-Lyon high-speed line. The EU has already provided grants to help fund initial studies and preparatory works.

The contribution will fund 40% of the main works programme, which will include replacing or modifying interlockings, upgrading the power supply, and remodelling stations in Paris and Lyon. More than €600m (£530m, $£702m) will be spent altogether upgrading the line, which opened in 1981.

Work is due to start in 2019 and will be commissioned in 2025. A third of all of France's domestic high-speed trains use the LGV Sud-Est, as well as international services to Spain, Italy and northern Europe.

On an average day, around 240 trains will operate on the busiest section of the line, which carried 44 million passengers last year. The signalling upgrade will increase peak time capacity from 13 to 16 trains an hour.

Trams for Luxembourg again after 50 years

Luxembourg: Luxtram has reopened the Luxembourg City tram which will eventually run from the city airport to the Cloche d'Or business district, after a break of 50 years. The original signalling systems on the 3.5 km stretch between the Luxexpo conference and exhibition centre and Pont Rouge have also been renewed using HIMA's commercial-off-the-shelf (COTS) programmable logic controllers (PLCs) to increase the tram frequency.

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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North Eastern Railway Engineers' Forum
22nd Annual Event

Tuesday September 18th 2018
York Engineers' Triangle Hub Auditorium: 17.30 to 21.00

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The Programme

Trans-Pennine Upgrade	Mark Livock, Department for Transport
New Lines in the North	Gareth Dennis, Permanent Rail Engineering
The New TransPennine Express Nova 3 fleet	Robin Davis, TransPennine Express
The Huddersfield-Bradford Re-Signalling & Re-Control Project	Daniel Forbes, Network Rail

The Forum is Free of Charge. There is no need to book but pre-registration by email to ivmi@cowi.com is advisable.
The York Engineers' Triangle venue is at YO26 4AB.
Refreshments will be served from 17.30. The Forum will commence at 18.00.

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IRSE News

Institution of Railway Signal Engineers

October 2018

Ethics
and engineering

Thinking ahead
artificial intelligence and rail

Tactical agility
have we delivered our promises?

Saying goodbye to summer is always hard but why not get back to business and improve your existing knowledge or start afresh as a signalling engineer.
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Addressing the skills challenge

On 12 June 2018, the IRSE Southern Africa Section held a skills workshop in partnership with Terrapinn Ltd at the Africa Rail Conference 2018, Johannesburg, South Africa. The purpose of the workshop was to allow the South African railway industry to consider the skills challenges that the signalling, train control and communication disciplines face today.

The workshop was part of the Section's 2018 annual programme, which this year had the theme 'needs gathering', with the intention of developing a responsive strategy for the future. The objective of the workshop was to engage with the rail industry and consider the role of industry stakeholders in tackling this issue.

Discussions considered how operators can influence the railway industry, not only addressing the skills shortage but also seeking to reprofile the skillset of existing signalling professionals, taking into account recent advances in technology and the impact on these requirements. The workshop also discussed a holistic approach to addressing the skills gap and what needs to be done in the education system.

The skills workshop was moderated by the Transport Sector Education and Training Authority (TETA). Speakers included Transnet Freight Rail's general manager for the Rail Network, TETA's research and knowledge manager, the IRSE chair, and the University of Johannesburg's director of the Institute of Intelligent Systems. Closing remarks were provided by the African Association for Public Transport (UATP) president who is also the Gautrain Management Agency's CEO. The Passenger Rail Agency of South Africa was in attendance and listening intently as part of the audience.

As a highlight of the discussions, TETA is faced with a challenge of minimal participation from industry with regard to the development of the Sector Skills Plan. The industry on the other hand has a challenge of skills and generational gaps that have not been addressed. Furthermore, the academic institutions currently do not offer formal qualifications in railway signalling, train control and communication systems, while the IRSE as a professional body has a wealth of knowledge and skills that could allow the IRSE to make a significant contribution to the skills challenges in these disciplines.

The deliberations were engaging and pointed to a need for a collaborative effort from all stakeholders in addressing what has become a complex topic. The advent of the fourth Industrial Revolution, coming at a time when we face an existing backlog of work, exacerbates the challenge even more. We the IRSE have a role to play, and a unique combination of knowledge and experience. If the industry is to change and to address the challenges we face, we need to step up and lead this debate.

Portia (Xaba) Nkuna
Chair Southern Africa Section

Cover story

Manchester's Metrolink first opened in April 1992, running from Altrincham to Manchester city centre and on to Bury. Over the years the system has been extended a number of times, which has included over some former heavy rail routes, to become the largest tram operation in the UK.

Signalling in the city centre section is similar in design to systems in Europe, with vertical (go) and horizontal (stop) white bars interlinked with road traffic lights and track loops for tram detection and recognition. The former heavy rail sections were originally equipped with traditional block signalling, but using only red and green aspects and 'train stops' linked to red signals. This has now been replaced, however, with line of sight operation to achieve consistency across the network.

Photo Paul Darlington.

In this issue

From the IRSE and its sections

IRSE///
Institution of Railway Signal Engineers

Ethical engineering

Paul Darlington and Rod Muttram

Image Shutterstock/Olivier Le Moal.

A seminar in July undertaken jointly by the Institute of Electrical and Electronics Engineers (IEEE) and the Institution of Railway Signal Engineers (IRSE), explored the underpinning principles associated with ethical issues in engineering.

The aim was to explore the issue from various perspectives, raise awareness and explore how to instigate an ethical value based approach to the design and delivery of products, systems and services. This ensures that it becomes as embedded in engineering as safety is today. It was considered important to examine the subject at this time as the increasing use of Artificial Intelligence (AI) and autonomous systems presents new challenges.

Ethical decisions

In 2005 the Royal Academy of Engineering and the Engineering Council jointly created a statement of ethical principles to guide engineering practice and behaviour, which was updated in 2017. The principles require engineering professionals to have a duty in the following four areas.

1. Honesty and integrity – to uphold the highest standards of professional conduct including openness, fairness, honesty and integrity.
2. Respect for life, law, the environment and public good – to obey all applicable laws and regulations and give due weight to facts, published standards and guidance and the wider public interest.
3. Accuracy and rigour – to acquire and use wisely the understanding, knowledge and skills needed to perform their role.
4. Leadership and communication engineering – to abide by and promote high standards of leadership and communication.

Similar to many other engineering professional institutions the IRSE and IEEE have incorporated the principles in their codes of professional conduct, which are available from their websites.

In an age when increasing automation means that ethical decisions are being incorporated into complex systems, engineers have to think about how machines behave in scenarios that they have not had to consider before. This applies to many spheres of engineering, including transport. Autonomy of road vehicles is challenging previously accepted principles and ideas. The potential introduction of artificial intelligence into control systems, using 'self learning' techniques rather than algorithms, will create even more ethical issues which will need to be addressed.

It is not just about safety. In transport and many other fields of engineering and design, engineers are constantly encountering fresh issues that demand urgent, ethically sound answers. Respect for the planet, the environment and natural resources are factors that engineers must incorporate into their work, whether it is in the context of a major project such as Crossrail or HS2, or in finding practicable alternatives to the use of plastics for consumables.

The Hon Mr Justice (Sir) Charles Haddon-Cave

The first speaker at the seminar, Sir Charles is a judge serving in the Queen's Bench Division of the High Court of England and Wales, and has been involved in the fields of aviation, insurance, travel law and arbitration. He has appeared in many of the aviation route licensing hearings before the UK Civil Aviation Authority and was involved in law cases that followed major aviation and marine disasters including the Manchester Air Disaster and the Herald of Free Enterprise capsizing.

He was responsible for the damning report into the crash of RAF Nimrod aircraft XV230 over Afghanistan in 2006. His report was scathing about the money-saving edict that took priority over safety. "Unfortunately, the Nimrod Safety Case was a lamentable job from start to finish. It was riddled with errors. It missed the key dangers. Its production is a story of incompetence, complacency, and cynicism"

His keynote address set the tone for the evening, and was delivered using only two PowerPoint slides. One of the Nimrod XV230 report criticisms and a notable recommendation was related to the excessive use of PowerPoint in the Air Ministry, with people focused on watching and not thinking about the important messages being delivered. The report is available at **irse.info/okazl** and is recommended reading for anyone involved in safety engineering.

Sir Charles explained that engineers faced a challenge in designing driverless cars, driverless trains, drones, intelligent buildings, robots etc, so that they operate in a way that reflects human values and principles. Franklin D Roosevelt once said "Rules are not necessarily sacred, but principles are".

The Nimrod report highlighted the importance of engineers and Sir Charles said he loved the work delivered by engineers, and how important engineering is to society. Ethics he explained is the branch of moral philosophy that defines concepts such as good and evil, right and wrong, virtue and vice, justice and crime, and seeks to resolve questions on human morality.

The issue of ethics in engineering is 'applied ethics', which is whether a person is obligated or permitted to do something in a particular situation. The word engineer is derived from the Latin roots ingeniare ("to contrive, devise") and ingenium ("cleverness"). Indeed, the words ingenious and ingenuity also have the same origin as engineer, so by definition engineers are clever. He described the negative aspects of an engineer's ethics and behaviours in terms of the 'seven deadly sins'.

1. Pride – being vane and narcissistic.
2. Greed – charging too much.
3. Lust – lusting after other people's designs.
4. Envy – being jealous of other engineers.
5. Gluttony – taking on more work than you can handle.
6. Wrath – getting angry with clients.
7. Sloth – being lazy.

He did add that these may apply to most disciplines, not just engineering.

When bringing up children, most parents aim to 'engineer' their offspring to adopt values which will guide them successfully through their life. Sir Charles reflected that he hoped and trusted that good engineers feel and do the same with the products and systems they design and build, and which they feel they have a responsibility for; just like bringing up children.

Ethics and engineering though is a very serious topic which requires deeper understanding. Sir Charles highlighted three ethical theories which could be adopted or amalgamated to help ethical engineering.

1. Virtue theory is person rather than action based: it looks at the virtue or moral character of the person carrying out an action. It says an action is right if it is done by a virtuous person (someone conforming to moral and ethical principles).
2. Consequentialism theory. Which is based on outcomes and says an action is right if it promotes the best outcome.
3. Deontology theory. An ethical position that judges the morality of an action based on process. It says an action is right if it is done according to the right process.

Codes of Conduct/Ethics

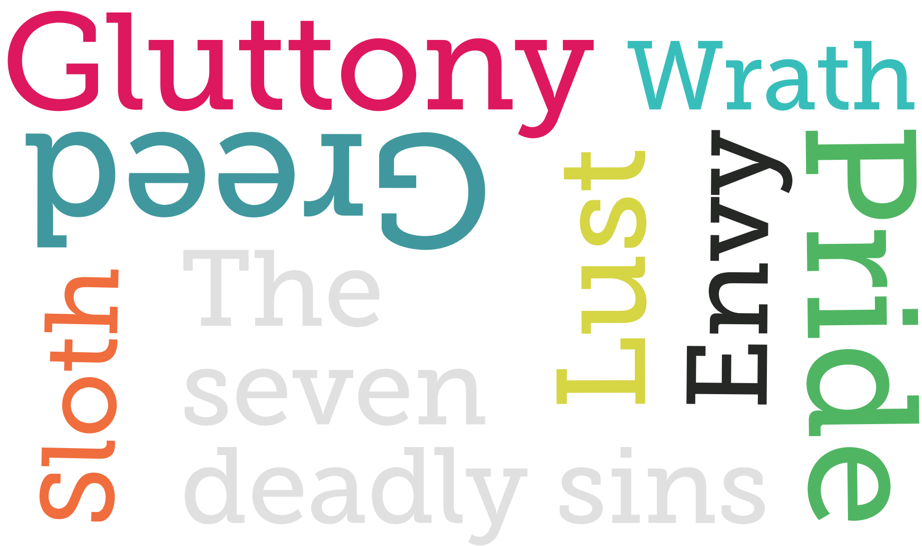
Sir Charles commended the IEEE Code of Conduct, which is similar to the IRSE Code, but noted that all engineering disciplines and professions have slightly different versions and he recommended that there should be more uniformity in codes of conduct within industry and society. The IEEE code requires its engineers to:

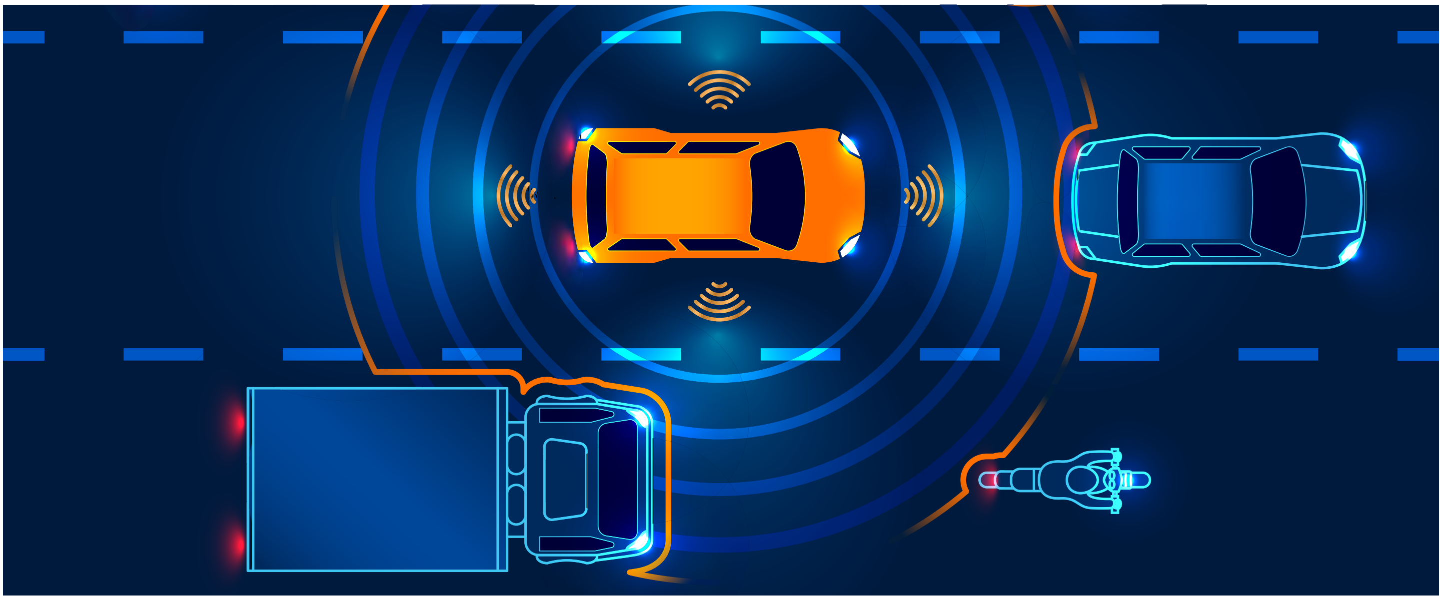
1. Hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, and to disclose promptly factors that might endanger the public or the environment.
2. Avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist.
3. Be honest and realistic in stating claims or estimates based on available data.
4. Reject bribery in all its forms.
5. Improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems.
6. Maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations.
7. Seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others.
8. Treat fairly all persons and to not engage in acts of discrimination based on race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression.
9. Avoid injuring others, their property, reputation, or employment by false or malicious action.
10. Assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

All ten are affirmable but Sir Charles questioned if they go deep enough and whether they help engineers when faced with really difficult ethical and moral decisions. There are other tools to help, one being ALARP (as low as reasonably practicable). ALARP is deeply embedded in the common law and is based on whether an action is reasonable, given all the facts that have to be considered.

Making sure a risk has been reduced ALARP is about weighing the risk against the resource (termed 'sacrifice' in law) required to reduce it further. The decision is weighted in favour of health and safety because the presumption is that the risk reduction measure should be implemented. To avoid having to implement an action you have to be able to show that the sacrifice would be grossly disproportionate to the benefits of the risk reduction that would be achieved.

The process is not one of simply balancing the costs and benefits of





The rapid adoption of automation in vehicles leads to a widespread discussion about engineering ethics.
Photo Shutterstock/Andrey Suslov.

measures but requires the adoption of measures except where they are ruled out because they involve grossly disproportionate use of resources. Extreme examples might be:

- To spend £1m to prevent five staff suffering bruised knees is obviously grossly disproportionate; but
- To spend £1m to prevent a major accident capable of killing hundreds of people is obviously proportionate.

In reality many decisions about risk and the controls that achieve ALARP are not so obvious. Factors come into play such as ongoing costs set against remote chances of one-off events, or daily expense and supervision time required to maintain mitigations. It requires judgment and there is no simple formula for determining what is ALARP. What is ALARP also changes over time, for instance with advances in technology.

Another ethical tool that Sir Charles demonstrated was the Heinrich Triangle Theory. Heinrich proposed that for every major injury, loss or event there are 29 minor and 300 no-injury accidents, losses or events. So ethically to reduce the 1 'major' it is necessary to investigate and eliminate the greater number of 'minor' and 'no-injury' events. Or put another way, don't just look at the tip of the iceberg, think about what is below the surface.

He also referred to the organisation of the MOD air section at the time of the Nimrod accident. It was very complex, with no clear lines of authority. There had been a period of intense, major organisational changes which left many people unclear about where responsibilities really lay. He said the organisation was unethical and noted parallels between Nimrod and other major accidents such as the Herald of Free Enterprise, the King's Cross fire, BP Texas City and, in particular, the Columbia Shuttle accident in 2003. He espoused the adoption of 'Four Key Principles':

1. Leadership – strong clear leadership from the very top.
2. Independence throughout the regulatory regime.
3. Much greater focus on people in the delivery of high standards of safety (not just on process and paperwork).
4. Simplicity – regulation, processes and rules must be as simple and straightforward as possible.

Sir Charles finished by emphasising that any safety management system must be made simple, and the greatest risk to safety and ethical engineering is complexity.

Ethics and transport engineering

The second speaker was Paul Campion who was appointed the chief executive of the Transport Systems Catapult in July 2017. His previous experience spans leadership roles in IBM's travel and transport, consumer products and in its software business, financing business and other executive roles.

He observed that society and transport engineering is about to face a huge challenge which will require many ethical considerations. If we look at publishing, music, finance, retail (home shopping) and some other industries, they have been fundamentally transformed by IT and communications, but we have not yet seen significant changes to the transport sector. While there have been some changes, we have hardly started.

A time traveller from a hundred years ago would just about recognise the transport options available today and the way they operate. The options may be shinier, more modern, affordable and numerous, but it is still cars, trains, trams, boats and planes, operating in much the same way. In the future this may change dramatically.

It is not just what the changes will be to the components and modes, but to the overall relationship with society such that in the future the silo boundaries of transport are likely to be broken down and transformed by new technology. It will be the way that the engineering interfaces with the political and societal values that will raise so many ethical questions.

Autonomous cars and societal acceptance of risk has already raised interesting points. Whenever a semi-automatic car has had an accident it is front page news. When actress Mary McCormack's husband's Tesla car caught fire while he was driving in the Los Angeles area, her post on Twitter was shared 1.5 million times. The popular press reported her post showed a "shocking video of a Model S spewing flames from the driver's side front wheel well". Conventional vehicles also catch fire and Tesla make the point that their cars are far less likely to catch fire than petrol and diesel vehicles.

A single incident on a train where someone is hurt will make headline news, but everyday several people are killed on the roads, such is the acceptance of risk by society for some situations, but not others. It has been suggested that an autonomous vehicle will have to be many times safer than a person driven vehicle for it to be accepted and allowed on the road. Why is that? It may be that when a driver makes a mistake they can be taken to court and made accountable, but what happens if someone is hurt by a machine? There is nowhere for the 'human attributive instinct' to go and 'seek justice'.

Take the example of an autonomous car in a queue of cars joining a busy main road at a T junction. Traffic starts to build up and slow down. Cars with drivers at the front of the queue 'nudge forward' and cars on the main road let them in. Should the autonomous car be programmed to do the same, or should it wait until the road is clear, which could take hours?

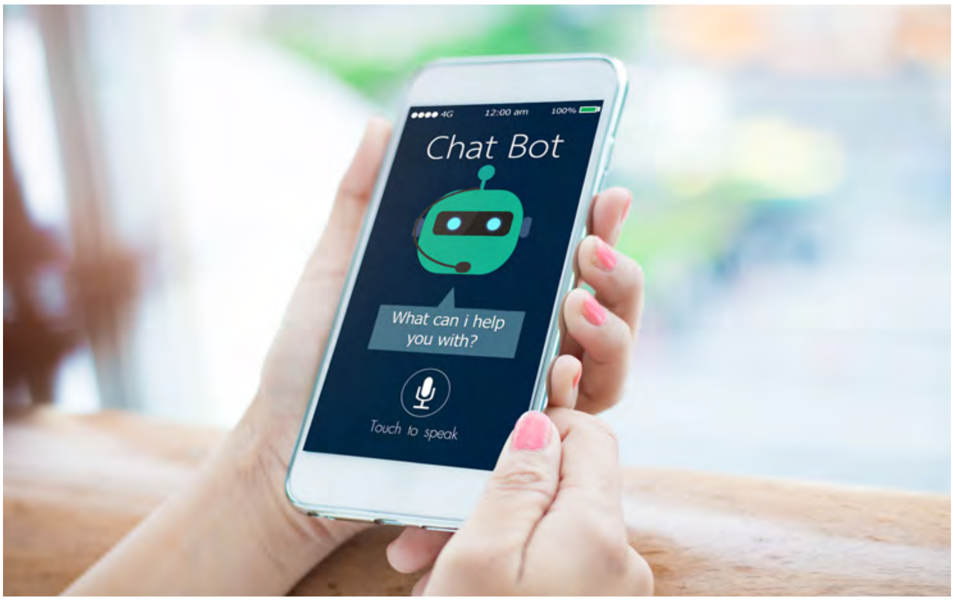
Should the autonomous car have a sliding scale of 'caution or bold' which could be selected by the client? Select 'caution' and you could be waiting at the junction for some time, but select 'bold' and the risk of an accident increases; and your insurance premium would increase as the insurance company would know because everything is recorded and reported.

What happens if a perfect autonomous car could be developed such that it will always take action to avoid accidents? Other road users know this and start to deliberately pull out in front of the perfect autonomous car. Do engineers then deliberately make the autonomous car less safe? If an autonomous car has to take action to avoid an accident what rules apply if the choice of action is to hit a pedestrian or another vehicle? These are the sort of issues that engineers of the future may face.

To be effective the autonomous vehicle will have to be more human like and make ethics-based decisions. It will have to be provided with artificial intelligence (AI) so that it will learn and adopt different behaviours similar to a human. Let's assume that a car can be taught to drive itself through AI. If it makes a mistake due to the way it has learned who is to blame? The designer, programmer, tester, or the salesperson? It may well be that in the future accountability for such incident will move from the criminal to civil courts.

Unethical AI Chatbot

To illustrate the issue further Paul gave an example of AI behaving unethically. Tay was a Microsoft 'chatbot' which used AI to responded to users' queries and emulate the casual, jokey speech patterns of a stereotypical millennial. The aim was to experiment with and conduct research on 'conversational understanding' with Tay able to learn from conversations and get progressively 'smarter'. When it began posting racist messages in response to questions it quickly had to be shut down.



Can you trust your Chatbot, or its programmers, to act ethically?
Photo Shutterstock/Panuwat Phimpha.

It was identified that it was vulnerable to racists, trolls, and online troublemakers who persuaded it to use racial slurs, defend white-supremacist propaganda, and even make outright calls for genocide. Tay's racism was not a product of Microsoft or Tay itself, but Tay was simply a piece of software that was trying to learn how humans talk in a conversation. It didn't even know what racism was but Tay spouted 'unethical obscene language' because racist humans on Twitter quickly spotted a vulnerability and exploited it. The problem was that Tay didn't understand what it was talking about.

Microsoft's developers didn't include any filters on the words that Tay could or could not use and came under heavy criticism for the bot and its lack of filters, with some arguing (with hindsight of course) that the company should have expected and pre-empted the abuse. Now imagine what unethical behaviours an AI safety related system may be vulnerable to when faced with unethical humans.

Future of mobility

Paul said that autonomous vehicles are likely to be very expensive and therefore may not be as 'mainstream' as some manufactures predict, certainly in the short to medium term. He added that it may be more cost effective to buy a conventional vehicle and hire a chauffeur for three years, rather than buy an autonomous vehicle!

He therefore suggested that the future of transport mobility is likely to be more about the way forms of transport work together and in particular the services layer of transport with the use and management of data. The use of personally identifiable data however also has ethical and legal issues, as illustrated by the Facebook-Cambridge Analytica data scandal, and which engineers will have to deal with along with the ethical safety considerations.

Hindsight bias

The third speaker was George Bearfield a visiting professor of Railway System Safety at the University of Huddersfield, and director of system safety and health at the Rail Safety and Standards Board (RSSB). RSSB is responsible for supporting the GB rail industry in all aspects of its health and safety management and assurance processes and capabilities.

He opened his part of the evening by reflecting that as an engineer and a tax payer, and like everyone in the rail industry, he wants to do the right thing as far as he is able. The challenge for everyone though is that when people are under pressure they can have difficulty with complex ethical issues when making 'high stake' decisions in the rail industry.

When dealing with complex safety engineering in rail it can be an ethical minefield. Investment decisions have to be made over very long-time frames during which the political, social concern and tolerance, and ethical standards may change. Where safety or accident risk is involved the tensions will be high and decisions are often governed by what is affordable, and by the balance of risk.

When making ethics-based decisions one of the traps that can occur is 'hindsight bias'. This is the inclination to see past events, such as accidents, as more predictable than they really were. Major accidents in the railway industry generate widespread press coverage and societal concern. This in turn leads to pressure on the government, regulator and industry to act in a way that may not be proportionate to the risk. If such events are seen as being predictable – an accident waiting to happen – it places great importance on the ability of a transport operator to argue that they had appropriate safety measures in place.

Hindsight bias can lead to knee jerk reactions. How many times have we heard after a major accident a politician quickly say 'money is not a problem'? This is often an unethical statement as in many cases money will be a problem when ALARP is applied and it is determined that the money involved could be far better used to reduce risk somewhere else.

As a result of the fatal Paddington, Southall and Clapham rail crashes the Automatic Warning System (AWS) was widely considered to be inadequate and outdated. The Hidden Inquiry into the Clapham train crash in 1988 and the Paddington train crash survivors both favoured the expensive Automatic Train Protection (ATP) system.

A report by Sir David Davies, President of the Royal Academy of Engineering, after the Paddington crash recommended the cheaper Train Protection Warning System (TPWS). That conclusion was endorsed by the Joint Inquiry into Train Protection Systems chaired by the Rt Hon Lord Cullen and Professor John Uff. TPWS delivered 80% of the benefits for 20% of the cost and is part of what has made Britain's railways the safest in Europe. This is despite the 'money is not a problem' statement and in ALARP demonstrating that neither system could be justified based on the benefits against the sacrifice involved. The decision to provide TPWS was a government ethical decision that took society's acceptance of the risks involved into account.

Narrow framing

Narrow framing refers to people's tendency to view problems in isolation, rather than taking a broader view. The likely outcome is that decisions that a transport operator makes on a problem-by-problem basis will not combine to provide a rational and coherent way of managing the safety of its operation as a whole. The RSSB and industry approved approach to cost benefit analyses (CBA) seeks to standardise the rules around developing analyses to support decisions.

This should make it possible to view a set of seemingly unrelated analyses as a portfolio to help understand and interpret

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each and reach a better set of decisions over time. Transport operators need to be aware of opportunity cost. The money (or other costs) required to retain a control that is demonstrably reducing risk below the level required by law could potentially be used to provide a larger risk reduction elsewhere.

A recommended document for anyone involved in safety management is the RSSB document "Taking Safe Decisions – How Britain's railways take decisions that affect safety". This is available from the RSSB website and it discusses many of the topics relating to ethical engineering.

IEEE P7000 Ethical concerns during system design

The final speaker was Ali Hessami, an expert in systems assurance and safety, security and sustainability, and has a background in design and development of advanced control systems for business and safety critical industrial applications, which includes railways. He represents the UK on CENELEC and IEC safety systems, hardware and software standards committees and is a group leader for a pan European Cyber Security standard. He is also the technical editor for the IEEE P7000 process standard on addressing ethical concerns during system design.

As the discussions during the evening had identified, engineers, technologists and other project stakeholders need a methodology for identifying, analysing and reconciling the ethical concerns of end users. Consumers are not trained to think about ethical considerations regarding the products and services they use and it is only by rigorously examining ethical concerns that manufacturers, engineers and technologists can ensure products and services are as safe and relevant for end users as possible.

Approximately 40 people are expected to be actively involved in the development of the P7000 project, and the scope of the standard is to establish a process model by which engineers and technologists can address ethical considerations throughout the various stages of system initiation, analysis and design.

The expected process requirements include both a management and an engineering view of new IT product development, computer ethics and IT system design. The requirements will also include value-sensitive design and stakeholder involvement in ethical IT system design.

The purpose of the standard being produced by Ali and the IEEE is to enable the pragmatic application of a value-based system design methodology. The intention is to demonstrate that conceptual analysis of values and an extensive feasibility analysis can help to refine ethical system requirements in systems and software life cycles.

The standard will provide engineers and technologists with an implementable process aligning innovation management processes, system design approaches and software engineering methods to minimise ethical risk for their organisations, stakeholders and end users. It is planned for publication in early 2019 and will be the first global standard to guide ethical principles in engineering design.

Conclusion

The event was well received by all who attended and there were some very good questions and a good discussion at the Q & A session after the presentations. A follow up session is being considered.

Artifical intelligence in railway applications

Alexandre Pires
Portugal

In this article Alexandre considers the move of railway signalling and control towards being software-based, and the relevance of techniques such as 'artificial intelligence' to the future world of command and control.

When the first electronic interlocking systems became available to the railway market, many conservative signalling engineers offered heavy resistance to their introduction, primarily because of a lack of confidence in terms of safety. While the status, behaviour and electrical parameters of a vital relay can be seen and measured, the absence of knowledge and a complete understanding of what happens inside the mysterious black-box of an electronic interlocking and its software brings can create a lack of perceived safety. We all know that safety is not a feeling, but the proven absence of unacceptable risks, however much of the time feelings are important in such decisions.

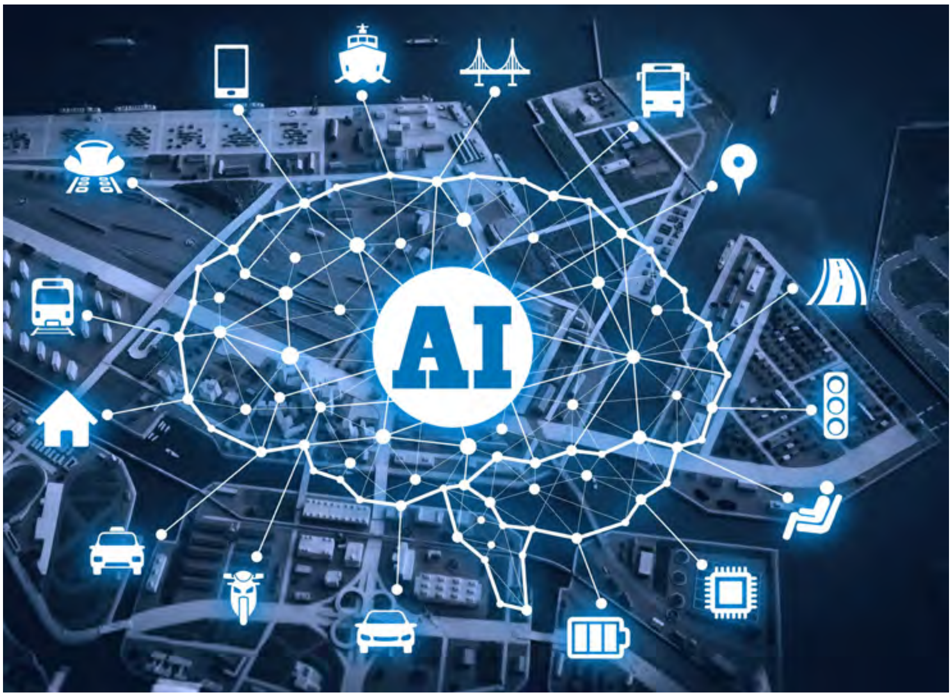
The use of software in critical signalling applications promised cost reduction, lower energy consumption and substantially smaller physical space requirements, but changing the old reliable and safe vital relays to a new technology and system that may introduce unforeseen hazards to the life and integrity of passengers was just not, at first, acceptable. Fortunately, the application of safety standards and processes of software engineering were strong enough to provide evidence of safety and make the use of computers in railway signalling feasible. These processes now enable us to use SIL4 hardware, running SIL4 certified software.

Artificial Intelligence (AI) seems to be the next breakthrough technology in engineering. While deterministic programming requires a full understanding of the desired software behaviour (which may require months or years of physical system study and modelling), followed by well-designed algorithms and many hours of software coding and testing, using AI modelling requires only the basic neural math and huge processing power. AI can't solve every problem in the world, but it can solve many problems better and cheaper than using deterministic programming. There's no need to refuse its entry into railway control and communications systems, but like the introduction of software based interlockings we need to know where and how to use it.

What exactly is artificial intelligence?

Artificial Intelligence is an algorithm, mathematical model or software that can 'learn' what to do and improve its own performance with time, based

Artificial intelligence will inevitably be part of the future transport system.
Photo Shutterstock/Pavel Chagochkin.



AI is already playing a role in many systems that make up the infrastructure we depend on, including transport.
Photo Shutterstock/Metamorworks.

on information from its own past performance. While deterministic software does exactly what it was told (by the programmer), AI software is only programmed with a learning mechanism, some kind of trial and error routine. While the behaviour of a deterministic software can be totally determined, the behaviour of AI software can never be completely foreseen, but only taught.

One of the most popular models for AI software is the neural network. As the name says, it's a simulation of a network of human neurons. It can 'learn' by adjusting some constants used for the neuron math, very similar to a biological synapse. By repeating a task many times and analysing the result of each action, right or wrong, the computer can adjust the constants and thus enhance its performance.

The AI software will always do things wrong the first time. It may even do nothing. But as the computer has the chance to try to perform the same task several times, it will get better each time reaching the point that it is able to do better than any programmed software and, in a way that no human could do as fast or efficiently. It is possible to watch several videos on Youtube where AI learns to drive a car, climb walls and even beat Super Mario Brothers faster than any human. And the best of all, it requires minimum programming effort and almost no knowledge of the system response.

Even if it has the chance to try to perform a task millions of times, AI software as we know in 2018 will always have the potential to make mistakes and always have some degree of unpredictability, mostly because the inputs in the real world can surprise it and trigger some undesirable response. It is just impossible to foresee every response for an AI software system, even for a mature one. This is where the hazard lies.

Despite of its 'bad behaviour' in early stages, there are a lot of railway applications where AI can be useful, either delivering a task with a consistently better outcome after the initial teething troubles, or by being cheaper than classical coding and therefore delivering a solution where none was available.

AI in SIL0 railway applications

When waiting for a train to arrive in a metro station, I always watch the display that predicts the time until arrival of the next train. And it is never totally accurate, that is acceptable for this application, but I can't keep thinking of how much time and money was spent to create software that predicts the arrival time of each train in each station. If an AI was used in this application, all we would need to do is introduce the related track circuits (or the position of each train) as input and let the AI learn how to predict the time-to-arrival. Of course, in the first day, it may show inconsistencies or even nothing, but as time goes by, within 30 days perhaps, it has the potential to be more accurate than the human coded software and at a much lower cost.

It is possible to use the same philosophy for every non-deterministic and non-safety application in railway operation. Train regulation, timetable creation, mechanical ventilation control (how to provide maximum comfort with minimum energy consumption), joint synchronization, lighting control and so on. Many applications where rules are flexible or where a controller is needed may benefit with AI.

AI in SIL4 railway applications

There are a few applications where a computer doesn't have the opportunity to make mistakes. In the safety functions, a critical software mistake may result in the loss of life, something that can never be accepted. This means that AI software can never be used to make the final decision but that doesn't mean that AI cannot be used. Even the more experienced humans can make mistakes, and that's why the safety systems are so important.

If a signaller attempts to put two trains in collision route, the interlocking system will not authorise such a manoeuvre. If a train driver tries to accelerate it to an unsafe speed, the train's protection system will restrain its speed. Humans can fail, AI software should be treated the same way.

Since safety integrity levels are about functions, AI software may be used in critical applications, but only when not performing critical functions. It may learn how to control the train speed better than a human driver or human coded software, and it may actually drive the train, but only if a SIL4 function allows it to do so. That way, a software that can make mistakes is watched by the trustworthy Automatic Train Protection (ATP, GOA1) that has the final authority over the train.

The example in Figure 1 shows a possible application for CBTC onboard ATO system using a SIL0 AI software in its core. The AI itself doesn't have

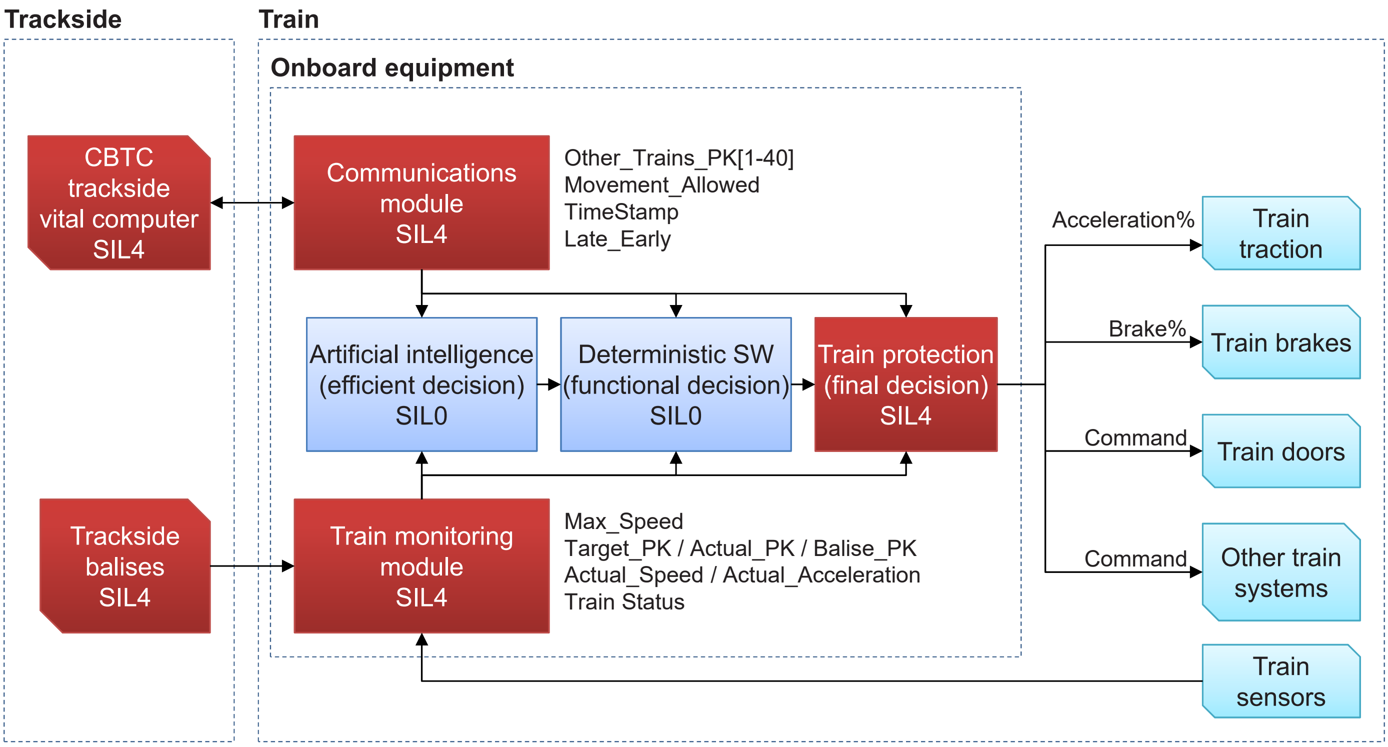


Figure 1 – a possible application of artificial intelligence in automatic train control.

direct control of the train traction or brake but is limited to only "advise" the SIL4 functions in how to drive the train efficiently.

As may be noticed in the figure, AI is always looking for improved efficiency in driving the train. Efficiency may be better passenger comfort, lower energy consumption, lower travel time, etc. It really depends on the application, but at some point, it is correct to say that AI should look at every one of these variables and consider all of them in its decisions. I have a few reasons to believe that, in this task, AI is more efficient than any human driver or any human coded software.

Teaching an AI how to drive a train

The obvious question that must be asked is how to make the train's AI learn the driving processes, without wasting lots of megawatts and disturbing operation? Is the AI capable of 'watch and learn', absorbing a human driver's skills? Well, AI as we know in 2018 doesn't work that way. The trial and error experience are a requirement.

The solution for this problem is to model the train's behaviour in mathematical terms and run computer simulations. Thousands of them. Once the AI learns how to drive the train virtually, the AI core and its synapses may be copied to a real train and tested. The AI core's design and teaching process for a train speed controller may be described as:

- Model the train behaviour and system response models based in real world parameters (which can be obtained from the specifications or measurements).
- Create a set of challenges for the AI (on precise station stop, late train, early train, one train ahead, speed reduction, etc).
- Establish the train efficiency parameters (what is really important? Energy consumption? Comply with the time table?).
- Establish the input and output variables for the AI (actual speed, target stop, train/station, late/early, etc.).
- Create a generic AI neural network, with nothing learned (blank slate).
- Run computer simulations. Let it learn by itself.
- After a few simulations, if AI is not performing as well as it should, review the input and output variables (is there something missing?), rebuild the neural network and run simulations again.
- Once the AI's driving performance is good enough, download the parameters matrix (AI's experiences and memories) to the train's AI.

This is an initial approach based on early studies of AI, and are not meant to be the final method, but a good starting point to those who want to create a design model for using AI in real life.

Conclusions

Artificial Intelligence is already a reality for several applications and has proven its value by doing highly complex tasks that humans could rarely achieve or doing simple tasks very efficiently. For some applications, programming and teaching an AI can be a lot cheaper and quicker than classical logical programming.

AI can make mistakes sometimes, and that's why it should not be allowed to have the final authority in critical functions.

The question is no longer 'if' AI will be used in critical railway software, but 'when' and 'how'. System engineers around the world must prepare to change and understand how to use AI in safe, efficient, reliable and cheaper systems. It is also important to encourage professionals, students and universities in the development of AI techniques and studies, as well as to adjust safety, RAMS and efficiency standards to this new, inevitable, future.

About the author ...

Alexandre is an electronic systems engineer who graduated from Rio de Janerio Estate University and now works at Alten UK. Having worked in railways for 7 years, specifically in safety-related systems for urban railways, Alexandre's current role is related to ensuring the quality of software created for Manchester Metrolink.

The ITC view on the residual risks to the Railway as at Q2 2018

Prepared on behalf of the International Technical Committee by Rod Muttram

Safe operation of the railway is a complex task, with many sources of risk. Command and control is just one area that needs to be considered in depth.
Photo Shutterstock/DaveNavarro Jr.

Imagine that you are being asked to endorse a new project or to reduce the scope of a running project due to budgetary constraints or time deadlines.

In the voluminous documentation presented, how do you identify and ensure suitable control and/or mitigation of those issues that may well affect safe operation of the railway?

We suggest that there are some key areas where you could certainly start:

- How will the way in which the railway is operated change?
- How do the changes impact on the technical and operational interfaces both from a permanent and a transitional perspective?
- How do the humans in the system, most importantly drivers and signallers/dispatchers, understand and deal with the changes, particularly transitions and operation in degraded modes during partial failure?
- Is there a reliance on long standing standards and practices, and if so are they still robust in the changed circumstances?

During the presentation day of the IRSE Annual Convention in Dallas on 26 September 2017, the IRSE International Technical Committee (ITC) presented three linked papers which we consider to be amongst our most important outputs in recent times. For that reason we have decided to produce this article to summarise those papers in a form that is digestible to non-signalling specialists. People make far reaching decisions affecting safe railway operation, but may not fully appreciate the implications and risks associated with proposals (which might appear superficially minor in nature) to change operational practice and/or the technical systems of infrastructure and rolling stock.

The three related papers cover a proactive approach to speed control, the need to recognise the importance of considering human factors and the methodology now used in the EU for railway risk analysis and management. They are primarily related to the main line railway (heavy rail) but a number of the messages and principles they outline are applicable to metros and light rail systems as well.

All ITC members are very experienced professionals. These three papers were prepared respectively by our current chair, Frans Heijnen, a former IRSE president, technical director of the ERTMS EEIG (European Economic Interest Group) and former vice president technology at Invensys Rail; by Rod Muttram, who as director, safety and standards led Railtrack's input to three of the four public inquiries into the Southall and Ladbroke Grove collisions before setting up the RSSB and then holding a series of vice president roles at Bombardier, and by Libor Lochman, executive director of the Community of European Railway and Infrastructure Companies (CER) and former director of the Railway Research Institute (VUZ) of Prague.

All of us are passionate about safety and the need for rail to protect, maintain and where possible improve its position in land transport safety performance.

Over 1.25 million people are killed every year on the world's roads. In the time it is likely to have taken you to read to this point, on average, 3 people will have died in road accidents. Despite these appalling statistics (or perhaps because the events are so frequent and common) road accidents get little publicity outside the areas where they occur. By contrast, rail accidents leading to fatalities become worldwide news. Consider the coverage of the Santiago de Compostela derailment in Spain in July 2013, the Bad Aibling collision in Germany in February 2016 and the derailment of an inaugural Amtrak service near Tacoma, Washington State, USA in December 2017. It is these types of infrequent but high consequence high speed derailments and collisions which the industry must continue to strive to eliminate.

We stress this because nothing is constant but change, and after a recent period of renaissance and significant growth the rail industry now potentially faces a new challenge from autonomous road transportation which allows the road sector to erode some of rail's competitive strengths. In the area of safety, the replacement of human drivers by autonomous driving systems offers the opportunity for the road sector to make huge improvements in safety performance and this will undoubtedly be something that the proponents of these technologies will emphasise.

The recent publicity around accidents involving Tesla cars believed to be driving using 'autopilot' (not a fully autonomous system) and Uber's (now suspended) self-driving trial in Arizona, would seem to indicate that the degree to which the public and media will accept a big incremental improvement in overall safety but with a remaining smaller residual risk of system error, is still unclear. No-one should underestimate the selling power of these global mega-corporations.

Rail must not be complacent: its average performance is very good, but it must be vigilant in maintaining that performance and continuing to improve in the areas that lead to the rare, but significant, major accidents and incidents. The three papers all drew heavily on the lessons from some of the recent more damaging ones and pointed to the sort of actions that will continue to reduce the frequency of such events.

Summaries of the papers

Paper 1: Adopting a proactive approach to the implementation of Speed Control Systems (Frans Heijnen assisted by Alan Rumsey)

The full paper can be found at irse.info/itc43.

Guided transport systems, and heavy rail in particular, have some characteristics that make them fundamentally different from road transport. Steel wheel on steel rail is a low friction system that gives low energy consumption but also leads to long braking distances meaning that drivers must often take action long before a curve that requires a reduced speed is visible to them.

At that point (for instance) they may be more prone to loss of concentration or distraction because they have had a low workload during a long period at constant speed and may not yet have recognised the approaching hazard. If they miss a lineside speed reduction warning, then by the time they do see the curve and perceive the risk it may be too late to achieve a sufficient speed reduction. This is one of the reasons why many driver training systems place such significance on 'route knowledge'. Further, if a train does enter a curve at higher than the safe speed then derailment, and quite likely overturning, is inevitable. There is nothing the driver can do to prevent or mitigate it, he/she cannot try to steer a different course in the way a road driver might if one is available.

The recent history of derailments due to overspeed highlights such deficiencies in the recognition of these risks associated with driver error. The behaviour of even the most vigilant and professional driver can be affected by external factors, such as pre-existing health conditions, shift patterns, distractions and the working environment. Changes to the track speed profile, whether permanent or temporary, customarily managed by use of signs, rules, and procedures are thus inherently prone to human error.

It is important to recognise that best practice is to have an operative engineered (automatic) control system like ETCS to underpin driver management of train speed. The emphasis is on 'operative' and it is vital to consider what happens when such systems fail, particularly at transitions between different systems or between areas where there is a system and where there is not.

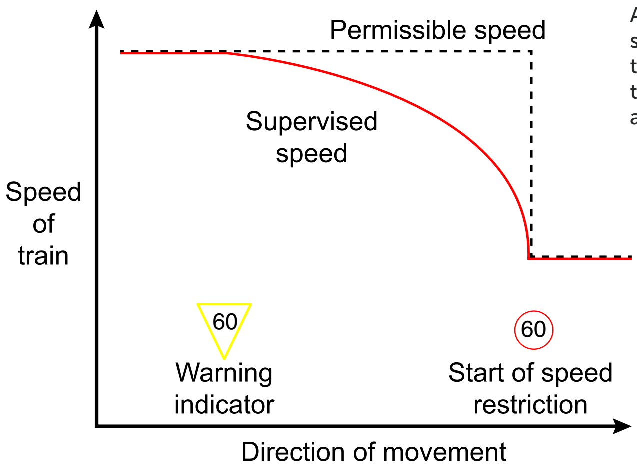
The paper makes the point that where a railway identifies such risks, or where action is forced upon them by Regulators, they have two choices; replace the existing signalling system with a newer generation of signalling technology that inherently provides the required level of safety protection; or overlay an additional system or systems on to the existing signalling system, to provide the additional safety protection required.

The paper describes a number of the systems of varying maturity that are available to fulfil the speed control function. Some are intermittent (fitted only where there is determined to be a high risk), while others provide continuous speed supervision. They have different whole life costs, operation, maintenance and training requirements and some may present much more of a challenge in terms implementation and transition from existing systems than others. Selection of the right system is therefore a complex issue but that does not justify doing nothing or excessive delay in taking action.

Risk assessments must thus cover more than just errors that relate to human interaction with the technology. It is often considered that long standing practices 'must be good enough' and they are not always challenged in the light of incremental changes happening around them.

At Santiago de Compostela the interface between new and 'traditional' infrastructure was a contributing factor, along with distraction and the use of a cruise control (speed hold) without the protection of an automatic braking system to prevent overspeed. The ETCS on-board the train concerned was switched off because of availability/compatibility issues and the track in the area of the accident was not yet fitted with the system anyway. The ITC believe that had the EU Common Safety Method (CSM) processes been followed in full to assess the system level risks, at least some of these issues would have been identified.

The paper concludes by making the observation that speed control is nowadays considered a 'must have' even if the business case is not always totally clear. The only thing sometimes missing is the recognition by all parties that times have changed. Automatic speed control is now a de facto norm and the assumption that the manual systems of the past provide sufficient protection is simply not defensible.



A continuous speed control system such as ETCS knows the maximum braking rate of the train and supervises the approach to speed restrictions.

Paper 2: How do we reduce the number of accidents due to Human Factors (Rod Muttram)

The full paper can be found at irse.info/itc47.

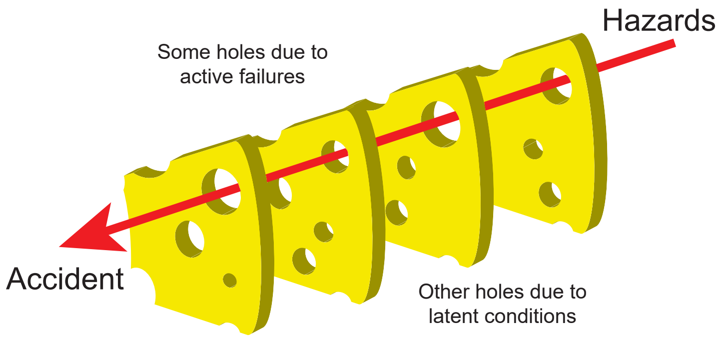
The performance of all systems is dependent on people, processes, equipment/tools and the interaction between them. Speed Control as considered in the first paper is one very representative example.

Human factors is a broad term for the analysis, understanding and optimisation of human performance in the work place. It should consider the working environment, interfaces and processes from a human-centred viewpoint, by looking at the whole system and its influence on the way people make decisions and interact with the other system elements and each other. Another (more or less interchangeable) term for this is 'Ergonomics' which has three branches:

- Cognitive ergonomics (concerning people's perception, reasoning, memory, motor response etc.).
- Organisational ergonomics (the impact of organisation structure, policies, processes, culture, etc.).
- Physical ergonomics (how people interact with equipment and tools including things like work layout, the design of symbology, required reach, strength etc.).

These three branches help us to understand why humans sometimes fail to do what they know only too well that they should.

Most accidents result from a combination of events, and human factors almost always play some part. The paper seeks to explain and illustrate this by presenting a number of industrial and railway examples and by using Professor James Reason's 'Swiss Cheese Model'. This represents safety barriers by slices of swiss cheese with holes randomly distributed in each slice representing flaws or weaknesses in those barriers. In a stable situation the holes in all the slices do not align in a way that lets something pass right through all the layers; but if there is 'noise in the system' that causes the layers to move, or something changes to introduce a new hole, a path can appear through all the barriers and that is when failures and accidents occur. Human factors often contribute those change factors.



Reason's 'Swiss Cheese' model recognises that multiple protections are necessary to ensure safety.

Risk assessment should seek to identify the potential weaknesses (holes) and aim to eliminate or mitigate them. For any system with people involved (and that includes the design of automated systems) an understanding of what makes people more prone to making errors is essential. Human performance is not a given – systems need to provide layered protection, and risk assessments should be cautious in assuming that different issues cannot occur simultaneously.

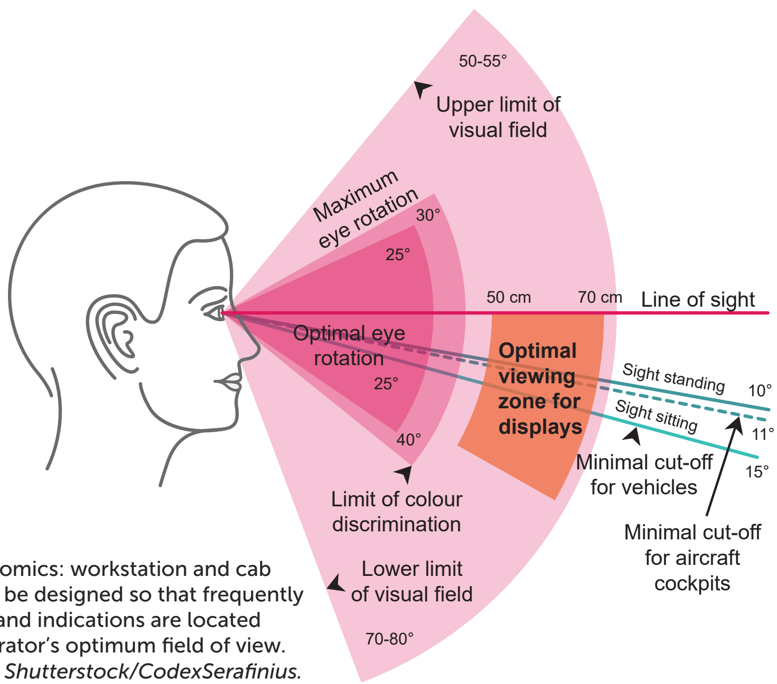
It is important to recognise that risk is not always a linear factor, e.g. increasing train density may cause a 'cliff edge' to be reached where risk suddenly increases markedly. Running in degraded (partial failure modes) where safety is more dependent on manual procedures always presents greater risk and needs to be planned for, and training provided. As one of the examples (Bad Aibling) illustrates, (and it is by no means unique), it is also possible for people to wrongly believe that technical systems have failed, even though they have not. Assessments should look for new emergent issues as well as incremental changes which can add up to significantly changed risk levels.

Safety systems should always include provision for the collection of data relating to human error both in normal and degraded modes in order to identify and then act to control or mitigate the factors that make errors more likely or even inevitable.

All railway businesses should have access to human factors expertise, and human factors must be integrated into all railway processes, particularly those involving significant change.

The increase in the use of automated systems of operation which are still designed by humans means that diligence is needed in design processes and system verification and validation (V&V) to reduce error rates. Early investment in a good system architecture, automated validation processes, the avoidance of over specification (and thus unnecessary complexity), and good system documentation for future maintainers will all pay later dividends. Once again planning for degraded modes of operation is essential.

The full paper sets out a number of other good practice pointers for human factors management.



Physical ergonomics: workstation and cab layouts should be designed so that frequently used controls and indications are located within the operator's optimum field of view. *Original image Shutterstock/CodexSerafinius.*

Paper 3: Improving the management of emerging and residual risks of Railway Control Command & Signalling (CCS) systems (Libor Lochman assisted by Jean Baptiste Simonnet – presented in Dallas by Francis How).

The full paper can be found at irse.info/itc48.

One of the aims of the European Union is to create a Single European Railway Area, supported by advanced regulations and standards delivering interoperability and a sufficient level of safety. There are emerging as well as residual risks in CCS technology and there is believed to be an insufficient knowledge of how to mitigate them (including the very topical risk of cyber security) without threatening system level safety, and decreasing system performance in terms of capacity and punctuality, and increasing overall cost. The EU believes that a harmonisation of safety practices can lead to better performance, reduced cost and therefore greater competitiveness for the railway sector. Whether you agree with that philosophy or not, the framework now produced does reflect acknowledged good practice in Safety Management.

Through the Railway Safety Directive the EU has introduced the Common Safety Method (CSM) for risk evaluation and assessment which for EU member states is a mandatory generic harmonised risk model. The rationale is that current practice should change and evolve towards a more harmonised approach that will contribute to improved rail performance. Harmonisation should help to reduce diversity and the impact of technical failures in a cost-effective way.

Within the European safety management framework, the CSM provides a detailed methodology for assessing safety risks related to any change within the railway system; it should also allow the identification and mitigation of degraded modes that can lead to severe consequences. It provides a guidance for safety hazard identification, analysing the risk impact from those hazards, defining relevant and suitable safety requirements and measures for accepting/managing residual risk.

Risk assessments may need to be adjusted to take account of hazardous cargos being transported by rail. *Photo Shutterstock/s_oleg*.

When the CSM is used properly the documentation trail produced can be an important tool for recording the 'corporate memory' of residual risk. CSM requires Railway Undertakings (RU) and Infrastructure Managers (IM) to have a collaborative Safety Management System in place and to use it to manage change.

Using CCS as an example, and the CSM Risk Assessment process, if the conclusion is that the risk does not need further reduction due to the system being compliant with established practices and standards, the associated decision must be justified and documented. This will also include explicit safety design targets.

There must be assurance that the acceptance criteria (code of practice, reference systems or explicit design target) is relevant. All interfaces within and to areas outside the scope of the change should also be very carefully considered.

CCS is only part of the overall railway system, and very often some risks are exported to other sub-systems or processes and to other duty holders e.g. where degraded modes of operation rely on operational rules and procedures. The risk handover process must not be unidirectional and the acceptance and understanding of these exported risks by those who have to manage them must always be negotiated and agreed and never assumed!

The paper concludes by saying that safety arguments based on long standing custom and practice, often embedded in rules and procedures, should be reviewed periodically, particularly when other changes are being made. Emergent threats like cyber attacks, incremental changes and increased usage over time can affect both rail and road traffic. A good example is the impact of these on safe level crossing operation; simpler crossing types may present an acceptable level of risk when rail and road traffic are light, but increase the traffic density, type or speed of either road or rail and more comprehensive risk control measures may be needed.

Conclusion

These three papers were intended as a call to action. Rail accidents with a significant loss of life or injury may be few and far between, but recent high-profile cases show that they are still headline news. With new competition emerging, the rail industry needs to be even better. The first two papers address the most common causes of recent significant accidents and the third sets out the rationale and opportunities for applying the structured methodology that the EU has developed. We commend them all to you and recommend that you take the time to read the full papers.

If you are a manager or responsible engineer in the rail industry then the ITC suggests that, to perform your role in a diligent manner, you should consider whether your safety management system is adequate. You should consider if it has been applied correctly and whether your organisation is using appropriate good practice solutions and engineered systems to protect staff from the errors they will occasionally make. Relying on past 'custom and practice' is simply not good enough.

The ITC's intention is that this paper should be read by a wide audience within the railway industry – please help by sharing with your colleagues who are not IRSE members.

The link to a PDF copy on the ITC page in the Knowledge area of the IRSE web site is irse.info/itcreports.

More information about the ITC and its work can also be found on that page.

Distributed Acoustic Sensing (DAS) in the railway sector: realising a vision

Gavin Lancaster and Martin Rosenberger
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Since conducting the first trial systems based on Distributed Acoustic Sensing (DAS), significant progress has been made in continuing to develop this technology for use in the railway sector. International installations provided numerous insights into various influencing factors, data processing and the relevant solutions. This article outlines some of the most important findings and developments. It uses the DAS-based Frauscher Tracking Solutions FTS as an example application.

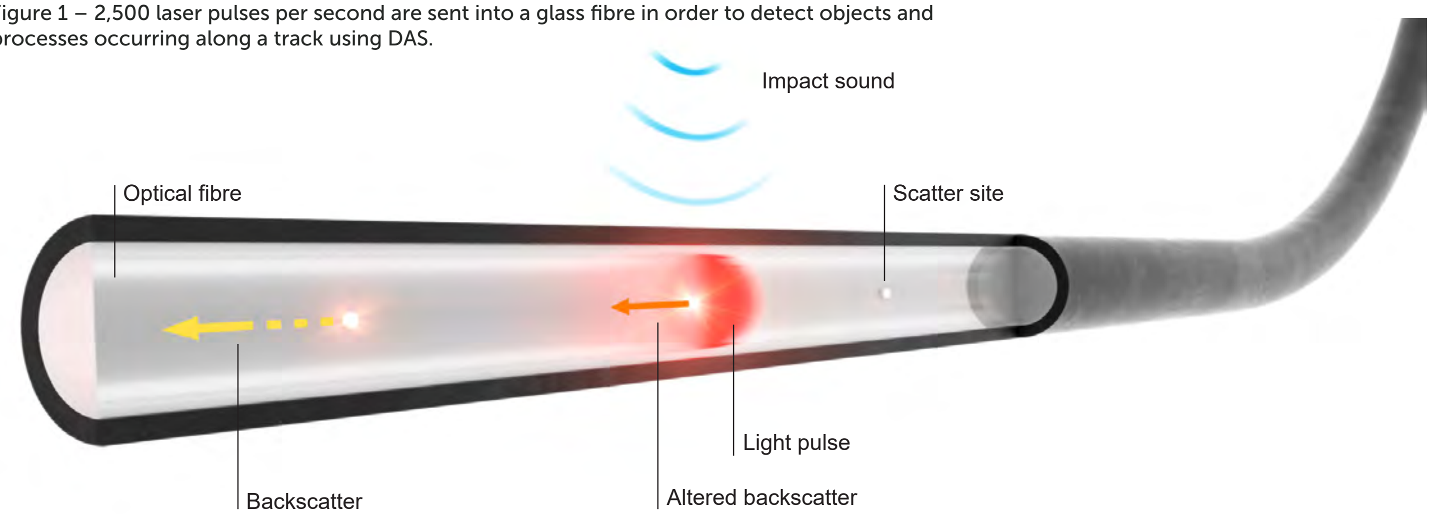
Train detection systems in the digital age

With the digitalisation of the railway industry, an increasing number of different train detection systems are emerging. Their main task is the same: to confirm the presence of a train and continuously update the details of its position. This enables safe and efficient operation to be maintained and relevant information to be passed to passengers and other stakeholders, e.g. workers on the line.

Axle counters and track circuits currently represent the state of the art in train detection. Due to their high availability and significantly lower life cycle costs compared with track circuits, axle counters continue to be on the rise throughout the world. While both systems are in principle suitable for the fail-safe output of clear/occupied status of a section of track, they only detect a train in defined track sections and do not provide any information about the position of a train within this section. In contrast to this, other systems are available that continuously detect the position of a train. Since these systems also enable greater train frequency rates and in turn better utilisation of the line, their development is potentially attractive to railway operators. With this in mind, a whole host of new approaches have been developed for the recording and transmission of the relevant data. These solutions include the European Train Control System (ETCS) and other systems based on satellite positioning, train-to-train communication and DAS, or a combination of these and other technologies.

Each of these approaches has the potential – as a stand-alone solution or in combination with other technologies – to increase the train frequency on certain lines. Depending on the characteristics and costs, the individual concepts are suitable for use in different segments, such as freight routes, highly frequented lines, or branch lines with little traffic.

Figure 1 – 2,500 laser pulses per second are sent into a glass fibre in order to detect objects and processes occurring along a track using DAS.



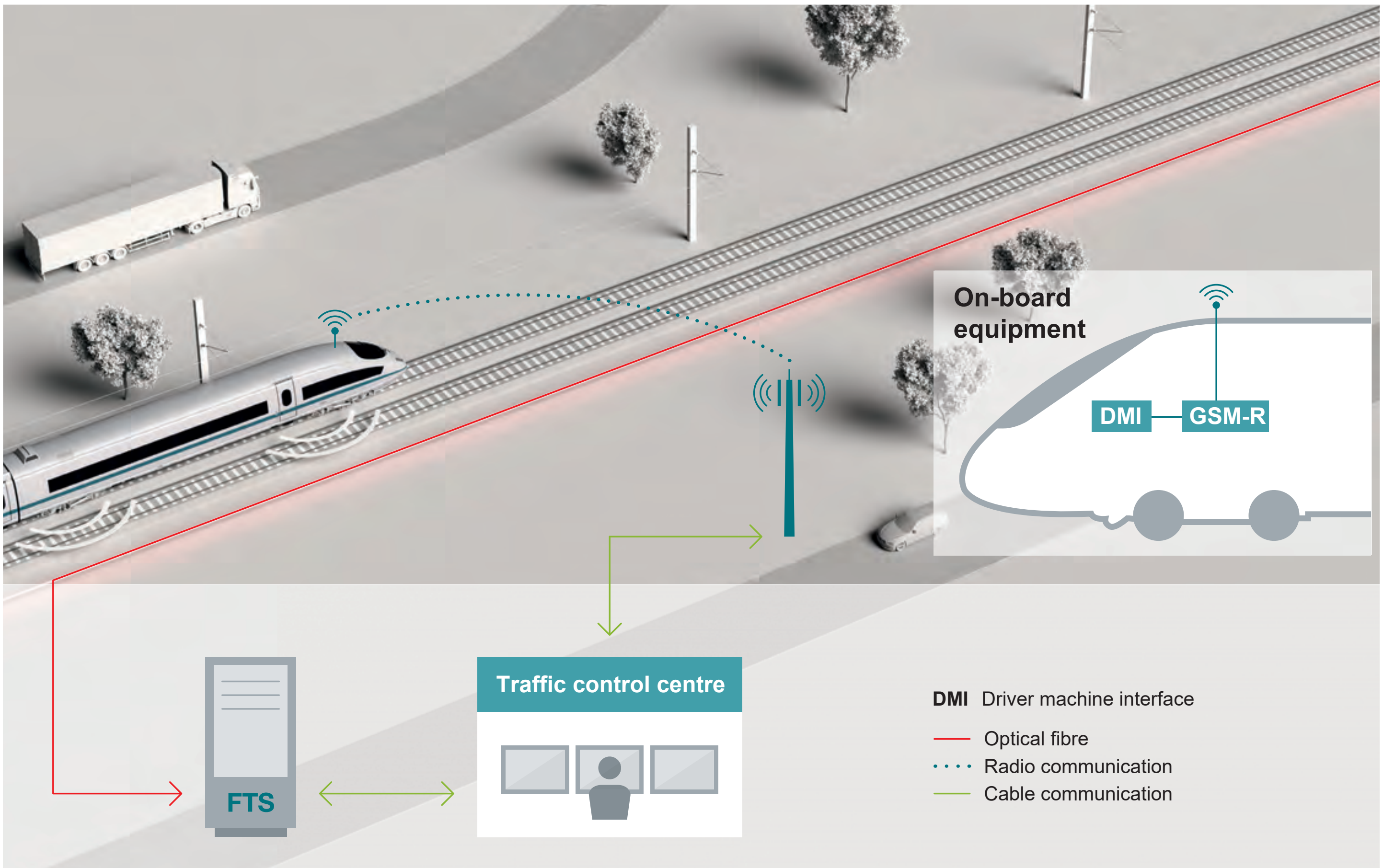


Figure 2 – DAS-based train detection systems only require minimal retrofitting work.

Train detection using DAS-based systems

The principle of DAS is based on the ability to detect changes in intensity of light reflections caused by sound waves radiating against a single-mode fibre optic cable (Figure 1). A coherent laser is pulsed into this fibre at a set frequency. Natural impurities within the fibre cause a small portion of light to be reflected back to the source; this is called backscatter. The intensity of the reflected Rayleigh backscatter is measured as a function of time after transmission of the laser pulse, translating to physical changes in any given fibre section. These changes can be caused by structure-borne sound and vibrations in the vicinity of the fibre optic cable. Classification algorithms translate these measurable signatures into alerts and reports for example about movements of vehicles, rail defects or footsteps of persons.

The huge potential of the basic physical principle was already apparent during initial evaluations of the use of DAS in the railway sector. Since then, together with interested operators, system integrators and research institutes various concepts and ideas as well as various installations have been realised. Implementing a DAS-based system provides operators with an extremely efficient way to upgrade their infrastructure. The fibre optic cables needed are already in place along many routes, often being used for communication purposes. Only a single fibre is needed from the fibre bundle to integrate these solutions. Vast sections of the route can therefore be equipped economically and efficiently. What's more, the optical fibres used are practically maintenance-free. Unlike some other solutions for continuous train detection (e.g. satellite positioning), which are geared towards a reduction in trackside components, systems based on glass fibre optics focus on minimising retrofitting costs on trains (Figure 2). Origin, design and technical equipment of the rolling stock are insignificant when it comes to detection since this is exclusively realised via fibre optic cables along the track.

Thereby, DAS-based solutions make it possible for all trains within a monitored track section to be located in real-time. The information obtained provides considerable benefits for traffic management. In remote areas, this technology can provide a cost effective and efficient solution for signalling control systems. In non-safety-relevant areas, they can be used as a stand-alone solution. Integration of an axle counter makes it possible for the DAS-based real-time tracking of trains to be combined with safety-relevant applications. Associated interfaces enable level crossings to be controlled with greater precision. Inputs from both systems can be combined in the Traffic Management System (TMS) in order to calculate accurate times of arrival, supply platform displays or to precisely coordinate platform announcements.

In simple terms, the fulfilment of the fundamental tasks of train detection systems is based on the detection of the start and end of the train, the direction of travel and ideally the speed. Tests have shown that a single DAS unit can optimally cover up to 40 km of glass fibre in each direction, so 80 kilometres in total. In this range, the cable can detect trains as moving objects with a large mass and high acoustic energy level within a radius of approximately 50 metres. Smaller acoustic sources can be detected, but within a smaller radius.

It has become evident that detection is influenced by various factors. These include the intensity of the signal and the condition of the transmitting media, the type and site of the cable routing, the type and sensitivity of the cable and ambient noise sources. These variables are explained in greater detail below. Technological parameters, such as the optimisation of measurement methods through adjustment of the laser pulse, are also crucial. In addition, different

Figure 3 – Trains can be detected by DAS within a maximum radius of 50 metres.

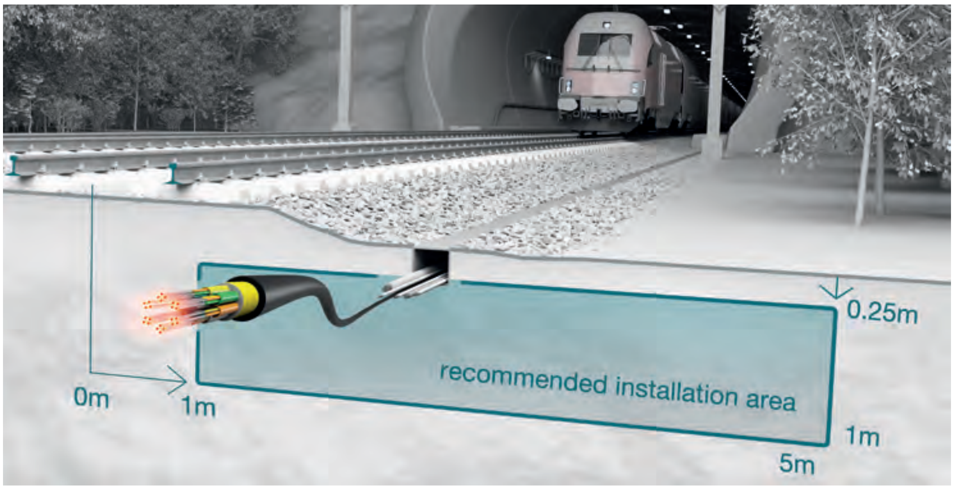


Figure 4 – Fibre optic cables are often already in place along a track and can be used to install FTS.

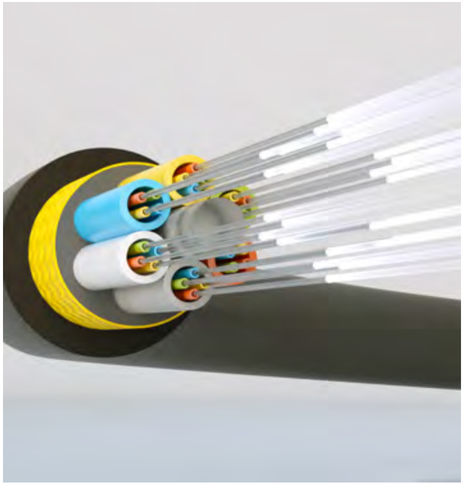


Figure 5 –Fibre optic cables consist of a whole range of layers and components, which influence the sensitivity of the system.

solutions must be found for specific scenarios, such as cables laid in loops or cable routing that deviates from the track. The relevant approaches are explained later in this article, together with a description of how the evaluation and further processing of the acquired data presents an additional challenge.

Signal and transmission

When using DAS for train tracking and the monitoring of infrastructure components, the fibre optic cable itself becomes a linear sensor. Accordingly, a signal must travel a certain distance from its original source to the glass fibre for it to be detected. Various factors can have an influence on the signal across this distance.

Intensity of the signal

The intensity of the original signal has a considerable influence on the fundamental detectability – an individual's footsteps will of course generate fewer sound waves and vibrations than an approaching train (Figure 3). The distance of the acoustic source to the glass fibre also plays a role.

Condition of the transmitting medium

The conditions in the immediate surroundings of a glass fibre have an influence on the type and extent of the signal reduction from the source to the glass fibre. While sand, for example, represents a poor transfer medium, argillaceous (containing clay) subsoil has been proven to be a highly effective conductor for the signals of interest.

Type and site of routing

Until now, ideal results were obtained with cables laid in a concrete cable tray or directly into the ground, running approximately three to five metres away from the track (Figure 4). Other methods, such as attaching the cable directly to the foot of the rail or to attachments near the track, might make it easier to detect certain acoustic sources. At the same time, the sensitivity also increases with regard to various other influences, such as wind or rain.

Cable quality and condition

The different types of fibre optic cable can influence the sensitivity. Whilst the quality and purity of the glass fibres co-determine the range, the material, strength and condition of the sheath can increase or restrict the sensitivity of the system (Figure 5).

Ambient noise sources

Since DAS-based solutions detect and classify different incidents through their acoustic signatures, all acoustic sources in the vicinity of the track must be taken into consideration. Depending on the type of installation, static installations such as industrial plants, point machines or compressors can also be counted among these factors. All of these influences combined can lead to overlaying, which in turn must be taken into account in the evaluation. Suitable filters can, for example, incorporate or mask fixed locations and routinely detected acoustic sources.

While the use of DAS-based systems was still uncharted territory a few years ago, this short overview demonstrates how various specific parameters can now be named that permit optimisation of the system's usage in the field. It has been found that different approaches to handling these factors can lead to varying degrees of success in different applications. It is therefore already possible to draw specific conclusions from fluctuations (resulting from the above-mentioned factors) in the continuous train signal along a section of track. For example, it can be determined in which sections specific applications can be used effectively or with limited function, and as a result of which factors.

Ways to improve train detection using DAS

Various challenges arose in the further development of DAS for use in the railway sector. For example, in order to continually detect moving objects along a section of track, a suitable solution first had to be found that satisfied the specified requirements. To increase the accuracy and reliability of the data acquired, various factors were identified which allow for optimisation of the system.

Further development of the measurement method

Initial installations of the FTS functioned according to the principle of sending a single laser pulse into a glass fibre and evaluating the changes in the reflection. This measurement method has been improved in order to obtain detailed information when using DAS in the railway sector, e.g. on the length of the train, its speed, or even the condition of individual train and infrastructure components.

The optoelectronics are being optimised with regard to the type and evaluation of the optical pulse, meaning that considerable advances have been made in relation to quantitative measurement results. More detailed information can be obtained during the detection of moving objects using this modified measurement method. The beginning and end of a train can thus be identified much more clearly in the evaluations, which ultimately means that the completeness of the train can be checked, at least in non-fail-safe applications. Special filters allow for a reduction in noise signals and in turn an increase in the range covered by individual DAS units.

Owing to constant advances in computer technology, continuous progress is also being made in the development of methods for extracting information from the datasets collected. In this regard, the use of artificial intelligence opens up completely new possibilities. Initial approaches to handling these volumes of data are explained in more detail later in this article.

Comparison of the cable routing and track layout

Fibre optic cables that are already in-situ and that have previously been used for communication purposes are frequently used in the installation of DAS-based systems. This practice leads to significant cost savings during installation, as new cables do not need to be laid. This also brings with it certain challenges.

Coils of fibre are often left within existing fibre optic cables, which usually function as reserves. These ensure that, for example, repairs can be carried out on the cable quickly and easily. When detecting trains using DAS, however, these coils can lead to differences in the optical distance measured in the cable and the true distance that a train has travelled. The starting point in both cases is the transmitting unit, from which laser pulses are sent into the glass fibre.

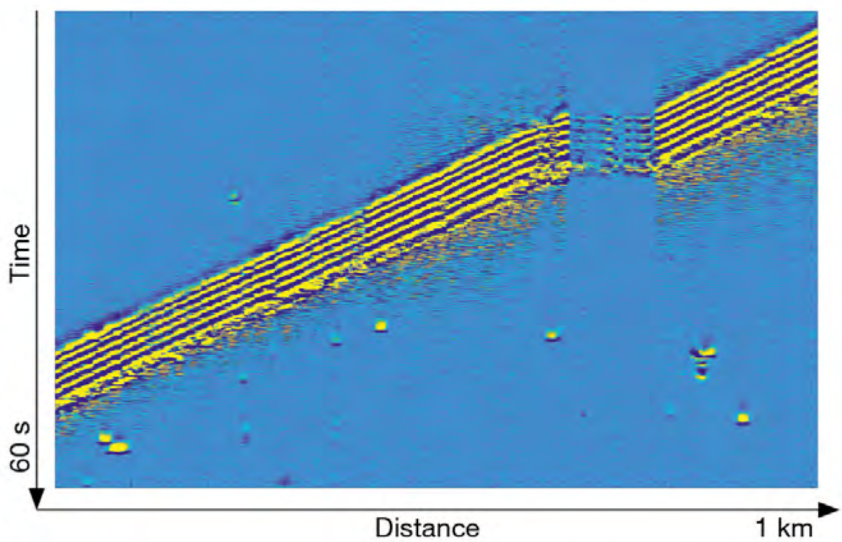
As a solution to these irregularities, the Frauscher research and development team has manually identified and filtered relevant points in initial installations. The aim is to develop a logic in order to automate this step. To do so, an algorithm will be developed using artificial intelligence, which independently identifies, classifies and filters the pattern occurring at the relevant points (Figure 6). Not only is the accuracy of the measurement increased still further, but the calibration phase during the installation is shortened significantly.

In addition to these coils, sections in which the cable follows a completely different route to the track posed a particular challenge. To solve this problem, so called geo-referencing points were defined. The optical distance between the transmitting unit and defined points along the fibre was measured for this purpose. At the same time, the true distance that a train has travelled along the track when it reaches one of the measurement points in the glass fibre was also determined. This means that a comparison could be made between the measured distance and true distance at specific points. The aim of the subsequent development is to automate the manual measurement processes that needed to be performed here and to progress from determining the train's position at certain points to continuous position detection. Additional logic was developed for this purpose, which enables an automatic and continuous comparison of the measured distance and the distance travelled along the track. The data required for this is determined during selected train journeys. Thanks to the automatic evaluation process, as many points as desired along the track and glass fibre can be taken into account, increasing the accuracy of the system considerably.

Data processing: harnessing new potential

Highly complex datasets are generated using DAS-based systems, such as FTS. This data can contain information about the position of the train, the status of infrastructure components on trains and on the track, or different processes occurring along a section of track. To

Figure 6 – Coils in the glass fibre will be automatically filtered in the FTS by specially developed logic.



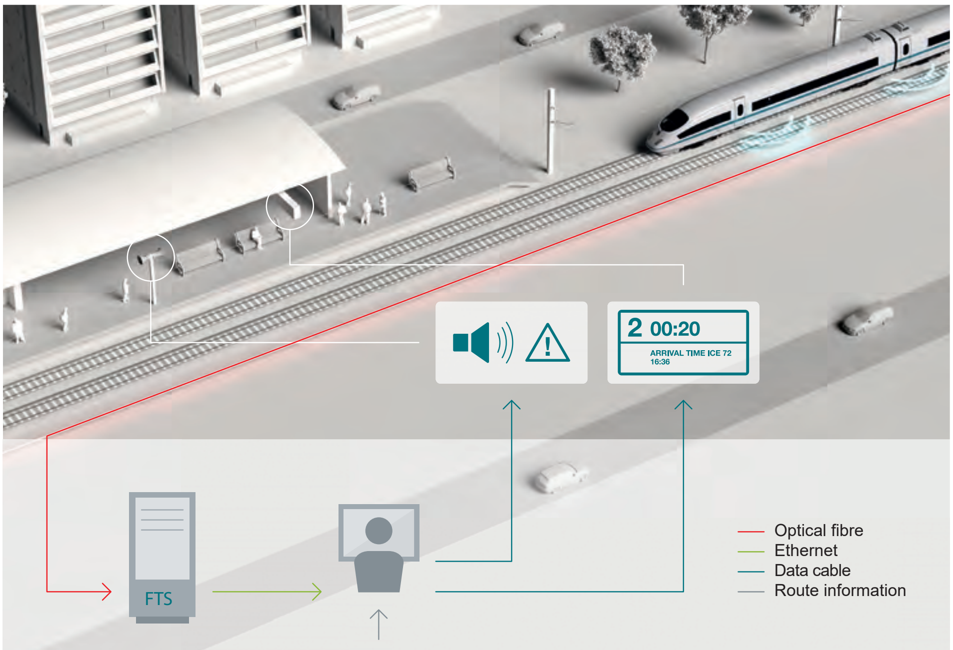


Figure 7 – The combination of information from the FTS and additional data allows for the implementation of various applications.

derive this information and to be able to supply it in a meaningful format at a suitable juncture, new approaches to data processing are being employed.

Location of processes in the system architecture

The system architecture plays a fundamental role here, as it determines where data processing and classification takes place and where corresponding resources must be provided. To increase the flexibility and performance of the system, the connection between the detection unit and the processing unit of a DAS -based solution should in future be enabled via high-performance networks, for example a fibre optic backbone. Implementing suitable interfaces allows for the setup of different architectures. In doing so, data can either be transferred to a centralised processing and classification unit based on specific hardware or cloud technology, or a decentralised unit. To enable this transfer, a thorough pre-evaluation and data compression must be carried out in the detection unit. The development of additional filters may contribute towards reducing the amount of data transferred here.

Logic and artificial intelligence

Various approaches and tools are used in the processing unit of the FTS for data collection and data processing. Mechanisms for detecting patterns, deep learning methods and specially developed algorithms enable efficient data preparation. Particularly with respect to classification, the use of artificial intelligence offers great potential since corresponding algorithms can be further developed on a global scale and independent of the system. Specially developed logic levels allow the system to take into account factors, which if ignored, lead to false detections – for example, stationary trains disappear from the data and are identified as new trains when they start moving again.

Interfaces and data implementation

The implementation of logic and artificial intelligence takes into account the import of data from other systems, such as information from inductive wheel sensors or axle counters. Thereby, additional inputs, such as train numbers from the TMS, can be incorporated. Platform announcements can thus be supplied and controlled automatically, based on continuous train detection, reliable track vacancy detection and the accurate identification of individual trains, for example. (Figure 7).

Depending on the requirements of the individual application, relevant data can be fed in at the processing unit level during data classification. This requires a suitable logic, sufficient computing power and the establishment of suitable interfaces.

Experiences gained from previously implemented FTS installations have shown that both the use of high-performance interfaces, networks and computers and the implementation of a reliable logic and artificial intelligence are crucial. In this way, data acquired using this technology can be prepared in a targeted manner and information appropriate to the application can be transferred. A variety of inputs can be fed into different rail infrastructure systems via communication interfaces developed for this purpose, which enable the operator to derive instructions, alarms, and more.

The future of train detection

Trains can be detected along long sections of track in real-time using DAS-based systems. Minimal complexity in terms of hardware and installation allows for cost-effective implementation in various, even remote regions that may not have a train detection system yet. Since no specific equipment is required, this solution offers various advantages compared to other satellite- or cellular network-based approaches.

Since the introduction of DAS-based FTS, more than 30 installations have been carried out in various countries. These test different applications in the field of train detection as well as the monitoring of infrastructure components. What's more, various pieces of information for increasing safety in the vicinity of rail networks – for example through the detection of unauthorised access to sensitive areas – have been evaluated and are already being put to use. The findings obtained based on these systems are incorporated directly into the further development of hardware and software, whereby new possibilities and insights are being identified on an ongoing basis.

Frauscher also involves customers, partners, component manufacturers, universities and other institutions in this comprehensive research and development programme. They are working on a variety of issues in a wide range of fields mentioned in this article. In light of the complexity and sheer scale of the possibilities identified up until now, the roadmap for processing corresponding tasks now covers several years.

It is safe to assume that DAS will become an indispensable technology in the railway sector. Progress is already clearly noticeable, not least because of the increasing digitalisation of the railway sector. New impetus can also be found outside of the railway industry, e.g. from new ways to record – and in particular transmit and process – data. Close collaboration between component manufacturers, system integrators and railway operators will therefore be more important in the future than ever before. Only then can the complex challenges in the strategic triangle of technical possibilities, normative requirements and individual parameters be met.

What happened to 'Tactical Agility'?

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For many years both authors have been involved with the development and implementation of modern technologies in signalling and operations control. We have encountered a number of recurring issues and this article is intended to highlight the most significant problem area, which continues to cause us serious concerns.

Opinions given in this article are those of the authors rather than of any of the organisations mentioned.

Part 1: ARS – Realities and Perceptions

ARS background

Thirty years ago Automatic Route Setting (ARS) was the name of a product developed, installed and maintained by British Rail Research (BRR). It not only set routes according to the timetable but could alter the sequence of trains, and in some circumstances choose different routes or platforms, to reduce overall delay. At this time ARS was well ahead of the technological 'curve'.

Since then development has continued, albeit rather slowly, and the acronym ARS should perhaps now more usefully be used to describe the concept of a system which sets routes automatically and, preferably, has the intelligence to do so in ways which optimise performance. In what follows, we use 'intelligence' and 'intelligent' in this specific context. Notwithstanding the development of more sophisticated automation products in several other spheres, in railway terms the UK products described below still lead the world.

Ten years ago, Network Rail introduced an update to their ARS standard (NR/L3/SIG/10120). The original version, which essentially described what the BRR ARS did, only ever had 'interim' status but the later version had a compliance date of Sept 2008. It is not clear whether Network Rail still regard this standard as in force. The major change which the new version introduced was the capability for the ARS configuration data (described below) to be modified by staff at the signalling centre. This 'standard', which is still as much a product description as a set of user requirements, is colloquially known as ARS+.

ARS products

Two products comply with ARS+ and are in use on Network Rail. Both have all the intelligence of the original ARS with some detailed improvements.

Resonate's Enhanced ARS (EARS) is a direct descendant of the original ARS and is supplied as part of IECC-Scalable.

Hitachi's Signaller's Assistant Route Setting (SARS) is very similar to the original ARS. It forms the ARS engine within Hitachi's Signaller's Assistant package (TRESA) which includes the ability to modify configuration data (and which formed much of the basis for the development of the ARS+ standard). It is installed on some Siemens Controlguide Westcad and Alstom (GETS) MCS signalling control systems.

An 'unintelligent' ARS system, also coming into use on Network Rail, is Siemens' Immediate Route Setting (IRS). This was originally developed for London Underground schemes and is used in connection with Siemens' ETCS/ATO system on the two Westcad workstations controlling the Thameslink Core. There is no inherent reason why intelligence should not be added to IRS (although it would require some software development). There are some key parts of ARS+ with which IRS does not comply.

ARS benefits

The ARS concept was developed to provide a number of benefits including the following.

1. Avoidance of misrouting by keeping trains on their planned routes or on alternative routes which meet all their planned calling points. Signaller misrouting is known to be a significant problem in some areas.
2. Continuous vigilance by setting routes as near to instantaneously as the infrastructure allows in a way which no human operator, however skilled and diligent, can match.
3. Implementing associations by making code insertions where trainsets change their identities, managing splitting and joining moves correctly, allowing double-docking, and managing connections in the (now few) cases where these are allowed.
4. Automatic regulation by optimising in real-time the sequences and routing of trains to minimise overall delays

or to achieve certain other business objectives. To deliver this benefit, an ARS must possess what can be called 'tactical agility'.

5. Making signallers more effective by allowing them to concentrate on resolving problems, some safety-critical, which inevitably make it impossible for them to respond effectively on every occasion to short-notice perturbations. Reducing signaller numbers is also made possible.

Although the first three of these could be achieved with a dumb ARS, it is the last two which provide the greatest operational and financial benefits and for which an intelligent ARS is essential.

ARS data

ARS systems, like all operational systems, and particularly Traffic Management (TM), are heavily data-driven and require (at least) four data streams.

Geographic data

This data provides a factual description of all relevant elements of the infrastructure to be controlled – signals, points, berths, train detection sections, Timing Point Locations (TIPLOCs), etc. Some of the data, such as that used for interpolation (see below) has to be calculated but this does not involve a significant element of judgement.

Configuration data

This data involves careful judgements to specify a series of parameters which describe how the user wishes the area to be operated. It is sometimes referred to as an Operating Requirements Specification. It includes factors such as how far ahead of a train route should be set. Three key parameters specify the thresholds of operational benefit (expressed as minutes of reduced overall delay) below which the ARS should not change the currently planned train sequence or routing. The intelligence of the ARS can be completely disabled by setting these thresholds to very high values.

Timetable data

Essentially this is the working timetable for the area concerned, provided as an extract in Common Interface File (CIF) format, generally referred to as a CIF-extract. In addition to the identities, timings, planned consists, allowances, etc. of each train, this data should also include information such as associations which, among other things, make possible Automatic Code Insertion (ACI) where the identity of a trainset changes. Signallers consider ACI to be a significant benefit of an ARS. Currently, CIF-extracts do not contain on-the-day changes to the timetable and these must be made by the signallers. The essential purpose of TM systems is to enable controllers to implement these later changes and corrections, and to make alterations to improve on-the-day running, the final timetable being passed to the ARS (integrated TM) or the signaller (isolated TM), at least 5 minutes before the event (and in some circumstances Network Rail suggest at least 10 minutes).

Real-time data

The current positions and identities of trains and the states of infrastructure elements are obtained by ARS primarily from the interlocking and the train describer system (TD). ARS+ specifies (in paragraph 7.2.9) that the "ARS shall not test the availability of a route by requesting the interlocking to set that route", so an ARS must maintain an internal map of infrastructure states and train positions. Train lateness is determined by comparing train positions with the timetable, using interpolation information from the geographic data between TIPLOCs. ARS+ does not require that current train speeds be known to the ARS.

Misconceptions about ARS

In the three decades since the pilot scheme at Three Bridges in 1983, and the initial deployments at Liverpool Street, York, and Yoker in 1989, ARS products have shown themselves to be very capable of delivering the benefits expected. However, perceptions have emerged that ARS is surrounded by problems and that it is unpopular with some signallers. There is little justification for either of these perceptions. Some of the key issues are discussed below.

Some signallers have made complaints about ARS, but careful examination of the records and interviews with signallers show that such complaints are neither as frequent nor as serious as often claimed, and signallers do have much to say about ARS which is positive. It is notable that signalling centre managers are often more positive about ARS than their staff and do not consider the complaints to be a major issue.

One complaint which is sometimes made is that the ARS does not always do what the signaller expects - when it doesn't do what they would have done. If the automation cannot sometimes make more carefully judged, and superior, decisions than a human operator then much of its value is lost.

Some signallers say they would like to be told in advance what the ARS is going to do, whether or not 'unexpected'. In order to make its decisions on the basis of the best possible (and therefore the latest possible) information, an ARS must be a real-time system, for which any 'pre-announcement' is not possible. There seems to be, in some parts of the railway, failure to recognise this point. To describe TM as capable of "real-time planning" is to misuse the term "real-time". "Planning", by definition, has to take place before the event being planned.

Most of the complaints made about the ARS are not due to inherent inadequacies in the software but arise from inaccurate, inappropriate or incomplete data, in particular the geographic and timetable data.

The geographic data must be comprehensively tested but its sheer scale means that inaccuracies can creep through and are then difficult to correct. The ARS+ enhancement made adjustments to the configuration data easier to apply but it is not clear that this facility has yet been used effectively. The scale of both these challenges will be increased significantly for TM.

The biggest problems lie with the timetable data. As recent events demonstrate, Network Rail's cohort of timetable planners is always stretched and can be overwhelmed by events. It is telling (and depressing) that one of the 'benefits' claimed for TM is the ability to correct errors in the timetable. It is important to recognise that in the automated world of the Digital Railway it is the timetablers who, in many senses, 'operate' the railway.

A belief has emerged that, although the ARS makes good local decisions, its breadth of view is limited and its choices often cause problems further away. No objective evidence has been put forward to suggest this is a significant issue. It seems much more likely that making the best local decision will be preferable to considering distant situations which are subject to further change due to unexpected events en route. In any case, if, for example, a planned sequence has been changed to improve throughput in a busy area, there is usually an opportunity beyond the congestion to reverse the sequence if it will cause problems further on. The Thameslink core is a prime example of such a busy area.

As a result of these misconceptions a view has emerged that the ARS should be 'unintelligent', although this opinion is sometimes repetitiously over-stated, without any clearly-articulated supporting evidence. Instead of dumbing-down the ARS it would be far better to ensure that both the automation and the signallers perform well the tasks at which they are best, and thus form an effective partnership.

Part 2: The role of ARS with TM

The Network Rail Traffic Management Project

Traffic management systems have the potential to provide railway operators with a wide range of automated tools which it is hoped will enable them to make significant improvements in performance and efficiency. Initially the focus will be on managing on-the-day running of the train service itself. In time this can be expanded to cover stock and crew scheduling, maintenance and possession planning, information gathering and dissemination, condition monitoring, and many other aspects of running the railway. At the heart of such a system is its ability to hold a "single version of the truth" which all those involved can rely on and, where appropriate, contribute to.

Over more than a decade a small but dedicated project team within Network Rail has been developing plans for deploying TM schemes across the network. We warmly welcome this development and have been pleased to be involved in the process. Now several much larger teams are working hard to bring some initial schemes into operation. Whilst we are pleased that this is happening, we are very concerned that some of the key issues which we have identified during our work are not being addressed effectively and that operational performance may suffer considerably as a result.

Unfortunately, early progress with TM has faltered as the implementation phase approached. Only two, much abbreviated, schemes remain from the original programme, Cardiff and Romford, and both of these appear to be struggling. Two more schemes, however, Thameslink and Didcot, have developed independently and are making better progress.

The original bidding process was won by Thales who were to install their ARAMIS-D TM system at Romford and Cardiff. At Romford their proposal was to replace the Upminster IECC with ARAMIS-D and Westcad. IRS would be used to set routes in accordance with the last timetable produced by ARAMIS-D at least 5 minutes earlier. So, the tactical agility of ARS would be discarded in favour of a process which would require signaller alacrity to act ahead of IRS if any disruption occurred during this > 5 minute 'window'. It was originally proposed this scheme would be in full operation by now, but progress has slowed and ARAMIS-D will, at least initially, be used in 'isolated' mode, simply providing advice to signallers.

Thameslink currently is the big issue. It was decided to introduce a TM system covering a substantial area on the approaches to the Thameslink core with the objective of improving the chances that trains can be presented at Blackfriars and Canal Tunnel junctions at regular intervals. Hitachi won the contract with their Tranista product. In parts of the area this will operate in isolated mode, providing advice to signallers (for example at Kings Cross) about train routing and sequencing. But in the core and in key parts of the approaches Tranista will be interfaced to Westcad workstations and routes will be set either by IRS (in the core and at St Pancras) or by SARS operating in timetable-order (TTO) mode. TTO will be achieved by setting certain configuration parameters of SARS to values which effectively disable all of its intelligence.

Network Rail has specified that any change to the current plan (as held by Tranista) will almost always be prohibited during the 5 minute window ahead of the associated route setting. This restriction would apply whether the change was initiated by a human controller or by Tranista's conflict resolution process. Note that Automatic Conflict Resolution ('ACR') is not currently proposed to be implemented in the Thameslink Project, although we believe that a very busy area like Thameslink could benefit from such a capability. ACR was included, at least as an option, in Network Rail's Interim Digital Railway TM Requirements Specification in 2017.

Resonate have recently deployed their Luminate TM product at Didcot, in conjunction with the existing Scalable IECC and EARS. It is not yet clear whether EARS will finally be allowed to apply its full range of intelligent decision-making capabilities.

'Unintelligent' ARS

Whilst TM is a welcome addition to the tools available to operators, it would be ill-advised to abandon the intelligence in ARS without a careful evaluation of the implications for operational performance. We have recently reviewed our analysis of the adverse effect on performance likely to result from a lack of intelligent real-time ARS and remain convinced that there will be significant problems in areas of high traffic density such as Thameslink.

It is clear that, relatively often, train running will differ, during the 5 minute TM window, from that anticipated when the last timetable was generated. Sometimes such differences will make a further change to the plan desirable or even essential. Having a real-time system capable of making the best possible final decision seems the obvious solution.

There seem to be two reasons being put forward for choosing an unintelligent ARS instead.

There are concerns in some quarters that having two systems making independent decisions in series will cause some form of contention. There seems to be no reason why this should be so. TM must, to function effectively, be monitoring continuously the progress of trains. If TM observes that the ARS (or, for that matter, the signaller) has caused trains to progress in a different order or on different routes from those expected by TM, there is no reason why it cannot take these into account in generating its next timetable.

Opinions are expressed that the ARS should not be allowed to overrule a TM decision without the signaller having an opportunity to agree to the change. This has led apparently to the conclusion that it is best to allow unintelligent ARS to implement what is sometimes a worse, even disastrously worse, decision and to rely on an 'ever-alert signaller' to intervene in the short time available if unexpected running occurs! This conclusion is primarily based on anecdotal evidence of shortcomings in ARS. Part 1 of this article explains why this view of ARS is mistaken.

This approach seems to us to be fundamentally flawed and likely to lead to significantly worsened operational performance.

Intelligent ARS on Thameslink and elsewhere

To sharpen the focus on the precise nature of our concern, it is timely to consider in a little more detail the Thameslink core and its approaches. ATO is being introduced in this area because it is recognised that a fully automated and intelligent system is needed to achieve the necessary performance, despite the generally high levels of skill and diligence of human drivers. It is therefore surprising and disappointing that there is a reluctance to rely on the tactical agility of an intelligent ARS and, instead, to require signallers to possess almost super-human qualities. This is not to cast any aspersions on signallers, many of whom we know from our own experience to have at least as much skill and diligence as the best drivers. Consider the following example.

Off-peak at London Bridge. *All photos Mike McGuire.*

Once the full 24 trains per hour service is in operation, northbound trains must present themselves at Blackfriars Junction at precise 2 min 30 s intervals, in many cases alternating between trains via London Bridge and via Elephant & Castle. Scheduled running times from these stations to the Junction are 4 min and 3 min respectively, both times being within the TM window as described above. Suppose a train is delayed significantly in the platform at Elephant & Castle. The TM window constraint prevents Tranista from altering the current plan to allow the following London Bridge train to go first through the Junction. The unintelligent ARS is also incapable of intervening so everything depends on the alacrity of the signaller. Within about 3 minutes, the signaller must observe that a delay has occurred (which may not immediately be apparent), decide upon a change and then implement this.

A diligent signaller will sometimes achieve this and minimise the inevitable delays, subsequently slotting the Elephant & Castle train into the sequence as and when an opportunity arises. But there must inevitably be cases where this proves to be beyond human ability as sometimes signallers will, indeed as they must in safety-critical cases, be focussed on sorting out problems elsewhere. As a result, in such cases, there will be an extended gap in the sequence of northbound trains which, if long enough, will cause delays to all trains until the peak traffic subsides. The crossing conflict at this double-track flat junction means that some southbound trains may also be affected.

Frequency cannot necessarily be given priority over adherence to schedule in this case as, beyond the core, Thameslink trains must fit into other service patterns, including those through the double-track section at Welwyn North which is at full capacity at peak times. Delayed trains to Edinburgh seem an excessive price to pay for a hold-up at Elephant & Castle.

Wherever a TM system is deployed, circumstances can arise, though not as frequently as is sometimes claimed, where it is essential that trains pass through a point of conflict in a specified order. The existing provision in ARS+ for mandatory sequences could readily be used to facilitate this. Some changes to TM would be needed to allow operators to specify such sequences and insert them into the current plan. Likewise, minor changes would be needed in the ARS products to interpret one-off mandatory sequences in the incoming plan.

Wherever TM and ARS are deployed, a vital requirement is that the optimum configuration of both products is determined by a comprehensive programme of realistic simulations.

A wide range of factors can lead to differences between one location and another which are not always obvious but can have important implications for performance. Such simulation programmes represent a significant cost which must be considered in costing a project. There are no 'one-size-fits-all' solutions for configuring such data-driven products and the temptation to impose general rules should be avoided.

Disseminating the truth

In recent years, information provided to customers about train running has been much improved by the availability of better data about train location. Unless very well-informed and detailed data is inserted manually however, customer information systems (CIS) have no ability to predict how trains are going to run other than assuming adherence to sectional running times. This results in errors such as two trains shown as arriving at the same platform at the same time as shown in the photo below.

TM brings the prospect of major improvements in this area because it will disseminate, from its comprehensive version of the truth, its predictions about

Contradictory information at Finsbury Park.

One of the new Class 700 trains passes the Three Bridges ROC.

future train running. We were surprised and disappointed to hear recently that dissemination to CIS will not be automatic in the Thameslink deployment (at least initially).

In general, if, after a TM window has commenced, delays make a change to train sequence necessary, TM will not be aware of this until an unexpected TD step occurs. This will not occur until well after the signaller or ARS has set the route and customers may not be aware of the change until a different train from the one they are expecting is approaching the station.

There is no reason in principle why TM should not be informed immediately by the signalling control system when a route is set and hence be able to infer several minutes earlier the predicted train arrival times and sequence at the next station. The feasibility of such a link was demonstrated by the IECC Information Generator a quarter of a century ago, but the initiative to implement such a scheme has been lacking despite its obvious benefits for station dwell times - for Thameslink not just obvious but, we would suggest, vital.

Workstations at Three Bridges ROC. *Photo Network Rail.*

Conclusions and recommendations

Our principal conclusions are:

1. UK ARS products can continue to make a major contribution to the performance, capacity and efficiency of railways.
2. Claims of shortcomings in ARS are greatly exaggerated and any problems which do exist can largely be overcome by improving the quality of timetable data.
3. There is no justification for dumbing-down the intelligence in ARS when working with TM. On the contrary, only with the two technologies working in tandem can the best use be made of our railway infrastructure.
4. Whatever combination of technology is deployed in any individual case, it should be thoroughly tested by simulation to ensure that levels of performance and safety, particularly in disrupted conditions, are acceptable.

Notwithstanding the hype surrounding the 'new' Digital Railway, it is worth remembering that Britain's first digital railway project began in the 1980s. By the end of that decade, solid state interlocking and computer-based, automated signalling-control had been developed and introduced, and their roll-out was underway. The subsequent splitting up of Britain's railway services created the potential for a lack of overall vision and direction, particularly in the field of signalling and control. The resulting slow progress in implementing further digital technologies such as ETCS and TM has been dispiriting. By now the use of these technologies, and so much else, should have become both established and widespread. Performance, capacity, efficiency and safety would all have benefited markedly.

The coming of Digital Railway part 2 is to be welcomed, although as yet the vision seems clouded and the direction unsure. It would be extremely disappointing if the first accomplishment of the revived Digital Railway were to emasculate ARS, one of the innovative technologies which has survived railway re-structuring. Tactical agility is still vital for the railway of today.

Another way to modernise: Western Region Route Relay Interlockings in the 1950s

Michael Page

Early in this century we entered a major cycle of signalling modernisation in Great Britain – an adventure which seems to come up at roughly 40-year intervals. On the previous occasion (beginning in the 1950s), it was a period of immense challenge on the Western Region (WR) of British Rail for all those involved, who had to make the leap from mechanical to electrical signalling and abandon all those reassuring lumps of wood and iron. It was a steep learning curve.

This article is not intended to be about the history of the Great Western Railway (GWR) and its signalling, but it may be helpful to have an understanding of the development of WR practices overall, not just its route relay interlocking (RRI) design. This is not in order to indulge in a nostalgic look at some sort of industrial dinosaur – perhaps there is something here to note for the future.

Historically, the WR could trace its lineage directly back to the birth of the GWR in the 1830s – and it was proud of this heritage. Prior to the '1923 Grouping' it had been one of the largest UK railways in existence, and many of the governing boards of the smaller companies within its boundaries were controlled by the GWR anyway. The invention by the GWR of the Automatic Train Control System (the predecessor of BR-AWS) in 1906 had a huge impact on their thinking for the next generation – signalling investment concentrated on spreading this system across the network, a decision justified by an excellent safety record and improved train performance in conditions of bad visibility.

In the 1920s, the GWR had developed the first route-setting concept. Two large signal boxes at Newport using a mechanically interlocked, route-setting system, were installed by Siemens in 1928. These were based on an earlier experimental installation at Winchester, and were the very first route-setting systems in the country. In its day, the GWR's commitment to 'total train movement' was a highly controversial idea amongst Britain's railways, and was bitterly opposed nationally. The GWR therefore had early experience of the route-setting concept and no doubt would have continued this policy but for cost considerations. The Newport installations were ahead of their time, but they were expensive, not least because all signals (including shunt signals) were motor operated.

At the time of nationalisation in 1948, the WR was a rather conservative organisation, and its design office observed practices which had hardly changed since the 1930s. Signalling and Telecoms (S & T) equipment, design and administrative practices were already highly standardised and centrally controlled across the Region. By comparison with elsewhere, some considered it was a pace behind everybody else, in signalling technology at least. The only colour-light signalling installations on the region were at Cardiff, Bristol and Paddington – and these were no more than equivalent to the semaphore systems which they replaced in the 1930s. Elsewhere, a colour-light distant signal was hardly to be found and the first multi-aspect colour-light signal did not appear until 1955.

In the early 1950s, Britain's railways were in a run-down state and the need to renew the mainline signalling systems nationally was recognised, to be funded by Government under the 1955 Modernisation Plan.

When modernisation began the WR went its own separate way and did things differently from the rest of the country. Why was this? It is a question people often ask and the answer is not just a matter of wishing to be independent.

Unlike the other Regions, the WR had little experience of major contract installations. Since the 1930s, most of their work had been designed and installed 'in-house', and this policy was set to continue. Moreover, the other Regions' own modernisation plans in the 1950s used virtually all of the available contract industry resources between them.

The WR had a fully staffed design office and competent installation staff, and so decided to do the work themselves in accordance with their traditional practice, thereby maintaining its general policy of standardisation. Although some design contracts were let and contract labour employed on site on many schemes, all work was done strictly in accordance with WR standards.

In 1950, the Region opened a newly-built, fully-equipped factory at Reading whose ample capacity would be capable of a wide range of work required in the production of signal structures, relay racks, location cases and for off-site prewiring etc. At the time, one press report described it as "the best equipped factory of its size in the south of England"

There were financial constraints, too. Without the stimulus of electrification and new station construction, any business case based on renewals alone failed to meet the investment criteria of the day. It was therefore necessary to achieve savings in infrastructure and to adopt an economical re-signalling strategy.

The control panel at Swindon, originally commissioned in 1968 and based very much on the standard 'turn and push' control panel design adopted as part of the WR RRI project. Following its recent decommissioning it has been preserved by the Swindon Panel Society. *Photo Swindon Panel Society.*

The WR considered they had as much experience as anybody in route-setting operations and had no need of a contractor's offering. They felt fully capable of developing a single system to suit themselves, which could be adopted as a Regional standard. The early years of the 1950s were spent in developing a complete range of modern standards, not only in circuit design but also in equipment and installation practices.

It would be wrong to think however that everything was invented from scratch. A good example was always worth copying. For example, the type of point control circuit adopted was based on an early design used on the LNER. The control panel design was imported from the firm of Integra, Switzerland, and represented a major step forward in panel design which the UK suppliers were quick to emulate. The early design engineers drew upon general continental experience in arriving at this decision.

Distinguishing features

The main design features which distinguished the WR RRI system are as follows:

A standard signalling control panel

The standard design was a modular construction employing a mosaic of 40mm square tiles which contained the necessary indication lights, switches and push-buttons, arranged as a geographical representation of the layout. The operation of this panel required a switch to be turned at the start of a route and a button to be pressed at the exit. A continuous line of white lights indicated the route selected which turned to red progressively with the passage of a train.

This form of presentation is commonplace today but was a novelty when first introduced by the WR, and was soon to be emulated nationally. The track circuits were not coloured on the panel, as found elsewhere, this being regarded as irrelevant expense on the WR.

The Train Describer (TD) and Signal Post Telephone (SPT) concentrator was mounted vertically above the signalling control panel, using a similar construction, which related the TD and SPT to the layout of the signals on the control panel, again a novel concept at the time.

A distinct separation between 'safety' and 'non-safety' circuits

Broadly, all circuits which are driven by the panel or provide indications on it, are 'non-safety'. This permitted all such circuits to employ 'Post Office' (PO) 3000 type relays and wiring, in the interest of economy and space. To avoid the risk of a fault in either of these affecting the signalling interlocking wiring, the contacts for these relays are placed at the start of each 'safety' circuit, never later. This approach lent itself eventually to designing the non-safety circuits in solid-state form.

A double-coil lock relay for each set of points

Use of a separate coil for all control features and another for the 'holding' of the relay during point movement allowed for complete separation of the control and holding functions, an important feature when meshing circuits and thus removing an element of risk in the circuit design.

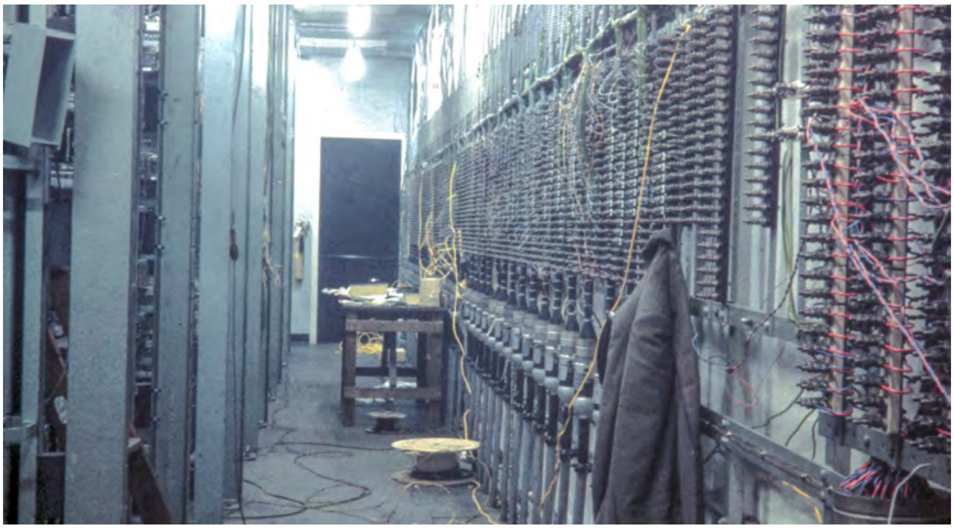
An indication of the 'locked' state of each set of points at the panel

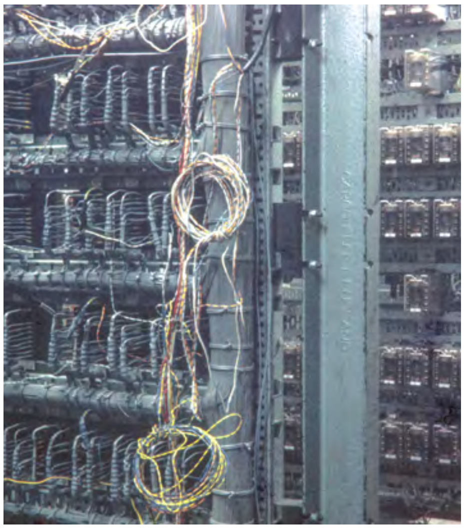
This is an important aid to the signaller which allows him to reason for himself, exactly what may be preventing him from an operation. As a result, so-called 'swinging overlap' controls (to release counter-conditional locking in the overlap) are not widely provided on the WR. In addition, it acts as a useful reminder during hand-signalling operations.

Remote control systems

The interlocking can be distributed, rather than being all centralised in the signal box. Up to a transmission distance of around 5 miles, control of remote interlockings was carried out using PO relays and 154 pair 10lb conductor cable. Beyond this distance, time division multiplex (TDM) systems were employed.

The WR always avoided sending a push-button type of control over a TDM remote-control system, and so the route-calling relay remained at the





E10K installation under way. *Photos John Batts.*

signal box-end, with a repeat circuit only being transmitted. This avoided timing problems in the TDM systems and avoided such refinements as 'immediate access', provided by some suppliers, to overcome conflicts when two signalmen set routes simultaneously over the TDM link. As an aside, the WR were the first to operate a London terminus by a remote control system in 1966, with the opening of the new panel at Old Oak Common, about 2 miles from Paddington.

Aspect-sequence circuits are different

Aspect-sequence circuits on the WR allowed a signal to change directly from 'red' to 'green'. This is a trap for the unwary designer and requires particular care when altering such circuits and during testing. The design is quite unlike the usual BR practices employed elsewhere.

'Double-cutting' of circuits is not usual

Apart from double-cutting the lock relay control of point contactors, this was never considered necessary until, in the 1970s, cases of silver migration on relay plug-boards caused a rethink. Earth faults in external Polychloroprene (PCP) cables also became a cause for concern. In later installations, controls in external circuits were double-cut.

The WR feed their circuits from the negative bus-bars

The feeding of circuits from the negative bus-bar is an historical relic from the days of dry cells and earth return circuits, which avoided corrosion of the earth terminal at every point.

The WR Train Describer

The WR conceived the idea, quickly adopted nationally, of the alpha-numeric 4-digit train description which would be associated with a train throughout its journey.

The WR TD system was developed in the mid-1950s, and was a clever relay-based design which used the best indicating device available in its day, an illuminated electro-mechanical counter. This elegant device also acted as the storage for the whole system but unfortunately proved to be very troublesome in the later years of their life, and faults were cumulative. Attempts to overcome these reliability problems by converting these counters to a solid-state equivalent were not entirely successful.

The 'Quick Release' track circuit

The WR developed its own standard track circuit equipment for use in the re-signalled areas. This was a departure from the usual range of conventional equipment and was specifically designed to overcome the inherently slow-to-release characteristics of the dc track circuit. In this respect, its performance could be compared with the ac vane type of relay, but its cost was much lower. In essence, ac was supplied to the rails at the feed end and a transformer/rectifier at the relay end, fed a standard 2.25 ohm dc track relay via a resistor. Track circuit length could be up about 1200m and the relay could be placed up to about 1.5 km from the relay-end equipment, if necessary. The units could also be employed in a configuration whereby both the feed and relay-end equipment were situated at one end of the track circuit, with a half-wave rectifier connected at the far end. This was useful in bay platforms, avoiding the need to put equipment in a confined area near the buffer stops.

Some general pros and cons

Standards

As in other matters, the WR had its own interlocking standards and BR Signalling Principles were not distributed or applied directly – they were interpreted by the issue of Technical Instructions. Broadly, the WR practices were similar to those in use generally but there were a number of differences, notably in the treatment of overlaps and flank protection.

Quite a number of other standards were developed during the design process as problems or new situations emerged. For example, lineside power supply distribution standards were developed by the first people to encounter a 650V feeder. The first people to put plug-in relays into a cupboard without rear access had to work out just how to do it. Features like the provision of simple lighting and access to a maintenance telephone circuit, in lineside cupboards, emerged as standard practice at an early stage.

Standardised approach

The WR adopted an approach whereby the design of every signal box was similar irrespective of which supplier's equipment was incorporated. There was, and still is, amongst many of the former WR signal boxes, a very high level of standardisation. Signalling staff and signal engineering personnel could be appointed to a job in any signal box, knowing what to expect. Design engineers knew that any alteration proposed would deal with a uniform technology regardless of location.

Experience gained

The fact that so much of the design and installation was done in-house simplified the training requirements and resulted in a considerable and well-shared knowledge base amongst all levels of design, installation, testing and maintenance staff.

Cost effectiveness

The adoption of well thought out standards and their rigid application produced an economical and cost-effective re-signalling programme for the modernisation period. This was proved later to be more than 10% cheaper than the offering from any supplier. A key advantage of the WR approach compared with a 'supply & install' contract, was that because the project planning, materials ordering, staffing, etc., were under the control of one client office, following strict and standard procedures, cost overruns were minimised. It was true, of course, that unlike a commercial company, the administration overheads resulting from scheme variations was absorbed, but nevertheless overspends never exceeded 10%.

Stock control

The range of equipment available, although extensive, was carefully restricted. For example, the use of the BR930 relay range was limited to a handful of different types. All equipment purchased was subject to a competitive process. Surplus equipment from one scheme could easily be allocated to a following project, and so waste was kept to a minimum.

Project control

Much of the success of the modernisation programme lay in the strong leadership of the head of major new works, based at Reading, who reported directly to the chief S&T engineer (CS&TE).

This man (it was always a man) was the total autocrat and difficult to please. His policy of 'delegation without abdication' resulted in a focused and motivated team, and the impossible became possible when working for him. Punishment by flogging was seen as preferable to admitting failure!

The new works department sought to have three major projects in progress at any one time – one at the initial design phase, one at the late design stage and one in the final implementation stage. This broadly meant the introduction of at least one new major signal box (or equivalent), each year from 1959 onwards. Peaks and troughs in the workload were avoided wherever possible by careful planning.

Lack of innovation

A valid criticism of the WR approach was sometimes made in respect of its rigid nature, namely that it did not readily embrace innovation. However, the corporate view was that there was no time or money available for developing new ideas, and that the advantages of sticking to the rules outweighed all other considerations. Many of us who were involved at the time did have some reservations about this.

Thus, for example, the WR stayed with an inflexible design of lineside cupboard, which did not lend it itself to rear access and which therefore made the use of plug-in relays on site a clumsy operation. Another example was the reluctance to adopt cable trunking on relay racks, making subsequent alterations more difficult. There were many such considerations and it has to be said that new ideas involving changes to established practices were not encouraged –"if it works, don't try to fix it".

Automatic route setting

Despite the generally conservative nature of the WR S&T department, innovation was not excluded entirely. The first use of automatic route-setting and train-operated route release was successfully introduced in part of the Reading signal box installation, in 1965. The intention at the time was to extend this to a form of Automatic Route Setting (ARS) which was to be driven by the Train Describer (TD), and indeed all the circuit design for this had been prepared. Lack of confidence in the reliability of the TD eventually resulted in a policy decision which cancelled these aspirations and banned such attempts for the future.

Undoubtedly this was the right decision at the time, but it was a major disappointment to those who saw ARS as the way forward, particularly as the interlocking design could absorb this feature in a straightforward manner.

Alterations

Major signalling schemes have a long period of gestation, usually 3-4 years from conception to birth. By this time, the original traffic pattern may have changed, or other factors have emerged, which require alterations to the newly-commissioned project. In fact the WR spent typically 25% of the original cost of every scheme altering the signalling arrangements within a few years of their introduction. This seemed to be the general way of life, and is still very evident on today's railways.

There is no such thing as an easy alteration and it is probably as difficult to alter a WR interlocking as any other. The fact that every installation was designed in a similar manner, supported by an experienced and knowledgeable design office, did at least mitigate some of the problems experienced elsewhere.

Testing

The WR developed testing procedures which served it well. Recognising that experienced staff are always in short supply, the testing programme for each job was broken down to reflect the different levels of testing skill required. Thus routine activities such as wire-counting, panel indication correspondence checking and continuity testing were allocated to appropriately trained staff, and the actual functional testing would be carried out by more senior and experienced staff. Incidentally, functional testing was required to be done without reference to the control tables. The testing thus acted as a final check of the control table.

In-service experience

Many years of satisfactory experience of the systems in service justified the WR's original policies and designs, certainly in respect of its interlocking equipment. As elsewhere, problems arose on the trackside with track circuit connections, point detection and so on, but problems inside the relay rooms were infrequent. By contrast, the TD was a source of regular complaints, and was time-consuming to maintain. We had also underestimated the maintenance requirements of the control panel itself, which required regular attention.

The arguments

There was continuing debate from the outset regarding the WR approach.

There was pressure from other Regions who resented the WR's individual approach, perceived as a perpetuation of the GWR tradition of independence. There was also pressure from the British Railways Board, who felt they had lost control (forgetting of course that the Regional organisation owed responsibility firstly to its General Manager!).

There was pressure from the contractors, who saw the WR as a lost opportunity and didn't see why they should be excluded by what was perceived as a trade barrier. This gained momentum with the formation of ML Engineering in c1962 in Plymouth, which appeared to have an exclusive arrangement with the WR for supplying design and installation labour support.

The contracting issue was finally resolved by requiring the WR to demonstrate in 1968 that their way was cheaper, in competition with the suppliers – which they did conclusively.

In reality, any signalling scheme could be broken down into three main areas of cost, only one of which was the province of a contractor, representing about one-third of the total.

a) The new signalling element – which was clearly capable of being let as a 'supply & install' contract, to one of the main contractors.

b) The cabling element – which would only be sub-contracted at extra cost by the main contractor (who was not a cable supplier).

c) Other work which would be done by the region anyway – buildings, telecommunications, public address, stage-works on existing signalling, disposal of redundant material and buildings etc.

Only the first of these was subject to competition.

First in the field

Despite the references in this article to the conservative nature of GWR/WR, it could claim a number of 'firsts', including:

- Release of starting signals by the block instrument at 'Line Clear' (but never developed beyond the simple release) (c1900).
- Proving of the 'distant' signal in the block control (c1900).
- ATC/AWS (1906)
- Route-setting system (1923)
- 3-aspect UQ semaphore signalling (Paddington E&C lines)
- Mosaic signalling panel (1959)
- Alpha-numeric TD (1958)
- Remote control of a London terminal station (Paddington from Old Oak) (1967)
- Train-operated route release and auto-route setting (Reading SR 1965)

Lessons which might be learned from WR approach

The WR did not get everything right, but its distinctive approach did offer some insights which might well be borne in mind today:

1. A supply and install contract is not the only way to do things.
2. It is important to exploit the resources already available to an organisation.
3. Self-sufficiency produces an established knowledge base.
4. Standardisation and tight control of standards brings benefits in time, costs, training and staff knowledge.
5. Strong leadership inspires a team.
6. Direct control over every aspect of a project reduces cost and timescale overruns.

The 'Total Train Movement' concept

The GWR's commitment to the "total train movement" concept (route setting) in the 1920s was highly controversial in its day and IRSE papers in 1927 and 1931 produced some robust discussions. The very idea that points could be left in the position last operated and that the signaller did not actually need point levers except for test purposes, was an anathema to some people and hotly debated as a heresy.

In the early 1900s, the French had produced a type of route-setting signal box, with the specific objective of reducing the physical size of some of their very large frames. This was achieved quite dramatically in places, using multi-position switches for the control of signals. The GWR's separate development of the route-setting system in the 1920s produced a slicker and more ergonomic system for the operator, but the reduction in numbers of levers was not a priority.

Colour-light signals had only been in use since 1920, and the signalling at Newport was essentially semaphore with motor operation of signals and discs, and the interlocking was mechanical. The installations were therefore expensive (nearly twice the cost of a conventional equivalent). The type of 'shadow' illuminated diagram used was also expensive. Had colour-light signals and electrical interlocking been used – a very novel idea in the 1920s – no doubt the costs could have been reduced significantly and the practice would then have been repeated elsewhere. The nearest modern equivalent did not appear until the York OCS (one control switch) panel opened in 1951. The Newport boxes gave excellent service over the years until they were replaced by Newport Panel in 1962.

The counter-condition – something not to be forgotten

The average young engineer tends to be somewhat dismissive of anything invented more than a few years ago. I met one recently who considered mechanical locking only suitable for a museum.

Such technology should not be lightly dismissed, however, because there are some things more easily done mechanically than by other means. For example: If it is a requirement that lever 1 locks lever 2 when 3 is in the normal position, it is not difficult to guess that lever 2 also locks lever 1, when 3 is normal. It is simply the converse.

Further, if lever 3 is reverse, then levers 1 and 2 will be free and can be operated together. If lever 3 is reverse and levers 1 and 2 are also reverse, then lever 3 will be locked in the reverse position. This is the counter-condition and is important – without it, the original locking can be defeated.

In mechanical locking, all this comes as a package in one operation!

This is not so in electrical design. To achieve this electrically, each control must be applied individually. The challenge for the designer is that the first two steps are easy to remember, but the counter-condition is easy to forget. Without it, there is a wrong-side failure – which can be career limiting.

In recent years, in Britain at least, there has been a preoccupation apparent in modern control tables with something called 'a swinging overlap', a name which disguises the real nature of what is required. The first priority is always to apply the counter-conditional locking which may be required in the overlap at a signal reading over a facing point. Any special route-setting applied is simply an aid to the signaller – the ability to swing a pair of facing points when they are actually locked by a counter-condition (it represents in fact, a release of some essential locking for a brief period). It is fairly unusual to find 'swinging overlap' controls on the WR route-relay systems but the 'counter-condition' will certainly be there.

For more information about the preservation of Swindon Panel visit **www.swindonpanel.org.uk**. There was also an article about the project in IRSE News 219 of February 2016 which can be found at **irse.info/kugid**.

What do you think?

Do we make the mistake of not learning from past experience – good and bad? Have you had experience of working on projects where current best practice has not been informed by previous schemes, and where time and money has been wasted as a result? Or do you believe that times have moved on, and that different approaches need to be taken if we are to meet our stakeholders' needs? We'd love to hear from you, write to irsenews@irse.org.

Industry news

CAFEO 36 conference to be held in Singapore

The 36th Conference of The Asean Federation of Engineering Organisations (CAFEO 36) will be held at Resorts World Sentosa Convention Centre, Singapore 12-14 November 2018.

CAFEO 36 will feature two engineering conferences, two technical visits, a 2-day exhibition, three post-conference workshops, a Welcome Dinner and a Farewell Banquet. The conference will be officiated by the deputy prime minister Mr Teo Chee Hean, and senior minister of state Dr Lam Pin Min will be attending the Singapore Rail Technology Conference as Guest-of-Honour.

The impact of big data, data analytics, IoT in rail transport, smart technologies in maintenance & operation, latest CBTC & automation, rail whole-life cycle management and ASEAN Country Updates, are amongst the topics. Practical solutions and success stories from more than 10 case studies from Singapore, Indonesia, Taiwan, Australia, UK, France, will also feature.

Key exhibitors and sponsors include SMRT, Bentley Systems, Arup, Mitsubishi Electric, Mun Hean, amongst others.

Please visit the website for further updates and details of registration with the reduced fee of SGD 590 (£140, €158) for IRSE members under 'Member of Supporting Organisation' at **www.cafeo36.com** using the unique member code CAFEO36-IRSE.

Future CTCS development

China: The rapid expansion of China's high-speed rail network has gone hand-in-hand with the development of the Chinese Train Control System (CTCS). Dr Mo Zhisong, director of the signalling division at China Railway Corporation, has confirmed that development is underway of a new train control system based on CTCS but using artificial intelligence.

CTCS levels 2 and 3 have been optimised and developed and is the backbone of China's high-speed rail network. The future development of China's railway signal system will focus on intelligence, integration, standardisation, and openness in the next few years.

In 2017, China Railway Corporation (CRC) achieved a 9.6% increase in traffic to 3.38 billion journeys, seven-times the number of journeys by air transport. By the end of 2017, China's total high-speed network accounted for about two-thirds of the total global mileage.

All Chinese high-speed lines are equipped with CTCS. Level 2 is mainly used on 200-250km/h lines, while Level 3 is mainly applied to lines with higher speeds.

Level 2 uses track circuits to provide continuous movement authority, while Level 3 uses GSM-R to provide continuous movement authority through a Radio Block Centre (RBC) and bi-directional information transmission.

CTCS Level 3+ATO is planned to be operational on the new Beijing - Zhangjiakou high-speed line in time for the Beijing Winter Olympics in 2022.

An artificial intelligence based high-speed train control system is also being developed including intelligent dynamic dispatching, coordinated control, transfer dispatching, and failure diagnosis.

Level Crossing collision – lessons to be learnt

UK: At around 05:50 hrs on 11 January 2018, a car collided with the rear-most wagon of a stationary freight train at Stainforth Road Automatic Half-Barrier level crossing, near Doncaster, England. The crossing's warning equipment was not operating and its half-barriers were raised when the car approached and entered the crossing. As a result of the accident, the driver of the car suffered scratches and bruises but their car was damaged beyond economic repair.

The train was at a stand because its brakes had been applied by the locomotive's vigilance device. This occurred because the driver of the train did not respond to the device's audible alarm in the time period permitted, probably due to the high level of ambient noise in the locomotive's cab. The car driver was not alerted to the presence of the train by the crossing's warning devices because the design of the level crossing's control circuits had permitted it to re-open to road traffic while it was still occupied by the train. The car driver did not see the wagon with enough time to take effective avoiding action, given her speed of approach. This was because the train was unlit and unreflective and also because there was no ambient light near the crossing.

The crossing's control circuits dated back to its original installation in 1974. The control circuits had not been modified to incorporate later features which prove that trains are clear of a crossing before it re-opens. This was because a retrospective modification of this type was not mandated by relevant standards and guidance, and also because the crossing's circuits had not required modification during the life of the crossing for other reasons. The crossing had not been renewed or replaced prior to the accident, because Network Rail had assessed it as still having useful working life left.

The level crossing risk assessment process used by Network Rail did not identify and address the risk of the original design of control circuit remaining in service without it having later design features intended to improve safety. The Rail Accident Investigation Branch (RAIB) has made two recommendations. The first relates to an assessment of the risk at other level crossings where there is the possibility of it re-opening to road users with a train still present on the crossing and the development and implementation of mitigation measures, where appropriate, to address this risk. The second recommendation concerns the revision of the current standard relating to the design of new remotely monitored level crossings so that this requires them not to open to road users while a train is present.

The general requirement not to retrospectively implement standards can often lead to a culture of 'we don't need to do anything' when ethically the correct thing to do is a proper balanced risk assessment to demonstrate that the situation is ALARP. Having historical knowledge of the infrastructure and accurate asset data can be another challenge but is essential to manage risk.

In-depth investigation in Siemens Alstom merger

Europe: The European Commission (EC) has launched an "in-depth" investigation into the merger of Siemens mobility and Alstom amid concerns that the combination may adversely affect competition in the signalling and rolling stock markets.

The EC says fears the transaction could lead to "higher prices, less choice and less innovation due to reduced competitive pressure in rolling stock and signalling tenders."

The decision to launch an investigation follows a study into the potential impact of the merger both within the European Economic Area (EEA) and globally (excluding China, Japan and Korea). In both the signalling and rolling stock sectors, the commission argues that the merger would create an entity much larger than its nearest rivals and remove "a very strong competitor" from the market.

Furthermore, the EC has found that the entry of significant new competitors into the EEA rolling stock and signalling markets, including Chinese suppliers, appears "unlikely" to occur in the foreseeable future.

The Commission has until 21 November to decide whether the merger is likely to have a detrimental impact on competition.

Britain's rail regulator, the Office of Rail and Road (ORR), has welcomed the opening of the investigation and believes the combined resources of two of the largest rail industry suppliers in the world would "have a significant detrimental impact on competition in important British rail markets". "The subsequent lack of competition could lead to significantly higher costs", said the ORR, "impacting negatively on passengers and taxpayers".

5G investment

UK: The Department for Culture, Media and Sport has revealed how some of its £1 billion (€1.1 billion, $1.3 billion) investment in a national programme of 5G testbed facilities and trials has been allocated so far.

£200 million (€224 million, $258 million) has been invested in the 5G Testbeds and Trials Programme to date. This includes a 5G mapping project being developed in conjunction with the national mapping agency Ordnance Survey.

£16 million (€18 million, $21 million) has been allocated towards creating the 5GUK Test Network, which is being run by three 5G research institutions in the UK - the 5G Innovation Centre (5GIC) at the University of Surrey, the University of Bristol and King's College London.

To ensure that 5G can be used to support the transport sector investment includes allocations to projects covering roads, rail and 5G security.

£35 million (€39 million, $45 million) has been allocated to exploring ways to improve mobile communications for rail passengers. This is being used to upgrade the Network Rail test track in Melton Mowbray, Leicestershire; to install trackside infrastructure along part of the Trans Pennine route; and, to support the rollout of full-fibre and 5G networks. £10 million (€12 million, $13 million) has also been allocated to the National Cyber Security Centre to test the security of 5G networks in various scenarios.

GSM-R train radio upgrade

UK: A milestone has been reached) towards rollout of an updated GB voice radio which will deliver greater immunity to interference from 4G/LTE public networks and additional functionality, including GPS, accelerometers and LTE. The update of the mobile, to be called version NR4.0 after operational trialling, will involve the replacement of the existing radio unit and the inclusion of a GPS incorporated GSM-R antenna plus installation of a new LTE antenna.

AEGIS Certification Services (ACS) has carried out the Notified Body conformity assessment for Siemens Mobility Limited, and has verified compliance of the Interoperability Constituent with the relevant requirements of the current Control-Command and Signalling TSI ((EU) 2016/919) and EIRENE specifications (FRS 8.0.0 and SRS 16.0.0).

News from the IRSE

Blane Judd, Chief Executive

It's been an engaging and stimulating first few months working in my new role as CEO for the Institution. I have to say that I have been made to feel very welcome and it's been a pleasure to get to know the staff at the London office, the Institution's committee and council members and begin to work alongside them.

I look forward to meeting more of you in the near future at events and meetings. It's most gratifying to get down to work continuing to enrich existing member experience and attracting more members to our ranks all around the globe. Here in London, autumn is indeed upon us; the winds are changing and all the more positively for the IRSE.

Presidential Programme: The Winds of Change – Technical Meetings

The next Presidential Technical Meeting event will take place in Zurich on 26 Oct 2018. This is the third of the events that will be live-streamed and in fact features two technical papers: (1) How to innovate on the railway; (2) The location and control of railway assets in SmartRail 4.0. The first paper considers the basic mechanisms of innovation in the train control and communications field and explores its potential future. The second gives an outline of the core principles of the Smartrail 4.0 project of SBB, which aims at fundamentally changing train control. These two papers are to be presented by Professor U Weidmann (Swiss Federal Institute of Technology) and by Vice President Steffen Schmidt, Program Manager for Swiss Federal Railways. For full details on the Presidential programme for 2018/19 please visit the IRSE website under the **Events** tab at **irse.info/ky93e**.

IRSE Exams

The IRSE Exams will take place on Saturday 6 October (Friday 5 in Australia) 2018. There will be 157 candidates sitting exams in 16 centres around the globe this year, extending from Swindon and Secunderabad to Sydney! In addition, there are two new exam centres this year in Canada and South Africa. I'm sure you would like to join me in wishing all of our candidates the very best of luck for the exam and with their future careers. For more information on IRSE examinations please visit our website under the **Membership** tab at **irse.info/irseexam**.

CBTC Reminder

The next CBTC and Beyond conference will take place on 29 - 30 November 2018. The Conference takes place at Fairmont Royal York Hotel, in the centre of Toronto. Bookings for this conference have consistently sold out every year. My advice is that you book as soon as possible to avoid disappointment. Registration opened on the 3 September and an early-bird rate is offered until 26 October 2018. Please note that the cut-off date for submissions of papers for this event has now passed. I would like to personally express my gratitude on your behalf to the sponsors of this event Alstom (Platinum), Gannett Fleming (Platinum) Hatch (Gold) and CBTC Solutions and Green Aspects (Joint Gold) for their most valued support. More detailed information about the conference can be located on the IRSE's website under the **Events** tab at **irse.info/xi5dq**.

Local Sections' Webpages

I encourage you to keep abreast of all of the local IRSE events that are going on in your area. Events in chronological order can be accessed at the website at under the 'Events' tab at **irse.info/events**. Should you wish to contact a local section secretary or organiser directly, details of their email contact are also available online under each individual local section's entry. The local sections' main menu may be found under the menu option **Near You** and at **irse.info/nearyou**.

Younger Members' Annual Seminar and Technical Visit

Communications are playing a larger role in railway signalling and in how stations and other facilities function as they attempt to transport passengers and freight as safely and efficiently as possible. So, this year the IRSE's Younger Members will be hosting their annual seminar on the theme of Communications. This free-of-charge event will take place over two days. Day one, on 1 November 2018 will be held at the National College of High Speed Rail, Birmingham, UK. Day two is a technical visit on Friday 2 November 2018 to Birmingham power signal box and New Street Station Control Room. More information can be found under the **Events** tab on the IRSE website and at **irse.info/2sc7i**.

IRSE Scottish Section Annual Dinner

The Scottish Section will be holding their Annual Dinner on the usual second Thursday of November. This year's event, on Thursday 8 November, will take place at the Marriott Hotel on Argyle Street, Glasgow, where about 300 members and guests are expected to enjoy an evening of good company and thoughtful discussion.

Open table tickets are remarkably good value at £25 for members and can be obtained by contacting Peter Allan (**peter.allan@siemens.com**). Different prices apply for Younger Members and for non-member guests. Full tables can be ordered for corporate hosts and, again, please contact Peter for details and pricing structure.

Engineering Council Registration

As a Professional Engineering Institution of the Engineering Council, the IRSE can register suitably qualified members in the grades of Chartered Engineer (CEng), Incorporated Engineer (IEng) and Engineering Technician (EngTech). The requirements for each of these registration levels are laid down in the Engineering Council's standard, UK-SPEC (UK Standard for Professional Engineering Competence). The team at the

IRSE London office are always ready and willing to support individuals from around the globe who wish to enhance their professional standing by becoming part of the growing number of registrants. There are opportunities for all grades of technician and engineer. There are also routes for those who do not hold the traditional qualifications (referred to as exemplifying qualifications in UK-SPEC). If you are interested in finding out more, start by looking at the guidance document available from the Engineering Council Registration section under the **Membership** tab on the website, **irse.info/don48**.

Your Annual Subscription

We hope that you consider your membership of the IRSE as an important part of your professional career. The letters after your name are an indication to clients, customers and colleagues that you commit to the high standards expected of people working in our sector. In order to continue to receive communications from the Institution beyond this month you will need to make sure that you have paid your subscription which fell due in July. If you have not yet renewed your subscription you can do it by logging into the IRSE website and navigating to the **Manage your Record** page under the **Home** tab. You can also find full details of our subscription rates under the **Membership** tab at **irse.info/rvpbe**.

Christmas closure

Please make a diary note that the IRSE Offices in Westminster, London, will close this year on Friday 21 December 2018 and will not re-open again until Wednesday 2 January 2019.

Feedback

Please remember that your feedback and views on the IRSE News are extremely important to ensure that this magazine continues to deliver the information that you want to read about. Please email us with your comments and views at **hq@irse.org**.

Members win with new member recruitment

Markus Montigel, President

As we hope you have noticed, we, the officers, staff and members have done a great deal of work to internationalise and professionalise your Institution in the past few years.

Many new IRSE Sections have been established, IRSE News has evolved and is a well-respected source of cutting edge knowledge and experience, and we have improved the esteem in which the IRSE is held by the wider rail industry. This is particularly beneficial to all of you engaged in or associated with railway signalling and telecommunications, train control, traffic management and allied professions.

By extending our presence on social media, your work and your profession is becoming more widely known and understood. As a new service, designed to help you engage more easily with your Institution, live streaming of Presidential Papers commenced earlier this year. As a member you can now attend and interact not only by attending in person, but also by logging in anywhere in the world. The work to provide a more modern appearance through the relaunch of the website, available within the next year, will also provide additional benefits.

I, as your President, together with the IRSE's Management Committee believe that many more people could benefit from these enhancements by becoming members of the IRSE. To meet our aspiration to encourage more professionals to join the IRSE community, we will be working to support you to communicate these benefits through:

- Individual member conversations.
- Local Section recruitment events.
- Employer engagement and events.
- The Younger Members Section recruitment events.

So, we are asking you to share with your colleagues and friends the membership benefits and improvements that you have experienced. Encourage them to be a part of the IRSE engineering community by joining as a member. Of particular importance is helping new entrants to the rail sector to appreciate how, by engaging with like-minded professionals, they can develop their skills, knowledge and career. As the Institution grows, so does our ability to utilise the expertise within it to do more and to grow from strength to strength.

Our goal is to create a measurable increase in membership between now and April 2019!

Some suggestions:

- Use the membership flyer available from the website to support you in your dialogue with prospective members.
- Share recent issues of IRSE News, highlighting the quality of the articles it contains.
- Tell them about events that the IRSE offers.
- Help prospective members to complete an application form. Why not do this during lunch or over a coffee?
- Signpost the website and when it is ready, use the new website to show the breadth of information available to railway control and communications professionals.

There will be a prize for the most successful recruitment campaigns, the winners to be announced at the AGM in April 2019.

We know you value your IRSE membership. Please help us to carry that message to others.

Irish Section

Golf social

Michael Murphy

To combat drought conditions, organise a golf outing! After three or four wonderful weeks of sunshine the second IRSE Irish Section Golf Social on Wednesday 11 July 2018 was greeted with a morning of rain. The brave and the hardy were prepared to confront the elements for a second year and at least try and get past the 10 holes that had been played the previous year. This year's course was the delightful Mannan Castle Golf Club, Carrickmacross, Co. Monaghan, a mature parkland course located in Monaghan's famous Drumlin terrain and setting a challenging encounter for the signalling fraternity.

Thankfully by the time the draw was made and the golf bags loaded the rains had disappeared and the afternoon was clear.

Using a multiple tee start system the round kicked off at 13:30 from the first, fifth and eighteen. Whilst the majority of the group had the knowledge and experience to pass the IRSE exams the same prowess was not always evident on the golf course. The individuals shall remain nameless, but some players quickly ran out of golf balls while others used perimeter fencing in novel and imaginative ways to keep their ball in play. To be fair, this was more a reflection on the challenges of the course than the standard of play throughout the day.

Following a well-deserved meal and the working out of a complicated scoring system that only a signalling engineer could dream up, the scores were in and the prize-giving could commence. The IRSE Irish Section would like to thank all those who took part, members, visiting members and prospective members, in a wonderful afternoon's social event and look forward to many more such events over the coming years. Particular thanks are due to the staff at Mannan Castle and to the RIVVAL signalling company who facilitated many of the arrangements.

Left, the winning team were Derek O'Mahony, Mike Murphy and Paul McGrory (not pictured). Right, the Chairman, Sean Burns with Des Cathcart and Michael Murphy.

More than 'just' technical lectures and seminars

The IRSE aims to be a true home for railway signalling and telecommunications engineers, not just organising technical lectures, seminars and visits – even though they're an essential and enjoyable part of ensuring that we inform, discuss, develop – but also finding others ways that let our members network in an informal way.

The Irish Section golf social is a great example of this. Why not find out what your local IRSE Section is up to in the coming year.?

Visit **www.irse.org** for more information on our local Sections around the World.

The missing link

Ever spotted the 'irse.info' links in IRSE News and wondered what they are?

They are web links to articles and pages on the internet, just click on the link if you're reading the electronic version, or type the address into your web browser – you don't normally even need to put a 'www' in front of the link.

Using our own link shortener allows us to greatly simplify web links, but also lets us track which links are most useful to our readers. We can also adjust the links if they change, functionality that isn't available with commercial systems like bit.ly or tinyurl.

London & South Eastern Section

Visit to London Transport Museum, Acton

Paul Baker

On the evening of Tuesday 3 July and with the kind permission of the London Transport (LT) Museum Depot – Acton, 17 members and guests of the IRSE London South East Section were able to enjoy a personally guided visit to the collection of vehicles, equipment and memorabilia that represent the history of London Transport from its origins through to recent days.

The Museum is part of the larger London Transport Museum collection primarily represented by the museum at Covent Garden in London but gives a more 'behind the scenes' view of the history.

Specifically, the attendees were able to have a close up explanation and demonstration of the cab and traction equipment that formed part of London's, if not the world's, first automatic railway, the Victoria Line, which opened 50 years ago in September of this year. The LT team was led by Ian Arthurton, former Passenger Services Director, and members of the team that had re-created the demonstration of the equipment operation that is normally hidden from view in the drivers' cab, under the car body frame and seats.

The interaction of the train control system with the way the signalling system transmitted information to the train to respond to commands was a topic of great conversation and many expressed a great wish that one day the whole system might be available to show the engineers of tomorrow what ground breaking technology the Victoria Line was, and what a great monument it was to the vision of the engineers of the day. With the upgrade of the Victoria Line in the last 10 years along with a new signalling system, and now worldwide introduction of ATO and driverless railways, what came before it could soon be forgotten and so this is a facility worthy of seeing.

One of the many interesting features of the original Victoria control system was that the safety functions of the control were physically separated from the train 'driving' functions. During the life of the stock, the unit doing the driving, the 'Autodriver Box' was changed four times (getting smaller each time!) whereas the original safety unit, the 'Safety Box', remained until the stock was removed from service.

Alongside the demonstration the building holds a great collection of items representing the development of London's transport system, with signal lever frames, destination indicators, complete four car tube sets, individual carriages, engineering locomotive, buses and the many artefacts that make up a transport operation for a city, from bus stops, through bus shelters to ticket machines to signage and sectioned bus engines.

The museum is open at regular intervals and is well worth a visit, and allow plenty of time! Information is available from the website at irse.info/lvsiz.

The original Victoria Line Autodriver (above) sat under a passenger seat in the saloon, and was a masterpiece of 1960s electronics as seen in the detail shot of the unit in the museum (top left). Later versions of the autodriver are shown in the photo on the left.
Original 1968 photo Westinghouse archive.

Younger Members Section

IRSE Exam module 1 and 7 workshop

Dhanya Srivathsan and Michael Bastow

On Saturday 7 July 2018 a selection of studious signalling and telecoms engineers resisted the temptations of the fine weather and England's World Cup quarter-final against Sweden to participate in an IRSE Exam study workshop hosted at Atkins (a member of the SNC-Lavalin Group) offices in Birmingham, UK.

The workshop focussed on two modules: Safety of Railway Signalling and Communications (Module 1) and Systems, Management and Engineering (Module 7).

This year the event offered two streams, the green stream was for the people committed to taking the exam this year, the blue stream was for those that were considering taking the exam at some point in the future. Most sessions throughout the day were aimed at one of the two different streams, but with some sessions discussing questions split between Modules 1 and 7. People were given the freedom to pick which of the parallel sessions they attended in each time slot. Sessions ranged from 'rapid fire' questioning and answers on key topics and practice under exam conditions for the green stream, to discussions on the railway as a system and a 'systems thinking' exercise for the blue stream.

Despite the temptations of fine weather and football, the event was well attended by a wide variety of engineers from across the industry and enjoyed by all. This event is made possible each year by the enthusiastic and dedicated support of David Nicholson, professional head of engineering management at Atkins and Peter Woodbridge, principal project engineer at Siemens. The Younger Members are extremely grateful to David and Peter and for the kind support of SNC-Lavalin's Atkins business.

David Nicholson starts the day with an introduction session.


Attendees concentrating!

Peter Woodbridge reviews previous results.

Hard at work.

Past lives: Robin Nelson

Robin Nelson (1938-2018) in Lugton signal box. *Photo David Hall.*

Robin was a gem of a man. Born in Falkirk in 1938 and receiving his early education there and George Watson's College Edinburgh, he completed his education at Glasgow University, graduating BSc in Mechanical and Electrical Engineering.

The family home next to the railway at Falkirk High stirred his interest in trains. It was not unknown for Robin to travel home from school on the footplate, or find him in Falkirk High signal box.

He started his railway career in 1960 as a graduate trainee and was subsequently appointed district inspector, Dumfries, moving there with his new wife Jessie. Robin took the position of resident Engineer, Glasgow, moving to Linlithgow and later they celebrated the births of their sons, Robin and Richard.

During 1967, he commissioned a Westinghouse NX panel in Glasgow Central SB. When modernisation of the West Coast main line started Robin, as project officer, prepared Glasgow Central for electrification, before promotion to divisional S&T engineer, Edinburgh.

In 1975, when appointed divisional S&T engineer Leeds the family moved to Poppleton and in 1981 he became chief S&T Engineer, Scottish Region, moving back to Troon in Scotland. In this role, Robin oversaw the introduction of major re-signalling schemes and also directed the conversion of the ageing regional telephone exchanges to digital operation.

Robin had a role to play in the introduction of radio electronic token block (RETB) on the line between Dingwall and Kyle of Lochalsh. This was the first use of both RETB and SSI (solid state interlocking) when commissioned in 1984.

He oversaw electrification and resignalling of the lines from Paisley to Ayr and Largs 1985 and in 1987 Inverness became the first conventional SSI scheme in Scotland. Between 1989 and 1992, a new Signalling Centre at Yoker, became Scotland's first IECC (integrated electronic control centre).

Robin's passion for learning was evident throughout his career and in providing a new training school in 1986, he ensured high quality training for staff. In 1992, he was seconded to the Engineering Council to promote the concept of continuing professional development. During this time, he lobbied for the IRSE to become a Nominated Institution in the UK, enabling it to confer professional status on members.

Following privatisation of British Rail, Robin was appointed head of train control & communications for Railtrack Safety and Standards Directorate, where he remained until his retirement in 1996, thereafter continuing for a number of years as a consultant working as far afield as Australia.

Robin joined the IRSE as a student in 1963, becoming a graduate in 1966, Fellow in 1982 and Hon Fellow in 2003. In October 1982, the Scottish Section of the IRSE was founded, with Robin as the first chairperson. In May 1987, the IRSE Convention was held there and included a special train to Fort William, where a locomotive was named 'The Institution of Railway Signal Engineers'.

In his Presidential year of 1993/4, Robin led a successful Convention to Florence with an excellent technical programme. His wife Jessie and he would go on to attend Conventions right up to this year until, on doctor's orders, he had to withdraw at the last minute. After retirement, Robin continued as senior invigilator for the IRSE exam and to pass the time, he would attempt all the questions himself.

He was very conscious of the history of railways and encouraged research and the preservation of records, participating in a comprehensive collection held in the archives of the Scottish Railway Preservation Society.

He assisted the National Railway Museum in York in the preservation of video and audio records and as a trained interviewer for oral histories of railwaymen. He restored carriages for the Scottish Railway Preservation Society and wrote articles and reviewed books, giving many talks, often illustrated by his own photographs. He was a past President of the Railway Officers Association in Scotland, and later assisted the secretary right up to July this year.

Robin slipped away peacefully with his family around him on Friday 10 August 2018. A service in his memory was held in Portland Church, Troon, on Friday 17 August. Ian Buchanan spoke of his career, joining in tribute with his sons. The church was full of friends and railway people, including three IRSE Presidents, many of whom later joined with the family in a day which Robin himself would have enjoyed.

My thanks to colleagues and family for their invaluable help with this tribute.

Bert Hope

Feedback

Re: MTA Genius Challenge

Traditionally resignalling projects are technically very complex. There are many challenges in upgrading old metros which are based on old technology. One has to understand the existing system and also has to know about the new system and how it works. If you have a new technology which is not yet proven and under development, chances are that a few people know about this.

We need a right mix of domain experts who know the signalling philosophy and experts in latest innovative technologies. Due to the complex nature of the Signalling technology and its interfaces, it is difficult to predict all scenarios in advance.

Any innovative solution implementing modern technologies need to take these things into consideration before deployment. If the new solution 'completely' eliminates all wayside equipment, then definitely it is a big step forward in the history of railway signalling.

Also it is worth noting that the main purpose of signalling is to ensure safety in train operations in normal as well as abnormal/degraded situations. Modern technologies yet to be developed and deployed on railway shall ensure that basic signalling principles are achieved in all situations. There should not be any room for this generation of engineer to develop a new signalling system without clearly understanding basic signalling philosophy. We must have sophisticated modern technologies and at the same time suitably skilled engineers.

Nagaraju Duggirala, India

What about the maintenance?

It seems to me, with the advent of the 'Digital Railway', the impact on the traditional organisation of S&T affairs, will need a far-reaching review right down to maintenance technician level. Perhaps this is already in hand, or has been done, but it is not clear, just what shape the organisation will emerge in the not-too-distant future.

Clearly the separation between the S & T technologies will become less than ever before but while all this is happening, the rest of the network will still rely on traditional methods for many years.

It is foreseeable that staffing, training, warehousing, recruitment and the location of these, must change but still provide for the existing systems. The fact that half the signalling system in future will be based on the train, suggests a disabling fault has a 50% chance of being on a vehicle, which may be anywhere on the network needing urgent attention on site. How this is to be addressed is not clear – perhaps a helicopter will be held on standby somewhere, for quick access; not a cheap option.

It would be interesting to hear something of the proposals being considered, to handle what may be perceived as a significant problem in the future.

Michael Page, UK

An old friend

Reference the picture of Francis How on page 37 on July/August IRSE News driving a steam loco. It needs to be recorded that you managed to get it into this edition with some luck! The loco was owned and driven by me since 1990 at the Great Cockrow Railway (GCR) until 2006 when I shipped it to Australia where it ran on a local miniature railway until 2015 when I sold it to another IRSE member David Grant in the UK and shipped it back to the GCR in Chertsey. So it is a much travelled Loco.

Tony Howker, Australia

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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Membership changes

Admissions

We have great pleasure in welcoming the following members newly elected to the Institution:

Fellow

Finlayson	R	Iarnród Éireann	Ireland

Member

Chutakorn	K	Bombardier	Australia
Clements	A E	London Underground	UK
Douwstra	R E	Bombardier	Netherlands
Furusawa	Y	East Japan Railway Company	France
Herrero Murillas	D	Rail Systems Australia	Australia
Hoogewoonink	B	Mott MacDonald	Netherlands
Motumi	F	PRASA	South Africa
Penneru	V L	Thales	Singapore
Steiner	M	Ansaldo	France
Sugiura	K	East Japan Railway Company	Japan
Telfer-Williams	C	Mott MacDonald	Australia
Windschmitt	P	Canadian National Railway	USA

Associate Member

Abd Manap	R	Rio Tinto	Australia
Aderna	G	Alstom	Netherlands
Bradley	A D	Thales	UK
Ferguson	D J	Linbrooke Services	UK
Gangalingaiah	N	WSP	India
Ismail	A F	Mass Rapid Transit Corp	Malaysia
Laureano	R J R	Alstom	USA
Lim	J	Land Transportation Authority	Singapore
Pantahala Venkata,	S B	Network Rail	UK
Romano	J	Aecom	Canada
Roy	S	Network Rail	UK
Sebe	K I	PRASA	South Africa
Van De Loo	J J	Siemens	Netherlands
Woods	B	Woods Signalling Service	Australia

Accredited Technician

Andrews	C	Amey	UK
Poonja	B	Siemens	UK

Affiliate

Ackland	L	WSP	Australia
Ankhoma	T T	Botswana Railways	Botswana
Brett	R	Canadian Pacific	Canada
Burns	C	Network Rail	UK
Gaodumelwe	L	Botswana Railways	Botswana
Gordon	R	Network Rail	UK
Grassick-Beattie	R J	RJG Consulting	UK
Hahlani	W	Bombardier	UK
Hoeksma	H	Railway Safe	Netherlands
Huang	Z	Siemens	UK
Hughes	A	Network Rail	UK
Keelediwe	K	Botswana Railways	Botswana
Kreuter	C	Frauscher	USA
Jetmalani	M	DPTI	Australia
Mgedezi	V	Gautrain Management Agency	South Africa
Moikotlhai	M L	Botswana Railways	Botswana
Mpebe	M	Botswana Railways	Botswana
Paulussen	R M	Railway Safe	Netherlands
Saolemose	L T	Botswana Railways	Botswana
Serameng	L P	Botswana Railways	Botswana
Thomson	L	Queensland Rail	Australia
Thomason	J	Atkins	UK

Transfers

Member to Fellow

Dapré	S J	Network Rail	UK
Dykstra	D F W	Network Rail	UK

Associate Member to Member

Gupta	N	Atkins	India
Teo	K C K	Rail Projects Victoria	Australia

Affiliate to Member

Mak	K F	MTR Coproation	Hong Kong

Affiliate to Associate Member

Crowther	S M	Ricardo	UK
Kokkonda	P K	UGL	Australia
Warshaw	I M	Transport for London	UK

Affiliate to Accredited Technician

Kerr	H R	Jacobs	UK

Engineering Council registrations

Congratulations to the members listed below who have achieved final stage registration at the following grades:

CEng

Clarke	G	Network Rail	UK

IEng

Turvill	A	Network Rail	UK

EngTech

Andrews	C	Amey	UK
Poonja	B	Siemens	UK

Reinstatements

Bowles G D, Dwiatmoko H, Ekhator J E, Grayston M, Mikusol S, Moser A, Nevasa I, Penneru S, Pentyala M, Rahajanto Y, Rigby J G, Susantono B, Tiruvaipati A R, Varghese P and Vivavong P.

Resignations

Bishop C A, Cauchi C, Coleman S D, Day K A, Dickin M D, Dobrovits P, Groves J C L, Heywood G P, Kichenside G M, Kneeshaw G W, Malarz Z, McDonald S P, Overton A K, Prior R P A, Swain D J, Tan K L, Tinsley S R, Vernon E L, Versloot W, Vetsch H-P, Vincent C A, Volkers H, Wheeler C G, Whybrow T K, Wilcox D and Young C.

New members' removal from database

Due to non-payment of first subscriptions the names of the members in the following list will be removed from the membership database: Avvaru L K, Kamalasuriya S J, Nazaruddin Y Y and Parkinson R.

Deaths

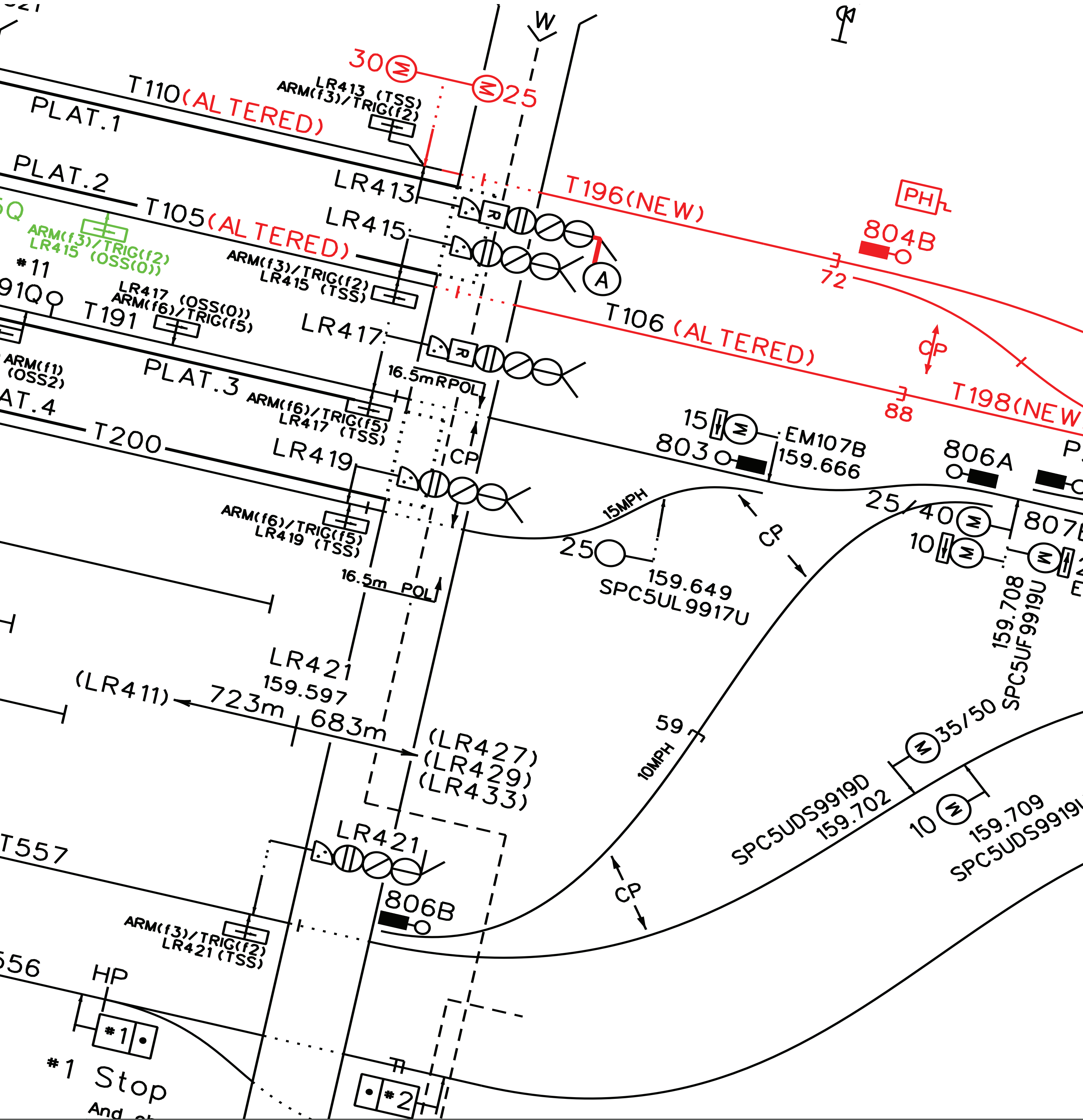
It is with great regret that we have to report the death of members Peter Corser, Stanley Hall MBE, Richard Moorfield and Robert (Bob) Woodhead.

Current Membership: 4879

IRSE /// News

Institution of Railway Signal Engineers

November 2018



Innovation
insights and proposition

Looking afresh
at UK signalling principles

Public address
IP-based speakers

This month Signet Solutions proudly welcomed back the Network Rail Graduate Groups, one of which is Phil Webster, a Graduate who is profoundly deaf.

Following on from their success in March in their Basic Signalling Technology course Phil, together with his interpreters Brian Gleed and Kevin Smith came back to undertake IST Layouts and Control Tables. Brian, Kevin plus the trainer Andy Knight helped Phil through the course with Sign Language, patience and time.

Andy assisted Phil with extra time during breaks, at the end of the day and during his assessment to get him through. His interpreters did a fantastic job of trying to understand the concepts of signalling principles together with specific jargon which does not always translate well in sign language.

We will be seeing Phil again for RRIDO to continue his programme. We have also offered Brian Gleed a place on our BS1/2 Introduction to Signalling course in order to help Phil in his success to become probably the UK's (if not the world's) first profoundly deaf Signal Engineer.

Good luck and well done Phil.

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Signet Solutions
Raising the Standard in Development

Hang in there, your idea is brilliant!

Once upon a time there was a young computer scientist who had decided to devote his research to improving railway signalling. When his thesis was complete, he was eager to convey his results – which seemed brilliant to him – at a presentation for managers and senior signal engineers of railways and suppliers in Switzerland.

On the surface, this appeared to be a big success, as there were double the number of attendees than expected. However, there was just one single, depressing, bit of feedback from an attendee: "My day would have been more productive, if I had stayed in my office". The young person's attempts to turn his ideas into reality also failed similarly during his employment with a large signalling supplier.

The computer scientist became a signal engineer and IRSE member, and devoted his efforts towards the automation and optimisation of railway traffic, because the interest in innovation by railways in this area seemed greater.

Almost ten years later, while working on an innovative signalling project, the signal engineer met quite an influential railway official, who praised the presentation from ten years earlier, and expressed his regrets that the ideas had not been pursued. It was nice to finally hear something positive about the ideas into which so much dedication and efforts had gone – but why hadn't the influential railway official said something earlier?

Moving ahead another ten years and finally, the same ideas – in a modernised way – became of great interest to a current innovative signalling project which welcomed the ideas.

This isn't a fictional story, but an excerpt of the memoires of your president. I don't think it is atypical, as there must be young people out there, having brilliant ideas about how to innovate signalling. Are they heard? I doubt it, otherwise we would see more and faster innovation in our field. But remember my paper "Winds of change"? We need more and faster innovation.

So, my message to experienced senior engineers is – listen! The ideas of the young person who came to you may sound fantastic, but unrealistic or too 'lifted off', but don't reject them immediately. Think them through carefully – as at least part of them could greatly influence your next project/system.

My message to young engineers is hang in there, your idea may be brilliant. It will take time and stamina, sometimes a substantial lot, to change the world, but the industry needs your brilliant ideas!

Markus Montigel, President IRSE

Cover story

This month's front cover shows an excerpt from a typical signalling plan produced to depict proposed new or altered signalling systems.

Network Rail, the railway infrastructure manager in Great Britain, has been considering the possibility of making alterations to some of the principles applied in the design of signalling systems, including the adaptation of principles for use with ETCS.

The IRSE was asked to undertake an independent review of the proposed changes and established a review group. For each set of proposed changes, the group undertook reviews and developed them to the point where the IRSE could endorse them.

It's a role where the IRSE may be able to help other infrastructure managers and more detail can be found on page 10.

In this issue

From the IRSE and its Sections

Insights and propositions on innovation of railways

Ulrich Weidmann
ETH, Zurich, Switzerland

This, the third paper in the 2018/9 Presidential Programme, was presented in Zurich on 26 October.

Innovation in the railway field can take up to forty years or more to become fully established. Today's innovations already give us an insight into what the railway system of 2058 is going to be like.

It's still likely to be steel rail-steel wheel technology but will aim to be fully digitised with far-reaching automation of systems. It needs to be precise, responsive, proactive, robust and economic. Automation aims to open up opportunities for break-through, providing new types of passenger services. Through this it aims to meet or exceed the customers' expectations of the mid-21st century and to play a leading role in land transportation.

This paper does not summarise just a single project, but rather combines insights into innovation in the railway sector from around 30 years, which the author has gained as a researcher and practitioner. It builds on previous publications and continues the respective considerations. In part, it is based on research results of his group, but partly also reflects personal opinions. This means many of the following ideas can be seen differently with good reasons, hopefully providing an inspiring contribution to the discussion.

40 years: the innovation constant of the railway

Fleeting observers and daily users will most probably agree with the proposition 'that rarely is there anything new to be noted on railways'. The station stops often consistently spread the charm of the seventies or eighties, if not far earlier and the vehicles sometimes remain in use for more than a quarter of a century. During this time, the neighbouring motorway experiences five generations of car model change. Is the railway really as incapable of innovation as it seems and is it facing its inevitable decline?

> "Innovation in rail has always spread slowly"

Innovation in rail has always spread slowly according to consistent human standards – since the beginning. Important pioneering achievements go back to the late 18th to early 20th century. For example, steel wheel on steel rail technology was introduced ca 1780, the steam locomotive ca 1800, the mechanical interlocking ca 1860, the electric train drive and the automated block ca 1880, the diesel locomotive ca 1910 and the high-speed railway around 1930.

In these and many other cases it took about four decades from initial use to general dissemination and adoption. To some extent an innovation constant of forty years can be concluded from this. Over the centuries, a transport system emerged which, apart from the basic principles, has nothing in common with the initial English coal mine tramroads.

Innovation intensity of the last forty years

These examples are historic and one could postulate that the innovation



Interlocking innovation: Mechanical interlocking, relay interlocking and solid state interlocking. Computer-based interlocking has followed, and cloud-based systems are beginning to emerge. *Photos Westinghouse archive*.

process has slowed down or even come to a standstill. In other words, is the innovation constant of 40 years still valid today? This can be established by looking back at the last forty years, the epoch since the mid-1970s.

Since then, passengers have the benefit of integrated timetables on many networks, air conditioning of the vehicles is the common standard, as well as dynamic passenger information systems, mobile phone, wireless connections and electronic ticketing in stations and in the trains of many railways.

General accessibility for disabled persons became a legal standard and has been introduced quite quickly, thanks to low-floor vehicles in city and regional traffic. In freight transport, intermodal transport concepts have spread.

In the vehicle sector, the high-speed railways have impressively demonstrated their capability for commercial speeds of up to 350 km/h over the past forty years. A little less convincing, but overall also positive, was the evidence of tilting trains. The first serious attempts to use three-phase current technology for locomotives began at the beginning of the seventies, this is today the undisputed state. It facilitated the development of standardised vehicle construction for high-performance locomotives, double-decker multiple units as well as trains for urban and regional transport. Finally, pneumatic suspension bogies and disc brakes are a matter of course in passenger transport.

The infrastructure includes new forms of track construction such as concrete sleepers, new rail grades, continuous welded tracks and slab track. The introduction of absolute track positioning and monitoring vehicles, allows the targeted track position to be clearly defined, the actual track position precisely recorded and position errors specifically eliminated. In databases, plans and factual information are available in digital format and often with time series. In maintenance, highly mechanised machines and the just-in-time delivery of new switches have arrived. At the same time, electronics has become established in the control and safeguarding of rail operations. Electronic signal boxes, signal box remote control as well as control and automation systems are widely used. The (more or less) Euro-compatible cab signalling according to ETCS Level 2 is operational.

“The railway of 2018 can hardly be compared to that of 1978”

The railway of 2018 can hardly be compared to that of 1978. The industry finally broke away from post-war technology and took the step into the 21st century. The innovation constant of 40 years thus seems to continue to apply – the railway has remained innovative!

Challenges until 2058

Innovation will remain vital in the coming decades. Railways will be in the middle of the century, in an environment in which the competing transport systems have made great innovative progress. The automation of road traffic will revolutionise mobility and not only passenger transport, but above all freight transport. This will have repercussions on the commercial settlement structure and logistics systems, which will be even more dispersed and thus even more difficult to address by the railway industry. Car users will benefit from privacy in their own car while taking the time to work or rest, like a passenger on the train. In addition, the conventional internal combustion engine will be replaced by new propulsion systems, which are ecologically more advantageous. Trucks will be not only cheaper by not requiring a driver anymore, but also quieter and cleaner. This eliminates the important relative system strengths of rail transport.

It is foreseeable that the railway may struggle to survive in various current markets. Even with comprehensive innovation, it will not be possible to compensate for fundamental systemic weaknesses. For example, infrastructure and rolling stock will still be very expensive and durable. Just the infrastructure costs per train ride correspond approximately to the full costs of a bus including the driver! The network density continues to remain about 15 times smaller than that of the road and stations in rural areas can serve only a few passengers.

Comparative strengths

In this situation, the railway with its wheel-rail system must consistently focus on three systemic and absolute comparative strengths, which will distinguish it from the other transport systems for an indefinite period of time:

1. The train is the fastest means of land transportation; road traffic will unlikely to ever be able to operate at top speeds of 250 to 350 km/h. It is unbeatable for distances up to 500 km.
2. The railway offers the highest transport capacity on small surfaces; the space efficiency of the road

is far below and, moreover, the train can be relocated in the underground, if needed.

3. The railway is extremely efficient in carrying large quantities of goods over long distances. The smallest amount of personnel and energy is needed to move large volumes of cargo.

It is these strengths that the railway and its innovation must focus on; these strengths which are increasingly central to our society. Never before has mankind been as urbanised as today, with huge metropolitan areas that can only be opened up by rail systems in an efficient and city-compatible way. Never before has the exchange of people and goods between metropolitan areas been so important, but the capacity of the airspace is finite and the acceptance of aviation by the population is decreasing. Never before has the global exchange of goods been so intense.

Concentrating on the comparative strengths may therefore have some painful consequences for railways, such as the withdrawal from regional services and the abandonment of single-wagonload consignments. In contrast, the railways will be able to render their services even more essential in their strong areas – the connection of the metropolitan areas, transport services within metropolitan areas, and the transport of freight over long distances.

Focus of system development

In order to really exploit its three comparative strengths in this difficult context, innovations are required in the following four areas:

1. Performance

The requirements of passengers and shippers regarding punctuality and reliability will continue to increase. The more difficult the traffic situation on the roads and in the air, the higher the expectations will be of the railway. At the same time, improved flexibility in freight transport will become increasingly important.

2. Economic efficiency

Despite many political assurances, there is no real will in the majority of European countries for substantial funding to be made available to the railways. The maximisation of cost-effectiveness is therefore still required, by minimising not only the initial investment, but also the operating costs.

3. Adaptability

The railway is a rigid system with high fixed costs. The European transport market, however, covers highly populated corridors as well as low-demand regions. Demand fluctuates significantly in terms of time and, with conventional operation, leads to average utilisation of typically between 15% and 30%. At the same time, population distribution is changing due to intra-European migration, leading to growth in parts of the continent but also shrinkage elsewhere. As a result, the railway system must be able to adapt to the different demand patterns in terms of time and space.

4. Resource consumption

While the railways are more environmentally friendly than other transport systems, this will not be enough in the future because the other systems are catching up and resources are becoming scarcer. The energetic advantage of a factor 10 in rolling resistance currently results in about a factor of 3 in real operation; sometimes a bus is even more eco-friendly than a regional train. Rail vehicles have become heavier and heavier, but the average load-factor is still low. For each passenger, two to three tons of material are also carried along!

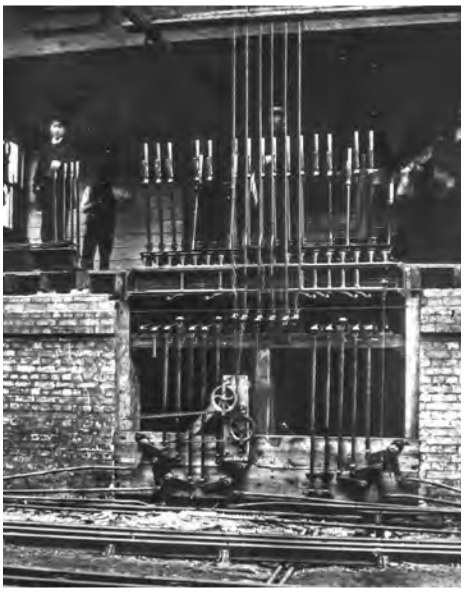
System innovation as a key and challenge

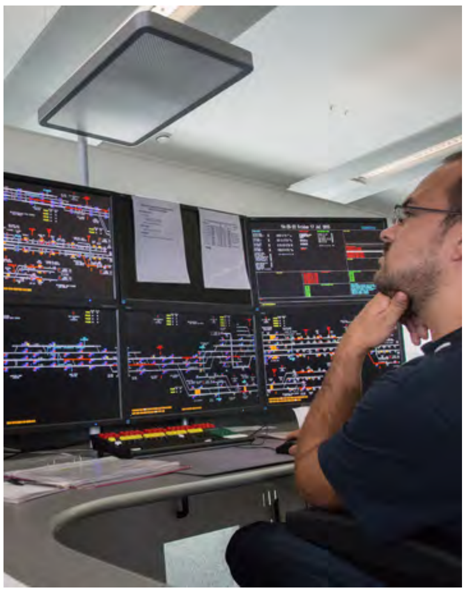
The railway is a system with a history of development of around a quarter of a millennium. Pure component innovations are still important, but they will not be able to give the system completely new properties. Breakthrough innovations – and such are required – can only be system innovations. This will be a challenge:

> “Breakthrough innovations can only be system innovations”

By definition, system innovation always affects the sphere of action of at least two actors and thus also the interfaces between them. For the target of system innovation, it follows that it must optimise the overall system. At the same time, the achievement of goals for individual actors can certainly deteriorate at the same time in several cases – system innovation

Control centre innovation: From the ‘hole in the wall’ at Victoria station, through panel technology, workstation based control is now the norm.
Photos Westinghouse archive and Network Rail.





Innovation in locomotive construction: SBB Cargo International Vectron freight locomotive for cross-border services. *Photo Steffen Schranil.*

can lead to winners and losers. This and the conditions of the railway system lead to three obstacles: actors in the innovation process, innovation processes and cash flows.

These obstacles are not new, but with the pronounced system character of the innovations they become particularly explosive and decisive in the pursuit for success.

First innovation obstacle: actors in the innovation process

The development of a railway system and the design of market-oriented transport services is the joint task of a large number of actors. The railway is a system with generically very distributed tasks and organisational fragmentation. This results in diverse, usually legally and financially delineated organisations.

Demand and policy

End customers: These are the users of the railway system and the final reason for running it, both in passenger as well as freight transport. Both groups want to get the best possible transport offer at the lowest possible prices.

Politics: As a primary goal, politics pursues a high-quality offer with the lowest possible need for financial support through tax funds. Further goals are the reduction of noise and pollutant emissions as well as energy consumption, universal access for disabled persons and affordable fares from a societal perspective.

Regulation: This sets the legal framework within the scope of policy frameworks. Primary objectives are safety, interoperability and fair competition between transport companies.

Services

Orderer: They order transport or infrastructure services which are desired as a public service but cannot be provided on a commercial basis. Since orderers are mostly political entities, they also have an interest in obtaining maximum transport performance with existing infrastructure.

Providers of transport services: Providers of transport services have an interest in producing these services at the lowest possible costs, while maintaining the highest possible quality, and in particular paying as little as possible for the infrastructure. Their goal is to optimise yields with the offer, be it through additional customers or through a higher willingness to pay by existing customers.

Operation

Service operators: The providers of transport services would like to produce these services with the lowest possible own costs. This entails low costs for the use of infrastructure and rolling stock.

Industry in the area of operation: This includes all suppliers of production-relevant system components. These can be, for example, in the field of dispatching software or of certain vehicle components. There is an interest in selling as many components as possible at high prices.

Rolling stock

Passenger coach and freight wagon owners: A vehicle owner aims at rolling stock that best meets the transport needs, at the lowest possible investment and maintenance costs.

Locomotive owner: The locomotive owners want to procure and operate their traction vehicles as cost-effectively as possible.

Rolling stock industry: The rolling stock industry has the interest to sell as many vehicles of the same type as possible at the highest possible prices.

Infrastructure

Infrastructure purchaser: Orders and finances the construction and operation of infrastructure facilities. Its goal is to have the (given) infrastructure capacity available with the lowest possible construction and operating costs.

Infrastructure supplier: The supplier builds the infrastructure. Their goal is to create the infrastructure as cost-effectively as possible.

Infrastructure operator: Maintains and operates the infrastructure. The infrastructure operator aims to utilise the infrastructure at the highest capacity in order to achieve the biggest possible earnings by track access charges. Furthermore, they want to maintain the infrastructure with the lowest possible costs.

Any railway specialist can confirm that the interplay of all these actors, with their different conflicting goals, is extremely complex, time-consuming and often grueling. Sometimes, therefore, one dreams of the long-gone monopoly structures before the railway reform. However, anyone who has experienced this – like the writer – knows that these times were equally stressful and inhibited innovation. Instead of complex interactions, the innovation was paralysed by a bureaucratic culture and lack of

Left, innovation in regional transport. Metre-gauge electric railcar of Aare-Seeland mobil, giving full access for handicapped people using a low-floor train entrance and elevated platform. Right, innovation in urban transport. TANGO low-floor trams of Baselland Transport allowing short dwell times and increased accessibility by use of more doors and a low-floor entrance. *Photos Steffen Schranil.*

innovation pressure. 'Back' is not a recipe for the future! Rather, all these actors are required to contribute to innovation if they really believe in railways. This requires a cultural change. Each actor must be aware that they can only survive if the railway survives as a whole.

Conclusion 1: Technical and operational innovation requires a cultural change in the cooperation of the actors; the maximisation of one's own interests must be replaced by the greatest possible strengthening of the railway as a comprehensive system.

Second innovation obstacle: innovation processes

Due to the structure of the railway system, as illustrated, with a large number of actors involved, as well as the strong role of state and society, there are major differences to the innovation in conventional companies in the manufacturing industry. These differences become particularly clear in system innovations and manifest themselves as a second group of barriers to innovation:

Research and development in commercial companies usually takes place in-house or, if carried out by third parties, under the clear control of the commissioning company. Every company depends on research and development in order to maintain an innovation advantage over its competitors. In contrast, rail transport and infrastructure companies have reduced their own research and development in the past and have switched to a functional tendering of supplies. This was further reinforced by GATT (General Agreement on Tariffs and Trade) public procurement legislation. Associated with this was a loss of knowledge, the balance between market requirements and the state of research and science becoming more difficult. Market requirements cannot be quickly and independently transformed into new products.

When introducing innovations in commercial products, the customer acquires the innovative product and profits directly from its benefits. Since railways only sell transport services as the final result of numerous production processes, a large part of the technical innovations in the system do not generate immediate added value for end customers and may not even be perceived by them. Examples are a new propulsion technology for locomotives or a new type of interlocking. The innovation is mostly used by the railway initially to improve the production of transport services – not to improve the transport service itself.

In terms of market penetration, an innovative company has a market advantage in the general economy, as its product has characteristics distinguishing it clearly and positively from products of other companies. In the case of the railways, first the transport service, as already mentioned, is only marginally improved for the customer by an innovation. Second, many innovations require full market penetration. Here, the innovative company cannot create a unique selling proposition because it also relies on the participation of its competitors.

From the perspective of the innovation leader in the commodity goods market, imitation of innovation by competitors is undesirable. However, this is often required on the railways, as system innovations only take effect if all system participants and thus also the competitors implement the respective innovation. By doing so, the willingness of industry to become leaders in research and development is naturally decreasing, since corresponding additional income cannot be generated.

"Close collaboration has brought benefits"

In the past, co-innovation has been common to railways and suppliers as well as between different areas within the railway companies. This close collaboration has brought benefits and has produced many important innovations. Implementation issues were already part of the development process. The railways were available as a test facility for prototypes together with the suppliers. For legal reasons, this is not allowed today and will probably not be possible in the future. There is therefore a lack of legal structures supporting system-compatible cooperation between supplier and railway in development. A central topic is the regulation of intellectual property.

Conclusion 2: The legal framework needs to be further developed with regard to the specific, coordinated forms of cooperation in the innovation process of railways.

Third obstacle to innovation: costs and yields of innovations

A system innovation should, therefore, lead to an improvement of the position of the railway in intermodal competition, in particular to a better economy. This results initially from lower costs and higher yields. What normally happens is that (1) costs are incurred first, followed by increased returns later on, and (2) the relative relationship between costs and revenues may vary greatly depending on the level of use or the level of dissemination of an innovation.

Costs

When determining the cost characteristics, initial costs for the development of the innovation, the preparation for the introduction, the training of the employees, etc., are to be provided, which are already incurred before the first device is put into operation.

With regard to the further cost trends, three cases can be distinguished:

Linear cost curves: Here, the unit costs per installed part are constant. Such cost curves arise, for example, with similar installation of mass components from other engineering areas in railway environments. No further economies of scale are to be expected due to the small additional number of units compared to the overall market. Each piece has the same installation costs under the same conditions. An example is the use of communication components in the train.

Degressive cost curves: Here, the costs per installed part decrease as the number of parts increases. Cost curves of this kind are to be expected above all in the case of innovations that have been specially developed for the railway sector and are being tested first in test applications or as prototypes. Subsequently, the systems are further developed and then installed as an optimised product in large quantities. Another possibility is the introduction of new products with only limited compatibility with existing systems, which initially causes additional costs due to incompatibility. As more new systems are introduced, it is more likely that only the new technology occurs in an environment and thus no costs for additional compatibility adjustments are required. An example of this is automatic coupling.

Progressive cost curves: Here, the cost per built-in part increases with the number of built-in parts. This cost trend curve occurs especially in systems where the favourable cases can be covered first and cases with complicated and expensive installation conditions have to be converted towards the end of the migration phase. Such curves can occur, for example, in the introduction of new components of the safety technology, if initially easily converted interlockings are adopted in simple stations and complicated cases will be converted later.

Revenues

For the benefits of an innovation, characteristic curves can be derived which are analogous to the cost curves:

Linear benefit: Each piece of equipment generates the same benefit. Such curves can be found, for example, in the introduction of similar additional equipment in vehicles with the same average customer frequency. Thus, the introduction of screens to inform travellers about connections always generates the same benefits per traveller.

Increasing marginal utility: Here, the benefit of a system increases with increasing equipment quota. These include especially, innovations where individual vehicles equipped with the innovative device must interact with other vehicles to generate benefits. As a special case, even a certain minimum equipment level is required to generate any benefit at all. An example is the use of intra-train communication, which only generates benefits when equipping a large part of the vehicles of a train.

Decreasing marginal utility: The marginal utility decreases as the number of installed systems increases. An example is the adaptive train control, which constantly defines a new speed target for the train, based upon the general operational conditions. This offers a significant capacity gain on highly loaded routes, but has only a minor benefit on secondary lines.

Transfer requirements

Finally, the economic viability of innovation results from the difference between the costs and the benefits of the innovative systems. Costs, savings and benefit are usually distributed unevenly among the actors involved. Often, the economic situation of individual actors will deteriorate permanently, even if the overall competitiveness of the rail system improves. From a financial point of view, it is therefore necessary to transfer shares of benefits to those actors who incur the main costs. A distinction must be made between the transfer requirement in the migration phase and that in permanent operation:

Migration phase: The transfer requirements during the migration phase concerns the rail system as a whole, which initially becomes more inefficient. For the time being even in the sum of all participants the system is disadvantageous.

Operational phase: In the operational phase, the overall economic situation of the rail system has to improve. So, a sustained transfer requirement refers just to cash flows between system participants to offset persistent cost-benefit imbalances within single actors. External funding is not required because the innovation is beneficial from an overarching perspective.

The overlay of the cost-benefit curve with the penetration-benefit curve shows that the break-even point is primarily defined by the shape of the cost curve. As a result, systems with decreasing marginal utility generally achieve break-even points at lower penetration levels than systems with progressive marginal utility.

Conclusion 3: Transfer mechanisms that, with some sort of credit, bridge the critical initialisation phase of disseminating an innovation, could greatly speed up the dissemination.

Innovation potential and ideas

In other words, system innovations can only be successful if they provide substantial benefits even at a low level of penetration and at the same time do not require high initial investments. This raises the question, which innovations may be considered today as being feasible, providing an answer to the major challenges of the rail system and having a favourable relationship between benefits and implementation costs.

The currently observable innovations in the railway sector can be grouped, for example, as follows:

New concepts of passenger transport: However, since the development and introduction of the integrated timetable in recent decades, this area currently appears to be less creative. The widely stagnating demand shows, however, that an innovation boost is urgently required.

New forms of supply and operation of freight transport: Firstly, attempts are being made to revolutionise conventional rail freight transport, whether with automatic or self-propelled vehicles. Secondly, an almost unimaginable number of intermodal transport systems has emerged, most of which unfortunately fail because of the low cost of competing directly with lorry transport.

Vehicle concepts and vehicle construction: Recent developments show the standardisation and modularisation of vehicles in the sense of standard designs, which are only specifically configured for the customer. This trend will continue to intensify with the internationalisation of the suppliers. Unfortunately, not all railways are willing to formulate their requirements so that they can be covered with standard type vehicles. The innovations in vehicle construction seem to be in the opposite direction with regard to vehicle weights: potential weight savings are offset by stricter safety standards and comfort features, among others.

Vehicle control: The full digitisation of the state-of-the-art traction control system allows novel approaches to automatic train operation (ATO), be it to relieve the train driver, to align the driving style to a predefined target or to completely shift to driverless trains. These innovations are particularly interesting in conjunction with traffic management systems (TMS).

Infrastructure planning and design: Little innovation has been seen in infrastructure planning. The separation of passenger and goods traffic through their own infrastructures is an old idea, but in reality, practically never feasible and ecologically not desirable. The station designs are not very innovative and do not follow innovative concepts that consider the latest knowledge on pedestrian flows.

Infrastructure usage planning: New methods from operations research have proven that the automated generation of timetables is feasible today, even in real time. This is one of the most groundbreaking innovations.

Infrastructure construction and maintenance: Very promising innovations go to sensors, diagnostics and state prediction. This area belongs to big data and will benefit greatly from the corresponding general developments as well as support the further mechanisation of maintenance. Silently, the track construction types and their components are constantly being developed, but without any fundamental breakthroughs being foreseeable. A maintenance-free track compared to the costs of a track on ballast does not seem to be feasible.

Safety and control technology: Digitisation opens the way to the most fundamental changes in this area. This applies first to new interlocking generations without specific national limitations, but a purely generic core. Second, the control technology is constantly being developed stepwise to full automation, first of all applied to the infrastructure, but ultimately the rail system as a whole. It thus becomes the core of the entire planning and production concept of the railway system.

Energy use: New traction and storage modes in addition to the electric traction with contact wire and the diesel engine are – despite extensive research and development – unpredictable. The large train weights and traction power requires amounts of energy that can only be obtained from the catenary or by fuel. More promising is the intelligent use of energy through automated energy-saving trajectories, but also the situation-dependent feeding of the comfort facilities of the train.

In contrast, no innovation will have any chance of implementation, when aiming at splitting the trains into individual vehicles and allowing them to run on demand. In addition to the almost unimaginable challenges in the timely control and management of these units, it is above all the long braking distances of the wheel-rail system that would radically worsen the capacity. 'Railways' will therefore always mean 'trains', but these trains will become shorter and more flexible!

Potential of railway automation

The most significant increase in performance and quality for the users at the lowest possible cost can be achieved by combining ATO and TMS into a fully automated rail system. Key factors are (1) the precision of the operating processes, (2) closed information and production control loops and (3) the automation of all critical operational processes.

> "The most significant increase can be achieved by combining ATO and TMS"

The train protection systems, in particular ETCS Level 2, allow driving in the physically shortest possible time of around 100 seconds. In order to use this in daily operation, TMS must automatically generate new timetables about every one to two minutes, which considers the current operating situation and its potential further development. To ensure that these precisely calculated slots can be used by the trains, their trajectories must be defined by correspondingly precise specifications. Since this overstretches the capacities of humans, at least in the nodal areas of the network, so the automatic operation has to take over the train from the driver.

In all passenger trains, passengers can be counted automatically; empty seats can be transmitted in real time to the passengers at the following stations. This improves the load factor and the variation of the stopping times can be reduced. This, together with the high-precision guidance of the trains, will contribute to the homogenisation of slot usage and/or to the minimisation of variations of the train runs and thus maximise capacity.

Even in the future, disruption will not completely disappear. However, if its probable duration can be predicted more accurately, dispatching can get more appropriate and more economic. The accompanying information to passenger and freight customers can also be significantly improved. Mathematical methods, such as neural networks, also allow predicting the expected future component failures. Proactive measures can pre-emptively replace components at risk of failure and thus reduce the frequency of faults.

New technologies for new supply systems

The full automation of the rail system, together with the digitisation of infrastructure management, is the largest foreseeable system innovation, since it changes all subsystems profoundly, from customers to infrastructure:

Standardise and streamline passenger services with denser and strictly systematic schedules for passengers. Since the trains no longer need train drivers, the economies of scale of very large trains are less favorable than they are today. In other words, more shorter trains do not cost much more than one single very long train of the same capacity. Thus, the schedules can be radically intensified practically without additional costs, but providing substantially more revenue.

Standardisation of rolling stock and operational processes; large series of uniform vehicles with economies of scale in procurement as well as efficiency-optimised production with minimised inefficiencies reduce production costs.

Radically simplified track topology and increased availability; leads to drastic cost reductions of railway infrastructure. Train connections no longer need to be concentrated in a few dedicated main stations, because trains follow each other within short intervals anyway. The track layout, even of major stations, will thus be radically simpler, and the railway infrastructure will resemble a metro infrastructure with its minimal topology

Therefore, this innovation strategy makes significant contributions to all four identified priorities:

1. Performance: The rail network can be used to its physical limits. Without adaptation of the topology, at least 15 to 25% higher train numbers are realistic, in combination with innovative service concepts even more.
2. Economic Efficiency: The infrastructure will become much simpler and thus more cost-effective as well as more reliable. At the same time, vehicle costs are falling due to increased productivity, and passenger revenues are rising due to the more attractive offers.
3. Adaptability: Automation allows the permanent adjustment to the effective demand and thus the load variations, regardless of the shift schedules and duty stations of the train drivers.
4. Resource Consumption: Automated train control reduces traction energy requirements. At least as important is the saving of grey energy for the production and construction of the railway infrastructure.

Finally, migration is made easier by the fact that these innovative approaches can be implemented in a modular and successive way, not needing unbearable costs, but already bringing great benefits locally in an early phase.

Synthesis: The Railway 2058 – A quarter of a millennium of innovations

The economic pressure on the railway will not weaken, on the contrary; it will be superimposed by massively increased requirements on performance and quality. "More performance for the same money" will take the place of "less money for the same performance", which, given the inherent economies of scale, can be a huge opportunity for the railways. At the same time, innovation strategy must consider the specific conditions of the rail system.

If the railways want to use them, they have to pursue four strategic directions:

1. Comparative strengths: Focusing on those areas where rail has comparative strengths over other transport systems. Specifically, these are the high-speed connections over medium and long distances, the urban and suburban transport as well as long distance cargo.
2. Information and intelligence: Rail operations today are characterised by open control loops and thus hard to keep within the defined margins. Information technology now enables an interactively and finely regulated network-wide operation on a closed-loop-basis.
3. Highly efficient and available infrastructure: Reducing costs and increasing availability of infrastructure, especially in the case of track and civil engineering. This is in addition to low wear components, continuous condition monitoring and streamlined maintenance procedures.
4. Minimisation: Advances in materials technology do not seem to have arrived at the railways yet, and progress is essential, and certainly possible.

The railway will be able to remain a relevant means of transport if it succeeds in minimising infrastructure costs while maximising capacity utilisation. Otherwise, it becomes a niche product, because many years of experience show that a really cheap train is physically not possible – the train is forced to maximise load and utilisation! Mixed traffic will continue to be the norm, minimising infrastructure investment as well as land consumption and landscape degradation.

If the railway uses its innovation potential, it will be marked in 2058 by fully automated planning and operation and thus maximum system performance and tight monitoring of the system and vehicle condition. Availability maximisation through early failure detection and novel, metro-like nationwide services with the greatest benefit for passengers together with radically simplified infrastructure with lower construction and maintenance costs.

> "Fully automated planning and operation and thus maximum system performance"

All required innovations are already present in their basic principles or initial applications. The railway is obviously still capable of innovation, but its innovations must not be hampered by regulations.

A major challenge for the coming decades will initially be that all actors see themselves as solitary contributors to the innovation process, regardless of their direct selfish interests. Standardisation and procurement procedures must be designed and practiced as drivers of, not as brakes on innovation. Finally, financial mechanisms have to be developed which balance asymmetric costs and returns between the actors. This should be understood as an opportunity to develop a new cooperation culture between all actors of the railway system under the new conditions, instead of mourning the patterns of cooperation of bygone days

In 2058, the railways will have been around for a quarter of a millennium, comparable to the lifetime of the Roman road network. The railway network will then be highly accurate, responsive, proactive, robust and economical. Maybe it will be less extensive, but it will meet even more the needs of the mid-21st century and continue to serve as a valuable, useful land transport alternative to the road.

About the author ...

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ETH Zurich (Swiss Federal Institute of Technology in Zurich; German: Eidgenössische Technische Hochschule Zürich) is a science, technology, engineering and mathematics university in the city of Zürich, Switzerland. It is an integral part of the ETH Domain that reports to Switzerland's Federal Department of Economic Affairs, Education and Research.

What do you think?

Do you agree with Ulrich's view of the past and the future? Do you think that the 40-year innovation constant is still appropriate, or is change more rapid than in the past? Do you think that we are committed to innovation, or are we always playing 'catch-up' as an industry? We'd love to hear what you think, email your views to **irsenews@irse.org** for inclusion in our Feedback column.

IRSE

Institution of Railway Signal Engineers

Looking afresh at Britain's signalling principles

Neil Porter, Graeme Christmas, David Fenner, David Nye and Francis How

For some time Network Rail, the railway infrastructure manager in Great Britain, has been considering the possibility of making alterations to some of the principles that are applied in the design of signalling systems.

The particular principles that were under scrutiny were:

- Overlaps.
- Permissive working.
- Route cancellation.
- Adaptation of principles for use with ETCS.

In addition, the safety criticality of various functions was considered, to determine which functions need to be retained in the interlocking, or placed at a non-interlocking level of the control system.

The original driver for this work was that the mainline GB rail network has utilised data-driven interlockings since the prototype SSI at Leamington Spa in the early 1980s. Since then the volume of interlocking data has increased dramatically, as have the complexities of some data structures.

Unfortunately, alongside the increase in data there has been an increase in the incidence of design errors. Many of these related to controls on points on the flank of and beyond the end of a movement authority. Though the reasons for such errors are not all related to data/logic complexity, a plan was developed to reduce the necessity for complex logic, which is now being enacted. One element of this plan has been a rationalisation of some signalling principles, with a particular focus on overlaps and flank protection.

Approach taken

Network Rail developed the ideas about potential changes to the principles during 2016, and then subjected the proposals to a structured review process (similar to a Delphi-style review), involving two independent expert groups.

One of those groups was a sub-group of Network Rail's own 'Signalling Principles Group'. The IRSE in its capacity as the supranational professional institution for railway signalling was asked to be the second group, by undertaking an independent review of Network Rail's proposed changes. The IRSE established a review group comprising Neil Porter, David Fenner and David Nye, with Francis How being the project leader. For each set of proposed changes, the project team undertook individual and collective reviews, presented their initial opinions to Network Rail through discussion meetings, after which the proposals and rationales were revised as necessary, to the point where the IRSE team could endorse them.

The initial review categorised each proposed change as being:

- IRSE agree with the rationale and conclusion.
- IRSE agree with the conclusion but it is felt that the rationale is not sufficiently developed.
- IRSE disagree with the conclusion.
- There is a mismatch between the conclusion reached and the rationale provided.
- Further information is required to enable completion of the review.

The work was broken into five sequential packages covering:

- Controls for ETCS.
- Route Cancellation.
- Permissive Working.
- Safety Criticality (of interlocking controls).
- Overlaps.

Controls for ETCS

Currently aspect level controls are generally proven continuously in the aspect level of a signal. Thus if there is a failure of (say) point detection after the signal has cleared, and before the train has passed the signal, then the aspect will revert to danger, giving the train driver an opportunity to brake. In reality of course, dependent upon his position on the approach to the signal, the train may or may not be able to stop before reaching the failed points.

The reason for this approach is historical and related to the technology in use. In mechanical signalling, any detection provided was, by virtue of the mechanical detection arrangement, provided at 'Time of Clearance' only. However, with the advent of relay circuitry, it was easier to provide continuous detection, and this practice has continued to the present day.

The purpose of this work package was to consider whether continuous detection was warranted in the ETCS world, or

Category	Description	Example
A	Control to be proven only at Time of issuing a Movement Authority. Any subsequent loss of the control has no effect on the issued Movement Authority.	• Route set and locked. • Opposing routes normal. • Train detection sections clear (route and overlap). • Trailing point detection. • Approach control conditions. • 'Inter signal proving' (pre-set, banners etc).
B	Loss of control to cause the train to stop if it is possible before the route entrance (i.e. it has not reached the 'indication curve'). If the train cannot stop before the route entrance then it proceeds.	Nil
C	Loss of control causes the withdrawal of the Movement Authority (and potentially tripping a train that enters the withdrawn Movement Authority), but allows a train that has already entered the route to proceed.	• Route cancelled by signaller. • Detection and locking of moveable infrastructure in the route or overlap. • Facing point detection (in route). • Level crossing incursion (Barrier strips etc).
D	Loss of control requires the train to be stopped. System seeks to stop the train before entering the route, and sends an emergency stop message to trains in the route.	• Train detection sections clear (flank and overrun). • All signals On control. • Un-authorised movement detected in the area (signal passed at danger, SPAD, detection).

Table 1 – Potential ETCS controls

whether proving of controls at 'Time of Clearance' only was sufficient. Key considerations were:

- The greater likelihood of an ETCS driver observing the equivalent of a reversion of aspect (and hence being subject to a brake demand), compared with conventional lineside signalling, because of the continuous provision of movement authority information to the train.
- The longer response time of the ETCS system, meaning that any transient 'blip' in the loss of a control would in practice become a much longer time for which the reversion was seen by the driver, and may not be recoverable until the train is stationary.
- The potential to configure ETCS to set routes 'just in time' such that the train will enter the route a relatively short time after the route is set. Therefore, the window of opportunity during which reversion might occur is relatively short for 'typical' route lengths.
- The use of robust SPAD management and controls, to preclude incursions into the signalled route by other trains.

ETCS was considered in both an overlay mode and without lineside signals.

Four types of potential controls were identified, as shown in Table 1. Each type describes how the signalling system is designed to behave under 'lost of control' conditions. The principal controls currently in use in lineside signalling were each categorised into one of the four types for the purposes of ETCS signalling, also shown in Table 1.

Route Cancellation

This work package considered the manner in which the release of routes is managed, looking afresh at the fundamental principles for train operated route release (TORR). This had been written on the assumption that it was implemented as an interlocking function. The key driver for this was a desire from Network Rail to facilitate re-control schemes, by allowing automated releasing of routes to be introduced to existing interlockings without intrusive alterations being made to those interlockings, especially when those interlockings are of an age where they can remain in use but should not be subject to significant alteration.

The conclusion was essentially that route release should be viewed as the logical interaction of functions as illustrated in Figure 1.

The Approach Locking function remains a safety critical function, generated in the same manner as currently.

A new function was postulated Train Operated Route Cancellation (TORC), which is essentially generated when the following conditions are all met:

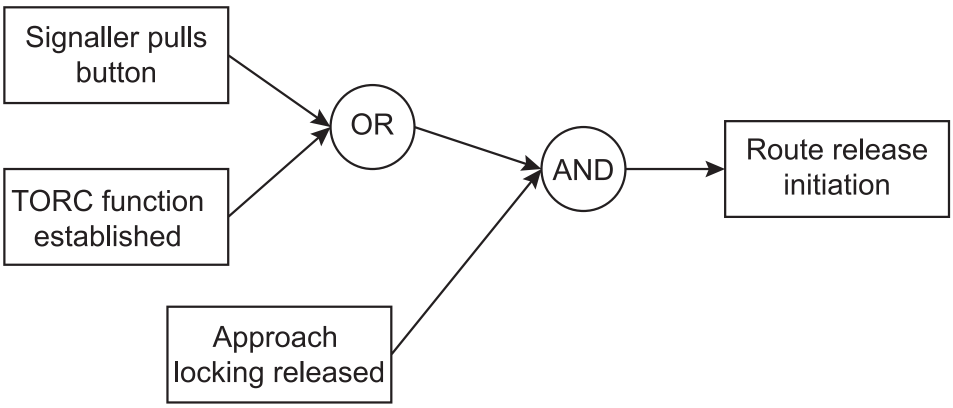


Figure 1 – Route release should be viewed as the logical interaction of functions.

- Signal disengaging sequence met (Signal off, with berth and first train detection section occupied) i.e. the train has past the signal in the forwards direction.
- Signal at red.
- Signal not set to work in auto mode.

The TORC function expresses a desire to initiate route release, (as does the signaller manually cancelling the route), whereas the release of approach locking expresses a confirmation that it is safe to initiate route release.

Since both TORC and the signaller cancelling the route manually can only have effect in initiating route release if the safety critical approach locking release function is present, then they can be classified as safety related. The view taken is that the extra integrity applied by train operated route release since the introduction of data-driven signalling has been unnecessarily duplicating the approach locking safety release function, and that a substantial approach locking release sequence alone is safe enough.

Thus in future schemes, TORC can be generated in a safety related control system, rather than a safety critical one. By avoiding intrusive alterations to existing interlockings, the following benefits accrue:

- Significant economies in the centralisation of control of existing interlockings
- Risk reduction by not altering existing interlockings which are sometimes of 'heritage' design and may be in poor condition.

Permissive Working

This work package reviewed the management of 'call on' routes into occupied station platforms, both from a principles perspective, and considering the application of those principles.

The long-established arrangements were seen as generally fit for purpose, with some notable exceptions (for which changes have been agreed):

1. The historic requirement to prove that the first train has 'completed its movement and can be assumed to be at a stand', was seen as unduly onerous, especially so if interpreted with a high degree of accuracy (e.g. to the metre or second). It can be replaced by a simpler requirement that the first train 'can be assumed to be at a stand'. The view was that the first train can safely be assumed to have come to a stand after a time delay since it entered the route (dependent upon the length of the route), and that additional controls that have historically been provided to attempt to prove that it is stationary were unduly complex for the risk that they managed.
2. The historic requirement for the entrance signal to be held at red and only released once the second train has approached and nearly at a stop can be simplified by requiring the signal to clear when it is readable, both aspect and route destination; the current standard requires a fixed 100m which does not reflect the various capabilities of the products available (particularly modern LED signals, with enhanced visibility).
3. The controls required for AWS magnets in permissive station platforms (which were designed to prevent a second train incorrectly receiving a clear AWS indication intended for the first train) can be significantly simplified, albeit with the risk of an occasional AWS warning instead of AWS clear indication for the first train.

Items 1 and 3 will enable simplification of standard data constructs, thereby reducing the potential for error in production, checking and testing, as well as reducing the time required for these activities. It also can allow, in some circumstances, longer trains to be accommodated without the tail of the train be interpreted as still being 'on its way' into the platform.

Safety criticality of interlocking controls

This work package looked at the interlocking principles (historically contained in Railway Group Standard GK/RT0060) and sought to identify the functional and non-functional requirements within the text.

Functional requirements were then classified as:

- Safety critical.
- Safety related.
- Non safety/performance.

The review also sought to identify whether there was any duplication or lack of precision within the requirement, and whether there were any simplifications that could or should be made in the light of the current understanding of risk on the railway.

The objectives of this process were to enable:

- Improved clarity in the statement of requirements
- Clarity as to whether a specific requirement needed to be implemented in the SIL4 interlocking level, with all the associated levels of verification and validation; or whether it could be implemented within the control system at a lower level of integrity (as determined by the interlocking).
- Reduced implementation costs and timescales by moving requirements implementation from a SIL4 platform to a lower integrity control systems platform.
- Improved safety by reducing the complexity of SIL4 implementation data and hence reducing the likelihood of undetected errors in its design, checking and testing.

The review identified very significant opportunities for improving the clarity of requirements, often related to the lack of precise definition of words and phrases commonly used within the profession, and by the addition of specific criteria associated with the choice of options within the requirements.

The main safety related functions that were identified were:

- Train detection for flank and overrun, on the basis that robust SPAD detection was in place which initiates the signal group replacement control for the area affected by the SPAD.
- Signal disengaging, on the basis that signal will only re-clear if it is safe to do so.
- The request for route setting (as opposed to the determination of whether it is safe to set)
- Those interlocking features applied to guard against the risks arising from automated route setting such as time delayed release of route locking and the automated cancelling of route requests by the passage of the train (as referred to above)
- The management of selectable auto working on signals on the basis that the signal will only clear if it is safe to do so.

Overlaps

The objective of this work package was to simplify the overall approach to the use of overlaps, with the perceived benefits of:

- Improved safety by reducing the complexity of interlocking functionality (and data) and hence reducing the likelihood of undetected errors in its design, checking and testing.

- Reduced implementation costs and timescales associated with the reduced complexity of functionality.
- Closer relationship between risk control measures and the risks that they were controlling.

The work package eventually led to a major rewrite of the overlap standard and the establishment of a requirement that the operational function of every overlap should be expressed as part of the layout design, so as not to leave it to the interlocking designer to guess what operational flexibility is required.

The purpose of an overlap (in conjunction with other measures such as Train Protection and Warning System (TPWS)) is to mitigate the risk of an over-running train becoming de-railed or colliding with a second train. Historically, measures have been put in place to mitigate the risk if the second train is either:

- Legitimately present (i.e. signalled), or
- Not legitimately present (i.e. the second train has also overrun).

The key principle underlying the re-written standard is that the second train should only be considered to be a legitimately present train. The rationale is that given the statistically low likelihood of an overrun, the likelihood of a second train overrunning at the same time and in the same locality is sufficiently small that the cost and effort of mitigating these risks arising is disproportionate.

The revised overlap standard has been totally re-structured to provide a more logical document with better definition of terms, and includes:

- Removal of unqualified point detection from the overlap.
- Simplification of the rules for the lengths of overlaps.
- Introduction of the concept of 'Simple Alternative Overlaps' and 'Complex Alternative Overlaps' with a requirement that, wherever practicable, signals are positioned such that alternative overlaps are 'simple' rather than 'complex' (and hence reduce the complexity of interlocking and associated data).
- General requirements to provide complex features only if there is a demonstrable operational need to do so.
- The sharing of opposing overlaps in certain (low speed) circumstances.
- Extensive guidance in the form of illustrated applications.

Progress with implementation

In March of this year (2018) a revised standard on approach locking and route cancellation was issued and briefed. It retains the shape and headlines of its predecessor but establishes the safety related function of route cancellation so long as the approach locking release function meets certain minimum integrity levels within the interlocking.

With a two-year old supplement to Network Rail's main interlocking standard which had already given permission to apply certain interlocking features in control systems, this new standard allowed the first re-controls of older route relay interlockings, confident that this could be safely undertaken without any intervention into safety critical controls. Two large schemes were commissioned within weeks of the standard being issued, having anticipated its publication.

In June Network Rail's signalling standards strategy managers agreed the publication of the new overlap standard. This was published in September. It removes much doubt and clarifies much hearsay about what Network Rail meant when, 3 years ago, it decided to no longer detect points in the overlap. In effect it has reverted to the practices of the early 1960s, described in a number of the IRSE 'Green Books'.

Though a number of projects have been commissioned without overlap point detection, the clarity in the new document is that train detection must be selected out by actual point lie.

Another key change is that permissive and non-permissive shunt routes are no longer separately required thus potentially 'halving' the amount of associated data (there will be some dissenters to this prediction of halving but this is the intentional purpose of change of practice).

A subsequent development is that the 'BR-era' use of separate end detection in signal aspects is to be reintroduced and one of the first projects to apply this will be Feltham re-signalling with the intention of doing so throughout the layout. A new standard to describe the change this causes to flank 'locking' is already in draft.

It is hoped that the whole of the main interlocking standard, GKRT0060, will be published early in 2019. Birmingham New Street resignalling project is pioneering the revised controls and associated data for the control of permissive moves.

Final comment

The involvement of the IRSE as the professional body for railway control systems in this project has provided Network Rail with an important independent review of the proposals. From the IRSE's point of view, it has been a very useful exercise, demonstrating a further way in which the Institution can add value to the industry.

One of the starting points for the work was the IRSE's Fundamental Requirements for Train Control Systems. These have been developed over a number of years, beginning in 2001 shortly after the completion of the Signalling Philosophy Review. The Fundamental Requirements can be found on the Knowledge page of the IRSE website, and they are also available on line in searchable form – see **irse.info/bru70**. These requirements are freely available for use, and readers may be interested to know that, in addition to the Network Rail project, the IRSE has also had enquiries from the Australian Rail Industry Safety and Standards Board who wish to make use of some of the material in their standard on signalling principles.

The authors would like to thank all of the wider team of engineers who have been involved in the review of the principles and standard.

Playing our part in the industry

The independent review into UK signalling principles is a good example of the Institution playing its part in the wider industry. The IRSE's remit includes "The advancement for the public benefit of the science and practice of signalling and the maintenance of high standards of practice and professional care amongst those working within the industry and the promotion of improved safety standards for the protection of the general public".

One way that we can provide that 'public benefit' is by providing expert, independent and unbiased opinion, as demonstrated in this case.

Is IP speaker-based public address ready for railway system roll-out?

Jasbinder Singh
IRSE Malaysian Section

Over the past 24 months, customer and consultant enquiries for railway Public Address (PA) systems incorporating Internet Protocol (IP) speakers have started to become more common. This article explores IP speaker based PA solutions and considers their suitability for deployment in fixed infrastructure railway environments.

The new technology is compared to traditional analogue PA solutions, distributed IP amplifier solutions and non-distributed IP solutions utilising an IP backbone. Recommendations are provided for the technology according to typical requirements of fixed infrastructure railway environments.

Figure 1 shows the architectural arrangements of each of the four types of system discussed.

Public address systems are an essential part of station equipment, and technology in this field is advancing rapidly. *Photo Paul Darlington.*

Traditional analogue PA system

Traditional analogue PA systems utilise high powered head end amplifiers wired via cable bus to multiple speakers. A discrete cable bus is required for each public address zone. The number of devices required in such an environment is typically lower then more distributed approaches, however cabling is required to run from the end locations back to the amplifier for every zone, which increases cable quantity, conduiting, installation time and effort. The fixed association of the bus cabling with zones, limits the flexibility of such an approach and does not allow for restructuring zones or creating sub-zones if required. Other considerations are where redundant cable buses are employed to minimise the failure area as this, typically, further doubles the amount of cabling required in order to drive alternate speakers on each bus. Multi-zone, redundant systems can result in large volumes of cable that may require dedicated containment and structural re-enforcement.

The benefit of the traditional solution is that it is a well understood and relatively simple system that allows for easy deployment where the zones and speaker locations are fixed and unlikely to change. Requirements for technically knowledgeable installation support is reduced. Furthermore, all equipment is centralised in a rack or cabinet which provides quicker access to the amplification hardware.

Centralised IP amplifier-based PA system

Centralised IP amplifier systems share many similarities with traditional analogue systems. Typically equipment is still largely centralised with multiple speakers connected via a dedicated bus per zone. However, unlike traditional analogue systems, it is easier to support multiple amplifier locations in order to reduce the bus length and installation difficulty. Audio information can be distributed digitally between amplifier locations via the IP Network/LAN in order reduce the bus lengths and improve audio quality. Flexibility improves to a limited extent as the digital audio distribution can be routed more easily, however zoning is still directly associated with the underlying speaker bus structure.

Distributed IP amplifier-based PA system

Distributed IP amplifier PA systems extend the approach used in the centralised IP amplifier system. Instead of having a small number of higher power amplifiers in locations as near as practical to the zones, small IP digital amplifiers are distributed throughout the environment. Each amplifier may

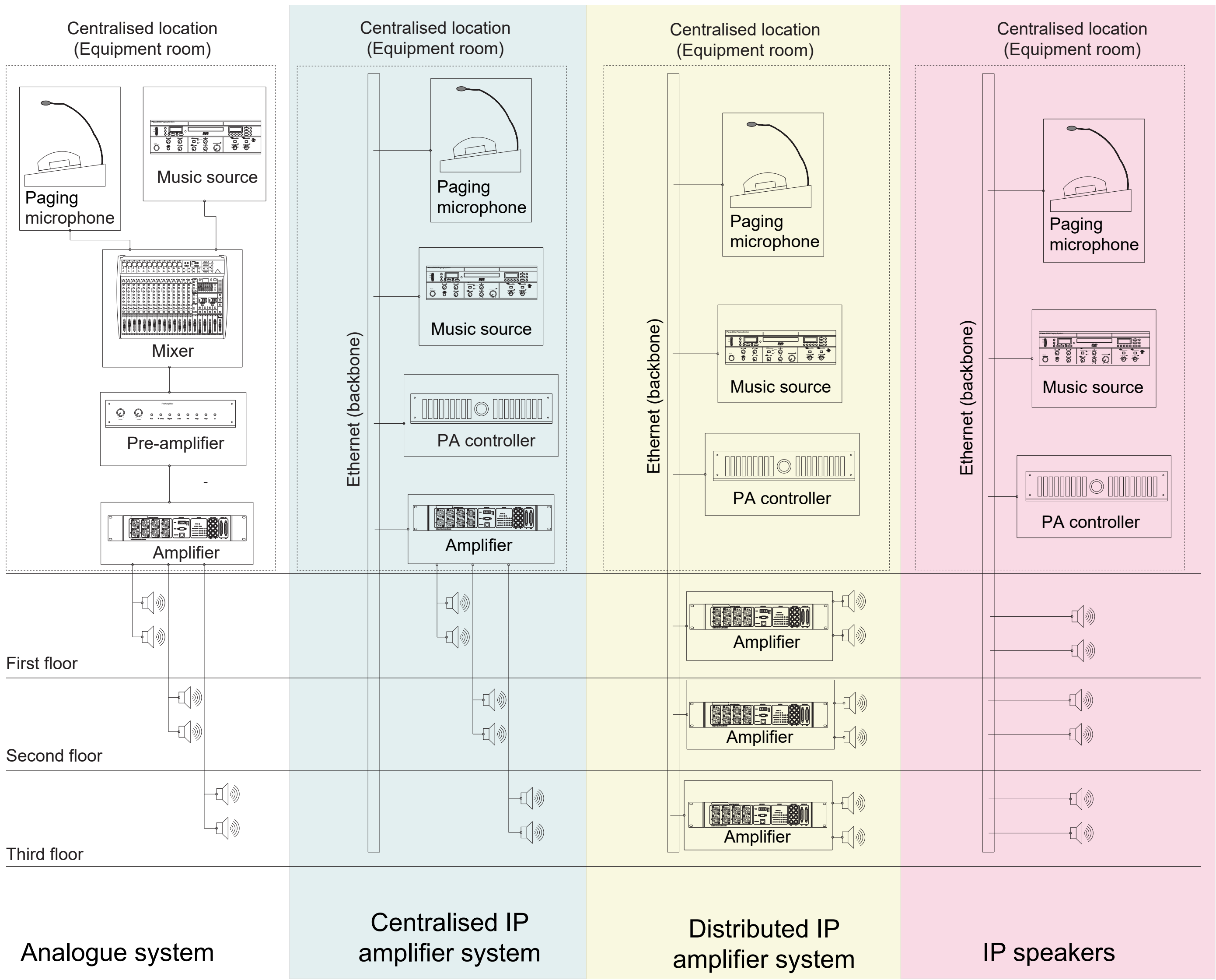


Figure 1 – Architecture of the four systems described.

provide audio from as little as one to as many as eight speakers. Such systems typically incorporate enhanced facilities such as logic control, non-blocking audio routing and mixing, audio filter and equalisers. Other enhanced facilities such as per-channel acoustic delay may also be provided in some solutions. All of these features are typically able to be controlled and configured via web based interfaces. Such a solution has lower electrical losses from audio propagation over long buses and enhanced audio quality due to being primarily digital.

As a single Ethernet cable can support as many as 256 acoustic zones in some configurations, such systems reduce the cabling that would otherwise be required from the centralised amplifiers to the speakers. Because the amplifiers are discrete from the speakers, it is still possible to use a wide range of speakers from standard vendors allowing for increased flexibility with respect to physical format and function.

Such solutions typically are more difficult to ensure correct audio synchronisation across zones and also may be impacted by the performance of the underlying IP network. Additional consideration are that the distributed amplifiers may not be as accessible for the purpose of service and maintenance, being typically located in ceiling cavities or other inaccessible areas. Due to the power required for each amplifier, another complication for such systems is the requirement to reticulate a discrete power bus to each amplifier. Distributed IP amplifier systems cannot typically be powered by Power Over Ethernet (PoE), due to the power requirements of driving multiple speakers.

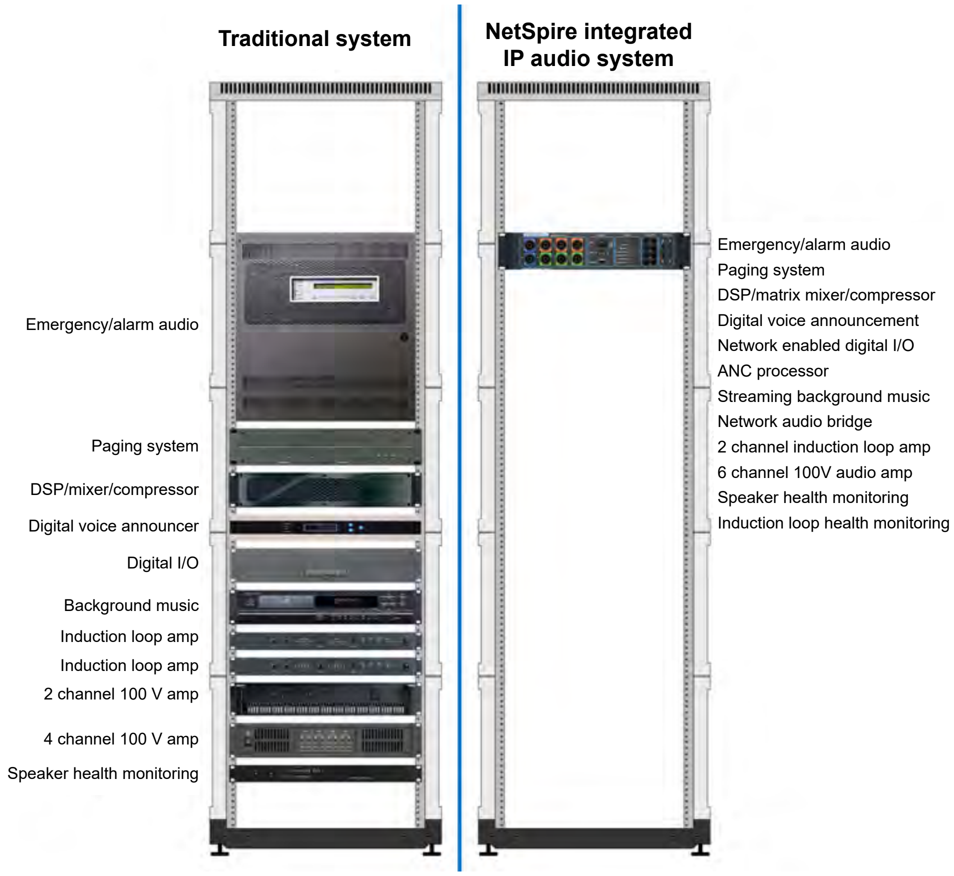
IP speaker-based PA system.

IP speakers further extend the distributed IP amplifier concept, such that every speaker has its own dedicated amplifier integrated into the speaker. Such speakers are typically able to be powered via Power over Ethernet (PoE) which also simplifies the power distribution and negates the need for a separate power distribution bus.

IP speaker solutions provide the most flexibility with respect to zoning, as every speaker can typically be associated with one or more zones. Remapping or changing the zones can be done through software in the event that requirements change in the future. IP speakers' solutions can also provide condition monitoring for every speaker and fine control of per speaker volume levels in order to match the requirements of the environment.

Some challenges for IP speaker systems are as follows

1. Cost – IP speakers are more expensive than passive speakers. Cost advantage reduces as the quantity increases. Secondly, the IP speakers need PoE cabling and cannot be daisy chained. The cabling cost for IP



The latest integrated IP audio systems are much smaller and have more functionality than analogue equivalents.

speakers has no advantages relative to traditional PA system essentially. IP speakers will also increase the network infrastructure cost as more PoE base switches need to be provided for the speakers.

2. Sound Quality – In IP Speaker solutions where there is no support for high-resolution acoustic synchronisation across speakers, sound quality may be lower than centralised systems due to acoustic jitter and delay between speakers. Conversely, more advanced solutions support high resolution synchronisation and delays, the sound level will be considerably higher than traditional systems, as acoustic delays can be incorporated in order to reduce echo and provide sound re-enforcement.
3. Power consumption – will result in higher power consumption as there will be a processor in each speaker in addition to the amplifier.
4. Distributed IP speaker systems are typically the most complex and difficult to configure. Not only is a detailed network plan and structure required, more information per speaker such as volume levels, EQ curves and delays must be specified.

IP speaker systems have advantages when deployed in small coverage locations such as a bus stop or a small room at remote guard house. Nevertheless, consideration must be given to the concerns outline above when they are implemented in large environments.

Detailed comparison between the four systems

Table 1 provides a more detailed comparison between the systems discussed above.

Table 1 – Comparison of analogue PA and IP systems.

Issue	Traditional analogue PA	Centralised IP amplifiers	Distributed IP amplifiers	IP speakers
Every speaker requires separate Ethernet port (if using PoE for power)	No	No	No	Yes
Failure in one speaker impacts all remaining speakers in a zone (if using daisy-chain-configuration)	No	No	No	Yes *1
Incompatible with VLAN configurations	No	No	No	Yes
Inability to support encryption (if required)	No	No	No	Yes
Power and data buses run to every speaker (where PoE is not used)	No	No	No	Yes
Inability to use speakers over 10W/channel (when using PoE)	No	No	No	Yes
Reduced Speech Transmission Index (STI) due to long cable runs	Yes	No	No	No
Likliehood of reduced STI due to improper delay configuration	Yes	No	No	Yes

Issue	Traditional analogue PA	Centralised IP amplifiers	Distributed IP amplifiers	IP speakers
Increased overall power use (due to processor in every speaker)	No	No	No	Yes
Requirement to disconnect bus during maintenance for occupational health and safety, avoiding dangerous voltages	Yes	Yes	No	No
Additional configuration effort, each speaker needs to be configured separately	No	No	Yes	Yes
Lower sound quality (due to lower performance amps/sync issues)	No	No	No	Yes *2
Requirement to conduct device reconfiguration when servicing speakers	No	No	Yes	Yes
Service technicians need to be trained on networking/device configuration	No	No	Yes	Yes
Security issue – access to network via every speaker (piggy back onto network)	No	No	No	Yes
Non standard audio distribution protocols	No	No	No *2	Yes
Higher cost of training field technicians/service staff	No	No	Yes	Yes
Reduced performance of Digital Signal Processing (DSP) due to need to reduce DSP cost (as installed in every speaker)	No	No	No	Yes
Great rate of failure in extreme temperatures (hot or cold)	No	No	No *3	Yes
Limited distances between speakers to 100 m	No	No	No *4	Yes
Not cost effective for high quantities of low power speakers (eg 1–2W)	No	No	Yes	Yes
Larger number of modes of failure at every speaker	No	No	Yes	Yes
Greater complexity and in trouble shooting/finding cause of fault)	No	No	Yes	Yes
Fault in single speaker can cause widespread audio distribution faults	No	No	No	Yes
Proprietary technology – leading to single vendor lock-in	No	No	No *5	Yes
High level of effort to upgrade software over all speakers	No	No	No	Yes
Potential incompatibilities due to speakers having different software versions	No	No	No	Yes
Costly interface to Session Initiation Protocol (SIP) channels at every speaker	No	No	No	Yes
Non compliant with fire/evacuation Standards	No	No	No	Yes
Susceptibility to failure from high levels of EMC from electric rolling stock	No	No	No *6	Yes
Requirement for every device to have surge protection	No	No	Yes	Yes
Greater time & cost to cable/install (every speaker requires 10-wire terminations vs 2 for standard bus)	No	No	No	Yes
High cable cost due to more copper required to support higher amperage at lower overall operating voltage	No	No	No	Yes
Greater likelihood of having issue with duplicated IP Addresses	No	No	No*7	Yes
Higher overall audio latency due to need for additional network hops	No	No	No	Yes
Loss of overall system intelligibility as result of fault (e.g. operating out of sync)	No	No	No	Yes
Requirement for Ethernet switches installed in ceilings/other location in field	No	No	No	Yes
Requirement for IP rated Ethernet switches	No	No	No	Yes
Difficulty in interfacing to other systems due to proprietary non-standard protocols and lack of analogue interface	No	No	No	Yes
Limited selection of speaker drivers/types to match requirements	No	No	No	Yes

Notes to Table 1:

*1 – The modules have audio synchronisation using Dante protocol which allows synchronisation to sample level

*2 – The modules use standard Dante or Real time Transport Protocols and are non proprietary.

*3 – The modules should not be exposed to direct sunlight and are designed for greater temperature range of operation.

*4 – The modules support fibre interface for extended distance runs when required.

*5 – The modules support standard non proprietary protocols.

*6 – Modules can be installed so as to reduce EMC effects. The modules are also designed with shielding against high EMC that is impractical to implement at every speaker.

*7 – The Modules have automatic IP address assignment due to Option 82 DHCP support.

Station concourse such as this at Birmingham New Street, UK, require modern technology if clear public address systems are to be useful to the travelling public.
Photo Paul Darlington.

Conclusion

Based on the discussion above, an IP speaker PA system definitely has many advantages over an analogue base PA system. Nevertheless, the application where it is used has to be considered carefully. In a small space such as bus stops and guard house which can be in remote location, an IP speaker system is the best solution. For rail system implementation, the roll-out usually has a bigger coverage and implementing IP speakers has its disadvantages. The distributed IP amplifier system is better suited for railway applications as it has the flexibility advantage of digital PA systems, and at the same time has lower cabling costs when compared with classic analogue systems.

About the author ...

Jasbinder Singh FIRSE is managing director for Rejaconsult Sdn Bhd specialising in railway telecommunication, SCADA and interface management. Jasbinder has more than 20 years experience in the engineering field. He has a Bachelor of Electrical Engineering and MBA qualification and is a registered professional engineer with the Board of Engineers, Malaysia.

Industry news

Albula Tunnel breakthrough

Switzerland: Members who attended this year's Swiss Convention may be interested to know that engineers working on the Albula Tunnel in Switzerland broke through on 2 October to complete the tunnelling. When IRSE members on the Convention visited the tunnel and the workings in May, there was still ~1 km of tunnelling to complete. Despite being behind programme, work was stopped for a day to allow the IRSE Convention to visit inside the tunnel.

Portfolio, Programme and Project Management Maturity Model (P3M3) success

UK: The Network Rail Infrastructure Projects (IP) Signalling team has achieved the highest ever score in an internationally recognised project management assessment.

The Portfolio, Programme and Project Management Maturity Model (P3M3), run by the independent body Aspire, looks at an organisation and how it delivers its projects, programmes and portfolios of work. The team achieved a score of 4.4 out of 5, measured across the seven perspectives, which is a first in the history of the assessment. No organisation in any industry worldwide has ever achieved a score of more than four in the assessment

P3M3 looks across an organisation and is unique in that it looks at the whole system and not just at the processes. The hierarchical approach enables organisations to assess their current capability and then plot a roadmap for improvement prioritised by identified actions which will make the biggest impact on performance.

Norwegian high-speed data

Norway: Rail infrastructure manager Bane NOR believes it has broken a new world record for mobile connectivity in a tunnel.

Working with Telia and Telenor a transmission rate of 580 megabits per second (mbps) is reported to have been achieved during tests. The tests took place in an old road tunnel in Holmestrand, where a test facility has been installed.

Inside the tunnel, four radiating cables were installed and connected to a radio transmitter with a 4G 4x4 [multiple-input-and-multiple-output] configuration, instead of traditional one radiating cable. It is believed that this has never been done in a full-scale tunnel before.

A high-speed mobile network is required for the development of the Follo line, a planned 22.5 km capacity-unlocking railway between Oslo and Ski which will include a 20 km railway tunnel with two separate tubes when it opens in 2021.

Project director David Borenstein said Bane NOR are looking forward to providing a high-speed mobile network to passengers. He added that they are building a mobile facility with a capacity that will provide good, stable and satisfactory mobile coverage for the many train passengers inside the long tunnel on the Follo line. Telia has plans for further tests to achieve even higher speeds.

How to live-stream an event

Paula Persson and Lynsey Hunter

For the first time, on 13 June 2018, the IRSE live-streamed an event. This is the journey we took to make it happen and what we have learned along the way.

Why live-stream?

The connection between strong leadership and effective communication is so obvious it's almost not worth mentioning. As the IRSE strives to maintain its place as a thought leader within the profession, the importance of the means through which it chooses to communicate with both its members and the general engineering profession can't be overstressed. Both the IRSE and our global professional engineering institute peers have identified that both video and live-streaming allows a level of communication that's difficult, if not impossible to achieve by other means.

By live-streaming events, the Institution is immediately perceived as being more approachable. Members can now see who the leaders of their institution are. They can see how such leaders and others communicate both on a one-to-one level and with their audience. A viewer not present at the event venue can ask questions of a speaker and receive an answer from them in real time.

By using a streaming platform, the accessibility of the Institution's information becomes available through mobile devices as well as PC users. The demand for engaging information accessed via mobile is on the rise, particularly for the younger generation. The use of a mobile device in itself facilitates further accessibility as content can be accessed through it when on the move; commuting or travelling for work, if the connection is good enough.

The live-streaming control room for the first event. Lynsey in the centre, Paula to the right. Stephen Dapré is operating the camera. *Photo Daniel Persson.*

Audience numbers and geographical reach increase enormously through use of a video and live-streaming platform. Furthermore, such platforms provide analytics so that we can learn, for example, how many viewers engaged with a live event, at which point some drop-off and how many watched the saved video again over a given period. The geographic location of viewers world-wide (by country) is also available. Such information is highly valuable for a global organisation such as the IRSE.

Although the Institution often holds convenient local events that are easier for local section members to attend, not everyone can attend each Presidential Programme Paper. As Theme 3 of the IRSE's Strategy 2015-2020 Implementation Plan is to attract more people to attend the president's programme of events, it's easy to see that by live-streaming and recording the programme, many more members would benefit from the programme which would also do much to enable the overall growth of the IRSE as a global engineering institution. As society increases its digital footprint, having the ability to break down geographical boundaries in this way is more important than ever before. If the IRSE does not embrace this, it could quickly become obsolete in the modern world.

In October 2017 at an IRSE Council meeting, the then senior vice president of the IRSE, Markus Montigel expressed a strong interest in having his 2018/19 Presidential Programme live-streamed from wherever each event was to be hosted around the world. As the communications company that the

IRSE has engaged for the roll-out of our re-brand and web development projects are also experienced in creating video for their clients, they were able to advise us on where to begin to learn this necessary skill, as an organisation. They suggested we begin by looking at the Vimeo platform and Open Broadcast Software (OBS).

Essential equipment

- A laptop.
- A fast internet connection.
- A video streaming and sharing platform (e.g. Vimeo, **www.vimeo.com**)
- An encoder/compressor – either hardware or software.
- A camera (or cameras).
- A Camlink or 'capture' card (if required, please contact us at **hq@irse.org**).
- Microphone(s).
- An audio mixer (possibly required; depending on the existing audio set-up at your assigned venue).
- Practice, determination and patience.

A laptop

You will need a laptop to be able to gain access to the live streaming platform (Vimeo) and the encoding software (should you chose the software encoding option) whilst at the streaming venue. Ensure that the laptop runs on Windows 7 (or newer) or MacOS El Capitan (or newer), CPU 3 GHz (or higher) and with at least 4GB of RAM with 2GB of free disk space. If these specifications are not met, the laptop will not be able support the stream. It's of course useful if you have several USB ports in the laptop; the more the better.

A fast internet connection

It's best to use a hard-wired/Ethernet connection rather than Wi-Fi at the venue's location for the laptop to connect to the streaming service. If there is no internet connection at the location you wish to stream from, do some prior research into the best 4G provider for the area from where the event venue is to be streamed. 4G internet 'speeds' are usually given by companies selling 4G in terms of their downloading speeds. However, when live-streaming, we are doing the opposite; we are sending information to the internet i.e. uploading. So, it's the upload speeds that you need to be aware of. On a similar vein, make sure the viewers of your streamed event are aware that the quality of their viewing experience will be determined upon the download speeds at their location.

A video streaming and sharing platform

The IRSE has set up an account with the Vimeo streaming platform. If you plan to stream an event for the IRSE please contact us at **hq@irse.org** for information on how to access our Vimeo account.

Vimeo is a highly intuitive streaming platform (more information can be found at **irse.info/e6891**). If required, you can embed your video onto another web page. There is a function to display the IRSE logo, or message your viewers using a front and/or end page to the live stream. There is also an option to add privacy settings to your videos. (Once we have a new IRSE website the intention is that future live broadcasts will be accessed through that.

Regardless of whichever of the encoding software applications recommended by Vimeo that you decide to use, the following explains how Vimeo and the encoding software needs to be connected in order to enable a live stream. We did not have access to encoding hardware so, if such is a piece of equipment that you have access to, or have chosen to use, please refer to Vimeo's instructions on how to connect their platform to the hardware device.

Vimeo will provide you with a connection or mount point (an alpha-numerical code) which comprises the 'stream key' and a server URL (which always begins by rtmp://). These details need to be entered into your encoding software in order to create the data link between your equipment and the Vimeo platform so that the live stream will work. The Vimeo platform receives the stream from your encoding software (which includes all of the encoded and compressed audio and visual data from the cameras and microphones that it's connected with) and delivers it to a server that also records the live stream (so that your video remains available to view at the end of the live broadcast.) In addition, Vimeo delivers the stream to a CDN (Content Delivery Network) which provides the best quality possible, in a matter of seconds, to the viewer wherever they are in the world. See full instructions on how to connect Vimeo to your streaming software on the Vimeo platform at **irse.info/taj9z**.

There is a 'viewer chat' module in the 'Embed' tab on the Vimeo dashboard which enables viewers to ask questions remotely (which can be forwarded to the speaker). Viewers won't be slow in identifying issues they are experiencing with the stream so you can try to address these issues during the stream if possible. Be aware when recording viewer statistics that the number of viewers shown to be engaged in the chat function is not the same as the overall number of viewers.

An encoder/compressor

An encoder collates all of the inputs required for a broadcast i.e. sound, video, PowerPoint slides etc. An Encoder Guide can be found at **irse.info/3gb4q**. We used OBS (Open Broadcast Software) available at **irse.info/zafmw**) because it's an open-source software suite for recording and live streaming, and is simple to use. OBS provides real-time source and device capture, scene composition, encoding, recording, and broadcasting. Transmission of data is executed via Real Time Messaging Protocol (RTMP) and can be sent to any RTMP supporting destination or to websites that are pre-set for streaming such as You Tube and Facebook (**irse.info/l618w**). Be aware: If you plan to simulcast to You Tube, ensure no music is part of the presentation programme. You Tube now use an algorithm which detects music and have the right to automatically cut-off your stream completely. This is due to copyright protection. For full information about this visit You Tube's 'Copyright and Rights Management' page, and Facebook's 'Copyright Management' page.

Interesting, but not necessary to know to perform the stream, OBS encodes video streams into the H.264/MPEG-4 AVC or the H.265/HEVC format, which are standard video compression formats. The instruction manual for the camera(s) you are using should reveal what type of data your camera is sending to the encoder. In preparation for a live-streaming event, we recommend that you thoroughly read your camera instruction manual(s).

Audio is encoded in OBS using either the MP3 or AAC codecs (AAC is often incompatible with open broadcast software.) A codec is a coder-decoder which encodes a data-stream or a single encoded data for transmission and storage. The decoder function reverses the encoding for playback or editing purposes.

The main user interface in OBS is organised into five sections:

Scenes: the configuration or convenient grouping of all of your input sources so that you can manipulate them with ease in real time. It creates a 'control room' view when broadcasting.

Sources: e.g. cameras and mics

Audio mixer: where audio and video inputs are synced manually (we didn't use this function – see microphones below.)

We used OBS open source software for screen capture and streaming.

Transitions: the mixer panel also enables the user to mute the audio input, and adjust the volume through virtual sliders/ faders. Effects such as 'fades' and 'wipes' can be applied by pressing the cogwheel next to the mute button, although we didn't use this function.

Controls: the control panel also has options for starting/stopping a stream, or recording. The upper section has a live video preview window which is used to monitor and edit an active scene. When in studio mode, there are 2 scene preview windows, the left one for modifying and previewing non-active scenes: the right window for previewing an active scene. In between, there is a secondary transition button, which allows for transitioning to the non-active scene in the left window.

There may be simpler broadcast software encoders available, but it's definitely worthwhile putting in the extra effort to acquaint yourself with the functions in OBS as it's completely free and available to download for Windows, Mac or Linux. Another alternative is to use a hardware encoder. Recommendations for this can be found on the Vimeo site. irse.info/px6f7.

A camera

You should be able to use any camera for streaming as long as it outputs in HDMI (High Definition Multi-Media.) However, you must still test that it is configured to live stream. Be aware: some cameras may look like they have HDMI outputs suitable for live-streaming but the manufacturers have set the HDMI interface to turn off whilst recording video. So, you can record a video onto a memory card with this type of camera, but not use it to live-stream. We found this out the hard way with a Canon Powershot S100 during an early test.

The camera eventually hired for the live-stream was a Canon XF305. The reason for this choice was due to reading recommendations on the Vimeo site and then speaking to camera hire companies who, although they may not have had what was exactly specified by Vimeo in their stockroom, were able to recommend equipment that does the same thing. Be aware: If you plan to hire cameras or any other equipment to live stream an event, hire companies (at least in the UK) will not permit you do so unless you have film and media insurance. We used a hire company that provides insurance for each individual hire. Other hire firms require that you buy your own insurance independently which can be time consuming and costly. If you decide to hire the needed equipment, we advise that you shop around for the best insurance deal. So, unless the hire company you intend to use can provide individual hire insurance, give yourself enough time to arrange the adequate insurances beforehand.

Second camera (for example for Q&A)

If, as did we, you intend to have more than one visual source for the live stream, i.e. a second camera for audience Q&A, then it's important to ensure you choose a compatible one. Our first choice had been, as Vimeo recommends, a GoPro. However it came to light during an early test that GoPro is not entirely compatible with the Windows operating system. Vimeo are possibly recommending it to a predominantly Mac audience. If you plan to use a GoPro with a Mac, still perform plenty of tests in advance (as with any camera,) so as to iron out issues that may arise.

In the end, we used a smart phone as the second camera for the question and answer session. In order to do this you will need to download software called Kinoni (www.kinoni.com) to your laptop and a mobile app called EpocCam (available to download to iOS/Android/ Nokia) to your smart phone. For this to work, whilst using your smartphone to live-stream, both your laptop and smartphone must be connected to same Wi-Fi/Ethernet network. If the audio inputs for your stream are to come from other microphones in the room, make sure the microphone on your smartphone is turned off completely. There is a good You Tube instructional video entitled: 'How to shoot steady video without a tripod,' which gives some great tips on how to keep your smartphone as steady as possible whilst filming/streaming.

A 'Camlink' or capture card– why we needed one

Interfaces are either uni or bi-directional. HDMI is uni-directional. So, even though your laptop may indeed have an HDMI port, it's only there to send data out. USB ports on a laptop, (just like the Ethernet and serial ports) are bi-directional and therefore can both send and receive data. A Camlink or capture card converts the HDMI data sent from your camera to USB so that your laptop can receive it. The HDMI cable is connected to the camera. The other end of the HDMI cable connects to the Camlink, there is another short cable that connects the opposite end of the Camlink to a USB port on your laptop.

If not provided with your camera, you will need to get hold of an HDMI cable for it: a couple of metres in length will do. This proves really useful if your laptop cannot be positioned right next to the camera at the streaming venue.

Some cameras, for example webcams, aren't sending HDMI data at all, but are manufactured specifically for live-streaming purposes. These connect directly, or are built-in to your laptop without the need for the function of a capture card. Be aware that for SD (Standard Definition) any USB will work. For FHD (Full High Definition) a USB 3.0 (or above) would be required.

Microphones

We used the microphones that were supplied by the venue which fed each audio signal from all of the mics (speaker, panel and roving mics) into an audio mixing deck. The beauty of this is that the mixing deck then produced one single audio signal which was connected by an XLR cable directly into the camera, thus ensuring the audio signal synced correctly with the visual.

Audio mixer

If the venue you plan to use doesn't have AV, you will need to supply your own audio equipment and cables. The Vimeo site provides details of the equipment that you will need. As mentioned above, there is an Audio Mixer function in OBS but we didn't need to use it. Receiving one audio signal fed through the camera certainly made things a lot simpler for us.

Practice, determination and patience

Don't put all of your trust in an 'it'll be alright on the night,' philosophy. Although it's hoped that everything does work out well, it's really important to plan your live-stream well in advance. Give yourself plenty of time to test all of the equipment you are using. Discuss issues with your colleagues to solve problems well in advance of your event. There is so much user advice on both the Vimeo and OBS websites so, be sure to familiarise yourself with it. Any questions that you have will most likely have been asked by someone before. So, the answers to your questions will most likely be easily accessible on the relevant site.

Another 'source' to consider – PowerPoint presentation of the speaker

This counts as an additional input 'source' and can be streamed at the same time showing viewers the same slides that are visible to the audience present at the venue. There are several ways this can be executed. If you are provided with a flash drive of the speaker's PowerPoint slides in advance of the event, as were we, the person who operates the OBS software during the live-stream simply has to run the PowerPoint presentation on their laptop and remember to change the speaker's slides manually; at the same time as the speaker does.

Issues we encountered

It seemed to us that at every test, everything that could go wrong, did go wrong. This is why determination and patience are needed. Don't be put off if things go wrong during a test: a live stream is still achievable. We were absolute beginners but we were eventually able to make it happen.

Buffering

If your upload speeds are reportedly good but your stream is still buffering badly, first make sure that you have a hard-wired/ethernet connection to the internet on site rather than using the Wi-Fi connection at the venue. Only as a last resort (or for back-up) would you try 4G and mobile broadband to connect to the internet.

Even though we had a hard-wired connection to the internet at an earlier test site, we experienced some buffering which meant that the bitrate had to be reduced.

There is a link between the resolution and the band width or bps (bits per second) that are uploaded. As a point of reference, 24 FPS (Frames per Second) is used in standard PAL (or SD) television for moving pictures. If we were to go below 16 FPS, the stream would become really jerky. No less than 24 FPS is recommended for a production to look professional. Be aware that the resolution plus the number of FPS, plus the effect of the compression encoder all have a bearing on the bps. There is a function in OBS to reduce the resolution and hence, the bit rate, in order to counteract buffering, if it occurs.

Conversely, just because you may be able to upload 20 MB/s without dropping a frame, it doesn't mean that all of your viewers will be able to receive such a stream/download. Your stream may look fantastic, but if it turns out that only 5 people in the world can watch it – then you still have a problem. Vimeo (irse.info/za7tj) recommends that your stream does not go above 60 FPS, which is the rate at which some HD (high definition) cameras can operate/stream.

Latency

We experienced a delay of around 20 seconds during our event. At the time, we simply could not work out why this was happening as RTMP is known to provide low latency delivery. However, further investigation reveals that the OBS application has a Stream Delay (in seconds) option which can be adjusted manually. Ours appears to have been enabled for 20 seconds. (You can locate this option in OBS at 'Settings' – 'Advanced' – 'Stream Delay.')

Some latency is not always a bad thing. It could prove to be a problem if you are conducting an event which features results/scores or if social media posts referring to your event in real time can be viewed alongside the stream. If this is the case your viewer experience could be adversely affected. However, if your event is a simple presentation, the majority of viewers will not be aware of the time lag. A pre-determined time delay would also give technicians the option to cut a stream altogether if anything inappropriate were to occur. At a live event – anything can happen!

Direction

It's advisable to have a meeting in advance with all those involved in the live-stream. If you are going to have a second camera for Q&A, decide if you are going to need to have the camera on the person who asked the question throughout the duration of the answer so that the OBS operator can switch views between the speaker and the audience member. An alternative can be to have the second camera on the general audience. In addition, although your main static camera will remain just that, you may want to zoom in-and-out on the speaker or adjust the angle of a shot to give a view of panel members for example. Make sure all are aware of what the plan is going to be in advance. This will lead to a much more professional

The finished product – visit irse.info/0db2g to watch – over 600 people already have!

production. To enable this you may want to use a production schedule or cue sheet(irse.info/g6tha).

Sound issues

Some of our viewers on the 'chat' function messaged us to say the sound on the stream was clipping. We didn't know for sure at the time what caused this as we hadn't had time to understand all of the functions on the hired camera. However, later investigation and discussion has led us to believe that the camera itself had a setting to amplify sound which, as explained, was being channelled through the camera via an XLR cable, most likely at an already adequate volume. Next time, we would try to turn the amplification down on the camera. (Just as soon as we learn where that control is!)

Main viewing window – skewed aspect ratio

Some viewers commented that the aspect ratio on the main window was skewed during our stream on 13 June. Adjusting the settings in the video 'scene' section of the encoding software would have overcome this issue. However, once streaming had begun, it was not possible to alter this without stopping the stream. This issue could be easily overcome with practice.

Administration – getting the Vimeo link out to viewers

It's advisable that you have your final notification email/social media posts about your event prepared in advance and ready for the stream link to be inserted just before distribution to your desired email list.

Once you have created the stream link for your viewers, it's advised that you do not change it as this may confuse or inconvenience them.

Once you click on the 'Create live event' button in Vimeo, you will be prompted to enter the name, date, time, and privacy setting of your event. Be aware that if you schedule your live event for a given time, Vimeo requires that you actually begin streaming at that time. (For test streams it may be easier not to set a time.)

We found ourselves having to perform streaming tests again on the evening of the event as it was the first time we had gained access to set up at the venue site. Neither had we used the audio equipment at that venue before so, further tests were absolutely necessary. If such is the case for your forthcoming live streaming event, we recommend that you take the time to test everything first before creating and sending out the link to your viewers. You might find the event start-time creeping closer-and-closer but if the stream isn't actually going to work, then there would be no point in sending out a link to it anyway.

Future live-streaming events

If you are involved in live streaming an IRSE event as part of the Presidential Programme 2018/19 or you want to practice live streaming for IRSE workplace events or for your local section, please contact us at hq@irse.org for more details.

The IRSE's CPD Manager suggests: Why not watch the next event together as a local section or with colleagues? You could include some potential members within your group so they can learn what the IRSE is all about. If your time zone is incompatible with the live event's streaming time, it is also recorded and accessible after the event.

If you haven't yet viewed the event that was live streamed on 13 June 2018, we invite you to do so at irse.info/0db2g . It's not perfect, but we were able to make it happen as absolute beginners, and we think that you can too.

With special thanks

We would really like to thank the AV team at the IET venue in London for their advice; Xen Christodoulou who put us in contact with the best advisors there (and for providing lunch); Daniel Persson for his unfaltering encouragement/technical advice; and serendipity for ensuring that the helpful and calming influence that is Stephen Dapré just happened to be in the right place at the right time.

Tell us your experience of live-streaming events

Have you had a positive – or negative – experience of live-streamed events? Do you have first-hand experience of the technology? Do you think that technology offers us a way to share information, and to inform, discuss, develop in a way that hasn't been possible before – or do you think that nothing is better than being at the event? Email irsenews@irse.org.

Educating the next generation of railway communication and control engineers

Jenny Illingsworth
Birmingham Centre for Railway Research and Education, UK

Efficient, effective railway control systems are vitally important for safe and timely running of the railway. The UK's Digital Railway agenda is reflected with similar initiatives with infrastructure and railway operating companies, world-wide.

The challenge is for rail industry leaders to embrace the change from railway signalling to railway control and communications. At the University of Birmingham we are playing an important part in making sure engineers, managers and future leaders are equipped to meet the needs of the new digital age.

Updated MSc

We have recently updated our MSc programme in Railway Safety and Control Systems which now has three potential pathways of study. Each meets the needs of a key theme within the safe, efficient management of railway systems:

Railway risk and safety systems: this pathway emphasises systems engineering and safety in critical systems, for designing new safety systems.

Railway risk and safety operations and organisation: this pathway emphasises management and safety throughout the system's lifecycle, for engineers and managers who will be responsible for the safe operation of a railway system.

Railway communications and control (including signalling): this new pathway focuses on railway systems, signalling principles and practice, and communication systems.

Uniquely, this programme is delivered in collaboration with the University of York where its High Integrity Systems Engineering Group includes experts in risk and safety systems. The resulting programmes mean that students benefit from the specialist risk and safety management expertise of colleagues in York together with the expertise in rail and rail systems from Birmingham.

IRSE relevance

Colleagues in the Birmingham Centre for Railway Research and Education (BCRRE) at the University of Birmingham worked closely with the IRSE in planning the Communications and Control pathway. Addressing the needs of both the Institution and its professional railway signalling engineering members, the modules which make up the programme of study contribute to a deep and robust understanding of designing and operating safe railway signalling and control systems.

Students will cover the fundamental knowledge needed to practice as a professional signalling engineer, including the following topics:

- Safety-thinking and safety management systems.
- Risk and hazard assessment
- Systems engineering.
- Railway business management and human factors.
- Railway operations and control systems.
- Infrastructure and rolling stock systems.
- Principles and applications of railway control systems.

Completion of this pathway, to PG Diploma or MSc level, is aimed at exempting graduates from the IRSE's examination for Professional Railway Signalling Engineer.

The programme combines theory and practice in railway control systems, with a third of the taught part of the course focusing on signalling and control systems. Half of this comprises classroom teaching about railway control and communication systems; the other half is practical, project-based demonstration of the student's knowledge and understanding. We have worked hard to ensure this embeds and develops a thorough understanding of railway communication and control systems, from first principles right through to practical application in real-world settings.

Students can attend the programmes of study as full-time or part-time attenders and we encourage the latter pattern. This means that students come to Birmingham or York for the week-long sessions of teaching and then return to their workplace to apply their learning

High fidelity cab simulation is just one of the facilities that BCRRE offers.

immediately into their professional life. We find that our part-time students thus benefit straight away from their studies and embed new ideas into their work.

The relevance of Birmingham's teaching means we also encourage attendance at individual modules for the purposes of Continuing Professional Development (CPD). All of our Birmingham-based modules are available for CPD, where students will attend for the week (or weeks) of teaching, and then complete homework, projects and assignments at home.

Completing the assessment means the student can collect academic credit which can be offset against future formal study. This means that a student attending and successfully completing two 10-credit modules for example will not have to repeat these if they register for the formal qualification in which those modules are taken. The academic credits and marks achieved are simply transferred into the student's record (subject to university regulations).

CPD modules

CPD modules still available for the 2018-19 academic year are listed below. For more information, to book or just to enquire, please contact Joy Grey on j.grey@bham.ac.uk.

Practical Ergonomics for Railway Systems (PERS)

Course dates: 3 to 7 December 2018
Registration closes: 23 November 2018

About the course

This practice-oriented week provides you with a comprehensive introduction to the concepts of ergonomics, starting from the principles of anthropometry and fitness for purpose. The module team adopts a holistic approach to designing systems which involve interaction between people, hardware, software and the provision of information in all forms. The module design follows a triangulation approach where students learn to adopt different perspectives to ensure that systems are usable for people of all abilities and levels of physical capability.

Who should attend?

Anyone designing any aspect of the railway system where their outputs will have an impact on how people access the system.

Strategic Business Management for Railways (SBMR)

Course dates: 21 to 29 January 2019
Registration closes: 11 January 2019

About the course

This week covers choosing railway technology elements and processes, matching technology to route, and looking at operational requirements and legislation. The course team discusses the option of future proofing, back-up systems and emerging technologies. You will learn about how to deal with issues such as obsolescence management, managing tolerances in documentation and quality control/quality assurance. The module also addresses managing design processes, supply chain specification, risks and change. The teaching is complemented with case studies of system application and relevant projects to bring your learning to life.

Who should attend?

Managers and future managers of railway systems, infrastructure operators, maintenance managers and technology managers will all benefit from this systems-approach to contextualised management.

Rolling Stock and Infrastructure Systems Interactions (RSIS)

Course dates: 11 to 15 February 2019
Registration closes: 1 February 2019

About the course

This course will give you an in-depth technical knowledge of rolling stock and infrastructure systems and an understanding of how to design and maintain them in order to minimise risk and maximise safety. The system-side approach includes railway alignment design, gauging and maintenance issues, as are issues relating to the rolling contact behaviour at the wheel-rail interface and to rail vehicle dynamics, including the steering of wheelsets. Aerodynamics, body-shell design and crashworthiness issues, choice of materials, vehicle maintenance, and the design and behaviour of suspensions are also covered, as are the topics of station design, station systems and infrastructure power supply components.

Who should attend?

Professional track design and maintenance engineers, vehicle designers, infrastructure engineers and station design/maintenance engineers.

Industry news

UK Real time train information to be more accessible

UK: More real-time train information in the UK is to be made more accessible to technology companies under government plans to improve travel apps. The measure is aimed at giving passengers access to enhanced information such as service updates, seat availability, toilet facilities and catering.

It is also believed that better use of data could allow operators to plan more effectively to predict and fix train faults before they cause disruption. The Joint Rail Data Action Plan, has been published by the Department for Transport and the Rail Delivery Group (RDG), which will involve standardisation of how data is collected, stored and published, and clarify what data is commercially sensitive.

1.7 billion passengers travelled by rail in the UK last year, a doubling of usage since the mid-1990s. This is projected to increase by another 15 per cent by 2024, putting increasing strain on the network. Using data more intelligently, and increasing collaboration between the rail industry and other sectors, is seen by the government as key to delivering these improvements.

The objectives is for the plan to create opportunities to exchange ideas, to devise new solutions to improve the running of the railways, to predict and fix problems before they arise, and to develop new tools and products for passengers such as better journey planning apps. It will also enable the rail industry to learn new skills and expertise.

Making South African level crossings safer

South Africa: ERB Technologies have provided South Africa's first COTS (Commercial-Off-The-Shelf) level crossing to meet CENELEC SIL 4. Following a level crossing pilot project near Rosslyn, South Africa, the company plans to roll out the solution across South Africa's rail network in a bid to make level crossings safer.

A recent report by the country's Railway Safety Regulator (RSR) indicates that inadequate level crossing signage one of the main attributes to the recent 25% increase in fatalities and injuries. To address this the (South African National Standard) SANS 3000 technical standard for level crossings is being updated. In order to guarantee the required safety improvements, the new version will refer to European IEC standards and CENELEC.

ERB evoCROSS system is based on HIMA's HIMatrix safety system, which meets all the new requirements. The level crossing for the pilot project is right in front of the main entrance of a busy factory. Previously it was protected by a stop sign only. Although train traffic is low, in the order of 1 to 2 trains per day, its use by vehicle traffic and pedestrians is very heavy and the physical layout of the level crossing is complex, with four lanes of traffic, a pedestrian rail crossing and a pedestrian road crossing.

The system meets EN 50126, 50128 and 50129 with the certification supported by a proven track record in rail and other industries.

New traffic management system for Tyne &Wear Metro

UK: A new computer based rail traffic management system has been installed at the South Gosforth control centre of Nexus, the operator of 60 km of dedicated metro tracks around Newcastle in the north east of England. The system has been delivered by UK supplier Resonate, based on the Scalable workstations and automatic route setting they have installed at several of Network Rail's main line control centres. Two controller workstations are provided, either of which can be used to control the whole network, together with a wall mounted route display on five 65-inch monitors. It replaces a push button control panel and a vehicle based route setting system, and interfaces with 12 existing relay interlockings. The migration from the old to the new system was achieved in a single Saturday night possession at the beginning of August.

This is the first metro application of the Scalable product, and Resonate developed a number of bespoke features for the Nexus application. This includes an interface to a recently installed Kapsch Tetra train radio system that allows the automatic route setting to take account of real time data from the trains, including driver entry of the train running number and 'ready to start' status. The new traffic management system also drives the existing station customer information screens and public address system, and exchanges data with Nexus's timetable planning and performance monitoring software.

Metro trains also operate over main line tracks to Sunderland under the control of Network Rail's Tyneside Integrated Electronic Control Centre. A data link between the control centres exchanges train describer steps and track circuit states for the shared running section and allows Nexus controllers to monitor the progress of Metro trains throughout their journey on the new workstations.

Record-breaking InnoTrans proves rail sector is booming

With international guest numbers reaching over 161,000 from 149 countries, and more than 3,000 exhibitors showcasing their products and solutions, this year's record-breaking InnoTrans trade fair closed on 21 September. The organisers have reported that all available space was occupied at Messe Berlin. 3,062 exhibitors from 61 countries presented their products and services, including more than 400 innovations, 155 world premieres and 155 vehicles on display.

Making its debut at InnoTrans this year was the four-day HackTrain Hackathon where approximately 80 developers took part to demonstrate how the rail industry could be revolutionised by smart IT solutions and data communications. The first prize was awarded to the three-person team named "Veggie on Rails" which, according to the judges, "showed an excellent understanding of the client's needs" in coming up with the best solution to the task presented to them by the UK's Network Rail – What is the best way of monitoring trackside vegetation at risk from the weather? In a cost-effective way the Veggie on Rails concept analysed existing video recordings and combined them with GNSS data and a way of classifying the growth of particular types of vegetation.

News from the IRSE

Blane Judd, Chief Executive

Professional development

A new academic year is upon us. One of the ways that some members may have made the decision to continuously develop professionally is by undertaking a master's engineering degree. If this is something that you have been considering, did you know that many universities offer full/part-time and distance learning (taught/research combined) courses specifically in rail safety and control, as well as systems engineering and integration?

One example of this is the UK's University of Birmingham, as explained in the article on p24 of this issue, and at their website, irse.info/1xjk8.

Professional development requires careful planning so why not look at what opportunities universities in your area – or internationally – can offer, and see if you would benefit from attending one of their courses next year?

If you do not have a Masters or Bachelors qualification, this does not disqualify you from following the individual route to professional registration. The team here at the IRSE are ready and willing to support those who are looking to become professionally registered with the Engineering Council. We will work with you and help determine the most appropriate grade and route to match your personal experience and qualifications. More information about the route to EngTech, IEng and CEng registration can be found on p30 of this edition of IRSE News.

December Presidential Programme Technical Meeting

The next meeting in this year's programme will be held in London on 4 December 2018 and is entitled "The main line ATO journey" This paper will be presented by Andrew Simmons and Nicola Furness of Network Rail. This event is free and non-members are welcome. For details visit irse.info/crqpm. Why not bring along some colleagues and introduce them to the knowledge base that sits within the IRSE?

'CBTC and Beyond' 2018, Toronto, Canada

The annual CBTC conference will be held on the 29-30 November 2018. The sell-out success of the IRSE's 'CBTC and beyond' conferences held in Toronto for the last two years has led the IRSE to hold this conference for a third time. Some of the topics covered at the convention relate specifically to Canadian CBTC projects currently being implemented or planned e.g. the application of CBTC on Light Rail projects, and commuter rail transit systems. The conference will also look to the future to areas such as: What are the user business needs? What research and development is currently underway on new/improved technologies to further improve operating performance whilst reducing life cycle costs? If you wish to attend this event, please do not delay as the number of remaining places are very limited. Visit irse.info/cng7d for details.

New IRSE website

Work is now well underway to develop the IRSE's new website. Following a rigorous procurement process, a company called Cantarus was selected to design and deliver the first phase of work. Great care has been taken in the selection process to ensure that the successful bidder has the required experience and understanding of designing websites for the professional membership organisation sector, as well as experience integrating with our existing database system. We will keep you informed of progress and timescales as the project proceeds.

IRSE Professional Examination

Well done to all those who took this year's examination. The exam results are usually released before the holidays at the end of December. For further information and guidance on the IRSE Professional Examination please visit irse.info/irseexam for information about exam tips, study groups and when you should take the exam. Information for employers is also available at the same link.

Strategic Planning for 2020 onwards

As we move towards 2019, work will begin on the Institution's strategy for 2020 and beyond. We will be listening carefully to what you want from your institution and incorporating this into the plan. Initially a small working group will develop a proposal which will then be shared more widely and, based on feedback, will produce a more fully clarified strategy. The Institution's existing strategic plan 2015-2020 is available to view at irse.info/027xj.

Upcoming Local Section Events

There's lots going on this month. So, if you are already a member but haven't made contact with your local section as yet so your local Section contact details at irse.info/nearyou or contact us at HQ (details on back inside cover) and we'll put you in touch with the right section.

Professional development

Your route to professional registration

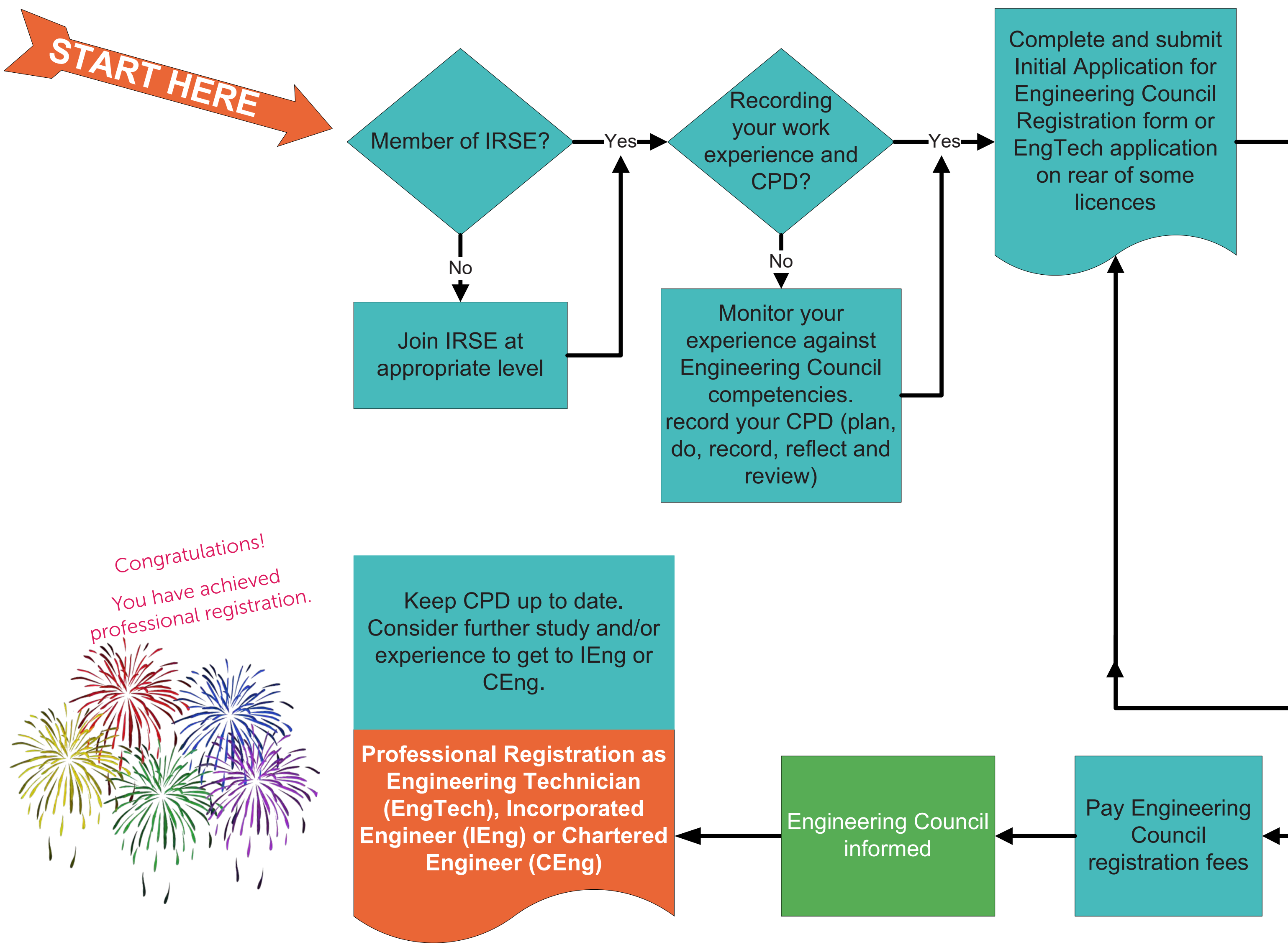
Judith Ward, Professional Development Manager, IRSE

The IRSE encourages all members who have not already done so to work towards professional registration as part of their professional development plan.

As the first part of the Institution's review and update of our information about professional registration, we have produced this flow chart which shows the various steps that need to be taken to achieve accreditation as EngTech, IEng or CEng.

For more information, see **irse.info/don48** or email **cpd@irse.org**.

There are two stages to the IRSE's process for assessing professional registration applications; the first stage is to ensure that you have sufficient engineering knowledge for the registration level you are applying for and the second stage is to ensure that you have sufficient engineering competence and commitment for the registration level you are applying for. Note that the IRSE has a duty to uphold the Engineering Council's requirements and make recommendations for registration at the level your knowledge, competence, experience and commitment meet.



What do the different levels of professional registration mean?

Engineering Technicians (EngTech)

Apply proven techniques and procedures to the solution of practical engineering problems.

Incorporated Engineers (IEng)

Maintain and manage applications of current and developing technology, and may undertake engineering design, development, manufacture, construction and operation.

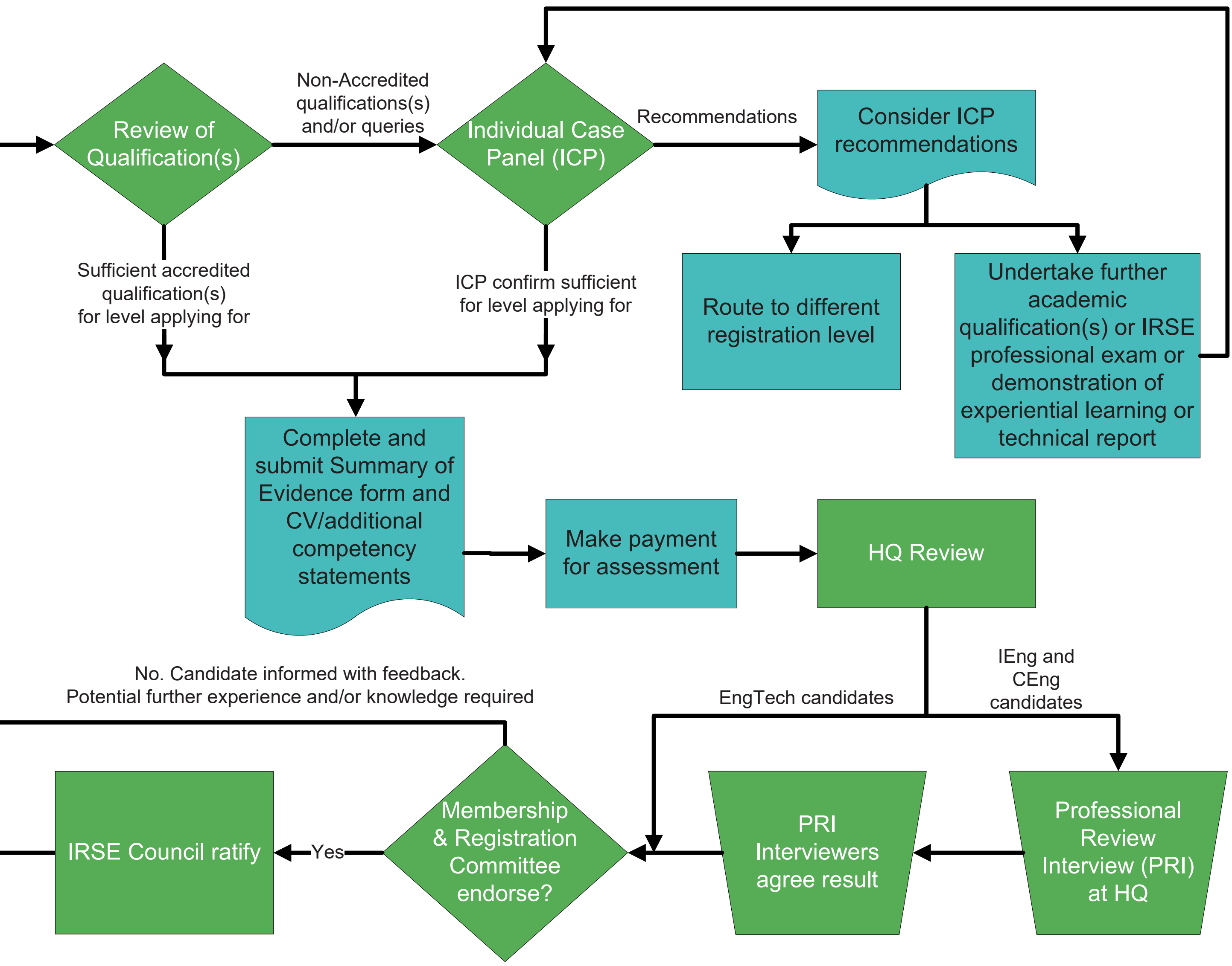
Chartered Engineers (CEng)

Develop solutions to engineering problems using new or existing technologies, through innovation, creativity and change and/or they may have technical accountability for complex systems with significant levels of risk.

IRSE News readers may remember an article which Judith wrote in January 2016 (IRSE News 218) on the process for gaining Incorporated Engineer status. To quote Gerry Loughran, a successful IEng candidate, from that article "Coupled with my accreditation and the successful completion of my recent number of projects, I was promoted to senior designer within my team, and I look forward to continuing my career progression coupled with the IRSE and Engineering Council."

His manager, Robin Kerr, said "Professional development has always been encouraged within the railway industry and the railway signalling environment in particular. I hope that the industry continues to recognise and reward people like Gerry when they strive to achieve professional registrations such as IEng."

Did you know that so far in 2018, the IRSE has already approved 31 engineers for professional registration. Why not become part of the elite?



Continuing Professional Development: what is 'reflection'?

Judith Ward, Professional Development Manager, IRSE

"Reflect" is one of the "stations" on the CPD journey shown in the diagram below – what is it and why should we be doing it?

Whilst the doing and recording of your CPD activities (going to events and seminars, formal training, academic study, self-learning, voluntary work and work experience) is important, so is reflecting on what you have (or haven't) learnt and/or how the activity does (or doesn't) fit into your career or professional development plan.

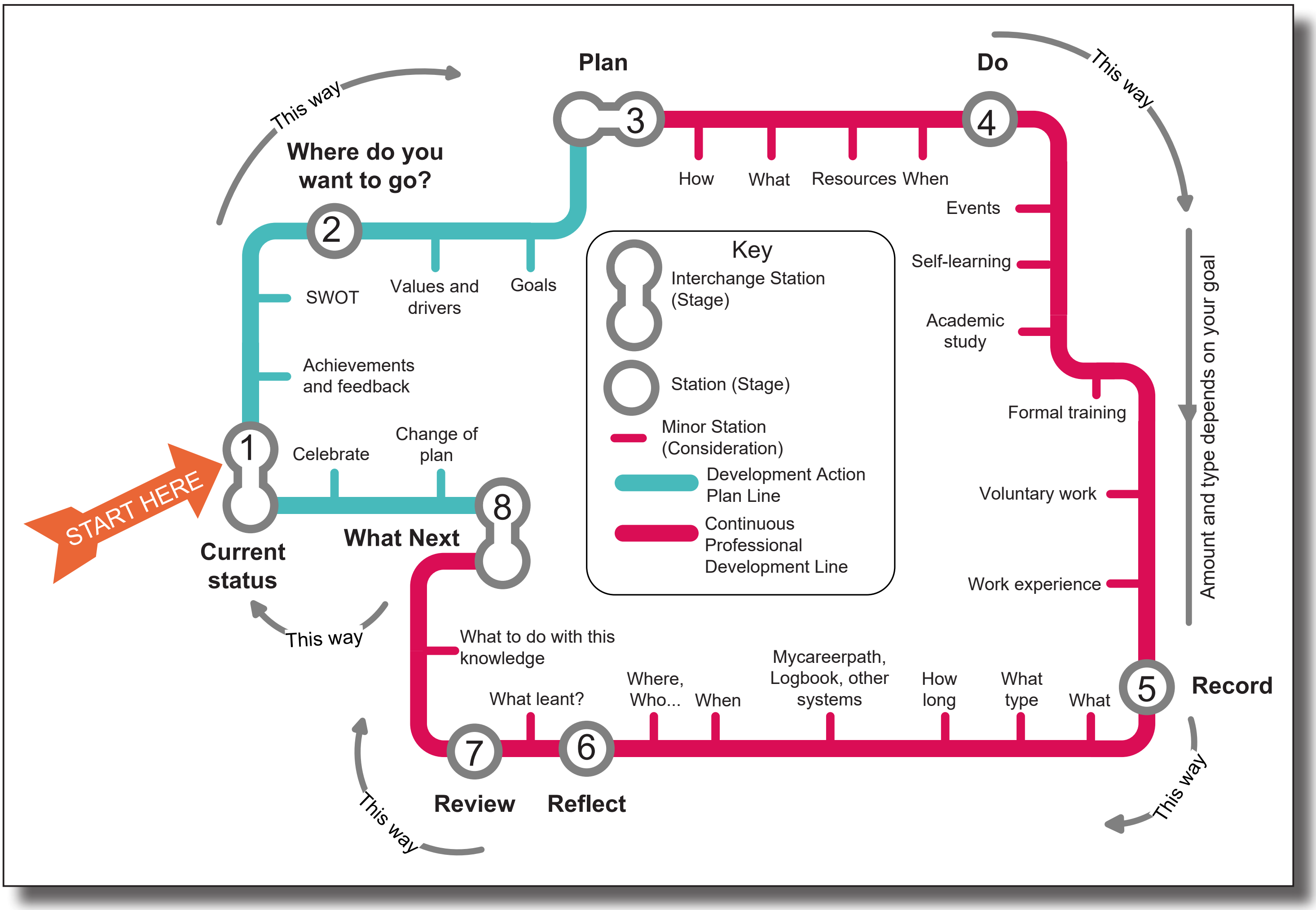
Whether your CPD activity is planned or not, taking time afterwards to consider how useful it was will benefit you, and potentially others.

For example, you may have attended a workshop on new equipment being installed in your area. Did you learn anything? Will/have you recommended it to others? Have you asked to go on the next workshop about fault finding? Should you have done the pre-reading? Will the information learnt help you do your job in the future? Does it give you an edge – can you apply for the next grade? Are you already putting something you've learnt into practice?

Inevitably, we will do some CPD activities which feel less worthwhile. Reflection is still useful to recognise why you didn't benefit from the activity. Was the course too basic? Did they just show photos of the equipment, not let you get hands-on? You may yet be able to draw some positives from this course. Is it mandatory for everyone maintaining the equipment to go on the course? Would you recommend that the trainees or project managers do the course? Have you already shown your notes to one of the trainees?

Note all your thoughts and reflections down in the "reflections" part of your CPD records, if there is one, or just add it to the main information about your CPD activity.

For more information, see **irse.info/i23ah** or email **cpd@irse.org**.



French Section

Innovative solutions for regional lines

Philippe Le Bouar, Pierre-Damien Jourdain, Jacques Poré, Hugh Rochford and Gilbert Moens

On 14 June 2018, the IRSE French Section (IRSE-FS) met for its ninth technical conference, which was attended by 40 members. The topic was "Innovative solutions for regional lines", with two papers: one about the French views currently at SNCF, the other about recent developments both in Italy (for low traffic lines) and in Australia (for freight lines).

Opening the conference, Christian Sevestre (IRSE past president 2014-2015) reminded everyone of the purpose of the IRSE and the objectives of the IRSE French Section; To develop mutual understanding between professionals in France, Luxembourg and Belgium in railway signalling and telecoms; to enable professionals to meet and exchange – outside of a commercial context– best practices in an informal setting; and to organize presentations and technical visits. Being an IRSE member also allows an expert to be recognised as such in the rail sector.

Hugh Rochford then gave some details about the IRSE-FS, the interest for professionals to be part of the Institution during a fast moving time for railways, and general information on how to apply to become an IRSE member (Hugh himself being the point of contact).

Two presentations followed, with Salvatore Sabina being introduced first.

ERTMS enhancements based on innovative train positioning

Salvatore Sabina from Ansaldo-STS made the first presentation, beginning by pointing out the rationale for the topic formed in 2012.

The objectives of Innovative Train Positioning are as follows

- Focus on regional lines, i.e. those lines with local and low traffics.
- Find earlier solutions compatible with the ERTMS roadmap based on the ERTMS deployment plan running to 2030.

Christian Sevestre opens the French Section conference.

- Find solutions that are interoperable, work in hostile environments, and consider cyber security issues (this is not simply a trend, but a fact of today's world).
- Find solutions that will cope with the rapid evolutions of some key technologies.
- Last but not least, meet strong expectations for cost reductions on radio, trackside and on-board equipment.

The challenges with the introduction of new types of train positioning are varied. GNSS (satellite) alone will not be enough to guarantee train positioning challenges and criteria. Therefore, a tight integration between signalling and GNSS systems will be needed. For train positioning that meets the required measured travelled distance accuracy, new technologies better than the current +/-5% will be required.

Train positioning is overall a SIL4 function and Interoperability issues between signalling and GNSS have to be considered together to avoid over-specifying. GNSS augmented information is required by the on-board system in order to meet the need for integrity. Local effects have a tremendous impact for rail (while being almost non-existent for air traffic) e.g. avoiding multi-paths of satellite signals in a built up environment.

All ERTMS players have invested a lot in ERTMS on-board, so when introducing a satellite solution an architecture compatible with the existing ERTMS is required. The two areas looked at were the odometry and the virtual balise.

Salvatore spoke about existing solutions with virtual balises. He outlined that these solutions are coherent with the high-level architecture of TD2.4 "Train Positioning (including Satellite)", an important initiative of the research framework named SHIFT2RAIL (S2R) that started in September 2017. The schematic solution is based on a multi-sensor technology, e.g. inertial measurement unit (IMU)/ micro electromechanical system (MEMS)/ radio localisation (or any other means) acting as a complement to GNSS.

Projects in Italian Railways are already underway, starting with a trial site in Sardinia. The track-side includes two reference stations with geolocalisation information sent to the track-side control centre and to the RBC (Figure 1). The trial site is 50 km long and uses virtual balises exclusively.

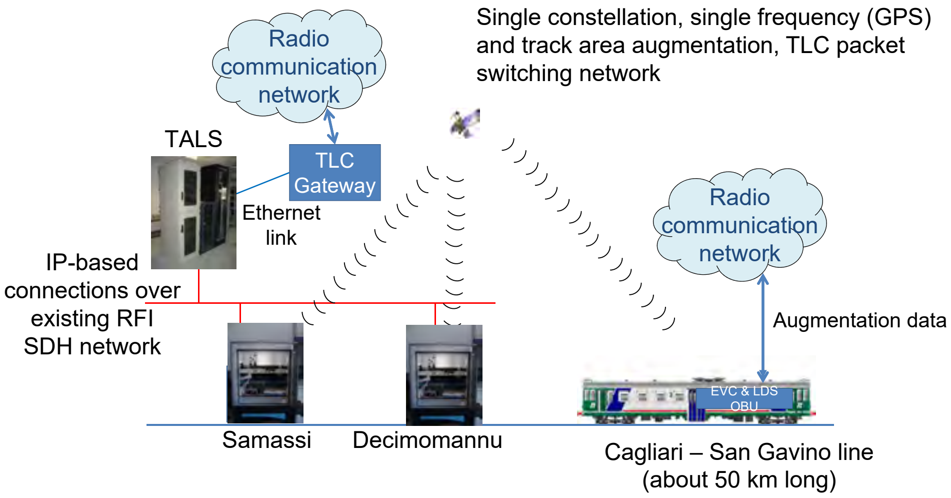


Figure 1 – Implemented solutions on the Sardinia trial site.

After the trial's completion, Italian Railways plan their first pilot line in 2020 at Pinerolo-Sangore (a location close to Turin).

Another project led by Ansaldo-STS, is in Australia at Roy-Hill. The Roy-Hill project is installed on a 350 km long single-track line. One of the challenges is the detection of both rail and road-rail vehicles. There are 12 reference stations separated by a maximum of 80 km. A lot of redundancy has been implemented on the site, as it was the first SIL4 solution of this type. The track area augmentation network implemented allows a maximum distance among the train and the nearest two reference stations of about 80 km without limitations in the performance.

An amusing point made by the speaker concerned the shape of the on-board satellite antenna. The initially selected reference station satellite antenna looked like an egg. This led to local birds attempting to take the 'egg' away! The antennas had to be replaced with COTS antennas of a different shape, and the anomalous damages have disappeared.

NEXT REGIO – economical solutions for regional lines

François Tainturier from SNCF Réseau explained that the focus was to find an economic model able to compete with other means of transport, especially with road.

The market for regional railway line signalling solutions in France was shown to be 10,000km of mostly single track. Today, conventional solutions are expensive and completely inappropriate to the specific requirements of regional lines. Based on 2018 estimates, if these lines are to be maintained at the horizon of 2025, an estimated €5 billion would be needed. This covers the signalling, of course, but infrastructure renewals are the main part of the budget, as are the civil works (tunnels, bridges, viaducts reinforcement works, etc). These lines and the modernisation projects are heterogeneous.

One of the key findings was that economical solutions for the regional lines must be found and discussed (very) early with all stakeholders in the regions, which led to the NEXT REGIO project.

The approach that has been taken include functional analysis (including the expected level of performance) and determining how many lines/kms in total along with a prioritisation schedule.

This analysis has led to high level requirements to steer the NEXT REGIO project: Radically more economical solutions must be found, meaning significantly less than half the costs of today, all aspects included. A modular set of solutions must be developed, adaptable to each specific line, i.e. no specific solution! Several solutions are to be specified, the short-term solutions however are to be compatible with the longer-term targets. The architecture should become centralised and linked with the SNCF Réseau core network. Building blocks already existing or being developed elsewhere should be used and ultimately, NEXT REGIO will be a range of solutions.

The speaker then presented ideas that have been proposed but still need to be refined.

For example, fibre is an expensive means of communication, so what alternative solutions are available? Axle counters are much better adapted to regional lines than track circuits which are too sensitive to ballast shunting. For rolling stock not equipped or yet to be equipped in the short/medium term with ETCS, alternative solutions (possibly mixing products and operating rules) will have to be specified. Rules will have to be adapted in some places; e.g. allowing blocks longer than 15 km.

The four levels of NEXT REGIO have been detailed

- The 'Preliminary Level' is intended to have axle counters for train detection and centralisation of controls ready, but still use the BAPR "standard" automatic block system. The line La Rochelle – La Roche-sur-Yon, West of France, is being considered for testing this level.
- Level 1 will enhance the Preliminary Level with centralised interlocking (PAI-NG3 type) and object controllers. Line-side signalling is retained.
- Level 2 introduces the suppression of line-side signalling with solutions to be implemented from 2025.
- Level 3 plans the suppression of any trackside train detection through new solutions to be developed for train positioning and train integrity.

François Tainturier ended the presentation with lessons already learnt by the NEXT REGIO teams. Development based on existing building blocks from the core network can be used for the regional line applications. The PAI NG3 interlocking, object controllers, digital block, portable EVC, and adequate use of fibre are all items that can be re-used within NEXT REGIO. Integrating the needs of interoperability and compatibility with ERTMS/ETCS can be achieved. Avoiding the problems of ballast shunting with the use of axle counters for track-side train detection and the use of longer blocks will mean further cost savings.

Q&A Session

A lively question and answer session followed, key points of this were as follows:

Q: Has ERTMS Regional (a "rustic" solution) that had been developed in Sweden been evaluated against the needs in France and Italy?

A: As far as we know, Sweden have not been happy with that solution. It is not necessarily more "rustic" and there was no return-on-investment with the development costs. ERTMS is a technical solution. The French (SNCF Réseau) approach is to have more a "system" and functional vision and to treat the topic wholly. SNCF Réseau is looking for a technical solution for the whole network i.e. with a limited set of technologies and "elementary building blocks". Neither will Italy develop ERTMS Regional. In Italy the focus has been to reuse what had already been developed in the frame of ERTMS. Coherence must be kept with what has already been developed. The need is to get an ERTMS adapted to the needs of the Italian Railways.

Q: Why keep lineside signalling?

A: The target is not to keep lineside signalling but to supress it as soon as reasonably possible. Equipping rolling stock means that it will become possible not to have lineside signalling any longer, but there are still trains being delivered without any ETCS on-board. Operators are still not convinced to order rolling stock directly equipped with ETCS.

Q: What is the roadmap for equipping trains with ERTMS?

A: Things are moving. Clarification is coming for TGVs (high speed trains) and all TGVs will be ETCS-equipped in 2030. On the Riviera Coast line (Nice-Vintimille), the ambition is to get rid of lineside signalling by 2025. This is also linked with the retrofitting of engineering trains in that and other French regions.

More globally, the projects do not mean necessarily to equip with ERTMS/ETCS, but to modernise operation in order to firstly improve the performance of the railway. In the coming year, SNCF Réseau has the task to present an overall modernisation plan.

Q: What about passenger information?

A: Discussions are taking place with the regions including the technological steps in each project, with strong customer-service-oriented solutions.

Q: Do you see any technical limitations for using satellites (GNSS) on a larger perimeter/scope?

A: In Italy all stakeholders have been very careful about the use of satellites.

Topics still to be improved include the performance requirements and what is achievable for train positioning ("localisation"). Cost impacts are important in this matter: both development costs and validation costs.

Q: What about level crossings?

A: Level crossings are independent of satellite (GNSS) positioning. The issue is the connection of trackside objects by radio rather than by physical connections via cable and fibre.

Q: Will there be compatibility between GNSS-based and GSM-R-based systems?

A: Yes, we are using/designing products and systems able to communicate by either mode. There are also other communication means that we can use such as TETRA.

Q: What about using products (building blocks) that have been developed for the core network? Are there risks that it becomes too expensive and that there may be unnecessary redundancies?

A: The target is to take constituents that will be assembled as elementary building blocks, considering the level of performance that is expected. The diversity of the so-called regional lines is actually large. Subsequently the challenge is to get the appropriate design and solution for each individual case.

After the usual round of thanks for the expert speakers, all attendees met for discussion, questioning and networking around drinks and nice petits fours kindly provided by Alstom.

The next gathering of the IRSE-French Section will be the tenth conference of the IRSE-FS: "Big Data for railway applications" and "Digital railways". Look for coverage of these in a future issue of IRSE News .

For further information regarding the IRSE French Section, please contact Hugh Rochford at **irsefrenchsection@gmail.com**.

Industry news

London – Paris – Brussels ERTMS accord

An agreement on the co-ordination of ERTMS deployment on high-speed lines linking London, Paris and Brussels has been signed by Dyan Crowther, chief executive of High Speed 1, Patrick Jeantet CEO of SNCF Network, Luc Lallemand, director general of Infrabel, and Mr Michel Boudoussier, chief corporate officer of Channel Tunnel operator Getlink.

The four infrastructure managers say they will adopt a common strategy for the implementation of ERTMS and aim to share expertise, select a homogenous system, and establish a joint timetable for deployment.

The cooperation agreement is also intended to generate economies of scale in the planning, procurement and operation of ERTMS.

SNCF to launch driverless trains in mainland France by 2023

France: National railway operator SNCF has announced plans to introduce prototypes of driverless main line trains for passengers and freight by 2023. SNCF says the initiative will allow it to run more trains on France's busiest main lines, and cut energy consumption. "Many French cities, including Paris, already run driverless metro trains but driverless long-distance travel presents a new set of challenges", said SNCF chairman Guillaume Pepy.

SNCF will be partnering up with rolling stock specialists Alstom for freight and Bombardier for passenger traffic. Pierre Izard, who runs SNCF's rail technologies division, said the shift to driverless trains was to happen in stages, "up to the most extreme of automatisation, when there is no human presence onboard".

"Although Australia, China and Japan are already experimenting with driverless trains, France is not coming too late to the game", said Carole Desnost head of innovation at SNCF. The French rail operator also confirmed it was talking to German operator Deutsche Bahn about promoting a European standard for driverless trains.

Midland & North Western Section

Liverpool Lime Street completion

Paul Darlington

IRSE///
Institution of Railway Signal Engineers
MIDLAND & NORTH WESTERN SECTION

The first meeting of the Midlands & North West Section 2018-2019 programme took place on 18 September at the Arup office in Manchester, for which the continuing support of Arup is most appreciated. The chair of the Section this year, Ian Allison, welcomed over forty members and introduced Ian Fury, Claire Hulstone and Steven O'Hare, and their presentation on the recent Liverpool Lime Street resignalling and remodelling.

What has been achieved?

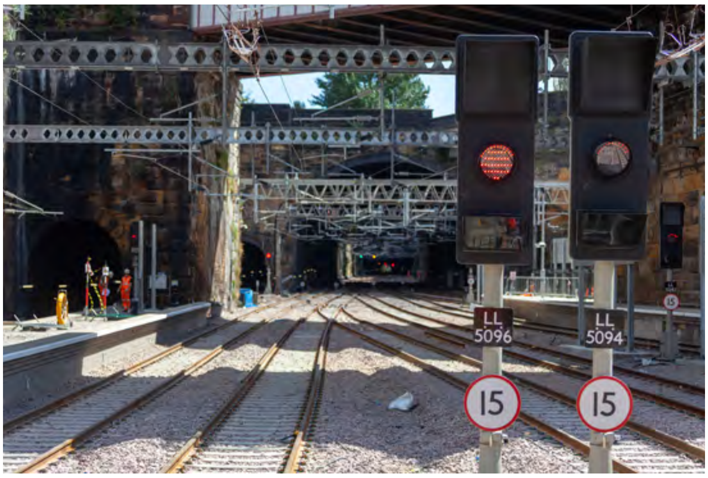
The need for the project was poor asset condition and the growing region – by 2043 more than 40,000 morning peak commuters (100% increase on today) is forecast. Liverpool Lime Street is also a key part of the Northern Hub programme, which is a regulatory milestone for Network Rail.

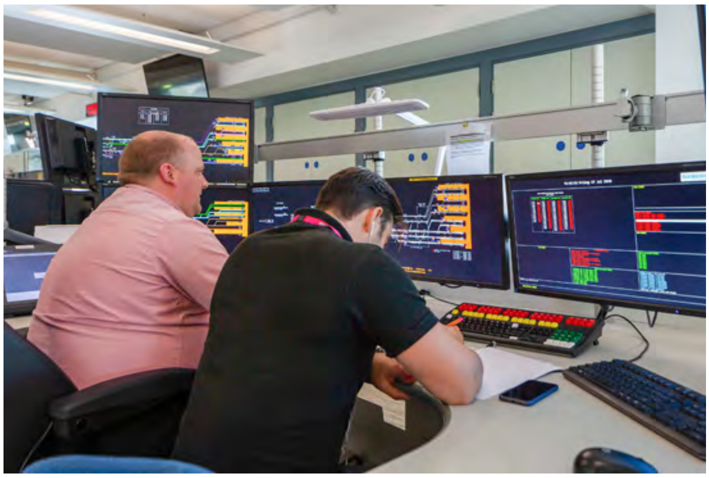
The scheme has delivered a capacity increase of three extra services per hour by creating; two new platforms, extending platform 10 for 11-car units, extending platforms 1 and 2 for eight-car units (previously four-car). Platforms 3 to 6 have been realigned to increase turnout speed and to provide safer wider access for passengers. All the signalling has been renewed with the signalling control moved to the Manchester Rail Operating Centre (MROC). This equates to a 100 signalling equivalent unit (SEU) renewal. 4 km of plain line track and 24-point ends have been renewed, along with the associated overhead line equipment.

Building Information Management (BIM), video simulation, and 4D modelling have been used extensively as part of the planning and implementation process. The model was used extensively for signal sighting and identified the requirement for several sighting screens. This enabled the exact dimensions of the screens to be modelled for formal design and build, well in advance of the signals being installed and commissioned.

Signalling changes

The previous signalbox contained a 95-lever Westinghouse Brake & Signal Co Ltd Style 'L' miniature lever frame was commissioned on 25th January 1948. It is being carefully removed and will be used to support the one remaining Style 'L' frame operated by Network Rail at Maidstone East. The building itself will be retained and may be reused for office space and storage. New signalling equipment includes Frauscher wheel sensors, standard strength AWS (permanent, electro and suppressed), TPWS, LED Signals and indicators, miniature banners, right away and train ready to start switches. All the points operating equipment is In-bearer Clamp Locks (IBCL) with condition monitoring.





Top, new signals and their supporting gantries before being brought into use at Liverpool Lime Street.
Above left, a view along the station throat. Above right, testing at Manchester Rail Operating Centre.
All photos Matthew Nichol Photography.

The signalling is connected via the telecommunication FTNx internet protocol (IP) transmission network to a single workstation in the MROC.

During detailed design a decision was made for Liverpool Lime Street to be controlled from a single dedicated workstation. An assessment of signaller workload confirmed that Automatic Route Setting (ARS) was not required. This meant that the Lime Street Control could not be provided as part of the ARS and therefore Lime Street Control has been provided in a conventional manner within the Interlocking.

One innovation introduced by the project was a Combined Alphanumeric Route Indicator (CARI) used for Standard (SARI) and Miniature Route Indications (MARI). SARI indicators have a readability up to 250 m with MARI having a reduced readable distance of 65 m. These were provided by VMS Ltd and have been installed as 'first of type' on a product acceptance trial certificate at signals LL3067, LL5071 and LL9073

The re-control of the adjacent Edge Hill signal box to the Manchester ROC is now planned for 2019 and will be re-controlled onto the existing Liverpool (Huyton) workstation, leaving Lime Street with its own dedicated workstation.

The rail industry sometimes has a poor reputation for delivering major projects, but the Lime Street project was a complicated and significant project with many interfaces and risks. It has, however, been successfully delivered and has provided the opportunity to provide a much better layout to suit todays railway, and one that is maintainable, sustainable and is able to support the "Northern Powerhouse'.

A number of interesting and thoughtful questions were competently answered by Ian, Claire, Steven and Paul Toole from the project team. This included the use of the BIM model which was considered essential in assisting with the signing off and approval of axle counter siting forms. The accuracy of the model allows equipment to be positioned within a 10 mm tolerance. Other questions clarified that the Electronic Route Setting Equipment (ERSE) system at Edge Hill will be decommissioned this Christmas. Train Operated Route Cancellation (TORC) will be provided as part of Edge Hill re-control next year, this is similar to Train Operated Route Release (TORR) but provided in the Controlguide Westcad control system rather than the interlocking.

The M&NW Section talk is typical of the many varied and interesting events organised by Sections. Why not find out what is taking place near you by looking at **irse.info/nearyou** and going along to listen. If you have an interesting presentation then the Sections would love to hear from you as work will start soon on planning the programmes for next year. It is a great way to maintain your CPD, to network and make new friends.

Past lives: Dennis Howells MBE

Dennis Howells MBE. *Photo Paul Donovan*.

Dennis Howells passed away on the 18 August at St Luke's Hospice in Harrow. He had been suffering with cancer for almost twelve months. However, in typical Dennis fashion, he refused to let this stop him enjoying his hobby, driving his beloved 9466 Engine. His last driving turn was on the 15 July at the Mid-Norfolk Railway.

Dennis joined the S&T Department of British Railways (BR) in 1955 as a probationer based at the Watford depot. He attended night school, passed his exams and became a qualified installer. By 1959 he had joined the London Midland Region (LMR) Modernisation Department and went to work in Manchester, modernising and immunising the existing signal boxes for the forthcoming electrification, and the introduction of Manchester Piccadilly power signal box (PSB).

By the mid-1960s Dennis had progressed to being a chief installer and was working in the Nottingham area, installing stage works in existing signal boxes and relay rooms, in preparation for the new Trent PSB. It was at this time that his work ethic and superb installation skills made a lasting impression on those working alongside him.

Further promotions into and up the supervisory grades continued and he became a senior works supervisor at Bedford, responsible for the post-commissioning work associated with West Hampstead PSB. Again, his attention to detail came to the fore and his determination to 'leave a tidy site' was embraced by those working under him. Having moved to Willesden during 1983, he continued in this role, undertaking several jobs on the West Coast Mainline.

In 1988 he became the signal maintenance engineer at Willesden. Further promotions followed and included spells as S&T engineer general at Croydon, testing and commissioning engineer Southern, lead design and construction engineer at East Anglia and a senior project manager for the Cotswold Line doubling project. In this last role he surveyed the entire thirty-six miles on foot. A not insignificant achievement for one aged well into his sixties!

Dennis was a Member of the IRSE and a Fellow of the Permanent Way Institute. He gained his IRSE Senior Engineering Manager License in November 2000 and in 2002 was awarded an MBE in the Queen's Birthday Honours list for Services to the Railway Industry.

Aside from work, Dennis was heavily involved in railway preservation. He owned his own steam engine (9466), which he restored and overhauled three times, together with a Hawksworth coach, a 'Toad' brake van and a Fruit D van. His engine was certified for mainline operation and, in addition, visited more than 20 preservation sites. He was either in charge of, or made a major contribution to, the restoration of several other ex-BR steam engines, helped to organise the running of steam trains on the Metropolitan Line of London Underground, and was latterly steam superintendent at the Mid-Norfolk Railway.

He was a skilled model maker, building from scratch a collection of O-gauge rolling stock. From 2010 he regularly attended the National Railway Museum at York, leading a team to catalogue their collection of rolling-stock drawings, photographs and other records. In this role he wore white gloves and was well aware that luminaries such as Brunel, Gooch and Churchward etc. had all handled the same items. When time permitted, he enjoyed hill walking and assisting his sister and family with 'do-it-yourself' projects at their home in France.

Dennis never married; he is survived by his younger brother John who lives in Canada, his sister Gwyneth, and their families. A small family service was held at Ruislip Crematorium on 14 September and a Celebration of Life event at the Buckinghamshire Railway Centre on 26 October.

Jim Hitchen

Feedback

Re: Do we need to enhance our train protection?

This is an excellent article (IRSE News September 2018) giving insight into the TPWS and ETCS L2 systems, limitations of TPWS, and issues involved in the upgrading of TPWS equipped sections to ETCS L2. I fully agree with the author's view that significant benefits of ETCS L2 cannot be achieved unless all, or at least most of the vehicles are fitted with onboard equipment.

This is a major dilemma Indian Railways are currently facing on the issue of train protection. A few hundred kilometres of track (out of the total of 67,000 route-km) and a fraction of the total number of locomotives (out of 11,000 numbers) were fitted with TPWS as a trial installation. With encouraging results of TPWS, the dilemma persists whether to go ahead with TPWS or move directly to ETCS L2; the full benefit of the latter option, will accrue only when most of the locomotives are equipped, even if a small section of the route is planned for installation of/upgrade to ETCS L2.

Coming to the article, the author, while discussing the equipment reliability, has shown concern about fail-safety of TPWS due to failure or isolation of the equipment at wrong time. I understand it is so because UK TPWS is meant to be an aid to the driver, and hence designed to a lower safety integrity level (than 4). Incidentally in case of Indian Railway TPWS, which requires SIL4, this situation is averted by taking the following actions in case of equipment failure (a) an audio-visual alarm is given to the driver, (b) emergency brakes are applied, and (c) the train is allowed to move only after isolation of TPWS. This ensures that the driver accepts that the train is fully under their control. Similarly, inadvertent isolation of the system is prevented by proper sealing of the isolation arrangement, recording each event of isolation, and giving an audio visual indication to the driver.

Mukul Verma, India

Re: The New York Transit Challenge

Reading the article "The New York Transit Challenge – do the prize-winners really have a solution for modernising older metros?" by Alan Rumsey (July August IRSE News), I understand that one of the key constraints is the broken rail functional requirements.

When introducing CBTC moving block functionality, we move from a track side train detection system to an onboard train detection system, so we don't rely anymore on track circuits to detect trains. So the issue raised in the article, about broken rail detection, is already present with current CBTC solutions. Therefore we already have to explore how trains can be used as trackside monitoring sensors, complemented where necessary, with trackside infrastructure.

Frédéric Bernaudin, France.

Carbon capture

You may notice that we have a new logo in our 'credits' below. Our printer, Herald Graphics, has signed up to the Carbon Capture Progamme. The paper used in production of IRSE News is subject to a levy, which is paid directly to the Woodland Trust. This is used to plant new native trees into UK woodlands. Currently, over £700,000 has been raised for the Woodland Trust, which has resulted in the planting of 187,800 trees. As a participant in the Programme, we are invited to attend a planting day which we will report on in a future issue.

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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Membership changes

Elections

We have great pleasure in welcoming the following members newly elected to the Institution:

Fellow
Keiji Kamijo, Sankosha Co Ltd, Japan
Yoshihisa Saito, Kyosan Electric Mfg Co Ltd, Japan

Member
Hianori Akune, Daido Signal Co Ltd, Japan
Kyusang Choi, Louis Berger Consulting, India
Robin Eyres, Network Rail , UK
Shinichi Furukawa, Daido Signal Co Ltd, Japan
Lesedi Tefo Gaolemoge, Botswana Railways, Botswana
Bill Gibbons, Railtricity, UK
Julien Le Bot, SafeRail, France
Zhiguo Liang, CARS, China
Cher Hwa Lim, Land Transport Authority, Singapore
Masaya Mori, Nippon Signal Company, Japan
Hiroaki Nakano, Daido Signal Co Ltd, Japan
Hideo Nishimaki, Daido Signal Co Ltd, Japan
Martin Pang, Land Transport Authority, Singapore
Isamu Sannomiya, Daido Signal Co Ltd, Japan
Shuichiro Saito, Daido Signal Co Ltd, Japan
Nukumi Shimizu, Daido Signal Co Ltd, Japan
Takayuki Terada, Daido Signal Co Ltd, Japan
S Vishala Hanumanthappa, Siemens, Australia
Toshihiko Yoshizawa, Sankosha Co Ltd, Japan

Associate Member
Kazuki Alba, East Japan Railway Co, Japan
Martin Allen, Siemens, UK
Elango Palanisamy, ASAP Mobility, Malaysia
Philippe Frequin, Bombardier, Netherlands
Anastasia Ivanonva, WSP, Australia
Ian Leworthy-Coleman, Siemens, UK
Jarrod McKenzie, Integrated Rail Eng Services, Australia
David Penson, Amey, UK
Xiaomeng (Cheryl) Wan, WSP, Australia

Accredited Technician
Ashley Newman, Resourcing Solutions, UK

Promotions

Member to Fellow
Stephen Tijou, Sydney Trains, Australia

Associate Member to Member
Andrew Reilly, Network Rail, UK
Raymond Sturton,Thales, UK

Accredited Technician to Associate Member
Luke Reeves, Network Rail, UK

Affiliate to Member
Nicholas Wellington, Network Rail, UK

Affiliate to Associate Member
Glenn Danyluk, Siemens, UK
Umar Mohammed Rafiq, Atkins, India

Affiliate to Accredited Technician
Christopher Emerson, Network Rail, UK

Professional registrations

Congratulations to the members listed below who have achieved final stage registration at the following levels:

CEng
Amit Kumar Srivastava, Aecom, UK

IEng
Paul Bly, GHD, Australia
Trevor Stevens, Transport for London, UK
Ross Tallo, Jacobs, UK

EngTech
Neil Elrick, Transport for London, UK

Reinstatements: David Mahoney, Faisal Mushtaq and Nigel Walrond.

Resignations: Martin Bridle, Honigan Luo, Ruurd Popping, Nicholas Rushby, Roy Stringer, Malcolm Tunley and Gerard Wolf.

New Affiliate Members

Tawsif Ahmed, London Underground , UK
Amir Hassan Alamir, Talgo, Saudi Arabia
Akshay Kumar Arya, Vocus Group, Australia
Jan Asmussen, Amena Group, Australia
Christelle Awona Essama, Lendlease Engineering, Australia
Jamie Barwell, Colas Rail, UK
Onkutlule Bautlwetse, Botswana Railways, Botswana
Andrew Kah Kin Cheng, Metro Trains Melbourne, Australia
Debojyoti Debnath, India
Kimberley Fok, Bechtel, UK
Aaron Hargraves, Metro Trains Sydney, Australia
Jordan Harris, Network Rail, UK
Abdul Hasnat, Rail Vikas Nigam, India
Venantas Krasauskus, Colas Rail, UK
Martine Lapierre, Thales, France
Elia Da Silva Lee, Rail Control, Australia
Andrew Oates, Transport for London, UK
Mark Richardson, Network Rail Consulting, Australia
Naqib Sagena, Alstom, Singapore
Ghayoor Hussain Sayed, Bombardier, India
Christian Simpson, Self-employed, UK
Dhirendra Singh, L&T ECC, India
Sik Lam Siu, Thales, Hong Kong
Kai Smith, Colas Rail, UK
Matthew Sutherland, Treadwll Group, Australia
Vinesh Tailor, Crossrail, UK
Robert Tait, WSP, UK
Paul Thomas, Linbrooke, UK
Darren Thomson, Babcock, UK
Arvind Kumar Tiwari, National High Speed Group, India
Mark Townend, Network Rail, UK
Charlie West, Aecom, UK
Moe Zaw, SMRT, Singapore

Past lives

It is with great regret that we have to report that the following members have passed away: Robin Nelson, Dennis Howells MBE and Nigel Webb.

Current Membership: 4935

IRSE News

Institution of Railway Signal Engineers

December 2018

Issue 250
IRSE News since 1982

smartrail4.0
modern technologies

It's only data
an alternative view

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IRSE News Issue 250

37 years ago, at a Council meeting on 8 December 1981 a decision was taken to produce a 'newsletter' for all members of the IRSE. The first issue was published the following October and this month we celebrate issue 250.

In 1981/82 electronic software control systems were only just starting to come into the world and the concept of using processors in safety electronics was just about developing. In UK SSI (solid state interlocking) was under development with some metro systems ahead of main line railways. The IRSE proceedings of the time included articles on electronic control systems for Tyne & Wear Metro, together with radio-based signalling for lightly used lines and the evolution of data networks.

Digital copper line systems, electronic exchanges and fibre optics systems were starting to appear, together the first processor-based passenger information systems. Data link systems were fairly well established, but mainly using modems over analogue links with data speeds of only a few kbps. Public cellular radio services would be another three years away and years before they became the basis of GSM-R.

Processor software interlocking and control systems are now common place, as are IP communication networks, VoIP, in-cab signalling, traffic management and automatic train operation. Building Information Modelling (BIM), video simulation, 4D-modelling, and intelligent auto design and testing are being increasingly used in the development and construction of signalling projects. Artificial intelligence is likely to be the next stage in control system development.

Since the early days of electronic processor-based systems at the time of issue 1, IRSE News has covered the development and introduction of innovative and creative engineering solutions for control and communications, and we plan to continue to do so for many years to come.

As well as looking to the future IRSE News has always reflected on the past, as there are often lessons to be learned or relearned on the basic principles of railway control, and Issue 250 is no different.

Paul Darlington
Managing Editor, IRSE News

Cover story

A class 158 unit leaves the 3,385 m long Cowburn tunnel on the Hope Valley route from Manchester to Sheffield in the North West of the UK. Train control technology is advancing quickly throughout the world and many routes will soon look like this one, with the only lineside train control asset being GSM-R/LTE masts.

First looks can be deceiving though, as the GSM-R mast just outside the tunnel is the only element of ERTMS on the route. The train is still signalled by absolute block working and while traffic management and other digital rail systems may feature soon, full ETCS may not be in place for many years to come on this route. Such is the huge volume of work involved to provide national ETCS control.

Photo Paul Darlington.

In this issue

From the IRSE and its Sections

IRSE///

Institution of Railway Signal Engineers

The location and control of assets in smartrail4.0

Steffen Schmidt

SBB, Switzerland

This, the fourth paper in the 2018/9 Presidential Programme, was presented in Zurich on 26 October.

The programme smartrail4.0, which is driven by the Swiss railway sector, has the goal of making railway operation significantly cheaper and more efficient by means of modern technologies.

The targets of smartrail4.0

All so-called "CCS game changers" (cab signalling with moving block, safe mobile localisation, high end radio, automatic rescheduling, automatic train operation, etc.) are combined in a modern, lean and open standardisable architecture.

smartrail4.0 is an open concept whose specifications are released for open use in the product market or in self-developed products after completion (see www.smartrail40.ch). Basic available technologies from different industry sectors are combined to develop requirements and concepts for new high-performance products and to develop innovative vendors in the marketplace.

The main aspects of the business case for smartrail4.0

smartrail 4.0 will feature full digitisation with fewer trackside assets with possibly only switches and crossings left. The architecture will be simple, but powerful with a reduced amount of safety critical functions. Higher capacity will be delivered by a high performance and precise train control and dynamic optimisation, which blocks only the necessary minimum of track for each train movement.

Automation of the CCS (control command and signalling) asset lifecycle processes, especially data preparation and safety cases, will be a key feature, along with automation of scheduling and production planning. Higher grades of automation for both existing operation centres and train operation will contribute to less energy consumption. Modular CCS vehicle architecture with high upgradeability will result in lower life cycle and safety cost, along with increased safety by using a generic and redundant protection architecture. Cheaper and faster migration will also be possible with minimised loss of CCS investment capital.

If all 30 projects of smartrail4.0 succeed, the operating cost reduction will have a volume of several hundred million euros every year. All the so called "CCS game changers" will combine to achieve these goals. There are two key elements of the concept. Firstly the methods, architectures and technologies for the localisation of trains on the track together with the function, logic and secondly the flexibility of the trackside safety system. This controls the safety of all types of movements and changes of the state of the trackside assets, such as switches. These are discussed in the article.

A lean but powerful CCS architecture

There are many dependencies between the "CCS game changers" that make it hard and expensive to install them one after the other. But installing them all in one step leads to a very lean and at the same time very powerful architecture. It could be used for high speed lines, for main line or for metro.

The three main layers in this basic architecture, shown in Figure 2, are:

1. The TMS (Traffic Management System) centralises all business logics as a real time optimisation system including automatic rescheduling and adaptive control of the traffic flow. It steers the underlying processes with geometric precision. It changes the switch positions or chooses between options to solve a conflict situation (for example lower speeds without flank protection or higher speeds and longer overlaps).
2. The APS (Advanced Protection System) is a "gatekeeper" that checks the safety of TMS commands going to the trains and to trackside assets. APS has a very small amount of generic safety critical check functions, everything else is done in the TMS. Its hardware abstraction layer allows the combination of different types of mobile or fixed train detection systems or train integrity monitoring systems.
3. The bottom layer, the physical world, is simplified and digitised by the means of modern communication and localisation technologies. Here the innovations are happening today. Having precise positions with high and safe reliability gives the ability to digitise every trackside signal and sign, and puts this information on the screen in a train. This can reduce the amount of trackside assets up to 70%, which is a really good business case.

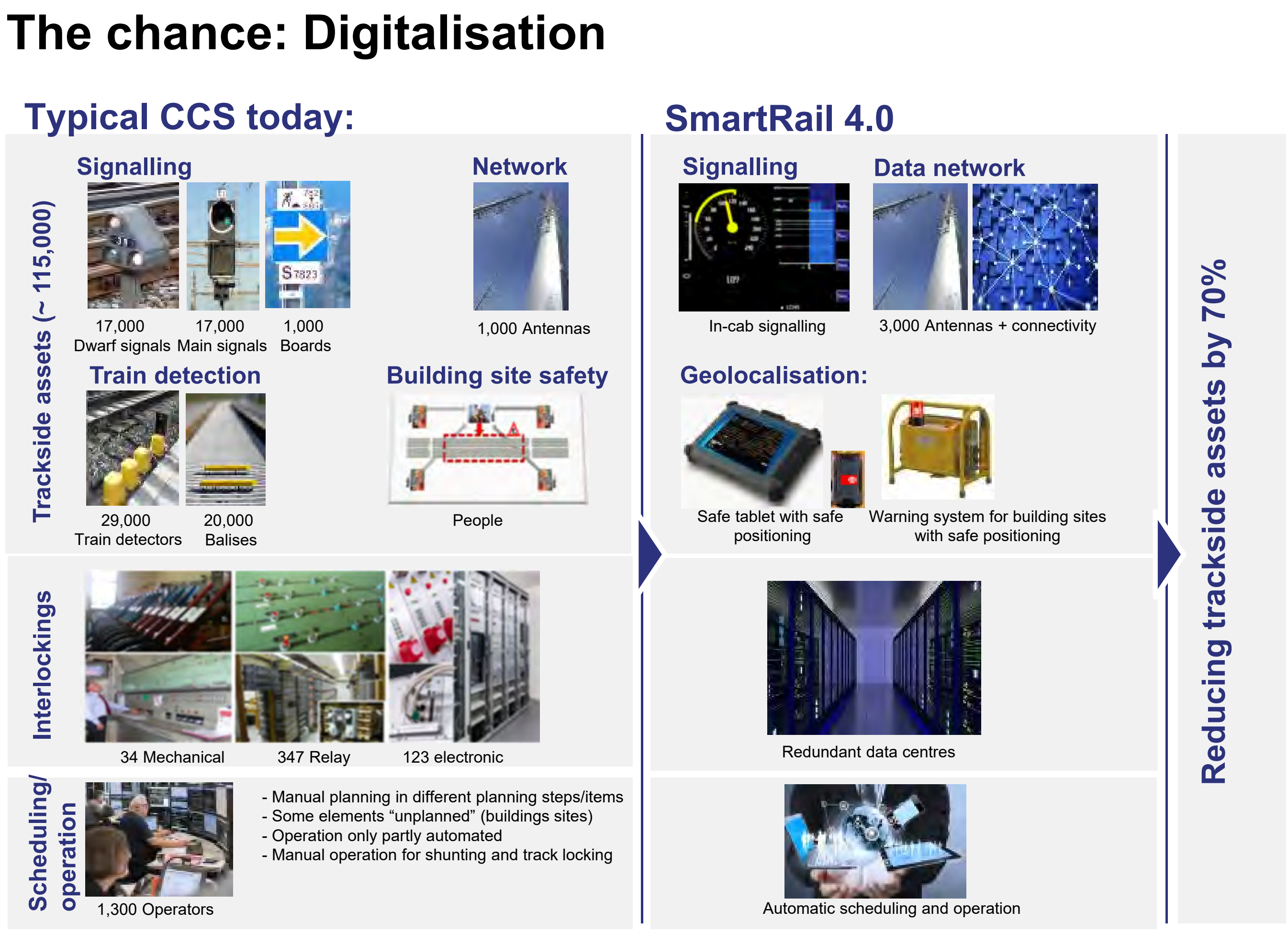


Figure 1 – The opportunity: digitalisation.

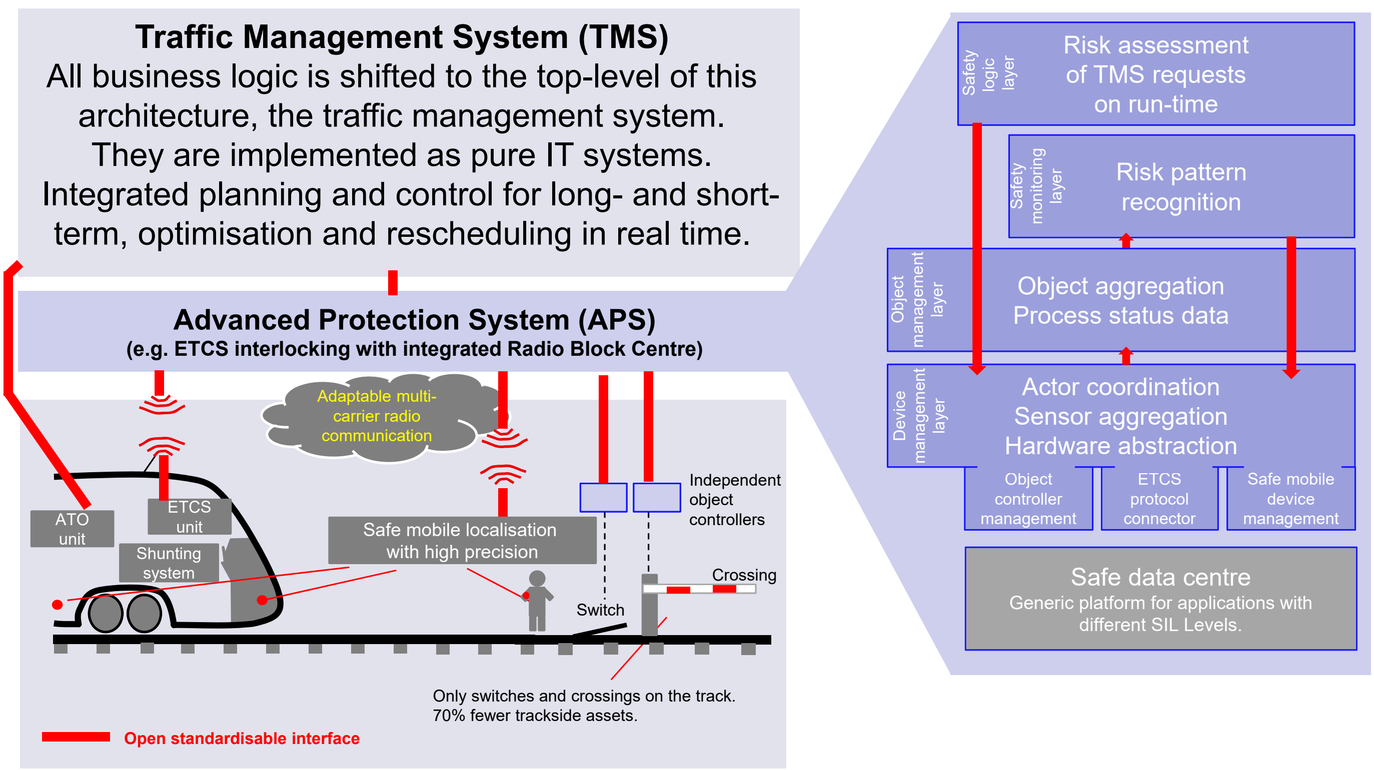


Figure 2 – The three layers of the basic architecture.

Advanced Protection System Interlocking and Radio Block Centre in one function and system

In order to avoid major system and configuration redundancies, distributed safety algorithms with complex system states and unused fine-tuning options for the ETCS cab signalling, interlocking and RBC are combined functionally. In the integrated APS safety logic routes from interlockings and movement authorities from ETCS RBCs merge to one "movement permission", for which trackside assets are locked and which are sent to the trains to control their movements. As a result, there is only one safety system – the APS (similar to an 'ETCS Interlocking') – which manages only geometrically defined movement permissions, checks them before passing them on to the train and locks the associated tracks.

Lean generic SIL 4 level and risk assessment at run-time

The relocation of all non-safety-relevant functions to the higher-level TMS creates a generic and operational process-independent architecture level with SIL 4 requirements. The APS primarily executes a generic check function for requests from the TMS, e.g. an extension of a movement authority or the change of a point machine status. If TMS requests lead to a safe subsequent status, they will be accepted. Even the preparation of a route is in the TMS (leading to requests for changes of switch position via APS), only the test of the suitability of a track for a movement authority (MA) remains functionally in the APS.

Part of the generic track layout and process independent test algorithm is the geometrically evaluated isolation of the movement authorities and danger zones or the parameterised testing of generically considered risk distances – an overlap length is only one special case of a risk distance. The generic risk assessment of risk distances at run-time is based on a pairwise assessment of two topologically adjacent risk objects (trains, localisable obstacles, restricted areas, locatable persons, etc.) and their safety-determining parameters (geometric distance, speed, object type, gradient, protective elements in the track, etc.).

The generic safety case for the APS will need some more work for the proof that a generic risk assessment on run-time is complete and correct, but the idea behind this assessment function is simple. When geometric train positions and geometric topology data is correct at run-time, the function can simply calculate the safety of a change triggered by a TMS request, e.g. new movement authority or changing a switch. This is shown in Figure 3.

A run-time generic risk-checking function of this kind makes it possible to safely use any given track topology – even very old and unfavourably constructed layouts. The change of old topologies is no longer required for reasons of safety, but only for capacity sizing. This eliminates a major investment risk.

The parameters of the risk function could be changed more easily and can also take into account additional information like weather, track status, train defects or train type to go into "safer modes".

The basic state flow of APS has the form shown in Figure 4.

Other safety rules like not exceeding speeds or checking the safe status of a trackside asset stay of course unchanged in the safety logic, like they exist in an interlocking of today.

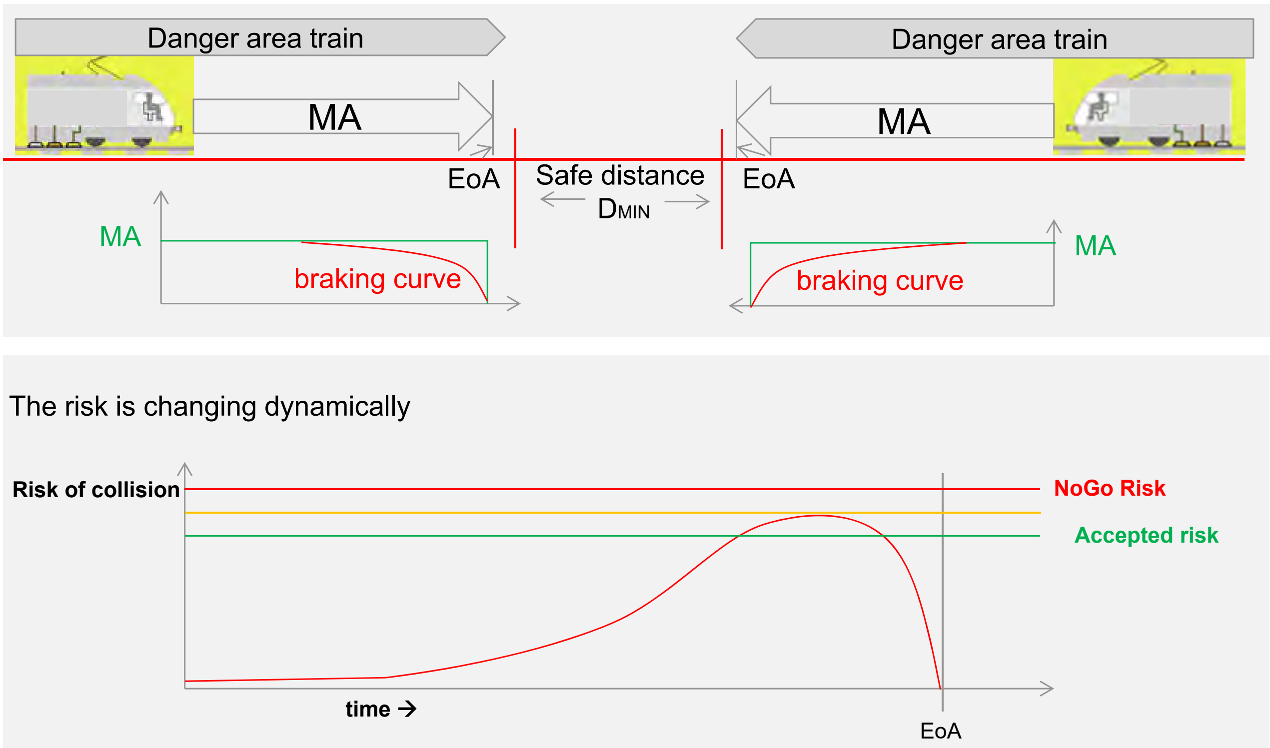
Geometric interlockings will be easy to plan and install

The generically applicable risk assessment at run-time has yet another significant effect – if the APS is approved as a generic application, no costly project planning of the safety and no comprehensive safety case for the behaviour of the single plant is required for the replacement or modification of the interlocking. If the topology has been precisely recorded and the system has been technically tested, the system can be safely used. This reduces the configuration effort and significantly shortens the lead times for interlocking projects.

Flexible combination of localisation technologies

A geometric safety logic has also another important advantage: it is upwards compatible to nearly every train detection system of the future because it can map every sensor information to a geometric

Figure 3 – Example of the APS in use. Two trains approaching each other, 'geometric' interlocking carrying out risk assessment at run-time.



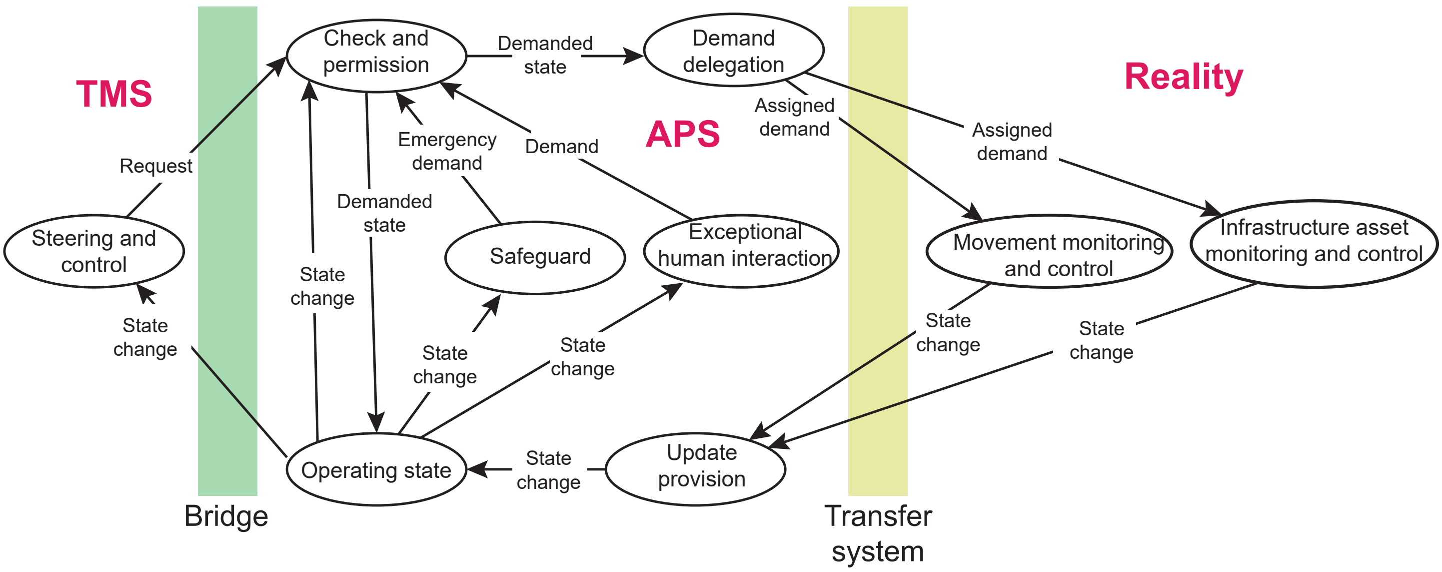


Figure 4 –The basic state flow of APS.

representation. Today's interlockings normally do not have this feature.

Traditional interlockings can simulate this flexibility by using virtual block, but this generates quite a lot of data preparation and configuration work. It is very important to be flexible for mixed migration scenarios with trains, that have different abilities, on the same line. Flexibility means safe investments and low migration cost.

Considering the future, it may happen that we stop numbering ETCS levels. For a communication based train protection architecture there exists a number of possible combinations of trackside and onboard localisation technologies – too many to give them a specific number like "Level 2" or "Level 3". The prices of high quality inertial measurement units (the primary localisation system in military applications) are coming down and there are algorithms for a sensor fusion with odometry, GNSS (satellite navigation), RTLS (real time localisation systems) or video localisation. Fibre optic sensing is a start. 5G may assist as an additional sensor channel. Even innovations like LGPR (localisation by ground penetrating radar) may surprise us in the future. The results of the feasibility studies in smartrail4.0 for a precise virtual balise with a reliability that is high enough for a SIL 4 application are very positive.

The important point is that the business case coming with a safe and precise mobile localisation system is really large (reduction of trackside assets). It makes sense to invest. Safe localisation is the basis of the big digitisation step of the railway operation process, as it is necessary in many applications. But analysing the decision processes in product companies shows another picture up to now: there is a paradigm, that a virtual balise or mobile localisation system should not cost more than the odometry of today. This is a mistake that blocks a big business case.

The fear that moving block is a completely new operational process triggering a really big change normally calms down when the operational analyst checks the real differences. It is normally just no more than a higher resolution of the train detection system, just a change of technology creating higher precision. While the block today is 'jumping' in big steps, it will still jump tomorrow in smaller steps determined by the time between repeated radio messages. For the safety logic it is not relevant if the localisation (full track occupancy) information comes from the train or from the trackside. Even the degraded modes are not so different as one may think, as the hazard analysis shows. The loss of communication to an ETCS Level 3 train and to an axle counter have a lot of similarities. It is an advantage if the operational processes for different combinations of localisation systems are not different as this allows an easy migration.

The "virtual track occupation" (real occupation + precision reserves) of a train is the result of the quality of the actual available localisation devices. When this mix of sensors changes the virtual track occupation may change instantly in both directions. A modern safety logic that can handle this new requirement needs algorithms for new types of localisation transitions. There are algorithms to achieve this, but a geometric safety logic is a prerequisite for them.

Only one 'production brain': TMS

The advantage of the shift of functions to the Traffic Management System (TMS) is not only that the software scope of the expensive safety systems can be reduced to approx. 20-30%. The main advantage is that operational processes only have to be mapped in the TMS, since the generic safety check function of the APS works in the same way on every topology and in every operating process and process state. The APS can therefore be used in any country and on any topology with the same functionality. The mathematical parameters of the generic risk assessment function are configurable so that different levels of security can be set for different types of traffic or regulatory requirements. Thus, the APS can be used both at high traffic densities as well as cost-effective for secondary lines. Only the amount and type of trackside assets or the quality of the vehicle equipment decides on what traffic densities are possible – the interlocking is always the same. With centralisation of the interlockings into safe data centres, the parameters of the risk assessment function can be changed simultaneously for an entire network, or can be set specifically for certain train categories.

As a pure IT system, the TMS can now carry out detailed, optimised fine-tuning of the traffic flow, like precise industrial measurement and control systems do. It can opt for either higher speeds with full flank protection or alternatively for less flank protection and lower speeds. Depending on the current conflict situation it may now opt for short movement authorities and slightly reduced speeds (better total capacity in the conflict zone), or equip individual trains with longer

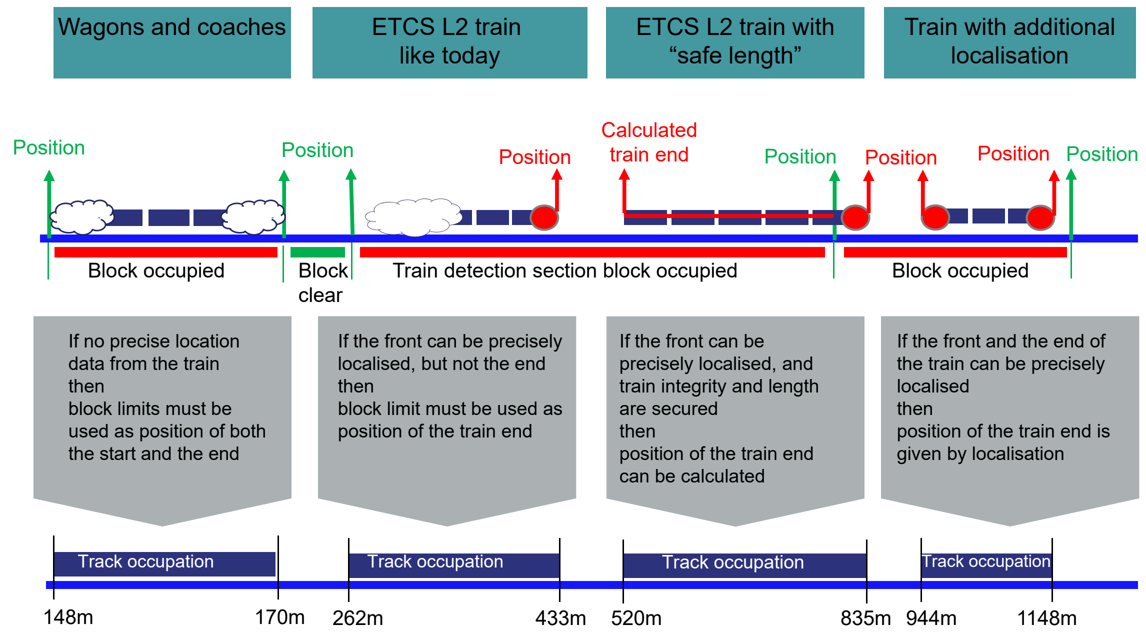


Figure 5 – Track occupancy can be determined by different sources depending on the equipment fitted to a train.

movement authorities and higher speeds (prioritisation). Simulations show that this precise adaptive fine-tuning can greatly increase the performance of a station and greatly reduce the capacity-damaging effect of speed changes. Short train ahead times with ETCS cab signalling, accurate automated driving and precise localisation are all part of the solution – but without an interlocking functionality that can take full advantage of them, their effectiveness is very limited.

Features of the system architecture

Hardware abstraction, investment protection and upward compatibility

More than 80% of the invested capital of the CCS investments lies in the trackside assets. For the protection and optimum use of this investment capital, an interlocking must have several specific characteristics that are not customary today in traditional interlockings.

The first important optimisation is the introduction of hardware abstraction. As in any modern operating system, specific properties of "end devices" (here trains or interlocking systems) may not be processed in the central application control (safety logic) or anchored in specific hardware. They must be abstractly and generically described and processed. Otherwise, a change in the safety logic and a new complete safety certificate must be made with every change of the trackside technology.

Therefore, the safety logic has to be separated from the end devices by a hardware abstraction layer (HAL). The safety logic only knows the necessary functions and status of the systems. Above the HAL in the safety logic it is only important to know whether and how an trackside asset is currently passable as a topology element and not whether it is a railroad crossing or a point machine and how it is technically equipped. Only their abstract functions and status need to be known.

Another key role of the new HAL is sensor aggregation and automated actuator coordination. Sensor aggregation means track occupancy that can be determined by many different sources of information – depending on the equipment of a track section or a train. Actuators are for example, driver interfaces at the trackside or onboard concerning a movement authority for a train. Puristic approaches such as ETCS levels, which numbered only some of the possible hardware constellations, do not represent an optimal solution and are unnecessary. More economical and easier to migrate is the constantly evolving mix of different sensor types, with which the interlocking must deal. In stabling or shunting areas, circuits or axle counters may last longer, but on the line they will become more and more obsolete due to self-locating trains. Behind one train which can precisely locate itself geometrically (e.g. via ETCS Level 3), another train can closely follow, even if other trains are still localised by axle counters (Figure 5). Pure configurations lead to expensive migrations.

An important functionality for a cost-effective migration to ETCS cab signalling is the ability of the new object controller to connect a single trackside asset simultaneously to the old and the new interlocking. The switchover is remotely controllable and enables the industrial preparation of large network segments including commissioning in one step, without incurring high costs for numerous temporary interfaces or necessitating a costly complete set of indoor and outdoor installations.

The APS as a prerequisite for asset reduction and cost optimisation

Trackside signals are eliminated by ETCS cab signalling. However, a favourable migration through specific interlocking technologies must be made possible, which allows the conversion in large segments, a favourable project planning and the reuse of the existing trackside assets. Shunting signals may also be eliminated by cab signalling. This requires an interlocking that can integrate mobile cab signalling systems and alternative localisation systems into the security process.

Today's train detection systems and the growing number of fixed location balises are eliminated by self-locating trains, i.e. by providing secure mobile localisation of the train's geometric track occupancy including integrity status. This requires a new interlocking logic that can handle geometric occupancy information and the various degraded modes of upcoming mobile localisation technologies in all combinations.

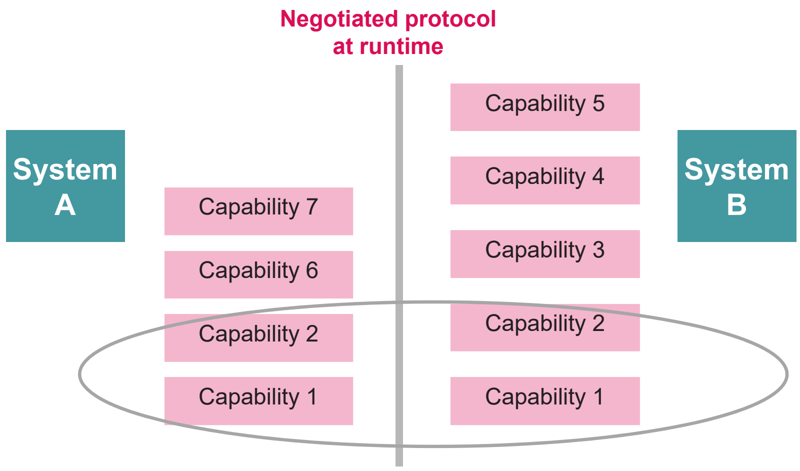


Figure 6 – Achieving high interface quality requires upwards and downwards compatibility via context sensitive protocols for each of the 50 to 100 important onboard and trackside interfaces of a CCS system.

Rule based pattern matching eliminates software releases and specific products

It is also a very important requirement to reduce the cost of safe software development and its releases. This goal can be reached by using formal methods and checker on run-time. It is an old discipline in computer or mathematical science to proof single rules and to combine them to higher rules. Safety cases for safe software are expensive when they must be repeated for every change. There are some ways to automate the software impact analysis, but this is not a requirement that is easy to achieve. Another important method lies in the "rule based systems". A basic system is developed with a generic safety case. Specific behaviours are implemented afterwards as certifiable rules, proofed at run-time with the formal methods that were part of the generic safety case.

Rule based customisation of safe systems by users at run-time sounds like a nice dream. But from a mathematical point of view a formal proof at run-time is possible and there are already existing products that are coming very near to this feature.

Of course, the harmonisation of railway processes would be the best idea. But this is not easy to achieve. The railway sector is not even able to use the same language in operations, which is a small and simple part of the problem. It is not only a problem of habits. There will always be other differences because not every railway can afford to reach the same safety target, can eliminate its national laws, can automate the same function or has the same ability to change, integrate or digitise. Operational processes are stored in the logic of thousands of interlockings today and are part of their safety cases. So the harmonisation will take a while and systems should be flexible to handle many different types of processes. To avoid small customer specific systems that will always have a reduced quality and low grade of automation, it is important to increase flexibility and to improve customisation features without triggering new safety cases.

'Open safety'

For the sanity of the digitalised railway sector it is highly important to copy the change of principles of the IT sector to handle new expensive and complex dynamic systems. Otherwise the life cycle cost will follow an exponential curve. One of the most important methods is to split the whole CCS architecture into independent components and to get rid of complex integration safety cases. There are technological fields in some countries, where they are not affordable anymore which leads to a complete stagnation – which was not really the idea of digitisation.

The idea of 'open safety' is to reduce the complexity of an interface so far that the behaviour of a certified system at its interface can be validated at run-time (plug & play) using the formal methods that were derived from a generic safety case for the integration.

Capability based protocols for interfaces

Writing down the specification of a protocol and committing it as a standard does not always mean that it will live for a long time. Protocols have very different qualities. One of the most important qualities is the release structure of a protocol and its negotiation features.

Protocols that are only released as full baselines often have bigger problems with upwards and downwards compatibility. Flexible high quality interfaces like USB or Bluetooth are structured in profiles or capabilities, that allow an intelligent negotiation of the cooperation of two systems at run-time (Figure 6).

Actual status and conclusion

Various studies, second opinions and proof of concepts for smartrail4.0 are currently being prepared, and will be complete by the end of 2019 in parallel with the first specifications and tender preparations for prototypes, products or development cooperation. The results so far confirm the feasibility, so that the programme team assumes today that the concept can be realised with the described advantages.

The railway system needs a big economic optimisation to assure its competitiveness in the coming years. Small evolutionary technological steps may be too small this time, since it will take again a long time to deploy them. The development manpower in the CCS sector should focus on the bigger economic steps described in this article. Products that are implementing such ideas may be disruptive, but this does not mean that they are not possible.

The smartrail4.0 programme will proceed to prepare this disruptive step and to encourage innovative industry companies to start a cooperative development.

About the author ...

Steffen Schmidt has worked as a technology, automation and process re-engineering consultant in the media, military and logistics sector. He joined SBB in 2001 and was member of the executive board of SBB infrastructure between 2004 and 2010. Since 2011 he focusses on specialised rapid innovation projects, especially since 2015 on the design of smartrail4.0, where he is the lead architect and responsible for the department that develops the next generation CCS.

250 editions of IRSE News

Mike Hewett, John Francis, Ian Allison and Paul Darlington

December 2018 sees the production of the 250th issue of IRSE News, 36 years after the first issue was produced in October 1982 during the presidency of Philip Wiltshire.

The first editor of IRSE News was Council member Bob Blyth, who at the time was British Rail divisional S&T engineer at Manchester. Council had agreed at its meeting on 8 December 1981 to introduce a newsletter, initially on a trial basis, with the ultimate objective of publishing four editions a year. Here are the reflections of some of the editors involved over the years, along with a fascinating comparison of issue 1 with what we do today, some 36 years later.

Mike Hewett, editor 1984 to 1988

During October 1984 I was approached by Bob to take over the editorship of IRSE News whilst I was at the Railway Engineering School in Derby. The preparation and production facilities of the school, which were used for the production of teaching and presentation material, were very useful for developing the production of IRSE News. My first production was issue 6 in December 1984.

The process was relatively crude compared with modern production, editing and printing processes. The draft copies were produced using my old manual typewriter, cutting and pasting the articles together with photos onto A4 sheets – carefully arranging and pasting all the different pieces of paper containing articles and photos so that all available space was used up in the 8-page format used at the time.

The completed A4 sheets were then forwarded to Communique Print Services in Manchester to arrange for the typesetting for the production run of each edition. I remember that Communique occupied a dim and dingy office space in the arches under Manchester Oxford Road Station – an office that was previously occupied by the Rick Astley Fan Club, complete with bags full of unopened fan mail in the corner.

In those days IRSE News was issued twice a year, although gathering sufficient material for the issues was always a challenge, with frequent requests to Council for some 'arm twisting' to produce suitable articles. Towards the end of my tenure as editor, however, I had built up a reasonable backlog of articles for future editions. In those days IRSE lecture technical presentation papers, both in London and the Sections, were published separately and were not included in IRSE News. There

IRSE News

IRSE Publication

October 1982 No. 1

PRESIDENT, 1982-83

F. P. WILTSHIRE, B.Sc.(Eng.), FIRSE, NIEE.

President's Message

It is a great pleasure to have the opportunity to contribute to this first issue of the IRSE Newsletter. Not only is it a rare privilege for a President to see the start of a new venture during his year of office, but I regard this Newsletter as a most important development for the future of the Institution.

Our membership is increasing rapidly and most of that increase is from overseas which means that the percentage of members who can regularly attend meetings either in London or the other centres is steadily falling and there has been a growing need for some other means to enable members to be kept in touch. I hope and believe that this Newsletter can fill that need and be of great interest and value to all members, both in the United Kingdom and overseas.

We are in an era where our profession is experiencing a very rapid change in the technology it can employ and it has never been so important that this Institution, if it is to fulfil its role of keeping its members informed, has a means of communicating with its whole membership. However, if the Newsletter is to succeed it requires the positive support of the whole membership and I sincerely hope that members, of all grades, will offer contributions for inclusion, because it is the quality and quantity of the contents which will determine the long term success of this venture.

Finally, in wishing our Newsletter every success, I would like to record my thanks to Bob Blyth, Chairman of the Recruitment Representatives Committee, who has worked so hard to get the Newsletter started, and to those who have helped him in getting this first issue into print.

EDITORIAL COMMENT by R. H. BLYTH, FIRSE.

Chairman of Recruitment Representative Committee.

MESSAGE FROM THE EDITOR.

At the IRSE Council Meeting of 8th December, 1981, it was agreed that steps should be taken to introduce a Newsletter, initially on a trial basis, with an ultimate objective of publishing four editions per annum.

The first issue has come off the press, and on time, with the help of the IRSE Recruitment Representatives Committee, the members of which will continue to serve as local sub-editors throughout the early months of this project.

As the President has stated, there is a clear requirement for the Institution to provide this additional service to its growing membership. There is also now an opportunity for the membership to voice its own opinions through Letters to the Editor feature.

However, the success of this venture cannot rely solely on the enthusiasm of a committed few and I offer an invitation to all classes of membership, both in the U.K. and overseas, to make their contribution.

Apart from letters to the Editor, I am looking for articles on technical presentations, news of members, current developments, reviews, events, in short anything newsworthy.

Major articles can be up to a nominal length of 1000 words and black and white photographs and diagrams are most welcome.

Contributions or offers to prepare contributions should be sent to the Editor, Mr. R. H. Blyth, DS&TE, Rail House, Store Street, Manchester or to your local Recruitment Representative. Please do not hesitate to discuss your ideas with these people.

Remember the IRSE needs a Newssheet, but the Newssheet needs 'YOU' to be a success.

Issue 1, October 1982.

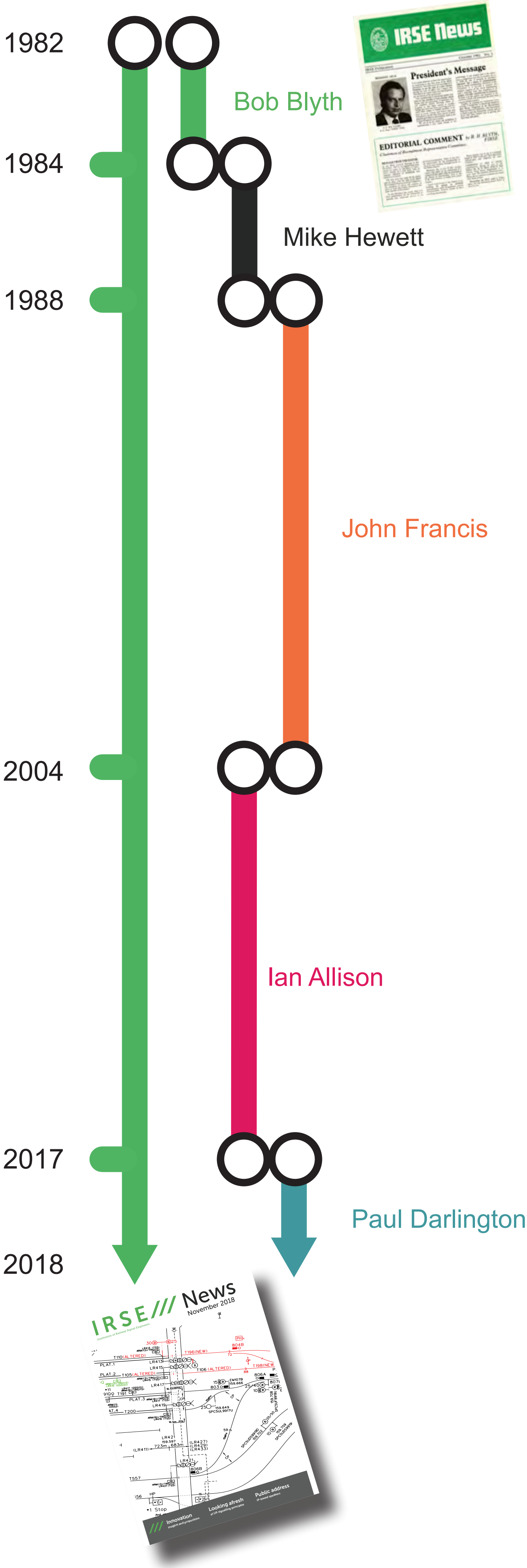
were no adverts in the early editions, although discussions with Council explored the possibility of expanding the size to a 10-page issue, with the adverts helping pay for production and printing costs.

A move from Derby back to the real world of signal engineering in Motherwell made it difficult to continue with production of the IRSE News, with trips from Glasgow to Manchester at the weekends required to deliver the draft copies to Communique. I was fortunate that John Francis and Tony Rowbotham offered to take over the production and my last production as editor was number 14 in November 1988.

John Francis, editor 1988 to 2004

Following an approach by the then President, Tim Howard, to find a replacement for Mike Hewett, Tony Rowbotham and I took over as editors of IRSE News from issue 15. So began a highly successful association that saw us collaborate on the production of the newsletter for the next 16 years.

Tony worked for GEC-General Signal at Borehamwood whilst I was employed by Westinghouse Brake & Signal in Chippenham, both companies affording support to us in this extra-curricular endeavour. Although my subsequent career involved periods with British Rail and Railtrack in various locations before returning to Westinghouse, Tony and I maintained our joint effort in developing the newsletter to meet the aspiration of Council that the content and frequency of publication should be increased.




Mike Hewett edited IRSE News from 1984 to 1988.


Past President of the IRSE, John Francis, edited IRSE News from 1988 to 2004.

Above, issue 50, September 1997, in the John Francis era. By now the magazine was making extensive use of colour and there were significantly more articles about work in countries other than the UK, in this case Oslo Metro.

Two of the most influential contributors to IRSE News over an extended period of time, neither still with us, but both very much missed.

Left, long-term Deputy Editor of 200 issues, Tony Rowbotham, and right, Stuart Angill, who was Production Manager from 2005 until 2014.

In parallel with expanding the number of pages we embarked upon a staged approach to moving firstly to quarterly publication, then bi-monthly and eventually 10 editions per year having to seek out ever more suitable content and contributors. Coinciding with this, the format and style evolved so as to make the News more appealing to readers, eventually culminating in full colour production. Regular features were introduced with timely comment together with articles and letters to stimulate the interest and response of members whilst reporting on IRSE affairs and, hopefully, introducing a little humour.

In furtherance of the aims of the Institution contributions were sought from a variety of sources worldwide to enhance knowledge and education. Whilst receipt of suitable word copy was one thing, the provision of acceptable supporting diagrams often required us to either redraw or create these from scratch.

Crucial to these improvements was the purchase of a desktop publishing package which enabled content to be imported and laid out in camera ready format. This provided us with greater control over the layout and presentation whilst extracting this element of the production from our printers, Communique, reduced the cost of each edition. Alongside this initiative a proactive approach to the procurement of advertising supported the enlarged format and more frequent editions by securing an income stream that defrayed printing costs.

In 1996 the response in a members' survey delivered the result that 92% of respondents were satisfied with IRSE News with comments such as "The most popular and successful of all Institution publications".

On becoming junior vice president, I relinquished the post of editor to concentrate on preparations for my Presidential Year. Tony continued his sterling contribution as assistant to the new editor, Ian Allison. So ended 16 years of direct association with IRSE News that has seen it flourish whilst contributing itself to the growth of the Institution. It was a pleasure and a privilege to produce and advance the newsletter as the voice of the Institution and the S&T profession taking it from a quarterly, two-colour periodical to a full colour regular magazine, editing 78 editions on the way.

Ian James Allison, editor 2004 to 2017

I answered an advert placed in the IRSE News by John Francis in late 2003 looking for a replacement editor. I spent time with him to understand how the publication operated at that time and I was given the reins to the magazine at issue 93 (April 2004), assisted in the deputy role by the late Tony Rowbotham.

The magazine was then published as ten editions a year. With the enthusiasm and support of the Institution and the industry itself, this was soon increased to the eleven issues a year that we all appreciate today.

The production of the magazine when I became editor was undertaken by the then Institution of Incorporated Engineers in London and printing was undertaken by the Fericon company. The production manager role was then taken in house by the Institution and previous Council Member, the late Stuart Angill was appointed and started at issue 108 (October 2005). And so, began a wonderful relationship between Tony, Stuart and myself for the next ten years.

During this time, a number of new features were introduced to the magazine including industry news, interviews with key industry leaders, Institution officials and comment from guest editors within the news view feature. In addition to this, the magazine was focused for the global membership and the world-wide signalling and telecommunications industry.

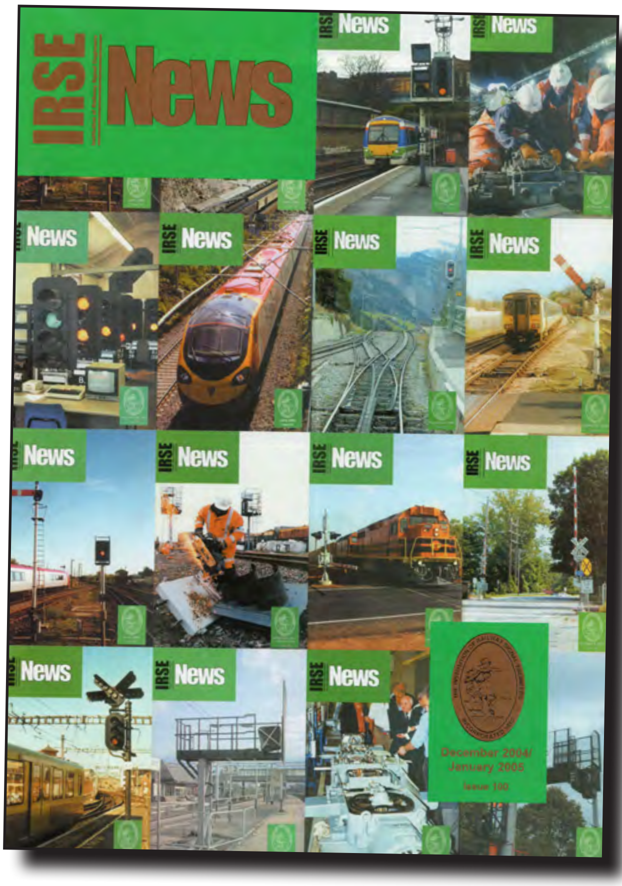
I am pleased to have played a part in gaining the trust of all involved, in order to provide interesting and topical articles, reports and photographs of the developing technology, processes and resources from around the world for the membership and the signalling, telecommunications and associated industries to learn from. This afforded the magazine to increase the opportunities to obtain or write the articles that make it such an interesting read and that are relevant to our industry. It has been hard work but this produced a positive change and the natural development of the magazine.

The untimely death of Stuart, the victim of a tragic road accident on 13 August 2014, occurred not far from his home in the south of France. Mark Glover then took over as production manager in December the same year and he continues to do an excellent job in the role today.

Tony was deputy editor of IRSE News for twenty-six years and 200 issues. Whilst he stepped down from the role after the publication of issue 214, the role continued for a period of time undertaken by Andrew Emmerson before reorganising to the publication team that is in place today.

Whilst undertaking the role, I was afforded many opportunities to meet new people, go new places and view and understand

Current Managing Editor Paul Darlington (left) and Ian Allison.



Issue 100 was produced for December 2004/January 2005 – plenty of signals and point machines in view.

new and innovative technologies. I very much enjoyed my time as the Editor, in particular the time I spent working with both Tony and Stuart. Issue 235 was the final magazine that I was directly involved with, so after 143 issues I was succeeded by Paul Darlington.

Paul Darlington, managing editor 2017 to present

I was first approached by Francis How, then chief executive, towards the end of 2016 to see if I would take over from over from Ian Allison who had been the managing editor since 2014. I was immediately interested, having contributed to IRSE News a number of times over the years together with writing for other railway technical magazines. In the early years of my career I had been a S&T instructor and have always been interested in developing new engineers, and had recently left the exam committee having served on it for ten years.

The editor role has evolved into a managing editor to lead a team of excellent contributing editors, together with a production manager to share the workload. From the humble beginning of being published twice a year with eight black and white pages, IRSE News is now published 11 times a year with up to 40 colour pages, and a 12th issue is also being considered. As fitting for a communications and control institution extensive use is made of collaborative remote working, using cloud storage and telephone/video conferencing to plan and edit each issue. Some editors have never actually met one another!

We have been fortunate to receive enough quality content over the last year to fill 40 pages in most editions, and without asking Council to do any 'arm twisting' as Mike had to! However, we welcome any content and an editor will work with a writer to help and advice any article. IRSE News is your magazine so don't hesitate in submitting any interesting article, paper, news or letter. The only thing we don't publish are articles overly promoting one company.

In early 2018 we redesigned the magazine format to incorporate the new IRSE branding, to provide a fresh modern look. Only the logo, font and colours were provided by the Institution's branding consultant, with all the other design changes developed in house by the IRSE News team. A lot of care is taken to try and make sure the magazine is readable by members wherever they are located and work.

The team are all railway signalling and telecoms engineers with publishing experience, so IRSE News is very much a magazine produced by S&T engineers for S&T engineers. The team is larger than it was a few years ago, but it is still small for the size and quality of the magazine; and other similar publications are surprised when they realise that IRSE News is produced by just a handful of people – and all in their spare time. A special mention must be made of Mark Glover, the production manager, who spends hours each month laying out the magazine and which includes redrawing many of the diagrams.

We work to a production manual, which has evolved over the years in order to specify consistency and guidance on writing style. This recognises that readers of the magazine cover a wide range of members; including students, technicians, maintenance and design engineers, asset managers, technical support, research engineers, policy and standards, training, testing as well as non-technical managers.

The readership is international and so articles and content must accommodate the wide range of readers. So, for example saying "summer holidays in July" is something we wouldn't write, as for many readers July is winter. The objective is to write a magazine to be read, rather than strictly an academic journal, therefore the intention is that the articles and papers should be easy to read and absorbing. IRSE News therefore aims to include papers with technical detail, but not too detailed, and balanced with articles to appeal to all members.

We try to include academic type papers and 'back to basics' articles together with features about the people in the institution. What is familiar to one of the magazine's readers may not be to another – so for example the peculiarities of UK relay interlocking may be obscure to some readers and we try to work with writers to explain such situations.

Stuart Angill's front cover for the 200th edition in May 2014 celebrated the diversity of the Institution's activities, and showed an earlier rebrand.

The aim is to try to make the text simple to understand, avoiding complicated long sentences (typically 30 words) together with locally used abbreviations and colloquial expressions. Latin terms (other than etc.) are avoided or translated.

Large areas of text are broken up by diagrams and/or pictures if possible. This also gives the production manager flexibility in laying out the pages with the size of the diagrams and pictures adjusted to avoid empty spaces on the page or at the end of an item. Paragraphs are typically no more than 100 words to make reading easier and suit the column format of IRSE News.

Advertisement support is becoming harder to secure due to competition from trade magazines with larger circulations than IRSE News and on-line services for recruitment – for example. There has been some interest from new advertisers more recently though, which may be a result of the redesign of IRSE News. We are also most appreciative of the regular advertisers who loyally support the magazine.

Issue 1 compared to issue 250

Comparing issue 1 with issue 250 is fascinating. Some of the content is as valid today as it was 36 years ago and things haven't changed, but in other ways it looks very old. In 1982 Bob Blyth said "We are in an era where our profession is facing a very rapid change in the technology it must employ and it has never been so important that this Institution, if it is to keep its role of keeping its members informed, has the means of communicating with its whole membership". This statement could have been written by the current editor, although we now also have the IRSE website (which is also being modernised) and social media; which IRSE compliments, with for example using 'link shorteners' to access additional web-based information.

Mark Glover, Production Manager of IRSE News since 2014, in his natural habitat of a darkened room with big screens.

The very first issue said that the content of IRSE News will contain "letters to the Editor, technical presentations, news of members, current developments, reviews, events, and in short anything newsworthy". Just as we aim to do today. Major articles were up to 1000 words, with black and white photographs and diagrams. We continue to aim for the same content today, although we publish papers up to 6000 words with colour photographs and diagrams. Obtaining these of suitable quality though is just as challenging as it has always been. We do try and include content that appeals to both UK and non-UK members and all grades of membership. This is why it's important that we receive contributions from as many members as possible, just as Bob said in issue 1.

Issue 1 contained an article from the past and one looking into the future, along with; UK and non-UK content, younger members, Section news and a Convention report. These are all items that we continue to include today. It also listed membership changes and in a format that has only just been updated after 36 years.

The font and layout of the newsletter looks typical of the 80s and the text alignment is 'justified', with a 'serif font' throughout. Justified text is where the spaces between words are stretched or compressed to align both the left and right ends of each. Nowadays this looks old fashioned and creates problems for readers with range of eyesight and reading difficulties. We use up to three columns to accommodate photos of varying sizes.

With full justification extremely large spaces may appear between words on lines with only two or three words, and when the spaces between words line up approximately above one another in several loose lines, a distracting river of white space may appear. This is why IRSE News, as most other technical magazines, now uses "left aligned, ragged right" text format to make the magazine as accessible as it can be. Something that wasn't considered much in the 80s.

Optical Fibre Systems, British Rail LMR

The operation of Thyristor controlled Electric Locomotives and Multiple Units has made it necessary to take remedial action to reduce the effects of traction noise and ensure that physical telecommunications circuits comply to CCITT noise limits.

To meet these requirements, and reduce the number of physical circuits over 10 miles in length, it has been necessary to make increasing use of transmission multiplexing techniques. Rather than provide additional 12 – channel FDM or 30 – channel PCM systems over existing composite and lineside cables, with costly alterations to plant, the opportunity was taken to install an 8 m bit Fibre Optic system on the Birmingham to Coventry Main Line under a scheme jointly sponsored by the BRB, D of E and respective manufacturers. As this route is electrified at 25kV, a Fibre Optic cable without metallic sheathing or copper conductors would not require immunising from induced interference.

STC Ltd. and Plessey Telecommunications provided line terminal and 2nd order multiplexing for Birmingham New Street – Birmingham International and Birmingham International – Coventry respectively. BICC Ltd. provided the fibre optic cable subsystem.

A diversity of manufacturers and equipment/plant techniques were employed to provide a broad test bed for evaluation. Birmingham New Street – Birmingham International (14.2 km) used a laser light source at a wavelength of 850 µm, line bit rate of 12.672 Mb/s. and a multi-core graded index fibre with core diameter of 50 µm. This gives a maximum path length of 12 km, thus requiring a repeater sited at Stechford in BR cable room. Birmingham International – Coventry (17.5 km) uses an LED light source at a wavelength of 900 µm, line bit rate of 11.264 Mb/s and a multi-code graded index fibre with core diameter 63 µm. This gives a maximum path length of 8 km, and a repeater was sited at Berkswell.

Planning of the cable sub-system was based on drum lengths of 1100 m between the joints and careful consideration was taken of expected light power losses. These losses comprise 5 dB/km for cable, 0.3 dB for each splice joint, 1 dB for each connector, 0.2 dB/km for dispersion and a planning margin of 7 dB for repeated section.

The cable was laid from an Engineer's train in two 12 hour week-end night possessions with complete line blockage and overhead isolation. Radio communication was used between man-in-charge and driving cab to assist the operation. Cable lengths were tested for fibre attenuation and band-width on manufacture, backscatter using an optical reflectometer to check for broken fibres upon delivery to BR stores, and backscatter again after cable was laid in route. Finally attenuation and bandwidth after jointing were measured on both fibres in each direction and the best combination determined system transmission direction.

Fibres were jointed with faces cut using a diamond scorer over a curved anvil and clamped in line using steel tubes, optimum fibre face alignment set by monitoring a light signal passed through the splice, and minimum loss adjustment made. Audio cable pairs in existing lineside cables were used for connecting BICC speech/data units to provide communication to select best alignment position. Transmit level of -6 dB and a minimum receive level -63 dB gives a repeated section margin of 7-10 dB with an average path loss of 48 dB.

The 8 Mb/s line systems are interfaced with 2/8 Mb/s 2nd order multiplexors and up to 4 – 30 channel 2 Mb/s PCM multiplexors which gives a capacity of 120 channels. Repeater power is derived locally from 650 volt signalling supplies. This enables the cable to be metal free and is made up of 2 optical fibres, fibre space fillers, helical paper tape, kevlar strength members, poly sheath, moisture barrier, protective poly sheath, giving an overall diameter of 13.5 mm.

As the Birmingham New Street – Birmingham International section uses laser class III b sources, which are categorised as 'Potentially Hazardous' and these are also used in Optical Time Domain Reflectometer test equipment, strict control under maintenance and fault conditions is essential as retinal damage could occur if viewed directly. All other safety aspects are comparable with existing BR practices.

The systems have been commissioned and carrying traffic for some 12 months now; one hardware fault caused a repeater failure at Stechford and system was restored within 2 hours using spare cards.

Cable damage has been minimal, considering its unarmoured construction. It is however, protected by an alarmed air pressure system and repairs are effected with heat shrinkable sleeving.

Looking back to issue 1 offers a remarkable chance to see what has changed, and in many ways what has stayed the same. The article above, on the topic of optical fibre systems is reproduced in a similar way to that of the original magazine. Optical fibre systems are now common place on most railways, although the futuristic line rate of 12.672 Mbit/s reported in 1982 compares with an 8 Tbit/s system available today on the same rail route. So, what will edition 500 of IRSE News contain we wonder?

It's only data!

Stephen Dapré

Stephen recently became a Fellow of the IRSE. He briefly considered writing a rigorous technical article about the obsolescence of modern technology, to demonstrate that he was now capable of being a grown-up – then he had another idea.

The characters described below are genuinely fictitious, whereas the story is less so. For those unfamiliar with UK railway signalling folklore, please do not be deterred by the frequent references to projects and sites; the technical themes and deeper philosophical meaning should still be relevant.

Several generations

Once upon a time, in a parallel (but curiously familiar) universe, there was a railway line. On that line was a station consisting of several platforms. For the first part of the twentieth century it had a mechanical signalbox at each end of the station, working mechanical signals and points. The signalling was maintained by various staff, one of whom was called Harold. Accredited learning paths had not yet been invented so he simply started at the bottom and gradually learnt on the job so that after many years he was in overall charge.

Harold knew that mechanical equipment needed frequent lubrication and adjustment which was quite labour-intensive, however the individual components could be removed and replaced (or hit with a well-aimed hammer) so that the overall system could continue working indefinitely. The highlight was the overhaul of the lever frame locking, with the frequency of overhauls depending mainly on the level of wear and tear – busy boxes needed overhauls more often than others. Although Harold was experienced in mechanical equipment, he understood the benefits of newer technology and led a targeted programme of installing a few track circuits and electric point machines to improve safety and operations.

Eventually the railway administration decided the station should be fully resignalled, with a Route Relay Interlocking (RRI) situated downstairs and an Entrance-Exit (NX) panel upstairs in a new building at the station. This would improve station operations and reduce staffing costs because two boxes would be replaced by one. Soon after the station itself had been resignalled, other signalboxes along the line were closed, with the line gradually resignalled using remote RRIs controlled from the new panel using new electronic transmission systems called Time Division Multiplexers (TDMs).

Harold retires

Some years after the RRI resignalling Harold chose to retire; however the railway was a family tradition and many years later his son Bob became the maintenance engineer responsible for the whole line. Bob loved the RRI technology: he could find interlocking faults quickly, and some said he could even tell where trains were just by listening to the relays chattering. The relays themselves could be easily swapped out for servicing so the lifespan of the relay room would depend mainly on the condition of the wiring. In general the wiring lasted well – although for some strange reason one of the remote interlockings had used internal rack wiring from a different manufacturer which had degraded quickly and become dangerous. It therefore had to be rewired at considerable effort and expense.

Several decades passed and the railway administration decided that the signalling was due for renewal again because the lineside equipment cases were reaching the end of their life. The line was therefore resignalled with the national railway's new SCI (Standard Computer Interlocking), controlled by a new control centre with screens and trackerballs. Bob was told that the modern technology would be easier to design, test and alter than RRIs because it used software and data. Bob continued to work a few more years, although he missed the RRI technology because he could see and hear what was going on – rows of flashing LEDs weren't quite as satisfying.

By this time Harold had many grandchildren, and wider society had belatedly realised that women were also capable of being engineers, so it came to pass that his grand-daughter (and Bob's niece) Ruth joined the industry. After spending her early career in a variety of technical roles, she was asked if she wished to be the signalling engineer responsible for a prestigious enhancement scheme with a baffling acronym at her family's home station. She chose to accept.

Ruth's project

The initial brief given to the engineers was "improve the perception and user experience of those choosing to enjoy the benefits of a journey to, from and through the station". After many months of stakeholder workshops, requirements capture processes and local consultations

Back in the real world, several London stations have seen major layout alterations in recent years, with differing technologies.

A tale of three termini, #1: Paddington station.

Recent work has been necessary to provide connections to the new Crossrail tunnels, depots and sidings (with other alterations further west). The 1990s BR SSI and IECC have been replaced by Alstom Smartlock interlockings controlled by a Resonate IECC scalable at the Thames Valley Signalling Centre.

All photos Stephen Dapré.

the remit had become: "provide one extra platform line". Good she thought, the signalling here is relatively modern SCI, how hard can it be?

Ruth firstly sought some informal opinions from the major suppliers, however she was soon disturbed to find that they didn't seem that interested in altering the existing SCI and wanted to undertake a complete renewal with their own new products. It somehow reminded her of the boiler technician who had patronisingly told her last winter that the new-looking boiler in her house was no longer supported, parts were impossible to obtain and it would have to be completely renewed at vast cost.

Ruth phones a friend

She decided it was time to ask some of her contacts elsewhere in the country for advice. The national railway had been through numerous geographical reorganisations over its history, with the latest one based on Communities who were allowed to choose their own local name. (Those in charge had said this was to help create a collaborative people-centric culture, although Ruth suspected that it was really because they had exhausted all the sensible geographical terms such as Region, Area, District, Zone, Territory, Division and Route.)

Firstly Ruth contacted someone she already knew in the Community of the New Forest. At the start of the 21st century the Community had been told that instead of the national SCI product they should adopt a computer interlocking new to this country made by a well-known overseas manufacturer, because "overseas technology increased competition". However, they were now finding that despite being less than 20 years old it was already becoming difficult to maintain or alter. (They also explained that although many people thought that their Community was named after the ancient woodlands in the area, it was really because the long and thick lineside cables necessary for the centralised system architecture resembled tree trunks and roots on a forest floor.) Overall they had little advice to offer, however they suggested contacting their colleagues nearer the capital city.

Ruth thus asked the Community of the Wombles. Named after a rare but famous furry creature that lived on a nearby common, their main signalling centre controlled some of the busiest lines in the country using RRI technology and NX panels. Reassured that RRI technology should be easier to alter, she asked how they would deal with providing a new platform line. She soon learned that although the panel and remote RRIs were relatively standard, they were connected by a rather temperamental electronic magical link system that combined panel processor and TDM functions as well as other mystical powers. If left alone it was reasonably well-behaved, but few were brave enough to ask it to do anything different. A recent platform remodelling at their terminal station in the capital city was reliant on the skills of individuals on the verge of retirement, so future alterations were unlikely to be feasible and they were now wondering how to replace it without massive disruption.

Ruth was puzzled that one of the youngest RRI installations in the country might prove to be the hardest to alter.

Community of the Broad-Minded

After extensive research using the company intranet and archives, within a few minutes Ruth found something much more useful on the public internet which said that a different terminal station to the west of the capital city was using computer interlockings. This station was managed by the Community of the Broad-Minded (CBM) so she arranged to meet them. She was wary because she had heard strange stories about them and their ancestral leader Bruno the Broad who had single-handedly built the entire line, tunnels and bridges to unusual dimensions in the 19th century. The conversation started awkwardly:

Ruth: Why are you Broad-Minded?

CBM person: Because we do things differently here: our semaphore signals go down not up; we put fuses in the negative leg; our signals, line names and relays are all identified differently. Even our NX panels use turn-push instead of push-push controls, so that we can avoid the curse of the Lord of the Pushbutton Rings.

Ruth (having done her research beforehand): Actually I thought your newer NX panels use push-push like everywhere else?

CBM (quietly): Hmm – they do, but we still managed to keep red "Locked" lights for our point indications to ensure that they are different to everywhere else.

Ruth remained unconvinced of the distinction between Broad-Minded and something else B-Minded, nonetheless she moved on. She quickly established that like the Wombles, the CBM's newest RRI/panel site used an electronic panel processor – a slightly different product but with the same end result: the railway layout was pickled in the 1980s because the processor was so sensitive and difficult to alter. (It even had its own special relay called a Freeze Up indication relay, which apparently was very amusing for those in CBM.)

The 1980s site was in stark contrast to their earlier 1960s-1970s era RRI installations which had been hand-crafted in their very own works and seemed to be lasting remarkably well, with some still in use now. The CBM had made several layout alterations at major stations with few problems except for the difficulty of soldering the tag blocks on the quaintly-named "non-vital" racks (Ruth wondered why they even bothered if they weren't essential). Ironically the RRIs themselves were still original whereas some of the ancillary electronic systems such as train describers and phone concentrators had been renewed at least once. What bemused Ruth most was that the older the site, the easier it seemed to be to alter it.

Whilst all this was interesting, her real focus was their experience with computer interlockings…

Ruth: I understand that you do have some computer interlockings?

CBM: Ah yes, our first was at our terminal station in the capital city. We decided in the early 1990s that because of our intense train service it was essential to have six parallel lines with full bi-directional signalling, to cover possible scenarios where we might have more than one train moving at a time. We also needed complex swinging overlaps, and some routes needed as many as four alternative routes between entrance and exit signals. We were told that the new SCI product would make anything possible, it's only data.

Ruth: I see…and how did it go?

CBM: Well, it was one of the first major stations nationally to be resignalled using SCI. We needed several SCIs alongside each other to cope with the data and they struggled with all the cross-boundary routes – so we had to amend or omit some of the data until it worked.

Ruth: OK…are the SCIs still in use?

CBM: Certainly not, we are preparing for an even more intense service for the new Happyrail line which requires major layout alterations. The existing SCIs simply wouldn't have coped, so our supplier has provided new computer interlockings backwards-compatible with the 1990s SCI data constructs and lineside architecture but with much larger data capacity. This has allowed us to alter the layout, rewrite the data to modern simpler standards and use fewer interlockings overall.

Ruth: That sounds great, improved capacity and flexibility. Presumably any future alterations can be done just like an SCI scheme then?

CBM: Yes – except we will now have to always use the same supplier for any future changes whereas SCI was supported by several suppliers. Oh and the interlockings cover much bigger areas so we have to block more lines if we want to change the data. Oh and all the neighbouring interlockings need to know what each other are doing, so data changes have to be co-ordinated across the entire system area, which typically limits us to two data changes a year. Oh and the ergonomics people decided the screens were too cluttered so we had to add another workstation. Oh and then there's UTCS…

Ruth had vaguely heard of UTCS: Universal Train Control System. Apparently, it was the new big thing.

Ruth: Oooh, UTCS, does that make it easier?

CBM: Hmm, not really – the supplier needs the layout design frozen much sooner than for normal interlocking design, which relies on the track engineers deciding what crossovers they are going to build when (and not changing their minds on the Friday afternoon when their cranes don't turn up). Oh and apparently UTCS needs everything dimensioned to the nearest nanometre otherwise it can't cope with any track layout calculations.

Ruth: Oh well, at least it will become the standard across the industry.

CBM: Indeed, as long as the same supplier supplies both the interlocking and the UTCS equipment. Oh and the national rules aren't that clear yet so we are customising them to be Broad-Minded to suit our special local requirements.

Ruth: I thought we'd already used UTCS somewhere nationally..?

A tale of three termini, #2: London Bridge station.

The area around London Bridge has undergone a major remodelling associated with work to upgrade the Thameslink line from south to north London, with ETCS Level 2 and automatic train operation in the core section. The work has seen the addition of extra through platforms, lines and flyovers.

Originally controlled by a 1970s Westpac geographical relay interlocking and an NX panel, the line now uses Siemens Trackguard Westlock interlockings controlled by a Controlguide Westcad system at Three Bridges Rail Operating Centre. The Westpac interlocking was extensively modified for the remodelling stages prior to full resignalling.

A tale of three termini, #3: Waterloo.

Work has seen the remodelling of platforms 1-6 (for longer trains), and former Eurostar terminal (for domestic use).

The 1990s route relay interlocking and NX panel are still in use.

In August 2017 about half of the platforms were closed for several weeks to allow the track remodelling and associated RRI alterations. During this blockade a point machine on an adjacent open line moved position, resulting in a low speed derailment of a departing train. The formal RAIB report is imminent, in the meantime it is a reminder of the inherent risks of working with trains still running.

CBM: Indeed, in the Community of Rural Song and Sheep. Actually, you may want to talk to them?

Ruth felt she could not face another Community opinion that day so decided to sleep on it.

Binary Railway and UTCS

The next day, before Ruth had even contacted anyone, she received a strange email claiming to be from a secretive organisation called Binary Railway. It said:

"Dear Ruth, we understand that you are considering a renewal/life extension/ enhancement scheme (delete as appropriate). We wish to make you aware of the numerous benefits that Binary Railway could offer your project. Simply by responding to this email you will qualify for headway points to unlock precious capacity on your line (T&Cs apply, performance is dependent on numerous external factors, the value of headway may go down as well as up).

"Just remember: anything is possible once systems become more interconnected, it's only data."

Ruth had recently completed her employer's Information Security training and knew it might be unwise to respond to an unsolicited email like this. She decided to ignore it for now, leaving it for a later date (and potential sequel).

Several days later, after careful planning and logistics Ruth was finally arriving at a station deep in the Community of Rural Song and Sheep (CRSS). Its name in the local dialect began with M and roughly translated as Middle-of-Nowhere. Ruth was already struggling to see how this was the vision of the future for busy railways.

The CRSS people were certainly very friendly: they proudly showed her their control centre for what was really a very long single line with a few loops. Ruth was polite but inwardly underwhelmed: applying UTCS to this line was one thing, yet she had seen the Wombles making good use of the things that they had, operating a genuinely busy railway using their c.1990 NX panel, RRIs and (admittedly fragile) panel processor thingy. She thought she would ask some questions:

Ruth: How old is your UTCS installation?

CRSS: Approaching ten years now.

Ruth: So will other UTCS projects be copying it?

CRSS: Not sure, I think their Communities have decided they have very important local requirements that means they need to adapt the principles.

Ruth: I can imagine. At least they can reuse your generic system and software.

CRSS: In theory – except that our installation is version 1.1.503.202.100.4 whereas other schemes might be using newer versions which may not be fully backwards-compatible. And we might be getting new trains soon which may run on a different version anyway.

Ruth: Oh well. At least with minimal lineside signalling it must be easy to alter the existing layout?

CRSS: In theory easy – we needed to make a minor line speed amendment last year, and we were told "don't worry, it's only data" (Ruth was normally good at keeping a poker face but she was now beginning to struggle.) Actually, we did have to base the entire project programme around the tester being available before he went to another continent far far away.

Ruth: THE tester..?!

CRSS: Yes, apparently the supplier has few people still competent to alter the system. Next year we will have another big alteration to make – we need to add a rectangle on the control system screen to depict a new station that is being built on plain line many miles – sorry, kilometres – away from any signalling features.

Ruth was losing patience now, and decided to leave. Back at the station, she had almost an hour to wait for her train (or any train), so she tried to do some emails until she realised there was no network coverage. In any case her phone had been malfunctioning recently, which she'd been told was because it was over a year old and was clearly obsolete and unsupportable. She instead amused herself by counting all the lineside signs that "cab" signalling still seemed to require. At least it was Grandpa Harold's 100th birthday party this weekend, she always enjoyed listening to his railway stories so it would be a good chance to catch up with the family and discreetly find out what they might know…

Harold's hundred

Ruth was on her way to Grandpa's birthday party. Her train was late due to what the train on-board executive head of despatch claimed were "infrastructure problems", but with her growing knowledge of the industry she instantly understood the root cause: it could be absolutely anything. Really she should know better than trying to travel on a Sunday. She only just arrived in time for the party and went to find her grandpa.

Providing a banner repeater, how hard can it be? In RRI areas it can typically be achieved within lineside location cases; on newer technology it could also require data and control screen alterations, adding time and cost.

"...looking quite worn out and needs constant lubrication to minimise the strange noises and grumbles, but the basic logic is still there and could go on forever, although containing numerous outdated principles that are no longer relevant or tolerable – don't you agree Ruth?" said her Uncle Bob. Having walked in mid-conversation, Ruth was in that awkward position where she was unsure whether Bob was talking about an obscure mechanical signalbox, or he was just being rude about his father again. She decided the best plan was to rapidly change the subject.

"Happy Birthday, Grandpa! I'm in charge of a major enhancement programme!"

The older men were both taken aback by the use of the E word. Although their station's track layout had been altered in previous generations, in their day it tended to get done with rather less fanfare, project management and acronyms. Nonetheless, they were genuinely interested in young Ruthie's career in the industry that they both knew so well.

Uncle Bob struggled to comprehend how it could be so difficult to alter computer interlockings when data changes meant most of the testing could occur off-site beforehand. Although retired nowadays, he knew friends who had been altering their 1970s Whizzpac geographical relay interlockings with great success despite people worrying about the obsolete technology. In his view all it required was proper planning, design, changeover and test by skilled staff who could understand the complex relay circuits. And some careful quality checks of any relay sets being reused. (And a decent Bank Holiday block. And a kettle and mugs.)

Blockade

Bob was also bemused as to why Ruth's project would need a three-week blockade to commission one new platform, with passengers having to use a mind-bogglingly complex timetable of replacement buses from nearby stations. In fairness to Ruth, it wasn't her idea – a risk review workshop with a list of attendees longer than a wedding guest list had concluded that the safest way to run trains was to not run trains. Bob gently told her that in his RRI days the operating department would set up single line working on one line for the whole weekend and they would do whatever was necessary on the other line, with drivers politely tooting when they passed the workers.

Knowing how to wind up his father, Bob thought it would be fun to tell Harold about Ruth's blockade.

"What nonsense!" Harold spluttered. "When we were doing our mechanical locking jobs, we would do all the work between trains to ensure we didn't delay anyone. And we wore dark clothing to avoid distracting the drivers. And it was usually in thick smog due to the coal fires." Ruth inwardly recalled his previous stories about various mishaps with light engines, trap points and how one of his best mates was hit by a train – but it was Grandpa's birthday so she decided to save her views for another time, it was not the time or place for a safety conversation.

Block shelf life

Ruth was intrigued by the fact that mechanical signalling seemed to be so long-lasting yet the newer technologies had a shorter life. National renewals programmes were starting to be driven by urgent replacement of obsolescent electronic systems whereas the older systems were expected to keep going forever. She had heard of several examples where there was no business case to resignal lines with numerous mechanical signalboxes, so they were being life-extended instead. Unfortunately, the modern systems still seem to require lineside cables, which becomes costly on long rural lines. Maybe the radio-based UTCS pilot scheme she had visited wasn't so crazy..?

Ruth decided to ask Grandpa Harold whether it would be better to go back to using mechanical interlockings. As soon as she did so, she regretted it – and she saw her Uncle Bob slipping out of the room. Harold had clearly been enjoying his centenary a bit too much, and started a rambling explanation about how there was an undercover club known as the Preservation Railways section. Having lived through the last war Harold was always full of stories about resistance movements, and he claimed that the PR section were secretly planning to overthrow the major computer interlocking suppliers and force the national reintroduction of mechanical signalling. Ruth had been around long enough to realise that this was highly unlikely: the public face of PR was clearly focused on heritage lines rather than worrying about the national railway network, and they also provided a safe haven for those disillusioned with the modern world.

Grandpa had fallen asleep mid-sentence, so Ruth decided she should maintain a healthy work/life balance (and be a dutiful grandchild) by patiently listening to distant members of the family telling her about their own careers and how bad the train/traffic/parking/weather was on their journey.

Several dull hours later, Ruth escaped to the garden. She felt a sense of release and happiness that she had gone into engineering: even though she was faced with what seemed like impossible puzzles, it was always fun trying to work out what would work and who would know best. She thought she would try Grandpa once more before she went home.

"Grandpa, why do you think mechanical signalling is no longer used for new schemes?"

Grandpa was refreshed after his nap and thought for a moment.

"Manpower. It just needs lots of men. Forever oiling, maintaining, pulling levers for every train." Ruth momentarily wondered whether to introduce Grandpa to the terms Whole Life Costs, CAPEX and OPEX: she knew he was still mentally alert and would quickly grasp the concepts from his own career but it might spoil the moment. Instead she hugged him and left.

Decisions, decisions

The time had come to agree how best to alter the signalling system to provide the extra platform line. Ruth did recognise the benefits of modern technology – there was no question that computer-based systems offered major benefits at complex stations and junctions, especially because the interlocking data could be pre-tested off-line. Whilst this was fine for major projects that were altering a recent interlocking or had enough funding to provide a new one, the difficulty seemed to be the longer-term support for a sensible lifetime. Suppliers didn't seem interested in altering the existing SCI at her station, and she knew of projects elsewhere involving even simpler alterations (such as adding repeater signals) that were struggling to be viable.

Being a professional engineer, Ruth had prepared an Option Selection Report to compare the advantages and disadvantages of various technical solutions based on her research, circulated a draft report and had invited a small group of genuinely useful people to join a short telephone conference to help agree the final decision. The day before the meeting, the project manager rang Ruth.

PM: Hi Ruth, just wanted to let you know that we're expecting a minor scope change from the client.

Ruth: OK, I see...any clues about what is changing?

PM: Don't worry, most of the work on the station building is unaffected, there's just a minor adjustment to the platform level.

Ruth: Define "minor"..?

PM: Well, apparently they've decided they don't need the extra platform line after all.

Ruth: So basically I've just wasted months assessing the signalling alterations..?!

PM: Oh, I hope not – the good news for you is that they want to extend the existing platforms for longer trains instead so you will need to move some signals out of the way. Do you happen to know what signal sighting is?

At this exact moment Ruth's phone decided that now would be a good time to reboot for no apparent reason. On this occasion Ruth was grateful for the imperfections of modern technology.

What do you think?

Do some of the fictitious events and attitudes in Stephen's article ring true with you? Do you think that our entire approach needs to change?

We'd love to hear what you think and always welcome letters for our feedback column. Email **irsenews@irse.org**.

Connectivity enables innovation

Mike Hewitt
Chief Technology Officer, ADComms

This article explains the role that connectivity has in enabling innovation and how I see connectivity has transformed our lives, the way we interact, the way we communicate and arguably has transformed the way we move, work and play. Most innovation has been delivered by the devices we hold in our hands and the services they deliver, and over the last 15 years there has been significant development in devices and services.

A smart phone with no signal is not very smart, and innovation has been reliant on the connectivity created by the ubiquitous communications networks we use. The smart phone and laptop have created the ability to work anywhere any time and to be connected to anyone or everyone all the time. New devices from lighter laptops, tablets, and services such as cloud computing, software as a service, iOS, chromeOS, and the applications that deliver information and entertainment, are all underpinned by wireless and fixed networks. I use the term wireless advisedly as I would argue all devices are wired plugged in at some point (charging – even wireless chargers have wires!) Our networks have evolved, based on the fixed connectivity that underpins the wireless world that we now move through.

Fixed networks now deliver connectivity to our homes from 50 Mbps (via FTTC – Fibre to the cabinet) to Gb+ with full fibre networks with direct fibre to the home connections. These fixed networks connect wireless infrastructure with Mb, Gb or at the carrier level from 10 Gb+ optical networks to radio transmission nodes, and our cities are interconnected with Terabit networks. We are moving more and more data at the speed of light, which is connecting us to our friends, our work and our suppliers.

We will continue to consume this fixed network capacity with an overlay of wireless infrastructure that will take the connectivity to our devices from Mbps to Gbps and that device could be anything from a phone, tablet, appliance, to robots, autonomous vehicles or trains.

Innovators like Google, Facebook, AirBnB, Tesla, Microsoft rely on the connectivity delivered through fixed and wireless networks to create value through the services they offer and we consume. The future we face continues to exploit the connectivity we rely on. Existing and new individuals and their technology partners and companies will innovate to deliver new applications and services, built on future technology platforms. And all these solutions will be delivered using the fixed and wireless infrastructure. These networks will provide the connectivity that future innovators, inventors and visionaries will use to deliver the next generation of services that could or will transform our society.

The next five years will see a series of innovative technologies that we will come to use every day and we ultimately rely on – look how quickly connectivity has become the 4th utility and a critical service to us all. My top 5 technologies for transforming our future are.

1 – IoT – Internet of Things

Connecting sensors, devices, appliances, vehicles, trains and any other device that you can imagine. The value comes not from the device or the data, but how the data is used, distributed and consumed – the engineers of the future will also be data scientists, data miners and the information aggregators who find a way to deliver value to consumers from the data we create.

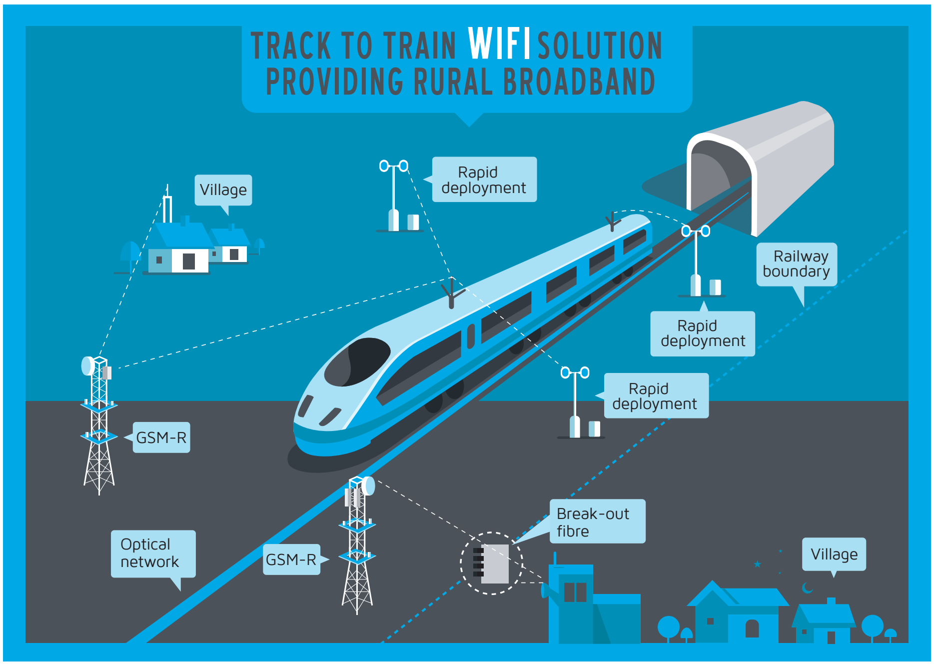
2 – Blockchain/distributed ledger

A distributed ledger is a database that is consensually shared and synchronised across multiple sites, institutions or geographies. It allows transactions to have public 'witnesses', thereby making a cyberattack more difficult. The participant at each node of the network can access the recordings shared across that network and can own an identical copy of it. Further, any changes or additions made to the ledger are reflected and copied to all participants in a matter of seconds or minutes.

Underlying the distributed ledger technology is the blockchain, which is the technology that underlies bitcoin. The blockchain is a growing list of records linked by cryptography to secure the information they contain. Example uses of the technology include; Smart Ticketing, Smart Contracts including property transfers, authenticated voting for government. A power of the blockchain is it is decentralised so the power is no longer with nation states to control economies, currencies or policies.

3 – AI – Artificial Intelligence

Or as I prefer Assisted Intelligence. This uses computer power to imitate human intelligence to automate decision making, to analyse data and make automated decisions, image recognition,



Rail connectivity requires an optical network with a wireless connection to the train. For operational purposes this is currently provided by GSM-R, with LTE/5G the likely technology for the next generation of operational connectivity. Customer Wi-Fi is generally provided by commercial LTE and fixed Wi-FI. Railway fixed infrastructure could also be used to deliver rural broadband connectivity as well as rapid deployment connectivity. *Graphics ADComms.*

facial recognition, creativity, game play, data analytics and decision support (the autonomous vehicle). The power of human intelligence in our evolution to date has been transformational. From sea dwelling to tree dwelling to where we are now is truly evolutionary and the role of technology will be revolutionary as we embrace AI. Some of the interesting applications of AI include:

Chat Bots delivering information to customers when they require it enabling staff to deal with complex issues.

Healthcare and Medical Diagnosis – with a GP in our pocket AI can help to make diagnosis based on the symptoms we enter and information from health monitoring devices we now wear.

Intelligent Cybersecurity – monitoring and defending networks from suspicious activity and protecting critical national infrastructure.

Google Deepmind and AlphaGo – represented a step forward in AI with the ability of the software itself to learn through reinforcement learning and learning to master the ancient game of GO in 3 days. Future applications of this type of learning would be assisting with solving elementary problems in physics or the development of new drugs.

4 – Additive manufacturing/ 3D printing

Manufacturing has gone through many iterations to move to more local production. While it is not yet in danger of replacing mass manufacturing, 3D printing will encourage production closer to the point of consumption. Whereas cars today are made by just a few hundred factories around the world, they might one day be made in every metropolitan area. Parts could be made at dealerships and repair shops.

More customised products – Additive manufacturing lends itself to the production of customised goods, and could allow us greater individuality in everything from our clothes to our cars and home interiors. A French company, Sculpteo, has launched the world's first 3D printing mobile app, which integrates the work of professional designers with end users' personal data.

A new era of creativity – Additive manufacturing opens up new possibilities for amateurs and professionals alike to follow their imagination, and could stimulate the creativity of a new generation of artists, designers and engineers. Vivek Wadhwa, VP of Innovations and Research at Singularity University says: "We are about to see a renaissance in design. Imagine what Leonardo da Vinci could have designed if he had an iPad and 3D printer".

New horizons for other industries – Additive manufacturing could revolutionise production in some industries. In the healthcare sector, scientists are already using it to create new body parts. In 2012 an 83-year-old woman became the first recipient of a printed jawbone created by a Belgian company LayerWise.

3D printing could also revolutionise chemistry and pharmaceuticals. Researchers at Harvard University have created a miniature battery while Lee Cronin, a chemist from the University of Glasgow, claims to have prototyped a 3D printer capable of assembling chemical compounds and printing drugs.

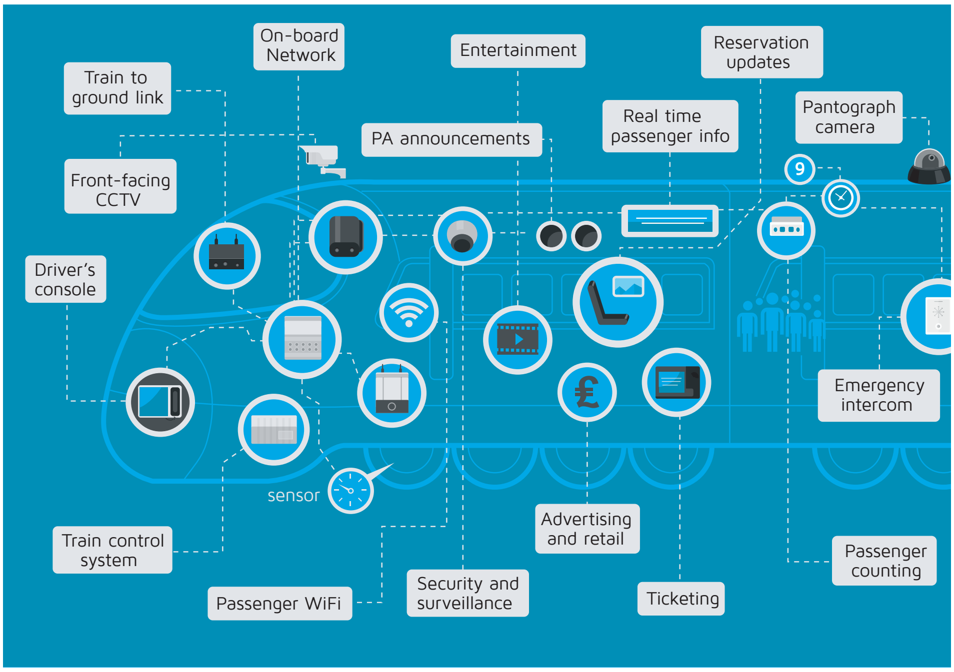
5 – Automation

Is such a large area for development of what we buy, how we move, from 1-Click to Zero-Click when products are delivered by drone to home without our input, based on usage, preference or prediction. Imagine having the bad day in the office and when you arrive at home there's the personal trainer, wine merchant and UberEat waiting for you without your involvement – exercise out the frustration, sip the fine wine and eat your favourite meal – your bad day transformed into a positive experience!

Automation applications are widespread from; logistics and picking – Amazon and Ocado have automated the picking and dispatch of the products we order; software solutions that automate the preparation of company accounts; autonomous vehicles changing how we move and automated online training solutions changing how we learn.

In my role I'm constantly challenged to evaluate, investigate and recommend technologies that can help transform our internal capabilities and transform customers' capabilities in order to deliver the core services that our end users demand. I would argue that connectivity underpins every transformational opportunity – that's why it's so important for rail that we provide and deliver connectivity solutions that will enable current and future technologies to connect, engage and transform journeys.

All of the above is possible albeit difficult. Delivering connectivity to everyone, everywhere is not without its challenges. Many people wonder why they can't make a call from a mobile phone on the train, why the on-board Wi-Fi



Train connectivity is required for both operational and customer requirements. The operational requirements are for both safety critical train control, emergency voice communications and rolling stock management. The customer requirements range from ticketing, reservation updates to entertainment and advertising.

doesn't enable them to connect to the internet, why areas of the country have no signal. We engineers know what the problems are and how to overcome them, and while a challenge it's a challenge we welcome.

There are so many elements we take for granted when we connect to our devices. These include the copper and fibre cables, optical lasers transmitting data at the speed of light, power to remote locations, backup power systems, underground infrastructure for cables, trackside towers and station based infrastructure. Sophisticated systems that secure, manage, and monitor all this infrastructure are also required. All of these capabilities are delivered by engineers, many of which I'm proud to call my colleagues.

The Government has committed via their manifesto commitments to deliver high speed passenger Wi-Fi – my commitment is to solve the wider challenge of high speed connectivity to all of the UK

To finish, many of the above are the positives of our future – and to balance – there are negatives and implications we need to consider.

- IoT – when every device is connected the impact of data security, data protection, identity theft, cyber warfare, cyber disruption and network security.
- BlockChain – we are all aware of the volatility of cryptocurrencies, illegal use of digital currencies and the complete dependency of the internet.
- AI – if I look back to HAL (in the film "2001 – A Space Odyssey"), Skynet ("Terminator"), WarGames ("WOPR") for those of you over 40, or now it's Siri, Alexa, Google, Facebook data breaches, data bias – will our future be what we envisage – or what we are told?
- 3D Printing – copyright protection – 3D printed undetectable weapons.

And as a final thought. Did leaving the ocean result in our loss of ability to swim? Did walking mean we couldn't sit? Did embracing fire burn all the forests? Did we learn to cook food that fuelled the increase in our intelligence? Did the industrial revolution result in the loss of employment for all? Will future technologies erode and decrease, or evolve and improve?

I suggest evolution is a process that has and will always exist. It's down to us all to embrace the technologies that evolve and transforms our lives for the better and refrain from the technologies that may degrade our lives for the worse.

We balance, we learn, we create, we invest, we challenge, we ask why, we ask how and we ask what – we ask consider, communicate and connect. It is the connectivity we have as individuals, the connectivity we have as communities and the global connectivity that enables innovation and evolution – if we use it correctly.

About the author ...

Mike is chief technology officer at ADComms (a Panasonic business). Mike has over 30 years' experience with leading engineering, innovation, and operational excellence in telecoms, delivery and customer focus in customer-facing and Internal operations roles. He specialises in network delivery and security but also covers wider IT and networks, operations and service delivery, consulting and R&D.

Industry news

French ETCS test trains

France: SNCF Réseau and SNCF Mobilités have introduced a specially equipped TER train to test ETCS on the French network.

The new train has been fitted out at the SNCF Technicentre in Nevers and, according to SNCF, is the result of an €11 m (£10 m, $13 m) investment and 70,000 hours of work.

Train X72633/634, which will replace one of SNCF's existing test trains, has 27 sensors and antennae installed on its undercarriage, 23 antennae fitted to its roof and five sensors mounted to monitor the bogies, axles and wheels.

The train will also utilise France's own TVM 430 in-cab signalling technology, allowing it to operate on the high-speed rail network. After it is commissioned towards the end of 2018, the ETCS test train will begin validation tests.

ETCS Level 1 has already been deployed on the Nîmes-Montpellier bypass and it is due to be commissioned between 2020 and 2022 on the Longuyon-Basel branch of the North Sea – Mediterranean corridor.

ETCS Level 2 is already in use on the LGV Est, Southern Europe Atlantic HSL and Brittany-Pays de la Loire HSL. By 2025, it will also go live on the LGV Paris-Lyon and the Marseille-Ventimiglia routes.

East Coast Main Line ETCS

UK: Network Rail is looking for a supplier to help deliver the first major inter-city digital railway on the East Coast main line (ECML).

The London North Eastern and East Midlands (LNE & EM) route is looking to team up early, and on a whole life basis, with a technology provider to work on designs, plans, phasing, costs and realising benefits. The selected partner will play a key part in the development and deployment of the European Train Control System in-cab signalling on ECML, starting on the southern end.

Group Digital Railway managing director David Waboso said: "There is a compelling case for a digital transformation on this southern section of the East Coast main line. The big challenge of digital railway is the integration of the infrastructure and rolling stock, and with the need for asset renewal coming at the same time as 70 per cent of passenger trains being fitted, we are presented with a huge opportunity to align track and train in an efficient way.

"The procurement is being done in a radically different way which will build on the key learnings from our Early Contractor Involvement programme. We seek a long-term relationship based on genuine partnership, extending for the whole of the asset life."

UK first live 5G trial

UK: Communications provider EE has achieved a major milestone launching its first live 5G trial, which it also claims is the UK's first live 5G trial. EE has previously tested 5G in lab conditions, hitting download speeds of 2.8 Gbps, using 3.5 GHz spectrum.

Hosted in Montgomery Square, Canary Wharf in London the trial is designed to test 5G spectrum and devices for coverage, speeds and performance. Canary Wharf was an obvious choice of location, as it's a very busy area, with 150,000 people there every day. With 5G having to cope with huge data demands from vast numbers of connected devices it's important to trial it in an area that will test it properly.

EE notes that high capacity zone testing is a critical part of its 5G launch programme, and it plans to put ten more 5G sites live across east London later this month. The trials are aimed at both consumer and business technology.

The trial will use 5G New Radio over the 3.4 GHz spectrum that EE acquired 40 MHz of at Ofcom's recent spectrum auction. This spectrum is likely to be the cornerstone of early 5G networks and EE wants to test how it behaves in a real-life setting. The trial will be carried out using Huawei equipment.

New train Wi-Fi for Merseyrail

UK: Liverpool-based UK train operator, Merseyrail, has announced that passengers on board the new Stadler-delivered trains will have free internet access, provided by Panasonic.

The new fleet, which is due to go into service in 2020, will be able to connect up on all 75 miles of the city-based rail system, including around eight miles of tunnels. Underground stations such as Hamilton Square, Liverpool Central and Moorfields are also planned to be provided with free Wi-Fi.

As well as offering Wi-Fi on board, the wireless network will feed exact passenger numbers on each train back to the control centre. According to the Serco-Abellio owned franchise, this will allow it to manage services better and ensure that the network operates at optimum capacity. This, it says, will be crucial at peak travel times or during the major sporting or cultural events.

The wireless system will also enable high-quality CCTV and voice links to and from the trains. AD Comms, a subsidiary of Panasonic, had previously installed a leaky feeder system in the region to ensure GSM-R coverage in the tunnels. However, it is understood that this will not form part of the new Wi-Fi network.

French innovation competition

France: SNCF's stations business Gares & Connexions has launched an innovation competition branded Open Beacon aimed at enhancing the accessibility of and service offering at major stations.

The term 'open beacon' refers to Gares & Connexions' plan to install Bluetooth geolocation tags in more than 300 stations across the country. These are intended to drive personalised alerts and information feeds to passengers' own devices as they pass through the station.

SNCF is keen to ensure the potential of such geolocation techniques is maximised as far as possible, hence the decision to open up the process to the wider digital and start-up community through a competition.

Entries from third parties are expected primarily to address one of three categories: navigation, services & retail, and accessibility. However, entrants will also be allowed to enter in a fourth category described by SNCF 'something we have not thought of'.

An initial group of 10 teams will be selected to take their pitches forward to a final judging competition in the first quarter of 2019. Three of the 10 will then be selected to work up their ideas in partnership with staff from Gares & Connexions.

Interlocking data validation

UK: In CBI interlockings techniques and technology now exist to recheck the data written without the benefit of such systems. Alstom Signalling, Systems and Infrastructure has been appointed by Network Rail to independently check and interrogate SSI and Smartlock interlockings using their data validation tool.

Data errors have resulted in some recorded wrong side failures on the infrastructure leading to unsafe movements of points machines during rail traffic. The number and potential of these incidents has concerned the UK regulator, the Office of Rail and Road (ORR).

Across the network, there are circa 300 SSI and Smartlock interlockings any of which may contain potential errors. To manually check these interlockings would take many years. The programme will interrogate 203 interlockings housed within 42 control centres across the network and controlling some 2396 sets of points. The results, including an analysis of any anomalies, will be completed before the end of control period 5 (April 2019).

Network Rail agrees Sussex traffic management strategy

UK: Network Rail has confirmed its intention to directly award Hitachi Rail Europe a £30m contract to supply a traffic management system for the Sussex area of its South East Route and the East London Line. Traffic management has been identified as a priority for investment under the Digital Railway Programme during the next five-year Control Period 6 starting on April 1 2019.

The South East Route has been identified as one of eight priority projects in the Digital Railway programme, and procurement of traffic management for the Kent area has been specified under the Southeastern train operating franchise which is currently being re-tendered.

Several of the main lines in the Sussex area are covered by the Tranista traffic management system which Hitachi is supplying for use at NR's Three Bridges Rail Operating Centre under the Thameslink Programme; work is now underway to interface this with the ATO and driver advisory systems fitted to the Thameslink fleet of Siemens-built Class 700 EMUs.

Because London Overground's East London Line and the remaining lines in Sussex form six 'geographically isolated areas' which directly interface with the Thameslink control area, Network Rail has determined that adopting a different traffic management system for those routes 'would result in the introduction of multiple operational fringe/technical edge cases that could potentially cause significant degradation to performance, significant additional workload and potential for error in route-wide train service management.'

It therefore decided that the best option would be to procure compatible technology from Hitachi as an add-on to the Thameslink contract under a negotiated procedure, without a prior call for competition.

According to Network Rail, an Outline Business Case to deploy traffic management on the remaining parts of Sussex was due to be submitted to the Department for Transport in November for formal review and approval. Any contract award would follow approval of the Full Business Case, which is scheduled for autumn 2019.

ETCS L2 operational in Denmark

Denmark: Regional passenger services operated by Nordjyske Jernbaner began using ETCS Level 2 between Frederikshavn and Lindholm near Aalborg on 21 October.

The Aalborg – Frederikshavn line was selected as the early deployment pilot route for the western ERTMS infrastructure contract within the national signalling programme. This is the first ETCS route in Denmark to go live.

Services were suspended for two weeks while infrastructure manager Banedanmark completed the installation of lineside equipment and the operator undertook staff training. A reduced service will initially operate until the December timetable change.

Banedanmark now hopes to complete the roll out of ETCS across the national network by 2030.

Humanoid robot

Europe: Eurostar passengers in the departure area of London St Pancras station can now interact with a humanoid robot to find more information about their journey. Eurostar expects this to be particularly popular with families.

The Pepper robot from SoftBank Robotics was supplied by Robots of London. It uses a camera to understand facial expressions, body language and speech, can respond to questions and can pose for a photograph.

Institution of Railway Signal Engineers

News from the IRSE

Blane Judd, Chief Executive

Council meeting 2 October 2018

Council members are elected by the corporate members of the Institution, i.e. Fellows, Members and Associate Members, for two-year terms, and can stand for election for subsequent terms if they wish to do so, as defined in the Articles of Association. In this issue of IRSE News you will find nomination forms which can be used to identify individuals who wish to become part of the governance structure. Details are on the forms regarding the process, but each nominee will need ten supporters from the membership to sign their forms. The results of the election process are announced each year at the Institution's Annual General Meeting held in April and are reported in IRSE News. A list of current Council members can be viewed on the website at irse.info/gdx9f.

Communications and Publicity: Council also agreed to continue to use the services of Prettybright, the public relations and communications consultancy, which has guided the Institution through the re-brand project, increased social media involvement, and supported the ongoing development and integration of the new IRSE website.

IRSE Strategic Planning: In order to produce a relevant and robust strategic plan from 2020 onwards, Council agreed that a working group be formed so that a year or more can be spent compiling the plan to ensure it accurately captures the Institution's vision in line with its core competencies and value proposition in the context of current industry realities. The plan will also include proposed operational mechanisms to be put in place in order to achieve an accurate execution of the strategic plan as well as the means through which the success of its execution will be measured. We will be asking for input from members as the plan is developed.

IRSE Industry Partner Scheme

Following the closure of the previous IRSE Industry Affiliation Scheme, work has been going on in the background to create a new Industry Partner Scheme; more appropriate for modern businesses and providing better benefits. Details of how the new scheme will work, and how your business can be involved, are nearing completion now. Further information about the scheme will be available in forthcoming issues of IRSE News.

Presidential Programme technical meeting in December

Our fourth paper in the Presidential Programme for 2018-19 will look at the use of automatic train operation (ATO) in two very high-profile projects in London. Our presenters, Nicola Furness and Andrew Simmons, have been influential in the delivery of ETCS and ATO in the UK and the challenges of bringing into service operation. This event will take place on Tuesday 4 December 2018 at 17:30 at EEF Broadway House, St. James, London. This event is free and open to the public. So, why not bring along some industry colleagues to demonstrate to them the benefits of the IRSE. This event will also be live-streamed.

Annual Dinner, April 2019

The IRSE's Annual Dinner 2019 will take place at The Savoy, London, on the evening of Friday 26 April 2019. If your company is interested in booking places, please contact Hilary Cohen in the IRSE London office (hilary.cohen@irse.org or +44 20 7808 1180).

From 2020 we will be decoupling the AGM and the IRSE annual dinner. The need to manage the governance of the Institution means it is not possible for them to take place on the same day. Instead the annual dinner will begin earlier in the evening and will include awards focusing on recognising your industry achievements over the past year. Look out for more information about criteria for nominating members for awards at the IRSE Annual Awards Dinner 2020 in forthcoming issues of IRSE News.

London Office winter closure dates

Please bear in mind should you need to contact any department based within the IRSE's London offices that the office will be closed for the winter holidays from midday on Friday 21 December 2018 and will not re-open again until Wednesday 02 January 2019.

Local Section events for December 2018

As well as the Presidential Programme Technical Paper event being held in London on 4 December, events are taking place in a number of Sections. More details about event subject matter, times and exact locations can be found on the website at irse.info/nearyou.

Midland & North Western Section

Technical visit to the Rail Accident Investigation Branch

Ian Mitchell

IRSE
Institution of Railway Signal Engineers
MIDLAND & NORTH WESTERN SECTION

On 23 October 2018 the Midland and North Western Section visited the Derby base for the UK's Rail Accident Investigation Branch (RAIB).

We were welcomed by Andy Hall, the Deputy Chief Inspector, who described the role of the RAIB and how it operates. It was established in 2005 to undertake investigation of accidents independently of the police, rail industry bodies and the safety regulators. Although administratively part of the Department for Transport, the Chief Inspector of RAIB reports directly to the Secretary of State in relation to investigations so independence is maintained. RAIB's mission is to independently investigate accidents to improve railway safety and to inform the industry and the public – RAIB does not apportion blame; that is the role of the police and the Office of Road and Rail who will look for evidence of criminal activity or health and safety violations.

Collision at London Waterloo in August 2017.
Photo RAIB, Crown Copyright.

RAIB has 44 full time staff with bases in Derby and Farnborough. To ensure evidence is not lost when deploying to remote locations it can also call on around 450 'accredited agents' who are industry staff trained to record evidence while RAIB inspectors are travelling to site. An RAIB investigation is mandatory for train accidents with more than one fatality, five serious injuries or two million Euros cost of damage, but less serious accidents still have to be reported to RAIB, and they choose to investigate those where it is perceived that there may be safety lessons to be learned. The results of investigations are published on the RAIB web site, either as a full investigation report or a shorter 'safety digest'. The key outputs of the process are recommendations for action by industry bodies (train operators, infrastructure managers, rolling stock owners, etc.).

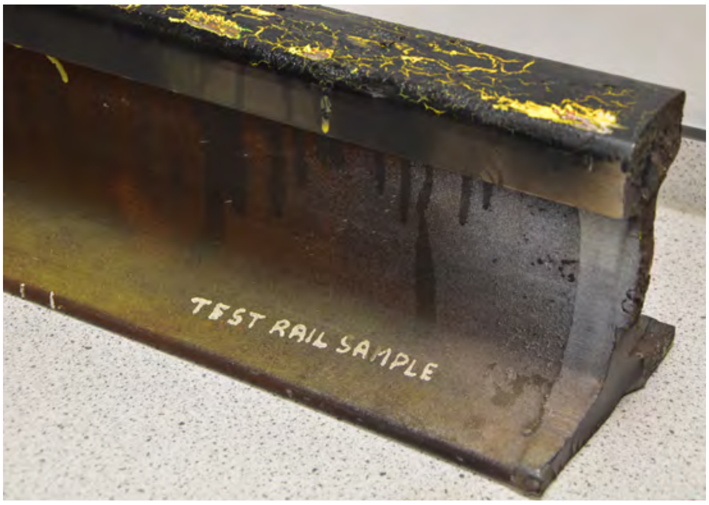
Richard Brown, an RAIB inspector based in the Farnborough office, then described an investigation into a specific signalling-related accident, which is due to be published in the near future. A collision

The MNW visitors at the RAIB facility in Derby.

A range of modern technology, including drones, is used by the RAIB.

RAIB has dedicated road vehicles equipped with all the equipment they need to gather evidence after an accident.
All photos Paul Darlington.

Analysis of aerial video evidence.



The RAIB's remit covers all elements of the railway.

occurred at Waterloo station in London in August 2017, during an upgrade project that involved extensive alterations to an existing relay interlocking. At the interface between part of the station that was out of use for remodelling and the part where trains were running, a set of points were not controlled and detected, and a passenger train leaving the station was diverted towards an engineering train standing on the adjacent track. The cause was identified as being temporary wiring that had been installed to allow testing of the interlocking changes using a test panel, but which bypassed part of the relay circuit for these points when the interlocking was put back into service. This is viewed as a particularly significant accident due to the similarities to the Clapham accident of 30 years ago and the report will make interesting reading when it appears (possibly by the time this IRSE News is published).

Stephen Brake, another RAIB inspector based at the Derby office, described some recent investigations into level crossing accidents. Two of these were at user worked crossing where power operated gate openers (POGO) have been recently installed. POGO was considered a safety improvement as it avoids the road user walking across the tracks to open gates, and ensures the gates close after the vehicle has crossed. However, the investigation found that a road user unfamiliar with the location had assumed that once the POGO had opened the gate it would be safe to cross without looking for an approaching train or telephoning the signaller. A contributing factor was the way in which the POGO instructions had been added alongside the original signage.

We also had a chance to see some of the equipment that RAIB use to gather evidence at accident sites. These include dedicated road vehicles equipped with everything they need to make measurements of track and vehicle components, and gather and preserve objects that may be evidence of what has happened. There is also a drone with video cameras used to obtain aerial photographs of the site, and associated software to process the images into a 3D model. This was illustrated using images gathered for the investigation into the recent collapse of a retaining wall into the deep cutting on the approach to Liverpool Lime Street.

The Midland and North Western Section is most grateful to all the RAIB staff who facilitated our visit. It gave a useful insight into the RAIB activities, and some serious 'food for thought' for the participants.

An opportunity for CPD ...

All the RAIB investigation reports and safety digests are publicly available at **irse.info/4ts28**. Why not spend some time studying these as part of your continuing professional development?

London & South East Section

Valise – the video balise

Paul Callaghan

IRSE
Institution of Railway Signal Engineers
LONDON & SOUTH EAST SECTION

The 3rd meeting of the London & South East Section's 2018/19 programme took place on 27 September at Transport for London (TfL) offices at 55 Broadway, London. The chair of the Section, Trevor Foulkes, welcomed close to sixty attendees and introduced Richard Shenton and Rob Hill of RDS International and their presentation on "Valise – the video balise".

Balises and virtual balises

Richard summarised the use of physical transponders or balises to determine the location of a train on a particular track for such applications as train control, platform stopping, door opening, tilt supervision and automatic train operation.

As individual items of equipment, balises have the advantage of being low cost, reliable and relatively easy to maintain. However, for the infrastructure operator, the management and cost burden increases as more balises are installed to meet an expanding range of needs, and once installed balises are fixed and relatively inflexible.

For many years the industry has carried out research and development into 'virtual balise' technology. This has focussed on the use of Global Navigation Satellite Systems (GNSS) to position a train without the need for any physical infrastructure. Whilst significant progress has been made for low density lines, the challenge of dependably discriminating between two closely spaced adjacent tracks remains unresolved for denser areas.

Video train positioning system

In parallel to wider industry GNSS R&D activities, RDS has focussed on developing a complementary technology based on real-time image processing of forward-facing CCTV images. The objective is to overcome the limitations of satellite-based positioning, including the errors caused by reflection of the satellite signals in the railway environment which prevent dependable track discrimination.

Richard briefly explained the history of the Video Train Positioning System (VTPS). The initial concept used a technique called Visual Odometry (VO) to measure the speed and distance travelled by the train. This approach was successfully trialled in northern Sweden in the winter and at high speed in Italy. For absolute or spot location, the forward-facing camera reads bar code signs, 'visual balises', at the side of the track.

Feedback from infrastructure managers indicated a reluctance to deploy additional signs at the trackside. As a result, the VO capability was extended to measure 'sideways' displacement on curves in addition to longitudinal odometry. This enabled VTPS to determine the direction taken through switches and crossings. Combined with a track map the system could then navigate around the network without the need for signs. However, the system still needed to be told its starting location.

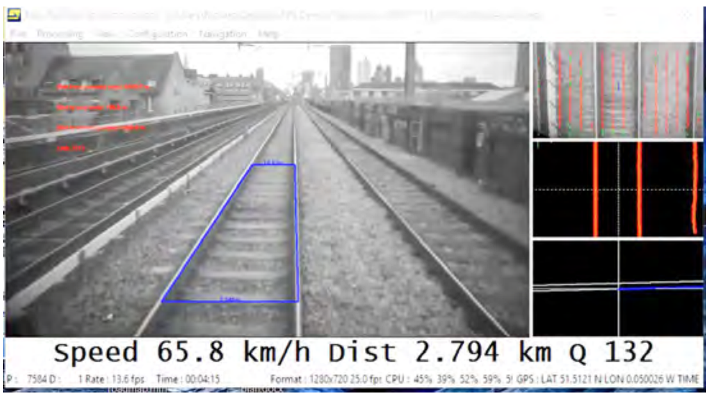
The video balise

In searching for a solution to the initialisation challenge, a breakthrough has recently been made to a more general approach to locate a train at a point on a specific track using Valise – a video balise. Broadly, the live images from the camera are matched with a database of images taken at known locations on previous journeys. When a match is found, the location of the train is known.

In order to optimise the matching process, the system compares small

Fitment of the equipment in the cab of the Network Rail NMT. The forward facing camera can be seen on the right hand side of the window.

The Video Train Positioning System in use.



'fingerprints' that are derived from the much bigger images. The design of the fingerprint enables the technique to be resilient to changes in environmental conditions, such as day, night, rain and snow.

This fingerprinting approach is already in use in other image and audio processing systems. To illustrate the technique in more detail, Richard described the workings of the Shazam mobile app. Shazam takes a small audio clip (around 30 s) recorded on a phone in a possibly noisy environment, and very quickly matches it to a large database of recorded music (around 45 years duration when played end-to-end). It then identifies the music to the user with a high degree of dependability.

Initial feasibility studies have shown that the video fingerprinting technique works well for train location and the company has now received funding from Innovate UK to develop and trial the technology in the Valise project.

The Valise project

Rob Hill then presented details of the Valise project which is now underway and is due to complete in early 2020. The partners in the project include Network Rail, First Group, Omnicom Balfour Beatty and Nottingham Scientific.

Nottingham Scientific, with its experience in virtual balise technology using GNSS, is working with RDS and their video based approach to provide a combined system which has the dependability needed for safety related applications.

The project will build demonstrators for a range of applications of increasing complexity including:

- Track precise positioning for train-based infrastructure monitoring from service trains – to be demonstrated on Network Rail's New Measurement Train (NMT) and compared with Omnicom's existing 'state of the art' Real-Time Positioning System (RTPS).
- Positioning for selective door operation (to be demonstrated on TPE Class 185 on route from Manchester Airport to Leeds).
- Virtual temporary and emergency speed restrictions.

Questions and answers

Following the presentation, the Q&A covered many topics, including; the performance of the system in changing environments, distribution of data to trains, use of signs for higher levels of safety and/or in tunnels, and the development of new fingerprints after layout changes.

Trevor concluded the event by thanking the presenters and the audience for a thought provoking and stimulating discussion, together with thanking TfL for their continuing support to the Section which is most appreciated.

Plymouth Section

Section activities 2017-2018

Dave Came

Attendance at IRSE events in the far South West of the UK has historically been dependent on the fortunes of the local private signalling companies, following the substantial reduction in numbers of British Rail/ Network Rail staff working in the area. Added to this is the risk that members may be working away from the area on the date of a meeting, so it is pleasing therefore to report on a good year.

The IRSE Plymouth section has begun discussions in preparation for a major milepost in our history, and we are pleased to announce that it is now approaching fifty years since IRSE meetings were first held in Plymouth. The section is currently planning for and much looking forward to celebrating the Golden Anniversary of the formation of the Plymouth Section in the near future. November 2018 saw the fiftieth anniversary of the first meeting held in Plymouth, although that meeting and the two that followed were under the auspices of the Western Section. The Plymouth Section came into being officially in January 1970, with the first technical meeting as the Plymouth Section being held on 21 January 1970.

A most successful programme of events for 2017-2018 has recently been completed as follows.

Crossrail presentation

An excellent presentation on Crossrail was given by Tom Godfrey of Bombardier Transportation. The paper was held at the Plymouth University in conjunction with the IET, and was well attended by an audience representing a variety of backgrounds. Tom's lecture, by necessity, commenced with a brief explanation of some fundamentals of current railway signalling for the benefit of the wider audience, including an explanation of the terms AWS/TPWS, ETCS and CBTC, followed by a more detailed presentation including answering specific queries put forward by the signalling representatives present. One interesting area of discussion resulted from a question from a non-rail source, when a university student queried cyber security within Crossrail, in answer to which Tom identified at a high level a list of the cyber security measures contained within the project, including a new development where balise data is now encrypted. Many other topics were raised during question time resulting in a lively debate.

The section plans to convene further joint IET/IRSE talks given the past successes of such papers.

Plymouth and South Devon waste incinerator visit

A sizeable group of members made a technical visit to the Plymouth Energy from Waste Plant, operated by MVV Environment on behalf of the South West Devon Waste Partnership which consists of Plymouth City, West Devon and Torbay councils.

Whilst the plant input is brown waste from the above referenced councils, MVV considers the works to be a power generation plant using domestic and industrial waste as fuel rather than a waste disposal facility, as its output delivers both electricity and steam to the adjacent Devonport Royal Naval Dockyard, with the option to feed surplus electricity to the National Grid. There are other by-products such as metals, and even the ash spoil is used to create construction material.

The scale of the process is indeed impressive with giant overhead computer controlled manoeuvrable grabs feeding the waste to the incinerator furnace, which in turn produces steam to drive an 11 kV generator. A key function of the process is the mandatory environmental monitoring of all residual matter, particularly gasses, the data concerning which is transmitted directly to the environmental authorities via a link that MVV does not control.

The complete works is managed on a 24/7 basis from a control room not too dissimilar to many of the control rooms familiar to the IRSE membership, except one major difference is a large window area overlooking the waste entry chamber such that operators may visibly monitor operations and take manual control of the grabs if necessary.

It was an excellent and thoroughly interesting visit and the tour experience was greatly appreciated by those present.

The Plymouth Section visited the Plymouth and South Devon waste incinerator.

Visit to Dartmouth Steam Railway

Returning to railway matters, the Dartmouth Steam Railway, which runs between Paignton and Kingswear, was the location for the next technical visit by the Plymouth Section. The group assembled at the entrance to Paignton station, and following ensuring all were suitably attired with safety wear, the tour commenced. Paignton platform trackside, Goodrington, Churston Workshop, Britannia Crossing (Dartmouth Higher Ferry) and Kingswear were all visited, utilising a combination of a timetabled steam train plus the maintenance bus for transport.

The signalling installations were of course of interest, but in addition it was fascinating to visit the workshop at Churston to witness the level and detail of work undertaken on the locomotives. Lydham Manor number 7827 stood impressive and complete within the workshop, whereas a second loco was virtually totally disassembled with only the chassis and cab seemingly present. Listening to the explanation by the mechanic of the works undertaken was fascinating, and illustrated to the visitors the depth of knowledge and abilities of these engineers.

Host Dave Helliwell facilitated an excellent and informative visit to this popular West Country tourist attraction.

Beer and curry night

Marking the diversity of the Section's programme of events, the traditional 'Beer & Curry' night proved ever popular, with a substantial number of members present. It has indeed become an annual event in recent years, with an evening on Plymouth's Barbican waterfront area whetting appetites, before dinner at the Jaipur Palace Indian restaurant, with friends old and new maintaining the IRSE signalling bond here in the West Country of England.

A visit to the Dartmouth Steam Railway was a highlight of the Section's year.
Photo John Fissler.

Past lives: Roy Bell MBE

Roy Bell passed away on 18 October 2018 aged 85, after brief spells in hospital and a nursing home, following a period of poor health.

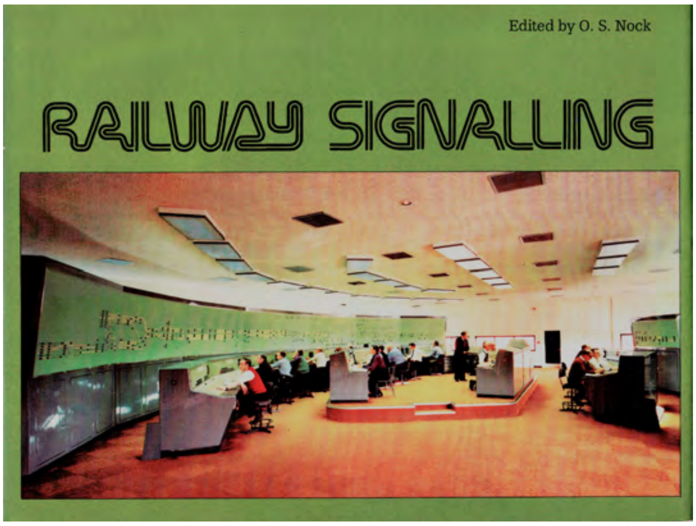
Roy was born in West Wickham, Kent, on 1 December 1932. He was educated at Beckenham and Penge County Grammar School and Imperial College (London University). After National Service in the Royal Air Force, from 1951 to 1954, he joined the Southern Region S&T Department at Wimbledon as a graduate S&T engineer in 1960. After training he entered the New Works Section of the Wimbledon signalling design office and soon gained promotion to various technical and managerial new works posts 1962-1964. During this period, he was involved with the Kent Coast and Bournemouth electrification schemes and the major power signal boxes introduced at that time such as Sittingbourne, Ashford, Tonbridge, Basingstoke and Eastleigh.

In 1965 he was appointed signalling project engineer for the Portsmouth re-signalling scheme and for the Dartford re-signalling scheme in 1968. He was an absolute expert functional tester and one could be sure that any installation that Roy had tested was safe and operationally sound. This part of his career was crowned with his commissioning of the London Bridge power signal box and the re-signalling of that area 1971 to 1975.

Roy then moved on in 1977 to become signal engineer (general) and deputy to the London Midland Region chief signal and telecoms engineer (LM CS&TE) at Carlow Street, London. In 1988 he was appointed as signal engineer (systems) at British Rail (BR) Department of Signal and Telecoms Engineering headquarters, Paddington. He was co-opted to the BR HQ team investigating and providing expert specialist support to the public enquiry into the Clapham Junction accident in December 1988. In 1989, following publication of Anthony Hidden QC's report into the Clapham Junction accident, Roy was appointed project manager (Hidden) in which role he was responsible for overseeing implementation of the Hidden report recommendations in the S&T department. Then, in 1991, he was appointed to become the last Southern regional S&T engineer at Croydon before the abolition of the Regions with implementation of BR's business management organisation under the Organising for Quality initiative in 1992. In 1993 he became testing director at BR HQ Central Services and in 1994, in

Roy Malcolm Bell MBE DIC CEng FIET FIRSE, 1932-2018.

Roy driving a 7¼" gauge replica of a Stanier 'Black five' loco on the Great Cockrow Railway.



Roy even appeared on the front page of the original IRSE 'green' text book, "Railway Signalling".

In the driving seat on the Spa Valley heritage railway.

preparation for the privatisation of BR, he was appointed signalling specialist for the Railtrack Major Projects Division at Waterloo. He retired from the railway after 36 years' service in 1996 but continued to serve the industry as a free-lance part-time consultant and was awarded the MBE in 1997 for services to the railway industry.

I first met Roy 58 years ago at Wimbledon when we were both undertaking our training to become S&T engineers on the Southern Region. Roy pursued his career in New Works projects whilst mine progressed on in Maintenance. Both of us being based at the Southern S&T HQ, first at Wimbledon and then later at Croydon, meant we were in frequent contact during those early years. Later as our careers progressed, we worked even more closely together, first on the LM Region, where Roy was my loyal deputy when I became LM CS&TE, and then later at BRHQ in dealing with the massive workload following the Clapham accident. He was always ready to explain, to clarify and to give examples of good S&T practice. His career in the S&T department was hallmarked by a conscientious devotion to his duty, to the signalling profession and to helping and supporting his colleagues. He recognised the vital importance of providing excellent standards of signal engineering; both for signal box staff to use to signal trains and more especially for drivers to be able to operate trains safely. He had an excellent understanding of both these operating disciplines and he put these talents to good use on numerous occasions, frequently on the Great Cockcrow Railway and sometimes on other railways too! Close examination of the picture on the cover of the IRSE 'green' text book entitled Railway Signalling (pictured above) will reveal that the third operator from the left on the London Bridge operating panel is Roy Bell. He owned a Black Five loco which he regularly drove on the Great Cockcrow Railway and was equally familiar with the West Coast AC loco classes as well. In the past Roy also supported the Bluebell and Spa Valley heritage railways, both financially and professionally.

Roy was a member of the Institution for 57 years. He joined the IRSE as a graduate member in 1961, became an associate member in 1966 and a fellow in 1969. He served as a member of the Institution's Council 1979-1982.

He was widely respected by the trade unions and by members of the legal profession for his unbiased and thoughtful advice on legal cases, both for public inquiries and on criminal cases. As with everything else he was informed, competent, kind and absolutely straight in all his dealings. He faced unpalatable evidence with the same integrity he brought to everything he did.

Outside of work Roy was a keen cricketer and an even keener umpire. He continued to play and umpire cricket despite three hip operations and was still in demand from his local cricket club this year! He was also a Marylebone Cricket Club (MCC) member and he and I enjoyed many entertaining hours together watching England test matches at Lords, whatever the result!

He lived at Groombridge, Kent, with his sister Valerie and continued to travel frequently, both in the UK to Scotland and also to Europe, especially to France, Switzerland and Scandinavia. They were regular users of Eurotunnel, and he was a shareholder of course.

Another of their joint hobbies was to visit the sites of published calendar pictures that they bought each year. This meant they drove quite a high mileage and they maintain a fleet of five cars to distribute the mileage. Both he and Valerie love the countryside and nature. Badgers, foxes, deer and numerous bird species can be found in their spacious grounds which they spent a lot of time looking after, and ensuring it was a haven for wildlife. Roy was completely opposed to any sort of sport that would harm animals.

He was a gentleman; possessing the ability to get on well with all sorts of people and a true railwayman with insight into operating matters as well as signal engineering. Throughout all the years I was privileged to know my friend and colleague Roy Bell. I never once saw him get angry. He usually had a smile on his face and was always ready to see the best in people, whatever their flaws.

We shall all recall with fondness, respect and affection a man whose example in his professional life and love of life in general was one to which many would aspire, and which will be long remembered by all his friends and colleagues, who offer their sincere condolences to Valerie.

Rest in peace my friend.

Ken Burrage
Former Chief Executive IRSE

Acknowledgements: My thanks to all those who contributed information for this obituary notice.

Past lives: Swati Prusty

It is with deepest sadness that we announce the untimely death of Swati Prusty, a former member of the IRSE. She died while hiking in Ras Al Khaimah, UAE in September 2018 with her husband and friends.

Swati worked as an assistant project manager in Atkins (now part of SNC-Lavalin Group) Dubai. Swati had been with Atkins for 10 years within the signalling and project management teams, having worked in the India, UK, Qatar and the UAE, and had recently received her 10-year long service award.

Swati had a very long association with the IRSE. She had successfully passed the IRSE Professional Examination Modules 1, 2, 3, 5 and 7 and had held Signalling Designer and Design Verifier Licences. Swati participated and volunteered in many IRSE events worldwide and was very active supporter of the Institution including being on the UK Younger Members' Committee. Swati was awarded the Hewlett-Fisher Bursary and attended IRSE International Convention held in Singapore and Malaysia in 2011.

Swati was known by all those who met her as a very happy, intelligent and highly professional person. Originally from Orissa in India, she was well travelled, always curious to learn and have new adventures and experiences.

Swati Prusty (centre) with other attendees at the Singapore ASPECT conference last year.

This is a very difficult time for her closest colleagues and our thoughts are with them and with Swati's family and friends at this sad time.

Jacob Daniel MIRSE

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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IRSE — Institution of Railway Signal Engineers — YORK AND THE NORTH EAST SECTION

Railway children — Fighting for street children

SIEMENS

The 61st York Dinner will be held at the National Railway Museum on Thursday 21 March at 1900 for 1930

Our sponsor

The Annual Dinner is, once again, generously sponsored by Siemens Rail Automation UK thus enabling us to hold the event at the National Railway Museum while only charging £50 per head. Tables seat ten people and can be booked in whole or in part.

The setting

2019 is our 61st Annual Dinner but only our third at the National Railway Museum in York. The museum is world famous, capturing two centuries of railway history and having an established reputation for the quality of its dining. We invite all IRSE and rail industry members to bring their partners, guests and friends to join us for what is always a most enjoyable evening

Our charity

Our chosen charity, once again, is Railway Children – one of the railway industry's favourite charities. It was founded in 1996 to rescue street children who have run away to escape from poverty, abuse, violence and neglect. Many are to be found sleeping rough at railway stations. Over the last 20 years, Railway Children has helped more than 270 000 homeless children in India, East Africa and even the UK find the help and essential support that they need. Last year, including Gift Aid, we raised £1717 and we hope to better that this time; that is the least we can do for these vulnerable innocents.

Guest Speaker

We are delighted that our Guest of Honour will be Rob McIntosh, Network Rail's route managing director for London North Eastern and East Midlands, who lives at Kirkbymoorside. Earlier roles have included programme manager at Westinghouse Rail Systems in York and vice-president of delivery for the UK and Northern Europe with Invensys Rail. Roles with Network Rail have included project director for national programmes for the European Train Control System and for Traffic Management, programme director – Crossrail and regional director for infrastructure projects across Scotland and the North East. Rob is therefore a senior industry professional with a strong local connection.

Hotels and parking

The National Railway Museum has free parking and is only five minutes' walk from York Station. There is a wide range of hotels within easy reach which can be booked through **www.visityork.org/sleep** (no booking fees) or through any major booking agency.

Booking

Please contact Ian Moore:

email **ianmooreirse@hotmail.co.uk**
visit **irse.info/yorkdinner**
or call **01904 761944**

IRSE News

Institution of Railway Signal Engineers

January 2019

Main line ATO
the UK journey

Waterloo collision
lessons to be (re)learnt

Blane Judd
the CEO's viewpoint

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The IRSE in 2019 ... and beyond

Welcome to the first issue of IRSE News in 2019. As last year drew to a close, two stand out events took my attention. The publication of the UK Rail Accident Investigation Branch report into the very serious incident at Waterloo station in August 2017 highlighted several instances of poor working practice (see page 7). For me this underlines the important role we as an Institution must play in addressing these crucial issues around competency, professional development and ethics to drive up industry standards through professional registration, membership and of course licensing and encouraging more communications and signalling engineers to adopt the Institution as a route to promote their professionalism.

Then later in November, a group of Members and I had the honour of representing our Institution at a special multi-faith service at Westminster Abbey in London to celebrate the engineering profession and its work in inspiring the next generation (see page 25). Sitting in that iconic abbey where world famous engineers Thomas Telford and Robert Stephenson are buried, it made me think about the legacy our members will leave behind. In years to come people will look back and recognise the significant contribution that railway signal engineers, 'led the way in digital signalling' helping to achieve safe and efficient rail transport for generations into the future.'

The year ahead will be another busy one for our Institution. We have ambitious plans to raise our external profile worldwide. The 2019 ASPECT conference to be held in Delft in October will provide a perfect platform to showcase the very best in technical excellence and demonstrate the enormous benefits that membership of our organisation can bring. Read more about our plans for the IRSE beyond 2020 in my interview on page 17.

Blane Judd
Chief Executive, IRSE

Cover story

This year the 10th ASPECT international conference organised by the IRSE will be hosted in the town of Delft and the Delft University of Technology in the Netherlands. The conference provides an opportunity for learning and the exchange of knowledge in the fields of train control, railway communications and related disciplines.

Our front cover shows the new Intercity train (type ICNG or 'Intercity Nieuwe Generatie') for Dutch train operator NS. The 200 km/h EMU is part of Alstom's new 'Coradia Stream' platform and 49x 5-car and 30x 8-car trains have been ordered for introduction from 2021.

The trains will be equipped with WiFi, LED lighting, a dynamic real time passenger information system, and security cameras for increased passenger and crew safety. The trains will also feature ATB and ERTMS train control systems, and will be able to operate on both 25 kV AC and 1.5 kV DC routes.

Photo © Alstom Design&Styling.

In this issue

From the IRSE and its Sections

The main line ATO journey

Andrew Simmons
Network Rail, UK

Nicola Furness
Network Rail, UK

Automatic Train Operation (ATO) was first introduced in the 1960s on London Underground's Victoria Line. Since then ATO has been developed through a number of technology phases on metro and people mover systems to allow driverless train operation operating on a moving block signalling platform. There have also been isolated main line applications such as ATO used on suburban lines in the Czech Republic.

Within the metro and people mover sector the latest generation systems are based on Communications Based Train Control (CBTC) standards which facilitate significant whole life cost savings whilst allowing the optimisation of service levels to satisfy customer demand. Although designed to common standards, CBTC systems have been designed as proprietary systems and therefore interoperability between different suppliers systems is not possible. For most metro/people mover system operators this is not necessarily an operational issue due to the 'independent' nature of their operations.

It was clear from metro operations that ATO has the capability to enhance capacity and performance whilst also optimising traction energy, but for main line applications it was also apparent to Network Rail that the lack of interoperability for ATO systems was a factor that could prevent widespread application and/or increase infrastructure complexity. Network Rail considered that a long-term strategy to develop the concept of an 'interoperable' ATO was the most appropriate way forward, if the benefits of ATO were to be realised across main line networks. This paper describes the main line ATO 'journey' from a Network Rail perspective.

Initial investigations

The signalling solution to deliver a reliable 24 trains per hour (tph) service through central London, as part of the Thameslink programme, had many iterations. Numerous studies were carried out trying to balance the benefits of different multi-aspect signalling configurations with the driveability/human factors issues of close headway operations. Having considered the issues identified from these studies, it was clear that an alternative approach to conventional multi-aspect technology had to be considered. In conjunction with Network Rail, the Department for Transport (DfT) commissioned a study to determine the benefits of ATO and whether this could provide an appropriate solution to the Thameslink challenge of providing a sustainable 24 tph service level.

The outcome of the study highlighted that from a conceptual perspective ATO out-performed all conventional configurations in terms of delivering a robust train service through the Thameslink core section. Recognising that the GB European Train Control System (ETCS) Deployment Plan also included the East Coast Main line (ECML) in similar timescales and as this would directly connect to the Thameslink Core, it was considered that ATO based on an ETCS platform would be a preferred solution from an overall system perspective. This would reduce the number and complexity of trainborne signalling systems on the Thameslink rolling stock and it also offered the possibility of extended ATO operation on the ECML.

Although the long-term strategy was to work towards an interoperable ATO concept, it was recognised that the required timescales to deliver the Thameslink business benefits were such that, in this limited initial application, a supplier's bespoke solution would be acceptable. The requirement for an ATO system using ETCS as the signalling platform was contained within the Thameslink rolling stock contract. There were requirements placed upon the infrastructure owner to supply balises at defined positions on the approach to stopping locations and stations to manage accurate stopping. This enabled the ETCS/signalling infrastructure contract to be let separately. This was facilitated by a clear system architecture proposal from the Thameslink programme covering ATO enabling integration with both the infrastructure signalling and traffic management systems.

Whilst the Thameslink procurement process provided confidence that ATO would deliver the desired outcomes for Thameslink, there remained much scepticism within industry (including suppliers) that ATO could deliver benefits in the general main line environment. There was certainly a perception that main line benefits could be delivered by moving to ETCS alone. However, when considering the GB network, many lines have capacity demands at levels similar to metros with complexities and service patterns which are even more demanding than for metros, Network Rail remained convinced ATO with ETCS would provide the optimal solution.

To understand better the capabilities of ATO in a main line environment, in 2011 Network Rail contracted 3 suppliers to provide 'hardware in the loop' simulations. The minimum requirement was the use of integrated ATO/ETCS on-board systems which typically involved utilising metro ATO hardware and software interfaced with ETCS on-board equipment. The simulations included the following scenarios:

- Low speed suburban.
- High speed suburban.
- Inter city.

The results from these simulations were mixed in terms of supplier capability. However where close coupled integration was possible, the simulations validated the majority of assumptions in the earlier DfT study. It was therefore clearly evident that ATO in conjunction with ETCS could deliver capacity, performance and energy benefits in various main line scenarios. It was also clear, however, that much work was needed to develop an interoperable variant that was also appropriate for the main line operating environment. In particular, the specification and development of products that would allow ATO data to be transmitted and updated whilst the train was mid-journey would be essential, as main line trains are not route specific and are occasionally diverted from planned routes.

Recognising that ATO capability would strengthen the case for ETCS overall and that development work was required, the then European Rail Agency (ERA) decided it was appropriate to support development of 'Interoperable ATO' specifications and Trans-European Transport Network (TEN-T) development funding was secured by the ERTMS Users Group to work in a consortium with UNISIG suppliers for their development between 2011 and 2014.

GoA1	Non-automated train operation	The train is driven manually; but protected by automatic train protection (ATP). This GoA can also include providing advisory information to assist manual driving.
GoA2	Driver attended ATO	The train is driven automatically, stopping is automated but a driver in the cab starts the train, the driver can operate the doors (although this can be done automatically), the driver is still in the cab to check the track ahead is clear and carry out other manual functions. The driver can take over in emergency or degraded situations.
GoA3	Driverless train operation	The train is operated automatically including automatic departure, a train attendant operates the train doors (although this can also be done automatically) and can assume control in case of emergency or degraded situations e.g. Docklands Light Railway
GoA4	Unattended train operation	All functions of train operation are automatic with no staff on-board to assume control in case of emergencies or degraded situations.

Table 1 – Grades of Automation (GoA).

TEN-T and Next Generation Train Control developments

The TEN-T ATO project was completed at the end of 2014 and was the first European initiative to look at developing the ATO function for ETCS. Network Rail took an active role in this project, feeding in the results of the 'ATO over ETCS' feasibility study [R1]. Network Rail was also the author of the ATO over ETCS Operational Concept [R2]. Network Rail was a core member of the ERTMS Users Group ATO working group which developed, reviewed and agreed the concept and concluded it was suitable for use across the European Railway network. In this work one of the earliest actions was to adopt the definitions of ATO Grades of Automation (GoA) already widely used in the metro world as detailed in Table 1. Although the operational concept covered all four grades of automation the detailed development work limited its scope initially to an GoA1/GoA2 solution.

After development of the concept, principles and user requirements the UNISIG suppliers then developed an ATO over ETCS systems requirements specification. The initial output was a set of ATO GoA2 system requirements which were produced as two new CCS TSI (Command and Control System Technical Specification for Interoperability) subsets, SUBSET-125 – ATO System Requirements Specification and SUBSET-126 – ATO Train/Track Interface specification. These were then formally submitted into the European Union Agency for Railways ERTMS change control management process for incorporation into the CCS TSI. It had been hoped to incorporate such changes into the ETCS Baseline 3 Release 2 published in 2016 but this proved not to be possible, so it was agreed it would be taken forward as one of the ERTMS Game Changers (as set out in the ERTMS 2016 Memorandum of Understanding) for incorporation into the CCS TSI at the earliest opportunity.

As the TEN-T work was concluding, a new research and development project began which also related to ATO. The main scope of the Next Generation Train Control (NGTC) Project running between 2013 and 2017 was to analyse the commonality and differences of the required functionality of both ETCS and CBTC systems. It aimed to offer customers the benefit of being able to choose the most competitive supplier, based on standardised functions and interfaces and also to benefit suppliers by providing system commonality in order to increase economies of scale for suppliers

The main focus was on developing a common ATO for metro and for main line railways. For the main line railways, the starting point was the European ATO Operational Concept developed in the TEN-T project. ATO up to GoA4 is now common in modern CBTC systems as used on metro railways. The NGTC project explored best practice from the experience of main line and metro operators and suppliers and provided recommendations to be taken forward in future development programmes.

Both the TEN-T and NGTC programmes had explored and assisted in the development of the specifications for a European interoperable ATO system, but the work so far had focused on production of paper specifications, which now needed to be taken forward into development of real products. The Shift2Rail Programme provided the opportunity to do this. Figure 1 shows the linkage between all these programmes

Shift2Rail

Shift2Rail (S2R) is a European rail joint technology initiative to pursue innovative rail product solutions [R3]. The S2R programme is split into five innovation programmes. Innovation Programme 2

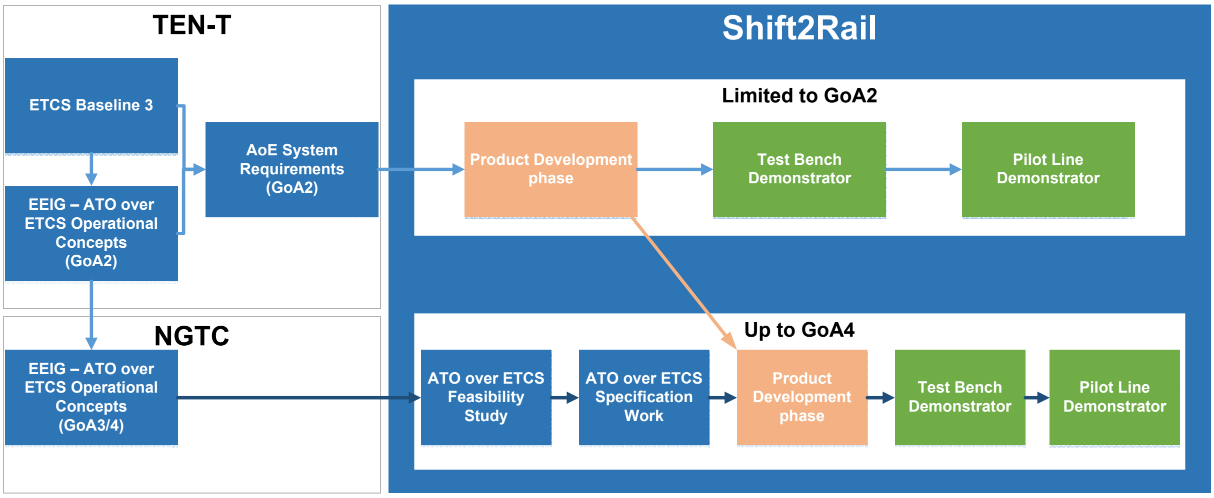

Figure 1 – Linkage between the programmes enabling the development of a European ATO over ETCS system.

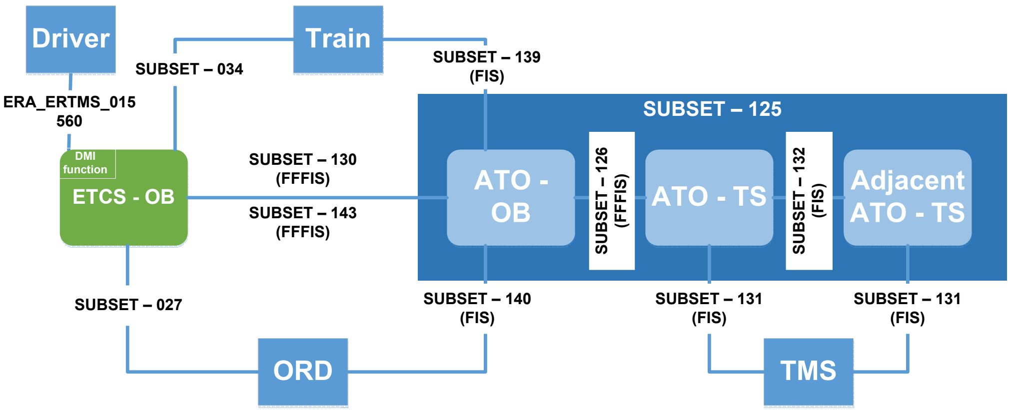

Figure 2 – ATO over ETCS Reference Architecture [R4].

(IP2) is the Advanced Traffic Management and Control System Innovation Programme with an objective to enhance the overall line capacity and contribute to life-cycle cost reductions and global reliability of the railway system, while maintaining the highest level of safety. With ETCS as a basis, S2R IP2 seeks to take forward developments required by railways such as moving block (virtual block and pure moving block), ATO, advanced traffic management systems and train integrity.

The ATO work package in IP2 is divided into two work streams, the first to develop a test demonstrator for GoA2 (Driver Attended ATO) and the second stream of work to develop a test demonstrator for GoA3 (Driverless ATO) and GoA4 (Unattended ATO) as shown in Figure 1. The development of these test demonstrators link into the continuing work to increase the maturity level of the ATO specifications by validating the specifications via the demonstrators.

Additionally, there is a work package in S2R IP5 which is developing technologies for sustainable and attractive European rail freight which is looking at autonomous freight operation. This work will also be an input to the IP2 test demonstrator for ATO, capturing the freight requirements.

Since 2016, in the GoA2 work stream, significant work has taken place to enhance the specifications developed in the TEN-T work and to ensure specifications are also available to enable the integration of ATO over ETCS into the wider railway system. This current system architecture listing the ATO specifications to enable ATO over ETCS operation (known as subsets) are provided in Figure 2.

The S2R work has now moved to the validation phase with the specification being validated in the laboratory using a test bench with ATO prototypes. The final phase will be to integrate it into a pilot line and test train for final validation. In the pilot demonstration, the plan is to fully validate the ATO concept and verify compliance with the system specifications and check the expected ATO system performance.

Network Rail will host the pilot demonstration for ATO GoA2 over ETCS testing at its ETCS National Integration Facility (ENIF) with its GSM-R radio upgraded to provide packet switching to facilitate the pilot (packet switching is required for operation with ATO to support availability targets). The tests will use an ETCS fitted train adapted to facilitate the testing of the ATO prototypes. This work is currently at an advanced stage of development for delivery in the first half of 2019.

Alongside the GoA2 developments significant work has also taken place in Shift2Rail IP2 on the GoA3/4. The work is following a similar cycle to the GoA2 work stream but is not as advanced due to a range of further considerations which need to be taken forward. A key focus of the work is understanding all the operational scenarios which need to be considered when there is no longer a driver in the cab to take over manual driving or to react to changing circumstances during the journey.

Integration of ATO into the CCS TSI

From the very beginning of the European ATO over ETCS development work in the TEN-T programme there was a plan to integrate the results of the work in the CCS TSI to enable the deployment of an interoperable ATO over ETCS solution across Europe. The initial change request into the European Agency for Railways ERTMS Change Control Management process was made during the TEN-T work.

This resulted in the first core set of ATO draft specifications being formally agreed with the Agency in May 2018, alongside the required modifications to the ETCS documentation suite to enable the full integration of the ATO solution.

The documents which have currently completed the review process with the European Union Agency for Railways are:

- Subset 125 v0.1.0 – ATO System Requirements Specification.
- Subset-130 v0.1.0 – ATO-OB / ETCS-OB FFFIS Application Layer.
- Modifications to the following ETCS documents (ERA_ERTMS_015560, Subset-023, Subset-026, Subset-027, Subset-034, Subset-035, Subset-039, Subset-058 and Subset-104).

These draft documents are to be made available on the European Union Agency for Railways website to enable use by pilot projects. It is believed that the current intention is for these documents to be finalised following feedback from the S2R ATO GoA2 over ETCS pilot testing in 2019 to enable publication in the 2021/2022 version of the CCS TSI.

Thameslink/Crossrail experience

Within GB two projects have pioneered the introduction of ATO on main line services and these have taken different technology routes to achieve very similar outcomes.

As identified earlier in the paper, the Thameslink solution was to develop an ATO over ETCS solution as it was considered that Thameslink would interface with both the East Coast Main line and Midland Main line schemes identified in the GB ETCS Deployment Plan. For Crossrail, the view was that the performance and operational requirements introduced too much development risk for an unproven technology, such as ATO over ETCS, when compared with CBTC systems having proven experience in delivering the required outcomes. It was therefore decided that a solution using CBTC for the central core area would deliver the ATO functionality but with dynamic and static transitions to ETCS and/or conventional signalling. Whilst this decision reduced the development risks associated with ATO/ETCS System development, it did introduce complexity in the need for the train systems to integrate with three different signalling systems.

Feedback from both projects have identified the following common themes:

Operational considerations

Both projects had very little in the way of a concept of operations and has required both projects to understand and then develop solutions as to how ATO needs to operate in the existing GB operating environment. Capturing this understanding is an essential element in the ongoing development of ATO for main line operations. While the technical interfaces between systems associated with the movement of trains appears to have been fairly well understood, it is the operational interfaces that optimise high capacity train operations that have created the most significant challenges.

Areas to be considered include:

Timetable construction, recognising that for high capacity operations with short distances between stations the current 30 second timing resolution introduces challenges. For ATO to work effectively requires more detailed timetable information whilst fitting within the existing national timetable framework. Recognising also that perturbations will occur it is also preferable to have the ability to update the timetable in real time. Traffic management functionality is therefore of significant importance in the operation of high density services using ATO, especially under conditions of perturbations.

Linked to timetable construction is the definition and location of timing points. These need to be fully aligned with the timetable production systems right down to absolute reference points as defined in ETCS/ATO balise groups.

Door opening and closing strategies need to be considered from an operational perspective. For the Thameslink Core area where the ATO system is fitted, the doors open automatically in all modes. For Crossrail, it is possible for the driver to select either automatic open or manual open.

Figure 3 – Thameslink Class 700 – the DMI display operating in ATO.

Figure 4 – Thameslink Class 700 ETCS and ATO Controls in the cab.

Train dispatch arrangements need to be defined such that it is possible to align driver dispatch procedures with timetable departure times. For instance, the dispatch information to the driver could relate to either the start of the dispatch procedure (with a standard time allowance for the dispatch procedure) or the departure time, such that the driver determines when to commence dispatch procedures. In either case it is essential that the processes for train dispatch are well understood and optimised from both an operational and technical perspective to maximise the available door opening times within the timetabled dwell allowances and/or reduce dwell times such that headways can be reduced.

Station stopping positions require particular consideration. Thameslink operates trains of different length and operates a 'centre line' stopping strategy, this allows alignment with reduced mobility features on the trains. However, such arrangements may not be appropriate for terminal stations – hence flexible stopping strategies may be required. Crossrail will operate with platform screen doors and fixed length trains therefore has consistent stopping arrangements throughout the CBTC fitted core section.

Transition arrangements need to be considered, including the relationship with ETCS transitions – this needs to be considered from a safety and operational perspective, recognising technical and human factors constraints. Figures 3 and 4 show how ATO was integrated with ETCS in the cab of the Thameslink Class 700 train.

Technical considerations

The major consideration from the Thameslink experience is the storage and update of the ATO track database. On Thameslink, an on-board database has been used, thus requiring an update when infrastructure changes are made. This lesson was captured in the development of the interoperable ATO requirements suite which specifies that the data is stored in infrastructure systems and transmitted to trains prior to the route section being used for ATO.

The interfaces between the train propulsion and braking systems are critical to achieving ride comfort, traction efficiency and optimised stopping arrangements. Whilst the majority of system interfaces were optimised as part of the off-site testing strategy, the Thameslink programme team had to fine tune this system – this was expected based on experiences with metro applications.

The future

Over the last 10 years we have moved from exploring the feasibility of introduction of ATO onto main line railways to the reality of ATO on a main line railway when Thameslink ran the first passenger service using ATO over ETCS on 17 March 2018. During this period there has been a growing appetite for introducing not only ATO to main line railways, but also for specifying an interoperable ATO for main line railways across Europe. This is evident by its inclusion in the ERA ERTMS game changer report published in 2015. In GB, our strategy has been on enabling future deployment of ATO GoA2 over ETCS across our network. Other railways such as Deutsche Bahn are also keen to explore the development and application of GoA3/4 solutions.

For our GB network the capacity, the service recovery and the energy efficiency benefits ATO GoA2 when deployed alongside the safety benefits enabled through use of ETCS are expected to bring considerable benefit to our network operation.

The HS2 project has collaborated with Network Rail during the European GoA2 ATO over ETCS developments and is taking advantage of this. HS2 is expected to be one of the next implementers of this technology in GB.

To really get the benefit from application of this technology on the GB network, it is essential that the available European interoperable ATO specifications are used and built into the procurement cycles of new rolling stock and infrastructure from conception. This should enable cost effective introduction and the opportunity to enhance network operation alongside the network deployment of ETCS – the continuation of the ATO main line journey.

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Collision at London Waterloo August 2017 – lessons to be relearnt from the past

David Fenner and Paul Darlington

A collision occurred on 15 August 2017 between a passenger train and a Network Rail barrier train that was protecting workers at London Waterloo Station in the UK. Although the accident could have led to serious injury and even death, thankfully, it didn't. However, the circumstances leading to the accident are very worrying for the signalling profession.

The collision was referred to the Rail Accident Investigation Branch (RAIB). Like the equivalent air accident investigation organisation, it may take many months for a final report to be published. This is largely due to the depth and scale of the investigation, which may need to be extended due to initial findings. Time is also allowed for extensive stakeholder consultation. The RAIB may issue safety bulletins and interim reports to share their initial and later findings especially when there are important or urgent issues to be addressed. This happened in the case of the Waterloo accident, and the final report was eventually published on 19 November 2018 (irse.info/oanv7).

The scene at Waterloo station after the incident. *Photo Jamie Squibbs.*

Events at Waterloo

Waterloo station was undergoing the extension of platforms 1 – 4 to enable the more widespread operation of 10 car trains together with associated alterations to the track layout and signalling as part of the Wessex Capacity Improvement project. As part of these works, platforms 1 – 10 were under engineering occupation to enable the extension works leaving platforms 11 – 19 to cope with a reduced train service. The area is signalled using a route relay interlocking commissioned in 1990.

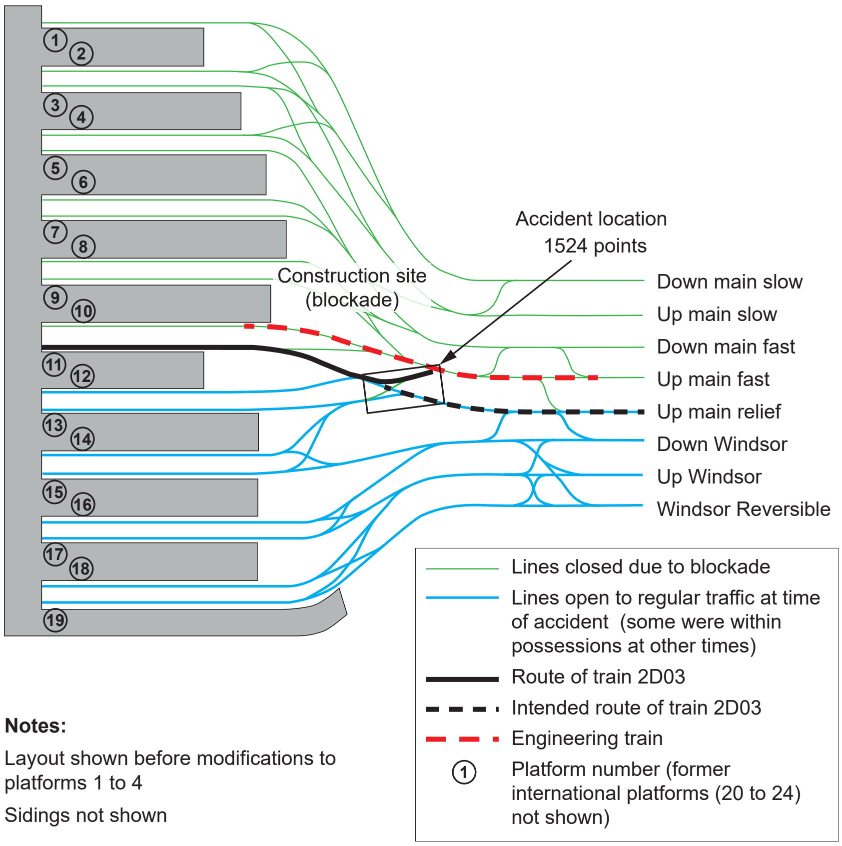
On Tuesday 15 August 2017 the 05:40 to Guildford, a 10-car train made up of a combination of Class 455 and 456 units, pulled out of Platform 11 on time. Having reached a speed of around 15 mph (24 km/h) it veered to the left and struck a train of empty Network Rail wagons. Of the 23 passengers and two employees on the train, only three were treated at the scene by paramedics, and fortunately no one required hospital treatment.

The role of the RAIB

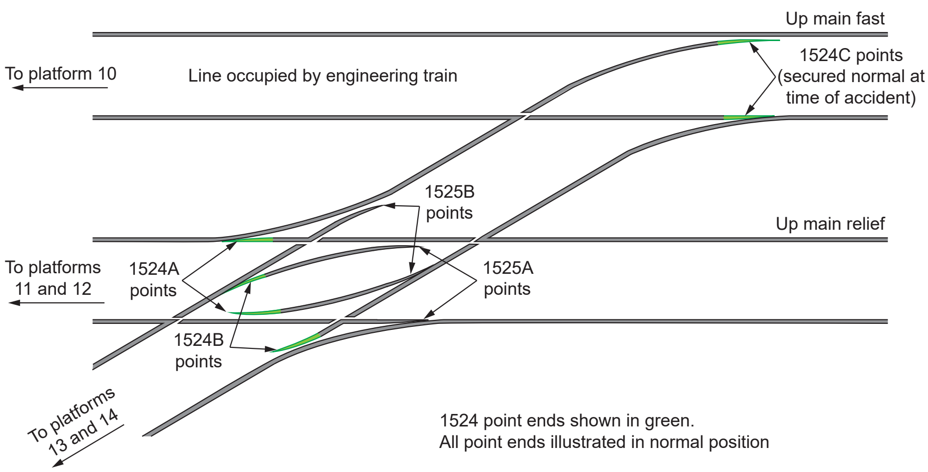
The Rail Accident Investigation Branch (RAIB), the independent railway accident investigation organisation, is concerned with the investigation of accidents and incidents on any rail network in the UK. It reports on lessons to be learned and makes recommendations to prevent further accidents. The investigations are entirely independent and focused solely on safety improvements with no apportionment of blame or liability.

The RAIB does not enforce law, nor carry out prosecutions. The RAIB aims to identify the causes of accidents along with other factors that contributed to the event or made the outcome worse, such as technical, operational or management system failings.

The RAIB allows the use of its publications to share the lessons learnt amongst the widest group of people and organisations.



The layout at Waterloo at the time of the incident.
All diagrams RAIB.



The layout of 1524 points, the accident location.

An early investigation by the RAIB revealed that points were misaligned and had directed the passenger train away from its intended route. The misalignment was a consequence of a temporary modification to the points control system. It was identified that the points were around mid-position as the train left the platform. It is pertinent to know that 1524 points consisted of three ends. The A and B ends formed a double slip whilst the C end was an ordinary single lead. Of these the C end was within the possession whilst the A & B ends were part of the operational railway. The full report has now identified the reasons why temporary modifications had been left in place, and it makes some uncomfortable reading for the industry. The incident presents added poignancy for the signalling profession being part of the same control area in which the Clapham rail accident occurred 30 years ago during construction of the current signalling centre, and as a result of temporary works carried out on the signalling.

The wagons were deliberately placed to protect the workforce behind them from the live railway and from some perspectives to limit distraction of the drivers operating service trains. It was therefore a step well taken in limiting the consequences of the accident. Had the points been clipped, as intended, there would not have been a derailment, which was another of the issues examined by the full report.

The cause of the accident

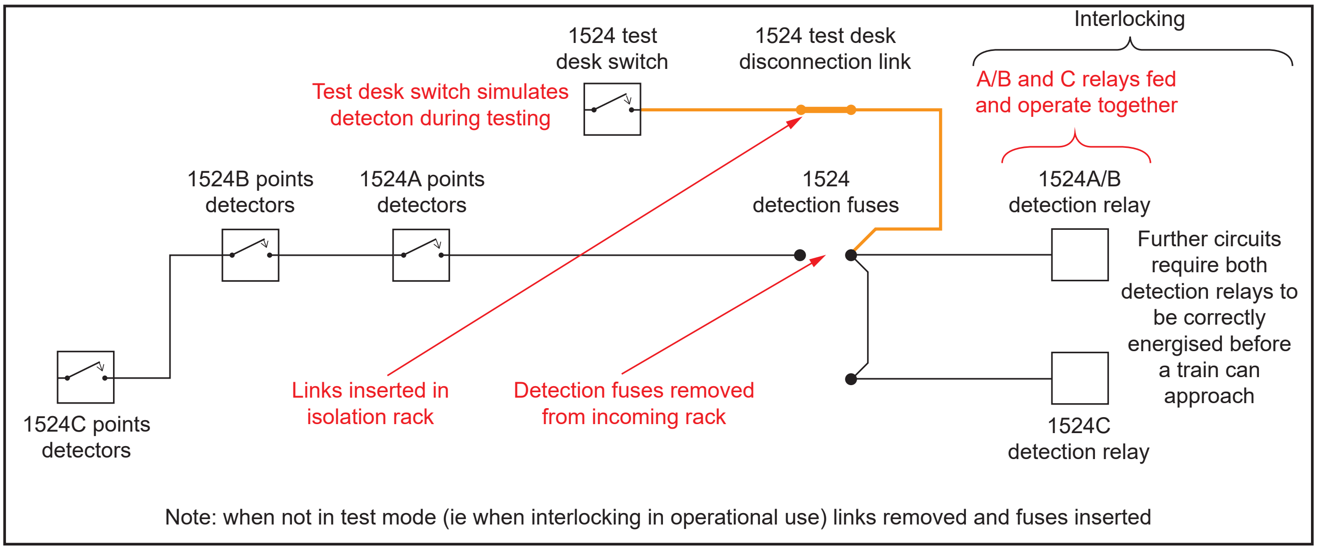
The final investigation report identifies that the train was diverted away from its intended route by a set of points, which were positioned incorrectly as a result of uncontrolled wiring added to the signalling system. This was to overcome a test desk deficiency following a stagework modification to a trackside location case. The test equipment design process had not allowed for alterations being made to the signalling system after the test equipment was designed and installed.

Soon after moving away from the platform under clear signals, the driver noticed that 1524 points were not correctly set and applied the train's brakes. The collision occurred about three seconds after the brake application which had reduced the train's speed to 13 mph (21 km/h). Drivers are not required, nor expected, to check point positions in these circumstances, and the driver was commended by RAIB for noticing they were lying incorrectly and for his prompt brake application.

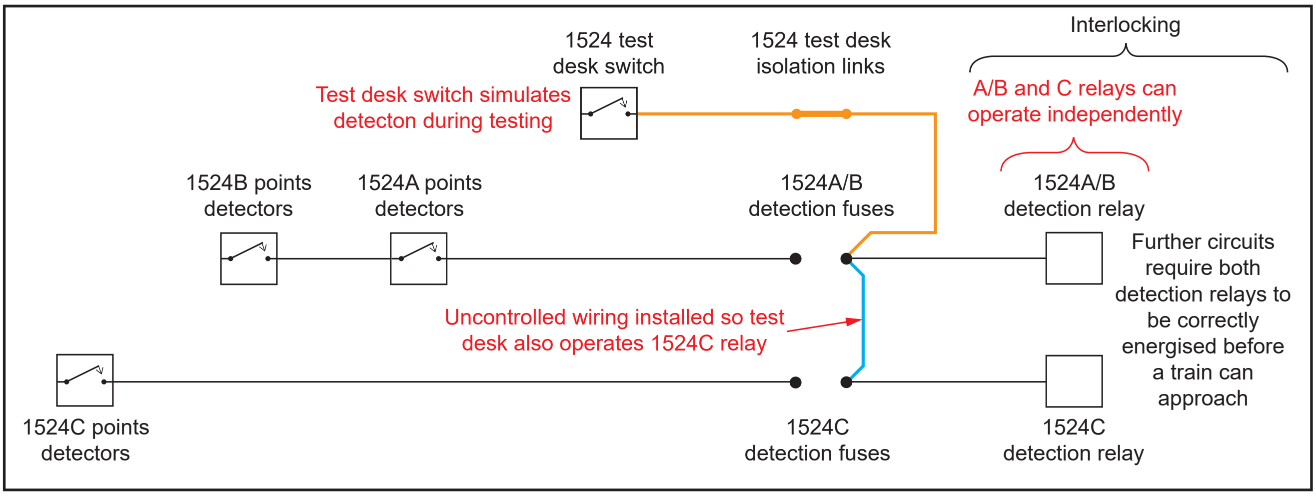
Immediately after the accident, the train driver made a GSM-R railway emergency call which caused an emergency stop message to be broadcast to all trains in the Waterloo area. Such a facility had been one of the recommendations following the Clapham accident, which led to the national roll out of GSM-R.

The immediate cause of the points being wrongly set for the passage of the train was attributed in the RAIB report to the uncontrolled wiring that had been added to the points detection circuits, such that the position of 1524 points was incorrectly detected. This wiring was added during testing when the test desk was found to no longer simulate the detection of 1524 points as required by the tester, a consequence of an incomplete design process. Whilst 1524 points themselves were not involved in the signalling alterations the location case through which detection of 1524 points passed was.

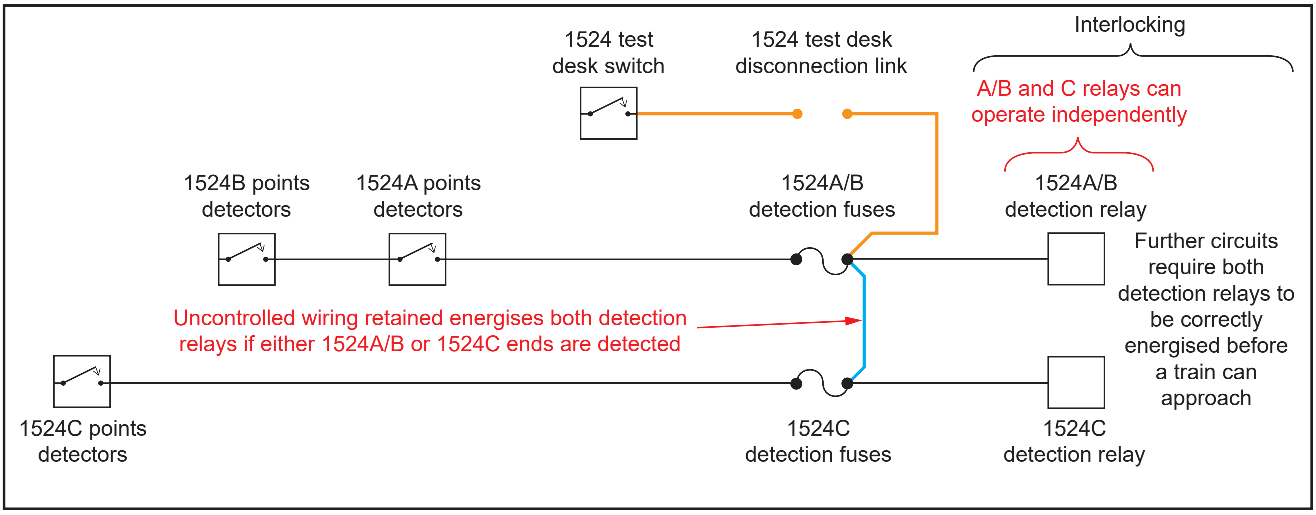
When making the amendment to cope with the new location case the signalling designers amended the detection circuits to correspond with current practice. Originally detection of all three ends was wired in series but operated two detection relays known as A/B and C. The change separated the C detection. The



1524 points in test mode, before location case W14 was replaced.



1524 points in test mode, after replacement of location case W14, showing the addition of uncontrolled wiring.



1524 points detection at the time of derailment.

integration of the two detection relays was completed in the interlocking as per the original design. The amended design was completed in the summer of 2017. The test desk design had been completed during the spring/summer period of 2016 and thus did not have access to this element of the design.

During a wider testing blockade on the 12/13 August there was a need to simulate, using the test desk, the detection of points 1524. This failed with the C end showing out of correspondence as a result of updated location case and associated wiring amendments. The principles tester requested the functional tester to resolve the problem. The functional tester proposed a solution that was already in use on another set of points, failing to realise the other points were totally within the possession and thus any temporary wiring alterations would be part of the removal checklist before the points were returned to operational use.

The actions taken to make the test desk correctly simulate the operation of the points were not in line with the signalling works testing standard, and the uncontrolled wiring was not removed before train services restarted. The actions of the functional tester were thus inconsistent with the competence expected of testers.

Because of the nature of the testing including disconnection of the point motor feed, the points remained in the normal position thus allowing the train service to operate throughout 14 August. A further possession taken during the night of 14/15 August would have called the points reverse, but there was no requirement to monitor that operation so no arrangements were made to disconnect the points or specifically observe indications.

Testers also assumed that all point ends associated with 1524 were clipped and padlocked normal. The additional uncontrolled wiring left in place at the end of testing had the effect of short circuiting the A and B detection with the C end detection (when called normal). Ultimately the points ended up in mid position because, during testing, they had been called reverse and the unsecured points had followed that command. When later called normal the C end quickly provided normal detection and, as a result of the uncontrolled wiring, the motor feed to all ends was removed leaving the A & B ends mid stroke.

RAIB findings

The accident occurred because:

- The test desk did not function as expected.
- The actions to enable the test desk to function as required were not in line with the signalling works test standard and the uncontrolled wiring was not removed before train services resumed.
- The actions of the functional tester were inconsistent with the competence expected.
- The failure to clip and padlock all ends of 1524 points.

Ineffective communication

The RAIB report makes comment about ineffective communication at several levels of the project organisation resulting in tasks being defined, but not allocated to a particular party. This further resulted in assumptions being made, but not checked, so that designs were not continuously compatible and tasks were not completed. Two key points were the compatibility of the interlocking design and that of the test desk, the second was the failure to clip and padlock all ends of 1524 points as discussed and agreed but not actioned.

Points not secured

The list of points in the project documentation included, among others, 1524A, 1524B and 1524C points. Securing of all of these points would have avoided them moving to an unsafe position, either due to a route setting error or to a wiring problem in the circuits being modified. However, only the C end (under the barrier train) had been secured.

The requirement to secure the points was identified in a risk workshop. The associated action was initially allocated to the tester in charge (TIC), but the risk register published later showed the owner as 'project team'. There was then no individual named in the risk register as responsible for implementing the securing of the points.

The TIC prepared the signalling test plan which detailed the testing process for the blockade. The final version of the test plan included a list of points to be secured. Testers in charge are responsible for the implementation of test plans and should check that all testers involved in the work are briefed and fully conversant with their duties. However, the TIC assumed that possession management staff would secure the points, so he did not instruct anyone to either secure any points, nor to check that any points were secured.

The possession management staff had only been asked to secure points required by the railway rule book to protect the blockade. These requirements do not include points on the blockade flank, such as 1524 points. Separately an email from a project manager requested that points which would be under the engineering train should be secured to protect against inadvertent movement while the track circuits, were disconnected. This led to 1524C points being secured, but not 1524A and 1524B point ends.

Weakness in standards

The interlocking design alterations and test desk wiring design were contracted to two different suppliers. However, although Network Rail standards demand processes to align designs when two projects are working in the same area, these are not explicitly applicable when one project has two suppliers. Engineers identified the potential issue but on receipt of assurance there would not be a problem no further action was taken. In addition, the relay room maintenance drawings did not provide a definitive description of the equipment in the relay room at every stage of the work. In particular the spur wires for the test desk were not shown. Had they been on the drawings, wire counting procedures would have identified that there was a problem.

Competence

RAIB said the actions of the functional tester were inconsistent with the competence expected. In particular it seems likely he designed, installed and checked the alterations required to make the test desk effective. The design was based on other examples and sets of drawings, but without full consideration of whether these represented the full and complete details of the arrangement then in place. As a consequence, the uncontrolled wiring was added without the safeguards required by the signalling works testing standards, and remained in place when the line was returned to service. The RAIB report questions whether non-technical skills (social, cognitive, and personal skills, and aptitude) are sufficiently well addressed in the competence assessment processes.

Corporate memory loss

Events at Waterloo and the RAIB's investigation of the serious irregularity at Cardiff East Junction in 2016 suggest that some in the railway industry are forgetting the lessons learnt from the 1988 Clapham Junction accident in which 35 people died. The RAIB identify 10 issues from the Hidden Inquiry

Remembering Clapham

The primary cause of the crash at Clapham Junction on December 12 1988, in which 35 people died, was incorrect wiring during resignalling. A redundant wire was left connected at one end, and bare at the other. It came into contact with a relay, causing a signal to display a 'wrong-side' green aspect regardless of the state of the track circuit.

The resulting 'Hidden Report', by Anthony Hidden QC, made a number of recommendations. Working hours for safety-critical staff were subjected to restrictions, to ensure fatigue could not cause such an accident again, and signalling testing and commissioning procedures were changed. The report was published on 27 September 1989 and can be seen at **irse.info/j5ck7**.

One major output of the Hidden Report was the realisation that an independent form of assessment of competence was required. This directly led to the creation of the IRSE licensing scheme, which was officially launched by Hidden in 1994.

which have parallels in the incident at Waterloo, indicating a degree of corporate memory loss.

At Cardiff East Junction on 29 December 2016 (**irse.info/1wq7k**), a set of redundant points were left unsecured in the railway when it was returned to service after an engineering possession. They were not secured because the team which was responsible for this activity did not identify all of the redundant points that required securing.

The major changes to signalling design, installation and testing processes triggered by the Clapham accident remain today, but the RAIB is concerned that the need for rigorous application is being forgotten as people with personal knowledge retire or move away from front line jobs. "This deep-seated, tacit knowledge is part of the corporate memory vital to achieve safety. Loss of this type of knowledge as previous generations leave the industry is a risk which must be addressed by organisations committed to achieving high levels of safety."

The RAIB produced a table in its report reflecting issues raised at the Clapham inquiry and comparing them with deviances at both Cardiff and Waterloo. It is uncomfortable to read that slipshod working practices, lack of full and current documentation, the quality of testing, the appreciation of the effect of design changes and ineffective communication played a part in all three events. The report also identifies five recommendations from the Hidden inquiry that if current standards had been followed to the letter should have avoided the accident. However, they were not followed literally and perhaps the monitoring and auditing of staff attitudes could have alerted the management to the decline in compliance.

Normalisation of deviance

The observation that people were committed to safety but not working safely has been developed as the "concept of normalisation of deviance" by the American sociologist Diane Vaughan. She developed the theory when looking at where conflicts, mistakes, and disasters find their roots. She summarises her theory of normalisation of deviance as: "Social normalisation of deviance means that people within the organisation become so much accustomed to a deviant behaviour that they don't consider it as deviant, despite the fact that they far exceed their own rules for the elementary safety."

The RAIB view

Simon French, Chief Inspector of Rail Accidents said: "The disastrous collision at Clapham Junction on 12 December 1988, in which 35 people died and 484 were injured, was a turning point in the history of Britain's railways. The immediate cause of the accident was poor working practice by a signalling technician, and the subsequent public inquiry into the accident highlighted serious deficiencies in the management of safety, particularly around the design, modification, testing and commissioning of signalling systems. Putting in place the recommendations of the inquiry fundamentally changed several aspects of how the railway is run, and for signal engineers one of the most important was the approach to routine tasks, such as testing alterations to signalling installations. It was therefore concerning for RAIB to discover, during our investigation of the collision at Waterloo last year, that some of these important changes were not reflected in the way that signalling modifications were being undertaken.

"Some of the people involved in the signalling work connected with upgrading Waterloo station and its approach tracks did not keep proper records of temporary works, or ensure that additional temporary wiring was shown on the design documents. Leaving that temporary wiring in place when it should have been removed led to a passenger train being diverted onto a blocked line and colliding with wagons. Compliance with the existing standards, developed since Clapham, would have provided the controls needed to stop temporary wiring being installed and used in the uncontrolled manner which resulted in this accident.

"These symptoms of a deep-seated problem should give us all pause for thought. How can organisations ensure that lessons from events that happened outside the personal experience of present-day railway people are taught and retained? Compliance with a standard comes more naturally to people when they understand the purpose of the requirement, and the consequences that may arise from disregarding it.

"We are recommending that Network Rail takes action to develop and reinforce a positive safety culture within the signal engineering profession as a whole, by putting in place processes to educate present and future staff about how and why the standards have been developed, and why these things matter. It's also important to give people the skills to recognise and deal with non-compliant behaviour, whether that behaviour is by themselves or their colleagues. I believe that this accident at Waterloo starkly demonstrates why the lessons of Clapham should never be forgotten."

Conclusion

There are lessons here for many parts of the industry including the IRSE. Clearly the competence and assessment of staff is important but their compliance when faced with the challenges of the wider working environment may also be an issue. This latter point may have an impact on the IRSE licensing arrangements. The IRSE is making a specific response to Network Rail regarding the implementation of recommendation number 1 of the RAIB report.

Finally, this is a classic example of the 'Swiss Cheese' of hazard control. All the defence layers of design, checking, testing had errors or deficiencies. When all the 'holes in the cheese lined up' the train was wrongly routed, Thankfully the last 'piece of cheese', the barrier train, reduced the consequence and resulted in minimal harm to the passengers and staff concerned. It could have been far worse though than the Clapham Junction accident had it occurred on a higher speed part of the route or at a busier time of day. Food for thought for everyone in the industry.

Sixty years ago – a look back at 1958

Stephen Clark

The December 2016 issue of IRSE News included the first of a series of articles looking back at developments in the world of railway signalling, control and communications in the second half of the twentieth century, starting with 1966. As another year has now come and gone, for this year's retrospective we are focusing on 1958, a year when British Railways (BR) could truly be said to be poised on the brink of the modern railway era.

To provide some perspective, ten years had passed since Britain's railways were nationalised on 1 January 1948 under the control of the British Transport Commission (BTC). With the exception of electrified suburban railways in London, Manchester and Liverpool, the steam locomotive was still the almost universal source of motive power and yet, in only another ten years' time, steam power was destined to disappear from BR.

The British Railways Modernisation Plan had been announced in January 1955 and early signs of the new technology were beginning to appear, in particular the planned electrification of the West Coast Main Line from Euston to Liverpool and Manchester (which actually started in Manchester and progressed southwards, reaching London Euston in 1965), and would use the then very novel high-voltage system, with overhead current collection at 25kV AC. Although this had been adopted shortly after the war in France, BR at this time was still constrained by the 'Standardisation of Electrification Order' of 1932 which limited overhead electrification to no more than 1,500 V DC and the BTC had therefore accepted a recommendation in 1951 that all future electrification schemes should adopt 1,500 V DC, other than for extensions of the former Southern Railway's already extensive third rail system.

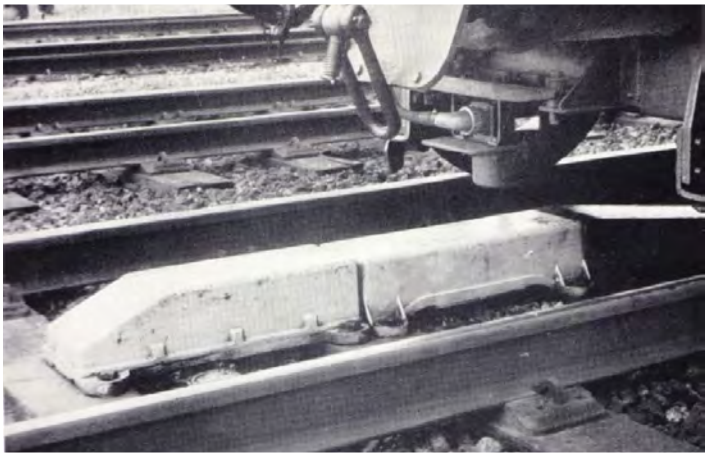
Several schemes that had been halted by the Second World War had been re-started in the late 1940s using the 1,500 V DC system, including the heavily-trafficked main line across the Pennines from Manchester to Sheffield, and on the suburban lines of the former Great Eastern Railway from Liverpool Street. By the time work on the Modernisation Plan began in earnest, however, a visit to France in 1955 by officers of the Railway Executive of the BTC (which would be succeeded by the British Railways Board in 1962), together with trials in the UK of high-voltage overhead equipment, had provided convincing evidence of the advantages of the 25 kV system and during 1958 work was progressing on equipping the 'Styal Loop' from Wilmslow to Manchester Piccadilly, then still called 'London Road'.

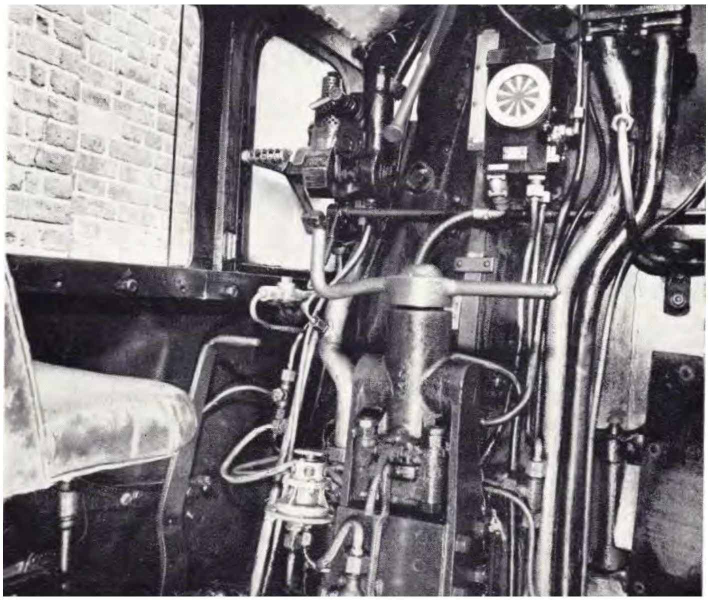
Looking at the IRSE's programme of Technical Papers for 1958, two themes stand out clearly, those of innovation and development. From the overall railway signalling point of view, the most significant of these was that 1958 was the year when implementation of a standardised system of what was then called 'Automatic Train Control' but which we now know as British Railways' 'Automatic Warning System' (BR-AWS) finally started its long-awaited roll-out, with the placing of contracts for the initial supply of production AWS equipment for 2000 locos and 2000 track installations. The phrase 'long-awaited' is quite appropriate here, as one of the British Transport Commission's first declared intentions at Nationalisation ten years before had been to standardise and implement such a system throughout Britain's railways.

The Technical Paper read in London on 12 February described the development history of AWS, starting with the formation of an Automatic Train Control Committee in 1951. Although this was the latest in a series of such committees that had been formed and dissolved over the previous thirty years, the decision was soon made to put in hand trials of the new inductive ATC system as soon as possible and these had commenced on the East Coast Main Line between London and Peterborough in late 1952, using equipment in store intended for a trial installation abandoned at the outbreak of war.

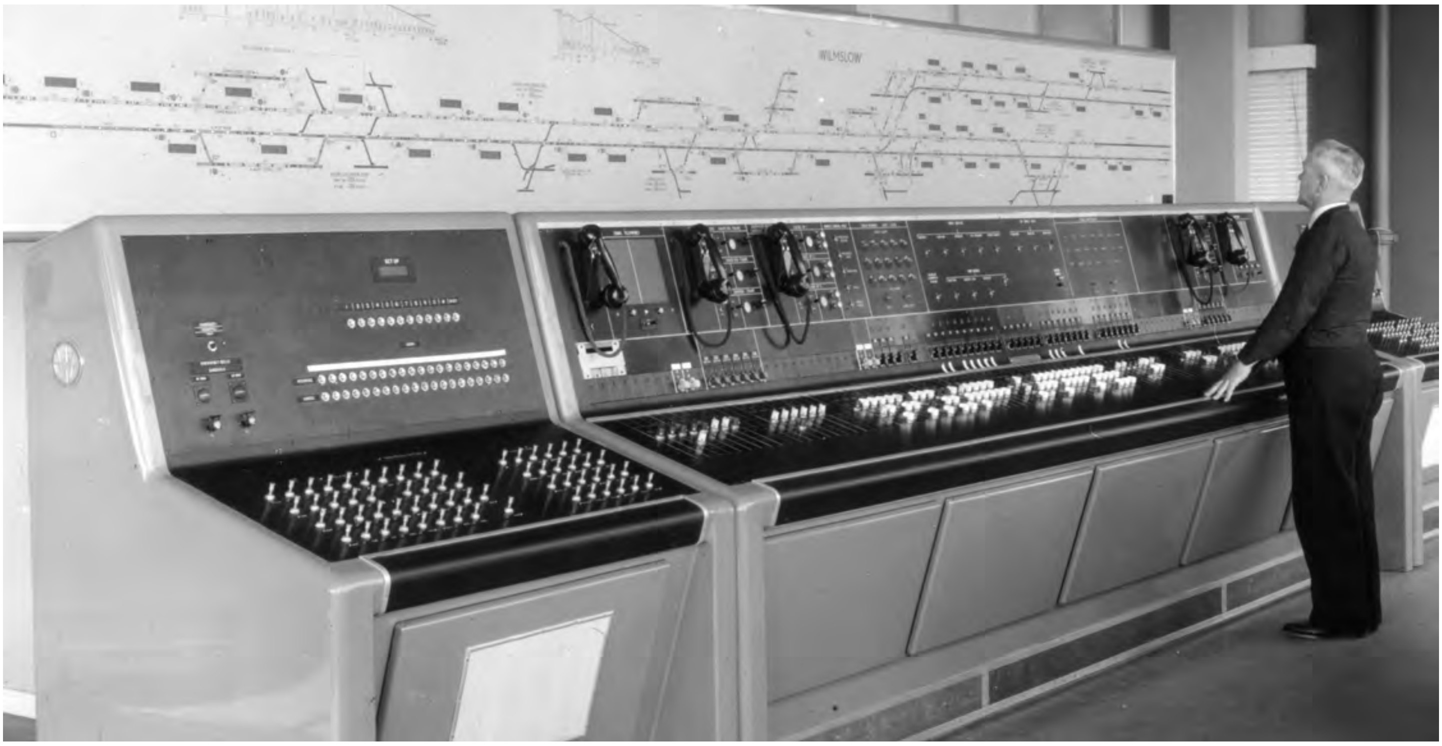
By a somewhat unfortunate coincidence, the start of the trials was almost immediately followed by the catastrophic double collision at Harrow & Wealdstone on 8 October 1952, which had brought the subject of Automatic Train Control dramatically into the public consciousness.

Although the basic concept of the inductive ATC system could readily be demonstrated (one such installation had been brought into use on the London to Southend line before the war), the requirement for it to be applied throughout the BR network meant that it would be necessary to fit receivers and driver's control units to a wide range of classes and sizes of locomotive, as well





BR-AWS in its original form, trackside magnet (above) and the familiar 'sunflower' display in a cab of the time.



Wilmslow signal box. *Photo Westinghouse archive.*

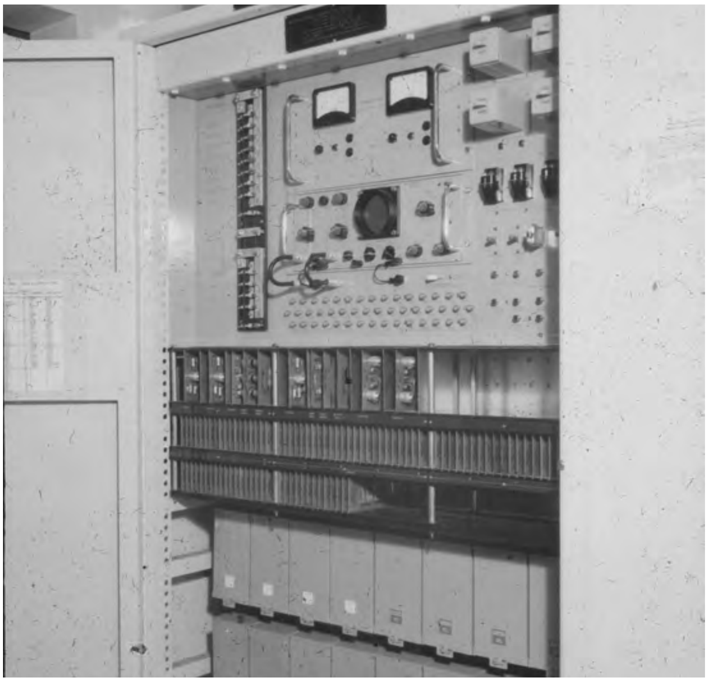
as installing track equipment on many types of track formation, and interfacing it to existing signalling systems.

It was also found that the track inductors would need to use magnets considerably more powerful than first anticipated, so that the receiver (a mechanical device using a centrally pivoted permanent magnet) could respond correctly and reliably at speeds up to 100mph and in the harsh environment of water, steam, oil, shock and vibration experienced underneath a steam locomotive. As this included ensuring that all mechanical fixings and electrical connections would withstand similarly hard usage, the trial period extended over a number of years and so it was not until 1958 that the system was ready for national roll-out. The installation of BR-AWS then continued over most of the next four decades and it is expected that this simple but effective warning system will remain in use into the foreseeable future.

The IRSE's President for the year 1958, Mr J F H Tyler, noted in his Presidential Address that he had 'had the greatest of good fortune in being able to spend not only ten years in each of three main line signal departments but also two years with… the London Transport Executive.' He also made reference to two potential benefits of the Modernisation Plan: miniaturisation and standardisation of both Engineering and Operating practices.

In his address, Mr Tyler expressed a concern that the wider introduction of modern signalling was being guided more by cost than by the consideration of operational benefits and that 'multiple aspect signalling… is a safeguard which should be accepted without question and at least on our trunk routes without financial justification'. He noted in particular the impressive rate at which resignalling schemes had been pursued in Germany since the end of the Second World War and suggested that their methods and techniques should be examined to determine whether the implementation of schemes could be progressed more quickly and economically.

The Crewe-Manchester trial 25 kV electrification was under way in 1958. This picture of the two platform end signals at Sandbach nicely shows the new world of main line signalling; instead of just a 'light on a stick' you had protective screens, guards and all manner of overhead 'knitting'. *Photo Westinghouse archive.*



An early Westronic system at Wolverhampton, using electronics to transmit data using time-division multiplexing. The Westronic brand continues to this day, albeit with a very modern platform, within the Siemens Controlguide range. *Photo Westinghouse archive.*

He noted that the formation of a Miniaturisation Committee the previous year as a joint undertaking between the IRSE and the BTC would be examining new methods with a view to reducing costs 'by breaking away from traditional British practice'. Revolutionary though this may sound today, it should be remembered that the work of the Miniaturisation Committee resulted in the adoption of two of the fundamental building blocks of British signalling development in the Modernisation era, namely the mosaic control panel and the British Railways range of specifications for Miniature Signalling Relays, now universally known in the UK and overseas as 'BR930 relays'.

What sounds somewhat less revolutionary, but which was a wish ultimately to remain unfulfilled during the remaining 40 years of British Railways' existence, was the adoption of standardised signalling practices with, as Mr Tyler said "Publication of a British Railways Signalling Manual [being] an urgent necessity." When the Big Four railway companies in existence prior to Nationalisation had been rearranged into six BR Regions (the former BR North Eastern Region being absorbed into the Eastern Region in 1967), many of the companies' preferences for operating and engineering practices, locomotive design and of course signalling were upheld and vigorously defended against what was seen as 'Soviet style' centralised control. Consequently, the diversity of signalling practices lamented by Mr Tyler, "our practice in regard to circuits varies from region to region and, in contract work. From system to system. This means that there exist 5 or 6 ways of doing exactly the same thing", was destined to continue for many more years.

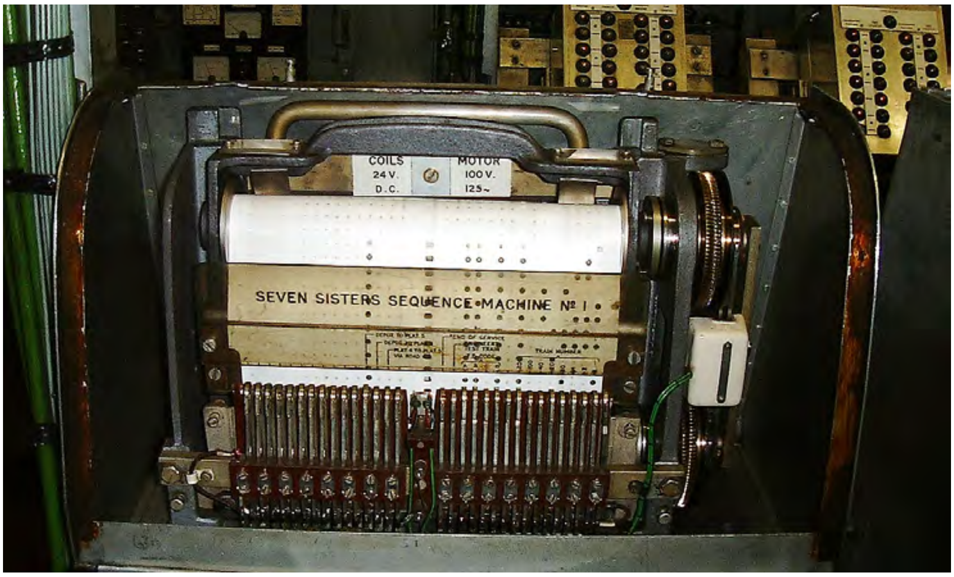
One particular form of standardisation that Mr Tyler wished to see promoted and which did achieve considerable success was the 'unit system of circuitry' or what we have since come to know as 'packaged geographical interlockings' and our article "Fifty Years Ago" looked at the fast-moving development of such interlockings on BR in 1966, exemplified by the 'Westpac' system. In 1958, however, such interlocking techniques existed only in Continental Europe but on 18 December Harry Codd's paper to the Institution on "Geographical Circuit Technique" opened a window on the technology and practices of these systems and prompted a lively discussion, which opened with Past-President A W Woodbridge referring to "a new conception of circuitry, one which appeared to have considerable merit and possibilities in practice".

Briefly, the concept described by Mr Codd was that for a particular track layout, signalling functions could be allocated to standardised and pre-wired units providing for signals, points, releases and plain track sections. A schematic would then show these units connected together by multicore cables in a configuration representing the geographic layout of the signalling functions.

The particular system described in Mr Codd's paper was that designed and built by the Swiss company Integra and was illustrated by photographs of the installation at Spiez, between Thun and Interlaken, as well as detailed circuit diagrams and schematics. Reading this paper today, one is struck both by the system as an obvious ancestor of British geographical interlocking systems that would follow (particularly Mk1 Westpac) and the fact that it incorporated two of the principal virtues described in the President's Address, namely miniaturisation and standardisation.

One item featured in Mr Codd's paper that was then very much a novelty to British eyes was the Integra 'Domino' control panel, construction of which echoed the modular concept of the interlocking, with the layout represented by a mosaic of 40mm square tiles. On these tiles plain line, points, signals and other symbols would be screen-printed on a dark green background, with indications being shown by small filament lamps with coloured filters. This design of panel, which was manufactured under licence in the UK by Henry Williams Ltd, went on to see considerable use on British Railways, over a hundred such panels being installed between 1959 and 2010.

In passing, it should be noted that although the first British-designed example of a truly 'packaged' interlocking would not be brought into use until 1964 at Rugby, a trial installation of the Integra system described in Mr Codd's paper



The Victoria Line was one of the lines to benefit from the Programme Machines introduced on London Underground. This example, from Seven Sisters, was commissioned some ten years after the paper describing the technology was presented to the IRSE.

was commissioned in 1962 at York Yard South, controlling the goods lines to the west of the station. This installation remains unique in the history of British signalling as, although it worked on the Entrance-Exit principle which had by then been adopted as standard for new signal boxes on BR, it required the entrance and exit buttons (which were coloured rather than clear, and hence non-illuminated) to be pressed simultaneously to set the route.

To consider for a moment events taking place outside Britain and the domestic railway scene, great interest had been shown in a paper presented by two Danish signal engineers in October 1956, which included both an explanation of Danish signalling practice and a description of the new CTC (Centralised Traffic Control) scheme being installed between Odense and Nyborg on the island of Fyn (Funen). In 1958, the IRSE made its first visit to Denmark for the Summer Convention, which was held in Copenhagen in May. This provided an ideal opportunity to inspect the section of the CTC scheme in operation between Nyborg and Odense, where there was also a substantial relay interlocking already in use, and the work then in progress to extend the new signalling beyond Odense and across the Little Belt Bridge between Funen and Jutland, as far as Fredericia. Visits were also arranged to the DSB (Danish State Railways) workshops at Valby, in the south of Copenhagen, and to the Dansk Signal Industri company's factory.

As a contrast to the signalling work examined in Denmark, the paper read in London in November 1958 described a considerably larger CTC scheme in progress in New Zealand, where prefabrication and factory techniques were being employed to install and bring into use a centralised traffic control system on the 340-mile section of the North Island Main Trunk railway between Frankton Junction (the principal station in the city of Hamilton) and Wellington.

The name "Centralised Traffic Control" was originally coined in the USA where the first true CTC scheme was brought into use in 1927. At this time, 'CTC' was used to describe the control of long stretches of (mostly) single line railway with passing loops, operation and supervision of which would be effected over remote control systems using relays and telephone-type equipment. The railways of New Zealand had been enthusiastic users of CTC since the 1930s, as this method of operation ideally suited their long single lines through sparsely populated areas. When, in the 1950s, powerful diesel-electric locomotives were being introduced on the North Island Main Trunk line, it became necessary to extend crossing loops and provide the associated signalling equipment to enable trains of up to 100 wagons to pass each other.

The paper described how these requirements had driven a need to both install new signalling systems in remote and inaccessible areas and to achieve a high rate of progress. The method used was to prefabricate equipment rooms and their equipment in a factory environment, to prepare lineside signals complete with their cables and to then equip a works train with a complete set of signals, point machines, mechanical equipment, cables, prewired relay racks and enclosures and tools (including augers and concrete mixers), in the order in which they would be required and then move it to site. As the train included sleeping and messing facilities for 50 men, it formed in effect a complete mobile factory.

When a trial of this method had been undertaken in 1954, it proved such a success that the prefabrication technique eventually allowed the resignalling of crossing loops to be completed at the rate of one a month.

Although not reported in the IRSE Proceedings, a significant development during the year 1958 was the trial of a solid-state transmission system based on the 'scanning' principle (a technique that would later be referred to as Time Division Multiplex or TDM) for controlling four remote interlockings on the Styal line between Wilmslow and Slade Lane Junction. Resignalling of this line was being carried out alongside its conversion for 25kV electrification, allowing it to be used as a test bed for new electric trains and signalling between Crewe and Manchester.

It should be noted that the term 'solid state' at this time was used to differentiate electronic systems using semiconductor devices from those using thermionic valves, cold cathode tubes and the like. The components used in such systems would be discrete transistors, diodes and passive components assembled on to printed circuit boards as required, the era of 'large scale integration' of components and circuit functions into the now universally recognisable 'microchips' being still some years in the future.

However, availability of a system of scanning that would allow individual functions to be transmitted over a single pair of conductors allowed the area of control of a signal box to be extended – in theory – without limit, and would in time facilitate the evolution of the signal box into the 'Area Signalling Centres' of the 1970s and 1980s, much as the introduction of power-operated signals and points had first extended the signaller's reach beyond the limits of mechanical connections over fifty years earlier.

Another feature that is now totally familiar but which first appeared at this time as part of the design of the new signalling installed to control the Styal Line was the display of the train's identity (i.e. its Train Description) using its four-character reporting number as shown in the Working Timetable in a position on the signaller's panel that corresponded to the train's position within the signal box's control area.

Although the original displays were provided by an arrangement of edge-lit Perspex characters (as used in very early electronic desk calculators), very considerable ingenuity would be exercised over the next few years to develop techniques for displaying train descriptions. These displays covered a whole spectrum of technologies including one-inch diameter cathode ray tubes, miniaturised (less than one inch square) back-projection displays where one of a matrix of lamps would be illuminated to project an alphanumeric character on to the rear of a translucent screen and 'Sodeco' electromechanical counters, four of which could be accommodated within two adjacent 40mm square tiles of a 'Domino' panel.

As a complete contrast to the developing use of electronics on the main line railways, the Technical Paper presented on 23 October by Robert Dell of London Transport (LT) explored in considerable detail a most ingenious electro-mechanical system being applied to automate the operation of junctions on LT's Northern Line. Titled "Automatic Junction Working and Route Setting by Programme", the paper explained the concept of the 'Programme Machine', an electro-pneumatic device in which the timetable details of an entire day's train service at a particular junction is encoded on a plastic roll as a series of punched holes indicating each train's description, its route and its time, the last being used to check correspondence with the timetable in conjunction with a separate 'time machine'. As LT signalling practice under Mr Dell's leadership had long been to rigidly segregate the 'vital' interlocking and safety controls from the 'non-vital' supervisory functions, the programme machines' control and interface circuits were effected using Post Office telephone relays.

During a technical visit on 29 November 1958, members of the IRSE were able to see at first hand the Northern Line Programme Machines in operation, starting with the 'Central Supervision Room' at Leicester Square. This included visits to the installations at Kennington, Euston and the remarkable 'three-dimensional' junctions between the City and Charing Cross routes, and the Edgware and High Barnet lines, at Camden Town. Control by Programme Machines eventually extended over the whole of the Piccadilly and District Lines, as well as the new Victoria Line opened ten years later, where in combination with Automatic Train Operation they created London's first fully automatic railway. Until resignalling of the London Underground Sub-Surface lines with Communication-Based Train Control and computer-based supervisory systems is complete, a number of areas remain under the control of Programme Machines, sixty years after their introduction.

It remains to record one final technological railway milestone from 1958, which has clear parallels in current rail vehicle developments. On 21 April, BR's first battery-operated railcars entered experimental passenger service on the Deeside line between Aberdeen and Ballater, a total distance of 43miles, with 12 stations. The two-car unit was converted from a pair of 'Derby Lightweight' diesel multiple-unit vehicles, although these needed substantial strengthening to bear the weight of the 16 tons of batteries.

The experiment was undertaken as a result of collaboration between the BTC and the North of Scotland Hydro-Electric Board, who undertook to provide power for charging at a rate of no more than three-farthings (approximately 0.3 pence) per kilowatt-hour for up to two years, and to provide and install the power supplies for the charging points at the two terminal stations. The vehicles remained in service (albeit with replacement batteries in the early 1960s) until the Deeside line was closed in 1966, after which they reappeared for a while as a Test Train for Automatic Train Operation at the Railway Technical Centre in Derby.

To conclude, it is worth recording a striking feature of the IRSE Proceedings for 1958, which is that they included no less than 28 full pages of advertisements, including many for organisations with long-gone names such as Metropolitan-Vickers-GRS Ltd, the Siemens and General Electric Railway Signal Co Ltd, the Automatic Telephone and Electric Co Ltd and the W R Sykes Interlocking Signal Co Ltd.

Acknowledgements

I am most grateful to the following publications, reference to which has allowed me to confirm a number of items of information presented in this article:

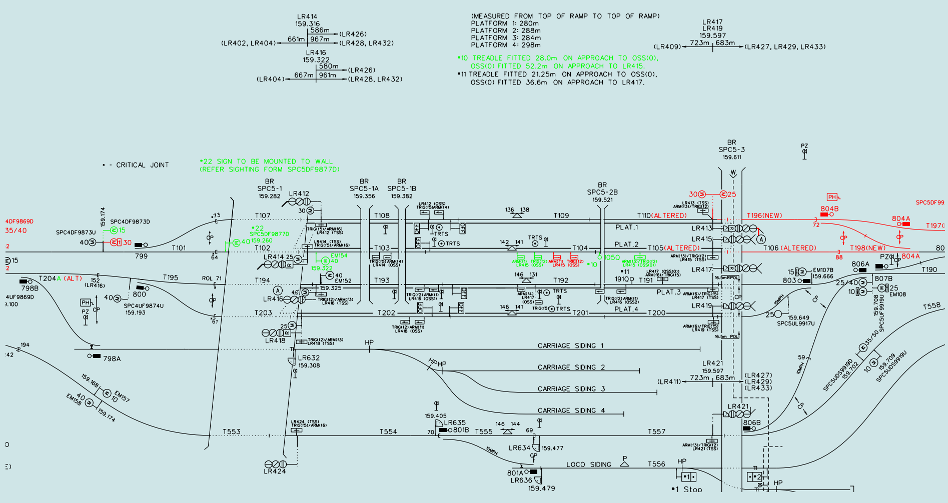
- Andy Overton's British Power Signalling Register for facts, figures and dates.
- Peter Woodbridge's "Chronology of UK Railway Signalling, 1825 – 2018", for particular details of remote control systems and geographical interlockings.

October cover

Some members have asked where the scheme plan shown on the cover of the October issue is.

Graeme Christmas of Network Rail has clarified that it is Leicester in the UK.

There have been two switch and crossing replacement schemes planned in recent years. One has been implemented and the second one, shown in plan, will complete the physical works and carries out some overlap locking finalisations for the first, thus relaxing some tight locking in the area.



A word with Blane Judd, Chief Executive, IRSE

Lindsay Jones

Chartered electrical engineer Blane Judd was appointed chief executive of the Institution of Railway Signal Engineers last July. A strong advocate of the importance of professional institutions and the role they play in driving up industry standards and developing members, he is looking forward to leading the IRSE into its next phase of growth. In his first IRSE News interview, we find out more about him and his plans for the Institution.

Tell us a bit about your background

My Dad and Granddad were both electricians, so their view was that I should enter a craft apprenticeship rather than going off straight to university. I was fortunate enough to enter an apprenticeship with the Central Electricity Generating Board which was the nationalised power industry in the UK. I found myself working my way up through the various roles within the organisation to the point where I had chartered engineers reporting to me. Realising that I didn't have the qualifications myself to get to chartered status, I approached the central learning function of what was by then National Grid. The head of the education division offered me the opportunity to combine studying for a degree in integrated engineering, if I worked for him to restructure the whole of their training programmes.

Whilst I was getting towards the end of my degree, I was part of the small team of specialist engineers that developed the technique and training used today to change an insulator string on a 400 KV power line without turning the power off.

I thought training would be the route through which I would accelerate through National Grid. But then I was spotted by the head of education and training at the Electricity Association which was the trade body for the generation transmission and distribution of electricity in the UK. They offered me the role of director of standards and training, which gave me a UK-wide responsibility to develop vocational qualifications for electricity transmission and power station operation working within safety critical environments.

The open learning material I developed became used internationally by other utilities, which led to me being invited by the Malaysian government to work with them to develop a better training package and a competency development model for their largest coal fired power station. There had been a number of human error faults that were causing lost time in generation. As a direct result of my new model in the region of $20M (£15.6M, €17.6M) a year were saved.

By this time, we had moved back to London, so when I was offered a midland based role to help set up the Energy and Utilities Sector Skills Council, I decided that I couldn't uproot the family again. I joined the Summit Skills Sector Skills Council as operations director instead. This involved working with, amongst others the heating and ventilating industry, and led directly to my appointment as chief executive of the Chartered Institute of Plumbing and Heating Engineering (CIPHE).

This was your first experience as head of a professional Institution. What challenges did you face?

They wanted to achieve royal charter status within two years which was quite a considerable challenge. After a lot of work engaging with industry and senior politicians, I succeeded in delivering their charter within the timeframe, which when you consider there have only been something like 700 Royal Charters ever issued was quite an achievement.

I also helped to develop international branches of the Institute, particularly the Hong Kong branch which grew to 1000 members. During my tenure at the CIPHE I worked to raise global awareness of the link between public heath and sanitation delivering presentations in Australia, Germany, India, South Africa, South Korea and Japan.

So, from there you went to head the Building Engineering Services Association and then the EngTechNow campaign. What did these involve?

I was tasked with re-branding the trade association and employers' organisation for the mechanical contracting sector from the Heating and Ventilating Contractors Association to the Building Engineering Services Association which was completed within nine months and on budget. Unfortunately, part of the change I had to deliver included working practices which as you might expect didn't go down well with the unions. I delivered the change but the relationship with the unions broke down and as a result my position became untenable.

The EngTechNow campaign was a two-year collaboration programme between the Gatsby Charitable Foundation, the Engineering Council and the three largest engineering professional bodies in the UK being the IET, IMechE and ICE. The vision was to change the image and raise the profile of the technician workforce in the UK and encourage young people to embrace the apprenticeship route to employment. Demonstrating the benefits of professional registration was at the heart of this strategy. I'm proud to say that as a direct result of encouraging clients to incorporate professional registration into their procurement and recruitment policies at 21% we saw the highest ever growth of technicians in one year.

What would you say have been your greatest achievements so far?

My three stand out achievements have to be the competency development work in Malaysia, being part of the team that developed the technique to work live at 400 KV and taking the CIPHE to charter status, which in turn led to me to the honour of being recognised by City and Guilds with a fellowship.

Which brings us right up to date. What attracted you to the role at the IRSE?

I really enjoyed my time at the CIPHE and had done two years running the EngTechNow campaign for Lord Sainsbury. I'd worked with a number of professional bodies during that period and demonstrated there are things that we can do as an institution to encourage more people to be engaged. That's not just members – a lot of my previous roles have involved engaging with employers and clients as well.

I have a significant network of people who already operate within this sector. As an engineer I had worked very closely with the railway industry because most power lines run along by rail lines as well. My knowledge of digital protection and communication systems within the power industry is equally relevant to railway signalling, as of course is my knowledge of working in a safety critical environment.

What will you bring to the IRSE?

I think it is a combination of the international experience and knowledge that I've had working with large corporate organisations in a global context. Having worked with a number of different institutions and seeing the way in which they approach particular issues, I'll be able to bring those into the IRSE to help to deliver a more attractive value proposition for members.

Possibly as a result of my own personal background and the work I did at EngTechNow, I am as much focused on the wants and needs of technicians as I am of chartered engineers. I believe looking across EngTech, CEng and IEng is vital. I get why a lot of people don't pursue incorporated engineer status because they might just as well wait for chartered engineer status, but we need to be doing more as an Institution to help engineers to understand why there is a benefit in being professionally registered at whatever grade.

That's interesting. Can you expand?

From a membership perspective there's a lot more that we could do to create relationships with employers and with clients to help them to understand why securing the services of professionally registered people in a membership organisation is beneficial to their business.

With EngTechNow I was able to convince HS2 to incorporate this into their procurement strategy. Their pre-qualification questionnaires now ask prospective subcontractors to specify what percentage of staff are professionally qualified. Just by asking the question we started to change the behaviours of those contractors.

Why does somebody become professionally registered? Perhaps it's because their employer expects it. Why does their employer expect it? Because their client expects it. We don't invest enough time in explaining to individuals why being a member of a professional body can enhance their career.

As an Institution we need to focus on that both in a government environment and in a client environment. I don't think we talk enough about the fact that the vast majority of what we do voluntarily regulates the behaviours of people that operate in our sector. The fact they are professionally ethical, and voluntarily put themselves into a position of being both regulated and evaluated by their peers is incredibly strong.

Most of the supervisory activity undertaken is done because we have concerns about people's commitment to doing the right thing when nobody's looking. As a result, we put supervision in place to facilitate that, but that supervision doesn't have the same level of productivity as the individuals that are carrying out the work.

If you can enhance the competence of those individuals and you know that they will perform in a professionally ethical manner we don't need the same levels of supervision and can therefore be more productive.

You are not a railway signalling or telecoms engineer, how will you do all that Francis did (and Colin and Ken previously)?

I don't think I need to. One of the great strengths of IRSE is the knowledge that sits within its membership and within my team. I can bring a completely different set of skills, but I can empathise because I am an engineer. I can empathise because I have worked in a safety critical environment. I can empathise because I understand the processes of pulse and digital techniques and communications, and because I feel incredibly strongly about the fact that professional membership of an institution is something that everybody in the sector should be striving for.

Just because I don't happen to be of the same type of engineer doesn't mean that I can't put that message across just as passionately.

What are your plans and challenges as Chief Executive for 2019?

What's important now as we are coming towards the end of our previous 2015 to 2020 strategy is to set a new vision to keep us moving forward which I am calling "Beyond a 2020 Vision".

We need to understand why we're doing some of the things that we're doing. Having a clear understanding of the targets and goals we want to achieve as an organisation will help us to focus.

We spend a lot of time creating ideas and initiatives, but we need to go further than that. I often talk about the 'So What' question. If I am making a statement to a member and if as a consequence, they ask 'so what' it means I haven't properly explained why we're doing what we're doing. My focus will be very much around people having a very clear understanding not only of what we're going to do but why we're going to do it and how they will benefit as a consequence.

Thank you, Blane. As we are coming to the end of the interview can I ask you a bit about your family and what you do in your spare time?

I love playing golf badly and as my in-laws live in Greece and my stepfather-in law is Greek I am learning the language. I am married to Kristen, who is a social care regulatory inspection manager at OFSTED, and we have two sons, Thomas who is a doctor and Lewis who is a project manager and works for National Grid on the gas side. Lewis is also a gold medallist world international cheerleading champion.

And finally, just for fun, can you tell us something we might not know about you?

I did 32 television commercials as a child, including adverts with David Prowse who became Darth Vader, before he was the Green Cross Code Man, and Dennis Price when he was Jeeves to Ian Carmichael's Bertie Wooster. I was also the child on the front of the space hopper box when space hoppers were first launched!

As a consequence of this on a more serious note, I can be a very strong and believable advocate for the IRSE. I enjoy being in an audience environment and I am very comfortable presenting.

About the author ...

Lindsay Jones has taken over the communications role at the IRSE on a consultancy basis to build on the work carried out by Paula Persson following the Institution's rebrand. Her role will be to help the IRSE engage more fully with its current and future membership worldwide.

A trained journalist with a master's degree in public relations, Lindsay worked in the communications departments of Honeywell Control Systems, The John Lewis Partnership and Burmah Oil before setting up her own PR and communications consultancy 20 years ago.

Industry news

Polish GSM-R roll-out

Poland: PKP Polskie Linie Kolejowe SA has selected Frequentis to provide its dispatcher terminals and communication nodes as part of a nationwide GSM-R mobile communications network to be deployed by Nokia. Nokia is providing a common IT platform for all core software in the GSM-R network for the Polish project.

Current driver-signaller radio communications in Poland already rely partly on GSM-R, but largely still on analogue radio networks which have limited functionality and are expensive to maintain. The project will enable Poland's state-owned railways group PKP to enhance the reliability and safety of countrywide railway operations, with the foundation for ETCS.

Poland will become one of the first customers to use the latest release of Frequentis' fixed terminal rail communication system, FTS 3020, featuring the new DICORA S20 operator working position with touch screen and new AudioHub. The DIVOS recording solution will also enable the recording of all calls and data over the entire GSM-R network. The FTS 3020 Dispatch Network along with 1600 operator working positions once the roll-out is completed, will be one of the largest in the world.

"Working on this project is certainly a leap forward in our goal to provide more software centric solutions and underlines our leading position in fixed terminal systems for railways. The first phase of the network, the Core Nodes and equipping the first lines with GSM-R is planned for end of 2019 and we are looking forward to working with PKP on this implementation.", says Thomas Karl, Vice President Public Transport, Frequentis AG.

Hitachi – Ansaldo STS

Europe: Hitachi has announced its intention to take full control of Ansaldo STS (which designs and constructs rail equipment and systems dedicated to signalling and automation) following an €808 million (£708 m, $922 m) transaction to increase its stake. Hitachi and Hitachi Rail Italy Investments have signed an agreement with Elliott to acquire its 32% stake in the company.

TU Delft news

Netherlands: Delft University of Technology, also known as TU Delft, is a public legal entity whose main tasks include providing scientific education, conducting scientific research, transferring knowledge to society and promoting social responsibility. The university has been designated as a 'public benefit' institution.

In his inaugural address held at TU Delft on Friday, 9 November 2018 entitled "Where are our railways heading?", Rob Goverde, professor of Railway Traffic Operations & Management, said that Dutch railways should switch much faster to the modern European ERTMS communication standard for rail traffic control and safety.

"Worldwide, railways are developing in all kinds of ways. For example, China is rapidly expanding its high-speed network. The European high-speed network is also attracting increasing numbers of passengers as a sustainable and fast alternative to flying. The same also applies to international railway freight connections.

"To enable this growth, railways are transitioning worldwide towards a modern digital rail transport system with continuous wireless communication to ensure efficient safety and management of train traffic. Timetables are becoming increasingly precise, in order to make optimum use of the track. In this process, train control systems are being supported by speed recommendations linked to intelligent traffic management systems. Automatic train control is now standard in modern metro systems and is also set to be applied on other rail systems in the future in order to maximise use of the track.

"Of course, all of this is also going on in the Netherlands. The Dutch railways are among the busiest in Europe and demand for railway transport from both passengers and freight continues to increase. Unfortunately, I detect a remarkably low level of ambition when it comes to transitioning to a modern digital rail traffic system. By 2030, only very few routes in the Netherlands will have been upgraded to ERTMS." Specifically, this concerns the switch from the old Dutch signalling and ATB system to ERTMS for safety purposes.

"However, ERTMS goes much wider than safety in terms of the opportunities it has to offer – it can also enable more efficient control of rail traffic. So far, the modernisation of safety and rail traffic management have not been examined cohesively.

"ERTMS makes continuous communication between the train and rail traffic control possible. Drivers can be given much better support in responding to the current rail traffic situation. Trains can reduce their energy consumption and unnecessary stops can be prevented. ERTMS also enables trains to travel closer together, increasing the capacity of the whole network."

Prof Goverde is therefore convinced of the need for a rapid switch to ERTMS, and to look further than the safety upgrade aspects. The Dutch House of Representatives is set to decide on the planned progress of the system soon.

Goverde also expects to see many other innovations in the railway system in the future. "For example, there is a European project exploring the virtual coupling of trains, which enables trains to travel even closer together. As indicated, timetabling is also becoming more precise, enabling optimal use of the track."

In the High-Frequency Rail Programme (Programma Hoogfrequent Spoor), efforts are being made to enable an intercity train to travel on the busiest routes in the Netherlands every ten minutes by 2028, together with increased numbers of sprinter trains and sufficient space for freight trains.

"Whatever the case, the current transition to modern digital technology represents a challenge for the traditionally conservative railway sector. The transition calls for an innovative, integrated approach with a view to developing a safe, efficient and reliable transport system."

The IRSE's Aspect 2019 conference will be held at Delft University of Technology. The conference will open on 22 October with the introductory day and welcome reception, the main conference days on 23/24 October. A selection of technical visits will be offered on 25 October.

ASPECT2019

Institution of Railway Signal Engineers | Delft University of Technology | IRSE Nederland

ASPECT Introductory Day
22 October 2019

Welcome Informal Evening Social
The Botanical Gardens

First Day of ASPECT
23 October 2019

ASPECT Conference Dinner
Delft Oude Kerk

Second Day of ASPECT
24 October 2019

Closing Social
Lijm & Cultuur Creative Laboratory

Technical Visits
25 October 2019

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GSM-R enhancements and scheme digitalisation

UK: The University of Huddersfield, Siemens and the RSSB, have developed a method for the detection of track voids and remote condition monitoring (RCM) using accelerometers fitted into the GSM-R cab radio. Using software to capture and analyse data the GSM-R cab radio is able to act as a low-cost RCM system, to accurately detect changes in track degradation and condition. Data is pre-processed on-board the train and the results transmitted over a GSM-R radio link to a ground-based system for further analysis and management.

The low cost RCM initiative is another example of features still to be developed and exploited using GSM-R. It follows the introduction of train describer berth triggered broadcasts. Signallers are now able to caution drivers with certain operational safety messages using a GSM-R berth triggered broadcast. A pre-recorded broadcast will be received by the driver over the GSM-R loudspeaker while on the move, with an automatic notification sent to the signaller if the message has failed to be received by the cab radio. The driver is able to confirm receipt and acknowledge a clear understanding of the broadcast by using the GSM-R 'ST' acknowledgement button. The process allows trains to be cautioned without specially stopping at a red signal.

Siemens is also working on a scheme digitalisation and verification project, with the universities of Newcastle and Birmingham, to develop concepts to digitise scheme plans, control tables and to provide automatic verification, which will significantly reduce development timescales and increase the quality of scheme data.

Tram-train services

UK: On 25 October 2018 long-awaited tram-train services started operating in South Yorkshire, England, with purpose-built vehicles running on-street in Sheffield and continuing on the rail network to Rotherham. Unfortunately, on the day of its launch a tram derailed after colliding with a lorry on the existing tram route in Sheffield. The incident is under investigation and it is understood that no one is thought to be seriously injured.

The Government-funded programme is a partnership between South Yorkshire Passenger Transport Executive (SYPTE), Network Rail, Stagecoach Supertram and Northern Rail to pilot tram-train technology for the first time in Britain.

Three tram-trains an hour will travel on the Supertram network from Sheffield Cathedral to Meadowhall South, then over a new section of track linking the tram line to the rail track called the Tinsley Chord and on to the national rail network to Parkgate Retail Centre.

Seven Class 399 three-section vehicles were ordered from Vossloh's Valencia plant (now owned by Stadler) in Spain. Issues that had to be addressed included the different signalling systems used by tram and train, and vehicle safety standards which extended to finding the best wheel profile for the track.

The pilot will run for two years while customer satisfaction, passenger numbers, reliability and costs are tested. Tram-trains will continue to run as a local service if the pilot is successful.

5G roll-out cities identified

UK: EE had already confirmed it was launching its 5G network in 2019 in the UK and they have now confirmed that London, Cardiff, Belfast, Edinburgh, Birmingham and Manchester will be the first cities to receive the 5G service.

Or rather, parts of them will be. As EE is focused on the areas that are busiest, such as Hyde Park in London, Manchester Arena, Belfast City Airport, the Welsh Assembly, Edinburgh Waverley train station and Birmingham's Bullring.

Throughout the rest of 2019, EE will work on extending its 5G coverage to parts of Glasgow, Newcastle, Liverpool, Leeds, Hull, Sheffield, Nottingham, Leicester, Coventry and Bristol.

Its focus will be on the busiest areas of those cities, as these are the areas that will most benefit from faster, more reliable data. The network notes that the first 1,500 sites it's upgrading to 5G carry 25% of all data across the whole network, despite only covering 15% of the UK population.

Alongside this announcement, EE has said that 5G smartphones from multiple partners will be available on the network.

BT and EE are also upgrading transmission to 10Gbps links at each 5G site, and are preparing the core network for the next stage of global 5G standards role out. This will include 'vitalisation' on the cloud based infrastructure. Virtualisation is a strategy for consolidating servers. It pools infrastructure resources to enhance the agility and flexibility of the cloud environment.

It is expected the 5G service will launch in the second half of 2019. This may also include 5G offered by BT Mobile at around the same time, since BT owns EE.

Yorkshire upgrades

UK: Network Rail has completed upgrade works to the signalling system used between Pudsey, Bradford, Halifax, Hebden Bridge, Huddersfield and Shepley as part of the Great North Rail Project in Yorkshire England.

The project sees the Rail Operating Centre (ROC) in York taking control of the mechanical signal boxes used on the West Yorkshire railway.

These upgrades will provide a "more modern, reliable and cost-effective railway which will improve journeys for passengers not only in West Yorkshire, but across the whole of the north" said Rob McIntosh, route managing director for Network Rail.

A replacement bus service was in operation across the weekend to allow the work to be completed, but train services are now running normally and Network Rail says they are now running on a "more modern railway." Rob said "Passengers across the north will start seeing the benefits of this upgrade today and will benefit from a more modern and reliable railway which will improve journeys."

Africa –high-speed rail arrives

Morocco: Morocco's main economic regions will be connected with quicker journey times and improved passenger comfort as the Tangier-Casablanca high-speed rail line, the first ever high-speed line in Africa, has been officially inaugurated.

Alstom supplied the Office National des Chemins de Fer Marocain (ONCF) with 12 high-speed trains and level 1 and 2 on-board ERTMS.

The trains will run at 320 km/h (200 mph) between Tangier and Kenitra, the first 180 km (112 mile) long section of the network. For the remaining 200 km (120 miles), between Kenitra and Casablanca, the trains will join the conventional network where they will run at 160 km/h (100 mph). The service will connect these main economic regions of the country, in two hours and 10 minutes instead of four hours and 45 minutes.

The Avelia Euroduplex trainsets are articulated double-deck trains adapted to specific climate and environment conditions. With a capacity of 533 passengers, each trainset is composed of eight cars including two first-class cars, a dining car and five second class cars and one section of the train is fully dedicated for passengers with reduced mobility. The trains are also equipped with digital passenger information systems, bilingual in Arabic and French.

News from the IRSE

Blane Judd, Chief Executive

Voting for new IRSE Council Members

Several nominations have come in for the vacancies arising on the IRSE's governing Council next April. Fellows, Members and Associate Members of the IRSE will be invited to cast their votes to elect new Council members in early 2019. There will be also votes for positions on Council for four people at the grade of Fellow and one at the grade of Associate Member.

Fifth Presidential Programme Technical Meeting for 2018-19 in Germany

The fifth Presidential Programme Technical Meeting for 2018-19 comprises two papers, both exploring Cybersecurity in Railway Signalling. This free event is kindly co-organised with the cybersecurity profile area of Technische Universität (TU) Darmstadt , and is to be held on 7 February at the University starting at 1800 hours CET. A welcome reception will be held at 1700.

Within the CYSEC (Cybersecurity [at] TU Darmstadt) profile area, 33 research groups from eight departments address the major issues and challenges of cybersecurity and privacy protection.

Prof Dr Stefan Katzenbeisser, professor of security engineering from TU Darmstadt will present "Challenges in Designing Secure and Resilient Railway Command and Control Systems" followed by Max Schubert, systems architect manager for DB Netz AG with his paper on "The Balancing Act of Implementing Cyber Security"

To attend please register at **irse.info/nzfu6** before 1 February.

IRSE launches the new Industry Partnership Scheme

Following discussions at Council and the formation of a working group the IRSE has now launched its new Industry Partnership scheme (IPS). The new scheme will replace the previous company affiliation scheme.

This is part of the strategic plan for the IRSE as it seeks to ensure we are aligned to the needs of the industry as we move forward into the next generation of railway control systems, recognising the impact of these technology changes on both the industry and the Institution. The previous IRSE company affiliation scheme had outlived its usefulness, and the new industry Partnership Scheme has been formed in accordance with our Strategic Plan.

The Institution seeks to promote the railway industry as a vibrant, innovative and a sustainable career choice for engineering professionals. The IPS, therefore, seeks to represent a unique opportunity for industry leading organisations to partner with the IRSE in its mission to advance the science and practice of railway control and communication.

The IPS will create a positive and valuable relationship for companies and organisations with the IRSE, which is a globally respected Professional Engineering Institution within the railway sector. Our 23 local sections serve 18 geographical regions, including all the major markets for railway investment across the world. The suppliers, operators, maintainers, consultants and academics who are the present and the future of our railway regularly engage through the IRSE and as such it is truly international learned institution, and therefore offers a global opportunity for prospective partners.

The IPS team has created a brochure introducing the scheme.

A special 'Industry Partners' edition of IRSE News will be produced each year.

How the Scheme works

Organisations can demonstrate their partnership with the IRSE through the IPS and demonstrate that they are they are among the most progressive and innovative employers, able to provide challenging and rewarding careers for their employees.

The IPS delivers this proposition through a number of channels, including co-promoting its partners via its website, at major industry events, and through all the many forms of communication that the IRSE uses to reach the industry and its professionals.

A key partner benefit, however, is through participation in the special edition of the IRSE News "Industry Partners". Through the pages of this unique publication, Partner organisations are able to deliver key messages about their organisation directly to the membership of the IRSE and a wider sector specific audience.

A sample of the IRSE News "Industry Partners" special edition has been produced, along with a brochure to explain the scheme to the industry. Industry Partners will be able to provide content for the special edition and the experienced IRSE News production team will work with Partners to publish the special edition IRSE News once a year.

With the launch of the IPS the IRSE is also inviting a new level of engagement with the industry. As a not-for-profit organisation, we have always relied upon the support of industry, both directly through sponsorship and indirectly through the efforts of volunteers, who are supported by their employers in those activities.

This is achieved by supporting employees to enhance their softer skills and competencies to plan, organise and network at events, and to share their expertise through the delivery of technical papers, or participate in study groups and mentoring programmes. The IPS is the vehicle for progressive organisations to develop railway signalling, telecommunications and control engineers, while receiving valuable recognition for that investment.

IRSE supporting industry for the public benefit.

The IPS is also an opportunity for industry to support the IRSE, as the professional body for railway control systems and communications engineering, in provided independent advice to governments and infrastructure managers, for the public benefit. Examples include the IRSE White Paper on the Digital Railway Programme in Great Britain. Comments from senior positions in the industry said that it was the best thing that had been written about the Digital Railway programme for some time, and others welcomed the partnership aspects of the paper and commented on the quality of the thinking that had clearly gone into it.

Another example is the review of signalling principles for Network Rail in Great Britain, which was also very well received. Both these and other examples demonstrate the IRSE domain of expertise, and that we are independent and have no particular fixed agenda, other than the wish to see railways being successful and its customers benefiting accordingly.

For more information on the IPS visit irse.info/industrypartners.

Calling all photographers

We're looking for a number of alternative front cover photos to use for IRSE News, and in particular non-UK photos.

The photos need to be high resolution (typically 3000px along the longest edge), well-lit, and in sharp focus. JPEG files are fine, RAW files are better.

The subject could be of anything related to signalling, telecommunications, control, system engineering, or trains in stations, at junctions or at speed and ideally of something interesting. The only thing we try to avoid is the back of a train passing a red signal.

The photo doesn't need to be one of your own, it's fine if it comes from a railway authority, company or rail organisation – as long as we are given written permission to use it. However, unfortunately we are unable to pay for the photographs we use.

If you can help please contact us at editor@irsenews.co.uk.

National celebration of engineering at Westminster Abbey, London

Blane Judd

The vast contribution engineers make to society was in the spotlight as Westminster Abbey in London played host to a special multi-faith service last November to celebrate the engineering profession and its work in inspiring the next generation.

It was an honour for me and a group of Members including our junior vice president Daniel Woodland and several past presidents to join engineers across all disciplines and represent our Institution at this most moving and inspiring service. It was the first of its kind to mark the UK government's Year of Engineering and the bicentenary of the Institution of Civil Engineers (ICE).

Students from local schools were also invited to attend, with the service providing a chance to reflect on how industry and government here in the UK have joined forces throughout 2018 to bring engineering to life for young people from all backgrounds – and the importance of this continuing in 2019 and beyond.

The service included personal testimonies from engineering ambassador Roma Agrawal MBE, associate director at AECOM and famed for her work on The Shard building project in London, and Colonel Deborah Porter, deputy commander of the Defence Medical Group, on how engineering had changed their lives and enabled them to help and inspire others through their work.

The IRSE group outside Westminster Abbey.

The congregation heard how Roma played with Lego and Meccano as a young girl and went on to study physics as an undergraduate before converting to engineering for her master's degree. She shared how she is now having her own personal engagement with engineering through IVF. Deborah spoke about working with engineers to help amputees and other injured service personnel to gain a better life through mobility.

Secretary of state for transport Chris Grayling said: "In a year which has seen government and industry join forces to raise the bar for inspiring the next generation of engineers, what could be more fitting than to come together to celebrate the contribution that engineers have made and will continue to make to all of our lives?

"The Year of Engineering has been a chance to show young people across the UK all that this profession has to offer them – and to spread the message that engineering needs talented young people from all walks of life to tackle some of the biggest challenges we face.

"I hope today's service serves as an important reminder not just of our proud engineering history but of the role young people will play in writing its next chapter."

Please keep us up to date

Please do let us know if any of your circumstances change, for example a change of employer or a change of home address. If our database isn't up to date then we can't make sure that you receive the benefits of membership, for example IRSE News!

To update your details, visit our website at **www.irse.org**, login, and go the **Your record** link on the left hand side of the page.

Please do also consider whether you are at the right grade of membership or whether you're ready to progress to the next step. More information can be found under the **Membership** tab on the website.

Membership changes

The following members have been removed from the membership database due to non-payment of first subscriptions:

Amukelani Ndindani, Alastair Carr, Michael Coghlan, Doyo, Jack Hesford, Tegoeh Hidayat,Shabri Kamil, Mosese Luveniyali, Ahmad Maulana Hizbullah, Angga Riki Rusady, Riccardo Risica, Suputra Sandra, Soleh Wahyu Nugraha, Martin Feeney, Tina Bandarchi, Polly Chan, Prasad Dhepe, Jyothi Halebeedu Manjunath, Kranti Inamdar, Ashwini Kambale, Jakhar Naveesh, Askhay Samse, Maciej Sorokin and Bharat Zanvar.

London & South East Section

Future Railway Mobile Communication System (FRMCS)

Paul Callaghan

On 26 October 2018, over 60 people attended the London & South East Section's talk on the Future Railway Mobile Communications System (FRMCS), the successor to GSM-R, by Pierre Tane of Kapsch CarrierCom.

Harvinder Bhatia from TfL took the opportunity to welcome all attendees to TfL's offices in 55 Broadway and to emphasise the importance and relevance of FRMCS to TfL and metro systems, and not just to Network Rail and main line railways.

GSM-R – The Story So Far

Pierre began his talk by summarising the history of GSM-R in GB, from the initial deployment on areas of the West Coast Main Line in the early 2000s in support of the Interim Voice Radio System (IVRS) – an early application of GSM-R deployed to mitigate the loss of Track Circuit Operating Devices (TCOD) in axle counter areas –through to the completion of the full national GSM-R network in 2015. In this time, GSM-R has been used primarily to support voice communication between drivers and signallers, with limited ETCS Level 2 deployment on Cambrian Coast, with Thameslink and Crossrail to follow soon.

He also stated that, whilst GSM-R was considered mature 2G technology, industry and equipment suppliers have agreed to support the system until at least 2030.

FRMCS in brief

Pierre explained that, having accepted that GSM-R has a finite life remaining, the International Union of Railways (UIC) initiated the FRMCS project in 2012, with the expectation that it would provide bearer-independence for railway applications, support multiple radio access technologies, provide high availability and robustness and maintain interoperability for cross border operations along with flexibility to allow different deployment options

The development milestones of the FRMCS programme are:

- Delivery of V4.0 of the User Requirements Specification in 2019 – V2.0 was previously approved in 2016.
- Standardisation of the system by 3GPP between 2017 and 2020.
- Availability of the new system from 2023 onwards for early adopters to deploy.

In terms of the solution, there are four main aspects for consideration:

Applications –identified as Critical, Performance or Business related.

Spectrum –currently under discussion with the Electronic Communications Committee (ECC) Working Group Frequency Management 56 (WG FM56) – the group responsible for developing strategies for the management the radio spectrum for railway applications

Technology –anticipated to be 5G based upon 3GPP Release 15/16 specifications

Migration –between of GSM-R and FRMCS which will co-exist for several years.

Applications

The User Requirements Specification contains a full suite of FRMCS applications agreed with European stakeholders over many years, including Performance and Business applications not currently delivered by GSM-R. Examples include –critical applications (voice communications between drivers and controllers, group calls, shunting communications), performance applications (on-train voice and telemetry and non-critical real time video and business applications (public information help points, wireless internet for passengers)

Spectrum

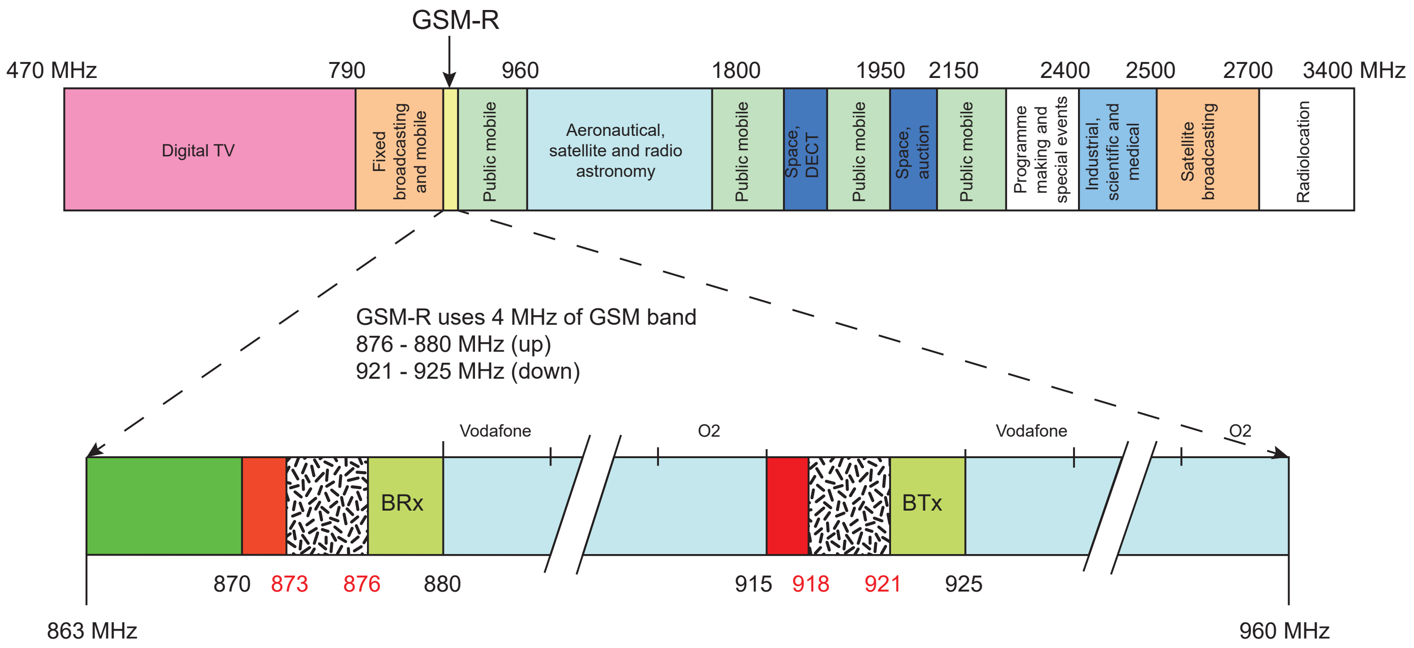
Pierre stated that three things matter for any wireless network i.e. "spectrum, spectrum and spectrum". With this in mind, it is safe to say that he sees spectrum is an important topic for the FRMCS project, but it is one that has not yet been resolved.

Most European GSM-R railway networks use the 2 x 4 MHz UIC band (876-880 MHz, 921-925 MHz), with only a few European countries having opted for an additional 2 x 3 MHz (873-876 MHz, 918-921 MHz) using the complete E-UIC band (873-880 MHz, 918-925 MHz). Network Rail has not opted to use this additional 2 x 3 MHz band. This is shown in the spectrum diagram opposite.

Competition for spectrum is fierce, especially in the 900 MHz band, with the Short Range Device (SRD) / Machine to Machine (M2M) / Internet of Things (IoT) markets making a bid for spectrum. EC Decision 2018/1538/EU published on 11 October 2018 preserves 2 x 1.6 MHz bands for railways in the upper part of the E-GSM R bands for the moment. There is a strong push at the European level (and to a certain extent at the global level) to harmonise the 870-876 MHz / 915-921 MHz.

The applicable frequency band for FRMCS has not yet been determined, although the majority of the European railway community have expressed their willingness to exploit fully the potential of the UIC band in order to facilitate and maximise the reuse of existing assets (specifically radio masts, transmission, and possibly antennas). Similarly, the channel bandwidth allocated to railways is under review in order to determine the amount of frequency (MHz) that should be allocated depending on the nature of the railway service requirements (Critical, Performance and Business applications).

In addition, consideration is being given within Europe to using other spectrum as complementary bands, such as 1800-1920 MHz or 2.3 GHz. This spectrum is not available in the UK as it used by Mobile Network Operators (MNO) and the Ministry of Defence (MoD) amongst other, and so Network Rail will need to work with Ofcom to identify alternative complementary bands which, unfortunately, will probably not be harmonised with the rest of Europe.



GSM-R occupies a very small part of a crowded and highly competed radio frequency spectrum.

Migration

Migration from GSM-R to FRMCS will be a major challenge. Pierre focussed on some key considerations as follows, which he is confident can be managed through product design and operational procedures:

Radio sites

The spectrum allocation will have a huge impact upon radio sites. For example, should the existing E-UIC band be used, operators can take advantage of the existing infrastructure deployed previously to support GSM-R, although Pierre did identify a number of issues associated with co-existence that will need to be managed e.g. potential interference, mast loading, transmission requirements, etc. In addition, sharing the E-UIC band between GSM-R and FRMCS simultaneously during the migration phase will be a challenge – will there be enough capacity available on both systems in busy areas? This will be a real challenge for infrastructure managers to plan and manage carefully.

Should a higher band be selected then inevitably additional ‘in-fill’ sites will be required to accommodate the lower propagation distances offered by higher frequency signals.

Rolling stock

The spectrum allocation for railways will determine the retrofitting of existing rolling stock to allow its operation on an FRMCS-enabled network as well as the specifications for new upcoming rolling stock. The spectrum allocation will also determine the timing and the introduction strategy of future services with high demands in throughput (possibly, making use of an additional band, possibly operated by a different party).

The concept of an on-board Mobile Communications Gateway (MCG) capable of supporting GSM-R, FRMCS, WiFi, etc. simultaneously has been introduced to ease the migration.

Pierre suggested that RSSB (the standards authority for GB rail) updates the “Key Train Requirements” to address areas such as the MCG as well as antenna types, spacing and power.

Infrastructure

FRMCS will place higher demands on the transmission backhaul, relying upon IP connectivity from trackside equipment to the core, as opposed to the TDM loops (or chains) currently employed by GSM-R. This inevitably drives the deployment of a national IP transmission network, although Network Rail is well on the way to achieving this through its FTNx network roll out.

Synchronisation and resiliency / geo-redundancy will also be critical requirements, with PTP protocol (for Phase / Time synchronisation) being mandatory.

Operations

Operations will require careful management throughout the migration phase as two networks (GSM-R and FRMCS) will be operating together. Ideally a unified view of the networks would be provided to enhance network operations and supervision.

Possible Evolution Plan

Pierre proposed a potential evolution plan and timeline that could be adopted by infrastructure managers in support of FRMCS deployment as follows:

Strategic Planning: immediately – optimise the GSM-R Frequency Plan and upgrade the transmission network

Tactical Planning: from mid CP6 (2019-2024) – capitalise on opportunities offered by incurred investments, familiarise with ETCS over IP and IoT/M2M

Migrate: throughout CP7 (2024-2029) – prioritise regions, franchises, services, etc. and ensure co-existence of GSM-R and FRMCS during migration phase

Phase Out GSM-R: throughout CP8 (2029–2034) –ensure CCS TSI is co-ordinated to maintain Interoperability, consider the lifecycle of the rolling stock equipment, throughout the GSM-R ecosystem lifecycle

Q&A

Following the presentation there was a constructive questions and answers to allow Pierre adequate time to catch his Eurostar train home to Paris immediately after the meeting.

Trevor Foulkes (chair of the Section) concluded the event by thanking Pierre and the audience for a thought provoking and stimulating discussion.

Northern Line Extension visit, 18 May 2018

Vivich Silapasoonthorn

London & South East Section visitors on the viewing platform.

The afternoon started with members of London & South East IRSE members meeting up outside the ticket hall area at Vauxhall Underground station, before setting off on a short bus ride to the site entrance at Battersea Power station.

After signing in and safety briefing we entered the site office and received a welcome from Thomas Stankowski, signalling project engineer, and Lawrence Weller, senior project engineer railway systems, from London Underground Northern Line Extension team. Thomas and Lawrence had kindly given up their day work to show us around this significant construction site and provide the project history together with an update on current work progress.

The delegates were given presentations by Lawrence on the brief history of the project from business aspiration to the conception, lifecycle and how the project will create new transport links to the area and invigorate this part of the city as a new economic hub south of the river.

He described the difficulties and challenges that the project had faced and how these have been overcome. The tunnelling work has all been completed and work is now underway for the installation phase on track, civil fit-out, power and signalling.

Nick Stuart, programme delivery manager, presented a site 'fly-through' with VR technology of the brand-new station that was being constructed next to the site office. We saw what customers will see from entering the station, down an escalator to the new ticket hall concourse and onto the platforms.

We were then given an insight on the challenges for the signalling part of the project. Thomas presented an update on how the project team has worked tirelessly to integrate the current signalling system into the Northern Line for two new step-plate Junctions.

The team has to work closely with their signalling supplier to seamlessly integrate the existing signalling system to the new section with 3rd Generation SelTrac communications-based train control and new control areas creating a smooth handover between old and new systems, without affecting the current service.

The team then led LSE delegates to the viewing platform, where the significant progress on the new station block of this contract site could be seen. This included the cross-over complex, situated just below the viewing platform, which is now close to completion.

A brief history and Northern Line facts

The Northern Line is one of 11 lines on the London Underground (commonly known as the Tube), which is the oldest metro system in the world.

The Northern Line is one of the oldest and busiest tube lines on the network. It covers 58 km and includes 50 stations (36 of them below ground). The line connects the southernmost station, Morden, with High Barnet, Edgware and Mill Hill East in the north.

It features a branching layout through Central London; trains can run via either of its two central London branches, Bank and Charing Cross. The line is used by more than 900,000 passengers a day and more than 200 million passengers a year.

The Northern Line features the London Underground's deepest station (58.5 m below ground level) at Hampstead. Angel station features the longest (60 m) escalators in Western Europe. The line also features the longest (27.8 km) tunnel in the underground network which is located between East Finchley and Morden (via Bank).

Current and future works on the Northern Line

The Northern Line Extension (NLE) work on this project has started to extend the line to Battersea, which will help regenerate the Vauxhall, Nine Elms and Battersea areas. Two brand new stations are being built at Nine Elms and Battersea Power Station. The main tunnelling works started in 2017, with two Tunnel Boring Machines (Helen and Amy) tunnelling beneath London.

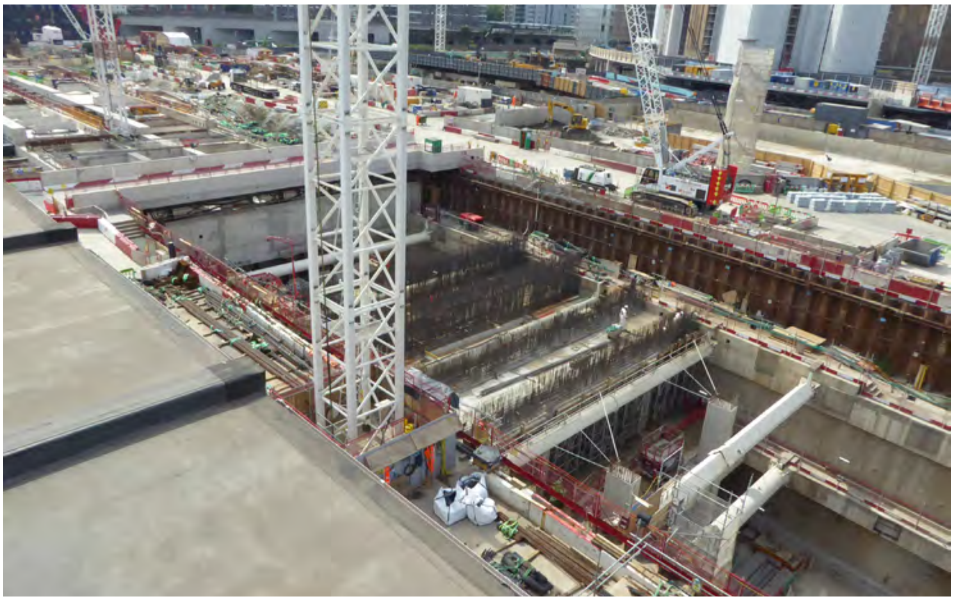
The Northern line from Kennington to Battersea will help to support 25,000 new jobs and more than 20,000 new homes. The stations to be built at Nine Elms and Battersea Power Station are targeted for completion in 2020.

Benefits of the Northern Line Extension

The NLE will improve transport links and public spaces in the area and is essential to support the transformation of Vauxhall, Nine Elms and Battersea, a designated regeneration area on the South Bank. An independent report on the economic impact of the NLE has shown it could generate substantial benefits to the area. Journey times from Nine Elms or Battersea to the West End or the City will, in some cases, be less than 15 minutes.

The visit to Northern Line Extension site of the London Underground has previously been offered for IRSE Younger Members back in October 2017. However, since then, significant progress has been made to the project, notably the successful commissioning of two new step-plate junctions connecting the existing Kennington loop and the new section of line to Nine Elms and Battersea Power Station.

The IRSE London & South East committee would like to extend their sincere appreciation to the presenters who had given up their time to present us with their works and show us around the site. It would not have been possible without them and the time they put into accommodating all of us there. Also, to Nick Stuart, programme manager, Alex King senior project manager, Stephen Hawkins, project manager of the Northern Line Extension team who initiated the contact and made this visit possible for the IRSE LSE and YM Members. A visit like this allows IRSE members to experience a different perspective of the project with access to one of the biggest construction works in the capital.



The scale of the NLE project is immense.

Midland & North Western Section

All change at Crewe

Ian Bridges

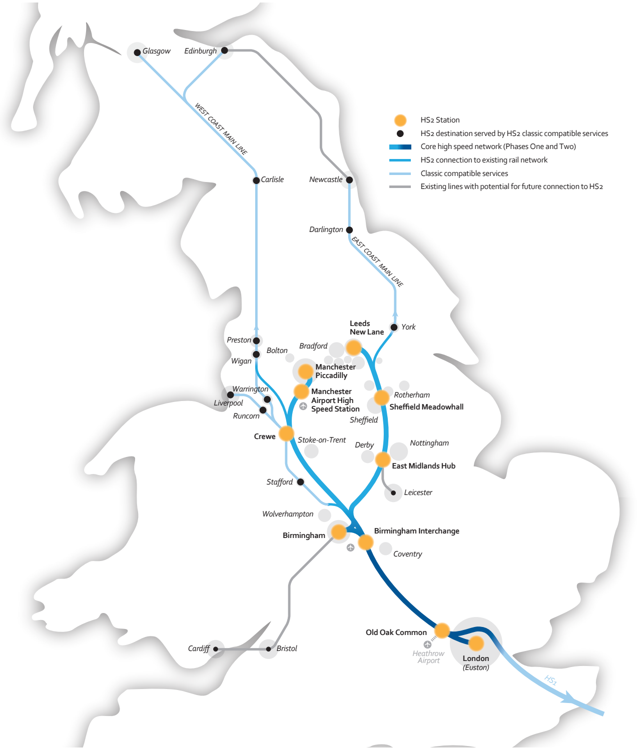
IRSE Institution of Railway Signal Engineers MIDLAND & NORTH WESTERN SECTION

Following a very successful meeting in January, the M&NWS invited David Gordon from Network Rail to come back to give an update on developments in Crewe at their October meeting. This time David was joined by Suzanne Mathieson from HS2 and an audience of around 35 members and guests.

Suzanne opened proceedings by reminding us about the history of the Crewe Hub project and how West Coast ridership has increased to a point where there is little extra network capacity and a bold solution in the form of HS2 was needed. Following the formation of HS2 Ltd. in 2009, a business case was developed and eventually resulted in Hybrid Bills being deposited in Parliament for phase 1 (London the West Midlands, now an Act) and phase 2A (Birmingham to Crewe). The new railway will be built in 2 stages, with the London to Birmingham and Handsacre, near Lichfield on the West Coast Main Line (WCML) opening in 2026, and the section from Lichfield to Crewe being opened a year later in 2027.

Crewe station was originally opened in 1837 and has changed many times since then into the present structure, the last major change being in 1985, when the north and south junctions were subject to rationalisation and the Up and Down Fast lines were built between the current platforms 5 and 6. With connections to many towns and cities in the North West of England, Crewe will become increasingly important as an interchange, serving the aspirations of the Northern Powerhouse. Suzanne explained how this is driving the importance for ensuring the facilities provided for implementing HS2 are fit for a long horizon.

Working with many stakeholders, including Cheshire East Council, DfT, HS2 and the current train operators, many sites for a new Crewe station were considered, eventually being narrowed to five higher potential solutions. After further research and debate, the Secretary of State for Transport announced in September 2016 that the existing Crewe station site had been chosen to become Crewe Hub. Many further decisions were now to be made around the detail of how this would be achieved, taking into account existing constraints,



The speakers at the MNW meeting explained why work is being carried out at Crewe in connection with the creation of the HS2 high speed rail link.

Extensive upgrade has been being carried out at Crewe for some time.
Photo Network Rail.

heritage and listed status, along with the required track layout to run the services that will be implemented post 2033 when phase 2B north of Crewe will potentially be built.

David opened his part of the talk by outlining the enormity of the re-development of the Crewe area. To the south of Crewe at Basford Hall and Sorting Sidings North are mechanical signal boxes. Salop Goods Junction, Crewe Steel Works and Crewe Coal Yard join the infrastructure from a similar era, along with Crewe Signalling Centre, which is now 33 years old and reaching the end of its useful life. These control areas represent around 500 Signalling Equivalent Units (SEUs) all of which require partial or complete renewal, in addition to the new connection to HS2 at the south of Crewe.

With a number of services crossing the layout from Shrewsbury to Manchester, along with large amounts of freight and connecting serves towards Stoke on Trent and Chester, mixed in with West Coast services, developing a layout that works has been somewhat challenging. David explained how many factors influence others, and a seemingly simple change have can have a large impact. The new HS2 lines will join the WCML via a new flying junction between Betley Road and Basford Hall, Platform extensions will be needed at Crewe Hub to accommodate splitting and joining of two 200 m HS2 train sets. Reintroduction of the old platform 1 (closed in 1985) will be needed to provide additional capacity for North Wales services. It is interesting to note that when Crewe was last re-modelled, the railway industry was perceived to be in decline, resulting in a degree of rationalisation. The proposed Crewe Hub reverses this, with additional infrastructure being required to facilitate the growth in trains and passenger numbers.

The ‘hub and spoke’ approach at Crewe.

David concluded the talk by making the audience aware that for the purposes of this talk, Suzanne and he had largely only been considering railway control engineering and operations. There will be similar amounts of work required by other disciplines, including a possible new passenger transfer deck, re-building the station roof and transferring the station entrance to Weston Road each of which are very large in their own right. Ultimately, however, the project will deliver a massive enhancement to Crewe and the wider North West of England.

The M&NWS wish to record their sincere thanks to David and Suzanne for taking time out to brief the section on the latest proposals for Crewe.

Minor Railways Section

A GWR heritage signalling success

Clive Kessell

IRSE
Institution of Railway Signal Engineers
MINOR RAILWAYS SECTION

The IRSE Minor Railways Section makes visits from time to time to feature and promote the work of heritage railways. The engineering challenges are just as great as on the 'big' railway but solutions are needed that demand creative thinking and bargain basement procurement with results that are quite remarkable. A visit in October 2018 took some 25 members to the GWR.

The GWR

To the uninitiated, GWR = Great Western Railway but in this instance it stands for Gloucestershire Warwickshire Railway that just happens to be in the old GWR territory, so a lucky acronym. The origin of the line was a Great Western route from Birmingham to Cheltenham to avoid paying running rights to the Midland Railway for use of their route between these places. Some of the route is still open – from Birmingham to Stratford upon Avon – forming part of Birmingham's suburban network.

The rest of the line closed in 1976 but the local stations had closed in 1960, none of the villages serving any significant population. A serious derailment and associated track damage at Winchcombe was judged too expensive to repair. By 1978 all the track had been lifted except for the short section from Honeybourne to Long Marston serving an MoD storage site. Most buildings survived but became increasingly decrepit. Honeybourne is where the line crossed the main Oxford Worcester route, still open today and increasingly busy.

Enthusiasts and railway preservationists in the area believed that the route could become a major tourist attraction and with a Light Railway Order granted, tracklaying commenced at Toddington in 1983, the first steam services running the following year, By 1986, Winchcombe had been reached, in 2003 the line had extended to Cheltenham Race Course and in 2018, the extension northwards to Broadway was opened. Landslips at firstly Gotherington and then at Winchcombe have been major setbacks but such is the determination of the company that huge funds were raised for these to be repaired in a manner that hopefully will prevent any future problems.

Signalling the line

Whilst the glamour of a heritage railway perhaps goes to the locomotives, coaches and stations, the line has to be operated safely and reliably, and for this the signalling is crucial. Initially, control was by train staff and ticket for the short section from Toddington to Winchcombe but as the line extended and more trains were operating, proper signalling arrangements were required. The GWR has five signal boxes, all of the traditional type but very different as to how they have been acquired and built. They are: Toddington, Winchcombe, Gotherington, Cheltenham Race Course and Broadway.

Linking all the locations is a buried cable of 0.9 mm twisted pair conductors, jelly filled and armoured. 20-pair is the norm but 10-pair is installed between Far Stanley (part way between Winchcombe and Gotherington) and Gotherington. The cable suffices for both signalling and telecommunication requirements. Each box is considered in turn.

Toddington

This was the only box to survive the demolition process but without its original lever frame, that having been sold to another railway prior to the GWR acquiring the site. The box never had running water in BR days and even electricity was a late addition. After repairing the box structure, a 35-lever frame from Earlswood Lakes on the North Warwickshire line was acquired after that route was re-signalled. The frame dates from 1906 and has a 3-bar horizontal tappet locking arrangement. A Tyers token machine controls the single line section to Winchcombe and for the present, a train staff is issued when a service runs to the newly opened Broadway section. Release of the Broadway train staff allows a single pull on the section signal preventing any unauthorised movement towards Broadway.

All signals are typical GW lower quadrant and enable signalled movements into either platform and to the sidings in the yard where the main locomotive depot is sited. Points and facing point locks are operated by conventional rodding except for those at the far end of the loop towards Broadway. These are worked by HW point machines as the 'pull distance' is too great for manual operation.

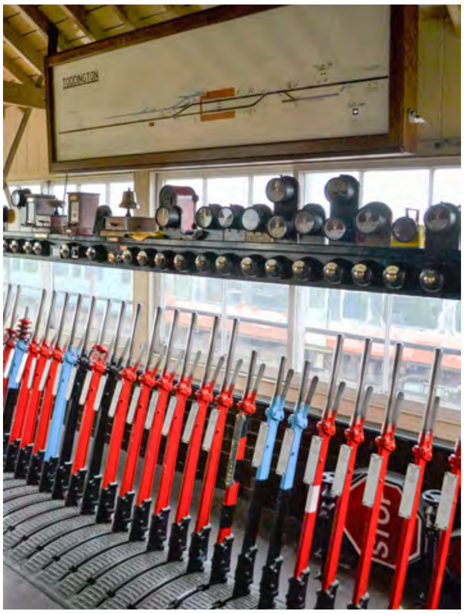
Winchcombe

The original signal box was demolished so a redundant structure from Hall Green on the North Warwickshire line was acquired when that route was modernised. It is built on the foundations of the original box with the brick work being carried out by GWR volunteers. The 35 lever-frame came from Honeybourne West Loop and is a 5 bar vertical tappet design originally manufactured in 1960. As such it is relatively new! The SB diagram is illuminated to show track circuit occupations.

The Tyers token instruments enable both short and long section operation. Going south, one token machine is for the section to Gotherington (the next box) but this is not always open. The

Toddington signal box.
Photo Ian J Allison.

The Toddington to Winchcombe token machine at Toddington. *Photo Clive Kessell.*



Toddington frame.
Photo Ian J Allison.

The new Cheltenham Race Course signal box.
Photo Clive Kessell.

Cheltenham Race Course station, northwards platform starter signal. *Photo Ian J Allison*.

other machine works the section to Cheltenham Race Course and is the one mostly in use. The two sections have different coloured tokens, red for Winchcombe to Gotherington, green for Winchcombe to Cheltenham. Another token machine with blue tokens covers the section Winchcombe to Toddington.

Although Winchcombe is in many ways the core of the signalling operation, the box can switch out by means of the Toddington – Cheltenham staff mounted in an Annett's Lock on the block shelf. When the line is closed, the staff is brought to Toddington. It is normally taken back to Winchcombe by road in order to open up the line for token operation. It is also possible to open Winchcombe as a ground frame by a train movement from Toddington southbound platform providing it has the Toddington–Cheltenham staff in its possession.

Signals are traditional lower quadrant but one unusual feature is the provision of two mechanical banner repeaters. The sighting for the southbound starter signals towards Greet tunnel is poor when leaving the platforms. As the signals are pulled off, a signal wire taken from the opposite side of the main signal balance weight arm, operates the banner. This operates identically to a normal signal and contains its own balance weight, down rod and pivot casting. It thus proves to the driver as near as is practical that the main signal arm is off.

Gotherington

The next station is lightly used and cannot accommodate full length trains in its short platforms. Gotherington did at one time have a passing loop in the platform area but this was removed long ago. The need for a passing loop only becomes necessary when a three-train service is in operation or when special events are being held. It was impractical to re-instate the loop in the platform area so a new loop was provided just to the south of the station. Since the line had always been double track prior to closure, space was available for this.

It meant building a new box constructed of Bradstone Blocks and a steel frame similar to Cheltenham – see next paragraph. The frame came from Claydon Crossing on the line from Banbury to Leamington Spa. It was originally stud locked but has been modified to a 3-bar vertical tappet layout. Signals are lower quadrant and the box is normally closed with signals being cleared in both directions for operation through the down side of the loop.

Cheltenham Race Course

When the line was extended in 2003, the Race Course station became the south terminus, with engine run round and stabling of trains having to be provided. A new signal box was constructed at the north end in stone coloured Bradstone Blocks with a steel frame and an internal staircase. The Race Course did have a station before line closure but it was only open on race days. Nothing except the wooden ticket office at road level remained after the line demolition so everything here is brand new. There are two platforms although not connected by a footbridge. The line extends southbound into a shunt neck, there splitting into two sidings that terminate at the southern end of Hunting Butts tunnel.

The box was built in 2001 with the 20-lever frame coming from Whiteball Sidings between Taunton and Wellington, near to the spot where City of Truro made its 100 mph dash in 1904. It is again a vertical tappet 3 bar arrangement. Track circuits are illuminated on the box diagram. Two token machines are provided covering short or long section working to Gotherington and Winchcombe respectively. On busy days two race specials can be accommodated at Cheltenham. The first to arrive gives up its token and proceeds from the platform to the headshunt. A second train can then be accepted and after arrival, the locomotive is detached and proceeds to the rear of the first train. With the first train locomotive uncoupled, the second locomotive takes the first train carriages back through the loop as empty stock and northwards to a stabling point usually at Toddington. The first locomotive then rounds run the second train for a return service.

Cheltenham box can work as a ground frame during light traffic periods. If long staff working is in operation, the box will be closed, with a signalman travelling on the train and inserting the staff into the Annett's key lock on the block shelf that permits ground frame operation for locomotive run round purposes.

Broadway

The much-heralded opening to Broadway in March 2018 was achieved with only one platform available, the footbridge still to be completed and without any of the signalling being operational. Hence the use of 'One Train Working' as a temporary measure. There was virtually nothing left of the station and the old signal box had been demolished so a brand new box has been built in traditional GW style. It is sited on the still to be completed northbound platform and is equipped with a 46-lever frame from Aller Junction near Newton Abbott, made redundant when Exeter Power Box was commissioned in the 1980s.

It had originally been acquired by the Gorse Blossom miniature railway who never got around to using it. The locking is a 3 bar vertical tappet arrangement and is already configured for station operation and any future extension onwards to Honeybourne. Most lower quadrant signals are in place, the only electrically operated signal will be the northbound distant and the line will be fully track circuited from Toddington. Commissioning of the box is expected in March 2020.

Train service operation

The line can be operated in various ways depending on the timetable requirements, the expected traffic levels and the signallers' rosters. The various configurations are described below.

Toddington to Cheltenham (three options)

- Normal Service. Signal boxes staffed at Toddington, Winchcombe and Cheltenham with trains able to pass at Toddington and Winchcombe. Electric key token working from Toddington to Winchcombe and long section token working from Winchcombe to Cheltenham.
- Busy Service. Signal box at Gotherington operational in addition to the above boxes, with short section token working from Gotherington to Winchcombe and Gotherington to Cheltenham. Trains can pass at Toddington, Winchcombe and Gotherington. Gotherington may be switched out for periods during the day depending on timetable and staffing requirements when the normal service will operate.
- One Train Working. Signal box staffed at Toddington, all other boxes switched out with signals pulled off in both directions at Winchcombe and Gotherington, trains using the southbound platform lines. The train must be in possession of the Toddington – Cheltenham train staff, which is coloured brown and contains an Annett's key on one end. If shunting moves are required at Winchcombe or Cheltenham, the Toddington signalman will travel on the train and insert the key into the block shelf mounted lock, thus enabling either Winchcombe or Cheltenham boxes to be used as a ground frame.

Toddington to Broadway

One Train Working with Toddington signal box open. The train has to be in possession of the Toddington to Broadway train staff which is coloured red and has an Annett's Key on one end. This is housed in a cabin at the north end of Toddington station and is collected by the train driver following a telephone call to the signalman in Toddington box. It also allows operation of the temporary ground frame at the south end of Broadway station for engine run around purposes. The points at the north end are hand worked.

The future

What the GWR has achieved in its 35-year existence is remarkable. The recent extension to Broadway has opened up a new market as the town is itself a tourist attraction. The infrastructure, stations, rolling stock and signalling are all things the railway can be proud of.

The one missing element is a main line connection. Whilst much of the track bed at the southern end through Cheltenham is accessible, parts have been built on so extending here is potentially very difficult. For all its prestige, Cheltenham experiences unsocial behaviour which could lead to vandalism problems in any future town centre section. At the northern end, the route to Honeybourne would be relatively easy to reinstate, which would allow a connection to the Cotswold line. North from there to Stratford beyond Long Marston is much more difficult as encroachment of the track bed has happened in several places.

Nothing is impossible these days, viz the Borders Railway and the Welsh Highland, but whatever transpires, the signalling fraternity will be there to play their part.

Thanks are expressed to Neil Carr, the operations manager and Malcolm Walker from the GWR signalling department, for shepherding the group on the day and for explaining the signalling and operation of the line.

Feedback

Re: Secondary signalling systems

I found Alan Rumsey's article on the subject of Secondary Signalling Systems (IRSE News Sept 2018) most interesting and thought provoking. It is certainly an area where we as a profession need to further develop ideas which are cost effective and efficient at mitigating primary system failure – which a secondary system at its highest level arguably could deem unnecessary significant and expensive resilience in the primary signalling system.

Of course, the concept of providing facilities for degraded working is nothing new in the UK – certainly from my detailed knowledge of 'Western' signalling practice – that is the continuous lineage from the Great Western Railway Company (GWR). The sole UK main line railway to survive all amalgamations/groupings from 1830s until the formation of the nationalised BR in 1948, through BR and Railtrack days to the present-day Network Rail. What is new I believe is the formalisation of the Grades of Secondary System (GoSS) with specific output expectations.

In the table below I give a few (Western Region) examples of where Secondary Systems have been deployed – some for many years – and what GoSS Levels I believe they achieve

There is also the issue of how is the safest way to work with existing signals under degraded conditions when some safety condition fails. I have always been a firm believer that depending on the nature of the actual failure it may be better to allow a signal to be cleared, or even the 'route set' as this actually provide a greater degree of safety than hand signalling with no interlocking at all.

A very real example of this occurred in BR days during my time as a signal maintenance engineer, involving routine testing of Approach Locking Timer Relays. Several relays which had not long been in use following cyclic renewal were found to be significantly under time (circa 40-60s rather than the required 120s), and were unable to be adjusted to the required time. Given the hitherto good reliability of such items, few spares were held. Following the discovery of the defects what was the safest way to continue operating the railway in the short term?

(i) Do as had been embedded in most signal engineering staff minds for many years, and restrict the signal(s) concerned to danger. Trains would then be 'hand signalled' past the affected signals, but without any security of interlocking against other moves.

(ii) Restrict the signal to clear only when berth track circuit occupied by disconnection of the 'Z' or 'A' link in the vital signal control circuits. This control was (and is) provided on controlled signals in Western track circuit block signalled areas controlled by Western Region (or E10k) Route Relay Interlocking.

After being contacted by the technician performing the work I decided on Option (ii) as the signal only cleared on the immediate approach of a train, the Approach Locking Timer still functioned, but with a reduced time, so if the signal did return to danger before the train passed it there was still a goodly margin of time to maintain the route operated controls before the train passed the signal if having seen the reversion it was unable to stop before doing so.

After initial hesitance the technician accepted my decision. It was the front-line Operators (signalman and duty supervisor) though who were not at all happy, and intended to carry on as they always had – 'talk' the train past the

GoSS	System	Features	Limitations
0	Signal Post Telephones	Enable identifiable discrete communication between Driver and Signalman when signalling system failed.	(i) Driver has to leave train to speak to Signalman. (ii) Only available at signals. (iii) Relies on voice protocol.
0	GSM-R	(i) Enable identifiable discrete communication between Driver and Signalman without Driver leaving train. (ii) Enables train to stay with communication between signals.	(i) Relies to a minor extent on communication systems via third party bearers which do not necessarily have full resilience from external failures. (ii) Relies on voice protocol.
?	Through Routes working	Enables the Route Relay Fail-Safe Interlocking to operate for the 'Main Routes' in Interlocking area by allowing these to operate automatically when the non-vital Command/Indication link between remote Interlocking and Signal box has failed.	(i) Signalman cannot 'see' passage of train. (ii) Signalman cannot stop individual moves unless all controlled signals in area placed at 'Signals Red'.
2/3	Penzance – 'overlaid' axle-counters in station throat area within Signalman's visibility which is subject to occasional high tide interference with reliable track circuit operation.	Axle-counters operate all the time, but output into vital signalling system only brought into use by Signalman when necessary. Enables pointwork to be remain operable under power. Single Counter covers several discrete track circuits.	(i) Not all signalled routes remain available for use. (ii) Signal Approach Locking 'train passage' release not operable, with only timed release available. (iii) Requires Signalman to visibly confirm trackwork still intact before bringing the system into use.

signal. It seemed to me perverse logic – with hand signalling the operators carry all the risk and there is increased total delay to trains – and yet doing as I suggested the risk then became an engineering one.

Eventually they grudgingly accepted my decision after I pointed out that if they chose not to clear the signal then it would be them that would have to answer for any delays. Perhaps that was my little bit to challenge needless delay to passengers, which too often seemed to me to be of little concern to a considerable number of staff.

Finally, the whole thrust of Alan's article seems only to have dwelt on the aspects of failure of the 'block' and control systems. There's one major item that seems to be omitted from the considerations – and that is how to provide a secondary system for operating, locking and detecting point positions.

Point failures still account as major causes of delay, in the UK at least. Without robust confirmation of the security of point position it cannot be permissible to permit a train to proceed over them, at least in a facing direction. Almost universally points failures require attendance of infrastructure operations staff before train movements can be permitted, either through rectification of the defect or manual operation and securing.

Invariably these will be staff who may have to travel many miles to site. I say 'almost' universally, because in the UK in the case of Train Operated Points (if indeed there are any left) when there is a failure then the initial attendance for operating and securing is the traincrew who have been brought to a stand at the Points Indicator. Elsewhere it must be utterly frustrating for a train driver to be at a stand at a signal possibly as little as a few yards from a set of defective points to be told that it will be a considerable time before staff arrive at site, and to just sit and wait.

I know that towards the end of British Rail days, on the Western at least, there was consideration towards some basic instruction for train drivers on securing points under the signalman's direction to enable limited moves to resume pending attendance of other staff. It did not proceed as there was the major break up of the industry to focus minds on other matters. In my view the break-up of the former 'vertically integrated railway' on the UK mainland into infrastructure manager, maintainers and a myriad of train and freight operating companies gave no incentive for the idea being developed further as the various parties became risk averse driven by the 'compensation' regime.

Perhaps now some 20 years later, with the Rail Delivery Group representing train operators and Network Rail, is the time to resurrect the idea of train drivers with their 'route-knowledge' being able to manually secure points for the passage of their train?

John Jenkins
retired Network Rail, Western, UK

Re: Ethical engineering and Swindon panel

I thoroughly enjoyed reading the article by Paul Darlington and Rod Muttram in the October IRSE News on ethical engineering. It was well worth reading and I would certainly recommend it as a standard of conduct worthy of applying to all engineering institutions.

I also liked the article on the Swindon signalling panel. It reminded me when I was an engineering student and a similar NX panel had been installed at Paisley, around about the same time period. There was a slight difference to the Paisley panel as a push button was used for both the route entrance and exit. I was lucky to be at Paisley when the new signal-box was commissioned.

Sandy McLuckie
Scotland

Re: Looking afresh at Britain's signalling principles

The work outlined in October IRSE News to look at the principles of signalling afresh is to be applauded as long overdue and especially as new technology can offer mitigation of risk by alternative means. I would like to share the following observations.

There is a statement in the section on Controls for ETCS which records that mechanical detection only provides detection at 'Time of Clearance'. This fails to recognise the reciprocal holding capability of the mechanical detection which, by virtue of its locking engagement on the ground, effectively holds the points, and facing point locking (FPL) where provided, in position resulting, in essence, in continuous detection by default. It is only where electric detection is substituted for mechanical, in mechanically signalled locations, that true 'Time of Clearance' becomes the result.

Route cancellation in the UK main line environment has long been overly complicated and given too high an integrity. Administrations in many other countries have sensibly been satisfied to enact cancellation outside of the safety critical element of the interlocking. It is encouraging to learn that this function has now been transferred to the lower integrity control system in line with practice elsewhere. The article states that the extra integrity had been applied since the introduction of data-driven signalling, but surely this overkill actually originated much earlier, in relay interlocking, as evidenced by the TORR appendix of BR850 circuitry.

Accidents occurring in Permissive Working situations are usually the result of too high a speed and/or the inability to locate the actual position of the train ahead by the driver of the second train. The relaxation, described in point 2 does not address the need to ensure the hazardousness of the class of route displayed is fully brought home to the driver in that they are being allowed to enter an occupied section. Nor does the location of the protecting signal (and hence call-on) in relation to the distance to the vehicles ahead, or the ability to see these vehicles from this signal, seem to have been factored. It would appear in point 3 of this section that the relaxation of AWS controls will result in drivers being exposed to Code 2 faults of the AWS by design in normal circumstances. Whilst a safe side failure, it is nevertheless a fault as far as the driver is concerned.

Finally, at a time when signalling is seen as the enabler to achieving greater capacity on an otherwise infrastructure constrained railway, I hope the simplification that is desired by the change in principles will not introduce unforeseen restrictions on the flexibility of layouts, particularly when considering the treatment of overlaps and flank.

J D Francis
Past President IRSE

We'd love to hear from YOU!

Our 'Feedback' column is your opportunity to share your views, ideas, concerns, predictions for the future and lessons learnt from the past.

If you have anything you'd like to share relating not just to articles in IRSE News, but to anything to do with our profession, please email us at **editor@irsenews.co.uk**.

Help us to continue to **inform, discuss, develop**.

Past lives: Werner Welti

It is with great sadness that Werner Welti has passed away. I would like to extend my deepest condolences to his family from the IRSE.

Werner, or "Werni" as he liked to be called by his friends, joined the IRSE in 1994. I got to know him when I joined the Swiss IRSE members' "loose group" in 2003. He strongly supported the foundation process of the IRSE Swiss Section and kindly agreed to become its first treasurer and member of the board in 2011, an office which he carried out with greatest diligence until 2015, often reminding us to treat the spending of IRSE funds with great care!

Werni was also a regular at the IRSE International Conventions, the last one being Dallas, and he had a lively network among IRSE members around the world. This suited one of his passions: traveling the planet with his friends and getting to know different cultures and their people. I regret not having had the chance to join one of his after- or post-Convention journeys due to my tight time constraints, but I always liked to hear the stories about them.

I have admired his great passion, not only for providing the newest technology for the signalling industry with his company, Sigwel Ltd, but also his ideas in so many different areas of technology, for instance, providing fish ladders in Asia. He was a real 'Jack of all trades' in a very positive sense, like there are almost none left nowadays.

I always felt a close connection with Werni, because we both were in the situation of owning and managing a small business in an area mostly occupied by the Big Industry. I was very grateful for his cheering up in difficult situations. Without knowing of each other, we had developed ideas to use field programmable gate arrays (FPGAs) in SIL-4 systems in parallel, a then quite revolutionary idea.

Werni was a model signal engineer and IRSE member: innovative, open minded, internationally oriented, with an excellent know-how on all levels of technical details, and with a great understanding of the railway system in its entirety. The concepts of "Winds of Change" didn't need explanation for him, as this was so close to his own thinking.

He attended the most recent IRSE's AGM and Annual Dinner on 27 April 2018 in London to honour the start of my Presidency as the second only Swiss President. This picture was taken there. I felt very touched by his support, knowing the great difficulties he already had with his health. London was actually his last international journey. A further meeting between me and him was not meant to be. He had to cancel his participation in the Swiss Convention, which was certainly very hard for him, and also my already planned visit to Ascona, his beloved holiday home, in July.

Werni's last e-mail to me on 12 September 2018 read: "Actually, I had planned to come to Berlin again [to Innotrans], but I still feel no longer able to make larger trips! I wish all IRSE colleagues a nice Wednesday evening. Will be there in the spirit! I wish you many happy hours, strength and health for the year of the IRSE presidency."

During his funeral service, which has deeply touched me, I got to know his and his family's strong faith, which helped them through his last difficult months and weeks. The refrain of the main song of the obituary read "Let the coastal fires burn, let them shine far out, for they will surely show some sailors the way home." [Song Book: May Jesus' Name never stop to resound, (in German), 1976] His last wish was that his efforts to be such a 'coastal fire' in his life may have been successful.

Werner Welti 1949 – 2018.
FIRSE, Honorary Member and former Treasurer of the IRSE Swiss Section.

I am profoundly grateful, Werni, to have been allowed to have met you in my life. You will continue to live in my memories, and in those of all your IRSE friends, not only as a great signal engineer, but also, and above all, as a great man, and as our coastal fire with your innovative spirit, your energy and your contagious optimism.

Markus Montigel, President, IRSE

Industry news

Radio spectrum for CBTC in Europe

Europe: Metro CBTC signalling systems typically use radio communications in the 5905-5975 MHz range, with bandwidth allocated by national regulators. In the European Union the adjacent band 5875-5905 MHz is allocated for safety related intelligent transport systems (ITS) –i.e. road vehicles, and there is a demand to extend this spectrum upwards into the area used by CBTC applications.

The CEPT (European Conference of Postal and Telecommunications Administrations) has made proposals (irse.info/54q9j) for an adjusted allocation of spectrum that will cover both road and rail applications across Europe. 5915-5935 MHz is proposed for Urban Rail ITS, and 5875-5925 MHz for Road ITS. The overlap is considered acceptable provided road vehicles only use 5915-5925 MHz for short range vehicle to vehicle communications.

The UITP (International Association of Public Transport) has been following this development through its Spectrum User Group, and they are generally supportive of the CEPT proposals. The main point of contention has been a need to strengthen the wording that is intended to guarantee the overlapping area of spectrum is available for Urban Rail ITS when it is needed.

A consultation on the CEPT proposals has taken place and the final report is due in March 2019.

Dean Forest Heritage Railway – Crossings

UK: The Dean Forest Heritage Railway near Lydney, Gloucestershire has recently commissioned two level crossing installations using Schweizer Electronics AG Flex R1.4 equipment. Lydney Bypass crossing is an automatic barrier crossing, locally monitored (ABCL) and Lydney Harbour Road Crossing a manned full barrier installation. The new crossings replaced existing Smiths BR843/Unipart Rail equipment. This is one of the first installation of a Schweizer automatic crossing in the UK, which follows a manual controlled barrier (MCB) Schweizer crossing at Norden on the Swanage Railway.

Each crossing is controlled by a Schweizer Flex Control PLC which interfaces with the Dean Forest Railway 'heritage' signalling. The Lydney Bypass crossing also features a Frauscher axle counter and RSR123 wheel sensors. Whilst these are common on main line installations, it is believed this is the first use of axle counting equipment on a heritage railway in the UK.

The scheme was project managed by Dean Forest Railway personnel with the design and installation of the interface equipment being carried out by qualified staff from outside the company. The factory acceptance testing and the site integration testing was carried out by qualified testers and a tester-in-charge. Civil Engineering work was subcontracted by Schweizer to Amco-Giffen.

The renewal was funded by Gloucestershire County Council through the existing agreement with Dean Forest Railway for maintenance and renewals. This situation is unusual in the UK as the railway was in place before construction of the roads. Normally roads were established before any railways, therefore it usually falls to the railway to meet any costs required for level crossings.

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at editor@irsenews.co.uk.

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Membership changes

Elections

We have great pleasure in welcoming the following members newly elected to the Institution:

Fellow

Trevor Allen, Metro Trains Melbourne, Australia

Member

Kylee Bishop, Aurecon, Australia
Andreas Boehler, Siemens, Switzerland
Kristiaan Bonthond, Movares, Netherlands
Brian Bowie, Hatch Africa, South Africa
Eric Brown, Metro Trains Melbourne, Australia
Kwaja Moinnuddin Chisty, WSP, India
Stuart Hope, Network Rail, UK
Rob Mersmann, ProRail, Netherlands
Lu Qu, Victorian Rail Track Corporation, Australia
Opdesh Singh Randhawa, Ansaldo, Malaysia
Sinan Sun, Bombardier NUG Signalling Solutions, China
Francesco Traquandi, Alstom, Italy

Associate Member

Ojuetimi AKinsolu, Gear Rail, South Africa
Diyaksha Jaykaran, Gear Rail, South Africa
Krishna Mutyala, Ansaldo, Malaysia
Hendra Tampang Allo, SMEC, Indonesia
Mark Williamson, OML Ltd/CH2M/Jacobs, UK

Accredited Technician

Robert Doyle, Irish Rail, Ireland
Colin Farmer, PCG Associates, UK
Mfundisi Moyo, Public Transport Authority, Australia

Promotions

Member to Fellow

Colin Adams, Siemens, UK
Robert Baughan, Siemens, UK
Mike Essex, Network Rail, UK
Takashi Kawano, East Japan Railway Company, Japan

Accredited Technician to Member

Robert Clarke, Siemens, UK

Affiliate to Member

Andrew McCann, Irish Rail, Ireland

Affiliate to Associate Member

Edward Zifodya, Siemens, UK

Affiliate to Accredited Technician

Andres Berruezo Ruch, Trenes Argentinos Infraestructura, Argentina

Professional registrations

Congratulations to the members listed below who have achieved final stage registration at the following levels:

CEng

Martin Halligan, SNC-Lavalin, UK

IEng

Simon Elliott, Babcock, UK

Reinstatements: Saroj Nanda and Siri Kalamasuriya.

Resignations: Neil Macdonald, Paul Copeland, John Cranley, Ian Harding, Andrew Oates, Bertram Malkmus, Colin Peers and Gordon Rogers.

New Affiliate Members

Nancy Alhamahmy, EHAF Consulting Engineers, Egypt
Jarrad Archer, Student, UK
Aaron Beard, London Underground, UK
George Bell, Network Rail, UK
Billy Belonio, Rail Systems, Australia
Isaac Botros, Rail Control Systems, Australia
Edward Burgess, Siemens, UK
Alan Byrne, Irish Rail, Ireland
John Chaddock, Park Signalling, UK
Keith Edwards, Spectrum in Sight, UK
Oliver Eisenlohr, Level Crossing Removal Authority, Australia
Matthew Golding, McGinley Support Services, UK
Richard Harmer, Network Rail, UK
David Holden, Retired, UK
Patrick Hughes, Alstom, Ireland
Syed Hussain, Arup, UK
Gary Innes, Network Rail, UK
Manjusha Jose, New Zealand Railways, New Zealand
Karthik Kannan, John Holland Group, Australia
Feiyang Li, Alstom, Australia
Kin Cheong Li, MTR Corporation, Hong Kong
Daniel Liew, Siemens, UK
Peter Lindley, SigTech Rail Consultancy, UK
Kathleen McGervey, Greater Cleveland Regional T'port Authority, USA
Robert Mitchell, Self-employed, Canada
Ronnie Mugisha, Gear Rail, South Africa
Fiona Nguyen, Coleman Rail, Australia
Marcos Nobrega da Costa, Alstom, Brazil
Philip Olupitan, Network Rail, UK
Kenneth Peters, Kenneth Peters Consulting, Canada
Thaang Rammutla, Ansaldo, South Africa
John Richmond, Park Signalling, UK
Kelly Rogerson, Australia
Greg Rooney, Queensland Rail, Australia
David Rudderham, Midland Railway Centre, UK
Jen Teh, Jacobs, Malaysia
Stephen Thomas, John Holland, Australia
Oliver Tremlett, Hitachi, UK
Minh Vuong, Macari Consulting, Australia
Andrew Wright, Park Signalling, UK

Past lives

It is with great regret that we have to report that the following members have passed away: Roy Bell MBE, Paul Cheshire MBE, George Nelson and Werner Welti.

Current Membership: 4951

IRSE News

Institution of Railway Signal Engineers

February 2019

Thameslink
testing new systems

WCML 1960s resignalling
geographical interlockings

Innovation
does rail get a bad press?

Business as usual, with challenges

We are now settled into 2019 and into the year's cycle of office life in the IRSE London offices. The year no doubt will be as varied as the last, some highlights of which I thought I would share with you.

I'll start with the biggest change for our working environment: Francis' retirement and Blane's appointment as chief executive in the summer. We always knew that Francis worked far more than his part time hours indicated, and we are still finding that "Francis always did ..." things (hence the well-thumbed HTML book on my desk for website alterations). Blane continues to lead us and his fresh eyes are helping us drive change along.

There were some challenges in 2018, including introducing the new branding. Not only does the IRSE have a new logo, but our local Sections have their own logos too. The work continues this year in preparation for providing a new website which will be a useful source of information.

Another challenge which we continue to work on is General Data Protection Regulation GDPR. The European regulations came into force last year and have had an impact not only on our daily office workings, but also for our local Sections and other volunteers running events. This has been a learning opportunity also, undertaking a course on the regulations in my spare time to understand the impact on the IRSE and myself as an individual.

It was great to be involved in the setting up of the London and South East local Section, with regular events already in place in the London area. I have attended a few meetings and been pleased to see familiar and unfamiliar faces from across the different infrastructures and companies. Personally, it is helping my CPD too!

I must acknowledge the other work which goes on too, for example the bringing in and supporting new members; encouraging and supporting members through professional registration; supporting our major events; the operation of the IRSE licensing (competence certification) scheme; and the provision of the IRSE professional examination.

I hope that your 2019 will be as full of interest and learning opportunities as ours.

Judith Ward
Professional Development Manager, IRSE

Cover story

Hitchin down fast signal showing route set to Cambridge on the lines between London and the East of England, UK.

The signal was renewed a few years ago using LED indications for both the main aspects and route indication as part of the project to create a grade separated junction for Cambridge bound trains, avoiding the previous flat junctions across the East Coast Main Line with their timetabling constraints. This signal has significant physical restrictions being placed between the down fast and down slow lines on approach to a 70 mph (110 km/h) crossover which the passing train is about to use. The use of LED technology reduces the need for maintenance visits to a difficult site.

Photo David Fenner.

In this issue

From the IRSE and its Sections

IRSE///
Institution of Railway Signal Engineers

The Thameslink KO2 WTS test system

Daniel Hill
Siemens Mobility Limited

The Thameslink Key Output Stage 2 London Bridge Signalling in London UK project involved much more than just the resignalling of London Bridge station. In fact, the project reached deep into the heart of London, stretching from Charing Cross and Blackfriars, through Metropolitan Junction, past The Shard skyscraper and London Bridge station, then out as far as New Cross and New Cross Gate stations via the new Bermondsey Dive Under.

Detailed design for the project started before the skyscraper was complete and coincided with the £1bn redevelopment of London Bridge Station. The Shard provides a spectacular backdrop from any angle of the project, but it is from the top of this giant that the real stunning sight can be taken in. An onlooker can understand the scale of the project by standing at the top of The Shard and realising that it included almost all of the railway that can be seen.

The project included the introduction of the Siemens Westrace Trackside System (WTS) and its successful six-month on-site shadow trial. Based on the Trackguard Westrace Mk2 hardware platform it is one of the first trackside fibre-based Signalling over IP (SoIP) systems to come into use on the GB main line railway.

As with any such railway project, completion was only possible in stages. Over 30 were needed in total from the very first Low Level Stage (LL01) on 25 May 2013 through to the final stage, High Level Stage HL17, planned in tandem alongside the London Bridge Station concourse which opened on Monday 1 January 2018.

The Low Level south section of the scheme from London Bridge's six terminating platforms through to New Cross Gate consisted of Solid State Interlocking (SSI) Trackside Functional Modules (TFMs) controlled by a new Trackguard Westlock Interlocking. The remaining High Level section of the scheme used the WTS technology, increasing both capacity and capability on the busiest of lines.

The problem

A 10-day blockade (HL17) of the Cannon Street and Charing Cross lines enabled a complete remodelling of the North Kent East lines from London Bridge to New Cross and the introduction of the Thameslink lines through the centre of the scheme (Figure 2). 256 signals, 75 sets of points and 222 track circuits were brought into service in this stage alone. A new interlocking, 'London Bridge Thames', was added to the existing system, bringing the total number of Trackguard Westlock Interlockings up to six for the project – all of which required new data for the stage.

HL17 was to be the biggest deployment of WTS technology to date with the entry into service of equipment in all of the 35 Relocatable Equipment Buildings (REBs) and two large Equipment Rooms across the project.

Figure 1 –The Thameslink KO2 London Bridge area partnership scheme.

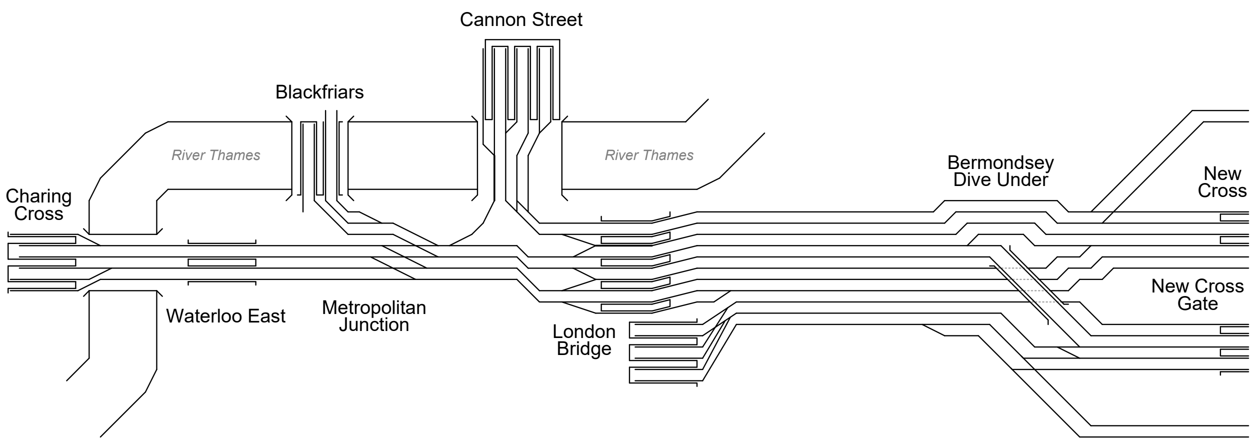
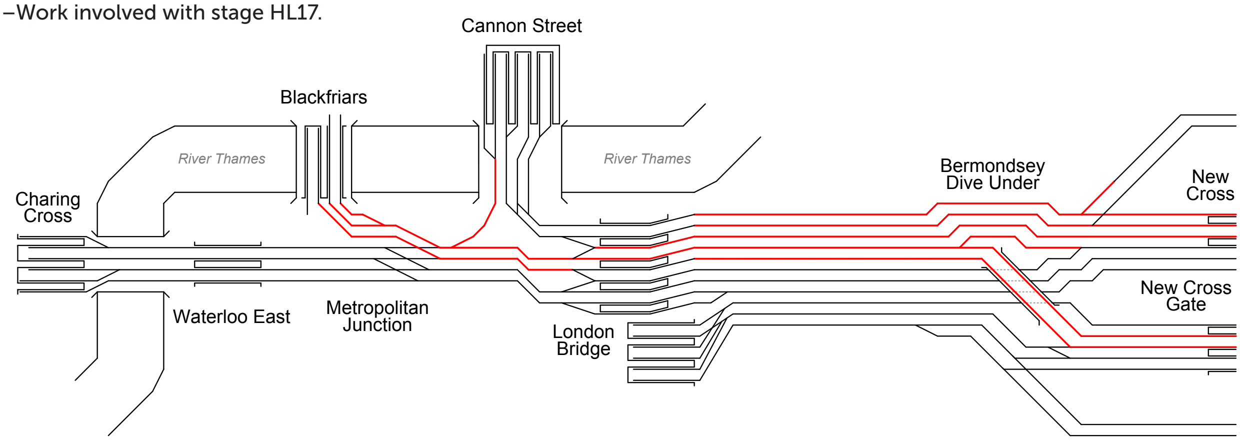


Figure 2 –Work involved with stage HL17.



This represented a major technological and logistical challenge, particularly for the testers. We were not able to simply install new equipment up to the outgoing links and then do correspondence testing of the rest of the system over the blockade. With limited access and permanent way works across the east of the scheme, we needed a smarter way to safely test and commission the huge amount of equipment involved before the blockade.

The new Thameslink lines running through the centre of the scheme was the only part of the puzzle that could be considered as 'green field site'. However, the layout of this interlocking meant its fringes ran along its full length. There was no way to test and correspond these lines without taking control of the adjacent interlockings and, more importantly, updating them to HL17 data in order to do so. Simply connecting 'test' versions of these interlockings was not an option either; the use of a digital backbone network means that their addition could have led to them commanding their 'real' trackside assets, leading to potential wrong side failures.

The combination of old problems and multiple new technologies had produced new challenges to overcome – a new way of thinking was required.

The solution

Adjacent interlockings therefore had to be simulated in a safe way. As mentioned before, adding test interlockings to the network could have potentially catastrophic consequences and with a non-Safety Integrity Level (SIL) rated network, just equipping them with 'test' IP addresses would not provide the protection and safety assurances needed. Adding further complication was the fact that it wouldn't just be the adjacent interlockings that we would need to simulate.

The main eight high level lines running through the scheme are divided into interlockings and control areas based on their destination (Figure 3). North Kent East lines terminate at Cannon Street and as such consist of the three most northernly lines. The Thameslink lines run through the centre of the scheme to Blackfriars and consist of lines 4 and 5.

Finally lines 6, 7 and 8 are controlled by the Charing Cross Interlocking as this is where they eventually terminate. 22 High Level REBs are spread across the scheme, each controlling the input and output (IO) functionality of a vertical 'slice' of the lines. Figure 3 shows how the scheme is segregated into slices per REB. The REB slice is then split down into areas depending on the interlocking that controls each set of lines that pass through.

Signalling assets within each interlocking's individual area are operated by Westrace Input/Output (IO) Modules, a group of which is referred to as a WTS Zone Controller (ZC). Each REB contains a number of ZCs equal to the number of interlockings that have lines running through the REB's slice. The example shown in Figure 3 indicates that REBs A, B and C each contain three ZCs.

ZCs do not communicate directly with the interlocking. They are instead divided into large groups relative to their geographical position on the scheme. Each group is operated by a Front End Processor (FEP). FEPs interface between

Figure 3 –REB and ZC designation.

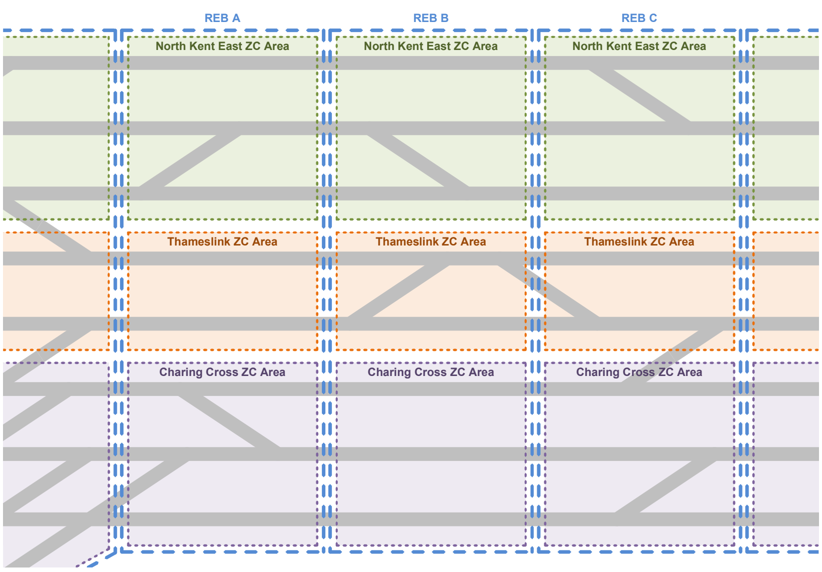


Figure 4 – WTS architecture.

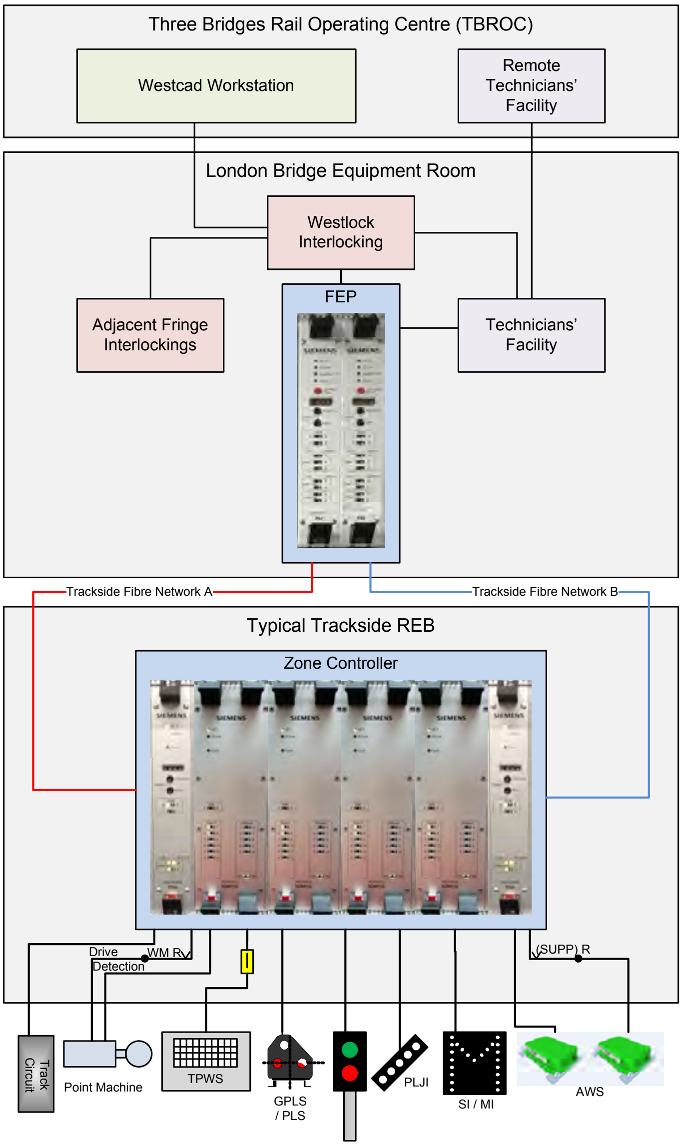


Figure 5 – Critical FEP function.

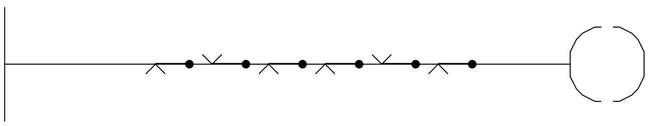
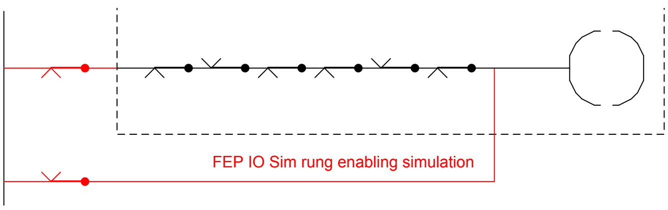


Figure 6 – Critical FEP function with FEP IO simulation applied.



the Westlock and the trackside Westrace. FEP Processor Modules (PMs) consist of Field Programmable Gate Arrays (FPGAs) and use ladder logic to operate their group of ZCs. They effectively convert Westrace Network Communications (WNC), from the Westlock Central Interlocking Processor (CIP) into the Westrace Remote Serial Module Bus (R-SMB) protocol, for transmission to each ZC via the trackside fibre network. Each interlocking will have a number of FEPs, splitting the interlocking area up into FEP areas.

Figure 4 shows the logical hierarchy of how WTS is connected. The physical reality is that each piece of non-trackside equipment is connected to the Thameslink Signalling Private Network (T-SPN). It is this network which manages the data flow, ensuring each individual packet of data ends up exactly where it needs to go. As previously mentioned, the overall system is failsafe even though the network is non-SIL rated, in other words we do not rely on it for any safety related functionality. This is instead carried out within each individual item of equipment that is deemed safety critical (SIL-4). Each of these safety critical devices contains what we have termed a 'SIL-4 address', a layer more complex and sophisticated than the simple IP Addresses.

So back to our problem, what did we need to use to test our new FEP Areas?

Test interlockings

Firstly, we obviously needed interlockings with their HL17 final commissioning data loaded. Luckily the Thames interlocking was brand new but what if we wanted to test an FEP area we intended to add to an existing interlocking, such as Charing Cross and North Kent East? For these we would need to add additional 'Test' Westlock Central Interlocking Processors (CIPs) to control the new FEPs.

Adjacent fringe interlockings

Simulation of interlockings such as Cannon Street, London Bridge South Central and London Bridge New Cross Gate was provided by a Trackside and Adjacent Interlocking Simulator (T&AILS). This is a PC based emulator, the data for which is produced within the Westlock Design Workstation Data Environment (WDW-DE) to enable off site testing.

Fringe FEP areas

Each interlocking needs to know what is going on within its other FEP areas so that it can provide the right information to the FEP under test. These fringe FEPs to the FEP area under test were not able to be simulated at the time so additional test FEP hardware was required with their respective inputs and outputs simulated by the T&AILS.

Control Centre

Next, we needed something to control the Interlocking and so a test Controlguide Westcad Control Centre Workstation was required on which the tester could set routes and observe indications.

Technicians' facility

A Technicians' Facility Local (TF-L) was used to ensure that diagnostic information was available to the tester. This is part of the Controlguide Commontech Facility (CTF) suite of products, a powerful tool enabling status indication and logging of each piece of equipment across the system.

ZC IO simulation

The approach was to simulate parts of the actual FEP under test to enable the tester to simulate what was happening if a real track circuit or set of points was not available trackside.

For this the Research and Development (R&D) team developed a tool called FEP IO Sim. This works by adding a rung to each ladder logic function within the FEP (see Figures 5 and 6). When simulation of a specific piece of equipment (eg track circuit) is enabled, the new rung allows the user to manually change the simulated equipment's value or status at the end point of the critical function rung. The result is a system that can be simulated at the extremity of each function, enabling the function in question to be tested in full each time. This technology was produced in time for use on the test system trial run.

All this equipment needed to be connected to the live T-SPN so that the FEP under test could talk to new ZCs in existing REBs. How could we do this safely and ensure that the equipment in the test system could not control its 'real' equivalents in the live signalling system?

The answer was Test Address Management, or TAM for short. This was another innovation delivered under accelerated time scales. This enables the WDW-DE data design tool to compile two sets of data for the scheme, one for the final commissioning and one designated as 'Test Only'. This test data contains all of the same principles and controls as the final commissioning data except for the fact that all of the equipment data is automatically and comprehensively populated with both 'test' IP addresses and crucially 'test' SIL-4 addresses.

This enabled a fully simulated version of the scheme to operate each FEP that was under test. The schematic in Figure 7 shows how this is connected using multiple network connections to each of the FEPs under test. These are highlighted in red along with their respective Zone Controllers located trackside. The multiple network connections on the FEPs allowed for one connection to

Figure 7 – The HL17 WTS test system.

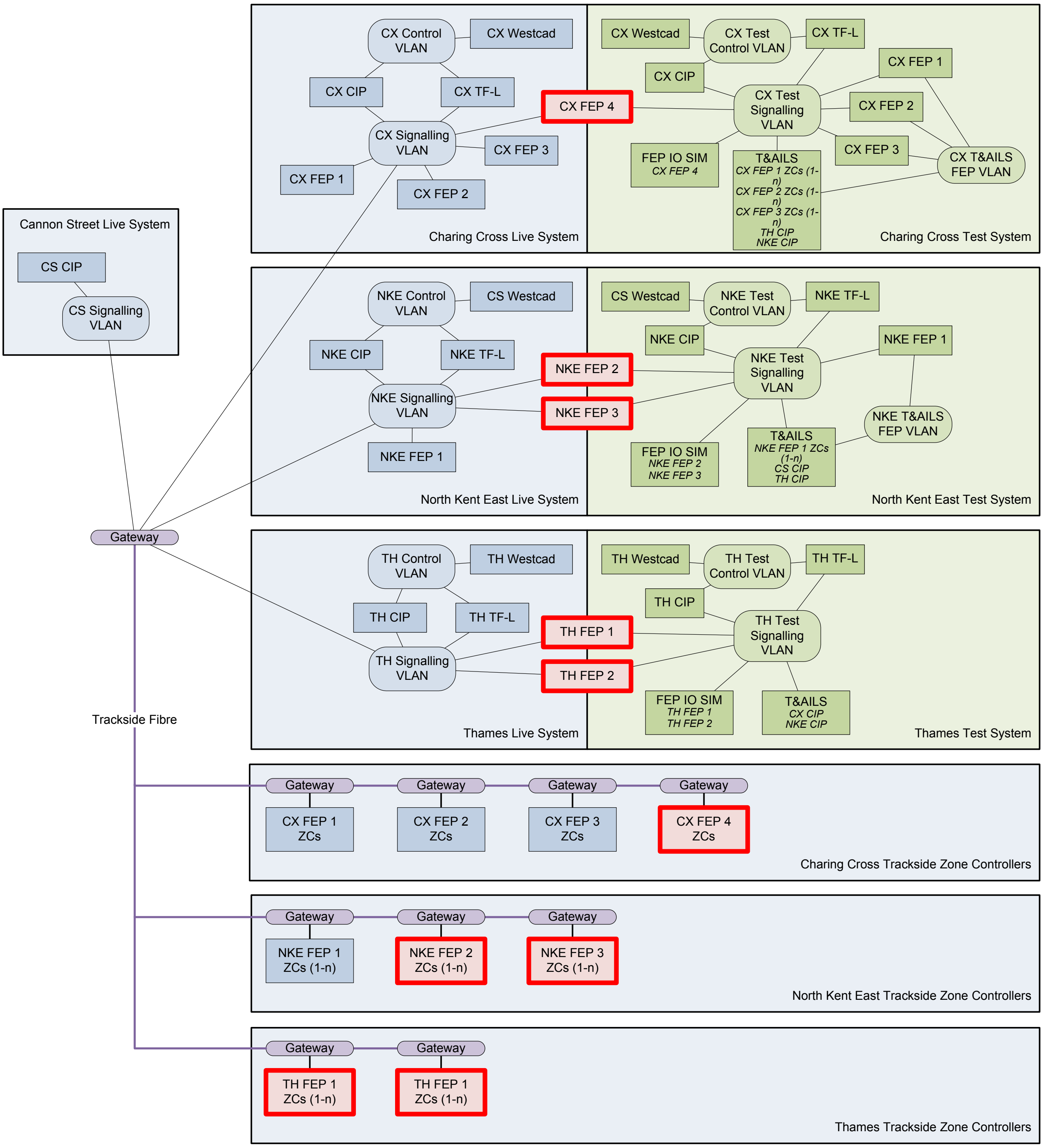
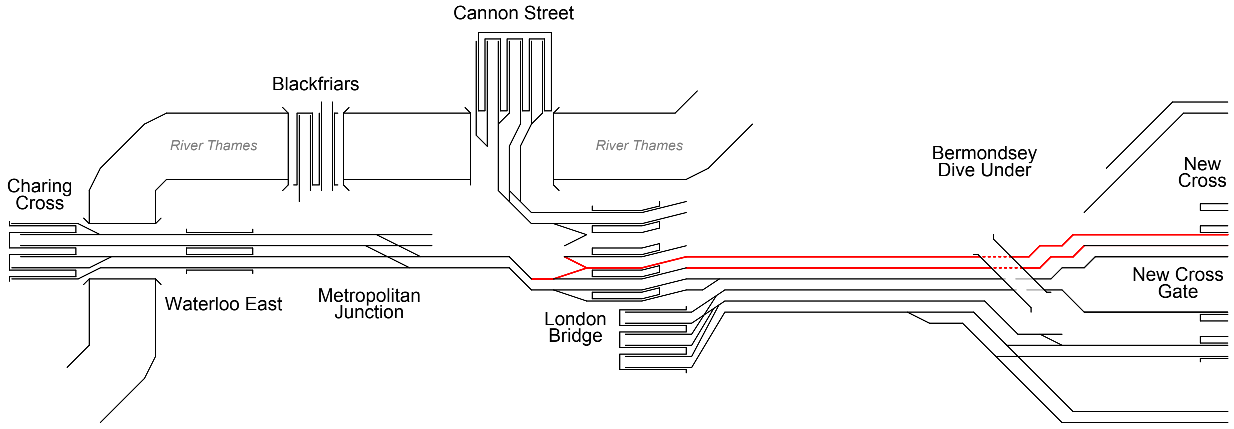


Figure 8 – Stage HL15.



the test system and another to the live system so that communication with its trackside Zone Controllers would be possible. This also put the FEP in the middle of two physically separate networks, the T-SPN on one leg and the Test Signalling Network on the other. The SIL-4 rated FEP hardware was now acting as a Firewall between the two networks, providing a physical layer of separation as well as the IP and SIL-4 addressing layers. This dual layer of segregation would give us the protection and assurance we needed to safely test the new layout without affecting the integrity of the live in-service railway.

The trial system

Such was the complexity of the HL17 programme that we needed to ensure we would get it right first time. The infancy of SoIP and the intricacy of the test system meant that we needed a way to trial it first. The TAM and FEP IO Sim advances in Westlock and WTS themselves needed to be tested so that we could be sure that they would all work safely and within the tight time restraints of HL17.

High Level Stage HL15 provided us with the perfect opportunity. A sizeable stage in its own right, with 50 signals and 23 points and 71 tracks, it was the biggest deployment of WTS to date (see Figure 8), a record beaten only by HL17 just three months later. This was the first time WTS Zone Controllers would be in operation to the east of London Bridge Station area and out at far as New Cross. This was a very large extension of the Charing Cross interlocking and crucially the first Zone Controllers to be entered into service along a chain of 15 brand new WTS REBs.

It was the new individual chain of REBs that provided the opportunity to trial the test system by operating this new leg of the T-SPN in isolation from the core network. This isolation enabled the operation of the test system in complete safety before the leg was connected to the live T-SPN before the commissioning blockade.

We set to work designing the first WTS TAM Test System (Figure 9) in February 2017.

The trial network consisted of a complete TAM Test System to operate the new FEP for Charing Cross. The TF-L and test equipment devices such as T&AILs and FEP IO Sim are each designed to be deployed on individual PCs and often use two or more network connections. This would however mean an impractical number of PCs would be required, especially the fifteen needed in the HL17 system. To get around this problem we deployed the systems on Virtual Machines (VMs) which meant that we could run all the equipment on a single high specification PC.

For the testing to be valid, we needed to be sure that safety critical functions would be carried out by the correct hardware. This meant that the test CIP and Westcad were operated on their respective target hardware platforms. There is an upcoming feature of WTS that enables simulation of adjacent FEP areas within an interlocking, however this was not available at the time, so instead FEP hardware was required.

Finally, we needed a place from which to operate the system. We had to look for a location that would enable testers to sit in relative comfort with a mobile telephone signal to communicate with the on-track test teams. With little or no natural daylight or telephone signal available in the equipment rooms, we used what little space was available in the London Bridge Signal Box (the mess room to be exact!). The setup was modest in appearance – a Westcad cubicle, desk, network switches, a set of screens and a PC – but it was capable. The PC alone was responsible for operating all four of the virtual machines in the system. These connected to the dedicated test network switches in the signalling box and communicated via fibre with the test CIP and FEPs in the equipment room downstairs (Figure 10).

The value of the trial was evident throughout its journey from concept to reality. Several challenges faced the team but the collaborative effort by the R&D, signalling, network and telecoms teams meant that we overcame each obstacle, be it product development, safety assurance, product acceptance, project management, planning, procurement, installation and testing of the novel equipment.

Following the many deployment challenges, the system went live as far as the Zone Controllers on 14 July 2017. Due to access limitations we were unfortunately unable to test the actual trackside equipment until the blockade. Although we didn't get to use the full system until this point, we had at least proved that we were capable of putting the system together, and more importantly that it worked. We had progressed the technology from a desktop concept to an operational test system within a year and learnt plenty from the trial to equip us for HL17.

The final application

And so to the final deployment and our chance to use the system for real and as intended. We handed back the new HL15 railway on Sunday 3 September 2017 and had just three months until we needed to sign in the biggest ever deployment of WTS in one of the most congested and metropolitan areas of the world.

The trial at HL15 had taught us many things. One of these lessons was that we had to improve the way we organised and managed our VMs to cope with the fifteen that were required for this stage. To help with this we brought in a higher specification PC, this time containing a 6-core processor, 64 GB of RAM and

Figure 9 – The HL15 WTS test system.

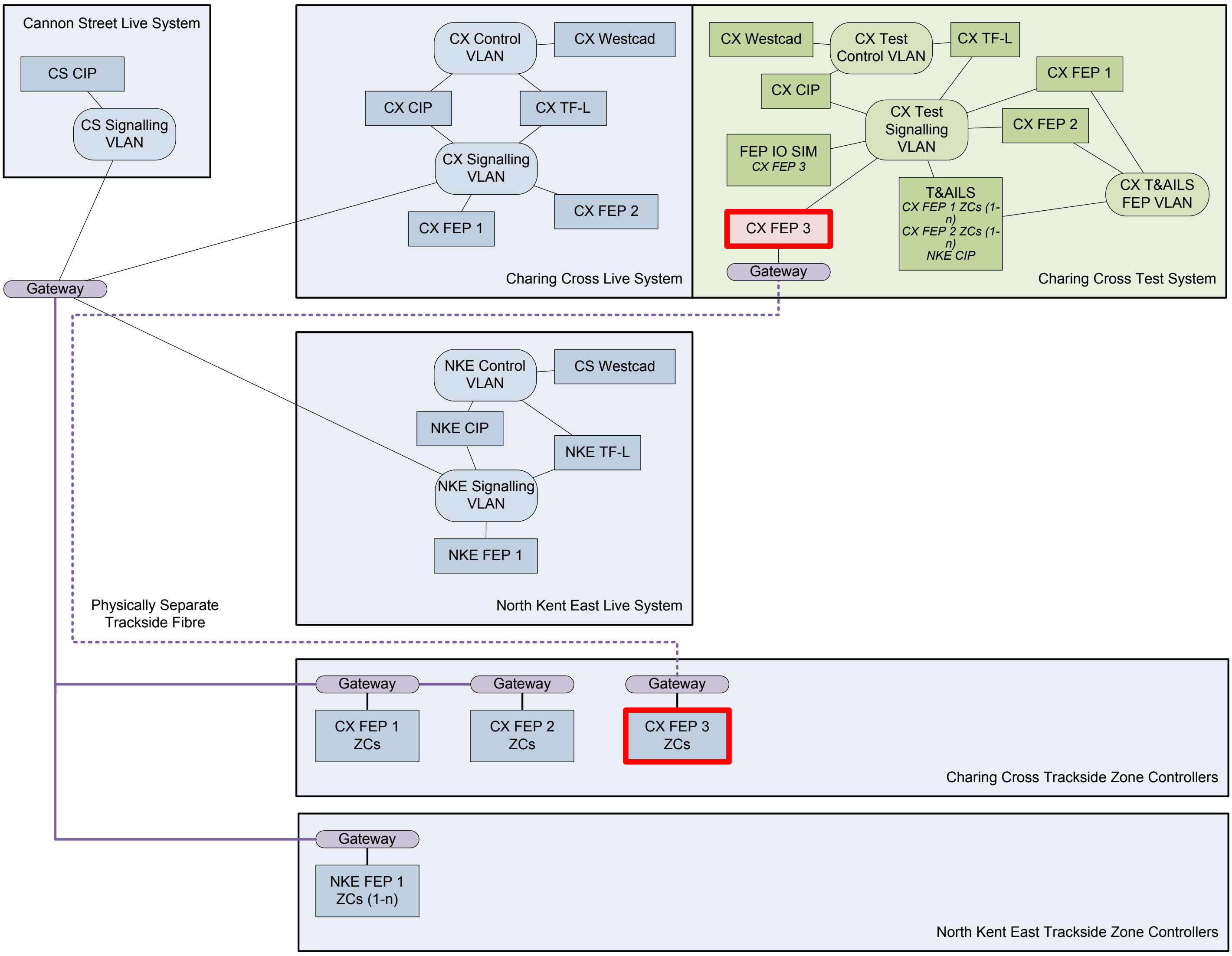


Figure 10 – Test CIPs and FEPs at London Bridge.

Figure 11 – The HL17 test system in use.

using solid state drives. We used multiple video and network cards to connect eight screens and designate eight separate VLAN connections across the virtual machines. Again, all lessons learned from the trial at HL15.

We finally got the system up and running on the 23 October 2017, except for the Westcad which was later added once the data was available on the 5 December 2017. It was a fantastic achievement by all involved and one I think I'll be pleased with for a long time. Unfortunately, much like HL15, there was very little opportunity to test trackside equipment on the Charing Cross interlocking and this was also the case with North Kent East. The P-Way work involved in reshaping the layout for NKE prevented us from testing it until deep into the commissioning.

The Thames Interlocking was a different story. With these lines yet to come into use and with all of the trackside equipment installed well before the blockade, the testers were able to make use of the WTS test system to simulate the adjacent fringes and IO as planned. This meant they could step through the interlocking one route at a time, safely simulating adjacent fringe interlockings and FEPs, changing track circuit inputs and simulating point movements with unprecedented ease all from the comfort of the workstation in London Bridge Signal Box (see Figure 11).

In total we were able to correspondence test over 75% of the new Thames Interlocking before the blockade began. Aside from the success of the correspondence testing, the test system also enabled us to monitor the 'set to work' of each of the many Thames Zone Controllers, an added bonus that we had not previously considered.

The WTS test system had given us a huge head start, just what we needed to get the job done in just a 10-day blockade. HL17 was a success, a remarkable achievement considering its scale and complexity.

Conclusion

Much of the success of Thameslink KO2 Stage HL17 was due to the teams out on track over the commissioning and in the months leading up to it. The sustained hard work by the construction and test teams was something that the teams will be proud of for years to come.

It's immensely satisfying to know that the test system was a big part of the achievement. In achieving this, many off-site staff from around the business can feel that they played a part in the success of the project.

The WTS test system has transformed the testing of signalling projects and will be pivotal in complex future signalling solutions. Future projects can use the London Bridge example of this technology and take components of the system to help solve individual requirements. Whether it's a project in Derby needing just the FEP IO Sim, or the new King's Cross Project potentially needing a full WTS TAM Test System, each can look at the success of the London Bridge WTS Test System and know that the WTS simulation capabilities are now possible and (more importantly) that the system works.

What do you think?

Do we make enough use of integration testing in railway signalling, control and telecommunications?

Should we make more use of these techniques, and new technologies such as 'digital twins' of complex systems in order to speed up delivery and reliability growth and to make projects safer through expecting staff to spend less time on track?

Have you used a different approach on another project with a similar result? We'd love to hear from you, email **editor@irsenews.co.uk**.

The successful introduction of WTS, permitted by the test system, underpinned the signalling changes necessary for work to redevelop the area around London Bridge station.
Photo Network Rail.

Railway innovation: are we really so backward?

David Fenner

Recently there seems to have been a number of articles suggesting the railway is slow at innovating and could, as a result, be losing out in the coming years to more rapidly advancing alternative transport systems, but is this really true?

It is true that innovation is an essential part of enhanced productivity, achieving more with relatively less input. It is absolutely true that an industry that stops innovating is one that will at best stagnate and most likely decline. It is however also true that the larger the industry, or at least the segment concerned, the more challenging the task of implementing change, and innovation brings change.

Vehicle innovation

In recent years innovation on the railway has often focussed on new vehicles and new vehicle technology. The application of new technology to infrastructure systems seem, at least at first sight, to have been far less. But hang on is this not also true of our principal competitors, air and road? Most of the new developments in air and road relate to the vehicle, the fundamentals of the infrastructure systems are still very similar and not a lot has changed. Let's explore some of the changes that have happened and see if we can find any parallels.

Rail vehicles have been in a state of flux for decades and with the desire for bi-mode and even tri-mode propulsion systems this seems likely to continue. There have of course been other innovations with vehicles including better ride performance, remote condition monitoring and enhanced connectivity for passengers. Compare that to road and I expect you will find much the same. Most innovation has been concerned with the vehicle. The actual road is much the same, although there have been improvements to the layout of some sections to either reduce accidents or improve traffic flow. Interestingly the pot hole team were fixing the road near my house recently blowing small stone in to the hole and tamping it down, reminded me of the railway equivalent of stone blowing which has been in use for some considerable time.

The advances in propulsion and braking systems for trains have led to several signalling innovations essential to cope with the changed patterns of interference. Initially it was only necessary to control specific frequencies often using an Interference Current Monitoring Unit (ICMU) and ensure train detection systems could be managed to avoid the allowed frequencies and power levels. But with the advent of full three phase variable frequency drives with faster switching using IGBT (insulated-gate bipolar transistor) converters on the train, the challenges have affected a wider range of equipment including data links and communication circuits. Many of these have been solved by innovations that have been implemented quietly but quickly because of the need to allow the trains to run.

Railway vehicle innovation has been at a high level over recent decades, not least in Japan. *Photo Shutterstock/PitiSirisriro.*

Our industry has been relatively fast to adopt changing technology to convey information to drivers, but for many railways this represents a new generation of 'lights on sticks', a step on the way towards digital, comms-based train control. *Photo David Enefer.*

Innovations as a result of new trains are not the only examples of the use of new techniques within our profession. Forty years ago, pre 1980, there were few if any solid state interlockings, now any reasonable sized interlocking renewal is likely to be on a second or third generation CBI. In that time, we have also transitioned from large mosaic panels in a control centre perhaps covering 50 miles (80 km) of route to large integrated control centres covering substantial geographic areas using reconfigurable VDU screens as the primary human interface. Much of the data used by these control centres is also available on the internet via open access systems so anyone can track the progress of a train, and of course this information provides a key feed to the nascent Traffic Management Systems (TMS) that are making a debut.

Fully automatic metro CBTC

Outdoors there is now significant use of axle counting rather than track circuits as the means of train detection and many signals have been converted from filament lamps to LED. It is also appropriate to consider the developments in level crossing control and especially the advent of obstacle detection systems as part of the operating cycle.

Arguably metro networks have moved even further and faster, leaving behind relay technology and colour light signals to be increasingly controlled by CBTC systems often with fully automatic operation. Here of course one of the advantages is the generally contained scale of each line or route making it easier to argue for the funding and then to implement such systems line by line. They are also in a position to maximise the capacity gains from such systems because the rolling stock fleet is usually homogeneous and the stopping patterns standard.

Communication systems have also moved significantly over similar timescales, from primarily lineside telephones and 4 MHz coaxial cables to mobile communications and fibre optic transmission systems, many now based on IP standards. Yes, we are behind the commercial operators in a number of respects but the railway has to provide all elements of the system whereas in the public realm the end user equipment is often bought by individuals. Another challenge for the railway is the expectation of typically a 40 year life cycle for a "system" albeit some components are renewed during that time, and in general the railway is only able to fund replacement after such a life cycle has been achieved.

If I now take a personal, and to some extent uninformed, look at equivalent road enhancements I find few. Yes, many traffic signals have become LED and are driven by a PLC rather than a rack of relays. There are areas where traffic signals are linked to improve the traffic flow and of course here in the UK we are seeing significant lengths of 'Smart Motorway' where the full road surface is available for traffic including the former hard shoulder. The smart motorway comes with considerable volumes of CCTV monitoring and gantry signage so that, in the event of a breakdown or other incident, lanes can be closed and speed limits applied quickly. There are of course other 'control rooms' but, by and large, these 'monitor' traffic flow and manage disruption, a lower level of control than the equivalent on the railway. Communication has of course also improved with the advent of mobile telephony but most of the other gains, such as GNSS, are in the vehicle and confined to the vehicle.

My last point brings me to a weakness in my argument. If the information currently locked in the vehicle can be released by the LTE and 5G mobile systems then road management could take a giant stride forward. So, although I would argue we are ahead at present it is not acceptable to become complacent. Of course, we have an equivalent in CBTC systems (or ETCS for main lines) which unlocks the data about the immediate train trajectory for railway control system and enables a significant increase in capacity, especially where the railway operation is pretty homogeneous (e.g. Metros). The challenge for railway networks (as opposed to metros systems) is the initial cost of the transition to an in-cab signalling system and the scale of the deliverable capacity gain given the other constraints of mixed traffic.

Main line rail networks have a big challenge with scale, especially the financial scale of a significant change. This is no more evident than the challenges seen across Europe with the implementation of ETCS. There is a

Mass transit and urban railways have traditionally led the adoption of new railway technologies. Driverless systems such as Dubai's Red Line (left) and complex, highly capable integrated train supervision systems like the ones in Hong Kong (right) use technologies that are increasingly being brought to main line systems.
Photo Shutterstock/Leonid Andronov and MTR Corporation.

large front-loaded cost in moving to an in-cab signalling system. How do you justify that expenditure when the pay back is probably many years later? This is made worse by the costs being incurred in different parts of the overall structure compared to the benefits. And remember few railways are actually profitable so who is going to provide the funding? Yet another pitfall arises because many of these systems are computer based and electronic products rarely have a life of ten years let alone 40. So, it is essential that designs are modular and configured so obsolete units can be easily replaced without major change to the system and with minimal impact on the documentation justifying its use, especially the safety case.

Railway innovation

I think I have demonstrated that railways do innovate and this will continue, however no one should assume that change is easy. Change is, however, essential to the implementation of new systems and new techniques. Just consider change in your local domestic environment. There will always be those in favour of a particular change and those who aren't. Those who don't will identify weaknesses in the idea and attempt to at least slow its implementation or perhaps even stop it.

The same applies to new ideas on the railway, they will either be too expensive, not certain of delivery of the proposed benefits, organisationally challenging or lacking in an adequate demonstration of reliability. If you study any of the innovations implemented over the last few decades you will find a promoter or sponsor who spent significant time and energy 'selling' the idea and winning round the support of others. The exceptions to this maybe the forced innovations such as coping with interference from modern traction or those created as a result of an incident or accident that shone a light on a particular hazard. Even here someone did some pushing to get the solution endorsed and rolled out as required. In my experience the two biggest hurdles are organisational and demonstrating reliability.

Railway equipment is generally highly reliable. It has to be because the volumes, especially on national networks, tend to be large and individual failures can thus appear to be frequent. They also disrupt operation making reliability a key topic. It can be difficult to prove that a new or even modified system will be reliable before implementation. Even if a reasonable level of confidence is demonstrated there is no guarantee others will accept the argument, pointing to weaknesses in the modelling. Disturbance of older systems during installation of the new can cause faults to appear although this is more prevalent for train-borne equipment than infrastructure signalling systems. People don't forget.

Organisational issues are the other major challenge. Developing new kit is not the end, it then needs to be installed, operated and maintained involving many other parts of the overall railway. With different interfaces and often different companies timely training of staff is essential and the training needs to be of a high standard so that it is used appropriately. Aligning all parties to understand the new system and be happy with the implementation is essential.

In discussing innovation, I have focussed on new equipment or new uses of systems that exist. Perhaps we shouldn't lose sight of new ideas in how the job is done. That can be just as innovative and the gains may be just as large as inventing new systems. A better way of doing the same task can improve safety, reduce cost or increase capability which is the entire purpose of innovation. So, a better design process or more effective testing could be just as important as a new gizmo.

In this article I have tried to suggest that the industry should not be depressed by its apparent lack of innovation or the speed of change, in many cases it is just that the innovation has been accepted as an essential step along the road, subsumed in to our everyday life. I have also attempted to say that I do not think railways are any more at risk than our competitor industries especially when you apply the concept to the infrastructure elements of those competitors. However, it is also true that as an industry we cannot rest on our laurels, innovation must continue and adapt to the changing world around us. Be ready to make changes, be prepared to fight them through the doubters, and enjoy the end result.

What do you think?

Does the railway get a bad press when it comes to innovation? Have we stood still? Are there barriers we need to remove to progress?

We'd love to hear what you think and always welcome letters for our feedback column. Email **editor@irsenews.co.uk**.

West Coast Main Line resignalling of 1960s – geographical interlockings

Tony Cotterell

On 1 December 1954 the British Railways Modernisation Plan was launched, a large part of which was the electrification of the West Coast Main Line from London Euston to Liverpool, Manchester and Birmingham. Associated with this was the requirement to upgrade and immunise the signalling over the same route, most of which was still mechanically signalled. The problem was time; there wasn't any – so a plan had to be formed to re-signal the entire route within a timescale not previously seen for such an ambitious project.

The western region (WR) of British Railways had its own E10k interlocking which was becoming the standard for that area and being rolled out in pretty amazing timescales too. However apart from anything else, it was not immune to AC traction and anyway anything invented by the WR was always different to anywhere else (e.g. diesel hydraulic traction) so was looked at sceptically. The Southern Region had various power signalling schemes in place, as did the Eastern Region, with the OCS (One Control Switch) panels at Hull (1938) Northallerton (1939), Goodmayes (1949), York (1951) and Newcastle (1959) standing out. However, there was no existing standard which would fit the bill and to speed up the process of design, implementation and construction so the concept of Geographical Signalling was developed.

The geographical interlocking idea is, for any given layout, the signalling is split into a number of standard blocks consisting of points, signals, track circuits, and ground frames etc. each as an individual element. A block schematic, very similar to a train describer layout or any flow-chart style diagram, is then drawn using these building blocks connected together in a way that represents the geographic layout for the specific site. The individual blocks are designed to provide every function possible for that particular element and the whole interlocking is then constructed by connecting the blocks together by multicore cables whose routeing reflects that of the track.

In principle the given layout could be designed very quickly and the factory construction of the necessary geographical units commenced in parallel with the site design. The maximum possible can be constructed off-site in factories and so could be undertaken at the same time as building the necessary infrastructure including the signalboxes, relay rooms and the installation of cables, signal structures and location case bases etc.

Euston PSB during its construction.

It wasn't only the signalling that was treated in this manner, but the approach also targeted the associated power supply arrangements, especially those involved with point operation. The recent modular signalling initiative is really just the 21st century incarnation of the same idea that had been implemented a generation before.

Three major signalling companies existing at that time separately pioneered different systems to implement different areas of the mammoth resignalling project; these were:

- The Westinghouse Brake & Signal Company Ltd (WB&S Co).
- Siemens & General Electric Railway Signal Company (SGE).
- Metropolitan-Vickers-GRS Limited (MV-GRS), a joint company formed in 1926 to introduce technology from the General Railway Signal Company (Rochester, New York) into the UK.

The company which was WB&S Co still occupies part of its original site at Chippenham next to the railway, and now trades as Siemens Mobility Limited.

SGE once had an enormous factory at GEC's East Lane in Wembley; the remnants can still be seen near North Wembley station. The manufacture and testing of the geographical units, however, were undertaken at Ingatestone in Essex for the 1960s projects. This factory used 'advanced' production techniques including a paper tape used to display "to" and "from"

Terminating connections at Warrington PSB, 1972.

information to a group of operatives simultaneously building a unit each; when all had pushed a button to confirm completion of an action, it stepped to show the next wire in the loom.

MV-GRS, later AEI-General Signal resided in Trafford Park (in Westinghouse Road of all places), Manchester. My father actually worked there for a time in the relay testing department in his younger days.

Principles of the different systems

WB&S Co, developed the Westpac system which packaged all the components necessary for the individual signalling function, be it signal, point, track circuit, ground frame, in one unit. Naturally, a simple signal with a locked overlap and only main routes was a much simpler unit than one requiring subsidiary routes, alternative overlaps and so on. Similarly, for single-ended and double-ended points the functions are different so there had to be more than one style of unit for each piece of equipment. However, the various units were produced in three sizes: small, medium and large, the biggest housing 40 relays for its various needs.

The signalling system was constructed by connecting together the units according to the schematic layout. In Westpac this used 48-core cables identified at their ends by colour coding: red, blue, green and yellow.

One thing to remember about the Westpac system is that the interlocking does just that; the route is set and the various components checked to confirm correct correspondence and the signal then allowed to clear. Nothing else is included: no route indicator proving, no flank protection, no swinging overlap controls, no 'better aspects', no comprehensive approach locking. These all have to be provided by separate free-wired relay circuits which can be very complex.

SGE took a rather different approach in that they split their packaged signalling function into smaller units for various uses and interconnected them with cables and straps to provide the required functionality. This led to many different types of smaller units and a large number of cables between them before the units were connected together to form the whole signalling system. However, all functions were provided for in the geographical interlocking (i.e. all those listed above and more) so there were far fewer free-wired circuits required; the corollary was that the interlocking was far more complicated and therefore challenged the brains of designers and testers alike when ensuring it would operate correctly.

MV GRS took a slightly different line again, especially in the construction area. Whilst Westpac and SGE made their modules small enough to fit on previously constructed racking, the GRS system involved each signal or point unit occupying a full height relay rack (albeit very narrow), with all the terminations on screw terminals at the top.

In addition, whilst they adopted the geographical principle in design, they adapted each rack to fulfil the function for which it was required and only used the relays necessary for that function, strapping-out the contacts of missing relays where necessary to provide continuity. Hence the signal rack, for example, would have all the necessary relay positions for the most complex requirement, but for simpler signals many would be missing and only some of the wiring provided.

Operation

All the interlocking systems had one thing in common; they all operated on 4 Levels:

- Route Selection/Initiation.
- Route Calling and Locking.
- Route Checking and Aspect Selection.
- Route Cancellation/Release.

Westpac

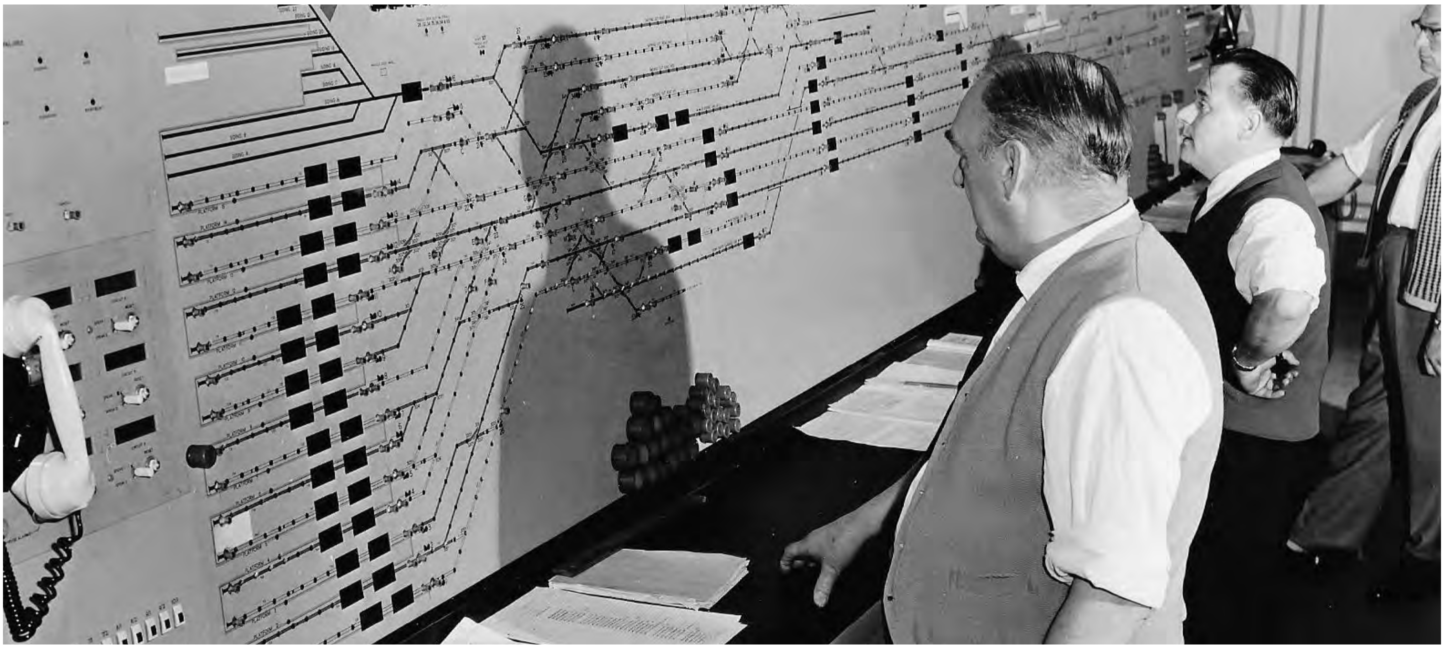
Westpac Mk 1 carries out these operations by firstly using a PBI (push button interlocking) to ensure that a signalman can only set one route at a time and that the right sequence of buttons is used. To call the required route an entrance button is pressed and released, followed by a valid exit button. The PBI also 'locks-out' any other buttons whilst this is occurring. This being complete, a feed is sent out from the entrance signal set to each interlocking set in turn to energise a CUR (route calling relay). This checks the points are free to move and calls them to the right lie, checks opposing routes and energises a route ULSR (route lock stick relay). Hence the initiation/calling level is complete and the PBI can now normalise.

Next another feed goes out, again to each interlocking set, to throw down the related LUR (route locking relay) in each set, this locks the previously called points, etc. lighting the individual route lights, thus signifying that the locking level is now complete. Finally, the aspect level then feeds out to check each set for locking, detection, tracks clear etc. before allowing the entrance signal set UCR (route proving relay) to pick and allow the clearance of the signal.

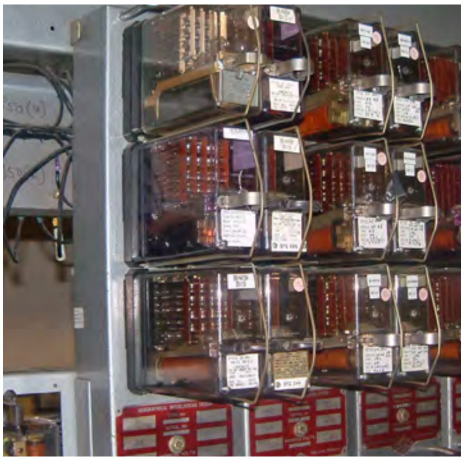
Release of the route is accomplished by cancellation of the route initiated by the signalman pulling the entrance button after the passage of the train, re-picking of the first LUR and dropping of the CUR in each set as each track circuit clears behind the train. This sounds very straightforward, and for a simple route it quite often is. However, when you bear in mind that each set is designed to accommodate full bi-directional operation, permissive moves and any other extra functions, the end result is a complex affair.

SGE

Looking now at the SGE version which in later life migrated to GEC via AEI the above functions are catered for slightly differently.



Euston panel in service.



SGE geographical interlockings at Bletchley, front (left) and rear (right) views.

SGE system at King's Cross, showing racks and indication unit at the top of the photo.

The interlocking is provided with a CCS (common control set] which provides the same functions as the PBI in Westpac as far as ensuring that only one route can be set at any one time and if not completed would then normalise the system. This facility is called route anti-preselection, but incidentally was not always provided. In the early days of power signalling it had been a common practice deliberately to allow the sequential setting of conflicting routes. This enabled a signalman to select a route despite it conflicting with another one that had been set previously, allowing it to set immediately the first route was released. However, a number of undesirable incidents due to track circuits bobbing (i.e. briefly picking as a result of poor rail conditions despite the presence of a vehicle) caused a reversal of this thinking and therefore this facility in the PBI was born.

When the entrance button is pressed, a feed goes out over the selection level ring which causes all available X(SL)Rs (selection level exit relays) to be thrown down (this is the term used to unset latched relays that are normally up to store a condition). Thus, the exit sets are now primed to receive the operation of a valid exit button, as is the CCS, which in SGE geographical also determines the class of route.

Subsequent pressing of the required exit button for the class of route then results in the XNR (exit normal relay) picking in the exit set and in turn the relevant XR (exit relay) picks and the SLR (selection level relay) picks in the entrance set thus marking the end of selection level.

The SLR picking then sends out a feed from the entrance set over the locking level ring to the chosen exit set with its XR energised which throws down the XLR (exit locking relay) in that set and thus returning the locking level to pick a ULCR (route lock proving relay) in the entrance set.

This completes the locking level. At this time the route lights will illuminate. Unusually, in SGE interlocking the point lights illuminate first and then the route portions fill-in.

In turn, this normalises the CCS and re-energises the X(SL)Rs which release the selection level.

Cancellation of route by the signalman pulling the entrance button causes the ULCR to drop and with the correct conditions the route NLR to re-pick. This allows USRs (route stick relays) to re-pick in each point set along the route behind the train finally re-picking of the XLR in the exit set.

As can be seen, this is a much more involved scenario than the Westpac as a number of things are happening in parallel. Nonetheless an experienced technician can pin-point how far the process has gone in fault conditions by establishing the state of a number of key relays.

MV-GRS

The MV-GRS system is more akin to E10K than the other varieties since it has no PBI and the circuits are very much 'made-to-measure' although as previously stated, each unit is designed in geographic fashion.

The initiation is carried out by a M (main) or S (subsidiary) NPR (normal repeat relay) picking when the entrance button is pressed.

A feed then goes out to the various exit sets via any points in the route to prove their availability and also checks any opposing route and route stick relays; this process ends with the energisation of a UKER (route indicator light relay).

This relay provides the anti-preselection feature mentioned previously and ensures that the exit button cannot be used as an entrance at that time. Pressing the exit button picks a (M) or (S)NPR as before but this time, since the UKER is now up, the UNR (route normal relay) picks. The relevant point NUR or RURs are operated and the points set. In the entrance set the UR picks; this completes the route calling.

When the UR is energised, its back contacts break and the USRs (Route Stick relays) drop in sequence throughout the route and illuminate the route lights. When the points are locked, the exit signal UNR picks and a feed travels back to the entrance set checking all point locking, detection, tracks clear, opposing routes clear as per the Westpac method. Finally, the entrance UCR picks to allow signal clearance.

Route Release is accomplished by pulling the button behind the train and with the approach locking released, the ALR (approach lock relay) picks and the route sticks energise behind the train until finally the UKER and UNR de-energise in the exit set and we are back to normal.

In service

In many ways the Westpac was the easiest of the three systems to work on, especially as far as fault-finding was concerned. There was a book of 'typicals', the bible of the system, showing the full internal wiring of each set plus the site schematic showing which geographical cable went where.

In addition to this, the wonderful positive/negative test meter mounted on the wall of each relay room was essential for tracing faults. However, the free-wired 'R' type relays were quite small and mounted in the 'cubicle' which originally had glass doors. The doors were quickly discarded.

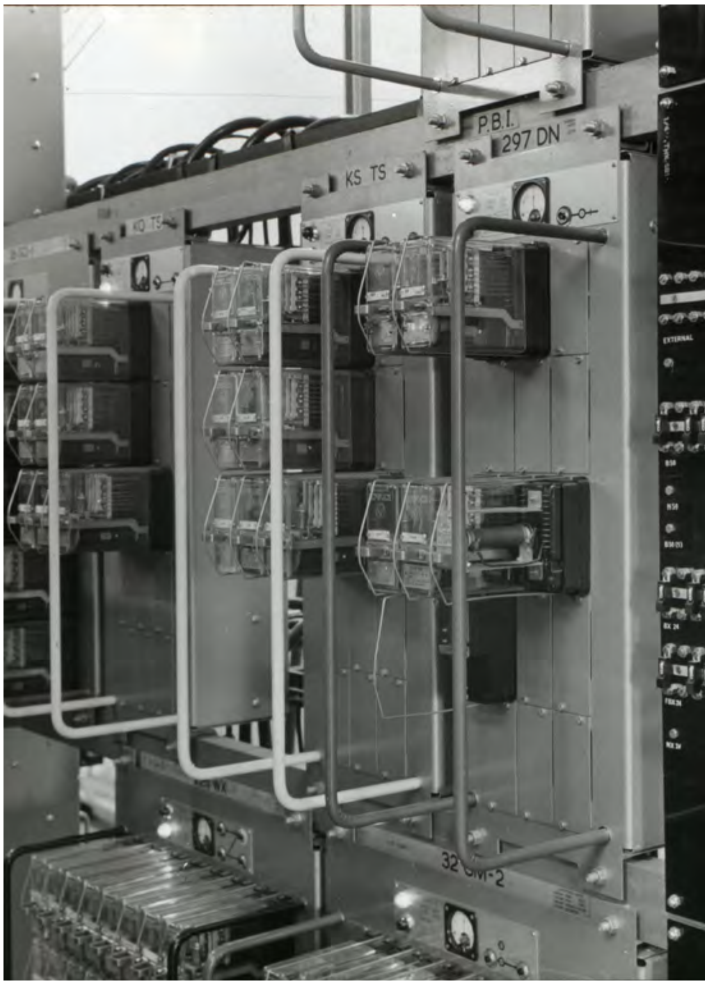
The trunking was also a problem as it was far too small for the number of wires it carried and therefore the wiring bulged out. The other issue was the interface between the free-wiring and the Westpac units which utilised a device called a 'Stapin Block'. This was marvellous for space-saving but not much else. It had double-sided multi-way terminations which used tapered pins crimped to the wire and inserted with a special spring-loaded tool. The one thing they did not do was stay-in; too vigorous use of the tool trying to get one wire in invariably meant that another four fell out!

The SGE system loved rings. There were rings for everything. The CCS had the Normal Proving and the Positive Entrance Ring, closely followed by the Entrance Registered Rings and the Exit Registered Rings, together with the Primary and Secondary Class Rings and Aspect Class Rings. Moving on we came to the Selection Level and Selection Level Release Rings, and then the Locking Level and Locking Level Release Rings. Finally, we meet up with the UR rings, for Route indicator operation and end up with the Aspect Level Rings.

The early diagrams were similar to the Westpac with a book of 'typicals' for the sets but just a list of straps showing the interconnections. This might sound acceptable but in practice, because of the multiple number of sets employed it was a complete nightmare; thankfully lessons were learnt and later on diagrams showed all the wiring for each route on one big sheet. There were also separate diagrams for the selection level, locking level and aspect level rings all of which were pretty enormous.

Not only did SGE provide geographical style hardware for the Interlocking but they built sets for the outside location cases too. The locations were fitted with track circuit sets, point drive sets, route indicator and signal sets all mounted on Geographical style bases.

Westpac units, complete with meter and status indications, in use at Birmingham New Street station.
Photo Ian Lynagh.



Westpac Mk2 at Basingstoke.
All photos Network Rail/British Rail LMR unless otherwise shown.

The route indicators relays were a particular 'trap for the unwary' as a route might, for example, be designated the B(M) on the scheme plan but in the interlocking the relevant indicator could be driven by a relay called 4UR yet out in the field it may well have been referred to as 2UR in the location wiring. Care was needed here to avoid a confusion having serious consequences.

Finally, the MV-GRS system had 'typicals' for the sets but due to their 'bespoke nature' all the circuits were shown on four huge diagrams for the four interlocking levels. These diagrams were typically the length of the relay room and were nicknamed the "Dead Sea scrolls". Sadly, because of the nature of fault-finding, they used to get rolled out in the only space available between the relay racks and therefore soon had many boot marks all over them, no matter how hard one tried to protect them.

Each Interlocking had a distinctive operating sound because of its construction. Westpac had some latched relays which operate with a healthy clunk and you can hear the route setting with the final little delay before the UCR picks almost as an afterthought. SGE and latterly GEC interlockings are full of latched relays and, because the route setting releases all these relays in turn from the entrance to the exit out and then back, the sound of a long route being set can never be forgotten. Finally, there are no latched relays in the MV-GRS interlocking so the route setting sounds more like a breeze blowing through the relay room. However, the downside of this is that after a power failure the technicians would have to rush round and re-pick all the ALRs to restore route setting.

As well as the interlockings, the power supply arrangements for point operation were also of a geographic nature and a large installation would have a 'ring main' installed, but not necessarily electrical. Westinghouse and SGE installed air mains around their sites and used the wicked E/P [Electro Pneumatic] machine (it operated very fast and robustly which was good at achieving detection despite obstructions but not good for anything that got in its way). MV GRS fitted a 120 V ring main supplemented with batteries and provided a point machine with a built-in contactor to interface to it. Again, the idea was to simplify installation as the main could be installed and then the various points tapped off it when available.

Implementation

In order to achieve the required timescale and ensure that all the industry was fully utilised, the three companies were all duly asked to bid for the re-signalling work; the cake was divided into pieces.

The first scheme to be commissioned was at Coventry (1962), which was not strictly a geographical interlocking because it did not consist of individual units, but was a free-wired interlocking in the SGE geographical style. It used vital relays for route selection in conjunction with a 1958 interlocking system.

SGE also provided the installation for the huge layout at Rugby (1964), Bletchley (1965) and Willesden (1965) and then added Tile Hill interlocking to Coventry (1966).

Meanwhile MV-GRS implemented Nuneaton (1963) and Watford Junction PSB (1964). This was interesting as it had a separate little panel for "the DC new lines" but the interlocking set routes into the station automatically depending upon platform occupancy and hence can be regarded as an early form of ARS.

WB&S Co then implemented Westpac Mk1 with a vengeance and re-signalled the whole of the Birmingham area with boxes at Wolverhampton (1965), Walsall (1965), Bescot Down Tower (Main and Hump panel, 1965) and New Street (1966). It was said that Walsall had every facet that could be provided with the Westpac Mk1 system somewhere in its layout, although it was an incredibly cramped building with little creature comforts. WB&S Co also built what can only be described as a showcase at Euston (1965), a 'picture perfect' set-up in a massive relay room, just right for visiting dignitaries.

Sadly, as so often happens with the railway, the scheme ran out of money and north of Wolverhampton and Nuneaton the old mechanical boxes were hastily upgraded to colour light signals and immune track circuits. Crewe workshops used the expedient of rotary converters to produce 83 1/3 Hz to gain immunity from both stray DC and the 50 Hz 25 kV overhead electrification.

The new power box that had been built for Stafford is still there on the down side although it has been the base for the local signal technicians for many years rather than an operating centre, whilst the mechanical signal box still controlled trains.

Warrington, Preston and Carlisle (Mk3) were commissioned between September 1972 and September 1973. They have all had extensive rewiring with new sets manufactured and new plug in bases, and the interlockings will be in service for many years to come until replaced by ETCS.

In the late 70s early 80s BR decided that no new geographical interlockings would be commissioned. This was primarily because the maintenance disadvantages; the number of faults from long series circuits particularly with back contacts and the cost of relay servicing the large number of relays were becoming apparent.

Industry news

India – high speed rail and ERTMS

India: The National High-Speed Rail Corporation (NHSRCL) is implementing a 508 km (316 miles) high-speed train route between Mumbai and Ahmedabad in India. The proposed route lies in the Western Railway zone of India (the largest of the 17 zones) and will start from the Bandra Kurla complex in Mumbai and end near Sabarmati Railway Station in Ahmedabad.

12 stations are proposed to be located at Mumbai, Thane, Virar, Boisar, Vapi, Bilimora, Surat, Bharuch, Vadodara, Anand/Nadiad, Ahmedabad and Sabarmati, and are all near major traffic points. Two depots are proposed at each end of the route, one near Thane and one near Sabarmati.

The project is planned to be around 15% complete by 2022, and the NHSRCL has now confirmed that the signalling system on the route will be ERTMS (European Rail Traffic Management System) Level 2.

"The signalling system on the 'bullet train corridor' will be ERTMS L2 as per the project feasibility report. As ERTMS is developed to standardise train protection systems, it will give Indian rail interoperability with other networks," said the NHSRCL in a tweet.

The ERTMS is considered one of the safest signalling systems as it enhances safety beyond the capability of legacy automatic train protection (ATP) systems. It reduces the possibility for human error providing a comprehensive ATP function."

Battery locomotive development

USA: A battery-electric freight locomotive is to be developed in the United States by BNSF Railway and GE Transportation. The programme will see GE Transportation design and build an AC Evolution Series locomotive which will feature an overall energy-management system, including onboard energy storage. This battery-electric locomotive will generate 2,400 kW of power and will be paired with diesel locomotives to power a freight train travelling from the city of Stockton to Barstow, California. BNSF estimates that it could reduce the train's total fuel consumption by at least 10%.

On-train wireless charging

UK: On-train wireless charging has made its debut on South Western Railway's (SWR) Class 444 Siemens Desiro five-car EMUs. Eventually all 172 of SWR Desiro trains will be fitted with the facility.

The wireless charging solution is integrated directly into tables in SWR's first class carriages as a complimentary service offered to passengers, enabling them to top-up their mobile phone by placing the device onto the charger without the need of a cable. The system is directly compatible with over 130 Qi certified smartphone models.

The wireless charging units are the first to be manufactured specifically for rolling stock, complying with all mandatory railway applications and standards including EN501121-3-2:2016, EN50155:2017, GMRT 2100 and IP55.

Either surface or sub-surface mounted, the wireless charging solution can be integrated into tables, seat back tables, dado panels, window panels, grab rails and side ceiling panels for metro applications.

Massive MIMO (multiple input-multiple output) trials in London

UK: O2 and Nokia are rolling out two Massive MIMO (multiple input-multiple output) trials in the King's Cross and Marble Arch areas of London UK. This will also pave the way for 5G deployment across the capital.

Massive MIMO makes mobile networks more efficient by allowing multiple beams of data to be transmitted from the antennas to the device, increasing both speed and capacity. The locations have been specifically chosen as they have high levels of data traffic. O2 plans to boost coverage in these areas and assess the technology for roll-out elsewhere.

Over 95 million people pass through the King's Cross/St Pancras each year and more than 14 million people travelled through Marble Arch in 2017. The pilot will deploy Massive MIMO technology as well as the 2.3 GHz spectrum that O2 won in Ofcom's auction earlier this year. O2 was the only UK network to secure extra 2.3 GHz capacity.

O2 says that as well as boosting capacity in these areas today, the trial will also lay important foundations for 5G as Massive MIMO technology is expected to play a crucial role in meeting the increased data demand that 5G is anticipated to create. Ofcom's 2018 Communications Market report finds that the average user consumes 1.9 GB of data per month. Some mobile network operators predict that the average user will consume 98.34 GB per month by 2025.

Emergency special working (ESW)

UK: ESW is a new alternative to temporary block working which allows trains to be moved more quickly and more safely following a major signalling failure on the GB Network Rail network. During a major signalling failure, trains may have to be authorised to pass multiple consecutive signals at danger to keep them moving. Until recently the main way of doing this has been temporary block working (TBW).

With TBW a section is set up on each affected line between an entrance signal and an exit signal, with hand signallers provided at both. All points within the TBW section must be secured on the ground, usually with clips, scotches and padlocks, regardless of whether they are still correctly detected by the signalling system.

Finding hand signallers, getting them to site and arranging for all points to be secured means TBW is a safety risk and can be slow to introduce, taking a few hours to put in place after a signalling failure. When trains are at a stand there is a greater risk of SPAD incidents and stranded trains can quickly become uncomfortable and unpleasant for passengers, especially in hot or cold weather or where trains are crowded. This has led to passengers self-evacuating from trains onto the track and putting themselves in danger.

ESW was introduced on the GB main line network from 1 December 2018 and is a new set of rules for dealing with the same kind of signalling failures as TBW is designed for. The rules have been developed over more than ten years and based on detailed research, risk assessment, and input from Network

Rail, train operating companies and trade unions, along with being trialled operationally since 2013.

ESW uses the same operational principles as TBW. Both methods of working can only be used on lines that have two or more tracks and are signalled under track circuit block regulations. However, ESW uses direct GSM-R communication between signallers and drivers, so does not need hand signallers. Where points are locked and correctly detected by the signalling system, ESW does not require them to be secured on the ground. The exit signal from ESW must be at a location that is easy for drivers to recognise.

The changes allow ESW to be implemented more quickly than TBW and on some occasions during the operational trials introducing ESW has taken less than 20 minutes rather than several hours, reducing the risks to passengers and staff that arise when trains are trapped for a long period of time.

Royal Academy calls for data to be used to drive culture change

UK: The Royal Academy of Engineering, the UK's national academy for engineering and technology, have called on engineering organisations to increase their use of data to measure and improve diversity and inclusion (D&I) in the profession at a 'Data Driven Culture Change' event.

At the event on the 27 November, the benefits of a data driven approach for both large and small companies were demonstrated by presentations from multinational IBM and Customem, a start-up focusing on capturing hazardous chemicals from water. Gary Kildare, chief HR officer of IBM Corporation Europe, highlighted the potential of data and artificial intelligence to help improve and extend the diversity of workforce. Customem's CEO and co-founder Henrik Hagemann outlined his philosophy of building a small team with specialist skills whilst consciously looking for maximum diversity.

At the event, attendees from across the engineering profession discussed the initial findings from a survey conducted in the summer of 2018 to shed light on the state of D&I in engineering employment – the full report will be published in 2019.

The survey found differences in the perceptions, actions and experiences of engineering employers of different sizes in relation to D&I, and that smaller organisations typically face challenges that limit their capacity to promote D&I. The Academy plans to address this by working with start-ups and SME leaders from the Academy's Enterprise Hub to develop guidance specific to smaller organisations.

Many engineering employers, especially smaller organisations, thought it unlikely that increasing D&I in their business would reduce or eliminate skills shortages, but they did identify other benefits including improving company image or reputation; improving compliance with legislation; and increasing collaboration.

Previous research, "Creating cultures where all engineers thrive"[1] found that inclusion benefits the performance of individual engineers, with 80% reporting increased motivation, 68% increased performance and 52% increased commitment to their organisations.

The Academy launched guidance at the event to give leaders, managers and people managers across engineering the tools to use existing and new data as a powerful lever for change.

John McCollum, engineering director a BAE Systems and member of the Academy's Diversity and Inclusion Leadership Group, said: "Measurement of diversity and inclusion is crucial to effect change across the engineering profession. The profession needs to become better at measuring diversity and inclusion to target interventions and actions, and make meaningful progress."

Measures for D&I in engineering were developed by the engineering companies working with the Academy to provide a framework to drive change across organisations, from large corporations to SMEs, and irrespective of whether they are beginning their D&I journey or progressing towards maturity or beyond. The measures are validated by the Employers Network of Equality and Inclusion and tested with both large corporate and SME organisations to confirm relevance and proportionality.

New Rail Industry Standard for DAS

UK: Driver advisory systems (DAS) enable drivers to monitor their train's progress against the timetable and get advice about the optimum speed they should target in order to reach the next station on-time. If the train is running early, then the DAS will advise a lower speed so that the train saves energy. If the train is delayed, then the DAS will advise a higher speed, so long as the line and train speed limits allow.

Until now, the implementation of DAS in GB has been mostly standalone DAS (S-DAS) i.e. DAS with limited or no ability to receive timetable updates at any time during a train's journey. With a Connected DAS, a connection is made from DAS systems to the Traffic Management system, so that revised timetables and other data can be provided at any time for extra performance.

However, there has never been a standardised interface for C-DAS, increasing the risk of proliferation of the data format. Now, a new RIS (0711-CCS) has been produced to standardise the interface between infrastructure managers' and railway undertakings' connected driver advisory systems.

The standard is based on documents prepared by the Digital Railway project including the operational concept and the set of system requirement specifications.

A common interface means the market for suppliers can be opened up and potentially increase innovation and reduce supply costs. This should also potentially help train operators reduce costs associated with upgrading from DAS to C-DAS.

Siemens Alstom merger reviewed by European Commission

Siemens and Alstom have proposed to the European Commission selling the bulk of Alstom's signalling business in Europe in addition to some Siemens signalling assets. They have also offered to sell either one of their high-speed train technologies to address EU concerns about their plan to create a major Franco-German rail company. The signalling assets on offer include three-quarters of Alstom's signalling business in Europe, which includes signalling for urban transport, main line trains and conventional trains.

The companies have offered to divest either Alstom's Pendolino platform or Siemens' Velaro Novo platform. Pendolino, which features a tilting technology that results in less braking before bends, is tailored for high-speed and conventional lines. Pendolino trains have been sold to 12 operators in 12 countries. Siemens' Velaro Novo high-speed trains will only enter service in 2023. The proposal includes a five-year license to sell the trains in Europe.

The Commission has given rivals and customers the opportunity to provide feedback, before it makes a ruling by 18 February.

News from the IRSE

Blane Judd, Chief Executive

IRSE Council Elections

All Associate Members, Members and Fellows will receive their voting papers shortly for this year's Council elections. Please ensure that you vote as it is important that the IRSE Council is representative of our members.

Council members make decisions on the strategic direction of the IRSE, act as trustees of the IRSE Charity and ensure that the IRSE's objectives are progressed. Council members also appoint the directors of IRSE Enterprises, the company which operates the Licensing scheme.

Presidential Programme Technical Meeting

Join us for the fifth paper in our Presidential Programme series for 2018-19 on the subject of cyber security in railway systems, to be held on 7 February in Darmstadt, Germany.

This free event is kindly co-organised with the profile area Cybersecurity of TU Darmstadt and is to be held at the Technische Universität in Darmstadt starting at 1800 hours CET. A welcome reception will be held at 1700.

Prof Dr Stefan Katzenbeisser, professor of security engineering from the Universität Darmstadt will present "Challenges in designing secure and resilient railway command and control systems" followed by Max Schubert, systems architect manager for DB Netz AG with his paper on "The balancing act of implementing cyber security".

Visit irse.info/9fbli for further information.

IRSE Annual General Meeting and Dinner

The IRSE's Annual General Meeting and Dinner will be held in London on Friday 26 April 2019, when our new President (for 2019-20) George Clark will deliver his Presidential Address. All are invited to the AGM, which takes place in the IET at Savoy Place.

The Guest of Honour at the dinner will be Mike Brown, commissioner of Transport for London. If you or your company/organisation wish to book places at the dinner, please visit irse.info/h2iyv. The dinner is kindly sponsored by Atkins, a member of the SNC-Lavalin group, and will take place at The Savoy.

IRSE Professional Examination

The IRSE Professional Examination remains the ultimate test of competence in our profession and candidates sit around 200 modules (in some years many more) somewhere in the world each year. Volunteer examiners devote many hours to setting and marking the questions. It is a tough exam, demonstrated by an average pass rate of around 50%. There are seven modules and to succeed in the overall exam, a candidate needs to pass four of them. Two of the modules specifically cover communications subjects, though very few people enter these.

It is now nearly 25 years since the examination structure was last changed, so Council agreed that it was time for a review. This was conducted by a team of 11 members led by Daniel Woodland and including several younger members with recent first-hand experience of the exam. The review reflected changes during the last quarter of a century (changes in employment patterns and testing techniques as well as changes in technology). It also looked at survey feedback from candidates during the past few years.

Council has accepted the review's recommendations in principle and is waiting for a costed and resourced plan before giving the go-ahead for implementation.

In summary the main proposed changes are:

- The existing seven modules would be replaced by four new modules (one 'foundation level' and three 'advanced level') covering all aspects of railway control and communications. There would be a sufficient choice of questions in each advanced module to enable candidates to pass predominantly from knowledge of their own specialisation. A pass in all four modules would be needed to achieve the qualification of an overall exam pass.
- The foundation level module would test breadth of knowledge rather than depth. Passing this would lead to a lower level qualification in its own right and also serve as a pre-qualification for taking the advanced modules.
- The syllabus would be updated, though it is unlikely to change radically.

In the meantime, the 2019 IRSE Exam will proceed with no change to the syllabus and modules. In the future, during the transition to the new style exam, candidates would be able to achieve the present 'IRSE Exam' qualification with passes in a mixture of old and new modules.

The IRSE will keep everyone informed as the project to re-structure the Examination progresses, and the date for implementation will be confirmed.

Union of European Assocations (Institutes) of Rail Engineers (UEEIV)

The Union of European Assocations (Institutes) of Rail Engineers (UEEIV) is an umbrella organisation whose main purpose is to represent member organisations on an European level. Frans Heijnen Hon FIRSE is their current president.

IRSE is signing a cooperation agreement with the UEEIV to help promote events and activities across Europe.

More information about the UEEIV can be found at irse.info/sajfh.

London Office IT Systems

The London office IT system support will be changing shortly to help us deliver the current and future strategies. I would like to take this opportunity to thank Spencer Williamson, our IT manager, for his continued assistance of not only office staff but of our volunteers too.

IRSE Local Sections

Our IRSE local sections report to Council annually and it is always good to hear about how successful their events are. More details about the sections and how you can participate in their committees and events can be found on the website at irse.info/nearyou.

HQ team

Tunnelling and Underground Construction Academy visit

Blane Judd

The IRSE head office team spent a fascinating two hours in December at the Tunnelling and Underground Construction Academy (TUCA) in Ilford, east London UK. The focus was part of the initiative to widen the knowledge of the IRSE in stakeholder bodies.

Purpose built for Crossrail Limited in 2011 to support the Crossrail project as well as the wider underground construction and tunnelling industries, the facility was transferred to Transport for London (TfL) in 2017 and is currently focusing on the training needs for the Elizabeth Line (as the line is now known). We were invited by PROCAT which delivers the apprentice and CPT training at the academy and our host was Julie Lakin project manager for rail apprenticeships and who I knew through the Thames Skills Academy when we worked together to establish that body.

Bruce Lawson, TfL's training operations manager showed us round the whole facility which includes fully operational signalling and communications equipment rooms.

The tunnels constructed for the Crossrail training are perfect for TfL training, and now house a replica Elizabeth Line station named West Ilford with full branding. The facility is the only one of its type in Europe and contains a complete suite of assets for London's newest line including working barriers, cameras, fire and help points, gates, platform doors and a movable mock carriage all linked into a live station control room.

The carriage doors open into the tunnel laid with track which has manual and electric points and the latest Siemens signalling equipment running alongside. The station also provides the ideal training environment for the emergency services and most recently over 150 people from the fire brigade, ambulance service and paramedics carried out an exercise simulating a chemical spill on the tracks.

After the site tour, Julie re-joined us, and we had a very productive discussion exploring how PROCAT and the IRSE could work together to promote membership of the IRSE to students and beyond.

The Tunnelling and Underground Construction Academy.

Some of the IRSE head office team with Bruce Lawson from TfL (in orange) at West Ilford. The visit coincided with national 'Save the Children's Christmas Jumper Day' day where we wore festive woollies to work and raised money for charity.

Track and platform mock-up at the Academy.

Swiss Section

A big rechargeable battery in the Swiss Alps

George Raymond

Most of us charge our mobile phones' batteries at night so we can use them during the day. Given that energy supply and demand vary over time, the railway system – and society as a whole – also need energy storage. As the share of energy coming from renewable sources like sun and wind increases, so does the volatility of supply. Consumption also varies over the day, week and year. While the consumption of Switzerland's electrified trains is largely predictable, other functions such as heating and cooling buildings depend on factors like the weather.

On 24 August 2018, 14 members and five guests of the IRSE Swiss Section rode 88 km southeast of Zurich for a look inside a very big rechargeable battery: the Limmern pumped-storage power plant (LPSP). Our hosts at the LPSP were Willy Schönenberger and Kurt Steiner. IRSE member Marco Lüthi organised the event.

When demand and electricity prices are high, the LPSP sends water from Lake Mutt, high in the Alps, through turbines linked to generators to make electricity. Conversely, when demand and prices are low, it buys electricity and feeds it to these same machines to power the turbines and pump water back from Lake Limmern to Lake Mutt, 630 metres higher up. It is the largest and highest such system in Europe.

80-year business model

LPSP is part of Kraftwerke Linth-Limmern AG (KLL), of which Axpo owns 85% and the Swiss canton of Glarus 15%. The LPSP's business model is simple: over the 80-year life of its concession, the difference between what it pays and spends for power must well exceed the plant's 2.1 billion-Swiss-franc construction cost and its operating costs. The LPSP also plays an important role in both ensuring a reliable electricity supply and keeping electricity grids stable.

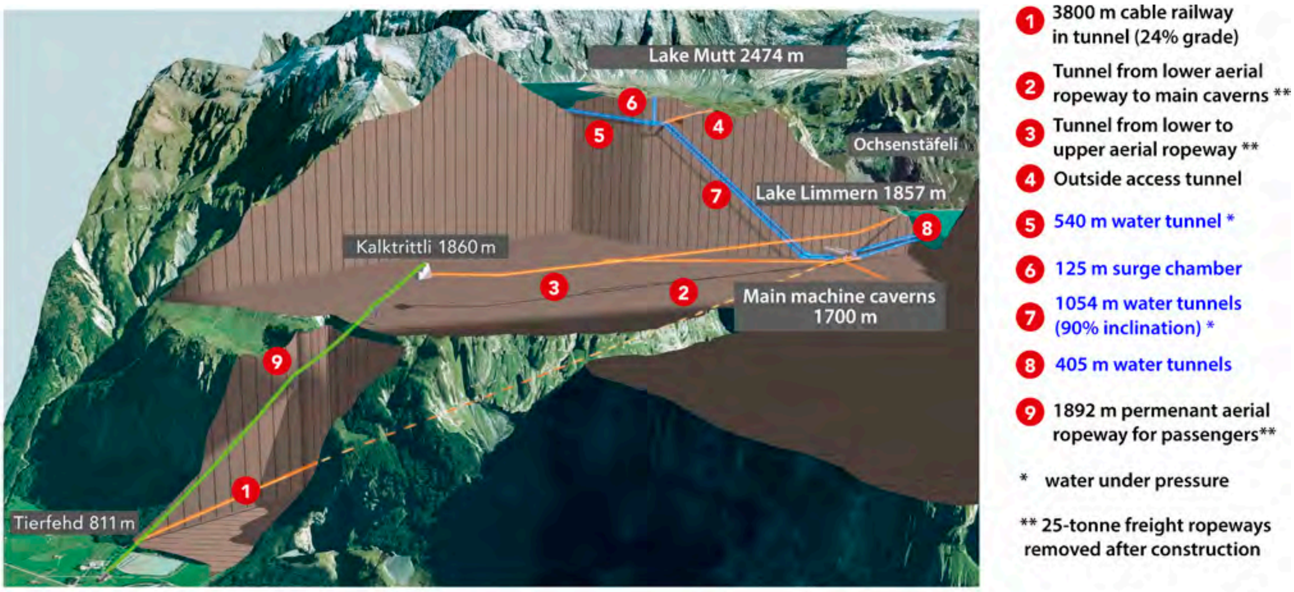
Five bodies of water

The LPSP is part of the KLL power plant and its five bodies of water shown in Table 1.

Today's KLL opened in three phases:

- 1963-1968: A 146 m tall, 370 m wide dam built on Limmern Creek in 1957-1963 created Lake Limmern. From 1968, Lake Limmern and the Hintersand and Tierfehd basins fed water to generators whose approximate total rating was 335 MW then and is 386 MW now.
- 2009: The Tierfehd pumped storage plant started operation. It added a 138 MW turbine that can also act as a 131 MW pump between Lake Limmern and Tierfehd basin.
- 2016-2017: The new LPSP started operation. Its four turbines have a combined rating of 1000 MW – comparable to that of a Swiss nuclear plant – and can also function as pumps. The plant can either pump water from Lake Limmern up into Lake Mutt or release water from Lake Mutt to generate power. Building the LPSP raised the KLL's total rated plant capacity from 524 to 1524 MW.

The underground Limmern pumped-storage power plant (LPSP).
Source: Axpo, adapted by the author.



Body of water	Altitude (metres)	Millions of cubic metres	Pump power (MW)	Generator power (MW)
Lake Mutt	2474	23		
			1000 ↑	1000 ↓
Lake Limmern	1857	92		
			34 ↑ ↑	444 ↓
Hintersand basin	1298	0.11		
			131	46 ↓
Tierfehd basin	812	0.46		
				34 ↓
Linthal basin	676	0.22		
				↓
River Linth				

Table 1 – the five bodies of water comprising the KLL power plant.

A tight schedule in a remote, delicate setting

In 2007, the designers of the LPSP faced numerous challenges, including an ambitious time schedule; construction logistics at roadless, high-altitude sites; concerns for the delicate Alpine environment; and the plant's required high reliability and availability.

The design and placement of the network of caverns and water and service tunnels took account of geological conditions, the building and operation phases and possible emergencies such as cavern flooding or fire from an overheated generator.

The LPSP project enlarged Lake Mutt Dam to a height of 35 m and width of 1054 m and raised its water level 28 m to an altitude of 2474 m so it could hold 2.5 times more water. Construction required two temporary, 25-tonne aerial ropeways to transport cement trucks and other large equipment. These ropeways ran from Tierfehd to Kalktrittli and from Ochsenstäfeli (altitude 1,880 m) to Lake Mutt (see diagram). Equipment such as two 180-tonne cranes and a 700-tonne tunnel boring machine moved in pieces. Up to 500 people worked in various places on the site at once. Winter snowfalls of up to 4 m restricted work on the Lake Mutt Dam to summer.

A 3.8 km tunnel railway at 24% grade

Since 2013, heavy equipment such as turbines, generators and transformers have been reaching the main caverns on a 3.8 km, cable-powered tunnel railway on a 24% grade.

Switzerland is known for its narrow-gauge rail networks, but the gauge of KLL's railway is a broad 1.8 m to keep large turbine parts and transformers from tipping.

The IRSE group's conveyance on the 3.8 km ride to the main caverns. *Photo Sascha Schneider.*

Two motors rated at 870 kW each power the inclined railway's cable. *Photo Peter Hefti.*

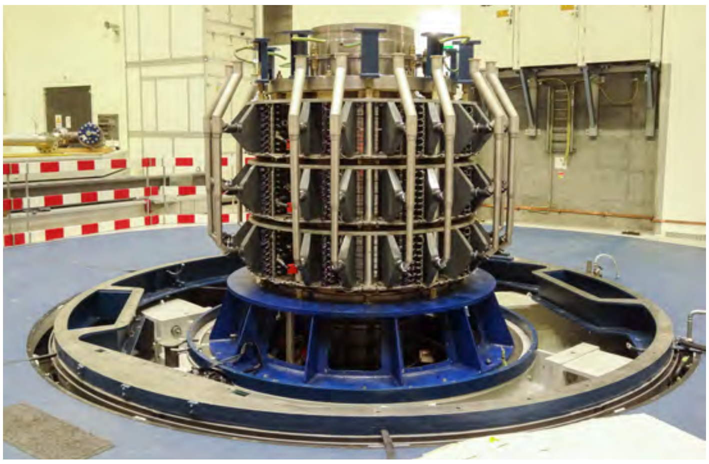
A film showed that the inclined railway brought some large components in pieces. The 40-tonne wagons run at 6 m per second empty, but at only 0.5 m per second when carrying their maximum load of 215 tonnes. *Photo Markus Grämiger.*

In the main cavern: four pump-turbines

A cavern 150 m long, 31 m wide and 54 m high – including multiple floors – houses the LPSP's four pump-turbine sets. Each set is rated at 250 MW and makes about 500 revolutions per minute to handle 47 cubic metres of water per second when generating and 40 when pumping.

Housings and parts of disassembled motor/generators in the main cavern. When operating, the 16-metre-high machines are below the floor.

A pump/turbine is located below us and its motor/generator above us. The vertical shaft connects them. A so-called guide vane directs water into the moving blades of the turbine for minimum loss of energy.



Disassembled top of a motor/generator set showing the slip rings that transmit the rotor's excitation current. This current creates magnetic fields in the rotor to control the speed and torque of the vertical shaft connecting the turbine and the motor/generator for optimal performance. The exterior pipes vacuum carbon particles away from the slip rings. *Photo Markus Grämiger.*

Conduits that carry the rotor's excitation power, which is about one-tenth the power the whole motor/generator handles. Sascha Schneider, who took this photo, later patiently explained to the author a number of important details, including how excitation currents regulate the speed of motor/generators.

An adjacent cavern houses switching stations and four transformers rated at 280 MVA each. Rock excavated from the caverns went into concrete for both interior works and Lake Mutt Dam.

Comments by IRSE participants

Marco Luethi was impressed that the entire plant was planned and built within 10 years. Patrick Sonderegger called the seven-year construction phase very short. Work proceeded in many places at once. True pioneers were at work. Markus Gräminger called the huge facility an important basis for the stabilisation of the Swiss electric power network.

One key to the LPSP's profitably is fast changeovers between pumping and generation ("charging" and "discharging") modes in response to price swings on the electricity market. Patrick noted that the plant can make a changeover in 3 to 6 minutes, and does so up to six times a day.

Above left, one of the 180-tonne valves, built for a pressure of 105 bars, whose movable sphere can restrict flow to 30% in 6 seconds and shut completely 36 seconds later.

Above right, a sphere valve in place and ready for action. Each sphere valve has two motors, an emergency generator and a mechanism that can close the valve even if the motors and power fail.

Oskar Stalder observed that logistics dominated the project (given for example the tunnel profile and the load limit of the aerial ropeways); that impressive know-how lies within the huge machines and complex control system; that huge physical forces (water volumes and speeds) are mastered; and that the dimensions and output of the whole plant are impressive.

"And I had always thought that railway signalling systems were complex", said Daniel Pixley.

Sources: KLL, Axpo, Wikipedia and "The Linth-Limmern hydro-power plant – Design and construction of a large pumped storage scheme", Müller et al, World Tunnel Congress, Geneva, 2013.

Photos by the author except as noted.

York Section

Signal maintenance in the 21st Century

Paul Darlington

On 6 December 2018 in York, Ian Puckrin presented "Signal Maintenance in the 21st Century". He began by explaining that digital and analogue event logging presents a real opportunity for maintenance engineers to change how they maintain their assets, and fundamentally improve the reliability of the railway.

Ian emphasised that case studies presented during the evening would be from 'front line' maintenance signalling engineers, who knew how the systems being monitored worked and what they needed from the logging systems, in order to maintain and manage the signalling assets to deliver a reliable railway. The evening would focus on problem solving and how to put the intelligence in to 'intelligent infrastructure'.

It was rather ironic that on the night there was a major O2 mobile network operator outage, affecting large parts of the UK. This compromised some of the planned demonstrations, but it did illustrate how important the communication infrastructure is to the 'connected railway' and why it is important that communications reliability and diversity of service is taken into account when designing a data logging, or indeed any, system.

Data logging systems are known by a number of names; which includes remote condition monitoring (RCM) and intelligent infrastructure. While systems have become more complicated and numerous, they have been in existence for a very long time, with one of the earliest examples being hot axle box detector (HABD) systems. HABDs measure the temperature of train axle bearing boxes when the train passes over them. The systems typically use infrared to measure temperature then send the measured values to the signalling centre, depot, fleet management team or even the train. HABDs were introduced when large power boxes were constructed, meaning that trains could no longer be visually checked by signalman located regularly along a route.

Things have moved on a lot during the last 40 years and systems have now been established to include the monitoring and logging of the following signalling assets.

Track points/switch condition monitoring: To predict and prevent faults with points motors, locking mechanism and detection relays.

Interlocking relay monitoring, replay and fault detection: These systems securely store and inspect the state of interlocking relays through graphical track maps. They are able to provide alerts to detect faults, and to assist with the investigation of signaller and driver errors.

Track circuit condition monitoring: To predict and prevent faults with track circuits, insulated block joints and relay supply voltage. It also allows intelligence to manage autumn leaf fall, although manual assessment is still currently required.

TDM and SSI Monitoring for replay and fault detection: These systems safely extract, store and inspect the state of TDM and SSI links through graphical track and indication maps. They can also provide set-up alerts to detect faults and errors.

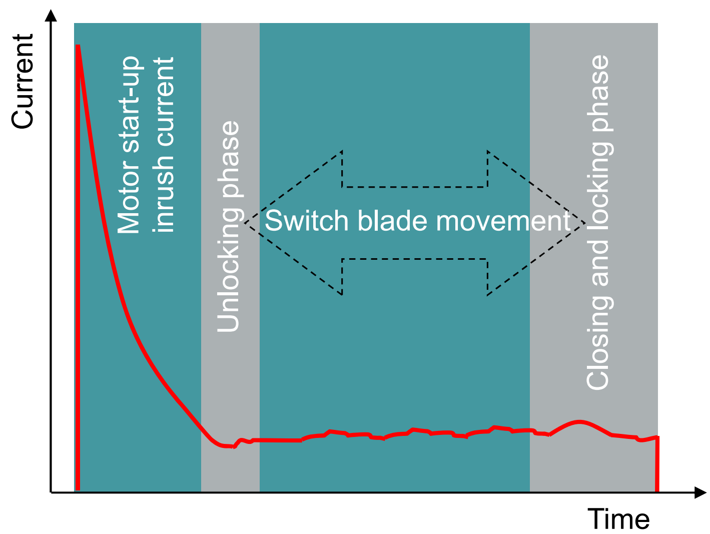
New Measurement Train

While not especially logging signalling assets, the New Measurement Train (NMT), affectionately known as the Flying Banana due to its distinctive yellow livery, is a unique high-tech machine that Network Rail has been using for almost 15 years to log asset condition. It is always equipped with the newest equipment (hence the name NMT) which includes; high-tech measurement systems, track scanners, and high-resolution cameras.

The NMT covers 115,000 miles in a year and will capture around 10 TB of data every 440 miles. It is believed to be the most technically advanced train of its type in the world, thanks to its range of sensory technology, with both mechanical devices and optical instruments on board. A laser sensor gives information about the profile of the rail head, measuring shape and movement optically. At the same time transducers and accelerometers mechanically measure the up and down movement of the train. This data provides information on the shape and profile of the rail head, and the twist of the track. The on-train technicians monitor the equipment and can close railway lines and order an immediate intervention if required.

Plain line pattern recognition (PLPR) on NMT and other inspection trains brings track inspection into the 21st century and has replaced track patrolling on many routes, reducing the amount of hazardous track work. Helicopters have also been

Points condition monitoring, a typical waveform showing phases of operation.



Network Rail's New Measurement Train, also known as the "Flying banana". *Photo Network Rail.*

used by Network Rail for remote asset condition inspection for many years, but are increasingly being replaced by drones, as a more cost effective and available solution. Similar systems on service trains monitor overhead line traction conductors.

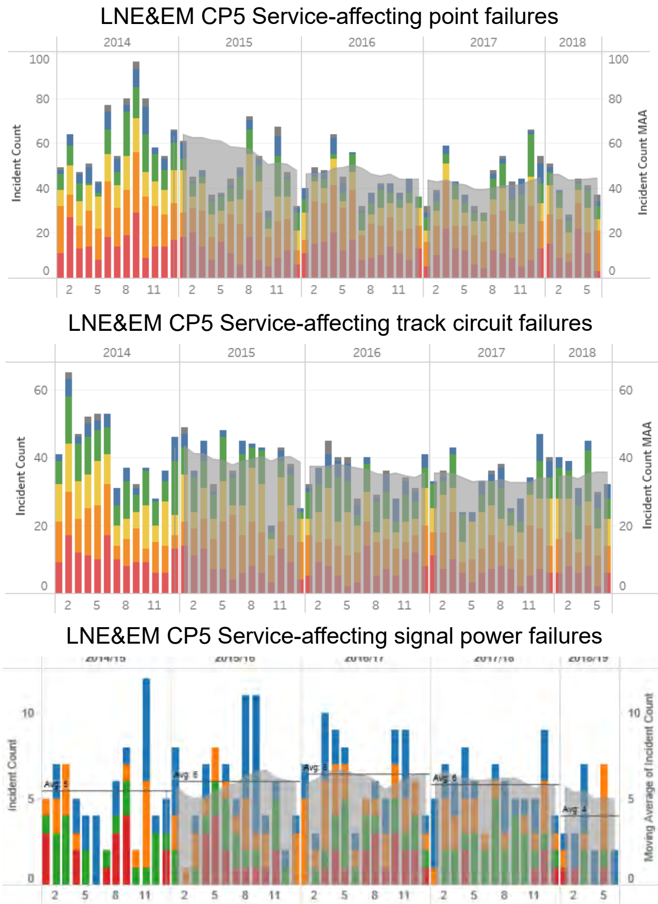
Failure reduction

Logging systems have played their part in the major improvements with asset performance over the last few years. A graph was presented which demonstrated an overall 23% reduction in service affecting signalling failures over the last five-year control period in the York area. Unfortunately, this hasn't resulted in a more reliable train service, due to the increase in the number of trains using the network. The curve in the improvements on the number of asset failures reducing is starting to bottom out. Therefore, because logging systems have in general already identified the worst performing assets, further improvements are more difficult to obtain. So new ways are required to identify potential failures allowing interventions to take place before the assets fail. This means that 'intelligent' infrastructure systems need to be more intelligent and to automatically flag up problems before assets fail.

Richard Storer presented an example of the benefit of monitoring asset data from what happened on a day known locally as "the day of horrors" when a lightning strike hit the centre of York. This took out signalling control in both the York and Leeds areas and it took several hours to restore service. Once service was restored and trains were running normally it was noticed that a remote 650 V feeder cable was showing low insulation, which occurred at the time of the lightning strike. This could have resulted in another major failure, but having the data available allowed a faulty jumper cable in a location case to be replaced when the train service was quiet. And because the work could be pre planned with the required resources in place, it only took 5 or 10 minutes to complete. Had it been an unplanned failure it could have taken far longer to repair and may have occurred in a busy train period.

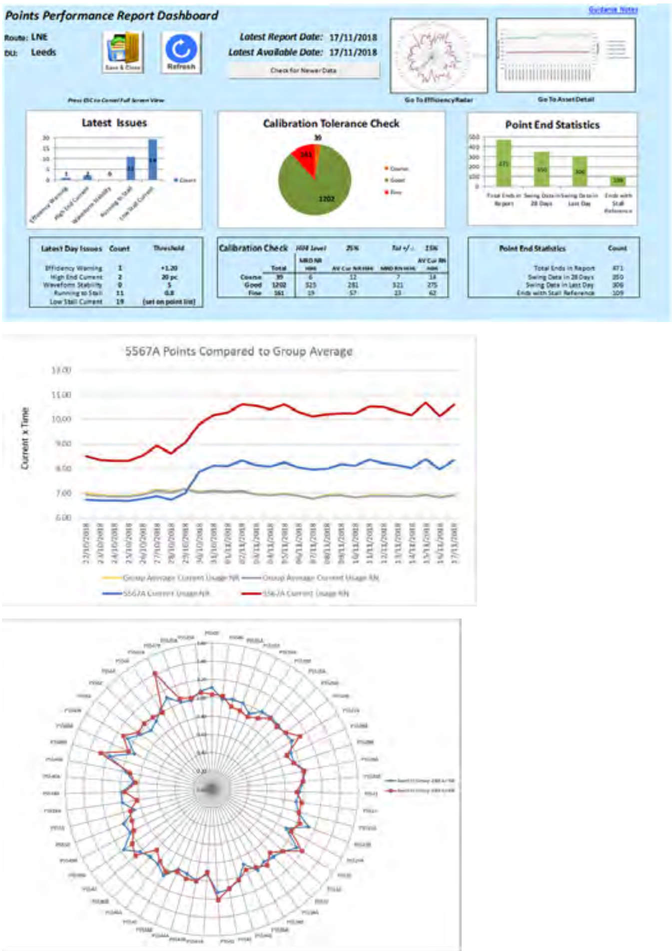
People, process and equipment

Ian explained that there are three major sides to a 'triangle of issues to address' when introducing anything new. These are; people, process and equipment (both hardware or software). Engineers sometimes focus on the equipment side of things too much, for example always wanting the latest 'widget' or version of software and overlook the people and process issues.



Service-affecting failures are decreasing since the introduction of more intelligent infrastructure monitoring.

Faulty 650 V jumper identified by data logger before service-affecting failure could occur.



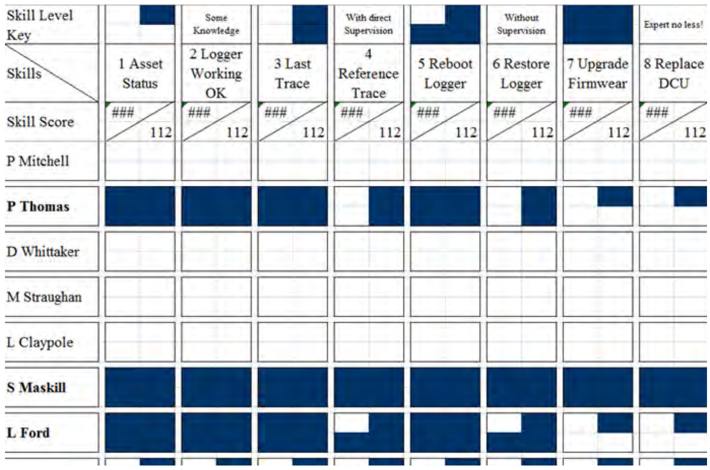
A wide range of statistical representations are used to show trends in performance and accuracy.

The first issue to address is the people side of the triangle, and to ask the following questions. Can the people use the technology that is being provided? Will they use it? What are their capabilities? Do their capabilities require improving? Do we know who our critical users are, and what's their capability level?

Ian demonstrated a capability diagram to identify the responses to the questions, allowing a plan to be formulated to address the gaps in capabilities. This also allows an organisation to identify who the experts are who can mentor those less capable. This approach has been used successfully when providing the data logging systems in the area.

The traditional maintenance specification process is typically many pages long and tells technicians what to do when trains are stopped and full access to equipment is available. With a data logging maintenance process, a different approach is required. A ten-step structured process approach to identifying potential points failures was discussed. This makes the most of the data available from the logging systems and is believed to be capable of identifying 90% of all point failures in a proactive way, before they result in train-affecting failure.

In some respects, logging systems have been too successful and provide too much information for engineers to manage. Control rooms can sometimes be a 'sea of red' especially in leaf fall season with too many alarms being presented to engineers. What is required are more systems to compare infrastructure operating normally, and to highlight when parameters start to change, and well before failures occur. Systems are starting to be introduced to do this; but throughout the evening this was a reoccurring requirement from engineers involved in maintenance.



Capability diagram to identify capability gaps and experts.

Level Crossing monitoring

Andy Whawell from MPEC technology said that one opportunity in the industry with the introduction of data logging is amending maintenance regimes and specifications to suit the asset information available from logging systems, a prime example being level crossing maintenance. In order to carry out level crossing checks manually involves road and railway closure, typically requiring £4k per crossing per year on 3,500 crossings, so the annual national cost in the region of £14m. "That is just for an annual test, but if it is such an important test why is it only performed annually?" asked Andy. Getting the level crossing to automatically monitor and report its condition could therefore be both cheaper and safer.

Andy believes it is possible to carry out up to 80% of the level crossing maintenance inspection tests with the passage of each train. This would include the verification of the correct order of operation (the 'sequence') together with trends of critical timings and alerts if approaching, or exceeding, the specification.

Periodic reports would provide confidence to stakeholders and demonstrate regulatory requirement compliance and developing problems could be 'nipped in the bud', with the logging of strike in to arrival timings, road closure times, together with "Another-train-coming" events etc.

Road light performance could be derived from simple low-cost CCTV images and many conventional sensors can be replaced with a cheap camera system. The wider benefits of the system could include misuse tracking and usage survey. With a higher resolution camera, some visual inspection tasks are possible for even better signalling maintenance specification compliance. This is not a 'pie-in-the-sky' idea, as the concept is backed up by research, and operational systems already perform similar tasks in other industries.

Questions and answers

Ian structured the evening for maximum audience involvement with a good range of questions and debate. This included the need to procure systems that are not tied to one supplier and allow data to be shared, but at the same time to build the intelligence into the data logging and to accurately predict when failures are going to occur. Processes are required to gain the confidence of operators, so that if a short-term equipment outage is required when train frequency is low it will be granted. Rather than waiting for an asset to fail at a critical time when the train service is at its busiest, Signalling engineers also need to look and learn from other engineering disciplines, such as electrical distribution and telecoms as to what they are deploying to log and manage asset data.

Younger Members Section

IRSE
Institution of Railway Signal Engineers
YOUNGER MEMBERS SECTION

Annual seminar and technical visit: Communications

Keith Upton, Chairperson

The Younger Members (YM) annual seminar is the key event in the Section's calendar and on 1 November 2018 we went to the National College for High Speed Rail in Birmingham. The theme of our seminar this year was communications. Communications are playing a larger role in railway signalling and in the 'connected railway' as they aspire to transport passengers and freight as safely and efficiently as possible.

We had a fantastic turnout to the event, selling all 50 places in only a few weeks! Our guests were joined by some great presenters and we want to thank them for helping to make the event a success: Markus Montigel, IRSE president; Paul Darlington, IRSE News; Arabella Bowers and Daniel Liew, Siemens; Ant Lane and Phil Mounter, Westermo; Peter Harbottle, Atkins and Tim Lane, Network Rail.

We endeavour to put on our YM events free of charge and so this event would not be possible without the generous support of our sponsors: Siemens and Westermo.

The venue, the National College of High Speed Rail, was excellent (with a good selection of refreshments) and we would like to thank the college for hosting our seminar.

Day one: Seminar

Keynote speech

The day started with a keynote speech from the IRSE president describing the important role of communication. Markus looked at how people communicate and the different mental models that we naturally form on our perception of reality. This perceived reality doesn't always match the actual reality. So how do we ensure that these mental models match as closely as possible. Markus then took us through his IRSE presidential address (on "Winds of Change") with a focus on younger members. He inspired us to drive forward this change, to persevere, to talk to others about the change and to not give up. Ultimately, we need to hang in there because our ideas are brilliant.

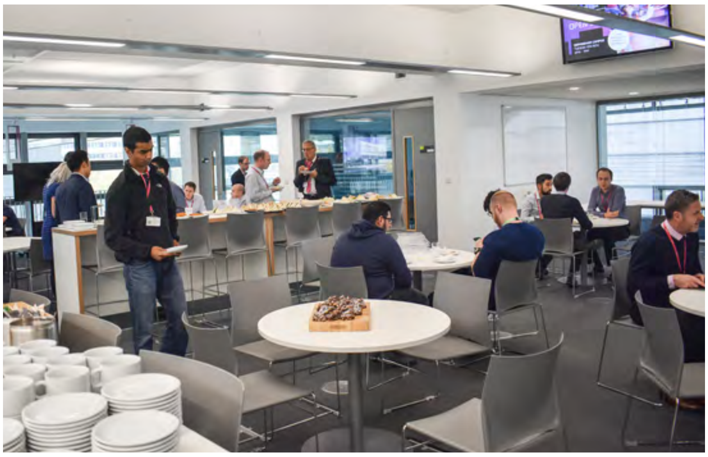
Future of train radio communication

Our next speaker, Paul Darlington, followed the theme of change and innovation as he discussed his thoughts on the future of train radio communication. Paul took us through the basics of GSM-R and then discussed how more is required from the next generation of train radio systems. He explained that GSM-R is now an old technology, in terms of telecoms engineering, and things are changing quickly in the mobile communications industry. He then took us through the different developments in mobile communications from 1G to 5G. GSM-R is 2G technology and while it has been a huge success, it has its limitations, especially for delivering faster data rates to trains. Paul mentioned that the security of 2G is based on 20-year-old technology, whereas 4G is state of the art.

But where do we go from here? Do we jump straight to 5G (planning for the future) or utilise 4G (which can deliver all the railway requires). The three most important things in a radio system are: spectrum, spectrum and spectrum! We need more spectrum for railway applications, but how can we compete when bidding against mobile telecommunication giants? Does the railway use the spectrum it has efficiently enough? Could railway operators be required to share spectrum in the future?

Paul then posed the question whether wi-fi could be the future? It has impressive data speeds but being license

Attendees at the seminar.



Our venue, the National College of High Speed Rail, had excellent, and unique, facilities.

free could cause a problem. Furthermore, if we decide on 4G, 5G or even wi-fi then how do we migrate across from the current GSM-R? There could be interference and many other challenges requiring innovation and creativity from the next generation of engineers.

This was an interesting talk with lots of questions for the YMs to think about. There was also a lively Q&A on the future and how the railway needs to take a more systems approach with cross-functional thinking.

Atkins Signalling Method: telecommunications

After more networking (and greatly appreciated tea, coffee and cake break) the YMs welcomed Peter Harbottle to talk about the Atkins Signalling Method. Peter opened by talking about ElectroLogIXS, a new interlocking that Atkins are going through product approval to introduce to the UK market. This is an Alstom (formerly GE) product that has been used in other countries. The key is the software within it, whereas the hardware is generally generic. The software uses ladder logic, which can be understood by those from outside the rail industry. Peter then talked about the telecommunications network, which is an IP network and utilises FTN or FTNx to bridge the gap between trackside and interlocking.

Each signalling location suite will have a dedicated telecoms case that will include the standard telecoms connections but also a fibre connection. All of the connections are made off site, reducing on site work.

Peter then talked about the Atkins Signalling Method (ASM), which is the way in which ElectroLogIXS is utilised in the UK and the ASM must be followed for all ElectroLogIXS projects. The ASM brings together templated designs and procedures including standardised designs. This means that most of the design is agreed by Network Rail as part of the ASM and only those sections highlighted on each design sheet will need a specific project design approval. The main deliverable for telecoms is the Network System Spreadsheet, which details the entire network. This spreadsheet can also auto generate the switch configurations.

Peter ended by looking to the future, noting the multiple future developments possible including replacing SPTs with Voice Over IP (VoIP) phones.

Another interesting presentation looking to the future of telecommunications and signalling, it was noted that the disciplines of telecommunications and signalling are merging.

ETCS

Next, we had our first sponsor presentation from Siemens. Two graduates who had only been in the company for a few months presented on ETCS. This was an excellent chance for these new graduates to gain some presentation practice and to build their technical knowledge.

YM seminars are a great opportunity for YMs to develop soft skills as well as building their technical knowledge, which is something that we encourage.

The graduates did an excellent presentation going through what the signalling system in the UK is now, through to ETCS and its different levels and then to the future of ETCS.

The Q&A was again lively, Markus asked the graduates whether ETCS was worth it, looking at the system with fresh eyes. The graduates all agreed that level 3 is worth it, but there is still work to be done, which will likely incur a high initial cost.

Data communications

After lunch, we listened to our second sponsor's presentation from Westermo. Westermo know that rail engineers need to be focused on building the railway and so they make it easy for the engineers. They make network products and data communication devices. The equipment can survive in location cases with temperature ranges of -40'C to 70'C and products are available that can support legacy protocols and equipment.

The presenters also talked through their complimentary software, Weconfig, that is shipped with all their network switches. This software gives a visual representation of what's happening on the network, there's the ability to see the topology and to complete diagnostics.

This was an interesting presentation and will help YM when specifying telecoms network requirements

Telecoms innovations for tomorrow's railways

Our last presentation of the day was by Tim Lane from Network Rail Telecom and was equally as interesting as the rest of the presentations. Tim began by asking the question: what does the future of the railway look like? To know the future then we need to understand the requirements. The Telecoms Innovations team are looking at four different areas: connected devices, connected operations, connected passengers and connected intervention.

However, the team know that innovations need to be fully tested off site before they are introduced onto the rail network, as past incidents have shown. Tim compared the testing phase to the development of a child from research and development (baby) through to alpha testing (toddler) and onto beta testing (primary school). The test track (or Rail Innovation & Development Centre, RIDC) at Melton is the main testing area and is the place to safely land technology. This centre has an open access test infrastructure and a chance to improve multiple suppliers' technology in a rail environment.

Tim Lane of Network Rail Telecom presenting to his attentive audience.

The Siemens presenters were joined by some of their colleagues for the questions after their paper.

Tim then went through some of the innovations that are currently being tested on the track. This includes fibre optic acoustic sensing, which can see items on the track from 1 to 10 m, so far 60 and counting uses have been found. This generates a significant amount of data, and the activity of interest will be a tiny part of that data. Therefore, the interesting, and difficult, factor is to create reliable actionable intelligence – the best way is to use machine learning and combining it with sensors and data from other companies and people. However, the maturity of this data processing is still quite low.

Another innovation that the team are testing on the test track is project VECTOR (Value Engineered Communications Technology On Rail). This project is looking at cost effective IP communications and creating power over Ethernet. Could the railway use the standard internet backbone, linked with modems and wi-fi access points to replace lineside fixed telephones where required or to support COMPASS (Combined Positioning Alternative Signalling System) and utilise the existing telecoms copper cables?

Tim then left the question over to the YMs of what next? What else can be detected? What data can be utilised to improve the railway?

Conclusion

The range of presentations provided food for thought and hopefully inspired the YMs to continue to push the railway to be more innovative.

At the end of the day we went on a tour of the college. The college has only recently opened and so the facilities and equipment available for the students is outstanding; most of which has been donated by companies. There is even a Eurostar locomotive with a virtual reality driving unit, which was a highlight of the tour for many.

The Younger Members would like to thank the presenters, Siemens, Westermo and everyone who attended.

We are already looking forward to our next event!

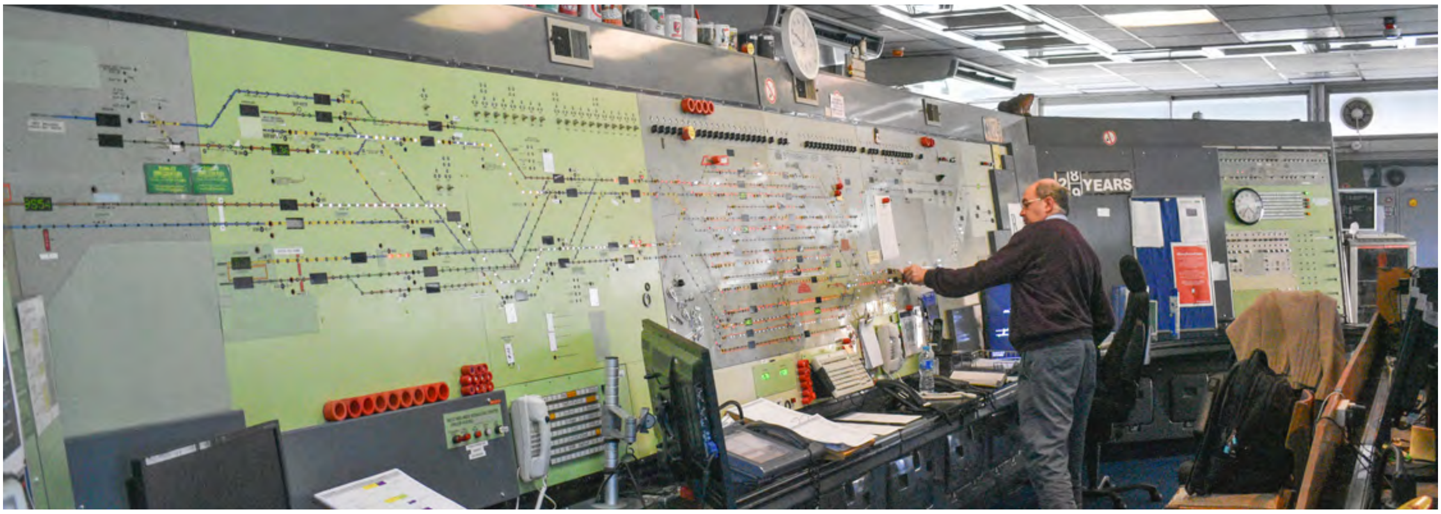
Day two: Technical visit

The Younger Members technical visit always follows the annual seminar. This year 25 young members visited the Birmingham New Street control centre and the Birmingham New Street Power Signal Box (PSB). We had some excellent tours and are extremely grateful to our Network Rail hosts at both sites.

The remodelling of Birmingham New Street station (opened in 2015) brings more light into the station and opens what was always a dreary dark and small station into a place where you don't mind transferring trains. Our host gave us a tour of the new station and talked us through the important aspects.

The attendees gather at New Street station for the technical visit.

The brutalist architecture of New Street signal box.



The NX panel at New Street PSB, due to be replaced in 2021.
All photos Michael Bastow, Keith Upton.

There are three unique aspects of the station:

1) The station is mainly an interchange station and so customer flow is very important; the station team have worked hard to create signage to help with this flow.
2) Network Rail dispatches trains from all the different Train Operating Companies (TOCs) that use the station, which means that Network Rail has 180 staff on the platforms.
3) The station is a sub-surface station.

Our host then showed us the entrance to the service spine, which runs through the whole station. However, access is strictly controlled, and only competent persons are allowed within the spine. Then he took us to the control room, which is within the depths of the building hidden from day-to-day travellers. This control room operationally looks after the station, there are six desks and a bank of screens on the wall. The front desks look after the here and now, whereas the back desks look at future requirements. The control room closely co-ordinates with the PSB and with the TOCs; during the leaf-fall season a representative from a TOC works in the control room to ensure the best co-ordination possible during this tricky period of the timetable.

The control room also looks after the CCTV, of which there are just under 1000 within the station. The CCTV can be switched when required, for example there is a fire, or crowd control. The control room team is also looking to the future and hoping to install technology that is used at Clapham Junction. This takes the concept of 'big data' and uses mobile phones to determine crowd control (i.e. the more mobile phones in an area generally the bigger the crowd).

This was an excellent visit; the Network Rail staff were very helpful and answered all the questions of the Younger Members.

We next visited the PSB, the building was built in 1966 and is Grade 2 listed (meaning it is protected as it has national importance, showing interesting architectural designs of the 60s). We met the signalling technician who showed us the panel and the interlocking. The panel was installed in 1966 and is an NX (eNtrance-eXit) panel, there used to be three (North, Centre and South) that covered 37 miles (55 km) and was controlled by five signallers. However, now there is only one panel controlled by one signaller as the others have been re-controlled to the West Midlands Signalling Centre. The existing panel only covers about 2 miles but controls the station area, so the signaller is extremely busy. The plan is to re-signal the area in 2021, however, there are certain complications for example there are no overlaps or AWS within the station area.

The control room.

Next, we visited the interlocking room and the technician explained some of the aspects of the interlocking. Specifically, the Westpac Geographical Mk 1, one of the few places in the country left with this technology. This interlocking is made of packs that match what is on the ground, each unit is colour coded and are easy to fault find as the units are laid out in a logical manor. However, the whole unit will have to be changed if part of it is faulty and it is increasingly difficult getting parts for this old technology.

The younger members appreciated seeing the panel and the interlocking. All the staff in the PSB were happy to answer the questions from the younger members and were very knowledgeable.

These two visits were an excellent chance for the YMs to see a working station and signal box and all found the visit interesting. The YMs would like to thank the staff at both the PSB and the control centre for the excellent tours.

For more information about the Younger Members' Section and its activities, visit our pages at **irse.info/youngermembers**.

Past lives: Paul Cheshire MBE

Paul Cheshire was a native of Stoke on Trent. His father, who was also a railwayman, had died on the track just north of Stoke when Paul was only 13, so he had to leave school at the earliest opportunity to help with the family income. He initially trained as a signal lineman (technician today) and having focused his growing expertise on telecommunications, transferred to Derby and quickly rose up the ranks.

To improve the connectivity on the Midland Line Paul managed to acquire second-hand transmission equipment that would operate over the long-distance overhead pole route wires. It was an uphill battle and the Derby telecom team, then around five in number, would be out most weekends to try and maximise performance with deteriorating line conditions. Although not the head of the group, Paul was the driving force to get things done.

To improve telecoms on the route a single tube coaxial cable mounted on the pole route was authorised. Paul was instrumental in getting this installed and tested. It transformed the communication capacity yielding 120 high quality analogue circuits but again, the cable was vulnerable to external mishaps and Paul effectively set himself up as a personal fault control, directing engineers and technicians along the route to locate and repair any damage.

When the telephone exchange was constructed at Stoke station there was a section of missing 'ladder racking' which was used in Strowger exchanges to support the twisted pair cables. It is believed that Paul quickly obtained a replacement, in the form of a signal ladder that can still be seen there today.

Eventually, the Derby Division relocated to Nottingham and acquired areas of the West Coast Main Line. This was at the height of the WCML electrification from Euston to Manchester and Liverpool. New telecom systems were being introduced as well as the need to understand the effect of 25 kV overhead lines interfering with copper cables. Paul rapidly got to grips with the challenges and made sure that staff of all grades were trained and equipped with the right test equipment for the new technologies.

He could cut through bureaucracy to get things done and managed to secure funding for projects that others would have found too difficult. He was a stickler for tidiness and had all the equipment cupboards sign-written as to their purpose. Woe betide anyone who put equipment in the wrong cupboard! Clive Kessell says he always found Paul to be good company and he certainly helped him in the earlier stages of his career.

Paul became the divisional telecoms engineer Birmingham, and he drove the organisation forward. He was always a strong leader in making sure the division strived to be the first with all it delivered. In 1984 he was appointed London Midland regional telecoms engineer in London before that role was transferred to Birmingham.

Paul Cheshire MBE, 1931 – 2018.
Photo taken at a visit to GEC in 1987, from left to right, Paul, Hedley Calderbank, a representative from GEC and Clive Kessell.

Allen Kerr remembers: "Paul was a great man manager and leader and terrific to work for. You always knew where you were headed. He had faith in his own ability and always focused on the end goal. He used to say 'Who knows better than us?' and 'They can only sack us.'"

What he would tell the general manager to obtain finance for new works schemes is another story. His main aim was to improve the telecoms network and look after 'his men'. My main recollection of Paul was his great leadership, his concern for his staff and telecoms in general.

In 1992 he was appointed telecoms engineer Regional Railways, Birmingham and in 1993 S&T engineer Regional Railways. He was also awarded his MBE, of which he was very proud, for services to the railway. Paul retired at privatisation in 1994 but continued to work until 1996 as project director training to implement the training recommendations of the Hidden report.

Roger Rowland recalls that outside of work Paul was always busy and a keen handyman and gardener, and he loved working on his three sons' houses as well as his own. He was in his element when any of them moved house, and he was there instantly renewing kitchens, rewiring, brick laying, plumbing and gardening. He was never happier than when working on his brother-in-law's cottage in Normandy, which he frequently visited with his wife Brenda. He was also a keen stamp collector and compiled several large collections.

He was a perfectionist and everything at home and in his garden had to be sparkling and neat. Well into his 70s he was seen on the roof of his house adjusting the ridge tiles. His real passion was working with wood and he was a volunteer woodwork teacher at the occupational therapy clinic attached to Solihull hospital for over ten years. A grandfather clock he constructed for his home is still going strong.

One of his last IRSE events was to attend the centenary celebrations in Birmingham in 2012. Although sadly by this time his health was starting to deteriorate.

Clive Kessell, Allen Kerr, Roger Rowland.

Industry news

Agreement to facilitate professional mobility with Engineers Ireland

UK/Ireland: The Engineering Council has announced an agreement with Engineers Ireland that will facilitate the mobility of engineering professionals between the UK and Ireland. This enables ongoing recognition of professional competence for UK engineers working in Ireland and Irish engineers working in the UK.

Engineers Ireland is the registration body for engineers on the island of Ireland and this Admissions Pathways Agreement (APA) creates streamlined processes for professional registration, in a straightforward way.

The APA aims to minimise duplication of assessment processes for all professional titles awarded by both authorities, supporting professional mobility and maintaining public confidence in the quality of professional competence in both jurisdictions. To support this, registrants of both the Engineering Council and Engineers Ireland are required to demonstrate they are maintaining and developing their professional competence through a process of Continuing Professional Development (CPD).

The Engineering Council is the regulatory body for the UK engineering profession, such as the IRSE, and holds the national Register of Engineering Technicians (EngTech), Incorporated Engineers (IEng), Chartered Engineers (CEng) and Information and Communication Technology Technicians (ICTTech). It also sets and maintains the internationally recognised standards of competence and ethics that govern the award and retention of these titles. By this means it is able to ensure that employers, government and wider society, both at home and overseas, can have confidence in the skills and commitment of registrants. For more information visit: www.engc.org.uk.

Engineers Ireland is the registration body for engineers on the island of Ireland and has regional branches in Northern Ireland, GB and in Australia/New Zealand. Engineers Ireland is the sole authority to award the professional titles of Chartered Engineer, Associate Engineer and Engineering Technician in the Republic of Ireland, and is the Competent Authority for engineers under the EU Directive on Professional Qualifications.

ICE 4 trains equipped with ETCS

Germany: Deutsche Bahn has ordered a total of 137 ICE (Intercity-Express) 4 trains, all equipped with ETCS, to operate in Germany and across national borders, and Germany's Federal Railway Authority (EBA) approved the ICE 4 for passenger service on the Berlin-Munich route, with ETCS, from 9 December 2018.

The ICE 4 trains are equipped with an ETCS Level 2 Baseline 3 system for cross-border operation. Approval for the German rail network also includes the route to Basel-Bad, Switzerland and the trains may use the border crossing at Basel for entering Switzerland. Type approval for the trains, including the ETCS system, has already been successfully completed for the Swiss rail network.

Of the 137 ordered trains, 100 13-car trains are intended for use in Germany, Austria and Switzerland. The remaining 37 seven-car trains will operate only in Germany and Austria.

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Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at editor@irsenews.co.uk.

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at 1830

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The Annual Dinner will raise money for the IRSE's chosen charity for 2019-20, RedR UK. The charity works to ensure that disaster-prone communities are resilient by giving them practical life-saving skills, advice and support, which help them prepare for, respond to and recover from natural and man-made disasters. Since 2010 RedR UK has trained 53,711 people and provided operational expertise to nearly all of the leading humanitarian organisations, including Unicef, UK Aid, Save the Children, The British Red Cross, World Vision, Oxfam, Medicins Sans Frontieres and International Rescue Committee.

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Institution of Railway Signal Engineers

March 2019

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a wake-up call

Optimising ETCS
New Zealand's approach

The IoRT

The Internet of things (IoT) is "the network of devices that contain electronics, software, actuators, and connectivity which allows these things to connect, interact and exchange data". Travelling to an IRSE seminar on Cyber Security the term "Internet of Railway Things" (IoRT) came to my mind in the context of connected systems contributing to control a railway. Another participant independently brought up the same term in a discussion.

If one looks up "Internet of Railway Things" on the internet, there are many interesting references containing the term. So, it seems that a new term is about to be born.

"Why do we need this", you may ask? Well, if you have followed the news about railways at the beginning of 2019, not all of them were good. Six killed in a train accident in Denmark, when cargo from a freight train hit a passenger train, and in Austria 300 passengers were stranded for four hours when a train hit a tree which had fallen due to heavy snow.

"Signalling systems are not designed to prevent such things", you may be saying, "therefore they are not our responsibility". I believe that the new world of connected sensors and actuators, which interact and exchange data – IoRT – can and must control a lot more than we do today. We should formulate modest safety requirements for these 'things'. Devices must appear in masses and must be low cost in order to fulfil their role. If we start to ask SIL-4 or even SIL-2 of them, they become so expensive that no one can afford to apply them in railways. But even if these systems have relatively high failure rates, such as 1%, wouldn't it be better to prevent 99% of events like the ones cited above than none at all? I am convinced that we should focus more on the full part of the "safety glass" than on its empty part. What do you think?

Markus Montigel
President, IRSE

Cover story

The recently resignalled Liverpool Lime Street station in England has delivered a capacity increase of three extra services per hour.

'Lime Street Control' is a signalling control method in operation at a number of terminal stations and, as the name suggests, was first provided at Liverpool, as part of the resignalling of the station in 1948. It uses the configuration of the train detection system to check that a partially occupied platform has sufficient length free before allowing the protecting signal to clear for an approaching train.

During detailed design of the 2018 scheme, an assessment of signaller workload confirmed that Automatic Route Setting (ARS) was not required, therefore 'Lime Street Control' could not be provided as part of the ARS and it has been provided within the interlocking.

Photo Paul Darlington.

In this issue

From the IRSE and its Sections

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Challenges in designing secure and resilient railway command and control systems

Stefan Katzenbeisser
Technische Universität Darmstadt

This, the fifth paper in the 2018/9 Presidential Programme, was presented in Darmstadt, Germany on 7 February.

Traditionally, the development of new railway command and control systems has focused on safety aspects. There are well-proven methods that prevent accidents caused by system faults or human errors.

Technical realisations typically follow the principle of redundancy, which assures that a second system is available if the first one fails, and the safety principle, which states that a system always fails in a way that does not cause harm. The assessment of a system with respect to its safety features is typically done by probabilistic analysis: average failure rates of systems can be determined by long-term inspection of components for failures, while failure rates of human operators are known from psychology. This allows computation of a residual error probability for a complex system. If the error probability is too high, it can be reduced by technical measures, such as the further addition of redundancy. Crucial to this process are various independence assumptions (individual system components fail independently) and the knowledge of failure probabilities for various components.

Despite being engineered for safety, recent reports have shown that railway command and control systems can be susceptible to cyberattacks (for example **irse.info/qts8m** and **irse.info/gquv5**). In the domain of security, we face active attackers, which try to subvert systems and cause harm. In particular, an active attacker will not trigger random faults, but will always try to attack the "weakest" component to achieve his goal. Thereby, the above-mentioned independence assumptions are unlikely to hold in the domain of cybersecurity: if an attacker managed to penetrate one part of a system, he will likely also be able to break a second. Furthermore, it is notoriously difficult to assess probabilities for attacks, as the attacker landscape changes over time. A system that can be considered secure now may be completely insecure in the near future, if new attack technologies emerge or new vulnerabilities are found. The latter is in stark contrast to safety features, which remain valid over the entire lifetime of a system due to unchangeable laws of physics. Thus, the security of a system has to be re-evaluated periodically.

Current trends in signalling work against security. For example, the increased use of open (rather than closed and proprietary) networks in the design of railway command and control systems creates new interdependencies between networks, which may (at least in theory) serve as entry points for attackers. Thus, special care must be taken to separate networks of different criticality levels (and, since network segmentation is often done logically rather than physically, one crucially relies on the security of network components such as routers to guarantee separation). Furthermore, there is a trend to decrease costs by relying on commercial off-the-shelf (COTS) components, both in hardware and software. COTS components are readily available to the entire world and are routinely analysed with respect to their security; reports on vulnerabilities spread

Current trends, for example the use of open networks, can work against security. *Photo Shutterstock/Coredesign.*

quickly. When COTS devices are used in critical infrastructure such as railway command and control systems, one "imports" all their vulnerabilities.

It is a fallacy to assume that closed and proprietary systems are secure, as an attacker does not "understand" them. There are various examples of systems that have been broken, despite implementation details being initially unknown to attackers. Sophisticated reverse-engineering tools exist, which allow users to understand and disassemble executable code. Advanced tools are able to break obfuscation schemes, which aim at making software 'unreadable' for attackers. Therefore, during a security analysis of a system, one should assume that an attacker knows the architecture and the implementation details of a system, and security should mainly rest on the inaccessibility of cryptographic keys or other secrets; this assumption is known in the field of

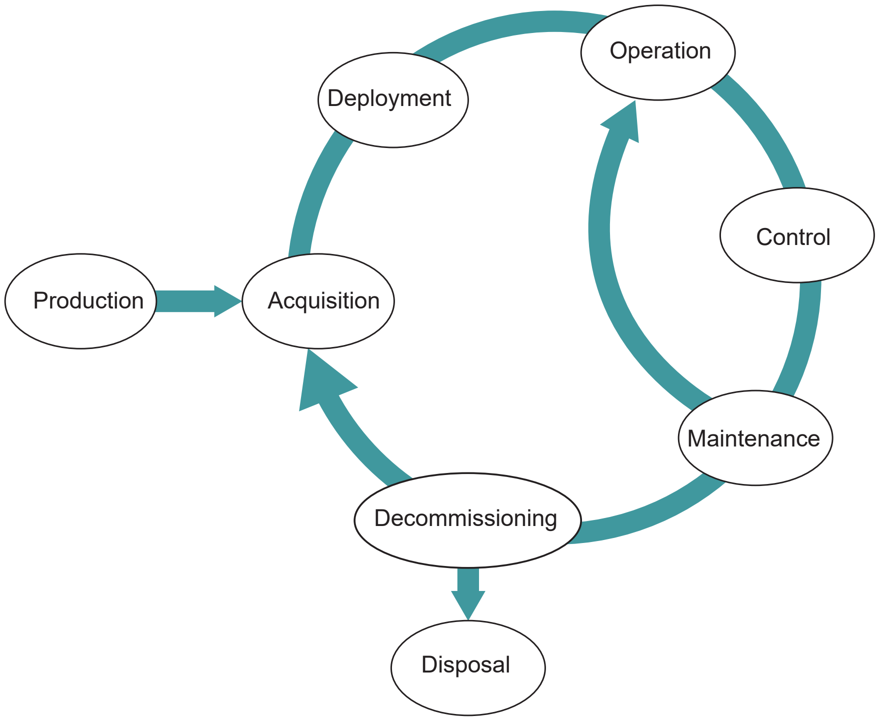


Figure 1 – A typical product lifecycle. Security requirements need to be built into command and control system at every stage and should be considered during the entire product development and usage lifecycle.

cryptography as "Kerckhoffs' principle." Proprietary systems may 'raise the bar' for attackers, as for instance attack tools may not readily be available, but need to be developed during the course of the attack. However, dedicated adversaries, such as nation state attackers or large criminal organisations with significant resources, will likely be able to break even proprietary, closed systems, as the example of the Stuxnet worm shows.

To summarise, systems designed only with safety in mind are unlikely to withstand active attackers, which try to undermine the operation of a system. This is particularly critical if open networks and commercial off-the-shelf devices are utilised. It is likely that a malicious attacker will be able to undermine safety checks in his search for the weakest link. Thus, security will play an important role in the development of future railway command and control systems. One can assume that if it is not secure, it is not safe.

Attack vectors

Before looking into ways to secure systems, it is worthwhile to investigate ways that attackers can use to penetrate a system, called "attack vectors". Such attack vectors can be very diverse, as illustrated by the examples below.

Software errors (called 'bugs'), in particular buffer overflows, are still the most prominent causes for attacks. Software bugs may allow an adversary to inject his own code in a running program and thus modify its behaviour at will. These attacks can only be prevented by enhancing the quality of code in a way that the number of bugs is reduced. The beauty of these attacks is that they can be performed remotely and that they do not necessarily change the affected system software persistently. While automated bug-finding tools employed during the coding process can help to increase software quality, exploitable bugs are still hard to identify.

In the past, simple and weak cryptography was repeatedly used to secure a system. Driven by the desire to decrease the computational complexity of cryptographic operations as well as the ability to control the distribution of knowledge about the system, some vendors opted for the use of "home-made" proprietary cryptographic primitives. However, the design of such primitives is complex and error-prone. There are numerous examples where such "ad-hoc" designs could be broken. It is generally recommended that only standardised and "proven" cryptographic technology should be used in order to avoid weaknesses.

Attackers who have physical access to a device can launch even more powerful attacks. This is particularly problematic for railway command and control systems, which are deployed in geographically large and unprotected areas. Physical attackers can either be passive or active. Passive attackers observe the operation of a device in order to gain information on the type of processing it performs; for example, through "side channel attacks", attackers may be able to monitor the power consumption of a device; if this power consumption is correlated with secrets stored on the device, an attacker is able to learn these secrets. Active attackers may even go further and modify the software or hardware of the device itself. The prevention of such an attack requires the ability to monitor the hardware or software integrity of a device periodically.

Security engineering

In order to avoid attacks, security measures have to be taken. These measures can either encompass technical protection mechanisms, which rely on technical implementations of security features, or management processes, which complement technical features. It is widely accepted that security is "not a product, but a process": it is not enough to add security features after a system is designed and implemented, e.g. by adding firewalls, virus scanners or encrypted communication tunnels. Rather, it is important to consider security as an integral part of the development process: security must be considered in all phases of system engineering, from the requirements engineering phase over the implementation phase through to decommissioning – a 'security engineering' process is required.

There is no universal methodology for a security engineering process, but it is commonly agreed that it consists of the following steps as a minimum:

Definition of attacker models: During this step, one surveys the different types of attackers that a system faces, and estimates their knowledge, resources and dedication. Attackers are very diverse and can, for example, range from "script kiddies", who like to explore different systems, to organised criminal organisations that may want to blackmail operators by disrupting services to nation

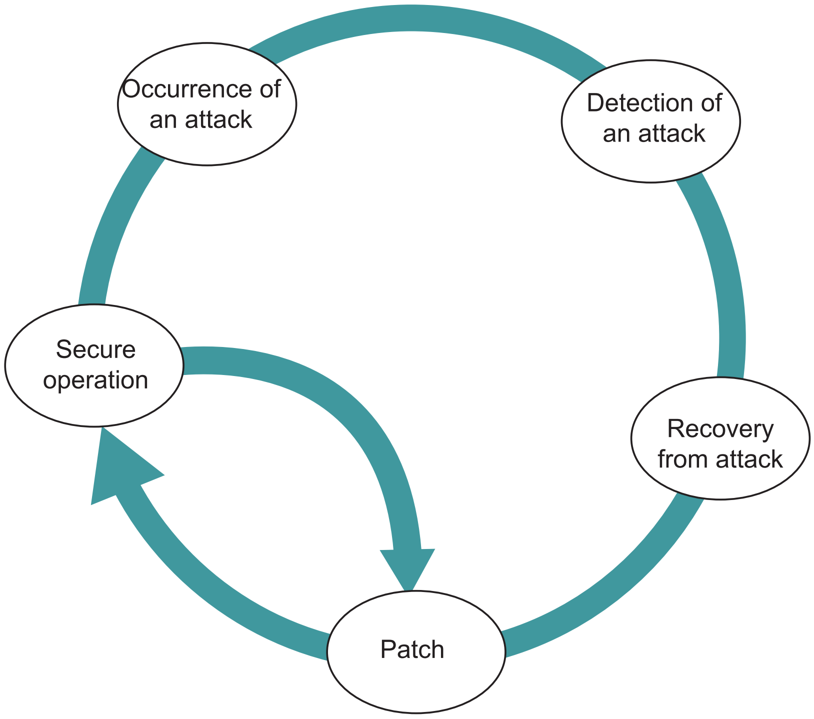


Figure 2 – Response to an attack. Security cannot be provided by technical means only; cybersecurity requires appropriate business processes, which are aligned with railway operations. These must include mechanisms to detect and recover from attacks with patches to ensure secure operation.

states preparing for cyberwar. Knowledge and resources can vary tremendously: while "script kiddies" have almost no budget, nation state adversaries can be assumed to have significant resources.

Identification of assets: For every system, one identifies key assets that need to be protected, such as critical data or cryptographic keys. Assets can also be non-material and include, for example, the reputation of a company or safe operations.

Risk management: Given the knowledge of attackers and assets, one needs to decide which assets need to be protected against which attackers by using which measures ("security controls"). Controls can be technical, such as encrypted communication links, or organisational, such as physical access protection schemes or password policies.

Secure design and implementation: Subsequently, a system design, which includes the selected technical security controls, is generated. Once the design leads to a product, the quality of the (software) implementation is a key property, as many security problems stem from unnoticed implementation errors, which can be exploited by attackers.

Strategy for support, updates and decommissioning: As mentioned before, the attacker landscape changes over time; furthermore, exploits will likely be detected during the lifetime of a product. This requires periodic verification of whether the first steps of the security engineering process (attacker model generation, asset definition, risk management) are still valid; if not, they need to be re-done in the light of the changed risk landscape. Further, to counter newly reported exploits, a strategy to patch software and securely distribute updates is required. Finally, there needs to be a strategy for decommissioning, so that critical data is removed before devices are taken out of use.

One example of a security engineering process which follows the above-mentioned ideas can be found in the DIN VDE V 0831-104 [1]. This is tailored specifically to railway signalling systems and is based on the norm IEC 62443 for industrial automation.

As mentioned above, any system designer needs to assume that no system will be secure indefinitely; one needs to expect that any system will be broken during its lifetime and mitigating measures need to be taken. This requires a process to be defined, which allows handling of security incidents. First, it is of utmost importance to be able to quickly identify that a part of a system was compromised by an attacker. This itself is a non-trivial problem: there are numerous examples of attacks, which were successfully carried out over a long period of time (weeks to months), without knowledge of the system owner. Fast detection requires knowledge of the status of all devices and all networks at any point in time; anomalies need to be reported to a central entity so that appropriate measures can be taken.
Once a compromise is detected, a quick first response is required, which contains the attack, protects against further damage, and allows fast recovery. During this step, no data shall be deleted which may be of use for a forensic investigation or later criminal prosecution. Once the vendor has supplied appropriate updates and patches, they need to be deployed so that the affected system is brought back to an uncompromised state.

Security versus Safety

Designing cybersecurity solutions for use in a safety-critical environment is challenging. As mentioned above, the security landscape changes over time (in stark contrast to the physical world, which drives safety). Safety-critical components may be in use for 25 years or longer. However, security features need to be constantly adapted to current threats and revised according to the state of the art, requiring some update mechanism. Typically, this contradicts the safety certification, which is issued for a complete system or software configuration. Once updates are made to the system, its safety certificate may become invalid and re-certification can be necessary, which is time-consuming and costly.

One way to mitigate this problem on the technical level is to separate safety and security functionalities to the greatest possible extent. This can be achieved, for example, by a 'security shell', which encapsulates safety-critical functionality in a way that the security shell can be updated without needing to touch the underlying safety functions. Ideally, the security shell protects against all malicious attacks against the system, so that the underlying safety features can assume the absence of attackers and deal with usual safety faults. One core construction principle of such a shell can be to transform active attacks against a system into faults, which can be handled by classic safety means. For example, if a communication link gets attacked and messages are maliciously modified, the security shell can detect this by verifying a cryptographic signature on the message; if signature verification fails, the shell can drop the message and simulate a link fault, which needs to be handled by the safety system. However, such an approach may jeopardise real-time guarantees.

Special care also needs to be taken in cases where security mechanisms directly interfere with the safety reaction of a system. For example, safety may require the processing and interpretation of incomplete and faulty messages to the maximum extent possible, in particular when it comes to emergency situations, while security may demand the deletion of messages that contain no or an incorrect authentication token. Latency may also become problematic: the use of cryptographic mechanisms to encrypt or authenticate messages takes time and slows down the reaction time of a device. Thus, security features need to be designed with safety in mind; they should not directly or indirectly influence safety.

Towards a resilient design

Ideally, systems in critical infrastructures, including railway command and control systems, should offer some form of resilience so that they can retain their essential functions in case of attacks. According to the US National Institute for Standards and Technology cybersecurity framework, a resilient system is characterised by the following capabilities:

1. The system should be prepared for unfavourable conditions and/or extraordinary stress.
2. The system should be able to react to unfavourable conditions and/or extraordinary stress and maintain its essential functions, despite potentially restricted functionality.
3. The system should be able to return to a defined state after an acceptable time. (Note that this does not need to be the state of the system before the attack happened; still, it needs to be a state where service is resumed fully.)

Designing a system for resilience is challenging and requires special security controls. Traditionally, systems have been protected with the "walled fortress" model in mind. Here, only the boundaries of the system are protected and the main goal is to keep an attacker completely out of a system. This has the main drawback that security critically relies on a few components and there is only a single line of defence, leaving the system unprotected if a powerful attacker is able to penetrate it.

Modern security architectures thus follow a different model, which is sometimes termed "open city model," where security is not only guaranteed by a single line of defence, but rather security is built into several parts of the system. Attackers then need to penetrate a number of different defences in order to reach their goal. This approach is called "defence in depth"; due to the presence of multiple layers of security controls, breaking one layer will not leave the system totally unprotected. This facilitates resilience.

Recently, the working group CYSIS, initiated by TU Darmstadt and DB Netz AG, identified a number of features which can make railway command and control systems more secure and resilient. A number of suggestions should be followed during system design:

Modular architecture

A large system shall be sub-divided into several smaller components – ideally in such a way that during an attack, affected systems can be isolated without restricting the functionality of the overall system more than necessary. However, it should be noted that attacks may not always be discovered in time and that the location of the effect of the compromise may not be the actual entry point of the attack. After an attack has happened, it must be possible to return a component to an uncompromised state; furthermore, it needs to be ensured that the system does not get compromised again immediately after restoration. Data of a compromise should not be deleted but made available for later forensic use. Asset and configuration management needs to be in place: it must be clear for a system integrator which components are present and in which state they should be.

Adaptability

Safety-critical parts of the system should be separated to the greatest possible extent from components that require a high frequency of modification. It shall be possible to quickly patch parts of a system upon detection of a compromise. Once attacks against COTS devices which are used in a system become publicly known, appropriate countermeasures must be taken. Furthermore, only features which are absolutely essential to the overall functionality should be active; other features should be deactivated in order to reduce the overall attack surface.

Platform integrity

A modern platform depends crucially on the integrity of the software they execute. Persistent attacks typically try to modify the code image of a system to gain and retain access. Thus, it is paramount to be able to determine whether the code which is running on a system, together with its configuration, is still in its expected state. Such a test must even be possible when the system is already compromised; this requires the use of trusted components in hardware. Furthermore, it must be possible to investigate the integrity of the platform remotely, which allows the use of integrity warnings in components like Intrusion Detection schemes.

Logs

Critical events should be logged and log files need to be protected from later modifications. Again, this facilitates observability and allows analysis of security incidents at a later stage using forensic methods.

Detection of physical attacks

Railway command and control systems may operate in a geographically large and unprotected area. In this case, physical attacks, where attackers analyse and modify the hardware and software of the device, may be possible. Such

Physical attacks should be detected, for example, through intruder alarms. *Photo Shutterstock/InkedPixels.*

End-to-end security is essential if critical data is to be protected and business continuity assured.
Photo Shutterstock/Best-backgrounds.

attacks tend to be extremely powerful, and hard to prevent. Physical attacks should be detected, for example through intruder alarms.

Storage and renewal of cryptographic keys

The security of cryptographic primitives is entirely dependent on the secure generation and storage of keys. To protect against software intruders, keys should always be kept in secure hardware and processing should ideally take place in the hardware module itself. If this is not possible, keys should be fetched from secure storage immediately before their use, reside in main memory for a minimal amount of time and be deleted after use. Furthermore, a process for renewal of secret keys must be defined, either periodically or after a system compromise. Keys should be personalised for each module; the use of global keys, which are present at various physical locations, should be avoided altogether.

The following suggestions should be considered when designing a resilient communication subsystem:

End-to-end security

Large and complex networks will typically not be under full control of the operator (e.g., through the use of open networks such as the Internet). This requires us to assume that the network itself is not trusted. Thus, assuring end-to-end authenticity and integrity is paramount (any proxies, which decrypt and re-encrypt traffic at network borders should be avoided entirely, as this would require storage of secrets at various places). Confidentiality (e.g., encryption) typically is less important in the railway context, even though it may make the task of an attacker to explore a network considerably harder.

Observability

The network shall be constructed in such a way that it is observable for security purposes. It is absolutely crucial to be able to know what goes on in a network at any point in time. Sensors in the network are required to be able to collect traffic and interface to management systems, which aggregate security alerts, preferably at a central place, are necessary. The involved organisations need to establish a security incident response plan, putting detailed procedural measures in place for how to react to anomalies.

Data filtering

Segmentation of a network is a key mechanism in order to contain ongoing attacks. At the border between networks, data filtering should take place so that only “expected” traffic that does not contain attack code is permitted to pass from one segment to the next. Filtering should ideally be implemented using whitelisting, an approach that explicitly specifies all ‘allowed’ traffic.

Business Continuity Management

While technical measures are required in order to prevent security incidents, appropriate business process need to be in place as well – and coordinated with the operational teams. Once an attack is detected against a system component, its impact on safe train operation needs to be assessed. This can only be achieved in close collaboration between cybersecurity and railway operations experts. In the worst case, affected systems need to be shut down.

A critical question is to decide when such shutdowns are necessary and justified, given the adverse effects on availability. One should also note that automated tools to detect potential cyberattacks are error-prone and suffer from false positives; it can require substantial efforts to distinguish a false warning from a real attack. New and innovative concepts for fallback systems may need to be developed in order to contain the effects of cybersecurity attacks before affected technical systems can be brought back to a ‘clean’ state.

Summary

The development of future railway command and control systems requires consideration of cybersecurity threats. A system that is designed for safe operation is not necessarily secure against malicious attacks. Security needs to be built into a system and needs to be considered during the entire product development and usage lifecycles. Ideally, newly developed systems should offer some form of resilience so that they can offer essential functions in presence of attacks. Finally, security cannot be provided by technical means only; cybersecurity requires appropriate business processes, which are aligned with railway operations.

References

[1] DIN VDE V 0831-104, Electric signalling systems for railways – Part 104: IT Security Guideline based on IEC 62443, 2015.

[2] C Schlehuber, M Heinrich, T Vateva-Gurova, Tsvetoslava, S Katzenbeisser, N Suri: A Security Architecture for Railway Signalling, in Proceedings of SAFECOMP 2017, pps 320-328.

[3] CYSIS Working group: Resilient Architectures in Railway Signalling, White paper, 2017. irse.info/n3uc6.

What do you think?

Do you agree with the points raised in Stefan’s paper? Do you think we’re doing enough as an industry to consider issues such as cyber-security and business continuity?

We would be interested to hear what you think – write to us at **editor@irsenews.co.uk** and we may publish your letter in our Feedback column.

A message from the UK Office of Rail and Road

Ian Prosser CBE
Director, Railway Safety, ORR

It is the responsibility of the Office of Rail and Road (ORR) to ensure that those responsible make Britain's railways safe for passengers and provide a safe place for staff to work. We protect the interests of rail users by monitoring compliance on a range of issues and will use our enforcement powers to take action when necessary.

Britain now has one of the safest railways in Europe – for passengers and for workers, but we cannot be complacent. There is always more the industry can do to improve this country's health and safety record even further. The ORR regulate health and safety for the entire mainline rail network in Britain, as well as London Underground, light rail, trams and the heritage sector.

The Clapham rail disaster on 12 December 1988 killed 35 people, injured many more and sent shockwaves through the industry. A little over 30 years later the industry can look back with satisfaction on the success of hard-won improvements in training, managing fatigue and the discipline under which different signalling functions work.

Of course, we can never sit back and say "job done" – complacency and fading corporate memory are ever-present dangers. Indeed, the Waterloo collision last year and the serious irregularity at Cardiff East in 2016 highlighted just how easily weaknesses can creep in and give rise to circumstances worryingly reminiscent of Clapham. Fortunately, no one was injured in either incident but, had similar factors come together in another place and at another time, the consequences could have been very much more serious.

Findings from the Rail Accident Investigation Branch (RAIB) report, and from investigations by ORR and the wider industry, highlight the need for continued focus in the following areas:

- Thorough planning and governance of all projects is essential to ensure safety is not compromised through time pressures and late changes.
- Good change management should identify safety-critical design changes, thoroughly assess the risks and devise appropriate controls so that consequential risks are eliminated or minimised, and processes, procedures and instructions remain clear and relevant.
- Rigorous adherence to process, including the functional separation of signalling roles, needs to be assured through genuine, thorough and suitably frequent monitoring of those undertaking safety-critical work.
- Training and maintenance of competence should ensure that individuals retain a thorough knowledge of their own work and a clear understanding of the purpose of their role within a wider system. Corporate memory should not be allowed to fade.
- Safety-critical roles and tasks need to be robustly supervised and monitored. People need to be effectively supervised and procedures monitored to ensure that people and processes work as expected to control risks.
- Recognise that fatigue in the workplace needs to be managed and mitigated, not just the risk of workers suffering fatigue while travelling to and from their place of work.

ORR inspectors will continue to work with duty holders to respond to RAIB's recommendations and help them maintain high levels of performance and safety. We have a policy for considering and following up RAIB's recommendations and ensuring that recommendations are duly considered and where appropriate acted upon.

The ORR assess the action taken by those to whom we have directed the recommendations to against clear criteria, using both technical and other experts, to decide our view on the responses and what further action we may need to take.

The Railways and Transport Safety Act 2003 and the Memorandum of Understanding between the ORR and RAIB say how the ORR report to RAIB, with a separate Memorandum of Understanding in place for Scotland. ORR report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

In assessing the status of recommendations, ORR make reference to a status definition list which has been agreed with RAIB. To assist those asked to consider RAIB recommendations we have also produced a glossary of commonly used terms within RAIB recommendations, along with our interpretation of what actions an organisation needs to deliver in order to demonstrate that the requirements of a recommendation have been satisfied.

Future Railway Mobile Communications System update

Paul Darlington

In 1994 UIC, the worldwide professional association representing the railway sector and promoting rail transport, selected the European Telecommunications Standards Institute (ETSI) GSM standard as the bearer for the first digital railway radio communication system.

The requirements of railways were captured in a specification named EIRENE, including both functional and system aspects. The specifications were reinforced as GSM-R within ETSI/3GPP international standards.

The 3rd Generation Partnership Project (3GPP) is a collaboration between groups of telecommunications standards associations, known as the Organisational Partners, which consist of seven telecommunications standard development organisations from around the world (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC). See side box for details.

The initial scope of 3GPP was to make a globally applicable third-generation (3G) mobile phone system specification based on GSM specifications. The scope was later enlarged to include the development and maintenance of GSM and related 2G and 2.5G standards, including GPRS and EDGE, UMTS, HSPA, LTE and related 4G standards. The scope now also includes next generation radio and related 5G standards, but it is still confusingly called 3GPP.

The first operational implementation of GSM-R was launched in 1999, and the first countrywide GSM-R operation started in 2004. In parallel, EU Directives officially adopted the GSM-R as the basis for mobile communication between train and track for voice (train radio) and control-command and signalling data (ETCS), with the aim to form a worldwide standard, the European Rail Traffic Management System, the now well-known ERTMS.

The objectives of ERTMS were to optimise the global investments for train operations, and at the same time to guarantee the interoperability between national networks and trains. This interoperability is regulated through the European Directives and the Technical Standards for Interoperability of Control Command and Signalling (CCS TSI), published by the EU and supervised by the European Union Agency for Railway (ERA).

Yesterday's technology? A GSM-R mast towers above the UK main line.

GSM-R has been a great success. Not only in Europe where more than 100,000km of railway are daily operated with GSM-R but also worldwide, and this is still increasing due to the on-going installations. However, the requirements of railways are constantly evolving, and railway telecom standards remain dependent on the telecom industry evolution cycles, with an end of support for GSM-R planned by 2030. These considerations led UIC, in 2012, to launch the first studies for a successor to GSM-R, named Future Railway Mobile Communications System (FRMCS).

The UIC FRMCS project delivered the new User Requirements Specifications (URS) focusing mainly on rail communication needs as a basis for the development of the GSM-R successor. This resulted in structuring the FRMCS initiative with the following governance and workgroups, with a Steering Group leading the overall global FRMCS strategy and planning.

- The FRMCS Functionality Working Group (FWG) ensures the matching between system functionalities and railway needs
- The FRMCS Architecture and Technology Working Group (ATWG) has the objective to define the architectures and to evaluate the candidate technologies
- The UIC Group for Frequency Aspects (UGFA) looks after the expected needs for spectrum, particularly sensitive in transition scenarios from GSM-R.

The objectives the groups encompass the following key activities:

- The maintenance and evolution of User Requirements Specifications (URS) along with the production of functional and system principle use cases. These are necessary for the development of the corresponding functional and technical standards within telecom standardisation bodies in ETSI Technical Committee for Rail Telecommunications (ETSI TC-RT) and the 3GPP Technical Specifications Groups (3GPP TSG), and in particular the Service and System Aspects (SA).
- The definition of migration strategies from GSM-R to FRMCS with their associated impacts in terms of traffic analysis and frequency spectrum requirements. The actions on harmonisation of frequencies at the European level and possibly worldwide is particularly challenging and requires extensive consultation with stakeholders and partners.
- To consider the extension of FRMCS to other domains such as metro rail, with the ambition to create synergies with other infrastructure stakeholders.

User Requirements Specification 4.0.0.

The FWG met at the Network Rail headquarters in Milton Keynes, England in January 2019 and reached another milestone in the project with the finalisation of URS version 4.0.0.

FWG also finalised the FRMCS functional use cases document, where all the railway application specified in the URS are detailed and transferred into use cases to assist the standardisation process ongoing within 3GPP, and the testing of FRMCS.

Both documents are planned to be published on the UIC website, including a review template, for open review by any member of the railway sector.

An LTE mast, technology which forms a key part of many railways' plans for future comms.

3GPP Organisational Partners

ARIB – The Association of Radio Industries and Businesses, Japan

ATIS – The Alliance for Telecommunications Industry Solutions, USA

CCSA – China Communications Standards Association

ETSI – The European Telecommunications Standards Institute

TSDSI – Telecommunications Standards Development Society, India

TTA – Telecommunications Technology Association, Korea

TTC – Telecommunication Technology Committee, Japan

FWG is committed to continue working on improving the documents, with a next planned release in January 2020.

The FWG will now continue their work on writing the Functional Requirements Specification (FRS) for FRMCS. During that process they expect to make changes to both the URS and functional use cases to make them consistent documents.

The first meeting of the new "Telecom On-Board Architecture" work group of the FRMCS Migration Scenario (FMS) programme was held at the UIC headquarters in Paris on 22 January.

Participants from seven European railways and representatives from European Union Agency (ERA) and Community of European Railway and Infrastructure Companies CER will now work together on the definition of the on board system architecture for FRMCS.

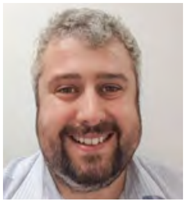
FRMCS conference to be held in May

The UIC (International Union of Railway) is organising the first global FRMCS conference at its Paris headquarters from 14 - 15 May 2019.

The conference will be an opportunity for delegates to know more about the current status of FRMCS specification and standardisation, to understand the global time-line of its introduction and to consider the operational impacts of the migration scenarios. It will also provide a global vision of how the rail industry will benefit from the new system as a bearer for ETCS and other rail applications.

Participants from several countries and including telecom and signalling domains, regulation authorities and standardisation bodies, railway undertakings, and manufacturers, are expected to attend the conference.

Optimising ETCS for busy suburban railways



Noel Burton
Siemens Mobility, New Zealand

The European Train Control System (ETCS) has now established itself globally as the train protection system of choice for many heavy rail networks. This is largely due to its open standards and multi-vendor support.

ETCS was rolled out across the Auckland suburban rail network in New Zealand a few years ago, with the sole aim of improving safety. Following the introduction of ETCS, the safe working ecosystem of rules, signalling principles and ETCS configuration have been reviewed and optimised. Changes have been made for scenarios where it was identified that operational improvements could be attained without compromising safety.

This article shares descriptions of some of the ETCS related improvements that have been successfully commissioned in Auckland. It is hoped that the success of these changes in Auckland encourages other ETCS ‘owners’ to develop ideas for improvements as well.

Changes made in Auckland include changes to the driver’s rulebook, defensive driving strategies, warner route principles, enforcement of speed restrictions and the interaction with level crossings for stopping trains at stations. The paper is intended to give a high-level engineering based description of some of these solutions and the reasons behind them.

Introduction

The re-signalling and electrification of the Auckland suburban rail network included the installation of ETCS Level 1. ETCS was fitted on all main line routes across the city and to all of the new passenger rolling stock. Since the new electric multiple unit (EMU) trains came into service in 2014, every EMU passenger service has operated with ETCS. As a result, the operators (Transdev) and infrastructure managers (KiwiRail) have now gained significant experience of introducing ETCS to a busy suburban railway.

Development of the system did not halt after the last new train was commissioned in 2015. In some scenarios it was found that ETCS made operations slightly more conservative than a human driver might deem safe, whereas in other cases it delivered performance benefits straight away. Auckland’s metropolitan rail network has closely spaced stations, many curves and constrained junctions. Because of these constraints, performance improvements or hindrances are measured in seconds – and every second counts. As such, subsequent upgrades have been implemented to optimise the configuration of ETCS and in some cases this has also involved changing the underlying interlocking design.

ETCS refresher

It is useful to understand some fundamentals of how ETCS works before we proceed to explore how the system was optimised.

In simple terms, ETCS works by the trackside ETCS equipment transmitting data to the train. This includes information about the distance to the end of the movement authority, gradients, speed restrictions and other relevant data. A safety critical European Vital Computer (EVC) on the train then uses this information, combined with its knowledge of the train’s braking characteristics, current speed and position, to calculate braking curves to the next speed restriction or red signal. Based on these curves, a target speed is indicated to the driver. If necessary, the EVC will enforce the braking curve by automatically operating the train’s brakes to ensure an unsafe event cannot occur.

Figure 1 and Figure 2 provide some generic examples to show how this works for an ETCS Level 1 system (but the principles are the same for Level 2). In Figure 1 the top graph shows the information sent to this train from the trackside balises at signal S101. In this case it is simplified to just two pieces of information: The distance to go to the next red signal (851m) and then the safe distance (i.e. overlap) beyond this (150m).

The lower graph in Figure 1 shows how the EVC uses the information received from the trackside. It calculates warning, indication and braking curves to supervise the train’s speed down on approach to the red signal. The service brake curve is targeted to 0km/h at the signal, but ahead of this is the warning curve. To avoid any visual or audible warnings from the ETCS driver machine interface (DMI), the driver must drive more conservatively than the warning curve. The EVC also calculates an emergency brake intervention curve based on the distance to end of the overlap, which is being held clear by the interlocking in case of a SPAD. The EVC must ensure that it caters for the worst case odometry error and brake delay but still allow time for the driver to react to a warning before

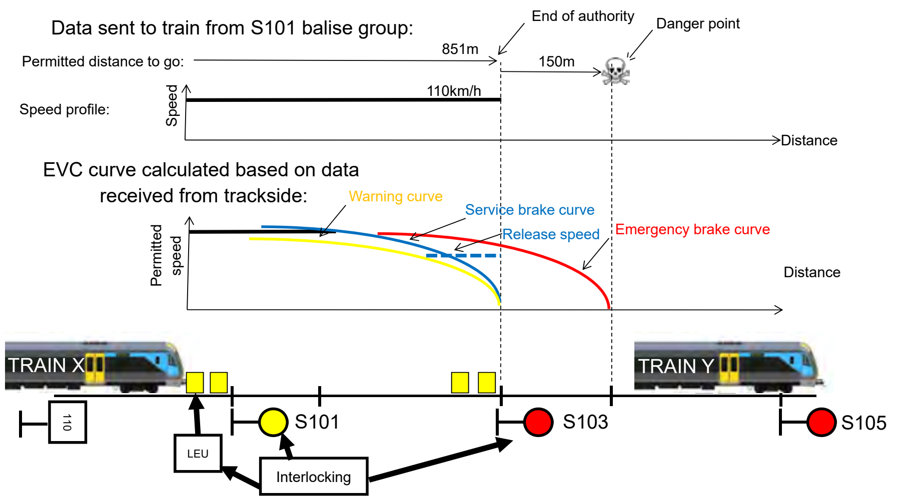


Figure 1 – Simplified diagram showing ETCS supervision up to a signal at red.

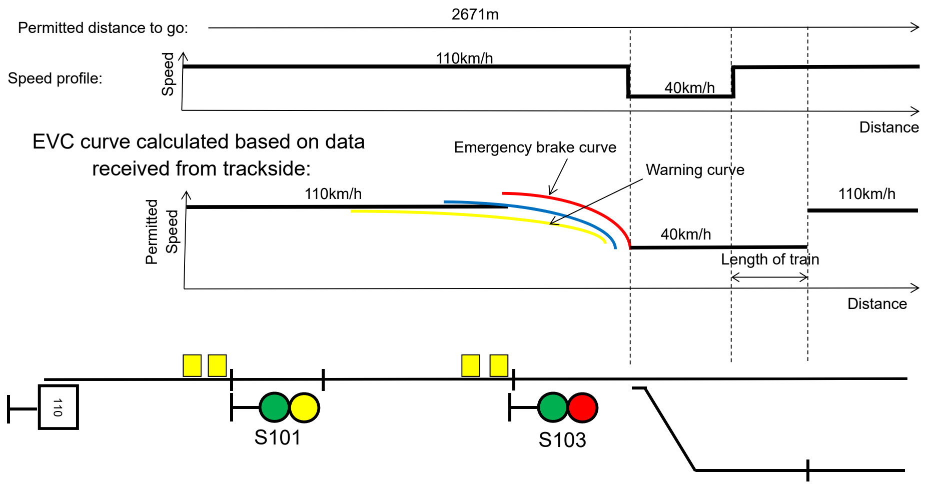


Figure 2 – Generic example of ETCS supervision of a speed restriction – in this case a diverging turnout.

applying the service brake. If the service brake (which may not be fail-safe) is not effective, the system must still have time to obtain full emergency brake effort in time to stop the train before the end of the overlap. All these curves and necessary "what if" fail-safes do have a compound effect. This is more noticeable from a performance point of view when the release speed is low.

The release speed, as shown in Figure 1, is a speed at which the braking curves are no longer displayed or enforced by the EVC. This allows the driver to control the last part of the braking in the most efficient manner. Release speeds in Level 1 systems also allow the driver to react to a signal ahead that clears from stop. The driver can then proceed (at below the release speed) up to the balise group at the signal to allow the EVC to receive an updated movement authority from the trackside.

In Auckland release speeds are normally configured to be calculated onboard by the EVC based on the distance to the end of the overlap. For EMUs release speeds are typically around 40-50km/h, depending on gradients and overlap length. However, in some constrained situations, the release speed has to be fixed very low to mitigate other risks as we will see later with level crossings that are near signals.

As well as supervising the train's speed safely on approach to red signals, ETCS also supervises braking down to speed restrictions on curves and turnouts. This is shown in Figure 2. The braking curves are similar to those provided for a red signal (albeit without a release speed). A subtle difference is that the fail-safe emergency braking curve is now targeting the start of the speed restriction (rather than a point beyond it, as was the case with a red signal – curves don't have overlaps!). This has the effect of pushing the other curves back.

In Figure 2 a long movement authority (all signals clear), but with a speed restriction through a diverging turnout, is sent to the train from signal S101's balise group. The EVC uses this data to calculate safe braking curves to indicate/enforce that the train will be slowed before the turnout. The train's speed is also not allowed to be increased until the EVC has calculated that the whole length of the train has cleared the speed restricted area.

One of the main benefits of ETCS is that it has a standardised interface between trackside and onboard. This means that there is interoperability between trains and trackside fitted with ETCS equipment from different suppliers. Although all ETCS equipment in New Zealand is currently supplied by Siemens, the ability to buy equipment from other suppliers is very important to KiwiRail to maintain long term market competition. When ETCS was installed on the network it was decided that only the standard ETCS functionality, allowed for in the ETCS standards, would be used (i.e. no special local functions developed). This rule has been maintained throughout the subsequent improvement projects. These also only use the standard ETCS functions built into v2.3.0d of the ETCS specification.

Does more safety have to mean compromising on performance?

Consider the railways in the early 19th century, before the signal engineer was invented/discovered. In some areas, trains were free to drive as far as the line was clear, at a speed the driver deemed was safe (i.e. drive on sight). Inevitably there would have been some accidents due to long braking distances and human error misjudgements. Now imagine the reaction of the operators when a new system, whereby the railway would be divided into discrete blocks, was suggested. Some of these blocks would be as long as the distance between two villages. The train would not be allowed to enter the block until it was clear of the preceding train. Some of the operators may have protested "but we can see the railway is clear to the next corner, why waste our time making us wait here?". What they might have failed to immediately appreciate, is that with this new safe working system, came operational advantages too. No longer would the speed of their trains be limited such that they could stop in the distance that they could see was clear ahead. As long as they timetabled operations well, such that they normally arrived at the entry to the section when it was clear, there was actually a big net operational benefit to be had from the new safety system in terms of higher speeds.

Of course, development of block signalling did not end there. The concept would be developed not only to make it safer (e.g. time interval working replaced by signals and block telegraph), but also to release more operational benefits. As pressure increased to reduce headways, eventually the distant signal for the next block section was combined with the home signal for the current block section, equivalent to three aspect signalling today. This was further refined into four aspect signalling to give optimised headways for trains with differing braking capabilities over the same line. All of this still used the same underlying fundamental safety system of discrete block signalling, but with subtle modifications to extract more capacity from the railway.

The roll-out of ETCS in Auckland has seen somewhat of a similar, if less extreme, set of initial concerns about restrictions on operational performance. This was then followed by recognition of the possibility to release operational benefits by leveraging the advantages of having removed the risk of driver error in many situations.

When it was decided to complete a full re-signalling of Auckland prior to electrification, it was clear that it would be indefensible not to fit a modern automatic train protection (ATP) system, given the relatively small increase in overall project costs to do it at the same time. Prior to this, Auckland had no ATP system and not even a warning system like British Rail's Automatic Warning System (AWS). ETCS Level 1 was selected by KiwiRail as the ATP system to be used. The project took the position that the ETCS system should provide as comprehensive as possible protection against all types of driver error. It was configured to be 'as safe as possible' as its primary requirement.

This inevitably was a radical change for operations in Auckland. The railway went from having zero automated protection systems to a comprehensive ATP system which, by its nature of being fail-safe, was more conservative in some situations than an experienced train driver would be.

It was quickly demonstrated that ETCS was fulfilling its intended purpose of improving safety. At the time, Auckland was introducing 10-20% additional services at every yearly timetable update. Yet as the EMUs came into service with ETCS the recorded signal passed at danger (SPAD) rates fell quickly to a very low level. More importantly, ETCS ensured that any train that did SPAD, would be stopped safely within the available overlap beyond a red signal. It also mitigated against over-speed risk on curves and turnouts, the consequence of which, only a few years earlier, had been demonstrated by the overturning of a thankfully empty stock passenger train.

Unfortunately, these improvements in safety were somewhat overshadowed by the new EMUs not delivering the magnitude of reductions in end to end journey times that had been expected. Although they could accelerate faster and obtain higher speeds than the old diesel rolling stock that they replaced, longer dwell times (not related to ETCS) affected their potential for journey time savings. To a lesser degree, on some routes where there were many speed restrictions for sharp curves, drivers complained that ETCS caused them to have to brake earlier than they would normally in dry conditions. Level crossings next to stations were a more serious performance restriction.

Given this situation, an investigation was started as to how the ETCS configuration or underlying signalling system might be able to be modified to help mitigate these side effects.

Reconsidering your principles

Critical to the success of optimising an ETCS installation has to be a willingness to look at the broader ecosystem in which the ETCS system lives. There is only so much that can be done by changing the ETCS configuration data alone. What has been successfully demonstrated in Auckland is that when everything is put on the table, including the rule book and signalling principles, then it is possible to truly optimise the entire safe working system, to maximise the potential for performance gains.

Many interlockings have common features that we take as essential or non-negotiable. In many cases the reason for providing a specific feature can be traced back as a control to mitigate human error by the driver. A good example of this is flank protection, where beyond the end of the safety overlap after a red signal, the interlocking will set up points to lie in the safest possible position in case of an overrun that exceeds the length of the overlap. However, if we introduce an ATP system for all trains, which provides a guarantee that a train can never exceed the length of the overlap in the event of a SPAD, then do we still need to provide flank protection?

A classic example of how interlockings can be simplified when comprehensive ATP is introduced is for route signalled railways where approach release controls are provided on signals that protect diverging junctions. In these railways the signals are held at red, until the interlocking can determine by timing occupancy on the berth track circuit that the train's speed is reduced sufficiently. Only then does the signal clear for the lower speed diverging route. However, if we know the train is protected with an ATP system that will enforce the speed restriction through any diverging points, we can remove this inefficient control from the interlocking.

Later in this paper some examples are given of where the signalling principles in Auckland have been modified as a result of accepting that they are doubling up on the protection that is now inherently provided by the ETCS system. However, before that, let's look at even more simple changes that can be made to complement ETCS, by just changing the written rules given to the driver.

Rules are made for changing

It may not always be the case in practice but, in theory at least, changing the rulebook should be easier than changing signalling data or complex signalling/ ETCS principles.

In Auckland during the rollout of ETCS, a mixed fleet of fitted new trains and unfitted old trains was in operation. It was quite normal for a driver to operate a train with ETCS on a Monday and then on Tuesday drive an old train with no protection systems. Wisely, it was agreed by all stakeholders that no existing rules would be modified during this period. Drivers were to treat the ETCS cab display as effectively just an advisory system during this transition.

However, as soon as the whole suburban fleet was homogeneous and therefore all fitted with ETCS, the gloves were off. The first change to be made was a simple rule change to say that the ETCS driver machine interface (DMI) would take precedence over trackside signal aspects and signage with two exceptions: red signals and temporary speed restrictions (TSRs are currently not included in the trackside ETCS data).

Speeding up speed signalling

This had some immediate benefits. One of the main ones was with respect to junction signalling. Auckland is a speed signalled railway with a 'red over green' aspect on a signal at a junction indicating 'all-clear, medium speed'. The rulebook states that medium speed is 25km/h, but this is sometimes modified by signage or dynamic speed indicators to a higher speed if turnout geometry allows this throughout the route.

Critically however, the existing rules state that medium speed must be maintained from the point that the front of the train passes the signal, until the rear of the train has cleared all point work in the area. As the 'medium speed rule' had not been included in the ETCS trackside configuration, (it could have been, but it offered no safety purpose) the ETCS on the train instead supervises braking to the speed restriction for each set of diverging points in a route separately.

As far as ETCS is concerned the lower speed limit only starts at the toe of each point and not at the signal, which in some cases was a long way before the points. A good example of this is shown in Figure 3, here not only are the crossovers some distance from the protecting signal, but also of differing speeds. Prior to ETCS the signal aspect and rules required the driver to proceed at 25km/h (determined by the slowest speed crossover in the route) from the signal until the rear of their train was clear of all turnouts in the route. The ETCS fitted train can now be braked in the optimum fashion just before the first crossover and then decrease speed again for the second sharper radius crossover.

The ETCS DMI also provides positive confirmation to the driver at the moment the rear of their train is clear of the speed restricted turnouts. This therefore allows the train to be re-accelerated at the first moment it is safe to do so.

Offensive driving?

Prior to ETCS in Auckland, defensive driving techniques and rules were one of the operator's best tools to mitigate against the risk of driver error. Once ETCS was live, it still took some time to convince all the stakeholders that it was a system they could trust. This wasn't because of any evidence or behaviour to the contrary, but probably just because of a failure to clearly communicate its integrity level to all parties. Eventually as the fail-safe nature of ETCS was better understood by everybody, it was evident to see the unwinding of some of the now unnecessary defensive driving techniques.

A good example of this is how drivers were taught to respond to caution aspects. When Auckland was re-signalled, four aspect sequences were provided throughout, with a standard green->flashing yellow->yellow->red sequence. Sufficient braking distance was always provided between the steady yellow and red signals to allow the EMUs to brake to a stop from line speed. The flashing yellows only being provided for the benefit of freight trains that also use the network and needed a much longer distance to stop. However, with no ATP in Auckland prior to ETCS and the rate of SPADs increasing, the operator soon developed a defensive driving strategy that encouraged braking from the flashing yellow for EMU drivers and passing the yellow at a slow speed to try and reduce SPADs.

Now that ETCS is established in Auckland, it is good to see some of the redundant defensive driving behaviour being unwound. Some drivers will now continue at full speed past a single yellow aspect and only start braking once the ETCS DMI indicates that they should, such is their faith in the system. This change in behaviour has obviously delivered significant performance benefits.

Figure 3 – Medium speed route at Papakura station in Auckland. ETCS approach speed profile shown in blue is compared to the blanket 25km/h speed profile permitted before ETCS, shown in green.

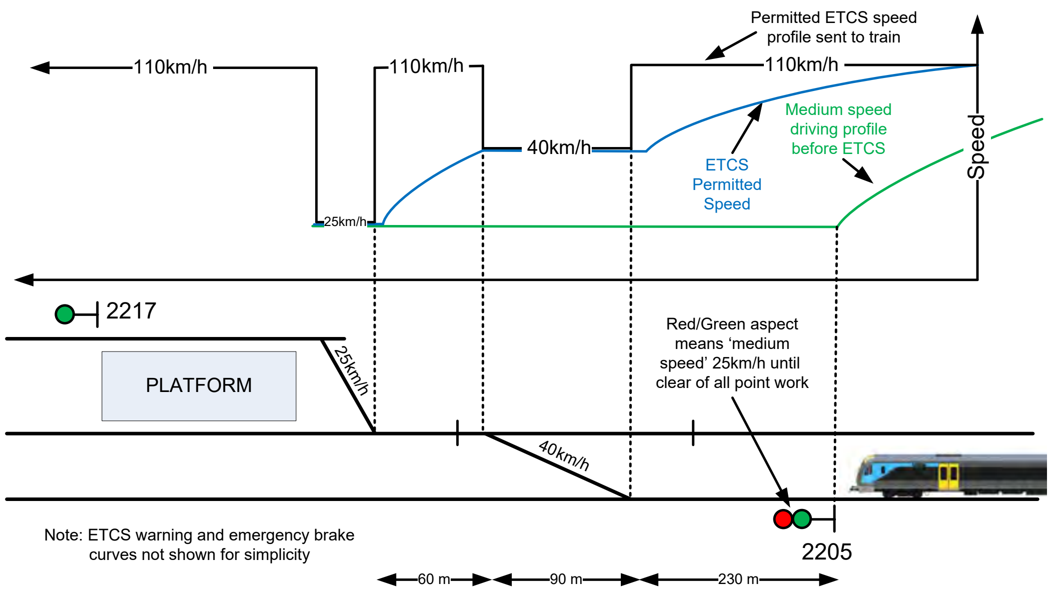


Figure 4 – Accelerating into the fog. The driver is about to pass a signal for which there will be less than 5 seconds sighting at full line speed. Can you see it?

Instrument rated

Whether it is Level 1 or Level 2, a full supervision ETCS movement authority provides the driver with continuous cab signalling. One of the benefits of this is that it gives the drivers the confidence to proceed at full speed even with less than ideal visibility outside. As shown in Figure 4, even in thick fog, which is a reasonably common occurrence in Auckland's winter months, drivers can continue to operate at full speed. This is despite signal visibility being severely reduced from the standard 12 seconds to sometimes less than 5 seconds and much less for unlit speed boards.

Another less obvious benefit of cab signalling is that it gives drivers confidence to proceed in some unusual circumstances. A good example of this is the simplified bi-directional signalling in Auckland. For these sections of plain line, regular signals are provided in the normal direction on each running line to provide the necessary headway, but the interlocking also permits wrong-line running, albeit with only one long block section for the reverse direction.

This can mean that after crossing over on to the 'wrong line', a driver can sometimes have to travel over 5km before reaching the next signal. Of course the use of such wrong-line facilities is unusual and normally only used for working around failed trains or emergency engineering works. Driving on the 'wrong side' can therefore sometimes be unfamiliar and unnerving for the drivers, given the lack of signals to reassure them of their movement authority. It was interesting to observe that once ETCS was introduced, most drivers became far more confident when driving on unfamiliar routes.

Speed, turnouts and curves

Get to know your Track Engineer

Before you attempt to unlock further benefits from your signalling system it makes sense to make an ally of your local track engineer.

The ability of ETCS to guarantee that speed limits will not be exceeded by more than a fixed, known, over-speed margin, needs to be explained to such stakeholders. Once they understand that this guaranteed safety protection is in place, they may be willing to review speed restrictions in some areas as their traditional over-speed safety margins can sometimes be extremely high (as much as 100% before derailment/overturn risk in some cases).

Depending on the additional maintenance that may be required by allowing trains to regularly go a little bit faster over a given piece of infrastructure, you may be able to negotiate permission for ETCS fitted trains to have a higher permitted speed in some scenarios.

Line speed

One of the first changes to be made to the Auckland system after the roll-out of ETCS was to increase the line speed on an 11km section of line between Westfield and Parnell. This section was targeted as part of a project to reduce the end-to-end journey time for trains on a specific route, so as to allow a more comfortable turn-around time at each terminus. This section of track, despite having no particularly sharp curves, had always had a relatively low ruling line speed of 80km/h (and 60km/h in one area). This was sufficient for the old rolling stock in the past, which would struggle to reach 60km/h on some of the steep uphill sections and never hit 80km/h between the stations.

However, the much more powerful EMUs could easily reach 80km/h between stations, although this maximum line speed could not be maintained for long before having to brake for the next station. It was found that some drivers would start to cruise once reaching about 70km/h, as to drive at 80km/h but not trigger an ETCS over-speed warning at about 85km/h, required constant close attention to speed control.

Discussions were held with the permanent way department (and overhead line equipment engineers) to agree on a safe higher line speed for ETCS fitted trains. This new speed was configured into the ETCS trackside data but the trackside signage was left as 80km/h for unfitted trains. Drivers were informed of the change by bulletin and the new rules discussed previously allowed them to immediately drive to the faster profile displayed on their ETCS DMI.

Although, for stopping trains, the new maximum speed is barely reached for trains heading uphill, it does mean the drivers can accelerate freely without having to worry about backing off before reaching ETCS enforced speed ceilings, thereby truly releasing the full potential of this area of track. As the ETCS onboard computer will never allow the train to reach a speed where it cannot brake back to stop before the end of authority, such changes do not require any associated review or modification to the underlying signalling system. A traditional speed increase without ATP would require signal spacing to be reviewed and could potentially be far more costly.

It should be noted that unfortunately such changes do get far more complex and expensive for lines where there are a lot of level crossings. In these cases, increasing maximum permitted speed may mean many changes are required to the interlocking as the level crossing strike-ins will have to be moved to maintain warning times.

Turnouts and curve speeds

Discussions were also held with the track engineers around curve speed restrictions. In some cases, the track engineers were willing to authorise (for ETCS fitted trains) faster speeds than previously posted.

In one case, in a critical area of the network, a very sharp but long series of 25km/h curves had its ETCS speed restriction changed by agreement to 30km/h. Due to its length this change alone liberated an 18 second time journey time saving for every train. To maximise the benefits of the change, it was also agreed that the speed on the 25km/h turnouts leading onto the curves could be safely raised to 30km/h for ETCS fitted trains. This has now become a standard for turnouts of this radius for ETCS fitted trains. The old speed limit is retained for unfitted trains to maintain the conservative over-speed safety margins.

Transitions

As with any safety critical system, the costs of altering ETCS trackside data can occasionally be significant. Generally, a change, no matter how small, will affect the ETCS data in movement authorities for up to three signals back from the area being changed. In Auckland it soon became apparent that if ETCS changes were to be made for any reason, then additional changes in the same area could be made for almost no additional cost at the same time. As such, even changes that only delivered relatively small improvements were sometimes considered worthy of inclusion when part of a bigger package of changes. Further optimising the ETCS speed enforcement on curves is a good example of this.

When discussing the ways in which speeds through curves could be improved for ETCS fitted trains, it was discovered that although signalling design typically considers a curve to just have a start and finish, there is actually more subtle detail to the make-up of a curve than that. When the detailed track engineering drawings for a curve are inspected, it can be seen that in most cases, at the start and end of a curve is an area called 'the transition'. This is provided to give a smooth and gradual change of radius between the straight track and the point at which the curve reaches its nominal fixed radius. Sometimes these transitions are short, but sometimes they can be over 100m and of a radius that does not require any reduction in speed for safe use.

The transitions for each curve in the areas being modified were reviewed with track engineering. Where a reasonable distance could be extracted and agreement was reached with all parties, the ETCS speed supervision for the curve was modified to only include a portion of the transition at each end. This allows ETCS fitted trains to brake later and accelerate sooner after the rear of the train has exited the constant radius part of the curve. Of course, the benefit of this is relatively small, but over a journey with many curves, it can add up and it certainly improves the driveability for the drivers.

Figure 5 shows how ETCS braking curves applied when the ETCS trackside data was first configured to supervise the whole curve (i.e. from the curve speed board) vs the improvements when the start of supervision is moved into the transition area.

Infill

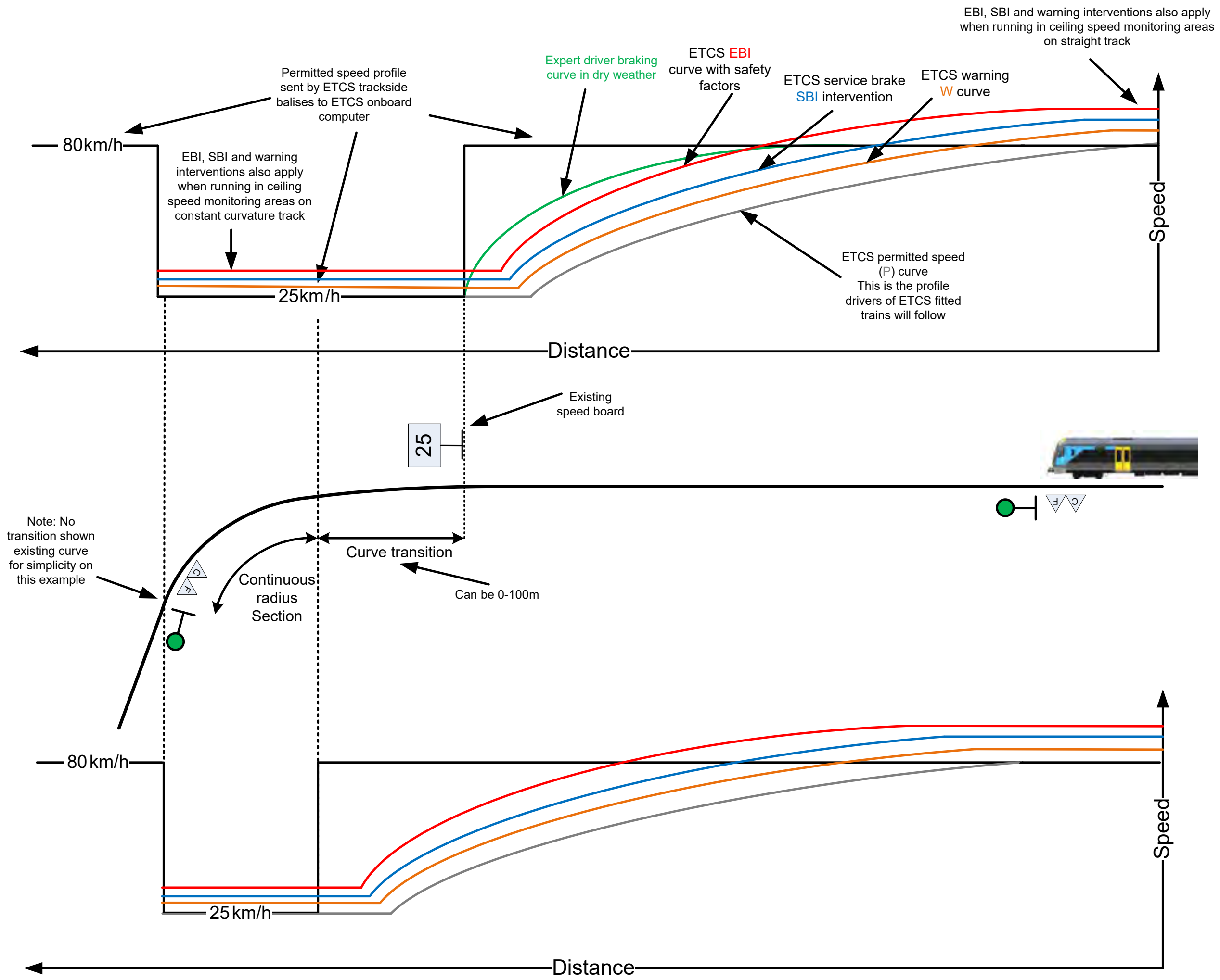
For economic reasons, but also to keep the amount of track mounted physical equipment to a minimum (for maintainability reasons), it was agreed with KiwiRail that the ETCS system in Auckland would be designed without the use of infill. The only exception to this would be where a special, specific, situation required it and a business case could be made to support the installation of additional equipment.

Fortunately, the onboard calculated release speeds combined with reasonable overlaps (nominal 150m) results in release speeds of between 30-50% of average line speed in Auckland for most signals. As such there is no real need to fit any infill for plain line sections as these release speeds are comfortably driveable when following another train. Any improvement would just allow the train to reach the next red signal even quicker.

There are some cases however where infill has proved useful. For junction signals with low release speeds that are often approached at red due to timetable saturation at the junction, infill balises have been fitted in some situations to remove the risk of ETCS hampering junction re-occupancy times.

Only 1-2% of signals in Auckland have infill fitted.

Figure 5 –ETCS curve supervision optimisation, before and after. The speed-distance graph at the top shows ETCS supervision in line with the signs at the start and end of the curve. The speed-distance graph at the bottom shows an optimised alternative where only the part of the curve with the constant radius is supervised.



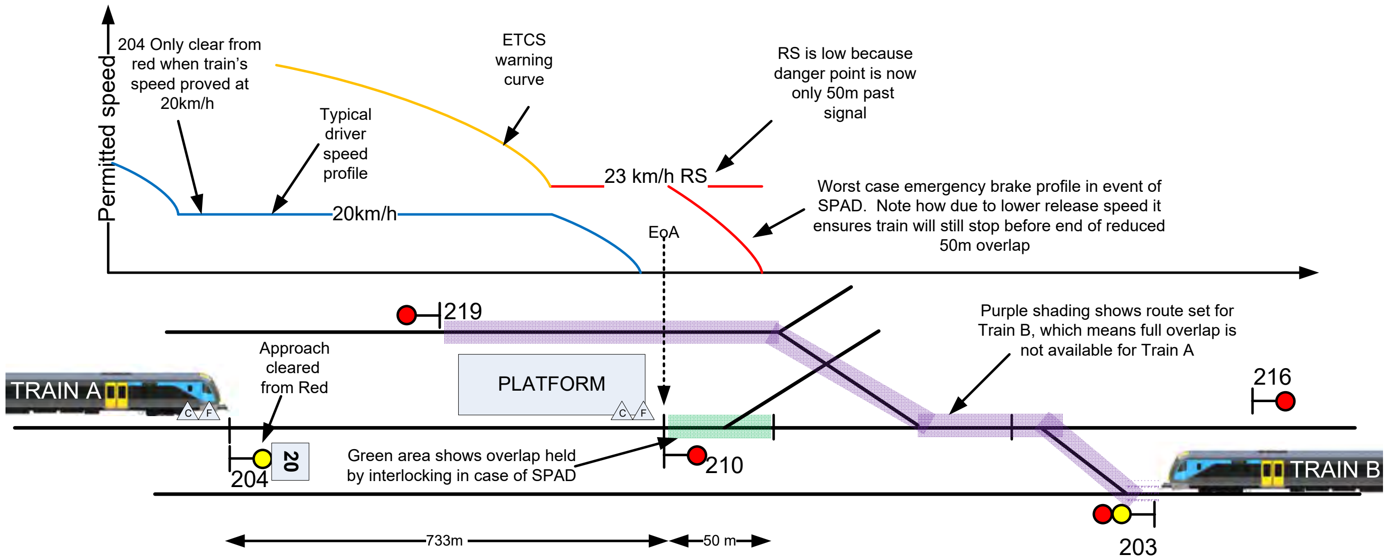


Figure 6 – Warner route with the approach clearing and prior to ETCS DMI precedence rule change.

Warner routes

Warner routes allow a signal to be cleared when the full overlap at the end of its route is not available. To mitigate the risk of a SPAD exceeding the length of this shorter overlap, the entry signal is approach cleared once the train's speed is proved under control. The train's speed through the route is also limited to a slow speed (typically 20km/h). There are only a handful of signals with warner routes in Auckland but where they have been targeted for combined ETCS/interlocking changes, the performance benefits have been significant.

As mentioned previously, most signals have a full 150m overlap, but for some layouts there are other routes that need to use part of the track in this overlap at the same time, to allow two movements to take place simultaneously. In the example shown in Figure 6, if another train needs to travel from 203 signal across to 219 signal, then this reduces the available overlap past 210 to around 50 m. To work around this conflict, 204 signal needs to have its warner route set (i.e. route with reduced overlap), if it is to be cleared at the same time. With the original signalling principles, this would mean that 204 would be approach cleared from red. The signal would only clear when the train's speed had been proved at 20km/h on approach to the signal. A dynamic speed indicator showing "20" would also be illuminated The rules for unfitted trains then dictated that the driver must not exceed 20km/h, all the way to 210. At Newmarket this is 733m, which takes over two minutes at this speed. As a result signallers would often elect to hold a train at 204 signal until the full overlap was available, rather than use the warner route with the 20km/h restriction.

When the 'DMI takes precedence' rule change came into effect, the drivers of ETCS fitted trains could ignore the "20" speed indicator and instead follow the ETCS DMI. To ensure the train can stop in the reduced overlap, the ETCS system enforces a lower release speed on approach to 210 signal when only the warner route is used. To further take advantage of the safety benefits of ETCS, an enhancement project in 2016 removed the approach clearing controls for 204 when the warner route is set. ETCS fitted trains (99% that use this route) gained no safety benefit from the approach clearing. To mitigate its removal for unfitted trains, a flashing advanced speed indicator was added to the signal prior as seen in Figure 7.

This change enabled an uninterrupted braking curve down from line speed all the way to 210 signal. In total, ETCS combined with these changes to the interlocking principles now saves more than 90 seconds when using this warner route compared to pre-ETCS operations.

Level crossings

Building stations in the wrong place

In Auckland all level crossings are of an automatic half-barrier type. This means that when the signals are clear, the crossing will strike-in only about 26 seconds before the train arrives. The ETCS data sent to the trains contains no information about the level crossings. However, level crossings can become a significant performance constraint when they are located in the 'wrong' place and if, like in Auckland, your ETCS engineering decisions are weighted heavily in favour of safety.

Specifically, where level crossings are located immediately next to railway stations, the KiwiRail signalling principles call for stopper/express controls to be provided for the platform starting signals that protect the level crossing. Stopping trains (100% of passenger services in Auckland presently are 'all stops') will come into the station with a red signal at the end of the platform and the level crossing not operating. This gives rise to the somewhat mismatched situation of maintaining a 150m distance beyond the red signal clear as the signalling overlap to mitigate the risk of running into the back of another train, but as shown in Figure 8, pedestrians and cars were not required to be kept clear of the overlap.

When the ETCS principles were originally being developed for this scenario, it was quickly agreed by all stakeholders (i.e. KiwiRail, Siemens, unions, Transdev etc.) that the ETCS release speeds for these signals should be fixed at a value that would try to stop a SPADing train from entering the crossing. In some cases where the level crossing is very close to the signal, the lowest driveable release speed of 15km/h would still not stop a train in time. Nonetheless, it was still a big safety improvement from the previous non-ETCS situation of trains being approaching the signal from up to 110km/h with no automated supervision.

The low release speed unfortunately has the side effect of a significant

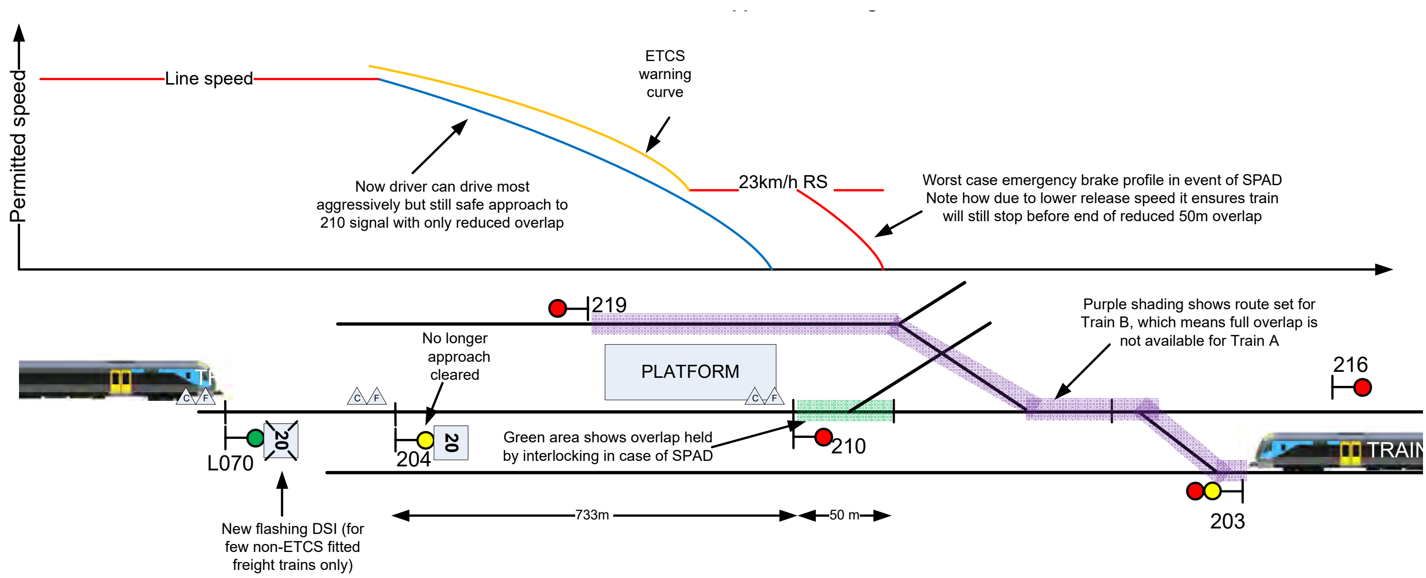


Figure 7 – Warner route with approach clearing for 204 signal removed.

performance penalty as it requires the trains to enter the platform slowly. Then after the dwell timer has elapsed in the interlocking, the crossing is down and signal has cleared, the train is still limited by the low release speed, until it reaches the balise group at the signal and receives its new movement authority.

Proposed solution

A project is currently proposed to change the way stopper mode signals and their ETCS data are engineered to mitigate nearly all the performance constraints currently in place at these stations. This can be achieved while not significantly reducing the overall system safety.

Three possible solutions were initially proposed to the stakeholders:

- Idea 1: Release speed time-off to a higher value.
- Idea 2: Higher release speeds and early level crossing operation.
- Idea 3: Virtual signal with ETCS balise group mid platform.

Ideas 1 and 3 only provided significant benefit to the trains after they had stopped and the signal had cleared, and they also had downsides in terms of complexity or unwanted behaviour. Most of their benefits would also be realised by ETCS Level 2 in the future if the system was ever upgraded as such.

Idea 2 was developed further and site trials are to start soon to validate the predicted time savings and gain feedback from the drivers before committing to a rollout of this change. The main change is that the interlocking is modified to start operating the level crossing just as the train starts to enter the platform. Even with a much higher release speed (~50km/h) this still allows the crossing enough time to complete its warning cycle and drop the barriers before the worst case SPAD could occur (i.e. a SPAD near the release speed). In reality a SPAD would likely only be at a lower speed due to a slight braking misjudgement, as the ETCS would have already supervised a reduction of speed to below the release speed.

This change does represent a slight trade off in safety versus operational performance as allowing the train to enter the crossing at a higher speed always comes with some risks. But these risks are relatively minor, especially compared to the risk profile of the crossings prior to the introduction of ETCS. Another project that is currently underway to fit all pedestrian footpaths at these level crossings with automatic gates, will further mitigate the risk of any person being on the crossing should a SPAD occur.

The change will also provide significant benefits for trains when it comes to departing the station. With the higher release speed, they will be able to accelerate away as quickly as they want. The train will still be below the release speed when it reaches the signal balise group and gets an update.

Simulations have shown that the time the road would be closed to road users would be very similar as is it today. This is because the existing stopper control timers are based on signalling principles that do not take into account the slow approach/departure of ETCS fitted trains

Figure 8 – A level crossing at the end of a platform in Auckland.

where there is a low release speed. As such, currently the level crossings in these scenarios already start to operate a long time before the train is ready to depart. With the proposed new arrangement, the crossing will start to operate earlier, but the quicker arrival and departure will mitigate this and mean the net time the crossing is closed to road users is broadly similar.

There are some subtleties that need to be considered with such an arrangement. Holding controls for the new stopper approach need to be provided. This is so that the crossing is not held up by minimum open time controls after a train in the other direction has cleared the crossing. The ETCS system must also prove that the platform starter signal is ready to clear and the crossing able to drop, before issuing a movement authority up to it with the higher release speed.

Solving these complexities will be well worth the effort however as it is estimated these changes could save between 20-30 seconds per station where this situation exists.

Conclusion

Hopefully this paper has demonstrated a few things, including:

- There are many ways to tweak the configuration of ETCS.
- ETCS brings huge safety improvements but these can sometimes slightly affect performance. However, increases in safety can also be leveraged to deliver performance improvements.
- Drivers won't have any choice but to abide by any slightly conservative behaviour that the ETCS system inherently brings with it. So be sure to change your rules to allow drivers to benefit from anything that ETCS allows them to do safely, which is less restrictive than current operations.
- To get the best from ETCS you must also consider changing other aspects of your signalling principles.
- ETCS installations can be continuously improved after initial commissioning.
- It helps if there is a small ongoing budget pool for small 'good idea' capital works – well we can wish!

Although the paper has described some of the ETCS optimisations that are planned for Auckland or have already been rolled out, the story definitely should not end here. There will be many more projects in the future that find new ways to tweak and improve the way in which we engineer ETCS trackside installations.

Acknowledgements

The proactive and enthusiastic approach from KiwiRail and Auckland Transport to further invest in their new ETCS system, should be commended.

It should be noted that some pictures and diagrams have been reproduced from the paper titled "Auckland – The ETCS City" by the same author. This paper was presented at the RTSA's CORE 2016 conference in Melbourne.

About the author...

Noel has been based in Auckland as Siemens Mobility's New Zealand Engineering Manager for the last nine years. He is responsible for managing the delivery and engineering on all Siemens' NZ rail projects.

Noel started his career in the UK, working for Westinghouse Rail Systems. He worked in a mixture of roles including R&D, signalling design and site testing. In 2006 he moved to Sydney, initially in a design role, but quickly finding his forte was in project engineering on complex or novel projects. He was project engineer for Invensys' participation in the RailCorp ETCS pilot trial and sat on RailCorp's ETCS collaborative working group. After this, he took up the role as lead engineer on the project to re-signal the entire rail network in Auckland.

Industry news

Network Rail innovation activities

UK: During the initial developments of renewal plans to support Network Rail's funding arrangements between 2019-24 it became clear that challenges lie ahead in delivering the Command, Control and Signalling System (CCS) required renewals from 2024 onwards within current funding and access constraints.

Network Rail's research and development plans for 2019-24 include activities to support the long-term CCS system sustainability challenge. Within the Regulatory Settlement announced in October 2018 the ORR supported Network Rail's research and development plan, associated funding. This plan included £54m of direct funding plus £26m matched funding for CCS innovation activities.

The funding announced by the ORR is intended to be complementary to the Rail Industry Sector Deal that was announced in December 2018 and the UK Research Innovation Network that was announced in July 2017. Network Rail which is also a founder member of the European Shift2Rail development activities is supporting and providing alignment of many of the development activities in the Innovation Programme 2 which is associated with CCS systems. In addition, Network Rail in conjunction with Rail Safety & Standards Board (RSSB) and the Rail Delivery Group (RDG) is launching a review into current and future train protection capability. Where appropriate, innovation activities to determine if short-term enhancements to the Train Protection Warning System (TPWS) or opportunities to provide efficient migration to the European Train Control System (ETCS) are being considered.

The funding for CCS innovation activities secured through the regulatory settlement is primarily focused on the opportunities to reduce the whole life cycle costs such that the forecast additional volumes required to sustain CCS systems across the network can be achieved safely and efficiently whilst also delivering opportunities such as enhanced safety, capacity and performance.

Similar innovation programmes to reduce whole life cycle costs are also being carried out by other European Railways such as SmartRail 4.0 in Switzerland. Network Rail is working closely with these innovation programmes such all parties can benefits from these programmes. This European cooperation is being pursued by European Infrastructure Managers under the umbrella of the 'Reference CCS Architecture' (RCA) initiative.

Within Network Rail, the coordination of all the innovation activities within the CCS system arena is being carried out by the Safety, Technical and Engineering Directorate, although specific initiatives will be carried out by other areas of Network Rail as appropriate recognising that all life cycles from renewals conception through to operations and maintenance of the system are being considered.

Funding for positive train control (PTC)

USA: The Federal Railroad Administration (FRA) has released details of $46 million (£36m, €40m) of funding it has released to 11 rail operators in the country to help with the roll-out of PTC, the signalling safety system developed to prevent rail collisions and derailments by allowing locomotives to be monitored and controlled remotely.

The US government department hoped that all of the US's rail operators would have been in a position to run trains under PTC by the 31 December 2018 deadline, after being extended from October 2015. However, the FRA has said that just four of the country's 41 operators have done so. The latest round of PTC is the second in a year from the FRA and brings the total amount to $250 million (£195m, €220m).

A year ago, in early 2018, US Transport Secretary, Elaine Chao, made clear her concerns that the safety technology would be ready in time, and appealed to operators to do everything in their power to ensure that they meet the requirements specified by Congress. The full-scale implementation is hotly anticipated in the US, particularly due to the setbacks that have been encountered to push back the deadlines.

North County Transit District (NCTD) is one of the four agencies that completed PTC implementation by the deadline and achieved full implementation of PTC for 58.5 miles of track within the San Diego County portion of the Los Angeles-San Diego-San Luis Obispo Rail Corridor. PTC is designed to prevent train-to-train collisions, derailments caused by excessive train speed, train movements through misaligned track switches and unauthorised train entry into work zones.

Telstra launches first 5G Melbourne and Sydney sites

Australia: Telstra has announced that it has been given early access to the 3.6GHz spectrum it won at auction, enabling it to switch on 5G at sites in Melbourne and Sydney. Telstra has now completed 187 5G upgrades across the country, including all the major cities across the country

In August 2018, Telstra announced it had started switching on 5G technology, making their mobile network the first in the country to be 5G ready. Since then Telstra has enabled 5G sites in Melbourne, Sydney, Canberra, Brisbane, Adelaide, Perth, Hobart, Launceston, Toowoomba and the Gold Coast.

They have secured between 30-80 MHz nationwide in the 3.6GHz spectrum auction held by the Australian Communications and Media Authority (ACMA). Combined with existing holdings, Telstra now has 60 MHz of contiguous 5G spectrum in all major capital cities and between 50-80 MHz of contiguous 5G spectrum in regional areas.

Toowoomba-based FKG Group will also use the first iteration of the HTC 5G Hub mobile broadband device to test the device's connectivity to the network, which as the device evolves, will allow exploration of transport, logistics and agribusiness use cases.

First 5G call

China: The Guangdong branch of China Unicom and ZTE Corporation in China have claimed to have made the world's first 5G call, by means of ZTE's 5G prototype smartphone in Shenzhen. The test also completed the verification of diverse services, such as group voice calls, online video and web browsing. This first call is reported to be in the non-standalone (NSA) mode and in compliance with version Rel-15 of the international 3GPP standard.

Known as "the City of Innovation", Shenzhen is one of the first 5G pilot cities of China Unicom, and is verifying the 5G network equipment's networking capabilities, special services, roaming and interconnection.

GSM-R roll-out complete in Luxembourg

Luxembourg: A three-year project to deploy GSM-R across the 271km network of infrastructure provider CFL has been completed.

Kapsch CarrierCom has implemented an all-IP RDN.core built on the 3GPP Project Release 4, with RDN.base stations, transmission networks, dispatcher systems and roaming agreements with France, Belgium and Germany. The contract includes maintenance until the end of 2021.

Automated heavy-haul trains

Australia: Rio Tinto has successfully deployed AutoHaul™, establishing the world's largest robot and first, long distance rail network. Since completing the first loaded run in July 2018, Rio Tinto has increased the number of autonomous journeys across its iron ore operations in Western Australia, with over 1-million km now travelled autonomously.

Over the coming months Rio Tinto intend to continue to refine their autonomous operations to maximise its value. They aim to continue to work closely with drivers during this period and do not expect to make any redundancies in 2019 as a result of the deployment of the system.

The AUS$940m (£521m, €579m) programme is focused on automating trains transporting iron ore to Rio Tinto's port facilities in the Pilbara region of Western Australia. The network is the world's first heavy-haul, long distance autonomous rail operation, with about 200 locomotives on more than 1,700km of track, transporting ore from 16 mines to four port terminals.

The average return distance for each train run is about 800km with the average journey cycle, including loading and dumping, taking about 40 hours. Locomotives are fitted with on-board cameras allowing for constant monitoring from the Operations Centre. All public level crossings on the network have been upgraded and are fitted with CCTV cameras.

US Level Crossings

USA: Indiana Department of Transportation is has announced more than $121m (£97m, €106m) of one-off funding under its Local Trax programme to support 12 level crossing safety improvement projects including grade separation and crossing closures.

Local Trax funding is targeted toward the highest priority rail crossings where accidents have been frequent, chronic congestion has frustrated drivers and rail crossings have limited potential for development.

The programme requires local authorities to meet 20% of the cost of land acquisition and construction, with the state providing 80%. INDOT will fund and manage design and environmental work, as well as providing project management through design delivery, contract award, construction and inspection.

Ofcom rail data vision

UK: The UK's communications regulator, Ofcom, has set out a vision for what data connectivity will be required by 2025 on British trains. From their research, in seven years' time, a crowded commuter train is likely to need 3.6 Gbps of mobile data capacity to meet the connectivity needs of its passengers.

The aim of the report is to support the policy work of the Department for Digital, Culture, Media and Sport (DCMS) on delivering fit-for-purpose mobile data services for rail travellers, and how the regulator can make it available.

In a commentary attached to the release of the report, Ofcom state that:

"Designing a network to provide track-to-train connectivity will involve many different considerations other than the choice of spectrum band, such as determining the business model on which such a service would be run, how the deployment would be funded, and potential interoperability across multiple routes or TOCs."

Mobile Network Operators (MNO) have rolled out their service to places where people live and as a result a lot of the coverage for trains is provided almost by accident. The UK rail network is a complex one, with lots of stakeholders including Network Rail, train operators, rolling stock providers and mobile networks so making change to deliver the connectivity needed requires a high level of co-operation.

The Ofcom report supports the UK government's current proposals for making 'uninterrupted' Wi-Fi and mobile (5G) broadband speeds of up to 1Gbps available on-board all UK mainline train routes by 2025.

Mobile coverage and Wi-Fi are increasingly considered as the essential '4th utility', similar to water, gas and electricity and passengers now expect a reliable and seamless service.

The vision will require cooperation and innovative working from stakeholders and engineers both in and outside the rail industry and it will be a challenge for all involved. High bandwidth connectivity will, however, deliver many benefits for railways. This includes both attracting passengers to use the rail service and delivering connectivity for operational purposes.

Danish ETCS progress

Denmark: Following Denmark's first European Train Control System (ETCS), which went into operation on 21 October 2018 on the line between Frederikshavn and Lindholm in Northern Jutland, an additional 11 lines are preparing for ETCS deployment from 2019. The roll-out will commence in the Western part of Jutland and the system will be operational throughout the country by 2030. The plan anticipates saving up to 720,000 hours a year in delays.

Improvements with train tracking for passenger information

UK: A Global Navigation Satellite System (GNSS) Global Positioning Satellite (GPS) led location tracking system is being installed on services run by five operators in Britain from next month, improving the accuracy of positional information for passenger use.

Chiltern, Grand Central, LNER and parts of Northern and ScotRail will be the first train operators to use the GPS technology. This will reduce instances of delayed trains incorrectly showing as "on time" on information boards, apps and websites. GPS tracking which is accurate to a few metres is due to be delivered across the whole network by 2024. GPS information is not suitable for signalling as it will not work in tunnels, and has insufficient accuracy to identify which line a train is on. It is however adequate for assisting passenger information and certain operational applications.

Rail Delivery Group (RDG) research found that passengers are most anxious when facing uncertainty, such as if they are unsure they will make a connection. It also revealed that travellers get frustrated when information about their service is not delivered in a timely fashion.

London Overground operator Arriva Rail London is also piloting another technology upgrade which involves using camera recognition systems to provide better information on the number and order of carriages and to transmit alerts when they need to be cleaned.

As more trains become connected to the internet, passengers will be able to find out the best place to stand on a platform to board their train, which carriages have the most free seats and whether the toilet is working and accessible.

A six-month trial was recently launched to enable passengers to receive personalised journey updates through Facebook Messenger.

RDG managing director of customer experience Jacqueline Starr said: "In 2019, technology will continue to transform the way we travel by train, as the railway introduces new innovations to provide more useful, up-to-date and personalised information at people's fingertips. We want to give customers more control over their journey than ever before and tackle the key points where they get frustrated, as the rail industry works to change and improve."

RAIB calls for safety review of Sheffield junction after double tram collision

UK: The Rail Accident Investigation Branch (RAIB) has called for a safety review after two tram crashes took place at the same junction on the Sheffield Supertram network in just six weeks. Investigators have written to Sheffield City Council advising that a "risk-based review" of the junction and road traffic signals is carried out and that prompt action should be taken based on the findings.

On 25 October, a tram derailed after colliding with a lorry at the junction of Staniforth Road, with police investigating the collision. No-one was seriously injured, but the crash came hours after the launch of the UK's first ever 'tram-train'. Then, on 30 November, a tram collided with a car, once again at Staniforth Road in Sheffield.

The RAIB reported minor injuries caused to the car occupants and to a person on the tram as well as the major damage caused to the car in the collision. Due to there being two similar collisions at the same locations, the RAIB sent an inspector to the scene of the November crash and following this has written to the chief executive of Sheffield City Council.

The city council said that, since November, it had improved visibility at the junction, improved extra warning signs, and started work on installing new LED signal lights. It added that Supertram had also implemented a reduced speed limit for the tram whilst travelling through the junction.

Inspectors also noted that the positioning of a pole supporting the tramway's overhead power supply wires had the potential to worsen the outcome of the accident. The RAIB has suggested that UK Tram consider the guidance in place for the placement of such supply poles in close proximity of roads which cross tramways.

Tram automatic braking system

UK: London's tram network will be the first in the UK to have an automatic braking system. Transport for London (TfL) has awarded Engineering Support Group Limited (ESG) the contract to build and install the new safety system.

It will automatically apply the brakes and bring a moving tram to a controlled stop if exceeding the speed limit at designated locations. Work began on the feasibility of introducing this new safety measure, shortly after the tragic overturning at Sandilands, Croydon, in November 2016. It is expected to be fully operational by the end of 2019, including a period of training and familiarisation with tram drivers, and will operate alongside the driver protection device that has been in operation since September 2017, alerting to any signs of driver distraction and fatigue.

Automatic braking is one of the recommendations set out by the Rail Accidents Investigation Branch (RAIB) following the tram overturning. It will initially be configured to priority high-risk locations as suggested by the RAIB but will have the flexibility to be introduced elsewhere on the tram network.

The RAIB listed 15 recommendations aimed at the UK tram industry following the overturning. Work has progressed on all of the recommendations specific to TfL with some already complete. These include a permanent speed reduction across the tram network, speed monitoring and signage at significant bends, an enhanced customer complaints process and the installation of a driver protection device that alerts to driver distraction or fatigue.

A new emergency lighting system, which will operate independently of the tram's battery in the event of an emergency, has also been procured and will be installed over the summer, addressing recommendation seven. Extensive testing with safety experts has also progressed and a new higher specification film that is 75 per cent thicker (from 100microns to 175microns) will be fitted to all doors and windows to improve containment, as per recommendation six, by spring.

Intelligent sensing and tracking

Austria: The 5th Wheel Detection Forum will be held in Vienna, Austria on 5-7 June 2019. This will provide an opportunity for a wide range of railway experts from across the globe to share their latest insights and exchange their experiences.

The event will feature presentations, discussions and reports on proven as well as future technology. It will focus on innovative sensing and tracking solutions for train localisation and asset condition monitoring.

Decision makers from international railway operators and system integrators, as well as manufacturers, consultants, researchers and association representatives are expected to attend.

Depot safety for Doha

Qatar: Sheffield-based Zonegreen has been commissioned to install its Depot Personnel Protection System (DPPS™) at the Qatar's driverless metro network's three maintenance facilities in Doha.

The system will be installed across three maintenance buildings at Al Wakra, protecting a total of 18 road ends. The decentralised control of safety mechanisms allows staff to isolate specific areas in which they wish to work, without disabling the entire depot. The system is interlocked with the signalling, wheel lathe and bogie exchange equipment, to prevent vehicle movements on roads where personnel are present, or machinery is in use.

Doha Metro will operate 75 driverless trains and will serve both the capital and the suburbs with all major locations.

Most of the lines will be underground with the system built in two phases. The first phase will see the construction of three out of the four lines (Red, Gold, and Green) and 37 stations by 2020. The future phases involve the introduction of an additional line (Blue) and the expansion of the existing lines, with more than 60 additional stations by 2026.

Huawei telecoms equipment and security

UK/USA/Australasia: The Financial Times has reported that BT will remove Huawei equipment from its core 4G network within two years. The report says the move will bring BT's mobile phone business in line with an internal policy to keep Huawei's equipment at the edge of their telecoms infrastructure. Equipment from the Chinese firm was brought into BT when it bought EE back in 2016.

This will also see the firm excluded from bidding for contracts to supply equipment for use in BT's core 5G network, although BT will continue to use the firm's kit in parts of its network, such as equipment on masts.

BT has confirmed that "In 2016, following the acquisition of EE, we began a process to remove Huawei equipment from the core of our 3G and 4G networks, as part of network architecture principles in place since 2006" BT are applying these same principles to their plans for 5G core infrastructure. As a result, Huawei has not been included in vendor selection for their 5G core. BT say "Huawei remains an important equipment provider outside the core network, and a valued innovation partner."

The Wall Street Journal has also reported that the US government is pressuring foreign allies to ditch networking equipment from Huawei. US officials have reportedly reached out to their government counterparts and telecom executives in European and Asian countries where Huawei equipment is already in use, warning them about the 'national security risks' posed by the Chinese firm. Similar announcements have also been reported in Australia and New Zealand banning Huawei's 5G equipment

However, Huawei have said they are "trusted by governments and customers in 170 countries worldwide and poses no greater cybersecurity risk than any telecoms vendor sharing as we do common global supply chains and production capabilities."

Huawei rotating chairman Ken Hu held a press conference in December 2018 with leading global media at the company's new campus in Dongguan. Journalists visited R&D labs showcasing materials and thermal management technologies developed for 5G equipment, as well as an independent cybersecurity lab.

Hu delivered messages about Huawei's business growth and prospects, citing the trust of hundreds of network operators, nearly half of the world's Fortune 500 companies, and hundreds of millions of consumers. Huawei's 2018 revenue, he said, was expected to exceed US$100 billion.

He also directly addressed recent allegations against Huawei, stating that it is best to let facts speak for themselves, while emphasizing repeatedly that the company's security record was clean. Hu noted that there have been no serious cybersecurity incidents in 30 years. He confirmed that:

"Huawei has secured 25 5G commercial contracts, having already shipped more than 10,000 base stations to markets around the world. Some security concerns based on the technology for 5G were very legitimate, noted Hu, but are able to be clarified or mitigated through collaboration with operators and governments.

Rare cases have arisen where some countries are using 5G issues as an excuse for groundless speculation. Security concerns raised as excuses to block market competition would slow adoption of new technology, increasing costs. If Huawei were allowed to compete in the US for 5G deployment from 2017 to 2020, around US$20 billion of capital expenditure in wireless infrastructure would be saved, according to some economists, he said.

Hu was open to a question about building cyber security evaluation centres in places such as the US and Australia, pointing to similar centres in the UK, Canada, and Germany that are designed to directly identify, address, and mitigate concerns. Huawei has subjected itself to the strictest reviews and screening by regulators and customers, while expressing understanding of legitimate concerns that some stakeholders might have.

However, no evidence indicates that Huawei equipment poses a security threat. Regarding often-quoted concerns over Chinese law, the Ministry of Foreign Affairs in China had formally clarified that no law requires companies to install mandatory backdoors. Huawei remains open to concerns about its openness, transparency, and independence as well as dialogue. Any proof or evidence could be shared with telecom operators, if not to Huawei or the public at large.

Some journalists asked about Huawei's Meng Wanzhou. A Canadian court has granted bail to the Huawei executive while she awaits a hearing on extradition to the United States. The US alleges she misled banks about the relationship between Huawei and Skycom – the latter of which had done business with Iran.

Hu said he was unable to comment due to legal processes underway, but he did express that business operations were not being impacted by this event. Executive travel plans were not impacted, and Huawei remains very confident about its trade compliance system, which has been running since 2007. The company has confidence in the fairness and independence of the judicial systems in Canada and the US.

Driverless in Sydney

Australia: A driverless metro train has completed its first full test run along the Sydney Metro Northwest corridor. The $AUS 8.3 billion (£4.6 billion, €5.2 billion) railway line stretches 36km from Chatswood to Tallawong in the city's northwest.

Sections of the routes existing infrastructure have been upgraded from to accommodate the new fleet of single-deck, autonomous trains. More than 19,000km of train testing has taken place so far with 17 out of 22 trains having already been delivered – up from nine in July when the Alstom-manufactured trains underwent their first major tests.

Further tests of the onboard train systems, signalling, acceleration and braking will be conducted before the planned opening of the Metro Northwest line in the second quarter of this 2019. Minister for transport and infrastructure Andrew Constance said "We're finishing stations, car parks and testing trains to get the Northwest rail line open as quickly as possible, on time and at least $500 million under budget".

Stage two of the Metro project, which covers the line from Chatswood through to Sydenham, is still undergoing construction, with tunnel excavation expected to continue until halfway through 2020. Testing of trains and equipment is then expected to be completed by the end of 2024.

Testing of autonomous vehicle technologies for public transit

Japan: Several companies have confirmed their involvement with a self-driving bus test project on East Japan Railway Company's Bus Rapid Transit (BRT) lines. These include Kyocera Corporation, Advanced Smart Mobility Co. Ltd., Aichi Steel Corporation, SoftBank Corp, Nippon Signal Co Ltd and NEC Corporation. They will participate in the project organised by the Mobility Innovation Consortium, an organisation focused on promoting autonomous driving, led by JR East.

The project tests will evaluate self-driving technologies for bus transit applications, including automated lane-maintenance control, speed control, parking assist and alternating passage tests on JR East's BRT lines. The companies aim to identify and solve technology issues that stand in the way of commercialising autonomous bus transit. Public demonstration rides will not occur at this phase.

The tests will be conducted using specially modified autonomous buses to evaluate lane-maintenance and speed control. High-sensitivity magnetic impedance sensors on the bus will read information from magnetic markers placed on routes to identify the vehicle's exact position. Tests will verify the operation of the bus's autonomous lane-maintenance and speed control systems. By automatically controlling the vehicle's brakes and accelerator, typical operation at speeds of 40km/h or lower, with stops at designated positions, will be evaluated.

When investigating precision docking, stopping tests will utilise magnetic markers that communicate spatial information to stop the bus automatically as it reaches the platform of the BRT station. The narrow road 'alternating passage' capability will be tested through radio communication between the bus and location-detection systems, verifying the bus's ability to negotiate passage on a roadway wide enough for just one vehicle, as another vehicle approaches from the opposite direction. The companies will also conduct location-detection tests using GNSS to verify navigation and distance-measurement systems.

Buenos Aires General Roca Railway's signalling system to be renewed

Argentina: An Alstom-led consortium with local engineering company POSE has signed a contract totalling approximately €90 million (£80m, $102m) to modernise the current signalling system on the General Roca Railway in Buenos Aires, Argentina.

Alstom will provide its Smartlock electronic interlocking technology, the Iconis centralised traffic management system and the installation of an ATS (Automatic Train Stop) system. Alstom's responsibilities within the contract also include design, engineering, factory and field testing, technical integration, commissioning and the guarantee of the systems, supervision systems through the local traffic centre, and centralised traffic control and operations post, pedestrian and automatic level crossing barriers, copper and fibre optic cables network and signalling room's detection and fire protection system.

POSE will install the copper and fibre-optic cable network, execution and integration of civil and electrical works, construction of the control and operations centres, engineering of the power line and optical fibre laying, and fire detection and protection system for the signalling room. Together both companies will jointly carry out field tests, commissioning and support.

The General Roca Railway is the most extensive line in the metropolitan area of Buenos Aires, including 237km of track that transports 600,000 passengers per day.

RSSB inquiry reports

UK: Rail Safety and Standards Board Limited (RSSB) provides research, analysis, and insight to help the GB rail industry to deliver a better, safer railway.

One publication by RSSB is a monthly collation of some of the world's railway formal inquiry reports. It includes a brief incident synopsis, along with the main causes and recommendations from each investigation, see irse.info/ujzga.

Some of the key issues raised and/or suggested by the reports include: change management, complexity of rules, fatigue management, GSM-R interface, interlocking of signals, knowledge sharing, learning from previous incidents, mobile device usage, on-site risk assessment, safety culture, signaller error, signaller training, signalling design complexity, signalling panel design, and track worker protection and safety.

Deep Tube resignalling postponed

UK: In its draft business plan published on 11 December 2018, Transport for London said that it had discontinued the current procurement process for resignalling London Underground's Piccadilly Line, as capital funding beyond 2020 was not confirmed and it had "decided to work with our suppliers to review the programme so that it delivers in the most efficient way".

If you have news you'd like to share, email it to editor@irsenews.co.uk.

News from the IRSE

Blane Judd, Chief Executive

February and March are always busy, expectant months for us here at IRSE HQ as Council and my team get ready for the AGM and the start of a brand-new presidential term. At the AGM we will officially welcome the current senior vice president George Clark as the 2019 IRSE president.

Outgoing president Markus Montigel presided at his penultimate presidential programme meeting last month in Darmstadt, realising his ambition to shine a spotlight on the truly international nature of the IRSE. Markus is also a champion of live-streaming and members across the world went online to take part in the presentation which was hosted by Technische Universität Darmstadt. The IRSE would like to thank the team at TU Darmstadt for their hospitality and warm welcome and look forward to future opportunities for collaboration. The full paper can be read on page 2.

The final presidential programme in Markus' tenure will be held in Brisbane on 15 March and to round off his presidency I am currently working on an exciting interactive seminar event taking place in London on 11 April.

The IRSE Council met on Thursday 7 February when we had very productive and full session. We discussed the preparations and programme for the next presidential year (April 2019 – April 2020) and the council elections taking place. Council approved recommendations from the Membership and Registration Committee for membership applications, transfers and Engineering Council registrations. These are published in this edition of IRSE News. Reports were received from some of our principle committees: Education & Professional Development Committee, Licensing Committee and Audit Committee in addition to those from local Sections in Malaysia, North America and Switzerland. We received and approved the recommendations for the Thorrowgood Scholarship and IRSE-Signet Awards from the Exam Committee which will be announced at the AGM.

Industry news

Whilst the news in the UK has been dominated by 'Brexit', I'm pleased to say that there has been a great deal of positive and exiting new developments going on in the railway signalling and communications industry worldwide – full details of which can be read from page 18.

55th IRSE Annual Institution Dinner

The Annual Institution Dinner will be held at The Savoy, London on Friday 26 April 2019, following the Annual General Meeting.

The capacity of the room is restricted to a maximum of 350, laid out in tables of ten. Please book early to avoid disappointment for what is always a sell-out event. Tickets cost £159 including VAT per person. Tickets will be despatched in mid-March, giving table hosts the opportunity to confirm invitations to their guests. Details of the menu and an order form for pre-ordering wine and a hosted bar will be sent with the acknowledgment of your ticket allocation. The form will also allow you to advise us of any special dietary requirements.

Please email hq@irse.org to obtain an electronic copy of the application form, or you can download it from irse.info/h2iyv. Completed forms should be emailed to hq@irse.org as soon as possible and no later than Wednesday 12 March 2019. Tickets will be allocated in order of receipt of application, so you are advised to apply as soon as possible.

Retirement news

This month also sees staff changes at head office. Our membership and registration manager Christine White (pictured above) retired at the end of February after almost 13 years of hard work and dedicated service to the Institution. We thank her for her contribution to membership services at the IRSE and wish her a long and happy retirement. We are at the final stages of recruitment and will announce details of her successor and also a new licensing registrar shortly.

Upcoming Section events

Events in March include the following. Please see IRSE website for full details of all events.

- Swiss Section AGM and technical visit of river port railway "Hafenbahn Schweiz AG". 8 March 2019, 1.30pm to 7.30pm.
- Midland and North Western UK Section technical paper 19 March 2019 7.30pm: Telecoms Innovation, Tim Lane (Network Rail) Location: Birmingham Network Rail Offices, Baskerville House, Centenary Square, Broad Street, Birmingham, B1 2ND.
- York Section annual dinner 21 March 2019 7.00pm. Location: the National Railway Museum, York.

French Section

IRSE
Institution of Railway Signal Engineers
FRENCH SECTION

Digital Continuity in signalling: to do what and why?

Yann Freson, Philippe Le Bouar and Hugh Rochford, SNCF Réseau

The French Section of the IRSE hosted a series of papers within the Presidential Programme on Friday 14 September 2018 in Paris. In this article members of the section explain some of the content of the presentations given on the subject of digital continuity in signalling.

The implementation of a Building Information Modelling (BIM) approach in any sector aims to build unifying media for the system lifecycle, from planning and delivery to operation and maintenance. The main idea of BIM in the field of signalling is to build a database that grows progressively during the implementation of a project, with data from various sources.

The data must be sufficient to facilitate the implementation of the installation, establish necessary deliverables for the operator or maintainer, and guarantee a digital continuity between the different stakeholders, including the infrastructure manager and its suppliers. This concept offers the opportunity to develop not only tools that help the design and validation, but also tools for unidentified future purposes that we cannot yet imagine.

The BIM approach for the signalling part of an infrastructure project must integrate with the approach taken for the overall project. The particularity of the signalling field is that the issue is more about the functional, rather than the physical, description of the constituents of the signalling system. The purpose of this article is to show the contribution of BIM in the field of signalling as used by SNCF Réseau.

A glimpse of tomorrow

The acquisition of topological data with modern methods makes it possible to benefit from a massive base of information. SNCF Réseau's 'data factory' provides a service for custom infrastructure projects. Even if this topographic data is not completely necessary for signalling equipment design activities, it is an opportunity to build for the future. For signalling in particular, some of the data must be sufficiently sustainable in reliability and integrity. SNCF Réseau's service guarantees the necessary level of integrity and accuracy of the data and ensures that it is adjusted to the needs of the design or modification activities.

Approaches such as BIM offer real alternatives to conventional approaches to infrastructure design and may be applied to railway command and control.

This data complements or updates the GIS (Geographic Information System). This is organised in a common data model, called RailTopoModel, which is promoted by the UIC. For a signalling project that modifies or renews an interlocking system or railway line, the modelling of the functional requirements is carried out first. The model is based on the topological reality of the infrastructure and called GAIA, which is compatible with RailTopoModel.

An operator describes their role within the future infrastructure to the engineer, who models their needs and constraints through tools and a standard data model constituting the functional catalogue of the rail system. This is known as the Common Model for Signalling (MCS).

The MCS is an initiative launched by the SNCF Réseau Signalling Department to define a common model of the overall signalling system. This aims to define a common ground to represent the different levels of the signalling system; from the detailed functional aspects of its components (interlocking systems, automatic train supervision systems, etc.) to the technical assets requirements.

The engineer has simple modelling tools, but they offer a standard library of railway objects. The model created allows for an in-depth dialogue between the engineer and the operator, a more accurate simulation of the solutions provided, and an early validation of the interfaces and future technical guidelines. In particular, the hypothesis and objectives of flow or station capacity can be validated quickly.

The model is the basis of the continuous digital process. From this moment on, the functional modelling only gets richer throughout the process without interruption caused by migration to a new data environment. The functional model thus becomes the specification of the subsequent design process, making it possible to work identically with an industry partner, or an external/internal design office. The model – within the limits of the common signalling model and its rules of coherence – does not prescribe tools that everyone must use to manage it.

The next activity is to populate the functional model with the design objects and in particular the signalling principles. This will include the description of

Glossary

ARGOS project: French innovation partnership whose purpose is research, development and deployment of a generation of generic platform for interlocking or RBC signalling systems. The main objectives of this partnership are to reduce the costs on the life cycle of the systems, to reduce the interruptions of circulation during their implementation, to optimise the maintainability of the systems and to allow an evolution of the product in the future limiting the homologation work. Strong requirements are imposed by SNCF Réseau to guarantee a good independence between the generic hardware; the generic software and the specific application (see EN50129).

EULYNX is a European initiative by 12 Infrastructure Managers to standardise interfaces and elements of the signalling systems. The first phase of the project provided a full set of specifications.

GAIA : SNCF Réseau GIS supporting RTM data and MCS models

GIS (Geographic Information System) is a system designed to capture, store, manipulate, analyse, manage, and present spatial or geographical data. GIS applications are tools that allow users to create interactive queries (user-created searches), analyse spatial information, edit data in maps, and present the results of all these operations.

Signalling principles: Formal description of the dynamic behaviour of signalling. The principles are a component of the generic application layer (see EN50129) specific to the signalling system implemented (RBC or interlocking). The setting of the signalling functions for each deployed site is part of the specific application layer.

RailTopoModel (RTM) is a logical object model prompted by UIC to standardise the representation of railway infrastructure-related data. Together with railML®, which defines the scheme for the exchange of data, it will revolutionise the sharing of information in the railway industry.

generic functions which are specific to the network and those common to all new generations of interlocking systems. The model is enriched until the required set of data for system design and construction is achieved.

The future design process will be one where designers no longer use simple drawing tools like today. Instead, modellers will use digital tools to ensure the internal consistency of the model. The process will support formal analyses to provide a higher quality of design.

When all the functional design activities are complete, the database can be provided to the industry partners to provide adequately parameterised systems independent of the supplier. Indeed, the signalling principles are common to the all-new generation of interlocking systems (ARGOS project, see glossary),

This will allow a computer interlocking system planned to support the common modelling with an architecture to anticipate the future (based on CENELEC standards), a separation between the generic product (the platform that can become an interlocking system or a RBC), the generic application (the principles and supports of common signalling model), and the specific local application.

The system can be fully tested by formal proof methods to increase the efficiency of the testing and commissioning activities, with standard verifications and tests appropriate to the scope of integration.

The user deliverables – operating documents, maintenance documents etc. are generated from the final database. Their format no longer comes from the limitations of paper-based design but is adapted to the end user requirements.

Finally, the model is entered into a GIS database "GAIA". This 'digital twin' provides information to all other 'actors' of the railway system and it is not just used for signalling. The functional digital twin of the installation allows, during the whole life cycle of the installation, the opportunity for re-design, simulations, training opportunities etc. In short, modelling to anticipate rather than react to any aspect of the system.

A route towards the future

Building a complete functional digital twin involves handling a very large amount of data. The data must be maintained and must remain relevant to limit the need for reacquisition or re-design. In order to achieve this goal and for it to add value requires a staged method of construction. To build the digital twin the functional aspect of the system is required before the technological aspect.

Moreover, the functional aspect is the most stable and the least impacted by the 'life' of the system since it is not subject to aging or alterations during maintenance, and therefore the least expensive to sustain over time. The first step is to build the MCS and associated tools to describe both the topography and functional needs, to complete the functional design, and finally use the accurate modelling technology to the complete twin. The steps must be the enrichment of the same model over time, without interruption.

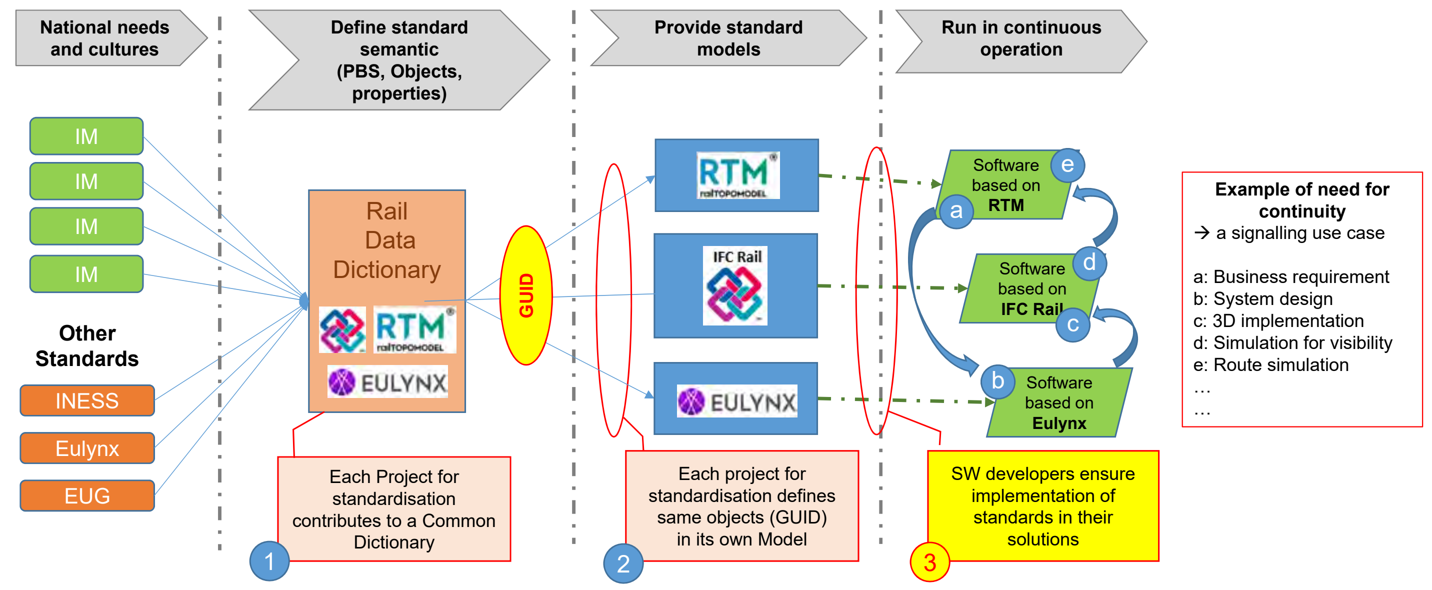
This MCS will be the common dictionary that will structure the digital twin. It is this model which, once localised or instantiated, will allow the parameterisation of the system. The SNCF Réseau teams are already working on building this model, which will be completed in 2019. It is specialist work that involves the designer, the operator and the maintainer. Part of this work is enriched by visions of different approaches to European railways and industrial collaboration. Eventually all the systems will use a common vocabulary to describe a route, a flow, or even topography.

In particular, the work by the EULYNX consortium (the RailTopoModel approach) are sources of inspiration for the teams and they actively contribute in return. The model is also enriched by a functional part specific to the French network and in particular derived from its specific signalling principles.

An ongoing exploratory phase aims to evaluate the tools and methods existing on other networks as well as those of industrial partners and engineering firms. This phase will result in a tool creation project to support the modelling in the second half of 2019. This will be followed by further work including simulation.

Although the vision of the target is becoming more precise, there are still areas of significant uncertainty. For example, academic work on formal methods is still in progress and our ability to develop effective tools on time is also a risk. The successive proofs of concept have a value in themselves, but their value increases tenfold when added together.

For example, a modelled functional requirement brings gains in itself in terms of validation of the requirements, but when associated with simulation tools the value increases, and even greater when incorporated with the digital twin. Gains on the implementation process and on tools must be made without having to wait to have a complete digital twin.



The concept of a rail data dictionary.

As a result, work is underway to review the design process. With the aim of defining the activities to generate the necessary value for the system setting and in particular in a context of ERTMS Level 2 without lineside signalling, based on the MCS. This work is independent from the format of the deliverables and even from the existing organisations of the SNCF Réseau design offices or the distribution of activities between the various 'historic' elements in the process.

It is necessary to build the most appropriate industrial tools to implement the targeted architecture and not to make compromises with the design of the target to 'fit' into an existing process.

Large gains of productivity are also sought in the implementation tools through formal proof. Demonstrations have already been carried out and requirements are included for the next computer interlocking system, ARGOS. Other research works are also under way, which may create more smart design tools.

Another aspect that should not be overlooked is the transformation of organisations and the impact on employees. Driving the change will be a crucial element. If initially this is an expert approach, it will have to find an operational and industrial reality within the human resources of SNCF Réseau and its partners.

The new process has an impact on how to understand signalling. Admittedly, it makes it possible to prepare the transition towards a frugal signalling in terms of assets, very abstract. The suppression of the lineside signalling makes it possible to rethink the functional solutions, as the cost of a signal is reduced. Engineers must get rid of their old design reflexes. These reflections are also coupled with architectural works on signalling solutions. These opportunities are also to be seized in the field of digital continuity: indeed, the foreseen tools of digital continuity will make it possible to increase the number of logical objects without increasing the design time.

Lastly, to ensure long-term performance, an action that puts the right data in the right place is required. Precision, integrity, durability are parameters to be defined in the context of signalling. Methods of massive data acquisition exist and are operational, but they are expensive. It is necessary to define the necessary and ideal amount of needed data, as well as to be able to adapt to the context, acquisition and the maintenance of the data.

In particular, the level of precision is often very important but without any functional reality. The tools implemented at acquisition should allow a great precision without additional cost, as to maintain this information to this precision during the life of the installation can be expensive and can be avoided. It is therefore necessary to precisely define what is necessary for the maintenance and the future modification of the installation.

An actual use case: Nice Vintimille

The strategy to create small gains but gradually drawing a trajectory towards the digital twin allows short term benefits from the work in progress, but the dynamics of the transformation also needs a clear, concrete, and complete vision.

The choice of an ERTMS level 2 system architecture without lineside signalling is an optimal compromise for our network which allows significant productivity gains in design and maintenance, backed by a complete digital modelling approach. This choice also makes it possible to partially prepare the network for ERTMS level 3 or other architectures to be researched.

It also seems essential to us to display an ambition to deliver the final target within the framework of an identified project. This is the modernisation (regeneration of the interlocking systems and deployment of ERTMS L2 without lineside signal) of the Nice Ventimiglia section, and the first phase of the Marseille Ventimiglia line plan. In doing so a plan is emerging and delivery milestones can be defined.

The context of the project is as follows. The track plan is simple; the local context makes it possible to get rid of aspect signals with little or no change of topography. The functional objectives definition activities will begin in September 2019 and with the commissioning scheduled for 2024.

Alone one goes faster but together we go further

There are still many developments to be undertaken, requiring innovation and research for collaborations and future opportunities. While the ARGOS co-design workshops will be laboratories of important ideas, the stakes are greater

The event, in Paris, at which the presentations summarised in this article were presented was well attended.

because the design process as well as the architectural solutions will be redesigned.

In particular, SNCF Réseau and its partners will be confronted with many issues. How to train signalling designers to the new tools and methods? How to allocate responsibilities in terms of safety? What new validation steps for this new process should be established? How to share a data model agnostic from a technological point of view and to the parameterisation of systems? How to both enable the innovation of our partners on the design tools to increase their productivity without creating as more design processes? And many other questions will arise.

Conclusion

Despite all these questions, the objective seems to us attainable and the target desirable.

In particular it is attainable, because we have confidence in the skills of the men and women who make up SNCF Réseau's engineering, and our industrial partners with whom we are building new ways of working. All the relevant organisations can be mobilised towards the objective and the need for modernisation is enormous.

Finally, we must sustainably modernise the railway. The challenges of tomorrow will be digital. Decision-making algorithms will massively need data.

Project needs are such that the 'time to market' of signalling projects must be drastically decreased. The service constraints and availability levels expected by the mass transit of tomorrow will no longer allow a reactive system – anticipation will be the key word and this will require more simulation and training capabilities. All this requires a functional digital twin that will be the foundation to build on.

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London & South East and Midland & North Western Sections

The journey of the tubular stretcher bar

Report by Peter Halliwell

IRSE Institution of Railway Signal Engineers MIDLAND & NORTH WESTERN SECTION

IRSE Institution of Railway Signal Engineers LONDON & SOUTH EAST SECTION

For its November 2018 meeting the Midland & North Western Section met at a new venue in its territory, Milton Keynes, and joined forces with the recently formed London South East Section, for a presentation by James Dzimba, professional head of switch and crossing (S&C) systems for Network Rail written by Neil Cunningham in his team.

At the time of the presentation across the network 13,086 tubular stretcher bars (TSB) are installed on 5507 sets of points which is 35% of the total scope for installation of 15,824 replacing all predecessor types (black, yellow and adjustable). The installations were risk-based such that the high-risk sites were completed first and the remainder will be replaced as and when a failure or renewal occurs. The aim is to replace all black and yellow stretcher bars with a tubular stretcher bar. A further 4641 sets are out of scope as they are either mechanical, hy-drive or HPSS point systems.

James gave the audience a potted history of the background to the development of the TSB, its design and testing process and explained the various configurations in the different circumstances in which it is employed.

Background

Former British Rail chairman Sir Peter Parker is quoted as saying "the railway falls flat on its interfaces" and one of the least well understood interfaces in S&C has been that between the P-Way engineer and the signal engineer. In Network Rail this challenge has been met professionally by recognising that S&C systems are a whole sub-system of the infrastructure and having engineers dedicated to each aspect of S&C and the sub-system integration.

Prior to the recent changes the existing forms of stretcher bar, the fixed (black), and the adjustable stretcher were taken for granted in application as fit for purpose in projects, in operation and maintenance. The design parameters and operational contexts were not considered, they were what was used, and they were assumed as fit for purpose. That was until the accidents at Potters Bar on 10 May 2002 and Grayrigg on 23 February 2007. The investigations into both accidents called for a fundamental review of the engineering of both the associated forms of stretcher bars and fastenings.

For black stretcher bars their load cases were measured by instrumentation of stretcher bars, junkers tests, which test bolt security, and torque checks. It was found that the bar did not meet the load case and further it could not be re-engineered to be fit for purpose. However, it could be re-engineered relatively quickly to eliminate a number of failure modes. This was done and the yellow stretcher bar was introduced in 2009. This gave a little breathing space to develop a fit for purpose stretcher bar.

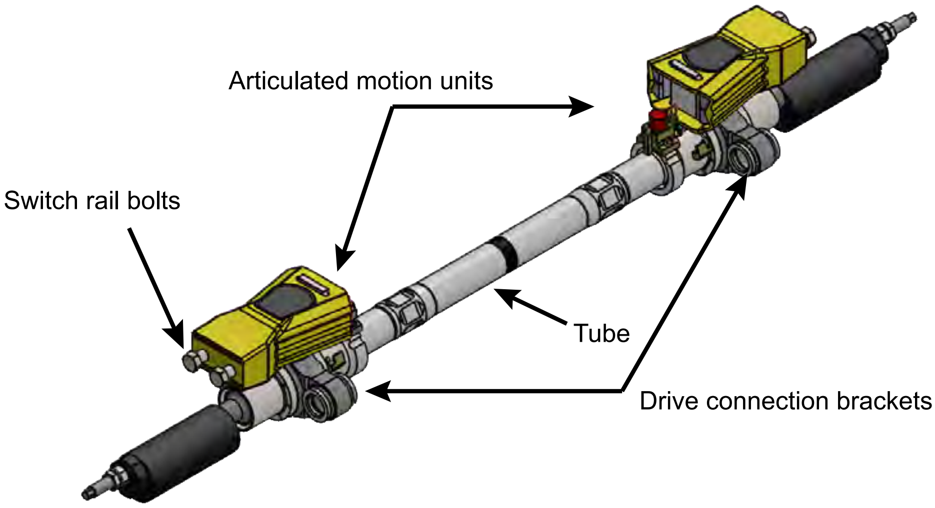
Development and design

One of the features of the loading on S&C identified was flange back contact (FBC) on the open switch rail by passing wheels in the flangeway. The stretcher bar has to hold the open switch and absorb the energy from FBC. Through design iteration a solution based on a tube for the stiffness and resilient mounts for energy absorption was identified as the preferred approach. Tubular bars were selected for their strength-weight ratio and resilient mounts, called motion units, were pre-loaded (compressed) to be able to transmit the load in normal operation but release the load during FBC or run-throughs of the closed switch in the trailing direction. This design effectively de-couples drive loads and system level overloads.

Testing

The testing process included: static testing to distortion, dynamic testing (10 units each tested for 2 million cycles), corrosion test, traffic testing in a test track, run-through testing in a test track, operability tests and finally pilot installations. The dynamic testing was carried out at Element Aerospace Laboratories in Warwick. The test track installation was at the Association of American Railroads Transportation Technology Center, Inc (TTCI) in Pueblo, Colorado. The test ran 2.68 million axle passes and an accumulated tonnage of 94.9 million gross tonnes. There was no loss of function or failure in the test assembly and the peak deflection of the switch rails was 19mm.ideally should be zero as this reduces free wheel clearance. During service the stretcher bar are set using a formula to calculate the correct switch opening so that there is no possibility of flange back contact occurring. The 19mm measurement equates to a 33mm free wheel clearance when in practice we require a 52mm clearance (if track gauge is measured as being correct).

An ergonomic assessment was also carried out as part of the process including TSB designers, S&T technicians, trades union representatives, maintenance engineers, training specialists, TTCI staff and the professional



A tubular stretcher bar.
Photo and diagram Network Rail.

head's team. This provided important input and led to design modifications to improve how the TSB is fitted, adjusted and locked and to the associated tooling used in installation and maintenance activities.

Configurations

For application there are 13 different configurations which are made from five different tubes and four different motion units. The tubes are identified by the number of stripes, from one to four, and there are two different types with a single stripe, black or red. This gives a range with short, medium and long TSBs and offset drive lugs and for clamp lock operated and other forms of points operating equipment. The motion units are identified by colour, yellow, red, orange or white. Yellow units are the most commonly used in all positions on full depth switches except for the front stretcher where the points are operated by the clamp lock operating equipment when white motion units are employed. TSBs are compatible with BR inclined, full depth vertical and shallow depth vertical S&C in BS113A layouts (CEN56E1 rail) and RT60 layouts (CEN60E1 rail) operated by HW, Style 63, clamp lock or in-bearer clamp lock points operating equipment.

Application in the field

Initial roll out was specified under special inspection notice (SIN) 126 under four phases. It was risk-based and targeted the highest risk switch configurations operated by electric and clamp lock point machines. It is complete and covered all higher speed (greater than 40mph, approx 60km/h) facing switches and switch diamonds operated by clamp lock and electric points machines.

Further developments

A number of further developments have been developed or are planned: application on other forms of points operating equipment, use of a 30mm deep socket extension on foot mounted rail bolts to avoid incorrect torquing, a head retaining plate to hold bolts on two faces and a new kicking strap for RT60 switches.

As a mechanical system TSBs as employed have experienced failure modes. In service application has helped understand these failures which may lead to other modifications, and informs the inspection and maintenance requirements for the TSBs. It was noted that in hindsight application of the common safety method for risk assessment might have identified hazards and risk earlier in the design lifecycle. TSBs are still a relatively new product which will evolve but they have driven a step change in system integrity in S&C systems.

The event was held at Milton Keynes in the Network Rail national centre known as The Quadrant:MK. The centre includes engineering, logistics, operations, timetable planning, IT, procurement, planning and finance.

The LSE and M&NW Sections would like to thank Network Rail for the facilities and refreshments provided and further joint meetings may be held there; it being the north of the LSE Section and south of the MNW Section.

London & South East Section

LHR T5 Transit Systems visit

Report by Rod Muttram

IRSE
Institution of Railway Signal Engineers
LONDON & SOUTH EAST SECTION

On 22 November 2018, 19 members of the section visited the Bombardier Innovia 200 Automated People Mover (APM) that connects London Heathrow Airport (LHR) Terminals 5A, 5B and 5C. Some members also visited the 'Pod' system that connects Terminal 5A to the associated business car park.

The visit had been facilitated by Bombardier RCS and was kindly arranged by the LHR T5 Transit Operations team led by Nathan Hill. We are grateful to Nathan and his team, particularly Jan Ancsell for her hard work in arranging all the temporary airside passes for us and to Mark Davies for the security arrangements needed to go into the airside operational areas.

The visit started by visiting the control room from where the transit and the Pods are both controlled. The transit is currently operated as two 4 unit 'push-pull' shuttles, one each on the North and South Guideways (as the tracks of rubber-tyred transits are usually known). LHR has ten units in total so there are two 'spares' which can be on maintenance/repair or standby in the depot. There are plans in discussion to upgrade by increasing the fleet size and modifying the layout slightly to allow 'loop' operation to increase capacity.

The transit already carries over 27 million passengers a year, but this is planned to increase as more flights move to T5 with the changes associated with the LHR third runway. The control room was a familiar control desk type with track layout displays showing the train positions and CCTV covering all of the platform areas. On train security is currently carried out entirely by patrol staff although there are plans to add on-train CCTV as part of the upgrade.

Leaving the control room, we passed through staff security to go 'airside'. Those of us who had not experienced this before were very interested to see that all staff entering the airport must go through exactly the same X-Ray and magnetic screening tests as the passengers so no chance of taking a flask of tea to work!

The IRSE visit group with LHR operations and maintenance staff in the depot area.
Photo Rod Muttram.

We soon found ourselves in the surroundings of the T5 duty-free shops and restaurants familiar to many of us, but after emerging from an unfamiliar small staff door. Down the long escalator to the platforms and we joined with passengers to ride out via T5B to T5C where we then 'disappeared' again though a small door onto the end of the walkway of the operational transit and into to the depot/maintenance area.

Heathrow's Terminal 5 sees some 32-million international passengers every year.
Photo Shutterstock/Alexandre Rotenberg.

The two Innovia 200 units currently in the Depot as spares/under maintenance.
Photo Rod Muttram.

Innovia 200 wheel and tyre and the CBTC Radiax antenna mounted on the solebar
Photo Rod Muttram.

The depot area felt very spacious with only the two spare units present. The depot has space for all the vehicles for overnight stabling and cleaning. There is one track on the North side and two on the South. The only switch in the depot is to access either of these south side tracks, there are no other interconnects so any vehicle movements from South to North must be made through the crossovers on the operational guideway. There is currently no signalling in the depot so all vehicle movements are manual, but as part of the upgrade it is planned to signal the north bay so that a unit or units can be kept in 'hot standby' to immediately increase capacity or replace a defective one.

Signalling is via Bombardier's Cityflow 650 full moving block CBTC which is not very challenged simply running two trains in shuttle mode. Track to train radio communication is via 'Radiax cables' (leaky feeders) trackside and antennas on the vehicle solebars. Train positional accuracy, particularly for accurate station alignment with the platform screen doors is provided by 'norming point' tags on the guideway using Tagmaster tags which have a lithium battery giving circa ten years life. There are additional tag readers at cant rail level at the tunnel entrance with tags on the vehicles to read the consist. With no signalling in the depot trains are registered into the signalling system as they enter the operational guideway.

The Innovia trains are each two axle units running of what are essentially truck axles and tyres. Axle load is circa 16 tonnes (tare) with a lot more for 'crush loading'. The vehicles can be elevated by jacks in the depot which have two 'tines' either side of these tyres. This allows most underframe maintenance to be carried out. There is also a pit on the central depot guideway (the north track of the southern two) but access from this is limited by the central guiderail so it tends to only be used for routine inspections. Tyre changing is done by elevating a unit using the jacks then lowering it on to axle stands. The central guiderail has power rails either side and a central earth rail as well as running surfaces for the two horizontal 'steering wheels' that guide the units.

The system is entirely operated and maintained by LHR staff with no day to day involvement from Bombardier. LHR believe this suits them best with full control and familiarity with the system as well as being most cost effective.

Talking with the maintenance staff the system is considered to be largely well built and reliable. Their biggest reliability 'headache' is the small plastic tops fitted to water bottles which are carelessly discarded by passengers and end up

Some members took an opportunity to try the 'pod parking' system.
Photo Shutterstock/Ceri Breeze.

in the platform screen doors preventing them from fully closing and detecting.

After the depot visit, we exited from the North guideway (having entered from the South) and thus moved from the outgoing (screened or 'clean') passenger area to the incoming (unscreened or 'dirty') area. We then rode back up on the APM to T5A along with the incoming passengers, however on arrival at T5A rather than proceeding up the escalators to passport control we were guided through a staff door back to the screened or 'clean' side to return to the control room.

All in all an interesting visit and the Section is very grateful to LHR for allowing and facilitating it as well as providing guides.

A number of the Section then took the opportunity to have a ride in one of the 'pods' out to the T5 'pod parking' and back. These are 'on-demand' shuttle vehicles which run autonomously on a mostly elevated concrete guideway from the terminal to one of the south side business car parks. There are two small 'stations' in the car park and one large one in the terminal with 'chevroned' parking and charging bays for the vehicles which are based on battery powered electric golf carts.

Midland & North Western Section

Innovations in the era of Industry4.0

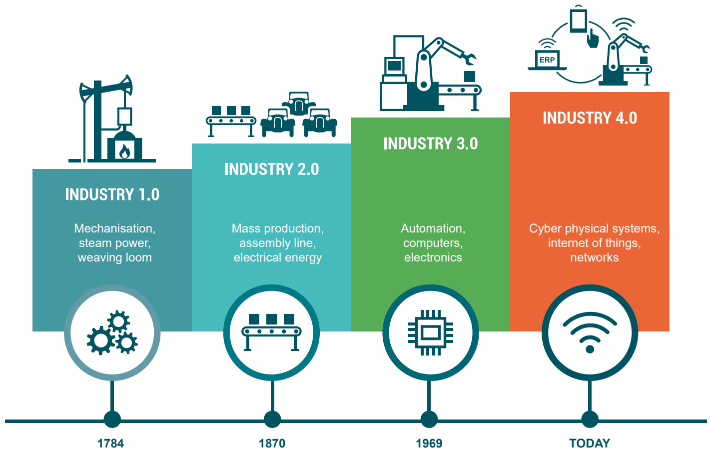
Report by Ian Mitchell

The speaker for the meeting at Derby on 11 December was a familiar face for members – our current section chairman Ian Allison, well known for numerous roles within the IRSE, but on this occasion speaking about his 'day job' as business development director for Park Signalling Limited (a Unipart Rail company).

He started by explaining the title for the talk. The first industrial revolution was about steam power and factories, the second about electricity and the assembly line, the third about electronics and automation, and we are currently living through the fourth which is about cyber-physical systems, cloud computing and the 'internet of things'. For instance, condition monitoring systems to detect deteriorating performance in trains or signalling have been around a while, but the real benefits are realised today through networking and 'back office' systems that analyse the data and integrate with maintenance management and the supply chain for replacement parts.

Ian went on to describe some examples where combining these concepts with older technology creates new products to cut costs and improve safety. The first example showed how even the most traditional component – a single line key token – can become part of the 'internet of things'. DiBLoC is a modern replacement for the Tyer's token instrument – compatible with existing physical key tokens but communicating via the internet. This allows operators to retire their hundred-year-old equipment and legacy communication systems whilst retaining a well understood method of working on low traffic routes that are at the back of the queue for investment in modern signalling.

DiBLoC, a modern replacement for the Tyer's token instrument.



The path to Industry 4.0.
Image Shutterstock/elenabsl.

A second example was TRAMSAFE, a speed supervision system for tramways. This has been developed in response to the multi-fatality derailment that occurred on Croydon Tramlink in 2016, where the driver of a tram failed to brake for a sharp curve at the end of a long straight reserved track section. The accident enquiry recommended UK tram operators to consider installation of an automated system to reduce the risk of this happening again, but conventional 'heavy rail' systems such as ETCS or CBTC are inappropriate. The solution needs to be low cost and compatible with 'line of sight' driving.

The TRAMSAFE philosophy is that the system is in the background, with no warnings if the driver is braking correctly for a speed restriction. The system uses GPS to determine location and speed, and if the expected braking curve approaching a speed restriction is exceeded, provides a warning to the driver. It can also apply the emergency brake, but this will only be a last resort, if the speed is so high there is a risk of derailment or overturning. Every journey is logged and analysed off line to monitor behaviour of drivers and ensure they are not relying on the system as a marker for when to brake.

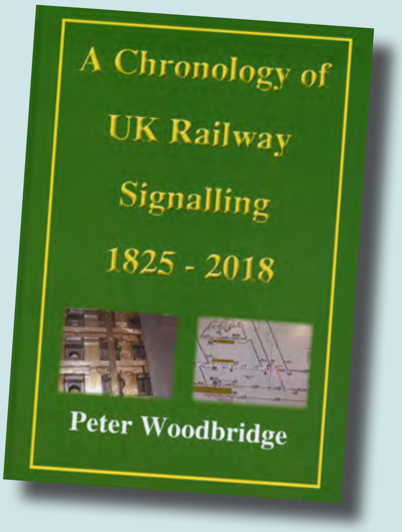
The final product described by Ian was GateLock, a locking system for gates at user worked crossings. The concept is still under development, with a number of options for unlocking and locking the gates, ranging from a keypad which requires the user to telephone the signaller to obtain a code, to monitor the location of trains in the area via the GSM-R system. This is planned to be compatible with the Future Railway Mobile Communications System (FRMCS).

The meeting concluded with a lively Q&A session, ending with thanks to Ian for the talk, especially as it happened to be on his birthday.

Book reviews

A Chronology of UK Railway Signalling 2nd edition, by Peter Woodbridge

Review by David Bickell



This nearly 500-page hardback book from Peter Woodbridge and contributors provides an insight into the evolution and innovation of UK signalling from the Leyden Jar in 1746 to the fibre optic axle counter sensor of 2017. This chronological synopsis of the development of railway signalling covers all UK railways, including 'mainline' signalling. Copies have already been shipped worldwide.

The index is split into categories such as accidents, block working, companies, legislation etc. and listed in chronological order acting as an at-a-glance summary directing readers to the appropriate year in the main body of the chronology. The aim is to present the overall story of the evolution of railway signalling and give the general 'big picture' of how, through innovation, accidents, legislation and pure chance, we have today's signalling.

The story starts with the Stockton & Darlington Railway of 1825 with an early attempt at providing signalling comprising braziers (fire baskets) into which burning coals could be hoisted as a stop signal. The section concludes with entries for 2018 including accidents at crossings and, more positively, the first Automatic Full Barrier Crossing Locally monitored (AFBCL). Former Western Region's E10k relay interlockings, and Geographical relay interlockings used elsewhere, are also covered.

The final section contains an extensive thought-provoking summary of significant accidents spanning 162 years involving signalling design, operation, maintenance and modification. Technical terms are clearly explained making it an easy read suitable for a wide audience.

At £30 plus postage it is not currently available from online retailers. If you wish to purchase a copy please contact Peter via LinkedIn, **irse.info/5ixws**. Proceeds go to Swindon Panel Society.

Hebel, Riegel und Signale, by Hans G Wägli,

Review by Wim Coenraad

At 476 pages this comprehensive work in German conveys in a vivid and entertaining way how Swiss railways were operated in the 19th century. It fills a gap in historiography of railway technology as part of the first industrial revolution. The described processes have now largely been automated, but are still based on the same principles today.

The reader can follow how the processes of railway operations were analysed thoroughly and systematically and mapped by mechanical means. The principles of that time are still valid today and are used in digital railway control systems.

The fact that the book obviously focuses on Swiss/German technology and its history should not be a deterrent, because, quoting Professor Jörn Pachl's book review, "It is noteworthy that the early development preceding the German development in England is also described. Particular attention is paid to the circumstances leading to a departure from cascade locking with sequential dependencies based on the English locking system and the transition to the German locking logic based on route locking. This has so far not been described so clearly in any other work, up to the comparison of the notation of English and German locking tables, [...] leading to a completely different type of interlocking."

Understanding 'first principles' is important and that is why books like this one are well worth the price. The book is richly illustrated and contains an impressive bibliography. When ordering from outside Switzerland, pay attention to the different posting and packaging charges of different providers.

For more information and some example pages, visit the publisher's website at **irse.info/9dqve**. Inevitably printing errors will occur, the errata can be found at **irse.info/p8i0j**.

Past lives: Jacques Catrain

It was with great regret that we learnt of the death of past president Jacques Catrain in October 2018. His friend, colleague and fellow past president, Jacques Poré pays tribute.

I first met with Jacques Catrain in November 1978, just a few days after having started myself working as a signal engineer with Jeumont-Schneider in La Plaine Saint-Denis to the north of Paris. Right away, Jacques' personality was impressive, between easy contact and friendly approach on one side, management to the point and a loud, unmistakable voice on the other side.

With the young engineers – and in those years the category was really a minority in the railway (not more than 10% in La Plaine among well over 1,000 people) – Jacques made you feel comfortable but also professional. My colleague Etienne Camus, who had himself also started as a signal engineer a few years earlier than me, told me that both Jacques and Etienne were once flying to a meeting in Stuttgart and Etienne said his English was perhaps not so good, technical words especially. Jacques answered: "Don't bother. If you do not know the right word, just say it in French. There will be a 50% chance it will be the same word in English and if it is evident that the other person does not understand, just laugh (Jacques knew that one very well and indeed loudly). You will see that the other will do the same and either he will actually understand or simulate that he has understood!" Etienne added "The story was kept deep in my mind and I have occasionally used it myself".

Jacques was borne in 1930 and studied engineering in ESME Sudria, a specialised superior high school in mechanics end electrics. He started his professional career with Mors, one of the small companies focusing in signalling and electrics (there were many of these in each country in the fifties and sixties). Mors was bought in 1968 by Jeumont-Schneider (the "JS" company, as it was nicknamed in France), that itself was integrated in 1988 with ALSTHOM (with a "H" until 1998). For a time, Jacques had been the director of the rail software company CERCI that itself also became part of Jeumont-Schneider. From 1988 to Jacques' retirement in 1993, the company became GEC-Alsthom and Jacques was the director of the signalling part.

He had been one of the main actors in the creation of CENELEC to build European standards for rail with the Technical Committee TC9X, complementing the international bodies, especially with signalling and its sub-committee SC9XA. Jacques has always been an active and strong supporter of the IRSE.

After Yves Paris in 1983, who himself became the very first non-British president of the Institution after 71 years, Jacques became IRSE president in 1990, holding his International Convention in Tours on the Loire River, a few days before the official opening of the second part of the French "Atlantique" High-Speed Line linking Paris to Britany and the South-West.

During Jacques' IRSE International Convention, as often when he was the organiser or a main contributor, side aspects were just as interesting. The dinner in Chinon on the river Loire, in a cave just under the castle dating from the Middle Age, was something to be remembered since it had been hosted by the "Confrérie des Grands Entonneurs Rabelaisiens", a sort of sect

Jacques Catrain (right) with Ken Hodgson at the 1991 AGM.

of 'experts' devoted to tasting the wines of the River Loire in general and especially from the Chinon surroundings!

Jacques organised himself or helped organise quite a few IRSE technical visits, conferences and seminars. He launched the IRSE International Technical Committee (ITC) in 1990, with the objective of studying pertinent signalling issues and writing an associated report. In those times most organisations in the profession, including the railways and the supply industry, were managed by people with a strong technical background, who were thus able to influence technology within their own company and outside. Having such people meeting together to discuss and set down their views, meant that a common approach was not only an achievable goal through efficient team-working, it also meant that any subsequent recommendations had a good chance of being adopted.

The situation in the railway signalling and telecommunications profession has changed much during the past three decades with the privatisation of some railways together with mergers in the supply industry. Most of the ITC members who were in the ITC at the start have been replaced by others, sometimes with quite different responsibilities, functions and seniority. As a consequence, around 2000 the ITC make up was changed to include new members to replace their predecessors as well as new countries from all over the world. Technical articles appearing in the railway press have replaced the reports, with now well over thirty articles published that show so well how visionary Jacques had been to internationalise the IRSE.

During his professional career with Jeumont-Schneider (later GEC-ALSTHOM), he had been the main advocate of several key products and systems of the company. To cite just a few, SACEM and all sorts of metro products and systems are included. For main line railways, one of Jacques' key successes was his contribution to KVB, the ATP for SNCF conventional lines. I remember the trip in 1988 between Paris-Saint-Lazare station and Rouen to demonstrate the ability of the prototype to manage perfectly all expected actions from the ATP in the exact track configuration of the Argenton-sur-Creuse accident in 1985. Jacques presented the solution to three of SNCF directors who were convinced and accepted KVB as the solution to avoid signals passed at danger and late braking of a train approaching a permanent or temporary speed limit. Jacques was one of the people who supported the foundation of the IRSE French Section in 2015.

Once retired, he rarely attended railway events. With his wife Ginette (who had always been a strong supporter of Jacques' activities and who participated with him in a number of IRSE Conventions), Jacques spread his retirement between his flat in Ermont, a few kilometres north of Paris, and his seaside house in Brittany on the Rance river close to Saint-Malo. Jacques had been a sailor in the French Navy in his military time and was actively involved in the local associations.

On behalf of all Jacques' former colleagues in Jeumont-Schneider and GEC-ALSTHOM, and all of the many people Jacques met during his professional career in railway signalling, I present my most sincere condolences to Jacques' wife Ginette, his children and all his relatives and friends.

Jacques Poré
IRSE Past President 2005-2006

With the support of several ex-Jeumont-Schneider and GEC-ALSTHOM colleagues.

Earl R Callender

We were also saddened to hear of the passing of another former Fellow of the Institution, Earl Callender.

Born on 22 July 1935, in Pittsburgh, Pennsylvania, USA, Earl Roy Callender joined the US Army National Guard Reserve in 1953 upon graduating from South Hills High School in Pittsburgh's Southside neighbourhood. He declined an appointment to the US Military Academy at West Point and worked for Union Switch & Signal as an engineering laboratory assistant

While working full-time at US&S in Swissvale, an eastern suburb of Pittsburgh, he attended the University of Pittsburgh, earning a Bachelor of Science degree in Electrical Engineering in 1960. He later received an Executive Master's in Business Administration from Pitt in 1975.

Early in his career at US&S, Earl was placed in charge of developing the new PN-150/250 plug-in vital relay and he held two US patents related to relay construction. Manufacture of this product continues today. Appointed manager of digital electronics design in 1967, he soon became manager of research and development, a position he held until 1978 when he was appointed manager of business and product planning. In 1982 he became the director of European marketing in the US&S' International Marketing Department before operating further afield during his later years at US&S.

Earl's earliest visits to Australia were to Westinghouse Brake & Signal (WBS), in those days a close cousin of US&S. However, by 1989 times had changed due to company acquisitions and this resulted in a separation between US&S and WBS leaving a void in the market. Ventura Projects quickly stepped in to become US&S's agent in Asia Pacific. From then on, he made frequent and protracted visits to Australia becoming an indispensable colleague and asset in gaining market share. As business boomed Earl recognised the merit of US&S acquiring Ventura Projects, and in 1995 US&S Pty Ltd Australia was established.

During the same period, with the support of US&S Australia, Earl was instrumental in the formation of US&S Pvt Ltd in India. In this way as a 'people person' travelling across six continents he had numerous colleagues, and developed many close and lasting friendships worldwide. After 47 years of continuous service, Earl retired from US&S in January 2000 as vice-president, international operations.

Earl R Callender, 1935 – 2019.

Earl was elected a Fellow of the Institution of Railway Signal Engineers in March 1985. He was also active in the Association of American Railroads Communication & Signal Division. Earl was an avid sports fan, closely following Pittsburgh's three professional sports teams, the Steelers (football), Pirates (baseball), and Penguins (ice hockey). His son, Earl S, recalls the climax of a heated debate when a friend of his father turned to him and said, "Your dad may not always be right, but he's never unsure of himself."

Earl Callender passed away on 2 January 2019, following a brief illness. He is survived by his wife of 60 years, Mary Catullo Callender, a brother, Raymond, and three children: Linda, Earl S, and Lisa. His family includes nine grandchildren and one great-grandchild. He will be remembered as a skilled card player, gracious host, and for his great wit.

Howard Revell and Bennett Feely

Feedback

Re "It's only data" and Waterloo incident

I am writing to tell you how much I enjoyed reading Stephen Dapre' fictional story "It's only data!" (IRSE News December 2018). I have not laughed so much in my life!

A classic tale of how something is gained with one hand, but something is lost with the other. And as we progress headlong towards the "awesome benefits" of centralised software driven signalling systems, we leave the 'fictional' infrastructure owner at the mercy of third-party suppliers should they wish to modify or replace anything!

The following IRSE News (January 2019) newsletter's first article was flag-waving from the rooftops the awesome benefits of 'driverless trains'. But in the following article we were brought back down to ground… with a crash, the collision at Waterloo in August 2017. The driver of the train was commended by the RAIB for noticing the points were lying incorrectly and for his prompt brake application. Have the designers of driverless trains designed and enabled systems to detect points not lying correctly or other track defects which lead to derailment?

As we proceed full throttle into the future, there does appear to be 'tunnel vision' syndrome, where everything new is awesome and hopefully no one will notice the drawbacks!

The RAIB identified many parallels between the Clapham and Waterloo incidents, indicating a degree of "Corporate memory loss in the industry". I wonder how much will continue to be forgotten as we move on ever forward or perhaps just choose to ignore?

Andy Fox, UK

Ed note – The RAIB report did comment that drivers are not required, or expected, to check point positions. Given the speeds involved it is very unlikely a driver, or a driverless train, would be able to detect points not lying correctly and take the necessary avoiding action.

Re "It's only data" (2)

May I start by saying how much I enjoyed reading "It's only data" before responding as Secretary of the "Preservation Railways Section" (the Minor Railways Section – MRS). I do however feel the need to respond, but undecided in what way I should do so: do I issue an outright denial of our subversive activities, thereby confirming the regressionist tendencies of our members (and who in their right mind doesn't think that rodding is far more attractive than SSI?); or do I point out that the heritage railways of this country tend to be earlier adopters of new technology than the main-line?

One only has to look as far back as IRSE News of September 2018 to read an article about TERN – an earlier version of which was viewed by the MRS in action on the Ravenglass & Eskdale Railway during a 2010 visit, and they were using radio to signal trains long before RETB or ERTMS. Or how about the MRS visit to the North Yorkshire Moors Railway (NYMR) described in the October 2016 edition where we learnt about the use of Electric Key Token over broadband internet?

The list of such innovation is extensive; the use of Voice Over Internet Protocol (VOIP) on the Severn Valley Railway as well as the NYMR; early adoption of LEDs as a replacement for oil lamps; the development and testing of new electric point motors; programmable logic controllers for level crossing control on the Romney, Hythe & Dymchurch Railway and Dean Forest Heritage Railway; and the list goes on.

Russell Withington, UK

Learning from the past

With reference to January's IRSE News (issue 251) Clive Kessell`s description of the Gloucestershire Warwickshire Railway made interesting reading. My eye was drawn to the feature of a signal box "equipped with a 3-bar horizontal tappet locking frame". The adoption of this type of frame post WW1, as a replacement for the old "double twist" type, standard on the GWR since about 1870, was an unfortunate choice. It proved to be high-maintenance and in heavily used areas could be a liability. Wear in the many linkages in its construction, could result in failed locking, when levers were pulled in a robust manner. The later replacement, in the late-1920s by the 3-bar vertical configuration, was major improvement, soon itself to be replaced by the 5-bar vertical type as the standard frame used on the GWR from the 1930s onwards.

Further to Stephen Clark's article "Sixty years ago – a look back at 1958". BR AWS was derived from the GWR physical contact ATC system, first introduced in 1913 and installed throughout the GWR main lines by 1938. The development of a non-contact inductive system, which became the BR standard, was suspended during WW2, recommencing in 1947.

The adoption of the mosaic signalling panel as standard on the WR in the mid-1950s was an initiative soon to be emulated elsewhere, but was a novelty at the time. The original design came from Integra, Switzerland, and the first major installation was at Birmingham Snow Hill in 1957. It was imported at a cost of £6000 to which a further £6000 was paid in import duties! The next major installation was at Plymouth in 1960, where it is still in service.

With regards to "Collision at London Waterloo August 2017 – lessons to be relearnt". Having read the report several times, I am still uncertain about some aspects. For instance, exactly who was responsible for the possession? It is a brave tester who adds test wiring to a `live` railway. Who assured the tester-in-charge that the railway was `dead` before he started work? Who was responsible for the safe working of a train through the area of possession? On what basis is a tester required to clip/scotch points within the area of possession, without supervision?

Michael Page, UK

IRSE Charity 2019-20: RedR UK

redr uk
people and skills for disaster relief

For the Presidential Year 2019-20 the IRSE's nominated charity is RedR, an organisation that aims to provide skills to allow those that live in disaster-prone areas to prepare for, respond to and recover from natural disasters.

At RedR UK, we train and support lifesavers.

Founded by engineer Peter Guthrie in 1980, we were once known as the 'Register of Engineers for Disaster Relief' but as the humanitarian sector, and the contexts we're working in, have evolved, so too has RedR UK – but we continue to celebrate and build on our engineering heritage.

We work to ensure that disaster-prone communities are resilient by giving them practical life-saving skills, advice and support, which help them prepare for, respond to and recover from natural and man-made disasters.

Citizens are always the first responders to a disaster. That's why we build the skills of national aid workers working for local organisations in disaster-prone countries through our training, through the co-working of our members and through our free technical advice service. Our approach ensures skills remain in-country for the long-term, ready for future disasters.

We've responded to every major disaster in recent years, including the Syrian conflict, the Ebola outbreak in West Africa, Typhoon Haiyan in the Philippines, floods in Pakistan and the Haiti earthquake.

Since 2010 RedR UK has trained 53,711 people. We've given training or provided operational expertise to nearly all of the leading humanitarian organisations, including Unicef, Save the Children, The British Red Cross, World Vision, UK Aid, Oxfam, Medicins Sans Frontieres, and International Rescue Committee.

For more information visit **www.redr.org.uk**.

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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Membership changes

Elections

We have great pleasure in welcoming the following members newly elected to the Institution:

Fellow

Mohd Abdullah, Global Rail, Malaysia
Keisuke Bekki, Hitachi, Japan
Christian Glätti, Thales, Australia
Ajay Vijayvargiya, Indian Railways, India

Member

Lee Baker, Alstom, UK
Michael Carr, Network Rail, UK
Salman Farook Kochi Metro, India
Dahlan Fraval, Integrated Rail, Australia
Tin Kin Ho, MTR Academy, Hong Kong
Alexandra McGrath, Level Crossing Removal Authority, Australia

Associate Member

Shankaar Gopalasamy, Network Rail, UK
Dilip Govindaraj, Mott MacDonald, UK
Hencil Martis, Arcadis, India
Christopher Moran, Network Rail, UK
Deepti Patel, Indian Railways, India

Accredited Technician

Fraser Ballantyne, Siemens, UK
James Morgan, Transport for London, UK
Ashley Newman, Self-employed, UK

Promotions

Member to Fellow

Daren Keates, Siemens, UK

Associate Member to Member

Peter Ashton, Colas, UK
Kevin Boyd, Network Rail UK
Yao Huang, Bombardier, Australia

Accredited Technician to Associate Member

Thomas Johnson, Siemens, UK

Professional registrations

Congratulations to the members listed below who have achieved final stage registration at the following levels:

CEng

Samuel Brown, Transport for London, UK

EngTech

Fraser Ballantyne, Siemens, UK
James Morgan, Transport for London, UK

Reinstatements: Helena Abbey, Mohd Anif, Jack Hesford, Subramanian Krishnan and Arnut Srisakuldee.

Resignations: Denvir Drury, William Jack, John Walton and John Woolley.

New Affiliate Members

Manish Agrawal, Maharashtra Rail Infrastructure Dev, India
Sutharsan Balakrishnan, Frauscher, UK
Priyanka Bandaru, Accenture Services, India
Dhand Bharat , Public Transport Authority of Western Australia, Australia
Ryan Burns, ARUP, USA
Sruthi Chityala, Arcadis Design & Consultancy, India
Lee Clinton, Telent, UK
Padraic Dunne, Siemens, UK
Kieron Hadlington, Alstom, UK
MD Tahir Hiryanizam, KTMB, Malaysia
Uppu Karthik, Indian Railways, India
Rochelle Marie Lacson, V/Line, Australia
Kallum Lee, WSP, Australia
Yin Ming Li, MTR Corporation, Hong Kong
William Liddall, Frauscher, UK
Shuxia Lu, Siemens, UK
Balraj Manikandan, India
Lindsay McInnes, Frauscher, UK
Miltan Munshi, SMEC, Australia
Ashley Murray, Queensland Rail, Australia
Don Ng Wei Chye, SMRT Corporation, Singapore
Vishal Patel, Balaji Railroad Systems, India
Ditendrababu Ponnam, Wabtec, India
Jasmine Robbins, Thales, UK
Lava Kumar Sibbala, TATA Consulting Services, USA
Surendra Singh, Concord Corporation, Singapore
Joshua Taylor, Transport for London, UK
Andrew Tham, Vocus Communications, Australia
Kevin Tribble, Frauscher, UK
Samian Trollope , Thales, UK
Rambabu Tulugu, Balaji Rail Road Private Systems, India
Nuno Vasco, Phoenix Contact, UK
Lee Watson, ADComms (Panasonic), UK
Tony Weisback, Queensland Rail, Australia
Ethan Williams, Arup, UK

Due to non-payment of first subscriptions the names of the members below will be removed from the membership database: Chatdanai Tralaksamee, Selvarajan Machap, Wai Ma, Imran Ali, Mohamad Faris Mohamad Shukor, Chi Kwong Wong, Yuen Yiu Lam, Wei Li, Ching Him Leung, Daniel Coineau, Angeline Ang, Joy Chua, Mnqoby Mbongwe, Toluwani Bello, Nick Peacock, Naveen Medepalli and David Donegan.

Past lives

It is with great regret that we have to report that the following members have passed away: Jacques Catrain, David Crabtree, Adriaan Heijnen, Barry Mogford and Noel Reed.

Current Membership: 4988

IRSE News

Institution of Railway Signal Engineers

April 2019

Human factors
learning from aviation

People perspective
the impact of the digital railway

Presidential view
a word with Markus Montigel

Volunteer-powered

In this issue we feature the final paper in the 2018-2019 presidential programme which compares human factors within the North American railway and aviation industries. The paper provides a unique insight into practices in both industries and demonstrates how lessons can be learned from others, and why we should always be open to new ideas.

Continuing with a people theme, Steve Denniss looks at the "Digital Railway" from the people perspective and concludes that the workforce of the future needs to be endowed with new skills to support the digital railway, and by working together in a collaborative way we can deliver success.

Stephen Dapré takes a light-hearted look at the art and science of signal sighting through the eyes of the fictional signalling engineer Ruth, but with some examples of people behaviours which some of you may recognise. We hope you like this style of article, let us know as we value all feedback.

This month's "Industry news" provides a snapshot of what is going on around the world with control and communications systems and we could have filled several more pages, such is the level of activity in the industry. The news includes ETCS Level 2, ATO, traffic management systems, communications, and the value of rail to society. If you are working on something you would like to share with other members please let us know.

"On the road with Blane" demonstrates how the IRSE is engaging with other professional bodies, leading suppliers and government officials to raise our profile and to help promote best practice. We celebrate and congratulate all members who achieved success in last year's IRSE Exam and Judith Ward provides advice on how we can all maintain and develop our professional competence.

Attending an IRSE conference is one activity to assist your CPD and Yousef Kimiagar reports on last year's excellent CBTC conference in Toronto, Canada. The local section reports include updates from the China and Malaysian Sections, which demonstrate how international and 'volunteer-powered' the IRSE is, and how we should all be proud of what we achieve with this approach.

In Feedback we have an excellent positive letter from Roger Ford, a respected British journalist specialising in rail transport. Roger expands on David Fenner's article on innovation (IRSE News Issue 252, February 2019), confirming the innovation that has already been developed by the signalling profession, and how we must have the confidence to innovate further and promote the steel wheel on steel rail as the transport system of the future.

On the rear cover we are delighted to report an increase in membership, which now exceeds 5000, and we extend a warm welcome to all our new readers.

Paul Darlington
Managing Editor, IRSE News

Cover story

This month's front cover is the swing span of the Grand Narrows Bridge in Nova Scotia, Canada. The 516-metre-long bridge is part of the only rail link to the urban community of Sydney. Over past decades, communications on the non-signalled line evolved from train orders sent to stations to train radio to mobile phones. Until 1993, colour-light signals confirmed to trains that the swing span was closed and locked. The bridge has been out of service since 2015, with the machine room reportedly full of sea water. The bridge would absorb about half the CAD102m ($77m, €68m, £58m) needed to reopen the line, but supporters say the line could remove 100,000 lorries a year from local roads and allow development of a new container port at Sydney. Changes in society and business may allow the reopening of mothballed lines like this all over the world, and our profession must be ready with novel and cost-effective signalling solutions.

Photo George Raymond

In this issue

Human factors in aircraft cockpits, lessons learned

Michael T McNamara
President, Gannett Fleming Transit & Rail Systems

This paper, the sixth and final in the Presidential Programme for 2018-19 and presented on 5 March in Brisbane Australia, compares human factors within the north American railway and aviation industries. The author's experience as a professional railway signalling engineer and a leisure aircraft pilot gives a unique insight into former and current practices in both environments, and proposes that lessons can be learnt from both railway and aviation safety regimes. Railways are very different from airlines and practices in the United States (US) (which the author is most familiar with) can be very different in other parts of the world.

Railway speed control in the US has its roots in the cab signalling system encouraged by the US federal government in the 1930's, which led to continuous cab signalling with overspeed control, jointly developed by Union Switch and Signal (US&S) (now Ansaldo) and the Pennsylvania Railroad, together with intermittent train stop, jointly developed by General Railway Signal (GRS) (now Alstom) and the New York Central Railroad.

The continuous system has been expanded and modernised and has been used in modern Automatic Train Operation (ATO) installations. The intermittent system became less popular and is not used for ATO, although it is still in operation in some places.

Some early railway speed control systems enforced speeds for interlockings and the following train, but not civil speeds (curves). The thinking was that the motorman/driver drives the train every day; how could he not expect the curve to be there as it never changes? That eventually became acknowledged as a problem and curves today are generally, but not always, protected.

Later systems evolved to control speeds for all situations including civil speed restrictions, which is required for ATO. In the US some of the first ATO system installations were the Delaware River Port Authority, Port Authority Transit Corporation (DRPA PATCO) line in Philadelphia, Pennsylvania, using 100Hz cab signalling commissioned in 1968, various metro systems in other cities in the 1960s and the Bay Area Rapid Transit (BART) system in San Francisco using audio frequency speed commands in 1972. They also include the audio frequency cab signalling systems used in Washington Metropolitan Area Transit Authority (WMATA) in Washington.

Aircraft flight decks and train drivers' consoles may seem light-years apart, but both rely on the safe and accurate provision of information and accurate implementation of control inputs. *Photo Shutterstock/Denis Belitsky.*

Modern aircraft cockpits may look complicated, but much of the equipment is there for redundancy.
Photo Shutterstock/Mikko Ryynanen.

Modern systems including Communications Based Train Control (CBTC) and Positive Train Control (PTC) are more vehicle centric than lineside. The train determines its own position, augmented by wire position, transponders, wheel rotation and occasionally, Global Positioning System (GPS). GPS works well in the air, not so well underground.

Autopilots in aircraft, according to some references, started as early as 1912. Bill Lear was awarded a trophy in 1949 for advancing autopilot technologies; he also developed the Lear Jet, one of the first business jets. Manually flying aircraft at high altitudes is tedious and difficult, due to thin air. These altitudes are also where jets have the most advantage, gaining high speed with little air resistance and very low fuel burn. It is no coincidence that autopilots and passenger jets were developed at around the same time; the jet requires the autopilot to function easily.

Early aircraft autopilots were used to hold the wings level (wing levellers). Indeed, one of the biggest hazards to flying aircraft even today, is having the pilot lose reference to the horizon and bank into a spiral and lose control.

Jet aircraft technology was advanced at a furious pace after World War 2 up to and including the space race of the 1960s. Space-ships to the moon, of course, used autopilots.

Modern cockpits may look complicated, but much of the equipment is there for redundancy. When things fail in the air, the aircraft has to keep flying and navigating. When things fail on the railway the vehicle can just stop.

Space travel to the moon used Inertial Navigation Systems (INS), since GPS was not yet developed. Jet airlines during that era also used INS. Modern autopilots are driven by GPS navigation almost exclusively.

The author owns a small aircraft which has a wing leveller, but no autopilot. (He doesn't trust autopilots for small aircraft).

Perspective

The railway is a more mature industry, having been around for 150 years or so. Aviation was a wild experiment until about 80 years ago and only developed into the reliable transportation system it is after the second world war. Railway safety and aviation safety developed separately; there are very few people who have extensive knowledge of both, with aviation having experienced rapid technological change and railways benefiting from technology at a slower pace.

The three dimensional aspect of aviation is an inherently more complex environment than the single dimension of a railway. But as railway engineers, we understand that the single dimension creates hazards itself; no train can swerve suddenly to avoid an accident. The steel on steel that creates efficient movement, also creates longer stopping distances; usually beyond a train driver's ability to see.

Early railway systems, and many in use today, use over-speed control with manual driving. This has advantages and disadvantages compared to ATO:

The advantages include: The motorman/driver has full control, is more attentive to the track ahead, and can quickly stop if an unexpected obstacle or person appears, the motorman/driver stays proficient in driving and station stopping adds proficiency. The disadvantages include; the motorman/driver loses proficiency with ATO, different motormen/drivers drive at different speeds, creating gaps in train flow, and station stopping is entirely reliant on the motorman/driver.

One of the issues with speed control is when there is a failure onboard (such as damaged sensor coil mounted ahead of the wheels) or on the lineside (broken track circuit cable), the failure is not easily distinguishable from a broken rail or, possibly, switch point not locked. The operator often has to go into manual bypass which can lead to an accident because the safety systems are being overridden.

The author has experience in one ATO system where operator skills were compromised by full time use of ATO. The motormen/drivers were then required to make one round trip per day in manual driving mode. During that trip, they would sometimes overshoot stations and have to back up. Even then, the operators lacked proficiency to operate without ATO in reverse running during single line working for maintenance. Bi-directional ATO had to be installed because of safety concerns and close calls.

Modern aircraft autopilots are very sophisticated but human interface is the biggest difficulty.
Photo Shutterstock/Brostock.

Early aircraft autopilots were used in cruise, especially up high, to hold course and altitude. There are hazards with this. The autopilot would disconnect without the pilot being aware. This is actually worse with two pilots, each one could think the other is flying while nobody is actually flying. Trim systems in large aircraft are electrically driven and required to compensate for varying loading conditions and flight regimes (climb, cruise, descent). The trim setting can conflict with the yoke position (which controls pitch and bank). Aircraft can often be flown with both trim and yoke automated, either one in manual and the other automated, or both in manual. Conflicts occur when one or the other is automated without the pilot fully understanding. This has caused accidents. Even today, this remains a hazard partially mitigated by training.

Modern aircraft autopilots are very sophisticated, but the human interface is the biggest difficulty. Cockpit voice recorders have recorded a pilot's last words as "What is it doing now?"

Interestingly, when autopilots first became prevalent, the Federal Aviation Administration (FAA) encouraged airline pilots to use it exclusively. Human skills lost effectiveness. When a pilot had to manually fly, it did not go well. Now pilots are trained to do a mix of manual flying and automation.

There are two thought processes which historically have been used in optimising safety in flight. To let the autopilot do the flying so the pilot can be the systems manager and provide oversight, or the alternative; that the pilot(s) should fly all the time to remain proficient.

The consensus today is halfway between the two. In jet aircraft, most time at altitude in cruise is on autopilot, while climbs and descents are manually flown using some autopilot functions.

Training

Pilot training is extensive, and lasts many years, and is rigidly regulated and controlled. Pilot training for jet aircraft is universally provided in very sophisticated and expensive simulators.

Train driver training is more casual, and not regulated in some countries. The more sophisticated railway companies have training centres and simulators and do extensive training. Some railway administrations do not undertake much training. None of the railway simulators that the author has seen in the US are very impressive.

Simulators are used in both aviation and rail, but with 3d motion for pilots. Aircraft simulators are used for extensive simulation of rare events, and pilots can move straight from the simulator to aircraft with passengers on them due to their sophisticated realism.
Photos Shutterstock/Polonio Video.

Checklists are used in both aviation and rail, but in different ways, and very different scenarios in some railways.
Photo Shutterstock/Marieke Dekker.

All pilots must fly both frequently using manual and automatic systems. Not all drivers of ATO-fitted trains regularly drive manually.
Photo Shutterstock/wellphoto.

Training in aviation concentrates on things that rarely happen, and this training is done repetitively. One example is training for an engine failure in a multi-engine aircraft. When an engine fails in a twin-engine aircraft (where engines are mounted on the wings), the aircraft yaws (nose goes left or right). Performance degrades from loss of power and increased drag from the inoperative engine. To keep the aircraft in flight, the pilot must push a rudder pedal robustly and slightly bank the aircraft into the operating engine. The pilot also has to properly shut down the failed engine.

This training is required by a combination of regulations, insurance requirements, and government oversight, to occur every six or 12 months. This training applies to all levels of pilots, from someone who owns a light four-seat twin aircraft used for personal and business travel up to and including professional pilots flying commercial airlines around the world. This training is done in the aircraft with an instructor in small aircraft and in very sophisticated and expensive simulators for larger aircraft.

Most pilots that fly multi-engine aircraft will have a lifetime of flying without ever experiencing the requirement to do this for real, as engine failures are rare.

The parallel in railways is failure of ATO requiring manual driving. Regulation is scarce in some railways, and insurance requirements may not apply. Accidents have occurred with manual train driving. Repetitive training in manual driving is not something that most railways do. Some companies in the railway industry could learn from the aviation industry.

Hazards and failure modes

When a railway signalling system fails, fail safe systems stop the train. When aircraft autopilot systems fail, the pilot turns them off (or they switch off by themselves!) and the pilot suddenly has to take control. This does not always go well.

When railway overspeed systems were first installed, failure modes were not much of a concern. It was considered to be an auxiliary system and, if it failed, the train would revert to manual driving by lineside signals which they had been operating with for many years. Failure modes in ATO are a greater concern; but mostly for headway and service disruption, not safety (assuming over speed protection remains).

ATO failure modes in railways create inconvenience but not safety hazards. Failure modes in aircraft create hazards, but not inconvenience (the aircraft typically continues on to its destination).

Pre-departure tests in railways and pre-take-off checklists in aircraft both do the same thing – to determine if the machine is safe for the trip. I've never been on a train that was cancelled because of a pre-departure test but it certainly happens in aircraft. The assumption is that some trains may be dispatched with ATO and/or overspeed control inoperative.

Whether or not an aircraft can depart with certain systems inoperative is strictly regulated. Within some railways this is not the case.

Environmental considerations for the equipment design are significant to compare. They are both stringent for different reasons. Railways experience more shock and vibration, but electronics in the aircraft panel have to keep working with explosive decompression at high altitudes. Temperature extremes at altitude are more severe.

Maintenance

The author uses his aircraft to travel widely and anyone who owns an aircraft gets to learn about maintenance, especially when paying for it.

Small aircraft used for personal and business use go through an inspection once each year, and certain other maintenance activities are done on a recurring basis. Small aircraft used for hire (such as training) are inspected every 100 hours of operation. Altimeters and transponders are tested on all aircraft by specialists every two years. Other maintenance is required by airworthiness directives (ADs) when problems in the fleet are discovered. A pilot does a pre-flight inspection before every flight. Most maintenance activities are kept in log books, for the reference of future inspection and maintenance staff.

Large commercial aircraft are inspected on a progressive maintenance program, normally developed by the manufacturer and approved by regulators. This programme includes inspections but also is oriented towards replacing major components after a certain number of hours, years, or cycles (take-off and landing), rather than inspection. Major aircraft components including landing gear, autopilot components and hydraulic components are merely removed and new components installed. Engines are replaced after a defined number of hours.

The aircraft is designed to facilitate the easy replacement of major subsystems.

This progressive maintenance program is more expensive than just inspection, but it creates a predictable cost structure, that is well suited to the financing and acquisition of these large commercial aircraft. It may result in a more reliable aircraft, important for scheduled airline service.

Aircraft maintenance procedures, practices and documentation is regularly audited by the FAA in the US and fines have been levied.

The US Federal Railway Administration (FRA) regulates some maintenance for railways under its jurisdiction. But most of the passenger railways are not under their jurisdiction (although all freight railways are). Passenger railways not under the FRA jurisdiction usually use the FRA regulations as standard guidance. Under FRA rules, trains must have safety systems (such as air brakes) inspected every 90 days.

American Railway Engineering and Maintenance-of-Way Association (AREMA) also has certain industry developed standards for maintenance. All railways in the US do have storage and maintenance facilities however the activities in those facilities varies.

Railways in the US have a choice of either; life cycle maintenance or alternatively, unscheduled maintenance. Life cycle maintenance programs include replacing components typically on a one, five or ten-year cycle. Unscheduled maintenance fixes components as they fail.

There is a culture in certain parts of the US railway industry that once installed, the signal system should last forever. Europe has more of a culture of maintenance. The US is slowly tending towards more maintenance, especially with the advent of electronics and microprocessors, which do not have the life expectancy of mechanical locking frames, vital relays, and other old-style equipment.

On-board automatic train control systems are electronics-based devices that often operate for 20 hours per day, with peripheral devices exposed to the weather. On-board electronics including automatic train protection and ATO are often maintained as part of an overall railway vehicle maintenance programme. Some operators do replace train control systems (on-board and trackside) after a period of time for reasons such as obsolescence and reliability, but this can be heavily influenced by funding constraints.

Parts are worth mentioning here. To manufacture and supply a part for an aircraft, even a small personal aircraft, the manufacturer must go through a complex approval process. The FAA may even visit the factory. Quality processes must be formalised. Anything in the cabin must go through fire testing. Every part has paper work accompanying it describing its origins. Although newer commercial aircraft would have all parts for maintenance supplied by the original manufacturer, as time goes on especially for smaller aircraft, after market suppliers prevail.

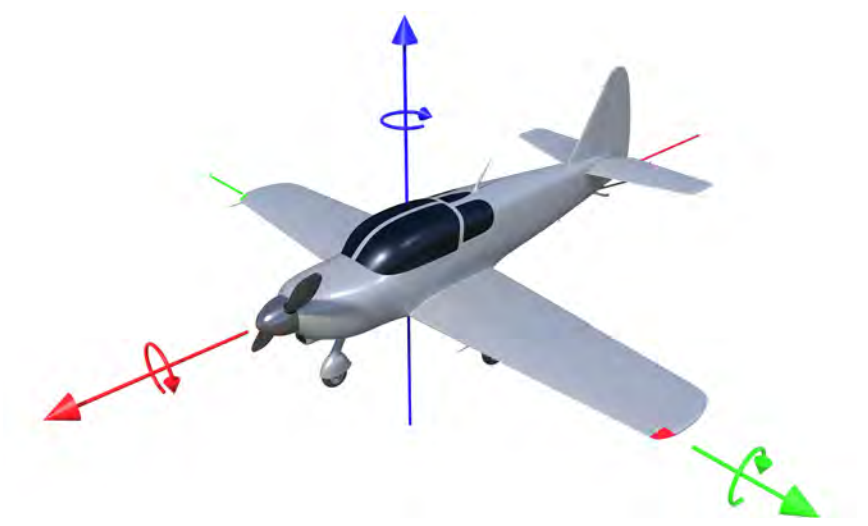
There is no equivalent system of parts manufacturing approval for systems in a railway vehicle (at least in the US). When ATO or other railway components become old and the manufacturer is no longer able to provide support, after-market suppliers may step in, with little to no formal safety approval process.

Train control engineers tend to say that their equipment is fail safe, so old failure prone equipment is not unsafe, just unreliable. This is not completely true; there is no unreliable, safe system, as failure modes are not always well predicted. Further, a system that fails in passenger service may be bypassed and the train will be driven manually, which creates risks.

The author designed a train control system for a subway (metro) in the 1990s which was installed successfully. Later a failure occurred in service. The train was driven manually to the end of the line, passengers departed, but then the train was driven around a loop and collided with two other trains. Injuries were minor, but three trains were damaged significantly.

The author has first-hand knowledge of another accident on a grade separated light rail system that has manual driving with overspeed protection. The overspeed system provides a penalty brake application to a full stop when overspeed, unless the train driver has the brake handle in braking mode, which suppresses the penalty brake. The amount of braking to achieve suppression is measured by a transducer in an air brake reservoir, that converts air pressure to electrical resistance.

Despite the immense complexity of modern rolling stock and railway infrastructure, the challenges of maintenance vary significantly between aviation and rail.
Photo Shutterstock/aapsky.



The three axes of rotation for an aircraft are roll (shown in red), pitch (shown in green) and yaw (shown in blue).
Image Shutterstock/MgPL.

The transducer characteristics changed over time, such that the train driver could suppress without sufficient brake pressure to be within the safe braking curve. This led to an accident.

The railway industry in the US could learn from the aviation industry in this area. Wholesale replacement of certain train control components after a certain number of years does occur, but there is likely to be room for improvement. The beginning of this should start with manufacturers recommendations. The ability to do major subsystem replacement easily should be designed into the equipment from the start.

Increasingly we are seeing train control manufacturers have universal (or at least similar) products around the world. Organisations that regulate and standardise are not worldwide, and this creates issues.

Optimisation

Railways, especially high capacity urban metros, require optimum close headway for maximum track capacity. Crucial to this optimisation is automated operation for consistent speed, deceleration and acceleration, and train positioning on the platform. Only with automation can this optimisation exist.

With aircraft, the optimisation is required when numerous aircraft arrive at a busy airport, where they all merge to land at one or a few runways. This optimisation is done manually with a rapid fire 'dance' on the radio of altitude, heading and speed instructions. This has no parallel in railways.

It is notable that the highest optimisation in railways is automated but the highest optimisation in aviation is to train a group of highly skilled people (pilots and air traffic controllers) to do it all manually.

High altitude

High altitude jet operations in the thin air require various functions of autopilots to work, otherwise the aircraft has to descend to lower altitudes and/or land nearby. Aircraft have three modes of flight. Pitch – nose goes up and down, roll – one wing drops while the other raises, yaw – the nose (and tail) moves left and right.

Long body jet airliners are very efficient at carrying large quantities of people long distances, therefore they are popular. However, this design creates instabilities at high altitude which are controlled by autopilots. In particular, yaw has to be controlled at all times at high altitude. These aircraft have redundant yaw dampers built into the rudder. The human 'touch' is not able to properly control the yaw motion in flight. This is a difference that has no parallel in railways.

Medical factors

The health of the aircraft pilot(s) and train driver is important. Airlines normally require two pilots, although airlines operating smaller aircraft are sometimes approved for single pilot. Turboprop and jet charter services are often approved for single pilot, but in practice use two pilots. Most personal and business-owner flown operations of smaller aircraft are single pilot. Trains in passenger service in the US are driven by a single operator.

The FAA has a three-tier medical system requiring pilots to be seen by FAA approved doctors, either six months, 12 months or 24 months (and sometimes out to four years for younger pilots) depending on the size, complexity, and service in which they are engaged. Large jet airliners, for example, require pilots to have a medical every six months.

Train drivers usually have some type of medical process, in particular, for vision and colour blindness because of the importance of colours in wayside signals. But the processes are not as regulated or standardised.

Sleep apnoea is of increasing concern in both industries. As the average weight of people in some developed countries increases, problems with sleeping are more prevalent, leading to inattention and being in a daze during work. Both aviation and railways require operators to operate unsocial hours and sometimes shift work, and this exacerbates the issue. Accidents have occurred as a direct result of sleep apnoea. Both industries are addressing this issue, which also affects long haul lorry drivers.

Another medical factor is hours of duty. Both industries have similar restrictions on the number of hours an employee can work without getting sleep. The industries are remarkably similar in this regard. Alcohol and drugs are forbidden in both industries and violations are rare. Both industries test workers after an accident or incident.

Safety certification

Early railway signalling and train control systems were installed without any formal safety certification process. Some railways still do that today.

Aviation used formal safety certification processes earlier, especially after the 1960s space program, which promulgated the processes. European railways started using formal safety certification processes earlier than those in the US.

Currently, authorities in the US and around the world are mandating formal safety certification for railways. One advantage is that it encourages group discussion and review, to see if any safety areas have been overlooked. This has the biggest advantage when the technology envelope is being pushed to its limits and characteristics are being optimised, such as headway or top speed.

New aircraft safety certification is subject to a complex set of standards, laws, rules and procedures. Modern rules are written around jet aircraft; there are movements underway to formalise simpler certification rules for smaller personal aircraft, in both the US and Europe. FAA laws for certification of new aircraft designs have no parallel in railways. Instead, the Federal Railroad Administration (FRA) has a set of safety regulations and exemptions to the regulations to optimise design. This is handled separately for each new vehicle design.

Both railways and airlines (and individuals who purchase private aircraft) complain about the cost and delay of safety certification. This is a similarity between railways and aviation. The author believes that both processes work reasonably well.

Summary of lessons learned

Initial training with a new ATO or completely new train or line should be done with simulators and should be made as realistic as possible. Failure scenarios should be introduced, and operators judged against standardised criteria with extra training and retesting if required.

Human machine interface and proficiency is an area that could be improved in some railways. Simulators for manual driving should be made more sophisticated and unexpected failures should be simulated. This training should occur every 6 or 12 months.

Maintenance standards should be established by the manufacturer and objectively managed by the owner/operator. Part or subsystem replacement after a certain quantity of years/hours/miles should be formalised. The maintenance practices should be audited against required procedures.

Parts manufacturing approvals for railways could benefit from the rigid procedures used in parts manufacturing in the aviation industry.

Comparing safety certification between aircraft and trains could benefit from more study. It is a complex issue itself, with a mixture of laws, standard practices and special knowledge. There may be room to improve and standardise certification of ATO and the railway trains themselves.

What do you think?

Do you agree with Michael's analysis of the comparison between aviation and rail and the importance of human factors in both? Has your railway taken a different approach, learning directly from aviation or perhaps transferring rail knowledge to the world of aircraft? Maybe you already implement ideas that Michael suggests? Perhaps you were formerly an aircraft engineer before moving into rail. The IRSE is here to enable the sharing of knowledge between members. Email **editor@irsenews.co.uk**.

IRSE///

Institution of Railway Signal Engineers

The Digital Railway from the people perspective

Steve Denniss

Technical Director, WSP, UK

A version of this article first appeared in Rail Professional magazine in July 2018.

A series of round table discussions was held in 2017 exploring issues facing the successful delivery of the digital railway. The subsequent white paper produced by the IRSE, "Making a success of the Digital Railway", for the first time presented the, sometimes discordant, views of government, regulator, infrastructure manager, operators and suppliers, exploring how we can create a digital future for rail in Great Britain.

In this paper Steve, a regular round table host, summarises the outputs of these think tanks from the perspective of the people issues and the skills challenge facing the Digital Railway and the introduction of any new command and control or communication system.

We need to plan effectively for the future. *Original photo Shutterstock/Mopic.*

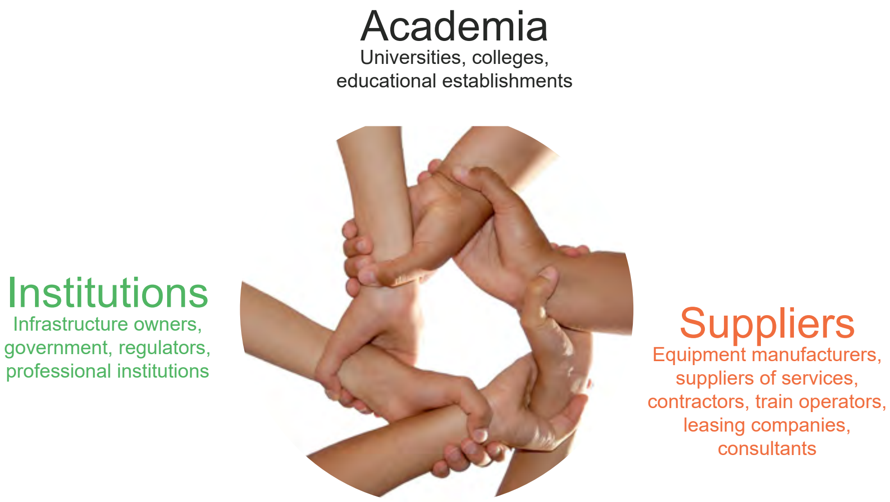
What are the real barriers?

It became clear early on in our discussions that the primary barriers to a digital railway are not technological – the suppliers around the table were unequivocally confident they could produce the goods, whatever they might need to be. No, the real barrier can be distilled down to one word: skills. The existing and future workforce would need to be endowed with new skills to implement, operate and maintain the digital railway.

This was a view endorsed by the then Digital Railway programme director, David Waboso who, at the launch of the white paper said that "the training of engineers needs to change", and that it was "vital" that institutions analysed the competence of their membership and how these competencies need to change. Few commentators would disagree that the entire industry should work together to achieve the necessary skills jump, drawing on the thoughts of academia, institutions and the suppliers, including the integrators, operators and maintainers.

Collaboration shouldn't end there. Beyond the workforce, the rail industry needs to reach out to the many stakeholder groups who have a part to play, or are themselves users of, the railway. This large group should include the communities that rely on transport to thrive, and the passengers who bear the brunt of delays and cancellations. Greater engagement will help industry to understand what will be required of the railway as a future transport mode. WSP's recent success in the Rail Partnership Awards' "Putting Passengers First" category showing what's possible, with passengers at two major stations clearly benefiting from a user-centric focus.

Through inspiring young people, first to use the railway and then to be part of its success, we can capture the imaginations of future generations that want to build a better railway. This capturing the 'hearts and minds' approach is important, and perfectly viable; on World Youth Skills



All parts of the industry and academia need to work together if we are to achieve our aims. *Photo Shutterstock/Luis Louro.*

Day, Network Rail's David Rowe found through his schools' workshop that young people are more than capable of harnessing new technology to benefit rail travel. I heartily agree with David that "bringing new technology to the railway will be most successful with the support and inclusion of all parts of society".

Achieving the necessary transformation demands a long-term outlook, from government and industry alike. Without a commitment from the policy makers to invest in and support the training of skilled people, we won't be able to resource the activities – automated design, software development, data management and wireless communications – that will create, operate and maintain a digital railway. While the £64m ($83m, €74m) earmarked by government in the 2017 budget is a welcome cash injection, and a reassuring sign of intent, every pound needs to count. This requires a plan.

The skills shortage has been a hot topic in the rail industry for several years, stoked by a general fear that industry lacks people with the right expertise to deliver necessary software, communications system, data or digital technology expertise. And this lack of certainty extends to whether the expertise required to deliver today's concept of a digital railway will be significantly different from the technological requirements of tomorrow.

Gauging future workforce and training requirements would be a lot easier and more certain if there is a fixed plan for delivering a digital future – without a clear requirement we can't assess the resources and skills required.

A pairing of people and machine

Our round table debates revealed confidence from suppliers that they already have the resources to develop a digital railway. However, slow progress of the Digital Railway Programme (DRP) means they are understandably cautious about investing in the future workforce until there is a credible programme of work and real confidence that it will proceed to time. Suppliers also face the challenge of not knowing what mix of expertise will be required, and how rapidly this will change with time. For example, how greatly will traditional signal engineering expertise support DRP projects?

The indication is that if suppliers are given contracts with the right scope and timeframe, they will make the necessary long-term investment in people. From a business-opportunity perspective, Gary Cooper director of planning engineering and operation at the Rail Delivery Group, said at the launch event, "If we embrace this opportunity, we can give the supply chain confidence to grow its people, and their expertise, and even export beyond UK plc".

There is no magic bullet, only through ongoing efforts to attract and retain people throughout their career, as they transition from college or university, to early professionals and experienced specialists, can we reap the rewards that Gary believes are possible.

Developing the core skills: how are we doing?

Clearly, our industry has a skills shortage (i.e. not enough people) exacerbated by a skills gap (i.e. those people we do have lack expertise for delivering the digital railway). Critically, though, industry needs to understand that skills come in many forms. Sure, they include the more obvious technical skills, but personal skills are also crucial, helping the collective 'us' to challenge the status quo in our standards-bound rail environment. Mostly, the railway needs visionaries to provide strong leadership.

We need better technical and personal skills, but above all, leadership.

New ways of working to be supported by new ways of learning.
Above, Resonate's Scalable technology in use at the Thames Valley rail operating centre.
Left, VR equipment at the National Training Academy for Rail in Northampton.
Photos Network Rail and NTAR.

The Digital Railway Industry People Strategy is a big step in the right direction. Providing a road map and principles to engage with, inspire and train a workforce fit for the future railway needs.

Then there is the Digital Railway Centre of Excellence, (part of the UK Railway Research and Innovation Network – UKRRIN and centred on the University of Birmingham), an impressive example of how strategy is being put in place. It has the potential to become a powerhouse of digital technology development activity for railways, with strong industry collaboration and input, and it could facilitate the growth of expertise to support the DRP. And the National College for High Speed Rail is certainly developing future skills to provide expert, practical training and curriculum development drawn from senior experts working on leading-edge projects like HS2.

Personally, I am optimistic that we can build the skilled workforce that will deliver the future railway. The students I was privileged to speak with and observe – as part of the National Training Academy for Rail (a joint project between the National Skills Academy for Rail (NSAR), the Department for Business, Energy and Industrial Strategy (BEIS) and the Department for Transport (DfT), with industry partner Siemens) – were switched on to new technology and not short on ideas that will benefit and challenge our rail industry.

Facing the future: the key to success

Our round table was unanimous in its belief the industry is facing big change, and that it will need to adjust accordingly. Encouragingly, this view is shared by NSAR, which specialises in talent planning and the development of training standards and plans, stating: "The industry is set to go through a major period of change in the coming years requiring a transition of skills from those needed for today's railway to those for the future railway. Managing this transition process is a key task for NSAR."

It is vital that qualifications in rail through MSc courses are tailored to the overall strategy so that our future pool of talent is aligned with what they will need to deliver. Universities must step up and work closely with the industry to deliver these skills so we can develop a better railway.

In general, the industry must collaborate among itself and with academia to identify the skills required, plan for the transition to train and support the people who ultimately will be delivering and operating the future railway. Neil Franklin, the head of skills intelligence at NSAR, sums up this need for collaboration perfectly: "On something as complex and challenging as the DRP, if there is no effective collaboration, you won't find an effective set of solutions. It's critical to enable success. The way the Round Tables brought people from all parts of the industry together is an example of how seemingly insurmountable challenges can be overcome".

In the light of the success of the first set of round table sessions WSP is, in conjunction with the IRSE, planning to commence a further programme focusing on the people and operational issues of the Digital Railway, an initiative to which the IRSE CEO Blane Judd has given his support.

Collaboration is the key, working together we can deliver success.

It's only an "Off" indicator

Stephen Dapré

We first met Ruth, a signalling engineer in a fictional railway world, in IRSE News December 2018 "It's only data". As in the previous instalment the characters described are genuinely fictitious, whereas the story is less so. For those unfamiliar with UK railway signalling folklore, please do not be deterred by some of the unfamiliar terms. The technical themes and deeper philosophical meaning may still be relevant. In this next instalment Ruth faces a new challenge.

"Ruth, can you just explain one thing to me: when is an Off indicator on?"

Ruth's heart sank. Over the years she had explained railway signalling to everyone from primary school children and politicians to civil engineers and accountants, yet there was one question that filled her with dread. It was obvious to her that Off indicators were off when they were on, and on when they were off, because she understood the ancestry of the terms dating back to mechanical practice. However, it wasn't really the best terminology to use nowadays when in modern practice the way to provide an Off indication was to switch a lamp on. After extensive trial and error she had found that one method of explanation with a higher than average success rate was to use the word "illuminated" – so she gathered her thoughts, took a deep breath and started:

"Well, we illuminate it when we want to show an Off indication…"

Ruth soon stopped because the project manager had stood up to answer a phone call which was presumably more important than Off indicators, so she concluded he didn't need to be illuminated now. She reflected that Off indicators might make a good interview question for potential signalling engineers: most people would just look blank or confused, but if they realised the name "Off indicator" was perfectly logical, just awkwardly named, then they might stand a chance.

Ruth had managed to avoid excessive exposure to Off indicators in her career thus far – that was until she became the signalling engineer for a station upgrade that required the platforms to be extended. As a result, she was now becoming an unwilling expert on the subject. What the project manager and others saw as a simple task of "just moving the platform starter signals along the track out of the way" was turning into an epic saga, primarily due to signal sighting. She knew her Grandpa Harold would not be impressed.

The craft of sighting

In some worlds signal sighting might be seen as a science based on facts and calculations, and certainly there were elements of that here: the reading times of signals were a function of train speed and distance that could be mathematically derived by most teenagers. Even here trains could not defy the laws of physics. However, in this universe there was also an underlying culture of spirituality, legend and custom, and it was considered foolish for key decisions to be decided by science alone. Instead, there was a whole tradition specifically to handle the topic: signal sighting sorcery. For each signal, a combination of facts such as train length and speed were carefully blended with a wide variety of less tangible factors to give an option carefully crafted to the unique circumstances. It was no coincidence that the word "option" was an anagram of potion.

Obviously such important and mystical tasks could not be undertaken by everyone, hence there were clearly defined roles, the key one being the signal sighting sorcerer (SSS). Their role was to oversee the gathering and inclusion of factors and fresh local ingredients from various sources and ensure that the resulting potion was suitably bespoke for each signal, yet compatible with local traditions. Each SSS had their own style: the majority were collaborative and sought to agree the balance of ingredients collectively before applying them. However, there were a few who tended to insist on their own favourite ingredients regardless of what others thought, or else be too passive and allow strong ingredients brought by others to overpower the recipe. Some other SSSs were excellent at the spiritual rituals, but weren't so good at remembering or recording what ingredients were used each time so that it was often impossible to repeat the same recipe twice, even for the same signal. Whatever their styles, there never seemed to be quite enough SSSs to keep up with projects nationally so they were always in high demand.

Train patterns

The SSSs were obliged to convene gatherings with representatives of those that drove trains in the area concerned. The national rail network had been split up many years ago into separate

Reading Down Main platform is almost straight, with the green LED signal beyond the platform ramp readable by drivers at 95mph (155km/h), yet it has three Off indicators.
Photo Stephen Dapré.

train companies serving the various Communities around the country, which had resulted in trains being painted a wide variety of colours to suit corporate styles and egos. More recently it had been decided that this was discriminatory to passengers who were colour-blind – some platform and train information displays were so unreliable that the only accurate clue about a train's route and destination might be its colour. The industry had therefore agreed to adopt vivid monochrome patterns painted on the trains instead, such as stripes or spots.

Several train companies used Ruth's station, and it had taken the SSS considerable effort to find a date when they could all attend an initiation meeting. Ruth decided that although she wasn't essential for the whole sorcery process, it would be prudent to ensure the project started in the right direction so she joined the gathering.

Within minutes it became obvious that some train company representatives had brought a whole bag of ingredients they wanted to add. Before the introductions were even complete, the rep for the Diagonally Striped (DS) company interrupted:

DS: May I assume this project will be undertaking a full resignalling of the entire route to rectify the numerous unacceptable features of the existing layout?

SSS: Well, we need to remember we are only extending the platforms with no impact on other signals outside the station area.

DS: But this is an opportunity to improve the railway for everyone. You will of course recognise that we have the fastest trains with the most streamlined nosecones and our passengers pay premium prices so we expect high standards.

SSS: I thought your trains don't even stop at this station?

DS: We have the commercial rights to do so, which we can exercise at any time.

At this point the Zig-Zag (ZZ) train rep couldn't resist joining in.

ZZ: Last time you lot ever stopped here was when our local team made it to the cup final and we hosted it, and your trains brought in all those rowdy opposition crowds from far away, but we don't need to worry about that happening again, do we – did you see how they performed last weekend?

Ruth was about to intervene when fortunately the SSS did so first and skilfully brought the gathering back to discussing the overall scope. At least this SSS was one of the good ones. Within minutes the DS rep made it clear that he had certain expectations:

DS: In my considerable experience of signal sighting sorcery I have found that there are two vital constituents for success. Do you know what they are?

SSS: The 3D CAD model?

DS: My friend, you are quite correct. And the other is?

Everyone else in the room looked blank, so after pausing for dramatic effect he continued:

DS: A decent buffet lunch. Professional signal sighting sorcery requires deep thought while drawing on experience from deep within our souls. A proper lunch is a catalyst to help cogitate while we compare our extensive knowledge of railway operations from Communities around the country.

Ruth was far too polite and inclusive to comment on people's physiques, nonetheless it suddenly dawned on her that the DS rep probably had far more experience of sighting sorcery meetings than climbing into train cabs nowadays. Ruth decided it was time to let the SSS work his magic so she stepped out of the room. She had agreed that she would drop in at intervals to check on progress and any issues arising, so she returned later. The reps for Zig-Zag and another local train operator known as Tiger Stripes (TS) were having a lengthy debate about assumptions for the project. Even though both operators used virtually identical commuter stock trains (ignoring the external stripes), they seemed to relish taking conflicting views on everything.

ZZ: 15m is insufficient stand back from a platform starting signal for this type of cab.

TS: Why? Our guys can see it OK, why can't yours?

ZZ: Our extensive audit of cab sightlines revealed that drivers over 1.9m tall with the seat at full height might not see a gantry signal.

TS: Why would someone 1.9m tall want their seat at full height? They'd bang their head on the aircon duct above the seat and what about...

A former BR Southern Region style Off indicator at Peckham Rye, South London. Lit by a filament lamp behind etched glass, the Off aspect was visible when photographed but the station lighting directly above it might make it harder to distinguish.
Photo P Hathaway.

DS (interrupting again): Hmm, clearly I also need to understand the sightlines even though our company doesn't use such slow and angular stock. We should spend a day visiting each of your depots.

And so it went on. Again the SSS carefully steered the conversation onwards and gave Ruth a knowing look, which she took as her cue to leave again.

Shortly after what Ruth would call lunchtime, she returned to find everyone packing up. The SSS explained that all the reps had important engagements or errands, but at least they had eventually agreed some ground rules.

Ruth: Well done. You look exhausted!

SSS: Oh that's normal. It's the quiet ones that worry me…

Sorcery in full flow

Several weeks later, the SSS invited her to join in one of the gatherings. She had witnessed sighting sorcery earlier in her career: the sorcery routine collected all the facts such as dimensions, then actively encouraged a wide range of other factors to be applied. These might include possible sources of driver distraction or misjudgement – some being physical (such as visual obstructions), some less so. This is where the true sorcery started: the SSS would have to guide the conversation to allow people a fair opportunity to throw their ingredients into the mix, whilst keeping some sense of perspective. The output was known as the Essential Reading Time (ERT) potion, which had a secret formula somehow influenced by the amount and nature of the ingredients added. Certain reps would sometimes compete to find the most obscure ingredient they could possibly justify using, to see if they could concoct a new record for a high-strength ERT potion.

Ruth entered the room with caution, and soon realised that instead of normal signals, Off indicators were topic of the day (again).

ZZ: …so we need another Off indicator on platform 3 so that our passenger welfare managers (PWMs) can see one from every doorway.

TS: Why can't your PWMs just stand at the rear or middle driving cabs like our door security operatives (DSOs) do?

ZZ: Our PWMs care deeply for our passengers so should be able to use any carriage along the train, rather than hiding in an empty cab like your DSOs.

Ruth was still standing in the doorway and asked what she thought was an innocent question:

"In some areas don't they just get the drivers to operate the doors nowadays?"

There was a long frosty silence, after which conversation resumed as though Ruth wasn't there.

SSS: OK so we will consider extra Off indicators for those platforms where we have moved signals.

ZZ: And replace all the old vintage ones for consistency.

SSS: The old ones still work don't they?

ZZ: But they cannot always be read by our PWMs, some need reading glasses to check tickets and it is unfair to expect our PWMs to remove their glasses at every station. We therefore need an Off indicator with large letters at frequent intervals along each platform to cater for every conceivable door position. It's only an Off indicator, a light in a box can't be that expensive.

Ruth wasn't so sure, based on her recent experience locally. A few weeks ago at a conference she had met the chieftain of the Community of Whisky Tasters (CWT) who had seemed more pragmatic than her local community so she quickly texted him.

Ruth: If you needed eight new Off indicators, how easy would this be on Standard Computer Interlocking areas?

Chief of CWT: Och, don't believe anyone who says "It's only data". Just do it in the lineside cases, it's only an Off indicator.

Ruth: No danger of that. Great, thanks.

Chief of CWT: Nay bother.

Ruth was pleased, although bemused that anyone could even say "It's only an Off indicator" after what she had endured in recent weeks.

Ruth decided to slip out of the room again, it was clearly going to be a long conversation. Glancing down at her phone she saw a new email from Binary Railway saying:

> Dear Project Person
>
> We see that your project is undertaking signal sighting sorcery, introducing undesirable stochastic factors into what should be a simple deterministic calculation without human intervention. Did you know that with our new cab signalling, you would no longer need lineside signals, offering your railway huge cost (excluding train fitment, to be completed by others) efficiencies?

Ruth knew that one day she should really embrace the future, however it was not going to be today. She decided Binary Railway did at least deserve a binary email response from her: "Yes.". Then she amended it to "Yes I did know, thank you" to make it sound more human.

Signal sighting sorcery on site

Later that week, the SSS told Ruth that they would be going on site because having invested considerable time and energy developing a 3D CAD model to show the entire station, the model had mysteriously changed in the space of a fortnight and nobody could explain which model file was the latest version.

The reps had therefore lost confidence in the images they were being shown and insisted a site visit was necessary, which was understandable but frustrating.

Ruth didn't mind going on site, it was a welcome break from a world of CAD and emails. When she arrived on the day they had already started and within minutes she was puzzled.

Ruth: I am sorry I don't quite understand the dimensions you are quoting?

SSS: It's quite simple, the height and distance from running rail for the signal are all in metric units.

Ruth: Yep I get that bit, but what about the dimensions along the railway?

SSS: Well, our ancestors decided that each mile of railway should be divided into furlongs.

Ruth: Furlongs? Doesn't sound very metric to me, I thought a furlong was one eighth of a mile?

SSS: Aha, the beauty of it is that because there are 80 chains in a mile, each furlong is 10 chains, and there are 100 links in a chain, which conveniently makes it a decimal system. A furlong is 1000 links.

Ruth was dubious – she knew that most engineering disciplines worked entirely in metric units nowadays, yet signal sighting sorcery used furlongs and chains for distance, millimetres for height and width, and of course miles per hour for speed. A few minutes later she asked another question:

Ruth: So why are you using a metric measuring wheel along the track?

SSS: We couldn't get hold of a wheel that showed chains or links so we just use a metric one and convert it in our heads, a chain is about 20 metres.

Ruth: So you measure in metric, convert it to chains, then the construction teams will convert it back to metric to make sense of it?

SSS: It's usually near enough, the construction gangs never follow it anyway so we use spray paint to mark the actual position.

Ruth: So what about when we've used 3D CAD models, don't they have a datum?

An approaching train sounding its horn meant Ruth's question was left unanswered.

Signed and sealed

At last the sorcery was nearing completion, with the final step being the Signing and Sealing of the Paperwork Ceremony. This was always a dramatic occasion, with ink quill pens used to give a traditional atmosphere, an enhanced hot buffet lunch, and a distinct tension in the air – it would be highly impolite to assume that everything (or indeed anything) would be signed on the day.

After the usual courtesies of "After you", "No no, after you I insist" had occurred, the reps started adding their signatures to the piles of paperwork that their sorcery efforts had spawned. The DS rep quickly clarified that just because he might sign the forms, it was purely to confirm that the sorcery recipe was adequate; his company might still object to the overall project for wider commercial reasons (or simply because it could).

Nearer lunchtime the project manager put his head around the door. Ruth thought he might just have smelt the hot buffet, but it was worse than that. Both Ruth and the SSS held their breath; they did not want any excuses for the sorcery paperwork to be reopened.

"Ruth, if I said version 17.0 of the remit issued this week now requires passive provision for electrification masts, what would you say to me?"

Ruth could feel herself wanting to say just two words, one being "Off" and the other one not being "Indicator". Instead she swiftly and firmly responded:

"No problem, that is clearly a scope change so will not affect our current work. I'm sure our industry colleagues will be happy to assist with any future sorcery required subject to the availability of suitable funding." "And buffet lunches" she quickly added, after a piercing stare from the DS rep.

The PM disappeared again, much to Ruth's relief. Whilst simultaneously signing forms and eating from the buffet (which itself brought a risk of spoiling the documents), the reps started chatting.

ZZ: I hear that you Tiger Stripes are finally getting some new trains for this line.

TS: Ah yes, I did hear something about that, though we always get told after everyone else.

DS: What are your new trains then?

TS: I think the rumour was Type H87, whatever that is.

Suddenly the room went quiet.

TS: What? What are they?

DS: Don't you know? H87s are those monstrosities with ugly gangway connections on the front.

SSS: Oh yes, of course, those ones with really poor views out of the right hand...

The voice of the SSS tailed off; he instantly regretted starting his sentence and could almost feel the floor opening beneath him. He looked across at Ruth helplessly. Ruth realised there was now a high risk of her saying something career-limiting, so to mitigate that risk she grabbed the last cake from the buffet, put the whole thing in her mouth to prevent any words escaping, and left the room.

One advantage of cab signalling is that it avoids all the problems of signal sighting … except when it doesn't! At London St Pancras on the northbound Thameslink line there is a 'co-actor' for an ETCS block marker. The primary board is tucked underneath the platform edge so is not visible from close range – although being near the beginning of the platform it would be unlikely that drivers would wish to stop at it.
Photo Stephen Dapré.

A word with Markus Montigel

Lindsay Jones
Communications Manager, IRSE

Dr Markus Montigel took over as president of the IRSE at the AGM last April and will be handing over to senior vice president George Clark later this month.

Markus chose the theme Winds of Change for his presidential programme of technical papers which were held across Europe and Australia and live-streamed for the first time in IRSE history. The papers focused on innovation and technology in railway signalling and communications and how the introduction of modern technology could be expedited for the benefit of the rail industry

Communications manager Lindsay Jones interviewed Markus as he neared the end of his term in office after a busy and very successful year.

Markus Montigel, IRSE President 2018-2019.

What would you say were the highlights of your presidential year?

There have been so many it is difficult to choose just a few, but perhaps one of the first highlights was the technical convention in Switzerland, the central theme for which was safety in long railway tunnels. I have not heard a single negative comment about the convention which was generally regarded as a most innovative and informative event.

My theme for the year was "Winds of Change" and I believe the series of presidential papers I organised this year set the scene for us as the IRSE to lead interesting discussions about the future of signalling. We had several landmark papers, notably the presentations on command and control from Dr Josef Doppelbauer, executive director of European Union Agency for Railways ERA and Steffen Schmidt of Swiss Federal Railways (SBB) who discussed some elements of SmartRail 4.0 and SBB's project implementing such a system.

The introduction of live-streaming of my presidential programme papers was another highlight for me. Thanks to those participants on the net, Dr Doppelbauer's presentation at my first presidential paper event was the most well attended IRSE event ever.

For several years it has been my goal to introduce live-streaming for these events so that not everyone has to travel to the actual location. Instead they can just follow from their desks and even ask questions during the discussion part at the end. It's a great experience to sit with your speakers around you and to know the whole world can hear you. Your message goes beyond the walls of the room you are sitting in.

If I had to choose just one, I would say the new IRSE branding and logo was the pinnacle of my year. Many people worked together over a period of two years to make this happen, and I am delighted it became a reality during my year – even if it was quite controversial! I understand that people liked the old logo and the tradition that went with it, but if we want to attract younger people – and we must – then we have to move with the times. The logo we have now is timeless and not in immediate danger of being outdated. Some members wanted to see a signal in the new logo but I told them in 20 or so years there could be no signals left.

Thinking about the theme "Winds of Change" what other changes have you influenced at the IRSE this year?

I am pleased to say that I have been instrumental in changing the election process for council to give more power to the members. Now it is the members who primarily propose candidates for the council. For me, as a Swiss – used to very democratic structures – this was an important goal to achieve.

When I joined the council, it was quite conservative – but things have really changed. For example, it would never have been possible to change the logo. Our previous CEO Francis began the process of introducing some new people into the team and

Markus selected "Winds of change" as this year's theme.

it has been really good to see that the Institution is able to bring about positive change within itself – a trait which is absolutely crucial for our future.

Are you seeing a change in the way that people on the outside are viewing the IRSE?

Yes – and it's a result of the activities of many members. The new layout and concept for IRSE News has been very well received by people both inside and outside of our Institution. I have had so many positive comments which I share from people who say it is a now professional journal of a quality almost unrivalled within the railway industry.

How did the reality of being president compare to your early perceptions of what it might be like? Was it a challenge to deliver on those very ambitious goals you set out in your presidential address and how did you find the task of making the presidential programme happen?

That's a very good question. I'm not a professional event organiser and of course neither is any president when they first start. The key is that basically everything should be ready during the year as senior vice president before you are in the headlines. I had almost all my speakers lined up by the end of 2017, although some of the fine detail had not been finalised and there were some surprises along the way when some speakers cancelled.

One of my main ambitions was to internationalise my programme – meaning that it wasn't just going to happen in London as it has mostly been in the past. Almost every paper was held in a different country, and that in fact turned out to be quite difficult especially if the country in question didn't have an IRSE presence. Where there was an IRSE section I could say 'hey guys I would like to do this' – and you know you'll always have someone there to help out, but in Germany for example I had to find another organisation, the Technical University of Darmstadt, who sourced the room and catering!

What was one of my great highlights proved also to be one of the biggest challenges. I totally underestimated how difficult it would be to achieve live-streaming. I was surprised and disappointed that this technology is not yet as standard as the telephone, and so difficult to deliver. We should somehow find a strategy to make these events accessible for everyone on a regular basis with less effort. It's a pity to organise such high-class events and have just 30 people or 40 people in the room.

What do you see as the main challenges George Clark will face during his year as IRSE president?

I see the challenges on two levels. The first is the challenge of steering the direction of our Institution and continue the modernisation process. Some of the challenges I faced won't go away just because I go away!

George takes over with the end of the life cycle of our current strategy in sight, so it will fall in his presidency to really think about and work on the new strategy of the IRSE with our CEO Blane.

It is generally hard for professional organisations to really sell their 'products' not only to the current members who have been around for many years, but to new members as well. It needs support of the industry, of the employers who also need to be willing to pay the membership fee for instance and give engineers time away from the workplace to attend professional events.

We need to have a formal and fruitful cooperation with other organisations within our industry, be it railways, suppliers or government so the development of a robust industry partnership scheme is essential.

The other level is the challenges facing the industry itself. There is still so much to innovate and renew and this such a big task for the mainline railways especially. One example of this is data communication because we are using systems which are so far behind the state of the art. Every child has a mobile phone which is four generations better than the technology we see in today's trains.

Without efficient communication you can achieve nothing on the modern railway, but it is still to a large extent, unclear at the moment how this will work in the future. This is an international subject and one to which the IRSE should devote much of its energy.

And finally, what have you learned personally as a result of your year as president of the IRSE?

I learned that I could increase my ability to respect the views of others and to find compromises instead of just trying to pursue my own opinions. It's important for the president not to drive forward with his or her own views but to listen to the various opinions which are around and try to steer the institution in a direction which makes most sense for the future of the IRSE.

I owned my own company for 15 years and made all of the decisions so my year as president has taught me to be more tolerant and collaborative – qualities which I will definitely take back with me when I return to 'normal' life.

Innovations introduced by Markus included a particularly Swiss means of gaining attention.

Industry news

Engineering Council sponsors international framework

UK: The Engineering Council, regulator of the engineering profession in the UK, has worked with The British Standards Institution (BSI) to develop an internationally applicable Publicly Available Specification (PAS 525) for assessing the competence and commitment of engineering professionals. This framework defines a standard for knowledge, skills and behaviours that are required to build and maintain competence. It is designed to be readily implemented by international professional engineering organisations. It can also be used by government agencies, employers and insurers as a framework to support specification for engineering projects products and processes, or to guide the training of engineers

A robust method of assessment of competence ensures that engineers are equipped to address the challenges of today and provides employers, government and the public with confidence in the engineering profession. Formal recognition of competence, such as professional registration, sets individual professionals apart from engineers and technicians who are not registered. It confirms their proven knowledge, understanding and competence. In particular, professional registration demonstrates a commitment to professional standards, and a continuing responsibility to develop and enhance competence.

As well as maintaining the UK standard for professional engineering competence (UK-SPEC), the Engineering Council is active within a number of multilateral mutual recognition agreements with national engineering bodies, such as the IRSE, and in other countries governed by the International Engineering Alliance (IEA). The Engineering Council is also a member of the European Federation of National Engineering Associations (FEANI) and the European Network for Accreditation of Engineering Education (ENAEE).

Network Rail reorganisation

UK: Network Rail is reorganising to put passengers and freight users first. The five new regions will be supporting the route teams with current headquarters activity to be further devolved into the regions and routes. The centre shrinks considerably with a shift to a service culture – changing behaviours is seen as key to success.

The number of routes is to be increased from the current eight to 13 to improve the responsiveness to needs and better match train operators' franchises, enabling track and train to work closer together and tackle train performance issues head-on together.

The 13 routes will be responsible to five regional managing directors, allowing Network Rail to further reduce its national centre and be much more aligned to the passenger and train operators. This is planned to enable a more cohesive and joined-up railway focused on delivering a better and more punctual service for customers.

PTC agreement

USA: The American Short Line & Regional Railroad Association has entered into an agreement for Wabtec Railway Electronics to provide Positive Train Control (PTC) to its members using a hosted multi-tenant back office system. This is designed to offer complete PTC back-office functionality within a package which is cost-effective for short line operators.

Mumbai contract

India: Mumbai Metro Rail Corp has awarded Alstom a €100m (£76m, €88m) contract to supply Urbalis 400 CBTC for unattended operation on Line 3, with platform screen doors and SCADA.

Driverless in Bahrain

Bahrain: The government of Bahrain has launched an international bid for its new metro railway project known as the Bahrain Metro. The Bahrain Metro project is expected to launch in the fourth quarter of 2019 and is to be completed by 2030.

The Bahrain Metro will have driverless trains and cover 109km via six lines, with a capacity to transport 43,000 passengers an hour. The project will be broken down into four phases. The first phase will see the construction of two lines that will cover 30km and 20 stations with lines strategically planned to connect key parts of the city.

According to Abdul Rahman al-Janahi of the Ministry of Transportation and Telecommunications, the Bahrain Metro project would cost between $1 billion and $2 billion. He explained that the metro would most likely include a partnership with a foreign party to help finance and manage the project.

ETCS Level 2 and ATO for new S-Bahn trains

Germany: The Stuttgart regional government has approved the purchase of 58 four-car Class 430 electric multiple-units and the installation of ETCS Level 2 and automatic train operation on the entire S-Bahn fleet.

The €422m (£369m US$483m) order is to be delivered by 2022. The rolling stock forms part of a capacity enhancement project that also includes the installation of ETCS Level 2 and digital interlockings for GoA2 automatic operation. DB Regio will equip the entire S-Bahn fleet of 215 EMUs with ETCS onboard equipment.

ATO over ETCS Level 2 is not currently in operation in Germany and the pilot is being conducted as part of the nationwide Digitale Schiene Deutschland project. ATO is expected to become operational on regular services in 2025 and will enable shorter headways and faster speeds, and together with extra rolling stock capacity on the network could be increased by up to 20%.

Chinese ATO

China: New automated trains will serve the line between Beijing and Zhangjiakou, two host cities of the 2022 Winter Olympics, and operate at a speed of 350km/h.

The implementation of fully automated train operation (ATO) will be provided in two stages. Initially a driver will remain in the cab and will control the train assisted by the ATO system. The plan is then for a second stage by eliminating the train driver altogether.

China Railway tested the ATO system on two lines in the Pearl River Delta region of Southern China using an older generation of bullet trains at a speed of 200km/h. The ATO system was then successfully tested from July to September 2018 on the Beijing-Shenyang line with new self-driving bullet trains running for more than 186,000km during the 94 days of trial.

For the automated operations, China Railway will use Fuxing bullet trains developed by Bombardier Sifang Transportation, a joint venture of CRRC and Bombardier Transportation. The first Fuxing CR400AF unit was unveiled in June 2015 reaching 420km/h during test rides on the Zhengzhou–Xuzhou high-speed railway in July 2016. The Fuxing trains started to run regularly between Dalian and Harbin in August 2016 and in June 2017, they debuted on the Beijing-Shanghai line linking two Chinese major cities in 4.5 hours. The Fuxing units run at a regular speed of 300-350km/h.

Australian news

Australia: The NSW government has awarded Network Rail Consulting and Go-Ahead the A$16m System Integrator contract within its Digital Systems programme which includes rolling out ETCS Level 2, ATO and a traffic management system.

ARTC has awarded Golder Associates a A$23m contract for geotechnical studies on the Gowrie – Kagaru section of Inland Rail.

The NSW government has awarded the A$1.38bn Sydney Metro City & Southwest tunnel fit-out contract to the Systems Connect joint venture of CPB Contractors and UGL.

PWI approved to assess

UK: The UK Engineering Council has announced that the Permanent Way Institution (PWI) has received approval to become a new Licensed Member of the Engineering Council and, like the IRSE, assess candidates for Engineering Technician (EngTech), Incorporated Engineer (IEng) and Chartered Engineer (CEng) status.

The granting of a licence to a professional engineering institution allows the assessment of candidates for inclusion on the national register of professional engineers and technicians, and on application to accredit academic programmes and professional development schemes.

Review of UK regulatory framework for tramway safety

UK: On Wednesday 9 November 2016 a tram travelling from New Addington to Wimbledon overturned on a curve approaching Sandilands Junction near Croydon, England. Seven people lost their lives and many more were injured. Recommendation 9 of the investigation report into the accident invited the ORR (the UK safety regulator) to "carry out a review of the regulatory framework for tramways and its long-term strategy for supervision of the sector".

The ORR has now started a consultation to seek the views of tramway duty holders on the ORR's proposed approach to improving how the safety of Britain's tramways is regulated and supervised.

The consultation explains and seeks the industry's views on the consideration ORR has given to each aspect of the framework; the areas where they are not recommending changes, and why; and three specific improvement proposals around the use of the Risk Management Maturity Model, the EU Common Safety Method on Risk Assessment and sharing of safety data.

Factors affecting safety-critical human performance

UK: The Rail Accident Investigation Branch (RAIB) say they have investigated numerous incidents in which the decisions of front-line workers have been pivotal to the outcome, and where the safety of the railway system has been entirely dependent on those decisions (scenarios in which there were no engineered safeguards). Many of these situations involve the decisions of signallers e.g. in arranging line blockages or responding to users at user worked crossings.

Moreover, the RAIB is aware of several more similar incidents which, although not reaching the criteria for a full RAIB investigation, highlight the vulnerable nature of such decision-making. In the light of these incidents, RAIB have decided to undertake an investigation into the factors affecting those decisions.

Fundamental to the investigation is the recognition that such decisions are never taken in isolation, but may be influenced by a variety of factors associated with the person, the task, the equipment, the environment or the organisation. The purpose of the investigation is to identify these factors and to determine what actions may be appropriate to address them, as well as aiming to improve safety.

At the conclusion of the investigation the report, including any recommendations to improve safety, will be available on the RAIB website.

Rail industry's social value

UK: The Rail Safety and Standards Board (RSSB), in partnership with Action Sustainability, ARUP and Simetrica, has worked on creating a way for the GB rail industry to measure its social value, through the new "Common Social Impact Framework for Rail" CSIF. This RSSB research pulls together a robust range of monetised, quantifiable and qualitative measures, that can be picked from and applied in a range of situations.

The GB rail industry has numerous economic performance measures, and is increasingly better at understanding its environmental performance, however, social sustainability is lagging behind and has limited metrics.

With sustainability becoming increasingly embedded within rail industry, for example with the likes of the Rail Carbon Tool now being commonly used to assess the carbon emissions of a project, it is important that a consistent approach for the whole rail industry is now introduced for social value.

Head of sustainable development program, Anthony Perret at RSSB, said: "Social value is a key element of what the rail industry brings to the country. It is increasingly important that we develop a way of measuring this, in terms of reporting value to local stakeholders, the communities in which we work, and our customers. And also to industry funders such as the Department for Transport."

The CSIF will provide the structure for the rail industry and its community rail partners to do more in terms of serving customers and communities, providing a consistent approach to understanding the implications of our activities, planning and delivering work.

Spending habits

UK: A new report into UK commuters' spending habits estimates they spend £23 billion (€26bn, $30bn) per year via their mobile devices while on the move, which seems remarkably high. The research was conducted by media agency Kinetic and media owner Exterion, who both specialise in OOH (Out-of-Home) advertising.

Across the whole UK commuters apparently spend on average £89 (€102, $115) per week on their mobile devices, London commuters spend £153 (€175, $198) per week.

The research confirms the requirement for on-train data communications for customers and the benefits of public transport commuting to society and retail business.

Polish investment

Poland: Infrastructure manager PKP-PLK has awarded Czech company AŽD Praha a contract to supply signalling and interlocking equipment for the modernisation of the Słonice – Szczecin Dąbie section of European corridor E59.

AŽD Praha will be responsible for the design, supply, installation and testing of ESA 44-PL electronic interlockings covering the 67-km route which includes level crossings and six stations. The 201m zloty (£41m, €47m, $53m) project is being co-funded with 166m zloty from the EU's Connecting Europe Facility. Completion is scheduled for late 2020.

Danish ETCS in operation

Denmark: Denmark's first European Train Control System (ETCS) has been in operation since 21 October 2018 on the line between Frederikshavn and Lindholm in Northern Jutland. It is believed to be the first ETCS Level 2 Baseline 3 system in the world.

The project was initiated by Banedanmark and delivered by Thales and Strukton. It includes the ARAMIS™ traffic management system that optimises and supports operational efficiency, flexibility and provides better punctuality.

An additional 11 lines are preparing for ETCS deployment from 2019, starting in the Western part of Jutland, with the roll-out to be completed by 2023. According to Banedanmark's plan, the system will be operational throughout the country by 2030 and can potentially save up to 720,000 hours in delays a year.

DB Advanced TrainLab

Germany: Deutsche Bahn has launched its advanced TrainLab, and is giving the entire rail industry the opportunity to test future technologies independent of regular railway operations.

The test train is an ICE TD Class 605. Manufactured by Siemens/Bombardier, they were in service between 2001 and 2017. The diesel-electric traction means this train can operate across the entire DB network, regardless of whether lines are electrified. The top speed of 200km/h means a broad range of tests are possible. The 107m train, with an axle load of 15 tons, consists of two central and two end cars, providing plenty of interior space for instruments and test setups.

The TrainLab train is currently fitted with three mobile phone antennas for the new 5G network. DB and Ericsson are testing them as part of the 5G-Connected Mobility initiative and they have already performed initial measurements to survey the 5G network installed for testing on the high-speed route between Nuremberg and Ingolstadt.

Over the coming months the advanced TrainLab will perform experiments with sensors for detecting objects and obstacles, as well as for identifying signals and the environment. Further tests include tests for data transfer between road vehicles, trains and the infrastructure, such as at level crossings, as well as the use of environmentally neutral fuels for rail vehicles that are currently diesel-powered.

ETCS in Italy

Italy: As a member of the Cepav Due consortium, Ansaldo STS has secured a €98m (£86m, $111m) contract to supply ETCS Level 2, IXL Multistation and the TMS-HS traffic management tool for the 48km Brescia Est – Verona high speed route.

German spectrum regulator offers industries local licences in 3GHz and 26GHz to boost Industry 4.0.

Germany: Germany's industry may acquire regional 5G licences from federal network regulator, Bundesnetzagentur (BNetzA) to build their own networks in next-generation factories and other facilities.

The frequency bands are suited to building dedicated networks for industrial complexes and research campuses to further the EU Industrie (Industry) 4.0 initiative, which originated in Germany and relies heavily on more sophisticated automation in manufacturing.

The regional licensing process will run in parallel with the national licences for network operators, which makes provision for the entry of a fourth competitor, 1&1 Drillisch, which is a subsidiary of United Internet.

Reuters quoted a spokesperson for Siemens, which is headquartered in Munich, saying, "We can't wait for the network operators to be ready – we are in the midst of Industrie 4.0". Volkswagen wants to run 5G "inside the factory fence", and its Audi division has begun work with Ericsson on a 5G lab to develop connected production approaches.

The German chemicals company BASF runs 600,000 networked sensors and other devices at its main production facility in Ludwigshafen on the Rhine, which is likely to rise by a factor of ten or more, hence the attraction of 5G. Maintenance employees will rely on tablets and virtual-reality goggles to guide them, which also needs very high capacity bandwidth. The licenses may provide connectivity options for the rail industry and its suppliers.

Manchester to York at the speed of light

UK: A 75 mile (120km) brand-new fibre route is currently being deployed by Network Rail in conjunction with government departments for Digital, Culture, Media & Sport (DdCMS) and the Local Full Fibre Networks (LFFN) Programme. The fibre backbone, stretching across the Northern Powerhouse and alongside the rail route, will give access to both 100Gb lit and dark fibre services for customers

With interconnects into key data centres in Leeds and Manchester the route offers diversity, ultra-high speed, and ultra-low latency solutions to both large and small telecommunication suppliers.

Trans-Pennine Initiative update

UK: The Trans Pennine Initiative (TPI) is a joint project between the Broadband Delivery UK (BDUK), Local Full Fibre Networks (LFFN) and 5G Testbeds and Trials (5GTT) Programme, to investigate the potential of using the rail network to enhance connectivity for rail passengers and the population more generally. There are three main components of the TPI:

1. An LFFN-focused element, deploying high capacity fibre along the Trans Pennine route from Manchester to York, to provide backhaul capacity for open access points along the route and test a commercial model for fibre deployment on the railways.
2. An upgrade to the existing Network Rail test track (the Rail Innovation and Development Centre, RIDC) at Melton Mowbray, to enable it to trial new technologies including 5G.
3. Passive infrastructure including masts along the Trans Pennine route, to enable radio trials by third parties of high-quality passenger connectivity on trains.

Survey and planning work have highlighted that the construction costs and complexity of the radio infrastructure required for the third item are significantly greater than expected, and feedback from the Department for Digital, Culture, Media and Sport's (DCMS) call for information has shown that although there was interest in the concept of the trial, the market was not prepared to participate on the basis of the available funding (covering equipment provision only) and that following the trial a supplier could be required to remove their equipment.

The DCMS has therefore taken the decision not to pursue the planned build of radio infrastructure along the Trans Pennine route. The decision does not impact the deployment of high capacity fibre between Manchester and York and the development of a 5G testbed at the RIDC.

Have we missed a particularly important item of news for your country, railway or organisation? Email us at editor@irsenews.co.uk with any relevant stories and we will publish the most topical every month.

News from the IRSE

Blane Judd, Chief Executive

On the road with Blane

One of my responsibilities as CEO of the IRSE is to engage with other professional bodies, leading suppliers and government officials to raise the profile of our Institution and help promote best practice for those working in safety critical sectors. Here's an overview of my recent engagements to give you an insight into my role.

I met with the MD of the Midlands Rail Forum Elaine Clark to discuss the findings of the newly published Government rail strategy document and explore ways we could work collaboratively on skills development. A meeting with staff at the Rail Safety Standards Board lead to discussions on how other industries manage verbal communications when issuing safety critical information. We spoke about the ways we might be able to apply that to further improve communications between drivers and signallers as technology changes.

The National College For High Speed Rail, Birmingham was the venue for the Alstom safety day where I had the opportunity to spend some time with Ian Prosser, HM Chief Inspector of Railways and to share my thoughts on how the IRSE could collaborate with others working in safety critical sectors to share experiences of using technology to reduce risk to operatives. I am also in discussions with Alstom about the development of a signalling and telecommunication asset maintenance handbook, with a view to creating a new international official standard.

Encouraging students to one of our strategic aims and at the launch of the 'This is Engineering' campaign at the Royal Academy of Engineering we looked at ways we as a group of like-minded professionals could work more closely together to promote engineering as a career of choice. The event was hosted by the Academy's president, professor Dame Ann Dowling who is a world authority on combustion and acoustics and deputy vice-chancellor and professor of mechanical engineering at the University of Cambridge.

IRSE/INCOSE symposium – beating the challenges

We're very much looking forward to our first interactive digital signalling upgrade workshop which is to be held at the Engineering Employers Federation in London, UK on 11 April.

This sell-out event will be of interest to anyone interested in the capture and development of requirements for complex systems of systems including project managers, designers, operators, engineering managers and sponsors.

Building on from last year's joint conference between the IRSE and INCOSE (the International Council on Systems Engineering), the structured workshop will be led by Karl King and Mike Morua of Frazer-Nash Consultancy to identify the fundamental needs and requirements of an example digital signalling upgrade project. This will demonstrate a robust and concise process of extracting significant volumes of requirements information in an organised and recorded fashion.

The event will be hosted by IRSE President Markus Montigel. At the time of going to press there are just a few places left, so if you would like to attend please contact hq@irse.org. Tickets cost £115 (exc VAT) for IRSE members and £130 (exc VAT) for non-members.

IRSE Subscriptions Renewal

We will shortly be getting in touch with all members to invite you to renew your IRSE subscription. The standard service to members includes the regular postal mailing of IRSE News, notices and event applications forms. In addition, the Annual Report and the Council nomination forms are circulated by post at the appropriate times during each year. The E-membership service level does not include any of these postal mailings, although all the items are included in our monthly e-bulletin (sent to all members) and can be found on the IRSE website (you may need to login to access some of them). In recognition of the reduced service level, E-members pay a lower annual subscription. See irse.info/74z32 for more details on current rates.

Whyte takes over from White! New head of membership and registration appointed

We are pleased to inform members that Polly Whyte has joined us as the new head of membership and registration following the retirement of Christine White after 13 years of service to our Institution.

Polly has considerable experience of working in similar roles within other professional bodies and will be responsible for membership and registration including management of the recently launched Industry Partnership Scheme (IPS). We welcome her to the team and look forward to working with her.

Licensing vacancy – do you know the right person for the job?

The IRSE is currently recruiting for a licensing registrar with previous experience of working within a competency or quality management framework. The licensing scheme is a competency-based scheme for railway signalling and telecommunications engineers and technicians. It is run by the IRSE on behalf of the rail industry in the UK and a number of countries worldwide to maintain high standards of competence in this safety critical environment. Each of the 54 different safety critical job roles in railway signalling and telecommunications has its own competence assessment framework set by the IRSE Licensing Committee and maintained by the registrar and the licensing team.

The role involves working closely with the Licensing Committee and implementing its strategic vision and procedural changes. The registrar is responsible for managing the day-to-day work of the licensing team including processing over 1500 applications a year. Another important duty is supporting and monitoring a network of external assessing agencies including in-house assessment teams – at Network Rail for example – and organising annual audits of these agencies. Candidates should have leadership skills, be confident communicators, have an excellent command of written English, and be IT literate as much of the role involves working with a database. Good organisation, administrative and document control skills are needed. Previous experience in a technical/engineering environment and working in a UKAS (United Kingdom Accreditation Service) accredited organisation or as a senior engineer in the rail industry would be an advantage.

IRSE Professional Examination

Results of the 2018 exam

The IRSE is pleased to announce the results of 2018's IRSE Professional Examination and to congratulate all those who have now successfully passed four modules. There are seven exam modules and to gain the full IRSE Exam it is necessary to achieve a pass in four of them. Module 1 is compulsory and candidates can choose a further three modules to suit their experience and specialism.

Congratulations to all of those named below, and a thank you to all who supported candidates through study groups, sponsorship, the exam forum and other means, and not forgetting the examiners, support staff and volunteers who always spend a considerable amount of time making the examination the success it is.

More information about the IRSE Professional Exam can be found on the website **irse.info/irseexam** with study information through the members' login **irse.info/ifcw6**. If you're planning to take the exam in 2019, don't forget to speak to your sponsor soon and get your sponsor declaration form to the London office by 30 April.

The modules referred to in the table are as follows: Module 1 Safety of Railway Signalling and Communications (compulsory); Module 2 Signalling the Layout; Module 3 Signalling Principles; Module 4 Communications Principles; Module 5 Signalling and Control Equipment, Applications Engineering; Module 6 Communication Applications; Module 7 Systems Management and Engineering. In the tables P signifies a pass, C a credit and D a distinction.

Successful candidates completing the exam by passing modules in 2018 are:

Name	M1	M2	M3	M4	M5	M6	M7
Firas Al-Tahan					P		
Matthew Barker	C						C
Max Bowerman	D		P		P		P
Kimberley Chang	D				P		
Andrew Clapham					P		
Shamal Crowther		P	P				P
Michael France					P		
Colin Hamilton-Williams			P			P	
Ian Hayes	P	C	P		P		
Io Ho	C		C				
Robin Lee	C						C

Name	M1	M2	M3	M4	M5	M6	M7
Reece Martin	C	C	C				C
Rinaldo Paolozzi					P		
Kiran Patel		D	C				
Daniel Paxton		P	C				
Thevjanan Shanmugaratnam			C				
Matthew Slade	C						C
Thomas Stankowski		C	P				
Amy Steele	C						C
Damian Westerman					P		
Kwok Wong	P		P				
Tsz Wai Thomas Wong	P						P

Candidates who have successfully passed modules in 2018, but not yet achieved the required four module passes for full exam completion are:

Name	M1	M2	M3	M4	M5	M6	M7
Victoria Aviomoh						P	
Annafee Azad	P		P				
Kevin Banks	P				P		
Mohammed Baporia			P		P		
Stefan-Horia Barbuta			P				
Andrew Belson		P	P				
Emily Bramble		C	P				
Jonathan Calderwood			P				
Ewan Campbell	C						P
VP Challa			P				
Shu Nam Cheng		C					
Pankaj Chopra					P		
Aidan Courts	C		P				
James Darlington	P						
Samuel Dooley	C						
Martin Duck		P					
Lee Edwards		D					
Adrian Farish	P				P		

Name	M1	M2	M3	M4	M5	M6	M7
Jonathan Farrell					C		
Boris Gabai	C				P		
Sean Gorman					P		
Udaykumar Gowrisetty		P					
Martin Halligan	C					P	P
Paul Hobden	D	D					
Ryan Hutchinson		D	C				
Rachel Hyde		P					
Mohammad Iqbal			P				
Clare Jameson	P	P					
Craig Kerrigan			P				
Leroy Koen		P					
Praveen Kumar		P					
Greg Larkin		P	P				
Tsz Yin Law	P	C					
Andrew Laz		C	C				
Kinsum Lee	P	P					
May-Ann Lew	C						P

Name	M1	M2	M3	M4	M5	M6	M7
Sam Loveless	P						
Stuart Maddock	C						
Charles Madinga	P						
Aaron McConville	P				P		
Alan Morrison		P					
Davison Mui		C					
Mohamed Navas Hussain			P				
Shiliu Ni			P				
Aisling O'Connor					C		
Sateesh Pamidi		P					
Kurt Pascal		C					
Yatin Pathan							P
Sai Polana			P				
Timmy Ryan	C						
Suhanya Saenthan				C			

Name	M1	M2	M3	M4	M5	M6	M7
Arvinder Singh					P		
David Snelling	C				P		
Mashia Tebele		P					
TSZ Tsang		P					
Philip Tully					P		
Susannah Walker	C						
Sean Wallace	C						
Jordan Wallis		D	C				
Boyuan Wang		C	P				
Craig Welsh	C						
John Whyte					P		
Kin Long Wong		P					
Wan Hung Yang		C					
Sing Chi Yuen		P					
Feng Zhang		D	P				

2018 Exam Review

Report by Judith Ward

This year's review of the 2018 professional exam was held on Tuesday 12 February in London. Approximately 30 people attended to hear examiners provide hints, tips and information on the exam.

Tony Kornas, chair of Exam Committee (pictured right), gave the overall feedback from all the examiners, including the familiar "read the question". While this seems an obvious statement, it is clear from the examiners' feedback that many candidates do not fully read a question, and do not answer the question asked. Further feedback was then given by examiners Tom Lee, Derek Hotchkiss, Roger Short and Tony himself, including examples of both good and poor answers.

Judith Ward gave a short summary of the draft proposals for the new exam, emphasising that the proposals have not yet been approved and may change. A healthy discussion followed, raising concerns which are being fed back to the Education & Professional Development Committee. General questions and answers followed about the administration, finding sponsors and other queries.

The Younger Members' Section would also like to reiterate some of the discussions which took place during the review, on how to get more experience of equipment, interfaces and the safe operation of railways. This year there will be three preparation workshops held in the UK, between them covering all 7 modules – the IRSE website will publish dates and further information when available. Attend your local IRSE section meeting and visits, and why not organise some technical visits? or get in touch with a local heritage/preserved railway. Use the recommended reading lists as a starting point. For Module 1 in particular, read up outside of your railway to widen your knowledge – safety incidents happen on other railways and in other engineering industries.

The Younger Members' Section would like to thank the examiners for preparing for and attending this session which is always very useful. For those who were unable to attend the event a recording, along with a transcription of the Q&A, is available at irse.info/0kux2. Please note, this year's exam will take place on Saturday 5 October in all parts of the world. See the IRSE website for the Sponsors' Declaration Form (SDF), guidance for sitting the exam and sample questions.

The exam review offers a superb opportunity to learn what the examiners are looking for, and to avoid the pitfalls.

Professional development

Maintaining and developing your professional competence

Judith Ward, Professional Development Manager, IRSE

It is really important to maintain and develop your professional competence to avoid being complacent and thereby putting at risk the safety and efficiency of our railways. Some members question what they are required to do and maybe are concerned that it is complicated and onerous. It's not either of these and most engineers are already doing most of what is required without realising it.

Maintaining and developing your professional competence is something that all IRSE Members and IRSE licence holders sign up to do as part of the IRSE and IRSE License Scheme codes of conduct. Maintaining and recording your competence development is also a requirement for gaining and maintaining your registration as a professional engineer.

This maintenance and development of competence is referred to as 'Continuous Professional Development' (CPD) by the IRSE and is sometimes known as simply 'Professional Development' (PD). No matter what you call it, or where you live, the maintenance and development of your competence requires planning, doing, reflecting and reviewing at regular intervals as your career and aspirations change. It is good practice, and a requirement in some countries, to record this to assist in the process.

Competence is made up of not only experience and knowledge, but skills and attitude too, shown in Figure 1. Your competence doesn't remain at one level. To avoid slipping into bad habits and lapses, and hence losing your competence, you should review your knowledge and skills and plan to use a variety of activities to maintain and develop your ability and attitude, of which there are examples from IRSE members in Figure 2.

Some people think that CPD is just attending training courses. This is not the case and many engineers will be doing quite a lot of CPD without realising it as part of their normal work. Once they start to record and reflect on their CPD activities many engineers are surprised how much CPD they already undertake.

I'll cover more about how to record and reflect, and about monitoring of CPD records soon, meanwhile if you have any questions, please ask! The CPD Team can be reached on cpd@irse.org.

Figure 1 – Definition of competence (from J P Baker and P Durrant, Developing and maintaining staff competence comparisons with rail industry experiences).

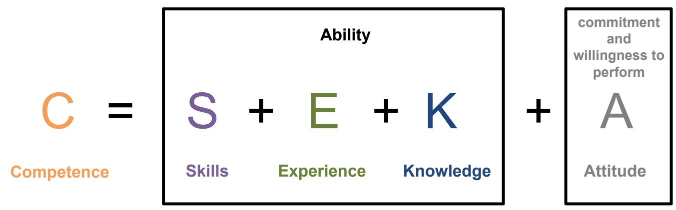


Figure 2 – Ideas of how to maintain and develop your competence.

IRSE section meetings	Standards briefings	Mentoring / buddying	Professional awards	Conferences
IRSE exams	Professional registration	STEM/STEAM activities	"lunch and learn"	Project/location placements
IRSE News	Local safety/ sustainability champion	IRSE Presidential Programme via live link	Formal training courses	IRSE membership
Presenting to IRSE section	Technical qualification	Supporting IRSE exam study group	Being on an IRSE section committee	Volunteer days

International IRSE Conference

An overview of "IRSE CBTC and beyond" 2018

Report and photos by Yousef Kimiagar

The third "CBTC and beyond" conference was held in Toronto, Canada on 29-30 November at Fairmont Royal York, with a special technical tour of the TTC Operation Control Centre demonstrating the conventional signalling and communication-based train control (CBTC) system side by side.

Similar to the previous years' events, more than 110 advanced train control and industry experts representing over 40 firms, organisations and agencies from around the globe came together to share and exchange their knowledge, technology advancements and the lessons learned in deploying the train control systems around the world. The conference agenda was delivered by 18 international speakers from the rail industry.

Day 1: Thursday, 29 November, 2018

Yousef Kimiagar, the chairman of the conference, welcomed the attendees and speakers to the third "IRSE CBTC and beyond". He thanked the attendees, the speakers and the sponsors. He also pointed to the fact that sell-out success of the conference weeks in advance is an indication of the need for the experts and professionals to come together and share their knowledge and experience, especially with the younger attendees. In his opening remarks, Yousef noted that the "Fourth Industrial Revolution" is transforming industries, economies, and societies to the point that technology is no longer a constraint to achieving goals. The constraints are our imagination and a supporting business case. Industry 4.0 is bringing better, faster and cheaper predictive capabilities and making more and more decisions on our behalf – that's why it is not changing what we do, rather it is changing us.

He highlighted that in the next 15 years, $30 billion will be invested in implementing the Internet of Things technology in the rail industry. As a result, smarter and more sustainable trains will be designed, tested, and calibrated in a virtual environment, and factory boundaries will extend to customer sites. This will empower manufacturers to monitor, collect, and analyse real-time data from millions of data points and enable them to predict service delays and interruptions. Benefits will include improved performance, reduced maintenance costs, increased return on investment, and enhanced safety. Yousef also indicated that over 70 percent of train accidents occur because of human error and fatigue, and therefore it is logical to increase the level of automation.

Yousef Kimiagar, the conference chair.

Yousef quoted the Harvard business professor John Kotter who said, "status quo is more dangerous than the unknown". Knowing that disruption is certain, we should focus on opportunities to invest in emerging technologies and intensify interconnectedness and collaboration between global transit

More than 110 attendees from 40 companies attended the event.

IRSE President Markus Montigel spoke on the topic of the "Winds of Change".


From left to right Markus Montigel, Alan Rumsey, Rick Leary (keynote speaker), Yousef Kimiagar and Pete Tomlin, also from the TTC.

agencies, rail operators, and consultants. This creates an ecosystem of shared values, knowledge, and innovation that enhances the customer experience. Therefore, embracing the outcomes of the fourth industrial revolution is essential for the agencies to remain competitive in a global economy.

At this point, Yousef invited the president of the IRSE, Markus Montigel to speak, who had travelled from Switzerland to attend this conference.

Markus welcomed the audience and spoke on the topic of "Winds of Change" as his theme of IRSE Presidential Year. He said that when the direction of the wind changes, some build a wall and some build a windmill and he asked a complex question: which one is the right thing to do? This perfectly reflects our age-old struggle between providing safety in a vast, heterogeneous and complex system, and at the same time being cost effective and efficient by harvesting the benefits of modernity. If we are building windmills, how fast should these be built? The speed of innovation in a specific domain such as railway signalling, compared with the speed of innovation of technology in general, is crucial. In the past decades, railways often seem to have struggled with innovation. He concluded his presentation by putting forward the following questions:

1. Have we thought about building windmills?
2. Is a gradual change right, or should we do more?
3. Application of modern technology: Do we engage with modern technology by attending IRSE events? do we persuade suppliers to apply modern technology to signalling? Are we ready for "digitalisation" and "Industry 4.0": data/sensor/actor/communication?
4. Modular architectures, do they support future innovations?
5. Have we learned the lessons of "Why signalling projects fail?"
6. What does the common sense of a signal engineer tell?
7. Do I communicate courageously to the decision makers that I have access to?

Keynote address

The keynote address of the conference was delivered by Richard Leary the chief executive officer of the Toronto Transit Commission (TTC) who was appointed to this position in 2018. He started by pointing out that public transit is a people business. It takes many talented and hard-working individuals driving the system forward, on the front lines and behind the scenes. At the TTC, there are 15,000 great employees who pull off the miracle of providing 1.8 million trips each and every day and that makes the TTC the third largest on the American continent, after Mexico City and New York City – these are cities with populations greater than eight million people, while Toronto population is 2.8 million.

Rick explained that in addition to the continued Automatic Train Control (ATC/CBTC) deployment on line 1, they have used different management techniques, and increased the throughput to 26-27 trains per hour on a regular basis – an increase from 23-24 trains. He continued by talking about how TTC will transform itself for financial sustainability, stating that we have a lot to deliver over the next 25 years, keeping in mind the approved priorities, and it's critical that we match revenue to the expected increase in expenditures for the TTC. That's an important lesson learned and the TTC will be more efficient ... more effective ... more reliable. This will allow us to provide the service we advertise.

The first presentation was "Is there a place for fixed block train control in the 21st Century?" by Jonathan Hulse – director of engineering at Parsons Corporation. The paper discussed how some agencies are still struggling with the decision to abandon fixed block conventional train control and instead adopt CBTC to address capacity, state of good repair, obsolescence, maintenance costs, resilience and improved service performance. While there is a role for conventional train control, he addressed the pros and cons of the options available. What factors sway decision makers and influencers? Perhaps it's a fear of innovation or the unknown, or that the capacity increase is not worth the time, cost or disruption or maybe they are just CBTC sceptics? He provided examples from within Canada, the USA and around the world of why CBTC is the new standard for the 21st Century.

The second presentation was "Inspiring confidence – CBTC end-user experience" and was jointly presented by Michael Hazlett, manager Transit Control Subway Transportation and Andrew Dixon, manager Rail Transportation Training at TTC. This paper was also co-authored by Leslie Wang at TTC. The speakers described that TTC is currently entering the third phase of a multi-phased project involving the conversion of a legacy signalling system on one of its busiest subway lines to a fully functioning CBTC system. The presenters shared a number of lessons learned from a CBTC end user perspective provided commentary that represented the combined views of experienced managers that currently oversee sections in the TTC's Training & Development and Subway Transportation groups.






Conference speakers.
Clockwise from top left:
Jonathan Hulse.
Michael Hazlett and Andrew Dixon.
Joe Greco.
Ash Majumdar.
Vernon Hartsock.
Gregoire Sulmont.
Laurent Fontaine.

The content was divided into three distinct sections – pre-revenue, trial operations, in revenue. The aspects that were presented were staff engagement ("the power of the grapevine"), Concept of Operations, customising vendor training to meet the needs of the organisation's culture, strategies for addressing the fear of change, the importance of consistent messaging, tackling unexpected system behaviour ("not as advertised"), mitigating risk and building confidence ("the rainbow" book), and, finally, promoting patience during fine tuning of the system. The speakers shared valuable insights into the end-user experience and how inspiring confidence among end-users can aide transit agencies and CBTC suppliers to improve the delivery and implementation of future CBTC system projects.

Joseph Greco, senior technical sales engineer – Rail Control Solutions and Ash Majumdar, Eglinton project manager at Bombardier presented "CBTC for light rail, Eglinton project update". They started by stating that for the most part, CBTC solutions would be directed to a metro or driverless system with the key functionality being performance. CBTC is designed to achieve the optimal performance of a transit system, limited by the physical design and vehicle capabilities. A CBTC system also provides a high level of automation (up to GoA4) for many implementations.

At this point the speakers asked whether a CBTC system might be applied to a streetcar or light rail system and what are the benefits that CBTC can provide besides performance improvement? In response, they outlined that a CBTC system provides a highly cohesive system where there is a continuous communication between the train and the wayside. A benefit in streetcar or simple LRV systems will be knowing where all vehicles are at any given time. This will benefit system operations where the planning of train movement can be better regulated. In addition, monitoring of all wayside assets in the signalling system can be achieved. All of the data collected from a CBTC system can be utilised in the maintenance of the system through data collection and data trending.

Many LRT or streetcar systems are typically manually driven with wayside signals, and CBTC can provide overspeed protection and collision avoidance and achieve a wide range of functionality in one system. Some of the challenges of light rail and street car systems, such as interface with automobile traffic systems and level crossings were also presented.

Vernon Hartsock, chief engineer Maryland Transit Administration (MTA) presented the "CBTC case study for MTA's experience with a brown-field installation". He provided an overview of the MTA metro and the current project to implement a CBTC system along with 78 new railcars in a single contract. Vernon presented the six phases of the deployment leading to the removal of the track circuits. The cutover strategy allows the mixed mode operation and the co-existence of the old and new cars. The old trains operate with the existing cab codes and track circuits along with the interlockings controlled by the Microloks while the new trains will be equipped with CBTC and will operate under the movement authority set by the zone controllers. The main control centre will control and monitor the system with the new ATS. An axle counter system is used for backup. Vernon shared the typical challenges of installation in a brown-field environment along with those of implementing a new train control system and purchase of new vehicles. The key conclusion that MTA reached, was that by combining the two contracts, MTA feels it has eliminated some of the risks associated with having separate procurements but still has those related to any new brownfield project and those with new technology implementation.

The next speaker was Gregoire Sulmont, the New York operation director at Thales who presented the "NYCT Flushing Project". The Flushing is NYCT's second CBTC resignalling project. This is the result of years of preparation and effort. Gregoire described the Flushing project details and compared it with the Canarsie line from an interlocking, cutover strategy and contractual setup point of view. A very detailed cutover strategy and timeline was presented, taking into consideration the underlying signal system and the carborne interface challenges. While both factors drive the schedule and cost, the carborne interface was identified as most significant in terms of debugging maintenance effort, while the underlying system was responsible for complicating the system. This constrained the operation, limited the performance, and remained as a maintenance burden. Gregoire highlighted that the lessons learned from Flushing will have a long-lasting influence on how NYCT plans its brownfield CBTC program.

Laurent Fontaine, a senior consultant at Systra USA spoke about "The ATS challenge for multiple CBTC upgrades". He touched on the fact that every CBTC system comes with its Automatic Train Supervision (ATS) control and monitoring system, but when there are multiple CBTC systems provided by multiple vendors on the network, what strategy should be followed for the ATS? Multiple ATS means different look and feel, different behaviours and possibly different functions, which could mean that operations personnel do not have the skills for working on different systems at the cost of flexibility. Laurent discussed that for multiple CBTC projects, NYCT which is in charge of the subway operations in New York, has chosen to have an expandable ATS for the main division of its network. This means that the ATS implemented for the first CBTC project on this division can be expanded when a new CBTC line comes into service. This expansion is performed by adding and modifying the ATS configuration only with no software change and developing all the functions at the first implementation, so a supplier other than the original ATS provider can come and upgrade the ATS. This can be achieved through an expandable database and a set of tools that allow the display upgrades and the configuration modifications and installations. NYCT contractually requires their suppliers to provide a live demonstration of the expansion tools.

The next presentation was "New York City Transit signalling – testing new technology for CBTC acceleration" that was presented by two speakers, Stuart Landau, train control and signalling consultant, and Nagaratnam (Rabi) Rabindran at Parsons. The speakers provided an overview of the aging New York City Transit (NYCT) subway system's signalling and car equipment, which are at or beyond capacity. CBTC, which has been implemented on the Canarsie Line and is currently being implemented on the Flushing and Queens Boulevard Lines, takes a considerable amount of time to implement. The current plan estimates the last of the lines being completed in 30-40 years even with an aggressive schedule. They explained that to upgrade the subway system's capacity and reliability and to accelerate the implementation of train control, NYCT, together with signal system and other suppliers, developed concepts for new technology. Proofs of concept (POC) have been implemented on the Grand Central-Times Square Shuttle and the Culver Line. Multiple phases of POCs have been planned to be:

- POC 1 demonstrating ultra-wideband (UWB) wireless technology to accurately locate trains within inches.
- POC 2A demonstrating Metrom's standalone train control system and platform intrusion detection system.
- POC 2 integrating Thales' CBTC system with onboard sensors and cameras for train positioning, and UWB train location capability already demonstrated during POC 1.

Based on the success of all POCs, NYCT will consider implementation of this new technology on existing lines.

Nicholas Columbare, solutions director at Alstom spoke about "Beyond good design: maintenance and operational recovery strategies to minimise service disruptions". He highlighted that the operational reliability and availability targets of 99.99% are increasingly demanding while maintenance costs and life cycle costs must be controlled. In addition to good design, maintenance and operational recovery strategies play a key






Conference speakers.
Clockwise from top left:
Stuart Landau.
Nagarathnam Rabindran.
Nicholas Columbare.
Andreas Steingröver.
Justin Edenbaum.
Matthew Butcher.
Shantilal Morar.

The technical tour visited the TTC's operation control centre. *Photo TTC.*

role in meeting those goals. The challenge is how to achieve increasingly high operational reliability and availability at reasonable costs in complex rail systems. Offering advanced recovery features for automated systems in today's solutions while pushing CBTC system enhancements away from corrective maintenance towards predictive maintenance can improve system recovery times under failure and increase operational system availability while decreasing lifecycle costs. Nicholas explained the predictive based maintenance in radio CBTC and the benefits of different levels of descriptive, diagnostic and predictive analytics. He also touched on the fully automated recovery features of Urbalis CBTC UTO systems and system wide predictive maintenance solutions such as Health Hub that can speed up system recovery after failure and improve overall system availability while lowering maintenance costs.

Andreas Steingröver, senior principal and key expert Rail Automation Solutions at Siemens talked about "Digitalisation of CBTC deployment". The presentation aimed to elaborate the success factors for deployment of metro signalling and control systems, where CBTC is the most commonly applied type of system for metro greenfield and brownfield projects. CBTC was developed in order to minimise and standardise signalling equipment as well as project durations. This is achieved by shifting most of the manual calculations such as safety distances and overlaps from the project design phase into the algorithms of the CBTC software. Andreas continued by explaining that the safety distances are then calculated by the onboard and wayside CBTC computer units in real time. Hence it becomes most important to obtain exact topological data of the tracks including elevation, curvature and related kilometry. Digital on-site capturing of field data and processing, as well as automated testing with system integration in an offshore system test centre, helps minimising onsite testing, which is then limited to the verification of reliable position detection, data communication and fine tuning of speed regulation.

The next two speakers, Justin Edenbaum founder of Never Gray, and Matthew Butcher, Rail O&M and modelling specialist at WSP presented the topic of "Is stacking trains with CBTC worth the risk?" In this presentation, they reviewed a case study about the TTC's Scarborough subway extension project in Toronto and how it limits the number of trains in a long tunnel (6km) while achieving a short headway. Justin and Matthew, while presenting multiple operating scenarios, highlighted the fact that signalling engineers and fire life safety engineers typically have opposing views on the number of trains allowed in tunnels between stations. CBTC systems maximise throughput and squeeze trains closer together during a delay, which can result in stacking in tunnels between stations. Fire life safety engineers typically want to limit the number of trains in tunnels between stations, quoting NFPA 130 requirements. They presented a technique using performance simulations to compare operations with CBTC signalling systems with two settings for trains between stations: stacking or limiting. The results suggest that stacking trains does not provide enough benefit to warrant the risk during a fire situation.

The final speaker of the day was Shantilal Morar, technical director 4LM Project at Thales who spoke about the "Lessons in implementing CBTC in brown-field environment on London Four Line Modernisation (4LM) Project". In this presentation, he addressed the challenges and lessons learned from London's 300km Four Lines Modernisation (4LM), a re-signalling project that is being currently delivered while maintaining daily passenger service. Its scope consists of the integration with rolling stock replacement/refurbishment, control centre modernisation, passenger information system upgrades, and enhancements to the backbone data communications network. Shantilal covered the strategy and processes for:

- Installation of CBTC signalling equipment in the control centre and trackside.
- Cutover to allow over and backing between legacy and CBTC system for testing and commissioning.
- Train installation and testing.
- Migration strategy and how to maintain revenue while other migration sections are under test.
- Shadow mode running on 4LM and benefits achieved so far.

Day 2: Friday 30 November 2018

The technical tour on the second day was arranged to visit the TTC's operation control centre. Following the opening of the line 1 extension in CBTC and the continued deployment of the CBTC on line 1, this visit provided an opportunity for the attendees to see the conventional signalling and the CBTC system side by side in the control centre. Pete Tomlin, the Automatic Train Control (ATC) project director at TTC, prepared a comprehensive presentation for the attendees and provided an overview of program history, the CBTC system architecture, the deployment phases, the challenges, the success and innovations, and the closure strategy. Pete's key message was focused on looking at what has not worked elsewhere and most possibly that applies to other operators as well. Pete pointed out that if one party fails, all fail, so it is crucial to work as one team.

The sponsors

Our thanks to the sponsors and supporters who were TTC as the delivery partner; Platinum Sponsors: Alstom, Gannett Fleming, Wabtec and WSP; Gold Sponsors: Hatch, Parsons, CBTC Solutions and Green Aspects.

China Section

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CHINA SECTION
中国分会

AGM and upcoming workshop

The IRSE China Section 2018 Annual General Meeting (AGM) was held in December 2018 in Beijing with the kind support of Beijing Jiaotong University. The president of the China Section, Prof Bin Ning, gave a warm welcome to all attending IRSE members and presented the annual report covering main activities during the past 12 months and plans for 2019. Section secretary Prof Yinghong Wen then gave a short report regarding membership affairs, including membership subscription payment, website maintenance and social media communication methods. Later, members expressed their opinions and suggestions around the expected development of IRSE China Section. After the tea break, two technical reports were presented by Weiqing Xue and Prof Zhongwei Xu, who are from industry and academia respectively. Attendees showed great interest and had a lively discussion. The annual dinner followed the AGM in the nearby Jiayuan Hotel.

The IRSE China Section will host the local technical workshop "Safety verification of the digital railway" in Beijing. This will be in association with the China Railway Society. In this workshop, domestic and European technical experts in the railway engineering safety verification field are invited to present and discuss the prominent issue of equipment safety verification in China. The workshop is planned to last one day and is open to all IRSE members. Any researchers and companies involved in the field are also encouraged to attend and present at the workshop.

Malaysian Section

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MALAYSIA SECTION

Recent section activities

The IRSE Malaysia Section was established in 2013 with 35 members and has grown to a membership of 101 in 2019.

The first talk in the 2018/2019 year was held in October and titled "Migration from legacy to modern signalling systems for main line networks in Malaysia" by Sri Viknesh and Peter Wyss. The main objective of the section's evening talks is to encourage IRSE members and industry players to share contents related to the railway engineering, knowledge sharing and updating the latest trends, technology, process, regulations and improvements in railway industry signalling, communications and train control systems.

The next meeting was held on 29 January 2019 and which in three hours included presentations from; the key note host Siemens, a presentation on ETCS as a way forward for Malaysian railways, a paper with a question and answer session by Bassam Mansour, and the section's 2019 plans by Sri Viknesh. Further talks are planned for April, July and October; with a site visit in May and a workshop seminar in August. See the IRSE website for further details nearer the time.

Malaysian Section members enjoying a recent presentation.

The section has an action plan with a number of strategic goals which include promoting diversity in membership for younger members and women in the railway industry.

Find out more by visiting **irse.info/nearyou**.

Western Section

IRSE Institution of Railway Signal Engineers WESTERN SECTION

Doing things a little differently

Report by Sam Loveless

In November 2018 the IRSE Western Section attempted to do something a little different with its technical meeting. Typically, a speaker will normally present a paper on a subject they specialise in, with a Q&A at the end.

For the November meeting in Chippenham, and inspired by a session the previous year where the engineers in the audience questioned the speaker throughout the evening, the section decided not to have a speaker for an evening and let the local members debate with one another, with the objective of developing new ideas and solving (or at least making progress on!) some of the big industry questions of the day through an hour-long debate.

The chosen subject for discussion was the one presented on the night that inspired the idea; the Digital Railway. Specifically, we sought to clarify the notion of the Digital Railway as an engineering concept, reasonably confident that there would be a varied viewpoint on the subject. A loose set of 'rules' was agreed, the section chair would act as the moderator and committee member Matthew Lupton would start the debate. With some whiteboards thrown in for drawing ideas and some refreshments on hand, we were ready to go.

The debate started in a challenging manner, the word "digital" being the first idea to get a rough ride. Western Section engineers proved to be capable linguists in the process, but confirmed it was too vague and inaccurate for those present to use to define a present-day technological change. When asking what the audience thought it was meant to be about, there was a consensus that the aspiration was to achieve improvements and efficiencies via the connection of new and existing signalling equipment. This led to the phrase "interconnected railway" being used by multiple participants and featuring prominently on one of the whiteboards.

The aims of the project as available on the Digital Railway website were then subjected to dissection. Phrases such as "more trains, better reliability, cheaper" were immediately consigned to the 'marketing box'. Attention focused on using connectivity to improve resilience and drive timetabling-based solutions. It was felt by the audience that the railway is still operated in discrete chunks, and the flow of information that would improve timetabling is still wholly done via ground-level staff, with sufficient information not being supplied to planners and other key roles.

Timetabling became a key focus, with arguments being made that improving speed profiles in junction areas would provide "better connectivity" (a Digital Railway website term) in the event of asset failures. Achieving this was a more contentious issue, with the prevailing argument being that the current contractual arrangements with the various operating companies are amongst the biggest obstacles.

It was also agreed that success in achieving the stated aims of the Digital Railway on an engineering level would require a change in engagement with the train operating companies, probably at a contractual level.

On an engineering level, talk on asset failure drove home the point that an increase in the number of assets will inevitably lead to a lower reliability, as quite simply there will be more assets that can fail! There was a particular and well-argued point that the overlap between current signalling and ETCS implementation will lead to precisely this situation, lasting until lineside signals are removed.

If this sounds a bit gloomy, then it may be encouraging to know that the discussion on the future of ETCS was on the whole positive. There was substantial discussion on how we should develop the ETCS engineers of the future, the identification of suitable ETCS records/handback requirements, client/supplier requirements and the exchange of asset data. The requirements argument was one of the most exciting of the night, with contract engineers sparring with Network Rail representatives on who should be leading who in terms of the design of handback documentation. Although it was concluded that neither had accepted responsibility, time prevented an agreement being reached on how this should be resolved.

Another exciting development was the idea of the "digital railway iceberg" – the idea of transient operational data, often held in legacy systems that cannot be migrated to new platforms. We look forward to papers on this idea!

At the end of the evening, the chair thanked everyone involved for a lively and productive discussion. Some of those in attendance expressed afterwards an interest in taking their ideas to their respective groups to develop them further. Lots of feedback was received saying that, even if there were few resolutions, there were many talking points that people could take away and use in a constructive fashion. We consider that to be a fine example of the benefits of local IRSE networks.

In addition to the debate, in January we organised a section pub quiz which was much enjoyed. Papers have also been presented on the presidential theme of command, control and communication, training for technological change and cloud computing. We are constantly looking to develop engineering skills and present engaging ideas; if you are a member of the UK Western Section, we would love to hear your ideas.

Midland & North Western Section

IRSE Institution of Railway Signal Engineers
MIDLAND & NORTH WESTERN SECTION

From Modular to Low Cost Digital Ready – The North Wales Coast story

Report by Ian Bridges

The Midland & North Western Section made history on the 15 January 2018, when it held what it believes was its first ever meeting in Chester. The logic being that it was close to the subject of the talk, the North Wales Coast (NWC) resignalling, which was presented by Andy Stringer and Gareth Meehan from Siemens Mobility Limited. Andy is the company's chief engineer and Gareth is their lead modular engineering manager. 22 members and guests attended the meeting.

Over the weekend prior to Easter 2018, Siemens commissioned their modular low cost digital signalling solution on the NWC, based on a concept developed by Network Rail around 12 years ago. The talk considered how the engineering of the project was planned and executed and the system handed over to the client. Only a few modular signalling schemes have been delivered to date, although Andy believes the future may be a lot brighter as projects can be delivered for around 75% of the cost of a conventional scheme.

Mechanical recovery

Gareth told the audience how the NWC scheme is the second major project to feature the Siemens modular low cost digital signalling solution, following on from the Crewe to Shrewsbury trial programme commissioned in October 2013, which successfully proved the modular concept. The NWC project has now built on the trial experience to deliver a signalling project covering a 30-mile section of the line between Shotton (where it fringes with Chester Power Signal Box) and Colwyn Bay (where it fringes with Llandudno Junction) along the coast of North Wales. A new workstation was provided at Wales Rail Operating Centre (WROC) in Cardiff, South Wales, replacing the mechanical signal boxes at Rockcliffe Hall, Holywell Junction, Mostyn, Talacre, Prestatyn, Rhyl No 1 and Abergele, together with a level crossing gate box at Tyn-Morfa. 96 mechanical signals were recovered during the scheme. A train travelling from London Euston to Holyhead will now only encounter semaphore signals at Beeston Castle and Tarporley signal box, (between Crewe and Chester), and on the approach to Holyhead, where the line terminates.

At the heart of the modular low-cost digital signalling solution is Siemens' Trackguard Westrace Mk2 Computer-Based Interlocking (CBI), enabling signalling schemes to be delivered from just a small range of core products. These include object controllers each controlling a number of objects, plug-coupled cables, axle counters and lightweight signals.

The man-machine interface at WROC is provided by a Controlguide Westcad. This communicates with the Westrace interlockings placed at three strategic points throughout the project area using Internet Protocol (IP) via Network Rail's

A service waits to depart from Rhyl station. The old No 1 signal box can be seen beyond the up main signal.
Photo Paul Darlington.

Fixed Telecom Network (FTN), known as FTNx. This provides both resilience to failure through diverse routing with reduced operational costs and provides Network Rail with complete management responsibility of the telecoms services, rather than relying on external telecom providers.

Each interlocking is housed in a Modular Equipment Housing (MEH) and has a number of local object controllers associated with it, as well as a Technician's Facility (similar in concept to an SSI Technician's Terminal). Remote terminals installed at Llandudno Junction, Shrewsbury depot and WROC are able to connect remotely to the Technician's Facility allowing technicians to monitor the status of the system.

Lineside equipment

Lineside objects are powered at 24V DC rather than conventional 110V AC, thereby enabling batteries to be used for standby and allowing a very much simpler power distribution network to be developed. 54 VMS lightweight LED signals were used, with the offset posts generally placed 3m from the running rail, preventing the need to disturb the ballast shoulder and, therefore, negating the need for Critical Rail Temperature (CRT) monitoring. Train detection was provided by 92 Frauscher axle counter sections.

170km of cables were required to deliver the functionality required, including 85km of double insulated super armoured fibre cable (DiSAC). The cables have largely been surface mounted using ground anchors to keep them in place, with

Siemens solution is based upon the use of modular object controllers built to a standardised design.

Top left, modular object controllers installed at Prestatyn.

Top right, the system is assembled an 'island' at a time in the 'hangar facility at Siemens Chippenham factory.

Left, setting up one of the OC(A) axle counter object controllers, based on Frauscher equipment.

only around 30% of cables have been installed in trough route, delivering a large cost saving as well as reducing the carbon footprint of the scheme. A standardised plug-and-play solution has been developed, enabling fast and efficient installation of cables on site.

The control centre, interlocking and object controller products are programmed using several standard signalling data templates that have been developed once and can be re-used many times. The templates mean that the engineering resource required for any given scheme is significantly reduced, and the validation and verification processes are much faster and more straightforward.

One of the key learning points Siemens took from the Crewe to Shrewsbury trial, was to avoid at all costs any re-work, carefully developing and locking down the requirements early in the design (GRIP 4B in Network Rail terms). This enabled a sequential design approach to be followed, in which a following stage could not be started until the previous one was completed. Experts from other disciplines within the business and from other industries were employed to help deliver the concept, advising where savings, even very small savings, could be made in the process using fresh ideas and innovative solutions.

One of the largest cost savings was achieved by carrying out as much of the work as possible away from the trackside, saving travelling time and cost, in addition to reducing exposure to dangers of driving to the site and from railway operations. Using the Siemens hangar facility at their factory, the system could be built and tested prior to shipment, with designers, installers and testers all working closely together in a safe and controlled environment.

In September 2017, a major programme milestone was achieved, when the first of the three signalling islands was delivered to site, following the successful completion of hangar testing (off-site testing in a large facility, similar to an aircraft hangar) at the Chippenham factory site. All installation of all the signalling islands and equipment was completed by the end of January 2018. With the system installed and tested it allowed two months of powered up 'soak testing in shadow mode' to prove the systems reliability before commissioning at Easter.

The future

The system is future proofed and can easily be changed to work as a European Train Control System (ETCS) based scheme, should Network Rail choose to do so. A Radio Block Centre (RBC) can readily be plugged into the Westrace interlocking. The Westcad at WROC would be replaced by a Westcad-E. On site the signal object controllers and the signal structures plus their cables would be recovered with the system carrying on working in the same way as now.

Finally, Andy went on to discuss some of the potential pitfalls of novel solutions. A lot of upfront cost had to be sunk into the development and as with any new system it takes a few schemes to iron out some of the problems, the solution then becoming mature. However, by this stage it is more than possible that a new direction or solution may have been instigated, effectively making the developed product obsolete. Ten months on from commissioning this project, Siemens does not know where their next modular scheme will be and if the development cost can be recovered.

The M&NWS would like to record their appreciation to Andy and Gareth for their time and for a very informative talk.

York Section

IRSE
Institution of Railway Signal Engineers
YORK AND THE NORTH EAST SECTION

High capacity system principles and the transition to communication-based train control

Report by Tony Pinkstone

Chairman Richard Storer welcomed members and visitors to the York Rail Operating Centre (ROC) on 17 January 2019. After the usual safety briefing he introduced the evening's speaker, Bruce MacDougall, to present his paper on "High capacity system principles and the transition to communication-based train control". Bruce then introduced himself, giving a brief account of his career to date, leading to his present involvement with the Hong Kong Metro.

Bruce started with an outline of his paper. It was aimed at a general audience including less experienced members, although some of those present might find some of it basic, it was useful to review developments from first principles. He detailed the basics of multi-aspect signalling, from two to four aspect conventional systems and some corresponding multi-aspect speed code based ATC systems, including the principles of automatic train operation (ATO) and automatic train protection (ATP) and their effect on headway – a law of generally diminishing returns. He went on to describe the major advantage of distance-to-go (DTG) based movement authorities, free of the constraints of aspect sequence-driven intervals. At present the Victoria Line was achieving 36 trains per hour, with a fixed block DTG system, on a metro type system where all the trains have the same characteristics.

On a mixed traffic railway, with high speed, heavy freight and local trains with different stopping patterns all sharing the same track these factors impose far more constraints than the signalling system. Even on a metro system, headways are also constrained by stopping patterns, junctions, speed restrictions, turn-back layouts at termini or intermediate stations, and most importantly, station dwell times.

Moving to communication-based systems obviously requires a vital two-way communications channel between train and control to ensure safe train separation and movement authority transmissions.

The system requires a train to report its position rather than fixed trackside equipment, hence smaller increments in location are practical. The basic principle of train separation by at least braking distance still applies, and these complex "Digital Railway" moving block systems will not provide great improvements in capacity unless the other practical headway constraints are improved. Station dwell times of 20 seconds are achieved on the Hong Kong metro but the cars have five doors per side on each car. The current Pacers on the Network Rail system have three doors per side for two cars. Trains such as the Class 158 DMUs and the InterCity stock generally have doors at the ends of each vehicle and hence take more time to unload and load passengers. Station passenger flow rate is another critical factor. Controls to prevent the heating effect of too many trains from overwhelming the tunnel ventilation due to the high temperatures and humidity of the Hong Kong climate create another capacity constraint.

Service needs in terms of the number of passengers per hour and the required journey time and station spacing will drive other capacity requirements. Hong Kong Metro moves 5.2 million passengers daily with 85 thousand per hour in the peak. It has both jointless track circuits and axle counters.

The use of platform edge doors is being extended to the suburban lines, and on curved platforms automatic mechanical gap fillers are to be used. Special measures are in place to deal with flooding and gales which can be expected in the typhoon season.

Migration to CBTC requires a strategy for changeover, which in Hong Kong has to work with possessions that are limited to four hours per night. The changeover can be progressive, where the trains are dual fitted with the old and new systems and changed over gradually with both trackside systems working during mixed mode operation. The alternative is a direct simultaneous changeover from old to new systems on train and trackside. There is typically limited siding standage to accommodate both old and new trains during a changeover and so dual fitting of some trains is usually needed even with change to a new fleet.

There have been some issues with complex software-based systems because of an over reliance on process by specialist software engineers with limited signalling background. New trains are harder to tune with intelligent traction and braking as well as ATO. Are things becoming too complex for the task in hand? The Great Eastern Railway achieved turn back times at Liverpool Street terminus of under four minutes with steam tank engines and mechanical signalling!

A short question and answer session followed and a vote of thanks on behalf of those present was given by Ian Moore.

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"The Roy Belle" memorial train on the Spa Valley Railway

IRSE News issue 250 December 2018 featured the past life of Roy Bell MBE FIRSE. Roy was a member of the Institution for 57 years and served as a member of the Institution's Council 1979-1982.

In memory of Roy, the Spa Valley Railway, Tunbridge Wells, Kent, UK will run a special train named "The Roy Belle" on Tuesday the 30 April 2019. Roy was a life member of the Spa Valley Railway and was a very good friend and benefactor. He was a true railway gentleman who will be missed very much.

All friends and former colleagues of Roy are cordially invited to attend this event to celebrate his life and work and to remember the many happy times spent in his company.

The special train will depart from Eridge station at 1215 after connecting with the arrival of the 1107 from London Bridge and work several trips between Eridge and Tunbridge Wells West until 1530.

There is no charge for travel on the train. A buffet serving light refreshments at cost will be available to passengers on the train. A collection will be taken in support of Roy's chosen charity 'The League Against Cruel Sports'.

Please let the organisers know by 25 April if you plan to attend this special event by contacting the Spa Valley Railway, preferably by email on **theroybelle@spavalleyrailway.co.uk** or by telephone on +44 (0) 1892 300143, as this will assist with the catering.

Past lives: Noel Reed

Noel Reed, a well-known and long-time Australian IRSE member passed away on 19 December 2018 after a short illness. Noel joined the IRSE as a student member in January 1948, making him one of the IRSE's longest serving members with 70 years' membership.

Noel was born on Christmas Day 1930 and joined the New South Wales Railways (NSWR) Signal & Telegraph Branch as a cadet engineer in February 1948. After initial training in design and maintenance he was appointed assistant engineer signals design at the NSWR S&T head office in 1953.

Between 1957 and 1959 he took leave of absence from the NSWR and worked with SGE Signals, and then Westinghouse in the UK. Whilst there he was able to familiarise himself with UK signalling practices as well as an introduction to European mainland practices.

Noel returned to the NSWR in 1959 and took on responsibility for signals design for various alteration projects as well as assisting with designs for major route interlockings.

Between 1972 and 1978, he worked in the head office under the engineer, new works and estimates being involved with liaison with traffic, civil and mechanical branches for the preparation and issue of safe working instructions. He represented the Signals and Communications Branch on the rule book committee during the introduction of new operating rules for remote control and CTC signalling. His interest in circuit design was maintained by assisting with major route interlockings from time to time.

In 1978 he was appointed contract circuit checking engineer, a role he carried out for 10 years. This was a period where a number of major 1920's power interlockings were replaced with route interlockings in the Sydney and Strathfield areas as well as other upgrade and duplication work in other parts of the metropolitan area. His role encompassed checking and approval of contractor's circuit designs function testing and commissioning as well as the inevitable stage-work circuit design to marry new work into existing adjoining signalling installations.

For a short period before he retired from the NSWR in 1989 he represented the S&C Branch on an inter-branch committee assessing modernisation requirements for the metropolitan and inter-city railway infrastructure due to the introduction of the Tangara trains.

After retirement Noel worked for six years with CSE Pty Ltd (later TMG International) as a contract signalling design engineer, then two years with Alstom Signalling, finally retiring from the industry in 2000.

Aside from railway signalling, Noel was very much involved with the tramway heritage movement, being a long-time member of the Sydney Tramway Museum since its inception and a well-known photographer of the Australian tramway networks before closure in the 1950-1960's. His pictures can be found in several publications, including "Newcastle Trams Remembered" published in 2017 as a result of Noel's offer of pictures, which was the instigation for this publication. His collection of unique tramway memorabilia has been passed to the Sydney Tramway Museum for the benefit of all.

Noel Reed, HonFIRSE, 1930- 2019.

Noel was very much a circuit design and review focused engineer but in later years was well remembered by Australasian section members as the person who carried out video recordings of the national technical and AGM meetings. The section holds video archive covering meetings from 1987 to more recent years as a result of Noel's recording work.

In his earlier years Noel was heavily involved with the IRSE Australasian section committee administration as well as helping to organise Sydney local technical meetings. He served as the Australasian Section's honorary secretary/treasurer from 1974 to 1979 and continued to serve on the Australasian committee until 1984.

Noel passed the IRSE exam in 1958 and was a W J Thorrowgood scholarship winner for young members excelling in the IRSE examinations. He progressed through the various grades of membership to attain Honorary Fellowship in 1994.

Noel's energy, enthusiasm and continued interest in railway related matters were beyond comprehension. Even at his advanced age, he attended our 2018 AGM in Melbourne (travelling all the way by train) and stayed back for the whole three-day event including the trip on Puffing Billy and the workshop tour. For Sydney local network meetings, until last year, he was a very regular attendee.

Behind all his railway activities, Noel was devoted to his wife Doreen and had two daughters Jenni and Sue whom he spent much time with. He was also actively involved with his local Uniting Church and was a long-time part of that community.

Noel will be remembered for his very robust discussions and knowledge on railway matters, and his drive to ascertain information and facts. He will be sorely missed by Australasian members.

Allan Neilson

(with contributions from Glenn Miller, Kaniyur Sundareswaran, Warwick Allison and Les Brearley.)

Feedback

Re Railway innovation: are we so backward?

Congratulations to David Fenner for injecting some common sense into the over-blown subject of innovation (IRSE News Issue 252, February 2019). In your requests for comment on his article you ask, "Does the railway get a bad press"? Yes, it certainly does, not least at conferences and seminars organised by the engineering institutions and even in IRSE News.

Go to any conference on railway innovation and the assumption will be that we poor backwards railway engineers are failing the industry which, as a result must look to other, more-dynamic, industries to bring in new ideas to help us. For example, it has even been seriously suggested that the railway could benefit from the technology being developed for autonomous cars. Yet our current ability to fire 36 automatically driven trains an hour through the London Underground Victoria Line as a matter of daily routine eclipses anything achieved to date by driverless cars.

It is this lack of confidence in our own technologies that really annoys me.

Regularly at conferences railway speakers warn that autonomous cars or lorries represent a threat to passenger and freight railways. Have these speakers never considered the yet-to-be answered question of who will validate the safety software for unattended use on the road? And who will be responsible for authorising their use?

And what rail traffic is at threat? Have they considered what rail journeys autonomous cars could replace? Commuting into busy city centres on already congested roads? Would people really prefer to sit in the back of a car, with no refreshment facilities, no toilet, for intercity length motorway journeys at road speeds?

As for freight, have they considered the economics of container trains versus 'brigaded' autonomous road haulage? For example, rail upgrades will increase rail services at the Port of Felixstowe from 33 to 45 trains a day – taking 22,000 lorries off the road every year. At the other extreme, rail operators are considering innovative ways of handling time-critical deliveries such as medicines to city centres.

As for the credence given to that other popular 'threat' Hyperloop, I would have thought signal engineers of all people would be able to work out the capacity implication of small discrete pods, the inflexibility of a system running from A to B, the challenge of intermediate stations, let alone safety certification.

As David points out, the railway engineering disciplines have been innovating since the Rainhill Trials. The signalling profession has taken the lead in the application of digital technology, long before the now deflated Digital Railway bubble. From TOPS and the first Vaughan train describer to SSI and IECC and the current ETCS and Traffic Management systems, innovation has been essential to an improving railway.

Of course we must continue to seek out and apply emerging technologies where they have something to offer, But when it comes to innovations everyone in the signalling profession should recognise a fad when they see it and have the confidence to promote the steel wheel on steel rail as the transport system for the 21st Century.

Roger Ford, UK

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the Editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at irsenews@irse.org.

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Membership changes

Current Membership: 5099

Elections

We have great pleasure in welcoming the following members newly elected to the Institution:

Member

James Bradley, JRB Rail Services, UK
Nicolas Estivals, RATP France
Manish Garg, Parsons, Qatar
David Jones, Network Rail, UK
Rama Kanumuri, SNC-Lavalin Atkins, India
Gabor Nemeth, Siemens, UK
Vinay Sadarahalli Druvakumar, Wayside Consulting, Australia
Ajay Sharma, CH2M, India
Mamoru Tamura, Sankosha, Japan
Joseph Williams, MW Engineers, Australia
Gary Wylie, Alstom, UK

Associate Member

Trevor Bennett, Siemens, UK
Nicholas Cantwell, Siemens, UK
Arjun Chauhan, Siemens, UK
Swathi Chigullapalli, Arcadis, India
Kevin Chivers, UK
Martin Cooper, SNC-Lavalin Atkins,UK
Nilofer Gooty Dowla, Cyient, India
Andrew Gotora, Gear Rail, South Africa
Jon Guaschi WSP, Australia
Hongyong He, Ricardo, Hong Kong
Paul Hockey, John Holland, Australia
Christopher Jones, Transport for London, UK
Sathguru Mariappan, Alstom, India
Mohd Maznudeen, Dhyay Maju Infrastructure, Malaysia
Matthew McDonald, SNC-Lavalin Atkins,UK
Selva Prabu Rajagopal, Alstom, India
Dipak Shukla, Keolis Hyderabad MRT, India
Pranhath Vakkantham, Wabtec, Australia
David Wibberley, Alstom, UK
Damon Widdowson, Alstom UK

Promotions

Member to Fellow

Malcolm Bint, The LED Studio, UK
Paul Callaghan, SNC-Lavalin Atkins,UK
Stephen Crocker, Network Rail, UK
Andrew Free, Network Rail, UK
Rob Goverde, Delft University of Technology, Netherlands
Fraser Greenwood, SNC-Lavalin Atkins, UK
Christopher Heavens, Siemens, UK

Associate Member to Fellow

Andrew Godden, Aracadis, Australia
Lazaro Sartori, ADIF SE, Argentina

Associate Member to Member

Steven O'Hare, Keltbray Rail, UK
Thomas Robinson, TPR Circuits, UK
Tsz Wai Thomas Wong, Alstom, Hong Kong
Alexander Wright, SNC-Lavalin Atkins, UK

Affiliate to Member

Alastair Hayden, SNC-Lavalin Atkins,UK

Professional registrations

Congratulations to the members listed below who have achieved final stage registration at the following levels:

CEng

Antony Jordan, Network Rail, UK
Aryldo Russo Jr, Certifier, France

Reinstatements: George Bowles, Rahim Khan, Ashok Misra, Heinrich Mostert, Vinod Saini, Jacobus Todkill and Frans van der Walt.
Resignations: Peter Brunner.

Due to non-payment of first subscriptions the names of the members below will be removed from the membership database: Ahmad Ismail, James Thomason, Jason Lim, Kabayaone Keelediwe, Kgomotso Sebe, Laurent Phemelo Serameng, Lesedi Saolesmose, Letlhogonolo Gaodumelwe, Moiktolhai Moikotlhai, Mpho Mpebe, Suresh Babu Panathala Venkata, Tefo Teddy Ankhoma and Viwe Mgedezi.

New Affiliate Members

Nadeem Waheed Ahmed, Network Rail, UK
Raghu Andru, AECOM, India
Joshua Bailey, Integra Rail, Australia
Pratishka Barge, Siemens, India
Derhasad Baseumatary, Indian Railways, India
David Carrington, MSL Eng Integrity, UK
Joi Chan, MTR Corporation, China
Ramesh Chandrasekar, Alstom, India
Mike Chapman, Siemens, UK
Bjoern Christensen, SNC-Lavalin, Sweden
Chijioke Chukwunonye, Amey, UK
Pui Chung, Siemens, Australia
Anthony Cleary, Irish Rail, Ireland
Darren Cooke, Siemens, UK
Eoin Devitt, Irish Rail, Ireland
Peter Dinsmore, Gear Rail, South Africa
Aravind Duppada, Siemens, India
Josh Ferguson, Mott MacDonald, UK
Jonathan Foy, UK
Neeta Gaiwad, Siemens, India
Stephen Goodwin, Hitachi, UK
Alex Grant, Alstom, UK
David Gustavsson, SNC-Lavalin, Sweden
Harry Hammond, Network Rail, UK
Stephen Hatton, Transport for London, UK
Catherine Hemmings, Australia
Valera Hill, Colas Rail, UK
Peter Hiorns, Siemens, UK
Ka Ho, MTR Corporation, China
Spencer Jones, SNC-Lavalin Atkins, UK
Jesus Jumangit, VicTrack, Australia
Daniel Jupe, Hitachi, UK
Manish Kalmady Ravichandra, Systra, India
Siu Kam, MTR Corporation China
Michael Kingston, SNC-Lavalin Atkins, UK
Neelima Kolla, Rail Vikas Nigam, India
Sindhusha Kosaraju, Arcadis, India
Navin Kulkarni, India
Andrew Lane, Siemens, UK
Tom Lane, BCS, UK
Dabi Laniyan, Network Rail, UK
Chien-Ming Lee, Egis, Saudi Arabia
Ka Lee, MTR Corporation, China
Gustav Lillo, SNC-Lavalin, Sweden
Ian Logan, Siemens, UK
Jaklin Malyans, SNC-Lavalin, Sweden
Kevin McComrack, Irish Rail, Ireland
Kevin McGuiness, Arup, UK
Mohd Mohd Zulhafiq, Rasma Group, Malaysia
Simon Oscroft, Hitachi, UK
Christopher Palmer, Siemens, UK
Chintankumar Panchal, Siemens, India
Toby Parker, Amey, UK
Ravishankar Pedada, Cyient, India
David Petch, Riotinto, Australia
Revathi Prakash, Alstom, India
Hiu Chun Pun, Siemens, China
Sunesh Raj, Etihad Rail, United Arab Emirates
Spoorthi Ramesh, SNC-Lavalin Atkins, India
David Rothbaum, Ericsson, Israel
Martin Rydstedt, SNC-Lavalin, Sweden
Andrea Scaricabarozzi, Alstom, UK
Nazeer Shaik, Arcadis, India
Sangeetha Siddaraju, Quest Global, India
Paramjeet Singh, Indian Railways, India
Emily Spudic, Siemens, Australia
Daniel Steel, Siemens, UK
Zack Stephens, Hitachi, UK
Antonio Suarez-Redondo, Hitachi, UK
Valai Murugan Subramanian, Alstom, India
Natcha Sujartiworakun, SNC-Lavalin, Atkins UK
Klas Sunnevik, SNC-Lavalin, Sweden
David Thistleton, Amey, UK
Youssef Touchan, Rail Control Sys, Australia
Michael Towers, Network Rail, UK
Tajamal Tuffail, Network Rail, UK
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