IRSE INTERNATIONAL TECHNICAL COMMITTEE

ERTMS/ETCS VIEWS AND EXPERIENCES

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SUMMARY

ERTMS/ETCS is now a credible system and available for implementation. It is especially suitable for new lines. ERTMS/ETCS includes the GSM-R radio system as the essential transmission path between track and train. ERTMS/ETCS is available in both Level 1 and Level 2 variants, with Level 3 still to be developed.

ERTMS/ETCS has been in commercial operation in various countries since 2005/2006 (Germany, Italy, Luxembourg, the Netherlands, Spain, Switzerland) and will be implemented in other countries soon, including Austria, Belgium and Hungary.

Over 600 vehicles in more than 20 differing types of rolling stock are running each day (Levels 1 and 2) and much experience has been gained to enable the production of the latest technical baseline (known as version 2.3.0), which is expected to provide interoperability.

With this important deployment step, ETCS will be confirmed as the future Automatic Train Control system for all principal lines in most European countries and elsewhere in the world.

Once in service, the performance of ERTMS/ETCS (in terms of reducing train delay minutes) already seems to be even better than the railways' initial predictions and targets, e.g. as seen in Switzerland. The present article includes information about some of the “Lessons Learnt” from these first projects, points that the other railways should consider closely when introducing ERTMS/ETCS.

Of course, and this is normal for any new system, there are still areas that need refinement, both with operational aspects and in the manufacture of the products, both of which are being addressed by the railways and the supply industry (UNIFE/UNISIG).

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As a reminder: Why ERTMS/ETCS?

A vision and major challenge in the European Union has been the harmonisation of fundamental practices to allow the Union to grow as a powerful world trading zone. The Rail sector was a clear candidate that needed special help and attention, being a major social asset for the movement of large numbers of people and large volumes of freight. The road sector has over the years fully exploited its natural freedom and, in an age of cheap fuel, low labour costs and almost non-existent regulation, the road freight sector has gained significant market share largely at the expense of the railways.

European railway development has needed to overcome the problems being encountered :

- more than 20 different and non-interoperable train control systems being in operation;
- different, and sometimes contradicting, operational rules in each country;
- different national homologation requirements in every country;
- different driver’s licensing procedures and processes in each country;
- 5 different electrification power supply systems;

- 8 different and non-interoperable radio and communication systems;
- different speaking languages in almost every country.

It was clear that without radical work, trains would continue to stop at border crossings with both the driver and the locomotive needing to be changed, and the European dream would be hindered by cost and delay.

It must be remembered that Europe has had experience of cross-border operation such as Eurostar and Thalys. These do cross borders at high-speed and are interoperable, but they have required the installation of, respectively, 6 and 8 ATC (Automatic Train Control) systems on-board. Having to cope with several systems is not very user friendly for the driver and is indeed more prone to higher failure rates than having only a single system. These are examples where ERTMS/ETCS will pave the way for improvement.

Under the name “European Rail Traffic Management System/European Train Control System” (ERTMS/ETCS) and including the GSM-R radio element, focussed efforts have been made, with the full involvement and participation of stakeholders, to generate and deliver a system that will support seamless train movement across country boundaries. The objective is to provide non-stop travel across the European Union for both passengers and freight but more importantly to provide the base from which Rail will win back traffic from the road freight industry.

The technical aims for the introduction of ERTMS/ETCS became obvious and include :

- to enhance interoperability by producing a standard European Train Control System;
- to expedite replacement of legacy systems by a harmonised European ATP (Automatic Train Protection) System;
- to facilitate standardisation of operations through a cab signalling system;
- to support the expansion of the Signalling Supply market and increase the customer’s choice;
- to introduce opportunities for economies of scale;
- to present equal levels of safety by the introduction of standardised safety regulations;
- to deliver a European system for the export market for worldwide applications.

Operationally these objectives will deliver enhancements compared to most legacy ATC and ATP systems:

- higher operational speeds e.g. 200 km/h on SBB new Mattstetten-Rothrist section of the Bern-Olten-Zurich line in Switzerland compared to 160 km/h on the old line. Such speeds could indeed be achieved with existing legacy systems in service in several countries, but those systems are not for historical reasons interoperable, i.e. “not European”;
- increased line capacity and improved return on investment. Level 2 ERTMS/ETCS allows shorter headways between trains compared to conventional signalling at the same cost, e.g. 2 minutes operational headways at 200 km/h has been achieved on the SBB line. This again can be obtained with existing legacy systems in service in several countries, but similarly those systems are not interoperable, and thus “not European”.

After the migration phase, there will be:

- reduced volumes of on-board installed systems, the goal being ETCS as the only train borne equipment in the future, compared with the myriad of up to 8 ATC / ATP systems, as can be the case in an individual vehicle presently;
- reduced line-side equipment both supplied and installed. ERTMS Levels 2 & 3 will permit a significant reduction in conventional line-side signals, even total abolition as the ultimate goal;
- reduced maintenance support in conjunction with the reduced quantity of both track-side and on-board equipment that will be needed;
- reduction in operational and capital expenditures; and
- major reductions in lost time at borders due to improved operational flexibility, common technology and elimination of incompatibilities;
- less cost in training of drivers through the European Drivers licence and much reduced need for training in route knowledge. Hence drivers will be authorised to operate larger network domains, facilitating effective planning and use of driver staff resources;
- the SIL4 safety and “Full Supervision” mode will make it possible to allow “guest drivers” to e.g. enter a network up to a first large station without complete training in the national regulation.

To achieve all these objectives, ERTMS/ETCS is currently available in 2 Levels with a third Level still in development. These are in ascending order of sophistication:

Level 1 – a standardised system of ATC/ATP control that gives basic train protection functionality as well as cab-signalling;

Level 2 – a full train control system including ATC/ATP, using radio as the transmission path but retaining (if needed or where needed) line-side signals for mixed traffic conditions;

Level 3 – an ongoing development of Level 2, totally dependent on radio and allowing the elimination of most line-side signalling infrastructure (signals, track circuits, axle counters). Will facilitate moving block operation if required.

It must also be stated right here that ERTMS/ETCS has not been designed just for Main Lines only. It is equally applicable for suburban lines, both new routes and for upgrading existing networks. ERTMS may also be useful for secondary and rural routes, where conventional re-signalling will be problematic in terms of financial return.

But where are we now within the signalling profession with ERTMS/ETCS implementation?

ERTMS/ETCS is now available for installation

ERTMS/ETCS is now available, its main applications to date being on new high speed or freight lines.
Today, in Switzerland, ETCS Level 2 is in commercial operation with well over 300,000 km of experience already achieved by the end of March 2007. The equipped train fleet has accumulated over 6 millions hours of commercial service, with SBB's goal of less than 1 minute average delay per train per week being fully realised.

In all, there are now over 60 commercial projects, mainly in Europe but also in other parts of the world, that have been won by the 6 UNISIG suppliers. This shows clearly the importance that ERTMS/ETCS is having as THE solution for both re-signalling projects and for signalling new railway lines.

Having started mainly with national projects, ERTMS/ETCS is in the process of expanding into the framework of European freight corridors, with the consequential performance requirements for cross-border traffic.

Slowly but surely ETCS is becoming the ATC / ATP system of the future on most main lines and in most countries.

ERTMS/ETCS has already started commercial operation

ERTMS/ETCS has already started commercial operation in various countries over the period 2004/2006. Germany, Italy, Luxembourg, the Netherlands, Spain, Switzerland are all countries where it is in commercial use. Soon to follow will be Austria, Belgium and Hungary.

The summary table shows present situation. The application of ERTMS/ETCS on these first projects has tended to be driven by differing applications. Some have been high speed new lines (Italy and Spain), some renewal of ATP systems (Austria – Hungary and Luxembourg), some re-signalling of conventional lines (Switzerland, which also incorporated a section of high speed line capable of speeds up to 200 km/h). In Spain, the new High Speed Lines are suitable for speeds up to 300 km/h in Level 1 (with the present, still low, levels of traffic); and Level 2 will be operated at up to 320 km/h with an ultimate goal of 350 km/h.

Among the main projects the following are examples that show the spread:

For ERTMS/ETCS Level 1, the CFL - "les Chemins de Fer Luxembourgeois", have begun operations. In Luxembourg, the market has been shared between two suppliers who have successfully demonstrated interoperability. The trackside equipment was supplied by THALES (ex Alcatel Signalling) and the on-board equipment by ALSTOM. The introduction of ERTMS/ETCS in Luxembourg will improve the safety of operation, if only because the introduction of ETCS as an Automatic Train Control facility is a great improvement over the previous national train stop system. Furthermore, it will allow cross-border and transit traffic with foreign rolling stock equipped with ERTMS/ETCS to run on CFL lines. Conversely, CFL vehicles will also be able to run outside the country, thanks to ETCS on-board equipment, on international routes such as the European freight corridors, with full ERTMS/ETCS control and protection.

For ERTMS/ETCS Level 2, several countries have also started commercial operation. In Italy, the Rome-Naples 220 km long High-Speed Line commenced service in December 2005. Trains run at 300 km/h and are totally dependent on ETCS, there being no back-up system. The ERTMS/ETCS Level 2 products and the architecture have been designed and implemented to produce the requested availability and reliability. Over 30 trains, initially comprising of the high-speed ETR500 rolling stock, have already been equipped and validated and are in regular service on the line. Many more trains are now also receiving ERTMS/ETCS equipment, including Pendolinos of Trenitalia and the Cisalpinos trains running to Switzerland. Cisalpino is a company shared between Italy (Trentitalia) and Switzerland (SBB-CFF-FFS). In addition, the Torino-Novarra part of the Torino-Milano line was equipped with ERTMS/ETCS in February 2006 as part of the Italian network roll out.

Optimising the acceleration and deceleration rates not only allows distances separating trains to be reduced but also contributes to a more fluid traffic flow and a shorter journey time. For example, on the Rome-Naples high-speed line, the journey time has reduced from 1 hour 45 minutes to 1 hour 25 minutes. At some future time, this journey will further reduce to 1 hour and 6 minutes, after complementary civil works are completed at the approach to Napoli.

In Switzerland, the Mattstetten-Rothrist line (i.e. the new high speed section designed for 200 km/h operation between Bern and Olten/Zurich) started full ERTMS/ETCS operation (Level 2) in July 2006. Initially the ERTMS/ETCS operation was limited to the night services (after 21.00 and comprising around 24 trains a day), mainly because some types of international trains were at the time not validated for operating with the system. Freight train operation started in December 2006 and full 24 hour operation in April 2007. The current usage consists of over 250 trains per day on the line, all using ERTMS/ETCS Level 2 and without any back-up system. The Lötschberg base tunnel line has also recently been equipped, another part of the Swiss network national plan for ERTMS/ETCS operated lines.

Today, more than 20 train types comprising over 600 vehicles are running each day (both in Levels 1 and 2) and much experience is being gained in the practicalities of day to day operation.

ERTMS/ETCS is reliable

Once in service, the reliability (in train delay minutes lost) seems generally to be better than the railways' targets, an example being Switzerland, where on average, the figures show less than 1 minute per train per week. The following data for trains in service can be given:

- On the SBB Mattstetten-Rothrist line, over the 100 days of planned timetable operation up to 22 December 2006, only 0.73% of the trains had to be diverted to the old line due to a potential technical problem related to ERTMS (e.g. failed GSM-R connection). It is worth noting that, once the teething problems were solved associated with software upgrades controlling the GSM-R connection when entering the new line, this rate has drastically reduced.

- As far as operation statistics are concerned, SBB have firstly achieved over 5 millions km operation with all the equipment working, including speed indications displayed, no equipment triggered brake applications and with the driver being in complete control. SBB has run over 1 million km of operation in full Level 2 mode, with an average delay of only 0.69 minute per train per week.

- Over one year’s experience on the Italian High Speed Lines (both Rome-Naples and Torino-Novarra) has also shown the high reliability of ERTMS/ETCS, especially in areas where ERTMS/ETCS Level 2 is the only control system with no back-up equipment available. It is true that the traffic on the line is presently limited to just 10-12 trains per day per direction, i.e. 20-24 trains per day, which is way below the design capacity, and should be compared with the 300 trains per day that run on the high-speed line from Paris to Lyon in France.

ERTMS/ETCS is flexible

ERTMS/ETCS Level 1 and Level 2 may be chosen because of different objectives. Their respective purposes will generally be quite different. Railways having no advanced ATC system, perhaps just a train stop or a warning system, might well prefer a Level 1 application in order to achieve greater safety over their present operation. Where extra capacity, higher speed or enhanced train regulation is required, then Level 2 would be the logical choice. It must also be remembered that the principle of ERTMS is that Levels 1 and 2 can be combined in order to improve the network performance at lower cost. It is therefore possible to make the investment in the areas where it will be most beneficial in line with the budget that is available. Migration from Level 1 to Level 2 can happen at a later date.

Another aspect about ERTMS/ETCS is that the system is not necessarily to be regarded as a signalling system in isolation but should be considered more as a necessary complement to other projects. The big European schemes supported both by the European Community and national governments may request ERTMS/ETCS as part of a wider European benefit; e.g. the Swiss Alpine tunnels that will put lorries off the roads are part of a nationwide project, which will make a huge contribution to improving the wealth and the environment of the country’s population.

Any country considering the introduction of ERTMS/ETCS into its existing signalling environment will have to consider a number of factors. It is quite certain that existing national ATC / ATP systems are becoming or will become obsolete. Compatibility and supply guarantee for 10-20 years should be a major concern. The flexibility and modularity that ERTMS/ETCS offers, are key advantages to get the optimal migration from today’s situation to the future train control and communication requirements of the railways.

ERTMS/ETCS will be more resilient to obsolescence thanks to the multi-supplier situation. It also features functionality requested by various railways and innovation from the different suppliers. The joint know-how provided by the participating industry and railways has resulted in the most comprehensive signalling system ever.

LESSONS LEARNT

With quite a few lines and several hundred pieces of rolling stock now in commercial operation, a number of lessons have been learnt about implementing and operating ERTMS/ETCS. Some railways, e.g. SBB-CFF in Switzerland, have also had months of Pilot Line testing that provided valuable experience in advance of the first lines starting service.

The period of extensive cross-testing that has been performed by the UNISIG suppliers, together and in full partnership with several railways, has been of paramount importance to achieve this initial harmonisation of railway signalling in Europe. There could have been other ways or solutions for updating or renewing ATC / ATP systems, but the chosen option, accepted by all parties, has been ERTMS/ETCS. This is now the only practical solution for the future, as to start again with something different would mean, maybe, another 10 years to achieve a similar result.

The initial ERTMS/ETCS work and the corresponding test line period from 1998 to 2004 (about) has contributed much to the specific development of railway signalling and, consequently, to rail transport in general:

- team working between the industry (the 6 UNISIG companies) and the railways has been a key element during these formative years of work;
- many individual interests have been successfully negotiated out; not always an easy job with so many players involved, but necessary for a harmonised solution satisfying different needs and contradicting ideas;
- the EMSET trials, as the first step for testing the interoperability between the on-board subsystem and the track-side subsystem, have also achieved good results in that all products are being tested in the same way, with the same tools and in the same environment. The CEDEX laboratory in Madrid has facilitated a large number of tests for checking the interoperability between the different pieces of equipment, with the actions and results being accepted by all parties.

The EMSET project was remarkably successful in that the UNISIG (at the time also called “Eurosig”) companies, with the assistance of ERSA as providers of software simulation, test tools and scenario generators, were able to deliver a complete laboratory and test track environment in which individual ERTMS/ETCS sub-systems could be tested against the Interoperability specifications. This very important step enabled the companies to demonstrate the achievement of interoperability, in a regulated and independent environment, to the European Community and the railway administrations.

There are various other lessons that have been learnt with different things in different countries. This was to be expected as each country has for historical reasons, a different background, a different culture, and different ways of working. The path towards ERTMS depends on the starting point.

In Switzerland for instance, SBB-CFF decided to go for a large Pilot Line trial, with 59 pieces of rolling stock operating over the 32 km long route for well over one year. Thus, around 140 trains per day averaging 1,000 runs per week, represented well over 60,000 train runs (about 2 million kms of trial running) on full ERTMS/ETCS supervision to test and debug the system. In addition to the technical work, it was shown that the train drivers universally appreciated the ERTMS/ETCS system. For them, the cab-signalling unit provides a permanent reminder of the signalling indications that have been passed, as well as information well in advance of the track conditions ahead. This is a significant addition to the driver’s comfort and security, giving much needed confidence at all times, but especially when the weather conditions are bad, such as heavy rain, fog, sleet or snow, day and night.

Extensive testing on any line is essential, preferably by using a step by step approach prior to the actual full commissioning of a new complete system such as ERTMS/ETCS. This leads towards a smooth introduction and has been practised in different countries. On the Italian High Speed Lines, the Infrastructure Manager RFI, and the Train Operator TrenItalia, decided together to adopt an incremental approach. The traffic was gradually increased on the line from an initial 4 trains per day, to the present 12, at each stage making sure that the customers had a good travel experience and that the new systems and facilities including ERTMS/ETCS Level 2 were working with optimum efficiency. The same has been done in Luxembourg with Level 1 introduction : today, 12 vehicles are equipped, certified and in service. The Spanish railways have seen a successful operation on the Madrid Lleida line, with around 20 trains a day running at over 250 km/h in May 2006, now increased to 300 km/h from November 2006, over distances up to 450 km. The accumulated travelled distance is now well over 1 million kms.

The validation of ERTMS/ETCS and the stages needed to get to final approval for introducing a system into service, has meant creating robust teams working at all levels. It has also been important to concentrate the final decisions into very few specific disciplines, and then using the same group of people and decision makers. This has certainly been the case with SBB-CFF “SA-NBS” team in Switzerland, and with the concentration of the final approvals with RFI in Italy. The message from this is to keep the validation process simple, especially if at first sight it looks complicated.

It is a fact that the railways that have commissioned ERTMS/ETCS (as seen in the attached table, but primarily Germany, Italy, Luxembourg, Spain and Switzerland), are all very happy with the reliability and performance of the technology and the system.

Lessons learnt also means learning about “what not to do”. Above all else, try to avoid change requests. This will not always be possible but they should be kept to a minimum. Requests for fundamental changes to the system in order to accommodate national preferences are a particular problem. There really are too many different ways of doing the same thing within the rail community that have no impact on the satisfaction of our clients, the passengers and the freight carriers. A suggestion to resolve this issue by having firmer discussions (and “impositions”?) from the European Community and the Railway Users’ Group would be an interesting proposition.

Summary and Conclusions

ERTMS/ETCS will make rail traffic more competitive and a large number of Infrastructure Managers have already committed to national deployment. After the initial introductory and migration period of between 10-20 years (we are well into this phase), less investment will be needed to implement a sophisticated train control system on the main trunk corridors, incorporating both ATC and ATP. Maintenance requirements and thus cost, will be reduced, a conservative estimate putting this at up to 15%. This is primarily due to the reduction in the amount of trackside equipment, this being far greater than the increased cost of train borne equipment. In addition, ERTMS/ETCS will permit for a higher train throughput.

In order to ease the migration and to keep the standard simple, the following measures are recommended:
- ETCS has to be provided by the suppliers in such a way that it supports the operational railway business and contributes to improved railway business strategy. Including ERTMS within the trunk corridors’ business case should be a necessary benchmark to be reached.
- Fully interoperable standards have to be stabilised and maintained as a European task by all involved parties over the migration period. European certification for all ETCS interoperability components will have to be provided by the suppliers.
- The railways, (Infrastructure Managers and Train Operating Companies together), should finalise as soon as possible the Operational Rules for ERTMS/ETCS in order to maximise the opportunities for the trunk corridor business and to contribute to stable standards.
- To ensure an efficient operation, especially in the face of increasing road competition, there should be one traffic management centre only per corridor.
- This single management entity would be a significant contribution to achieving the optimum cost benefit results and meet the targets of the overall business case.
Infrastructure Managers and Train Operating Companies should minimise national functionalities or, better still, replace them with wholly standardised European functionality on the freight corridors, in order to have identical on board operating conditions. This is akin to what road competition does already.
- In general, the focus should be on reducing the list of legacy ATC/ATP systems as soon as possible in order to simplify and encourage international long distance freight traffic in the shortest possible timescale.
- It should by now be agreed that all new trains and locomotives should be pre-fitted for ERTMS/ETCS wiring and power supplies, and preferably be fitted with ERTMS/ETCS equipment from the outset.
- Retrofitting older rolling stock is recognised as expensive and should only be considered where a large fleet of a common type exists, thus permitting economies of scale, and where such fleets have a future life of more than 5 years.
- A general methodology for cross acceptance per corridor is needed to ensure the least possible cost for implementation right across Europe.

The acceptance of the above measures, in full or in part, would right away improve the Business Case for ERTMS/ETCS implementation. The recommendations also recognise that each country, with its own governance for railway operations (Infrastructure Manager plus Train Operating Companies; or fully integrated railway) will have its own traditions, culture and preferred ways, which cannot be replaced overnight.

ERTMS/ETCS is of course a system designed for a long service life and further development work has to be done. This will be a continuing process. The IRSE International Technical Committee (ITC) will continue to monitor developments and will produce further articles on the ERTMS/ETCS situation in due course. Many railways have ongoing concerns

with the implementation of ERTMS/ETCS, particularly with regard to cost, migration methodology, specification control and software upgrade problems. The ITC is aware of these concerns and will give informed opinion at the appropriate time.

What is actually with (ERTMS)/ETCS in operation (mid-2007 = at the time of publication)?

in red = to be checked/confirmed; in orange: still not in service; in green = presently already in service

ETCS Level	Country	ETCS kms in service	from when?	kms % (of total network)	ETCS vehicles in service	from when?	vehicles % (from total fleet)	kinds of trains with ETCS	max speed (km/h)	wayside signals	Trains per day (2 dir. included)	special operation conditions	others; comments
Level 1	Austria	67	tbd	<3%	13	tbd	<2%	loco-hauled	160	X	tbd	no	should have been in service Q4-06; EBA qualification expected
	Hungary	170	Q3-06	~5%	17	Q3-06	<2%	loco-hauled	160	X	<20	no	
	Luxembourg	50	Q1-06	~20%	12	Q1-06	7%	EMUs and loco-hauled	160	X	~50	no	
	Korea	1st part of 700km	Q4-06	30%	100 (out of 413)	Q1-06	~50%	diesel (DMUs)	200	X	?	STMs for exisiting ATC and Japanese "mushrooms"	not really/fully ERTMS? is a safety case available?
	Spain (Zaragoza-Hu)	80	Q2-06	~2%	10	Q2-06	<2%	EMUS	160	X	6		
	Spain (Madrid-Le)	460	Q2-06	5%	16 vehicles (32 ends)	Q2-06 (Q4-06)	<3%	High-speed trains	250 (300)	X	30	Level 1 only until end 2007 when Level 2 will be operational	
	Spain (Lerida-Tarr)	120	Q4-06	3%	32	Q4-06		High-speed trains	300		10	Level 1 only until end 2007 when Level 2 will be operational	
	Spain (Cordoba-Málaga. 1st-Section)	90	end 07?	2%	?	end 07?		High-speed trains	250 (300)		?	Level 1 first	
	Taiwan	1100	Q2-05	first 10% (in Q2-05?)	500 (of 756+52)	Q3-05	first 33% (in Q2-05?)	DMUs, EMUs and loco-hauled including	130	Yes: 3100	to be precised	Tropical; Earthquake zone; Landslides.	33% local content is a mandatory contractual requirement. Total of 22 classes of vehicles. 14 types currently type approved
Level 2	Belgium	65	Q4-07	~2%	?	Q4-07	?	High-speed trains	300	NO	?	high-speed only	
	France	300	Q3-08	<2%	48 cabs	Q3-08	<1%	High-speed trains	320	NO	50	high-speed only	
	Germany	150	Q4-05	<1%	5	Q4-05	<<1%	loco-hauled	200	X	to be precised	200 km/h only for ETCS-equipped trains	
	Holland Betuwe Route	160	Q2-07	~2%	>50	Q2-07	to be precised	freigth trains (loco-hauled)	160	very few	?	high-speed only	
	Italy (Ro-Na)	216	Q4-05	~3%	27	Q4-05	2%	High-speed trains	300	NO	30	high-speed only	
	Italy (To-No)	75	Q1-06	~1%	(same as above)	Q1-06	(same as above)	High-speed trains	300	NO	10	high-speed only	
	Spain (Madrid-Le)	460	Q2-06	5%	16 vehicles (32 ends)	Q2-06 (Q4-06)	<3%	High-speed trains	250 (300)	X	30		
	Spain (Lerida-Tarr)	120	Q4-06	3%	32	Q4-06		High-speed trains	300	X	10		
	Switzerland (Mattstetten-Rothrist new line)	55	Q3-06	~2%	474 vehicles (518 ends)	Q3-06	30%	EMUs and loco-hauled	200	very few	270		
	Switzerland (Lötschberg basis tunnel line)	40	Q3-07	~2%	same vehicles as for "Matt-Ro" line	Q3-07	30%	EMUs and loco-hauled	200	very few	80	up to 200 km/h only for ERTMS-equipped trains	