IRSE INTERNATIONAL TECHNICAL COMMITTEE

Train Integrity is the Responsibility of the Railway Undertaking

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ERTMS/ETCS Level 3 remains to be fully specified but should offer railway infrastructure managers reduced cost and increased capacity. Despite this, existing projects in Europe and around the world are stuck at Level 1 and 2, so the International Technical Committee of the Institution of Railway Signal Engineers has been studying the obstacles to implementing ERTMS/ETCS Level 3. This is one of a series of articles that aim to promote some radical debate on removing these obstacles.

The Train Integrity Problem

When the first block signalling systems were introduced to improve railway safety in the mid-19th century, it was recognised from the start that before allowing a train to enter a block section, there needs to be a check that the previous train has cleared the block section without leaving any vehicles behind. This was achieved by a visual inspection of the train at each block section exit to check that the last vehicle carried an end of train marker (often a red lamp).

Train detection systems have been introduced progressively using track circuits or axle counters. These technologies provide an automated report when a block section is clear of vehicles. This means that the visual check of train arrival and completeness is no longer required, allowing large areas of railway to be supervised from a remote control centre. However, this benefit has to be paid for, not only in terms of the cost of a large amount of equipment installed on the track, but its impact on reliability, network capacity and safety of maintenance staff.

Where a modern signalling system incorporating cab signalling or automatic train protection is provided, each train is fitted with an on-board computer, a means of determining the train’s current location, and a data communications channel to the control centre. This means that each train can report its location and length to the control centre, allowing the train’s exit from each block section to be determined automatically without using train detection equipment installed on the track at the block section boundaries. This type of signalling system is now commonly employed on metros, where it is known as Communications Based Train Control (CBTC). It is also the ultimate goal of the ERTMS/ETCS signalling system for main lines known as ETCS Level 3.

Not having to employ track-based train detection equipment can give significant benefits:

- Cost savings through elimination of equipment, enclosures, power supplies and cables
- Improved reliability (train detection is one of the most frequent causes of train delay due to signalling failures)
- Less exposure of maintenance staff to hazards of working on the track
- Easier demonstration of rolling stock electrical compatibility by removing signalling equipment from the most exposed locations
- Improved network capacity as the block section length is no longer tied to the location of physical equipment

The problem with this approach is that it is based on information reported from the front of the train, but we need to know when the rear of the train has cleared the block section. This needs to be deduced from knowledge of the length of the train, and an assumption that the train remains intact. Proving an absolute block section clear is fundamental to the safety of the signalling system, so if this is going to be dependent on train integrity, the natural conclusion of the signal engineer will be that the on-board signalling system of the train must include a function that verifies train integrity with a very high degree of dependability. This requires some sort of communication from the front to the rear of the train. For fixed formation passenger trains, this is generally easily achieved , and this has allowed the widespread adoption of CBTC on metros. It is a serious obstacle for main line railways which operate variable formation trains, and especially freight trains where there is no through electrical wiring along the train and no power source on the rear vehicle. Many ingenious ideas have been suggested for how to solve the train integrity problem, usually involving a high-tech equivalent of the old end-of-train marker, but they all add complexity to the system, degrade reliability and introduce new logistical problems.

Allocation of Risk Management within the Railway System

In Europe and elsewhere in the world, responsibility for railway operations is now divided between Infrastructure Managers who provide the track and signalling infrastructure, and Railway Undertakings who operate the trains. Each organisation is responsible for ensuring the safety and efficiency of their own operation, and has a duty to co-operate with the other organisations where there are mutual dependencies. Technical Specifications for Interoperability provide for standard technical interfaces to support this duty of co-operation.

Considering the problem of train integrity in this light, it is obvious that this is a responsibility of the Railway Undertaking. It is a fundamental safety requirement that a train must remain intact throughout its journey, and it should be of little interest to the Infrastructure Manager how the requirement is satisfied.

Over to you, Rolling Stock Engineers

Another way of looking at allocation of responsibility is between the engineering disciplines. Train integrity is fundamentally a mechanical engineering matter, and rolling stock is designed and maintained so that the probability of couplings between vehicles breaking apart is small. So why do we make the assumption that to implement ERTMS/ETCS Level 3, the signal engineers have to provide an additional system on the train to detect the highly unusual occurrence of this event?

If we look back to the 19th century when the end-of-train marker was conceived, failures of train integrity were a daily event. Couplings between vehicles were simply loose chains and manufactured from wrought iron of variable quality. Brakes were manually applied in a poorly co-ordinated manner on a few vehicles in the train. In these circumstances there was a clear need for the end-of-train marker when the block system was introduced.

With modern materials and rolling stock design, the risk of a train dividing due to coupling failure is now very small. If a coupling failure does occur, there is a high probability that the train crew will be aware, and modern communications systems will allow the problem to be reported. If the level of risk is still a concern, then perhaps we should be investing in better couplings to improve the inherent reliability of the railway system. Whatever the conclusion, the decision making should be in the realm of the rolling stock engineer.

So signal engineers should stop worrying about train integrity, and let the railway undertakings and their rolling stock engineers decide whether their couplings are safe enough or need some further investment in equipment, maintenance or monitoring systems to reduce risk as low as reasonable practicable on a ERTMS/ETCS Level 3 railway.
Of course, there are other risks that we need to mitigate – e.g. the on-train signalling system reports an incorrect train length, or some part of the train is deliberately uncoupled during shunting activities, and this may require some specific investment in local train detection equipment on the track at locations where trains are shunted, coupled and uncoupled.