FROM TRUCKS TO TRAINS
HOW ERTMS HELPS MAKING RAIL FREIGHT MORE COMPETITIVE

Rail transport offers very significant advantages in environmental terms but road freight still dominates the inland freight transport market with a market share of more than 75% in the European Union against a figure of 18.2% for rail (Eurostat, 2012 figures). By ensuring interoperability on the European rail network, ERTMS helps the railway sector to position itself as a true competitor to roads by enabling significant line traffic capacity increase and promoting costs reduction which will subsequently introduce significant environmental benefits.

How can ERTMS ease cross-border freight operations?

As a unique and innovative signalling system, ERTMS considerably facilitates cross-border traffic movements. Trains equipped with ERTMS systems and components manufactured by any qualified supplier are able to run on tracks equipped with ERTMS of any other supplier. This enables the easy and seamless coordination of domestic and international train services and it also encourages competition.
Can ERTMS help increasing capacity on the railway network?

The ability to absorb the demand for greater capacity is a major element for rail transport’s competitiveness vis-à-vis roads. As a high performance signalling system, ERTMS enables significant increases of traffic along the railway networks, and proves to be a cost-efficient solution to absorb freight and passenger demand. Experience has shown that a continuous communication-based signalling system, such as ERTMS, reduces the headway between trains enabling up to 40% more capacity on currently existing infrastructure. It therefore offers considerable advantages to both infrastructure managers and operators wishing to run competitive freight operations: more capacity means more trains moving, thus more benefits. This “capacity advantage” partly explains why some countries which are outside Europe and isolated by the sea, like Taiwan, and more recently Australia, have opted for ERTMS as the signalling system of choice.

Does ERTMS bring any advantages in terms of costs for freight operators?

Still today, rail freight operators strongly suffer from the lack of a unified signalling system in Europe. Locomotives may need to be changed at each border or may need to be equipped with the appropriate signalling systems. This is costly and significantly increases the technical and operational complexity of train sets, not to mention their availability. In addition, drivers and maintenance staff have to be trained and totally familiar with each installed system making their jobs more complicated and increasing potential risks.

When ERTMS is installed along a given corridor in Europe, rail freight operators need to purchase only ETCS as the onboard equipment, as opposed to the several legacy systems running in the different countries. This significantly reduces the costs of the global signalling equipment whilst allowing for maintenance costs reductions and makes drivers more flexible in their working routines.

Does ERTMS provide a solution to all cross-border traffic problems?

As it ensures interoperability, ERTMS enables seamless traffic between countries. However, other obstacles may slow down cross-border traffic, such as operational rules or train certifications, which diverge from one country to the other. The European Railway Agency (ERA), the European railways and the rail industry are all working together on these issues which need to be further examined to allow the smooth and free movement of traffic between countries.
THE ERTMS MEMORANDUM OF UNDERSTANDING
A CROSS-SECTOR AGREEMENT TO ENSURE ERTMS’ SUCCESS

On 27th April 2012, the European Commission and the representatives of the European Railway sector signed a new Memorandum of Understanding (MoU) concerning the strengthening of cooperation for speeding up the deployment of ERTMS. This document now forms the basis of the long term commitment of all stakeholders - the rail industry, infrastructure managers, railway undertakings and EU institutions - to deploy ERTMS along the European railway network.

Why is such an agreement needed?

Three successive dedicated Memorandums of Understanding have been signed in 2005, 2008 & 2012. The primary intention behind these cross-sector agreements is the acknowledgement that the cooperation of all involved parties is secured to ensure ERTMS’ success.

For instance, the development of the ERTMS specifications rests with the European Railway Agency, but the drafting is done in close cooperation with both European Railways (gathered in the ERTMS users’ group) and the rail industry represented by UNIFE (under the umbrella of its associated member UNISIG). Similarly, it is essential for the stakeholders to agree on the content and timing of ERTMS development, for instance on the updating of the specifications, the addition of new functionalities or the content of policy measures to boost its deployment.

The ERTMS Memorandum of Understanding therefore serves as a reference document for all stakeholders involved on ERTMS.

Who are the signatories?

The 27th April 2012 ERTMS Memorandum of Understanding has been signed by the following stakeholders:
- The European Commission
- ERA, European Railway Agency
- UNIFE, the European Rail Industry
- CER, the Community of European Railways
- UIC, the International Union of railways
- EIM, the European Rail Infrastructure Managers
- ERFA, the European Rail Freight Association
- GSM-R group, representing the GSM-R industry
What does the Memorandum of Understanding contain?

This last Memorandum of Understanding contains a number of provisions, designed to deepen the cooperation between the parties in order to promote further the swift and coordinated deployment of ERTMS in Europe:

- Supporting the recommendation by ERA to include Baseline 3 SRS in the TSI, and the launch of Baseline 3 implementation projects, the agreement also recognises that version 2.3.0d shall remain in force in the future, protecting investments made and interoperability in countries that have chosen Baseline 2 as a reference.

- A major objective is to maintain ERTMS Specifications (Baseline 2 (2.3.0d), Baseline 3 and GSM-R Baseline 0, in a controlled way by applying the ERA Change Control Management (CCM).

- The principle of “backward compatibility” between Baseline 3 and Baseline 2 (Version 2.3.0d) is thus set again in stone by the text; being a priority during the finalisation of Baseline 3 specifications.

- Acknowledgement for the first time of ERTMS as having become a “de facto worldwide signalling standard”.

- A commitment is set, by 2015, that all existing ETCS equipped lines will be upgraded to an interoperable Baseline

- The agreement stresses the need to improve processes related to Baseline 3, especially certification, authorisation and testing processes.

- Important functional improvements are mentioned on the agreement. IP-based communications (such as GPRS), Automatic Train Operation (ATO) and other developments (new interfaces, satellite positioning and train integrity devices). These improvements would not imply the upgrade/replacement of existing 2.3.0d and Baseline 3 equipment.

- Lastly, ERTMS deployment should be accelerated through the implementation of July 2009 European deployment plan as well as by equipping new models of rolling stock with a standard ERTMS equipment under the conditions foreseen in the TSI CCS.

How are the commitments monitored?

The European Commission created a dedicated ERTMS Memorandum of Understanding Steering Committee, which gathers the signatories of the Memorandum. These signatories meet on a regular basis in Brussels to discuss the progress made and additional issues arising from the text’s implementation.

In addition, the European Commission has appointed a European ERTMS Coordinator, Karel Vinck. The coordinator gives the necessary political impetus for the ERTMS project and the realisation of the MoU. He also presides over the ERTMS MoU Steering Committee.
ERTMS LEVELS
DIFFERENT LEVELS TO MATCH CUSTOMER’S NEEDS

The ERTMS “levels” define different uses of ERTMS as a train control system, ranging from track to train communications (Level 1) to continuous communications between the train and the radio block centre (Level 2). Level 3, which is in a conceptual phase, will further increase ERTMS’ potential by introducing a “moving block” technology. Whilst it is commonly acknowledged that to date, ERTMS level 2 offers considerable benefits, the use of level 1 already brings significant advantages for the railways and allows for High Speed travel.

What is ERTMS level 1? What are the advantages?

ERTMS level 1 is designed as an add-on to or overlays a conventional line already equipped with lineside signals and train detectors. Communication between the tracks and the train is ensured by dedicated balises (known as “Eurobalises®”) located on the trackside adjacent to the lineside signals at required intervals, and connected to the train control centre. Receiving the movement authority through Eurobalises, the ETCS onboard equipment automatically calculates the maximum speed of the train and the next braking point if needed, taking into account the train braking characteristics and the track description data. This information is displayed to the driver through a dedicated screen in the cabin. The speed of the train is continuously supervised by the ETCS onboard equipment.

What is ERTMS level 2? What are the advantages?

As opposed to level 1, ERTMS level 2 does not require lineside signals. The movement authority is communicated directly from a Radio Block Centre (RBC) to the onboard unit using GSM-R. The balises are only used to transmit “fix messages” such as location, gradient, speed limit, etc. A continuous stream of data informs the driver of line-specific data and signals status on the route ahead, allowing the train to reach its maximum or optimal speed but still maintaining a safe braking distance factor.

Whilst enabling greatly reduced maintenance costs through the removal of lineside signals, ERTMS Level 2 also presents the possibility for substantial line capacity increase by enabling higher operational speeds and offering reduced headways: more capacity means more trains moving, thus more benefits.

ERTMS Level 2 provides the same interoperability and safety benefits of Level 1.
ERTMS Level 3, still in its conceptual phase, introduces a “moving block” technology. Under ERTMS level 1 and 2, movement authorities are determined using “fixed blocks” - section of tracks between two fixed points which cannot be used by two trains at the same time. With ERTMS level 3, accurate and continuous position data is supplied to the control centre directly by the train, rather than by track based detection equipment. As the train continuously monitors its own position, there is no need for “fixed blocks” – rather the train itself will be considered as a moving block.

Why should I opt for one ERTMS level or another?

ERTMS has been designed to meet the railways’ needs and this is reflected by the different levels available. The existence of another signalling system on the line, the possibilities to equip the line with GSM-R technology, the maximum speed allowed or capacity upgrades, are amongst the factors which come into play when choosing a particular ERTMS Level. However, it is commonly acknowledged that ERTMS Level 2 brings the full benefit of the system to a reality, as it allows for increased capacity and significant costs savings for maintenance through the removal of lineside signals.

Is it possible to upgrade from one level to the other?

Yes – ERTMS allows for a smooth migration from one level to the other. For instance, upgrading level 1 to level 2 mainly necessitates the installation of the radio network, the Radio Block Centre and some additional balises for positioning.

Introducing Level 3 will enable the train to monitor and report its own integrity thus releasing the need for track detection circuitry e.g. axle counters and/or track circuits.

What is the difference between ERTMS “levels” and ERTMS “versions“?

ERTMS “versions” (or System Requirements Specifications – SRS) designate the technical baseline of the ERTMS software – the current legal version is known as “2.3.0d”, whilst the so-called “baseline 3” will be available by 2015. All currently operating levels are defined in each version of the SRS.

Want to know more about ERTMS? Please check www.ertms.net or contact UNIFE at ertms@unife.org
ERTMS DEPLOYMENT IN ITALY
ERTMS LEVEL 2 IN OPERATION

Italy, as an early investor in ERTMS, distinguishes itself by the use of ERTMS Level 2 on the main national axis, from Turin to Salerno, allowing for mixed traffic (passengers and freight) on what is nationally called a “High Speed, High Capacity” network. In most sections of it ERTMS level 2 is used as the only signalling equipment (without any fall-back system and without trackside signals), which allows for considerable savings in infrastructure and maintenance costs. ERTMS has helped gain significant market share for rail transport in Italy and the completion of the High Speed network (new sections linking Milan to Venice and Genoa have been already scheduled) is expected to bring considerable further economic and social benefits.

What is the status of ERTMS deployment in Italy?

Italy has been heavily investing in High Speed lines since the early 2000’s. The construction of the first ERTMS-equipped lines started in 2004. RFI, the Italian Rail Infrastructure Manager, has opted for the use of ERTMS Level 2, which is currently installed and in revenue service in the following lines:

- Rome-Naples route (245 km) in revenue service since December 2005
- Turin-Novara route (85 km) in revenue service since February 2006
- Milan-Bologna route (219 km) in revenue service since December 2008;
- Bologna-Florence (78km) in revenue service since December 2009;
- Novara-Milan (40km) in revenue service since December 2009.

The completion of the above-mentioned axis in December 2009, together with the upgrade of the old Rome-Florence “Direttissima” High Speed line, enables High Speed travel between Milan and Rome in less than three hours. This travel time is expected to be reduced even further once new stations are built in Rome, Florence, Naples & Bologna.

How was ERTMS implemented in Italy?

Italy made the very important decision of installing ERTMS Level 2 as the only signalling system applied to its new High Speed lines without installing any fallback system. This has allowed considerable cost savings since trackside equipment needs to be carefully designed fit for purpose. Therefore, any ongoing or associated trackside maintenance costs are avoided.

ERTMS Level 2 does not need trackside light signals and allows for a significant increase in terms of traffic capacity.
What are the benefits brought by ERTMS in Italy?

In addition to the example of the Rome-Milan line (see below), ERTMS has brought considerable advantages to the Italian railways and society as a whole.

As far as the first ERTMS line that came into service (Rome-Naples) in Italy, it doubled its number of passengers in less than a year.

ERTMS has also proved to allow for very high speed travel, and this despite a difficult natural environment, where many railway lines go through the Alps or Apennines. For instance, 73km out of the 78km route between Bologna and Florence are made of tunnels. In test trips, a new worldwide speed record in tunnel was achieved at 362 km/h!

Modal shift in action: the Rome-Milan line

In the first 50 days of commercial service of the Rome - Milan High Speed line the airlines connecting Milan Linate Airport with Rome have lost a total of 91,000 passengers (almost 2,000 per day, representing 30% of the market). Conversely, the High Speed service has gained 1,600 new passengers per day.

On the whole Rome-Milan route, the transport mode share reveals that rail transport is now dominating the market.

<table>
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<tr>
<th></th>
<th>2008</th>
<th>2010</th>
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<tbody>
<tr>
<td>Rail market share: 36 %</td>
<td>Rail market share: 55 %</td>
<td></td>
</tr>
<tr>
<td>Air transport market share: 50%</td>
<td>Air transport market share: 35%</td>
<td></td>
</tr>
<tr>
<td>Road market share: 14%</td>
<td>Road market share: 9%</td>
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</table>

Source: Ferrovie dello Stato

Such modal shift translates itself in considerable CO2 savings. This High Speed line is even opening new opportunities for operators, and Ferrovie Della Stato is now considering the introduction of “low-cost services” for High Speed trains, as it exists already on some airlines.

Opening the passenger services to competition

Likewise, from 2012, NTV (Nuovo Trasporto Viaggiatori) will become the first completely private High Speed rail passenger operator in Europe. Italy will thus become the first European country with High Speed rail services open to competition. NTV plans to run services from the most populated Italian cities and has heavily invested in a modern Very High Speed fleet. Open competition will further boost the railway market for sure. Indeed, ERTMS is also an essential part of this achievement for the new NTV services will profit from state of the art interoperable infrastructure and from ERTMS equipment available from multiple independent suppliers.
ERTMS DEPLOYMENT IN SPAIN
FROM AIR TO RAIL— INCREASING THE SPANISH RAILWAY’S PERFORMANCE WITH ERTMS

With over 2,000 km of lines already in service and almost 6,000 km of rail tracks contracted or planned (almost 3,000 km of lines), Spain clearly emerges as a worldwide reference and leader in ERTMS deployment. Whilst ERTMS has contributed to the success of iconic lines, such as the “AVE” Madrid-Barcelona, where rail is gradually replacing air as the transport of choice (from 48% of market share after 12 months of service to 60% at end of 2013), the Spanish experience is also a showcase for the effective interoperability of ERTMS, with no less than 5 companies involved in various projects on the Spanish network.

What is the status of ERTMS deployment in Spain?

Under the strong leadership of infrastructure manager ADIF, Spain has embarked on a major program of railway investments, identifying ERTMS as the signalling system of choice. The first contracts were signed in the early 2000s and ERTMS now covers the major part of the Spanish High Speed network. Indeed, the “AVE” network has become a phenomenon in Spanish society and is a clear paradigm of speed, punctuality and efficiency. Travelling in AVE is fast, safe, environmentally-friendly and even “trendy”.

At present, the following major lines are running using ERTMS:

- Madrid – Lleida - Barcelona High Speed line (621 km route)
- Cordoba - Malaga High Speed line (155 km)
- Barcelona – Figueres High Speed Line (130 km)
- Madrid – Segovia - Valladolid High Speed line (197 km)
- Madrid – Toledo High Speed line (21 km)
- Madrid Atocha High Speed By-pass (12 km)
- Zaragoza – Huesca (80 km)
- Madrid – Albacete - Valencia High Speed line (500 km)
- Figueres - Perpignan High Speed international connection (45 km)
- A Coruña – Santiago – Ourense (150 km)
- Madrid “Cercanías C4” suburban network (Parla – Colmenar) (95 km)
- Albacete – Alicante High Speed line (239 km)
- Port of Barcelona – Can Tunis - Girona - Figueres Freight / Mixed traffic line (150 km)

Other major projects are currently under construction, with several lines scheduled for commercial service within the next few years:

- Valladolid – Ourense High Speed line
- Madrid – Portugal High Speed line
- Vigo – Porto High Speed line
- Alicante – Murcia High Speed line
- Sevilla – Granada High Speed line
- Sevilla – Cadiz High Speed line
- Basque “Y” Project (High Speed line linking the 3 Basque capitals with each other and with Madrid via Valladolid)

Which ERTMS suppliers are involved?

Six UNISIG suppliers of ERTMS have been involved in the Spanish railway network, and full interoperability between their products (both on-board and trackside) has been achieved. In other words, the trains supplied by any of the 5 on-board units suppliers in Spain (see picture below) are able to run on trackside equipment built by any of the others, which represents a major technological achievement. This brings significant advantages to the Spanish infrastructure manager ADIF, who has the guarantee that several suppliers will respond to tenders, lowering the cost of the signalling equipment through basic commercial and healthy competition.
What are the benefits brought by ERTMS in Spain?

Infrastructure manager ADIF is viewed as a pioneer in ERTMS deployment in Europe. After several years of ERTMS use in Spain it has brought considerable benefits:

– From an infrastructure manager point of view, choosing ERTMS means enlarging tendering opportunities, since any ERTMS supplier may respond to tenders;

– In the first year, passenger transport recorded considerable growth on Madrid - Malaga (+88%), Madrid-Valladolid (+109%) and Madrid-Barcelona (see below) lines.

– On these three lines, punctuality rates were averaging more than 98% (second only to Japan), attracting a considerable number of customers.

– As a consequence, ERTMS also has considerable environmental benefits, since passengers are knowledgeably opting for the train instead of the plane when travelling between these cities, therefore producing on average one sixth of the carbon footprint emissions as opposed to air or road traffic.

(Source: ADIF)

From plane to train: the example of the Madrid - Barcelona line

The Madrid-Zaragoza-Tarragona-Lleida-Barcelona line went into commercial service in February 2008, and is acknowledged to be one of the most successful examples of modal shift from plane to train, with the only equivalent to be found in the Paris-London and Paris-Brussels lines.

Thanks to the use of ERTMS level 2, trains enjoy record punctuality rates (see above). Travelling between the two cities takes only takes 2h30’ (compared to 6 hours in the past), with an average speed of 248,4km/h.

Spanish operator RENFE estimates that the line attracted 1.4 million passengers that were previously using air transport during the first year of service. In the first 6 months the average number of passengers had already increased by 84.5%!! After the first year of service, the AVE Madrid Barcelona enjoyed a share of 40 % of all trips between the two cities. But in 2013, the share increased to exactly 60%, with 6 M passengers traveling the corridor in 2013 (an increase of 18% over the previous year).

Additionally, international connections started in 2012 between Barcelona & Paris using the Figueres-Perpignan line opening exciting new opportunities for cross border High Speed traffic. In 2013 new services launched by RENFE & SNCF increased the frequencies between Barcelona & Paris but also inaugurated new services to Madrid, Toulouse & Marseille.

On the Spanish side, the opening of the Atocha by-pass in December 2008 considerably reduced travelling time between Barcelona and the South of Spain. Indeed, there are now new High Speed connections between Barcelona and Seville / Malaga that don’t need to pass by and stop in Madrid, reducing travelling time by more than 50 minutes.

Tweaking the Excellence

ADIF, in its never ending effort to reach excellence, has activated in 2011 its very first lines in ERTMS level 2. It is expected that every single Spanish ERTMS High Speed line will enjoy ERTMS level 2 services in the near future. This measure will increase speed and capacity while reducing travel time but always with the highest levels of safety and efficiency available in the market. It will ultimately also help passengers to shift from plane to train.
ERTMS DEPLOYMENT IN SWITZERLAND
INCREASING CAPACITY WITH ERTMS

Although not a member of the European Union, Switzerland with a considerable number of freight hubs and busy routes has nonetheless launched an ambitious ERTMS investment plan, as an integral part of its “Bahn 2000” Programme. In a country located at the heart of the European railway network, ERTMS has significantly helped to increase traffic capacity. With a large number of suppliers involved, and the highest number of vehicles equipped with ERTMS in operation in the world, Switzerland is now reaping the benefits of ERTMS at full speed – and plans to expand its use into the whole railway network.

Why was ERTMS implemented in Switzerland?

As explained above, ERTMS has been implemented on the busiest routes of the Swiss network as the train control system of choice. The reason behind this investment was to significantly increase capacity and therefore train speeds on the busiest segments of the Swiss national railway network.

For instance, the only 45 km-long Mattstetten-Rothrist line is a strategic bottleneck for the traffic from Bern to Basel, Bern to Zurich, and Bern to Lucerne. Equipping only this section with ERTMS level 2 has helped reducing journey time between Zurich and Bern by 15 minutes (from 70 minutes to less than 1 hour). Furthermore, it has also reduced journey times between Bern and Olten and subsequently allowed reductions in travel time for both international North-South traffic through Switzerland (mostly freight) and for East-West domestic intercity traffic.

What is the status of ERTMS deployment in Switzerland?

Switzerland, although not a member of the EU, is one of the leading European countries in terms of ERTMS deployment. An early investor – the choice to use ERTMS was made in the mid 1990s - Switzerland is strongly committed to the roll-out of the system as part of its program Bahn 2000.

A first pilot project was deployed on the Olten - Luzern line. At present, the following major lines are running using ERTMS as the only Automatic Train Protection (ATP) system:
- Mattstetten – Rothrist (45km)
- Lötschberg tunnel (34.6km)

The lines are known to be amongst the busiest in the country, which explains why Switzerland has a very high number of trains equipped with ERTMS (more than 500).

Whilst the completion of the Gotthard-base tunnel is expected in 2017, Switzerland has clearly embraced ERTMS as the train control system of choice: SBB has now also committed for Level 1 Limited Supervision and plans to complete its entire rail network by the end of 2017.

In total, over 1 000 are currently fitted with ERTMS to operate on the national network.
Which ERTMS suppliers are involved?

Switzerland is another proven success of ERTMS interoperability and flexibility. Not less than four suppliers are currently involved on the Swiss railway network, with trackside and onboard equipment being delivered by different companies. The Swiss fleet, the largest ever equipped so far with ERTMS, is made up of 19 types of vehicles locos retrofitted or new, Electric Multiple Units (EMUs), Motor coach and locomotives.

What are the benefits brought by ERTMS in terms of capacity increase?

Wherever installed, ERTMS has brought significant benefits in terms of capacity increase in Switzerland. For instance, the use of ERTMS Level 2 on the Mattstetten – Rothrist line, which started in 2006, has dramatically improved traffic conditions: an estimated 242 trains—both freight and passengers—pass on the line everyday; headways between trains have been reduced to 110 seconds whilst train speeds have been increased to 200 km/h!

Similar advantages have been brought to the Lötschberg base tunnel - with even higher train speed upon availability of rolling stock performance (see below) - and the opening of the Gotthard tunnel in 2018 will see new exciting opportunities for the entire Swiss network.

The Lötschberg base tunnel: ERTMS installed on one of the busiest routes in Europe

The Lötschberg base tunnel, which opened in 2007, was designed to provide a shorter and faster North-South rail link beneath the Alps than the existing tortuous line higher up in the mountains. During the design phase, it emerged that ERTMS would help to increase rail capacity, particularly for freight, which was needed to absorb the relentless growth in traffic between Italy, Switzerland, and Germany.

To a great extent, the Lötschberg tunnel appears as one of the most challenging rail projects ever built. The tunnel is nearly 35km long, with the Southern entrance located at 654.2 metres above sea level and the Northern portal at 776.5 metres above sea level. Adding to this complexity is the fact that the tunnel is only partially double-track – a challenge in terms of signalling for high speed trains.

ERTMS has greatly contributed to increase the traffic capacity and maximise the success of this project. Indeed, the use of ERTMS level 2 has enabled to reduce intervals between trains to three minutes, this despite the fact that trains may run as fast as 250 km/h. A “minimal” fall-back system was set up (light signals at the tunnel portal) whilst the high reliability of ERTMS has avoided the need for lineside signals within the tunnel, which brings with it a considerable maintenance cost savings.

Furthermore, the 57km long Gotthard base tunnel – the longest rail tunnel in the world – which is under construction will also be equipped with ERTMS and no fallback.

SUPPLIERS

Want to know more about ERTMS? Please check [www.ertms.net](http://www.ertms.net) or contact UNIFE at ertms@unife.org
ERTMS DEPLOYMENT OUTSIDE EUROPE
ERTMS AS A GLOBAL STANDARD

Originally designed as a unique signalling system to ensure interoperability on the European railway network, ERTMS has rapidly become a global standard and is now being embraced by a growing number of countries worldwide. Besides interoperability, ERTMS as a high-performance signalling system offers some significant advantages which makes it a showcase of European technological excellence worldwide.

From its name, ERTMS very much appears as a “European” system. Does this prevent its installation in non-European countries?

Not at all – whilst one of the key objectives of ERTMS is to achieve interoperability on the European railway network, the standard has also been designed and is fit for use by the railways worldwide.

What countries are investing into ERTMS worldwide?

ERTMS investments outside Europe represent more than 45% of the global ERTMS investment worldwide.

Countries such as diverse as China, Taiwan, South Korea, Saudi Arabia, the United Arab Emirates, Libya, Indonesia, Malaysia, New Zealand, Australia, Kazakhstan, Turkey, Algeria, Morocco, Brazil, Mexico, Chile and India have all launched major investments program to install ERTMS on their railway networks. Other major countries such as Argentina and even the USA are also showing an interest in this technology, with several pilot lines planned in different countries.

Is ERTMS already in service in some countries outside Europe?

Yes, ERTMS is already in service in a large number of projects outside Europe. In particular, major parts of the Taiwanese (1200km of tracks equipped with ERTMS) and South Korean (1500km) networks are operating with ERTMS.

China has already implemented ERTMS Level 2 on many of its High-speed Lines, such as the 1000km dedicated passenger line (DPL) between the cities of Wuhan and Guangzhou which went into commercial operation in December 2009.

In India, the Chennai-Gummidipundi line and a second line, Delhi-Agra (leading to the Taj Mahal) are in commercial operation. The suburban Cuautitlan – Buenavista line (70km) in Mexico is also running using ERTMS.

ERTMS investments worldwide, by geographical area (in lines km), June 2014 – Source: UNIFE
Why are so many countries worldwide opting for ERTMS?

For countries outside Europe, which are in some cases isolated by the sea like Taiwan or Australia, interoperability is obviously not the main reason behind ERTMS investments. Rather, the high-performance of ERTMS, and the significant advantages it brings to railways, have made it the signalling system of choice for these countries.

Indeed, regardless of interoperability, ERTMS brings considerable advantages to the railways worldwide:

- Increased capacity on existing lines and a greater ability to respond to growing transport demands: as a continuous communication-based signalling system, ERTMS reduces the headway between trains enabling up to 40% more capacity on currently existing infrastructure (see also factsheet #10, “increasing infrastructure capacity”);
- Higher speeds: ERTMS allows for a maximum speed up to 500 km/h and is considered in several countries as the system of choice for the construction of high-speed lines;
- Higher reliability rates: ERTMS may significantly increase reliability and punctuality, which are crucial for both passenger and freight transport;
- Reduced maintenance costs with ERTMS level 2, where trackside signalling is no longer required;
- An opened supply market: trackside and onboard equipment may be supplied by any of the ERTMS suppliers as the equipment if fully interoperable, which makes the supply market more competitive;
- Having a worldwide accepted standard brings significant economies of scale and competitive life cycle costs;
- Improved safety for passengers, employees and freight transport, which is a key issue in many developing countries in the world.

Are we evolving towards a unique worldwide signalling system?

Thanks to the above-mentioned benefits, ERTMS is indeed being implemented in a growing number of countries worldwide, being used in a total of 42 countries around the globe. As one of the key advantages of ERTMS is that it “opens” the supply market (the product may be delivered by different suppliers) and that the ERTMS suppliers represent the largest part of the global signalling market, it is indeed expected that ERTMS will gradually become the standard of choice for an ever growing number of railway companies worldwide.

ERTMS investments outside Europe, trackside (in tracks km), June 2014 – Source: UNIFE

SUPPLIERS

ALSTOM  AnsaldoSTS  BOMBARDIER  CAF  mermec group  PRAHA  SIEMENS  THALES

Want to know more about ERTMS? Please check www.ertms.net or contact UNIFE at ertms@unife.org
UNISIG
AN INDUSTRIAL CONSORTIUM TO DEVELOP ERTMS/ETCS TECHNICAL SPECIFICATIONS

UNISIG is an industrial consortium which was created to develop the ERTMS/ETCS technical specifications. As an Associated Member of UNIFE, a recognised stakeholder, UNISIG actively contributes to the activities of the European Railway Agency in the field of ERTMS/ETCS technical specifications.

When was UNISIG created?
UNISIG was founded in 1998/99 at the specific request of the EU Commission with the task of drafting the technical specifications for ERTMS/ETCS. It has always been a technical body first working in close co-operation with the European Association for Railway Interoperability (AEIF) and, since its formation in 2005, with the European Railway Agency (ERA) as part of the ERTMS Change Control Management (CCM) process.

What does UNISIG do?
The role of UNISIG today is to develop, maintain and update the ERTMS specifications in close cooperation with the ERA, which has been made the “system authority” for ERTMS. To do so, UNISIG actively contributes, together with the railway representative bodies, to the various related working groups of the agency. Whilst the final version of the ERTMS specifications is published by the European Commission following the approval of the Member States, it is based on a recommendation from ERA. This recommendation is widely discussed with the railway sector, including UNISIG, and considerable work is undertaken by the consortium to define these specifications.

How is UNISIG organised?
The UNISIG Consortium is an Associated Member of UNIFE. It is located in Brussels, where it has offices in the UNIFE premises. Seven companies now known as Alstom, Ansaldo STS, Bombardier, Siemens, Thales, CAF and AŽD Praha are its Full Members. MERMEC became Associated Member in 2010.

UNISIG is governed by a Steering Committee (SC) comprising senior technical management personnel from the full members, from whom a Chairman is selected to serve for a 2 year term. The SC meets monthly for two days. The day to day management of UNISIG is in the hands of the General Manager who reports to the Chairman and the SC.

The SC is supported by the UNISIG Technical Authority, known as the Supergroup (SG), which comprises two highly qualified ERTMS experts from each of the full members. The SG meets monthly for three days. The SG works closely with the UNISIG General Manager and with counterparts in the ERA; the SG reports to the SC.

The detailed technical work of UNISIG is carried out in Work Packages (WPs) responsible for specific technical specifications (eg Eurobalise, Euroloop and Euroradio) or in Mirror Groups corresponding to ERA Working Groups where UNISIG is represented by appointed nominees. All UNISIG WGs, WPs and MGs have clear reporting lines either through the SG to the SC or, depending on the nature of the activity, direct to the SC.
Is UNISIG a “commercial” body?

No – UNISIG is a purely technical consortium, with very strict rules of procedure and a dedicated code of conduct. A key principle of its activities is not to interact with its members’ contractual issues. It does not handle any political and communication activities related to ERTMS. The latter are managed by UNIFE, the association of the European Rail Industry (see below).

What are the benefits of UNISIG membership?

By joining UNISIG, eligible suppliers may directly contribute to the development of the ERTMS/ETCS technical specifications as they are part of a body which is an integral part of the ERA ERTMS CCM process.

Is it necessary to be a member of UNISIG to develop ERTMS products?

No – the ERTMS specifications are made public and freely available by the ERA, and are accessible to any company.

Who can be a member of UNISIG?

Any company involved in the development of ERTMS can apply for UNISIG membership. However, to preserve the efficiency of the consortium, applicants are required to have already played an active role and developed sufficient technical competence in the ERTMS field, and to contribute to the work of UNISIG both by providing the necessary workforce and funding for the consortium. Different levels of membership – Full or Associated – have been created to suit various needs.

How can a company become a member of UNISIG?

An application must be submitted directly to the Chairman of UNISIG. The application is then reviewed through a transparent process defined in the consortium’s rules of procedure.

How does UNISIG interact with UNIFE?

As mentioned above UNISIG is an Associated Member of UNIFE. Whilst UNISIG’s role is strictly limited to the development and writing of the ERTMS/ETCS technical specifications, its General Manager closely collaborates with UNIFE on ERTMS-related matters. However, all political and communications activities are directly handled by UNIFE, which represent the ERTMS suppliers in “political” forums such as the ERTMS Memorandum of Understanding Steering Committee.
A UNIQUE SIGNALLING SYSTEM FOR EUROPE
THE LONG JOURNEY TO AN INTEROPERABLE RAILWAY SYSTEM

As early as the 1990s, the European Rail Industry, with the backing of the EU Institutions, embarked into the creation of a common signalling system for Europe. Over time, ERTMS emerged as one of the most successful European industrial projects and is now on its way to making rail transport a more competitive transport mode.

Why is the concept of interoperability of railway systems important for Europe?

Today, rail transportation, as the lowest CO2-emmission mode of transport, emerges as a key alternative to road and air transport, both in terms of passenger and freight. Consequently, improving its competitiveness is a priority for European decision-makers as it is necessary to reduce CO2 emissions and help fight climate change.

Rail transport, however, suffers from several factors arising from its own historical development and its inherent nature that hamper the competitiveness of the sector by making cross-border traffic complex and difficult to manage. Among these, for example, the differences in gauges, electrification systems or administrative procedures, that makes it difficult for trains to run internationally while increasing operation costs. As a result, the competitiveness of rail transport is hampered while other modes of transport such as road and air do not face similar barriers.

What are the problems met in terms of signalling?

The existence of more than 20 signalling systems in Europe is a major obstacle to international rail transport. Indeed, each country and/or supplier tended to develop its own signalling system in the past, which resulted in a variety of systems in Europe – and sometimes even in one single country. Needless to say, all these systems were not interoperable.

Each train used by a national rail company has to be equipped with at least one system (sometimes more) just to be able to run safely within that one country, not to mention pan-European corridors. This is costly and significantly increases the technical and operational complexity of train sets.

For example, Thalys trains running between Paris, Brussels, Cologne and Amsterdam have to be equipped with 7 different types of train control systems. Various factors, including the constraints of having different onboard systems present and the “non-standard” character of train sets produced in a small series for a specific route, push up the costs of each train set by as much as 60%. Additionally, the driver's cab must have a screen for each respective signalling system, which has an impact not only on costs but also on the ergonomics of the Driver Machine Interface.

How can ERTMS provide an answer?

As a unique signalling system for Europe, ERTMS has been designed to be fully interoperable across the EU. This means that any train equipped with ERTMS may run on any line, as long as the trackside equipment is also fitted with ERTMS.
What is the exact meaning of “interoperability” when ERTMS comes into play?

The meaning of “interoperability” is two-fold:

– On the one hand, interoperability refers to a geographical interoperability between countries and projects: a train fitted with ERTMS may run on any other ERTMS-equipped line;

– On the other hand, it also refers to a technical notion of “interoperability between suppliers”: a train fitted by a given supplier will be able to run on any other trackside infrastructure installed by another supplier. This opens the supply market and increases competition within the industry.

How does ERTMS ensure that interoperability is reached?

The ERTMS specifications are developed by the European Rail Agency (ERA) - which acts as “system authority” for ERTMS – jointly with the suppliers (gathered in UNISIG) and the railway organisations. Once adopted, the technical specifications, which are publicly available, have to be enforced by the suppliers and railway undertakings, thereby ensuring a uniform implementation across Europe.

The current version of the specification is Baseline 3, approved in 2012. The first maintenance release of Baseline 3 was adopted in June 2014.

Are there already examples of cross-border lines using ERTMS?

Yes. The Vienna-Budapest line is running with ERTMS since 2003. In June 2009, a new ERTMS (Level 2) High Speed Line was opened in Belgium between Liege and the German border, whilst the Thalys is running with ERTMS from Amsterdam (Netherlands) to Antwerp (Belgium). The crossing between France and Spain, beneath the Pyrenees, is now in operation as well.

In the future, cross-border connections will multiply as investments are gradually being coordinated on the ERTMS corridors with the support of the European Commission. A dedicated European deployment plan was adopted in July 2009 to ensure that EU countries equip their network in the same timeframe – this plan covers more than 25,000 km of pan-European corridors and specific railway lines which will have to be equipped with ERTMS by 2020.

Can ERTMS alone ensure that interoperability is reached?

No – as explained above, there are additional possible hindrances to interoperability. While the differences in tracks gauges or electrification systems are all overcome through technology (gauge-changing bogies, multi-system propulsion, etc.), operational requirements and rules need further harmonisation to facilitate cross-border traffic – a complex issue on which the ERA and the European institutions are continuously working.
INCREASING INFRASTRUCTURE CAPACITY
HOW ERTMS IMPROVES RAILWAY PERFORMANCE

Today, railway operations in several parts of the world and in Europe in particular require a constant and increasingly intense flow of trains on busy routes. By allowing a reduction of headways between trains, signalling systems play a major role in increasing capacity on railway networks, as more trains can run on the same track. Whilst the primary objective behind its creation was to ensure interoperability in Europe, ERTMS also offers considerable benefits in terms of infrastructure capacity, which explain its increasing success outside Europe.

How can signalling affect rail infrastructure capacity?

Whilst signalling originally aims to control railway traffic safely and avoid collisions between trains, it increasingly plays an important role in increasing capacity, i.e. influencing the number of trains on a given line and the distance between them, and has therefore become a crucial part of railways’ competitiveness.

In the early days, "Movement Authorities" (i.e. the commandment for a train to continue its run at a given speed or brake in order to stop at a given location) were passed on to train drivers by flagmen or elevated flags located on the various sections of the track. These were replaced over time by lineside signals (traffic lights) which are nowadays still largely present on most railway networks.

However, the emergence of High Speed trains and the need to ensure a higher level of safety led to the emergence of Automatic Train Protection (ATP) systems in the 1970-1980s. As opposed to the previous lineside signalling systems, ATP will automatically apply the brakes if the driver fails to respect the Movement Authority – thereby removing the risk of a human error and allowing for higher speeds and shorter headways between trains.

Is signalling the only way to increase capacity on a given rail network?

No- There are a number of options to increase capacity, from building additional lines or renewing existing tracks, lengthening trains and loops or platforms, to operating more frequent services and higher density trains.

However, by opting for a modern signalling system like ERTMS, operators may easily increase the frequency of trains on a given line. Instead of building another line or lengthening trains and platforms, upgrading to ERTMS represents the easiest, most economic and least disruptive way of increasing capacity on a line or network.

What gains can be expected from moving from a conventional trackside signalling system to a cab-signalling ATP system like ERTMS?

Infrastructure capacity is always a result of several technical and operational factors, and this makes it difficult to provide a generic figure. However, it is commonly acknowledged and demonstrated by experience that the use of an ATP system like ERTMS with an appropriate block system enables up to 40% capacity increase on currently existing infrastructure. This is considerable and explains why countries all over the world are massively opting for ERTMS when building new lines or re-signalling their network, with nearly 50% of the total ERTMS sales being made outside Europe.
There are already a number of ATP systems already in operation. Does ERTMS offer any additional capacity as compared to them?

As the most recent signalling system, ERTMS is publicly acknowledged to have better performance in terms of capacity than its predecessors. This is due to the cab signalling features and the ability of ERTMS to take into account the braking compatibilities of each individual train – thereby allowing for shorter headways between trains and higher speeds.

Does ERTMS level 2 enable higher capacity increase than level 1?

Basically, the use of ERTMS level 2 can offer considerable advantages in terms of capacity increase. Indeed, when using level 2 a continuous stream of data informs the driver of line-specific data and signals status on the route ahead, allowing the train to reach its maximum or optimal speed but still maintaining a safe braking distance factor. This therefore enables higher operational speeds and reduced headways (see dedicated factsheets #3 on “ERTMS levels”).

Concretely, how many trains per hour can run on an ERTMS line?

As already mentioned, this depends on a variety of factors which make it difficult to provide a generic estimate. A 2008 study by RWTH Aachen University (Institute of Transport Science) for the International Union of Railways (UIC) provides a first estimates of the line capacity when using different ERTMS levels, concluding for instance that using ERTMS level 2 with optimised block sections allows to have a minimum headway of only 2.51 minutes between two high speed trains and 1.62 minutes between regular intercity trains, depending on the assumptions.

In practice, real gains can however be calculated by taking examples of ERTMS lines which are already in operation.

A typical example of a high-capacity ERTMS lines is given in the Swiss case of the Mattstetten – Rothrist line, which operates in level 2. An estimated 242 trains– both freight and passengers run on the line everyday, at speeds of up to 200 km/h. The headway between trains has been reduced to less than two minutes (110 seconds), allowing for a considerable capacity increase!

SBB infrastructure manager reported (ETR, September 2008) a 15% capacity increase with ERTMS Level 2 on already optimised lines. In case of lines with mixed traffic (passengers plus freight), a capacity increase of up to 25% was reported.

Many other examples may be found, such as the Very High Speed Line Roma - Napoli where 33 runs per day are made on a 216km line at speeds of 300km/h, with headways of less than 5 minutes.

Is this ‘capacity advantage’ of ERTMS recognised globally?

Yes – all across the globe ERTMS is seen by the railways as “the” way to increase capacity on busy routes. For instance, ERTMS is already in service in the route between New Dehli and Agra (one of the busiest lines in India) and will soon be installed on the Mexico City suburban line Cautitlan – Buenavista, as well as in busy parts of the dense Chinese railway network.

Together with other advantages, capacity increase has made ERTMS a very successful standard across Europe (see ERTMS factsheet #7 on “Deployment outside Europe”) as well as the most demanded signalling system elsewhere for new and upgraded lines.
RAIL FREIGHT ON THE RIGHT TRACKS
ERTMS BUSINESS CASE FOR FREIGHT OPERATORS

Today, cross-border operations account for a major share of rail freight operators’ activities. ERTMS, the European Rail Traffic Management System, facilitates cross-border movements whilst enhancing the reliability, quality and competitiveness of rail freight services in Europe. Investing in ERTMS today is a rational choice for freight operators that takes into account the evolution of the European rail network. It provides them with the guarantee of using a reliable high performance signalling system in the long term as the current legacy systems are being replaced by the common ERTMS standard.

What are the advantages of a unique signalling system for freight operators?

Due to the existence of several signalling systems in Europe today, freight locomotives have to be equipped with the appropriate signalling systems - and even in some cases they must be changed at the border, increasing costs and travelling times. As a unique signalling system, ERTMS provides the solution to the lack of interoperability of the existing rail networks in Europe.

Indeed, once a unique signalling system is installed along a given international freight route, rail freight operators will only need to purchase ERTMS as the onboard system, as opposed to having the several legacy systems required for operations in the different countries. This represents a significant cost reduction for freight operators. This will, in the end, benefit consumers, the economy and society as a whole because economic exchanges will increase and become cheaper.

Moreover, a common European signalling system also leads to a reduction of maintenance costs and facilitates staff’s training, as drivers will only have to be familiar with one signalling system.

Can ERTMS help in improving freight operations’ performance?

Besides interoperability, ERTMS offers advantages in terms of capacity, speed and reliability – three key components for successful rail operations. These advantages explain why nearly 50% of all ERTMS investments are made outside Europe – the system being recognised worldwide as best in class.

Why is ERTMS becoming a “must” for freight operators?

Already today ERTMS is used as a unique system on some crucial European freight routes such as the Betuweroute or the Lötschberg tunnel. Increasingly, passenger-lines equipped with ERTMS will be used for freight operations – for instance, in Italy, the use of High Speed lines for freight operations at night/off peak times is foreseen. In total, an estimated 22,000 km of route are already contracted to work with ERTMS in Europe.

In addition, infrastructure managers opt increasingly for a removal of legacy systems on ERTMS-equipped lines in order to increase their cost savings, in particular in terms of maintenance. Some countries, for example Switzerland, are even planning a full removal of legacy systems in the medium term. As a consequence, ERTMS will be the only signalling system on those routes.
Large parts of the EU rail freight network are not yet equipped. When will this be the case?

Besides the existing investments mentioned above, rail freight operators have now the guarantee that the European rail network will be equipped with the ERTMS technology in the short and medium term. Indeed, in July 2009, the European Commission adopted the European ERTMS Deployment Plan that provides strong guarantees for freight operators wishing to equip their locomotives with ERTMS:

- the plan foresees the equipment of more than 10,000 km of railway lines by 2015 and 25,000 km by 2020; this deployment is mandatory (part of EU Law);
- these lines consist in the 6 full ERTMS corridors (i.e. the busiest cross-border freight routes in Europe) and a list of designated freight lines;
- these requirements will also apply to freight locomotives (trains ordered after 2012 or put in service after 2015 will necessarily have to be equipped with ERTMS).

In parallel, an increasing number of European countries have planned to go beyond their obligations defined by the European ERTMS Deployment Plan and equip their entire network. This is the case of Denmark and Switzerland.

Are there any benefits for “early investors”?

Yes - since the equipment of ERTMS will be mandatory on the major European freight routes. Equipping fleets at an early stage may also provide freight operators with other key advantages. Indeed, trains will be ready to operate on the network as soon as the trackside is put into operation and an operator will therefore gain a significant advantage vis-à-vis its competitors. Front-runners will also be able to capitalise on their experience and maximise the advantage of their investment.

Are ERTMS investments made now safeguarded in the long term?

As the European Deployment Plan has made the implementation of ERTMS mandatory, freight operators have the guarantee that their investments are “future-proof”. Moreover, ERTMS as a standard is now stable and with a clear migration path that preserves its business case.

Indeed, Baseline 3, which was adopted in 2012, is fully backwards compatible – this means that trains equipped with baseline 3 will be able to operate on 2.3.0d tracks.

Freight operators can already take advantage of version 2.3.0d whilst safeguarding their investment, for example by including “upgrade clauses” in contracts in order to guarantee that their rolling stock will be equipped with the baseline 3 of ERTMS.
ERTMS DEPLOYMENT IN BELGIUM & THE NETHERLANDS
CROSSING BORDERS AT HIGH SPEED

Belgium and the Netherlands are two countries with a long-standing railway tradition, but which also invested massively to develop a modern High-speed rail network in recent years. In both countries, High Speed has by definition a European dimension, as lines connect Amsterdam and Brussels to London, Paris or Cologne. It also comes with a specific challenge – cross-border traffic – in which ERTMS can play a major role. It therefore does not come as a surprise that Belgium and the Netherlands were the first ones to achieve a High-speed ERTMS Level 2 cross-border connection in revenue service since the end of 2009.

What are the main High-speed projects in Belgium? What is the status of ERTMS deployment?

Located at the very heart of Europe, Belgium is a country of which invested massively in the past few years to upgrade its railway network. It subsequently became the first European country to have a complete network of High-speed lines from border to border in commercial service, with links to the UK, France, The Netherlands and Germany.

The two most recent connections to Germany (HSL3) and the Netherlands (HSL4), are already running in commercial service with ERTMS level 2:

- **HSL 3** connects the city of Liège to the German border. The 56 km long line (42 km dedicated high-speed tracks, 14 km modernized lines) came into commercial operation on the 15th June 2009. It is currently used by international Thalys trains and ICE trains. After completion of the line, the travel time between Liège and Cologne has been cut to one hour, whilst Liège to Aachen is achieved in about 20 minutes at speeds up to 260 km/h.

- **HSL 4** connects Antwerp to the Dutch border, where it meets the HSL Zuid (see below). The line is 40 km long, and consists of a dedicated high speed track. It is connected to a modernised railway line that runs from Brussels to Antwerp. HSL4 first opened in June 2009 and since December 2009, Thalys trains are running using ERTMS Level 2. Trains are now travelling at up to 160 km/h from Brussels to Antwerp (47 km), whilst on the “dedicated” part of the line reaching speeds up to 300km/h. HSL 4 is currently used by Thalys and fast internal InterCity trains.

What are the main High-speed projects in the Netherlands? What is the status of ERTMS deployment?

Like Belgium, the Netherlands has one of the most densely spread railway networks in Europe and a significant railway culture and tradition. The government approved in 1997 the first national High-speed rail project, known as HSL Zuid, which links Amsterdam with the Belgian border and is viewed as a crucial step in linking the country to Brussels, London and Paris.

The HSL Zuid is a dedicated 125 km High-speed rail line. It features state-of-the-art ERTMS level 2 technology. Whilst the northern part (from Amsterdam to Rotterdam) is in commercial service with ERTMS level 1 since September 2009 (used by TRAXX locomotives and Thalys trains), the southern section is in commercial service with ERTMS level 2 since December 2009.
What are the benefits brought by ERTMS to passengers on the high-speed line crossing Belgium and the Netherlands?

Amsterdam, Paris and Brussels are now closer than ever thanks to the new High-speed line linking Belgium and The Netherlands, whilst travelling times to Paris and Cologne have equally been reduced thanks to HSL3:

– From Amsterdam, it now takes 3h18 to reach Paris (51 minutes travelling time reduction) and 1h54 to reach Brussels;
– From Paris, travelling time to Cologne has been cut to 3h14 (36 minutes reduction).

This considerable travelling time reductions bring significant benefits to passengers, facilitating and improving travel of both tourist and business travellers.

As a side effect of railway investments, modernization and upgrade, Belgium now enjoys two of the most spectacular railway stations in Europe: the fully-renovated “Antwerpen Centraal” Station, and the scenic, futuristic Liège-Guillemins station, which was designed by Santiago Calatrava and has become the city’s landmark, known all over Europe.

Will ERTMS also benefit directly to infrastructure managers and train operators?

Yes - ERTMS also considerably reduces infrastructure and maintenance costs and increases safety, reliability, capacity and interoperability. Once the full line from Paris to Amsterdam will be equipped, it will also strongly reduce the number of signalling systems required to run on this line – from seven to one. This will greatly facilitate operations along the lines for both existing operators and new entrants.

Are Belgium and the Netherlands also planning ERTMS investment on their freight and conventional networks?

Yes - in addition to HSL Zuid, The Netherlands is also installing ERTMS on its freight network. In particular, the Betuweroute, part of the Havenspoorlijn, is now operating since July 2007 with ERTMS level 2 without any fallback system. The rest of the Havenspoorlijn, the new railway link connecting the Europort of Rotterdam with Germany, is to be fitted with ERTMS level 1. The Netherlands has also opted for ERTMS to be installed in a commuter line: Amsterdam-Utrecht (30 km, 4-lanes). This line, where the legacy system “ATB” was installed, is now operated with ERTMS level 2. Lastly the new “Hanzelijn” line, connecting the cities of Lelystad and Zwolle, is fully equipped with ERTMS level 2 and in operation since the end of 2012.

On the Belgian side, the country goes forward to fully equip its entire network in the long run. Frame contracts have been signed in this respect comprising a migration strategy at thousands of signals via the legacy system TBL1+ together with ETCS level 1. TBL1+ ensures a fast increase of the safety level until 2015 and ETCS Level 1 makes the network interoperable for ETCS trains. The whole network shall finally be operated in the ETCS level 2 mode. It has also plans to upgrade the High Speed connections with France and the UK to ERTMS – however final completion dates for these sections have not yet been provided.
ERTMS FROM THE DRIVERS’ POINT OF VIEW
HOW ERTMS FACILITATES TRAIN OPERATIONS FOR DRIVERS

During a train journey, drivers have to reconcile two objectives which may somehow seem opposed: maintaining complete safety whilst ensuring full operational performance and respecting timetables. By providing a specific cab signalling display, ERTMS helps drivers in their day-to-day operations. Thanks to the feature of continuous speed supervision, the driver receives full data about the maximum speed profile according to the track topology at each time.

What does ERTMS change from the driver’s point of view?

ERTMS affects the job of the drivers in four different ways:

– By providing full cab signalling;
– By monitoring all operational modes (full supervision, shunting, on sight, reversing, splitting,...) while any legacy system can monitor only some nominal modes. ERTMS therefore provides an enriched data entry process for the driver as compared to legacy systems;
– By strongly reducing the risk for human errors, as emergency brakes are automatically applied if a driver misinterprets a signal.
– By providing him with more time to observe the track ahead.

The planning area: which benefit for the drivers?

The “planning area” (the track is identified visually on the drivers’ desk) provides a powerful tool for the driver to improve the operation of the train, as he receives key information on the status of the tracks several kilometres ahead:

– Static characteristics, such as temporary speed restrictions, speed profiles, singular points like level crossings, bridges and tunnels, neutral sections, etc.
– Dynamic characteristics, such as speed restrictions subsequent to an occupied track: this allows the driver to anticipate braking and acceleration phases, and is of particular importance for freight trains in order to improve energy consumption and limit the efforts on the coupling.

Globally, ERTMS therefore provides all the necessary data for the driver, even with a reduced knowledge of the line. In the longer term, this may reduce the training burden of the Railways Undertakings.
Shall the driver still observe the lineside signals?

A key issue in the case of signalling-related accidents is due to the problem drivers may face to identify and interpret the lineside signals – for example because of the adverse weather conditions.

As an Automatic Train Protection (ATP) system, ERTMS will automatically apply the emergency braking system if a driver fails to interpret signals and speed limitations in a correct manner.

Besides this, in-cab information significantly helps drivers in their operations:
- With ERTMS level 1, lineside signals are still used for initiating the moves;
- However, with ERTMS level 2, lineside signals are no longer required;
- In-cab information for ERTMS is defined in order not to contradict lineside signals information where they are retained.
- In any case, national operational rules determine whether the driver still has to look at the lineside signals.

Will ERTMS allow for a reduction of Drivers’ Machine Interfaces?

Yes - the multiple signalling system currently implemented in Europe make a drivers’ cab particularly complex (see picture below), especially in locomotives designed for long-distance freight. In the long term, as an increasing number of railway lines will be equipped with ERTMS, the ERTMS cab display will gradually replace the other ATP systems onboard the train. This will facilitate operations, increase traffic safety and reduce implementation and maintenance costs of signalling equipment.

Can legacy systems be integrated into the Driver-Machine Interface?

Yes - Legacy systems can be integrated within ERTMS thanks to the use of a Specific Transmission Module (STM) device. In such cases, the legacy system indications (if and where maintained) can be integrated on the same Driver Machine Interface (DMI) as far as the driver is concerned. Information from the legacy system is provided to the driver in a similar way as ERTMS. In addition, the data entry procedure is shared, as far as possible, between ERTMS and the legacy system to avoid the multiple entries and therefore potential error introduction by the driver.
ERTMS DEPLOYMENT IN THE UK
RE-SIGNALLING AS A KEY MEASURE TO ENHANCE RAIL OPERATIONS

Although geographically distant from Central Europe’s freight hubs, the UK is gradually launching major ERTMS investments as part of an ambitious program to revitalise national railway traffic. In a country with a long history of conventional signalling systems and train operations, the introduction of a major re-signalling program raises some exciting challenges. Whilst ERTMS Level 2 first entered into service in March 2011 on the Cambrian line, railway authorities are now pushing for a larger deployment scheme, which would allow to increase capacity and performance on Britain’s railway lines and contribute to economic growth.

What is the status of ERTMS deployment in the UK?

So far, ERTMS has been put in service on the Cambrian Coast Line, a single track line of 215km, which links Shrewsbury (Sutton Bridge Junction) with Aberystwyth and Pwllheli in Wales. On this line, ERTMS replaced the legacy Radio Electronic Token Block (RETB) signalling system installed on the route. The line was put into service in March 2011, and operates with ERTMS Level 2. There are 24 sets of 2 coach Class 158 DMUs from Arriva Trains Wales which have now been ERTMS fitted for passenger operations, in addition to 4 Class 37 Diesel locomotives (now called Class 97) for freight and other operational duties.

How was ERTMS installed on the Cambrian line?

Equipping the Cambrian line with ERTMS posed several technical challenges. A new signalling centre with two signaller positions has been implemented to control the total route and cater for the expected growth in traffic. ERTMS is also supported by the deployment of a GSM-R system, axle counters, new motorised point machines and balises along the track and a single Radio Block Centre (RBC) installed at the control centre in Machynlleth.

In the Cambrian deployment, Network Rail with its single prime contractor/supplier has had the opportunity to learn much key process, operational and technical lessons with respect to both UK and ERTMS standards. These lessons will be used to positive effect when further programmes for the introduction and implementation of ERTMS cab signalling are put into place for the rest of the national network.

Are their further plans to introduce ERTMS in the UK?

Yes - the deployment of ERTMS is now an urgent requirement to cope with the high, continuing traffic demand seen by both passenger and freight transport operators. In this respect, the key features achievable with ERTMS - higher Safety, higher operational speeds, greater traffic capacity and accompanying cost savings/reductions in both CAPEX and OPEX are seen as vital benefits.
Which lines will be equipped with ERTMS in the coming years?

Future routes for the deployment of ERTMS in the UK are already advanced but first a further ERTMS Pilot 12.8 route km equipment test line and laboratory facility will be implemented at Hertford North, where any aspiring ERTMS supplier are now demonstrating their equipment compatibility with UK standards before achieving approval status to compete for the national ERTMS roll out.

Following this scheme, it is foreseen that the following lines will be equipped:

- **Great West Main Line** (177km route) from Paddington to Reading, Newbury, Oxford, Swindon, Bristol. This route will be signalled Level 2 ERTMS as an overlay with light signals in the first instance and with new electrification traction, resignalling and recontrolling work undertaken in parallel. The target date for ERTMS operational service commencement is 2017 with completion in 2018.

- **East Coast Main Line** (251km route) from London Kings Cross station to the approaches of Doncaster station will be signalled Level 2 ERTMS without signals. This line is already electrified. The target date of readiness for operational ERTMS services is December 2018 with completion in 2021.

- **Midland Main Line** (158km route) from London St Pancras to Leicester will be signalled Level 2 without lineside signals. The target date of readiness for operational ERTMS services is December 2021.

Other special projects are also under active development:

- **Thameslink London** project running North-South on upgraded, existing tracks, where Automatic Train Operation (ATO) functionality will be deployed in the central core section having been tested and proven at Hertford North. The new trains purchased will have to transition between ERTMS and the existing conventional light aspect signalling (TPWS). Approximately 119 new trains are expected to be required.

- **Crossrail** is a new high capacity urban railway system utilising two new 21km tunnels running East-West under Central London but joining the national “main line” network at each of the portal tunnels’ extremities. Thus transition to ERTMS and TPWS will be required on the new trains now purchased as well as being able to drive CBTC with ATO in the tunnels. Approximately 63 new trains are expected to be required for the full service pattern.

Will British trains be equipped as well?

In parallel to this infrastructure programme, there is concentrated work now being undertaken to plan the “retrofitment” programme for the “national” rolling stock fleet involving approx 2,500 locomotives up to 2030. This takes into account the fitment work required to match the fleets required for the routes to be upgraded to ERTMS, considering the current ages of the trains themselves as well as balancing this required volume against the “new ” build train ordering programme. In this respect the “UK” fleet is a remarkable mix of, and is distorted by, a large variety of differing trains and locomotive classes. Many will require costs associated with the first fitment engineering to be included. New build fleets will be expected to be either ERTMS capable or ERTMS ready from the day of delivery.
INTERNATIONAL FREIGHT CORRIDORS EQUIPPED WITH ERTMS
A COORDINATED EUROPEAN MIGRATION TO ERTMS TO IMPROVE RAILWAYS’ COMPETITIVENESS

Still today, the co-existence of more than twenty signalling systems in Europe is a major obstacle to railways’ competitiveness. Trains need to be equipped with several on-board systems to cross borders; drivers need to be trained to use these systems; sometimes trains have even to be changed at the border. The emergence of ERTMS as a unique European signalling standard therefore offers the potential to considerably increase railways competitiveness along international freight Corridors. However, the business case brought by ERTMS will greatly depend on the speed of its deployment on the trackside, and of the will of the EU Member States to make the necessary investments as soon as possible.

What is the “Corridor approach”?

In many countries (see factsheets #4,5,6,12,14…), ERTMS investments have brought considerable benefits, in terms of increased capacity, maintenance costs savings, multi-supplier opportunities, reliability or speed. As demonstrated by its worldwide success, ERTMS has emerged as “the” global signalling standard.

On an international basis however, ERTMS investments must be coordinated to ensure that cross-border interoperability is achieved. For instance, it is essential that a group of neighbouring countries equip their lines in a similar timeframe and in a coordinated manner, so that locomotives running on the lines crossing these countries have to be equipped only with ERTMS – and not with national signalling systems in addition to ERTMS.

A “Corridor approach” – whereby investments are coordinated amongst different countries – is therefore needed to collect the full benefits of ERTMS, i.e. cross-border interoperability.

What are the ERTMS Corridors?

Together with railway stakeholders, the European Commission has established a list of six priority Corridors for the deployment of ERTMS. These are major European rail freight axis, where the deployment of ERTMS will bring considerable benefits:

- Corridor A runs from Rotterdam to Genoa;
- Corridor B: Stockholm-Napoli;
- Corridor C: Antwerp-Basel;
- Corridor D: Budapest-Valencia;
- Corridor E: Dresden-Constanta;
- Corridor F: Aachen-Terespol.

With the adoption of the European ERTMS Deployment Plan (see overleaf), a number of key European freight lines were also added.
Are ERTMS investments mandatory along these Corridors?

Yes – whilst originally, ERTMS deployment was made on a “voluntary” basis, equipping the ERTMS Corridors became a legal obligation in July 2009, with the adoption of the European ERTMS Deployment Plan.

When will the ERTMS Corridors be equipped?

This depends on each section of the Corridors. An estimated 10,000km of lines will have to be equipped by 2015, whilst the rest of the network will be completed by 2020, raising the number of kilometres to be equipped to 25,000km. Many Member States have already gone beyond these obligations and announced their intention to equip their entire railway network – it is therefore expected that the total number of lines equipped with ERTMS will grow dramatically in the coming years.

Does this mean that railway operators have the guarantee that the network will be equipped according to schedule?

The European ERTMS Deployment Plan makes investments along these Corridors a clear legal obligation according to European law. In principle, a country which would refuse to make the necessary investments could face a European infringement procedure.

 Aside from trackside investments, are countries cooperating on technical aspects related to ERTMS?

Yes – typically, the Infrastructure Managers of the Corridors have set up an EEIG (European Economic Interest Grouping) to improve the coordination of investments, also from a technical point of view. Memorandum of Understanding between the countries part of the Corridors also reinforce this technical and political cooperation. Finally, technical topics and cross-border aspects are also raised with the European Railway Agency or by the specific European Commission working group handling Corridor issues.
ERTMS IN CONTROL CENTRES
HOW CAN ERTMS LEVEL 2 AND 3 FACILITATE TRAINS TRAFFIC MANAGEMENT FOR CONTROL CENTRE OPERATORS

Everywhere in Europe, Control Centre Operators have to ensure the full performance of day-to-day train operations to respect timetables and make sure trains and passengers arrive on time. This includes taking efficient decisions in case of perturbation, and offering mitigation measures. By minimising the operational constraints due to signalling and making additional functions and relevant data available to Control Centre, ERTMS helps the traffic controllers in their day to day operation.

What are the operational constraints of legacy signalling systems?

Control centre operators are usually limited by legacy signalling systems in their possibilities to ensure a full and timely control of the trains on their network:

- Emergency stops are only possible at fixed locations where the signals are located;
- Boundaries Temporary Speed Restrictions are in accordance with existing Block Section and usually wider than the area to be protected;
- Track conditions definition (“Neutral section” zone, “Axle load”, “Air Conditioning”, “No stop location”…) are also limited to fixed locations and upfront announced time periods;
- The removal of a route already dedicated to a train takes time due to the fact that the route is blocked during a period of time to guarantee that the corresponding train is actually stopped.

How does ERTMS improve this situation?

The European Train Control System (ETCS) is in permanent contact with the trains and knows precisely and permanently their position, their speed and their braking distance. This allows controlling the trains with the highest flexibility and efficiency:

- Immediate emergency stops everywhere and at any time;
- Temporary Speed Restrictions applied exactly on the portion of track which must be protected without disturbing the rest of the track;
- Track condition selectable everywhere in real time;
- Cooperative Movement Authority (MA) revocation and MA reduction permit operator to resume the itineraries quicker than a conventional systems having long latency periods.

In addition, the operator remains in permanent direct contact with the drivers by sending operational messages (operation information) via text messages (in the case of ETCS) or voice communication call (GSM-R voice).
How can ERTMS improve the global supervision of train operations?

ERTMS Levels 2 and 3 provide train position reports with additional train information like actual train speed, location, mode of operation (trip, system failure ...) and unique identity. Others types of Information (like train data, odometry problems, etc...) may be provided to the control centre and to the remote maintenance system.

The speed and status information is displayed to the operators in order to quickly identify trains operating in specific modes (non-nominal modes). The position report is worthwhile to anticipate traffic management and support the operators’ decision.

The train describer uses directly train identities instead of making references to pre-defined tables and specific algorithms for initialization follow-up and reset. This allows to know exactly which train is where whatever the situation, including highly degraded situations.

This interoperable dialogue with trains through the exchange of various standard information (regardless from train type and characteristics) allows for an improvement of train operations. It also eliminates the voice medium to transmit orders or advices - which is an issue for internationally driven trains.

How can ERTMS further enhance the reliability of train operations?

The use of train information provided by ETCS Levels 2 and 3 allows to perform and/or improve various useful functionalities like “consistency check” between planning and real situation (verification of “Train Running Number ID”, Train category, train length/convoy type, train characteristics), to trace conditional route/itinerary and thereby to anticipate and manage potential conflicts in a faster and efficient way.

These reports of the actual situation with accuracy allow for the allocation of incident root cause, so that train operators and infrastructure managers can agree on possible penalties in case of a delay.
ERTMS DEPLOYMENT IN TURKEY
MODERNISING SIGNALLING TO OPTIMISE TRAIN OPERATIONS

Historically, Turkey has always sat at the crossroads of trade between Europe, Asia and the Middle East, providing it with an enviable geographical location that offers high prospects for both freight and passenger transportation. In recent years, the country embarked into a major railway investment program to seize this opportunity. ERTMS now plays an essential part in the modernisation of the rail network and the establishment of high-speed lines.

When was the Turkish railway network built?

The first railway in Turkey was established in 1856 and linked Izmir to Aydin. Turkey experienced its railway golden age from 1923 to 1959 when over 3,700km of new track was constructed. Unfortunately, this growth could not be maintained, and for the second half of the 20th century rail investment suffered at the expense of road transport. Consequently, between 1950 and 1997, the road network increased in length by 80% and the railways just by 11%.

Fortunately, all this changed in 2002 when a radical change in Turkish transport policy put railways back at the forefront. Ambitious plans were put in place to rehabilitate existing lines, build a brand new High Speed network and develop an advanced railway industry. Just over a decade on, many of those plans have now become reality.

What are the major rail investments going on?

As far as freight rail, the Logistics Centres Project (several regional logistics centres being established) has been launched to improve expedite freight transfers from road to rail. For passengers, investment has been equally ambitious, with major investments in mass transit and light rail systems (Istanbul’s metro system first opened in 2000). Most important and significant of all and playing a key role in the development of Istanbul and the surrounding region as much as fostering economic exchange between Europe and Asia is the Marmaray Project which connects Gezbe and Halkali by a seamless high capacity suburban railway system. This means that the tunnel will be equally used for local transport (metro), high-speed trains and even freight trains, setting a milestone for the re-establishment of a new “Silk Route”, renamed as “Iron Silk Route”.

The importance of developing an inter-city High Speed rail network is also recognised. With Ankara at its hub, three corridors are being built linking Istanbul-Ankara-Sivas, Ankara-Afyon-Izmir and Ankara – Konya (already in service).
Is ERTMS part of this major investment program?

Yes – Turkey has become one of the largest ERTMS investors in the world. The first deployment of ERTMS in Turkey was completed in 2008 on a 196km section of the Istanbul to Ankara High Speed line between between Hasanbey and Esenkent, with 10 trains operating at 250km/h under ERTMS Level 1 supervision; while the most important milestone was set on 29 October 2013, on the occasion of the 90th anniversary of the Republic of Turkey, when the Marmaray tunnel was officially inaugurated.

The second High Speed line entering into operation in August 2011 was the Ankara to Konya line, which added 212km to the High Speed network under ERTMS Level 1 supervision.

Other notable projects are , the 419km route linking Bogazkopru to Yenice and Mercin to Toprak kale, the 58km Sincan to Esenkent and Hasanbey to Inonu extension, on which work started in 2009. More recently, contracts have been awarded on the 328 km long line, single track between Eskisehir-Balikesir, the 56 km route between Gebze and Mosekey, the 310 km route, single track between Bandirma and Menemen. the 415 km, single track between Irmak and Zonguldak and the 70 km route linking Pamukova and Köseköy.

When the current set of projects is complete and in operational service, Turkey will enjoy over 250 ERTMS equipped vehicles operating on over 2,300km of track, at speeds of up to 250km/h.

Is Turkey using only ERTMS Level 1?

Near all lines were initially designed to operate at ERTMS Level 1 but Level 2 has now been specified for the Ankara- Istanbul corridor, and the Ankara to Konya, Eskisehir to Balikesir lines. Bandirma – Menemen line project includes both ERTMS Level 1 and 2.

Are there further investment plans scheduled?

Ambitious plans exist to invest over EUR$28billion in the country's rail network by 2023, the 100th Anniversary of the establishment of the Republic of Turkey. This includes an additional 14,000km of track, of which over 10,000km will be high speed lines. By 2035 an additional 2,400km will be built giving the country a network of virtually 28,000km, hence ERTMS deployment is set to grow rapidly in the next two decades.

What are the benefits of ERTMS for the Turkish railways?

Not only ERTMS deployment will provide Turkey with a modern, safe and reliable railway network, but also the new High Speed lines will cut journey times dramatically between the major cities, providing a more convenient and efficient alternative to road and domestic air travel. For example, the historic journey time of 10 hours and 30 minutes from Ankara to Konya has fallen to just 1 hour 15 minutes now that the new High Speed line is operational. Likewise the historic journey time of 12 hours and 25 minutes between Istanbul and Konya will decrease to just 3 hours and 50 minutes, significantly faster than both road and air on a city centre to city centre journey.

In addition to this, as the new High Speed lines will be dedicated for passenger traffic only, capacity will therefore be freed up along the existing network, allowing for more local passenger and freight trains capacity.

A new High Speed rail terminus station is being finished in Ankara as well as new stations across the network including Istanbul, Izmir and Sivas. By integrating the new High Speed network with the Marmaray Project, the country will be able to provide seamless passenger transport between Europe and Asia for the first time in history, carrying an estimated 17 million passengers a year. This figure has to be added to the new commercial possibilities that the tunnel offers for seamless freight transport between both continents in the so called Iron Silk Route. Finally, the use of ERTMS will also make it possible to link the Turkish rail network with that of the EU and the Middle East.
ERTMS DEPLOYMENT IN SWEDEN

The Swedish Transport Administration has taken a cautious but measured approach to the introduction of ERTMS into the national rail network. The well operating existing/legacy ATP system was introduced in the 1980s and is expected to last both technically and economically until around 2020.

The rail network itself consists of 11 900 track-kilometres of which 3700km are either double track or multiple track and 9800km are electrified.

The Swedish vehicle fleet impacted by ERTMS introduction consists of between 800 and 1200 vehicles with approximately 50 different vehicle types.

The Swedish ERTMS Implementation Plan drawn up in September 2007 to comply with TSI 2006/679/EC clearly identified the Swedish order of priority for the introduction of ERTMS as follows:

1. New and/or essentially upgraded routes or lines
2. Routes or lines without signal plant, centralised traffic control and ATP systems
3. Routes or lines with major re-investment needs for existing signal plants
4. Routes or lines included in the corridors identified by the EU
5. The remaining parts of the routes in the Trans-European Network (TEN) and after that other parts of the railway network

Level 2 technology has been chosen for the whole of Sweden, with possible exceptions of a Level 1 solution being deployed at larger stations and railway yards with extensive shunting movements.

An ERTMS “Regional” solution will be implemented on very low traffic lines, which are currently supervised by manual operation.

The Swedish plan was for the introduction of ERTMS to begin in 2008, with the majority of Swedish lines expected to be finally equipped for full introduction of ERTMS by 2030.

What is the status of ERTMS deployment in Sweden?

ERTMS Level 2 is to be implemented first on the Bothnia Line, Ådal Line, City Tunnel and Haparanda Line. These are in the process of being equipped with ERTMS Level 2 and will provide invaluable experience for the next phases of ERTMS introduction in Sweden. According to current legislation, ERTMS must always be introduced in new construction, extensive upgrading of the railway, and signalling systems requiring reinvestment. In addition to these, priority is assigned to the lines that the EU has identified as being a part of a European strategic corridor network.

The Bothnia Line running between Umeå and Ångerman River north of Kramfors is 190 km long and comprises 25 km of tunnels and no less than 140 bridges. ERTMS Level 2 has been chosen for the Bothnia Line, and the entire line has been open for traffic since August 2010. Sections 1 and 2 were completed and ready for traffic in the autumn of 2009.
ERTMS Regional, based on the new UIC rail control specification for less intensely used routes, is now being introduced in Sweden on the so-called TAM lines – lines that do not have an Automatic Train Control (ATC) system – on which traffic control takes place manually using telephone communication between local train dispatchers. Safety will improve substantially when ERTMS Regional is introduced on these lines. Another benefit of the new system, which will see the lines upgraded from manual to automatic control, is the creation of a cost-effective alternative for lines which otherwise might face closure due to the cost of maintaining manual operation or upgrading to traditional remote-controlled signalling. ERTMS Regional combines the ERTMS standard for onboard Automatic Train Protection (ATP) with a radio-based wayside system, thereby minimising trackside equipment. The system reduces operational costs and enables increased traffic capacity and automated operation around the clock. Sweden’s low density lines account for approximately 21% of the total national network.

The Västerdal Line is the first ERTMS Regional line and was selected mainly because it is typical of its type and has no through traffic. This means that a limited number of vehicles are affected and only one traffic control centre is involved.
The Västerdal Line running between Malung and Repbäcken is 134 km long. The line has five stations, 33 level crossings and carries 16 trains per day. The maximum speed on the line is 90 km/h. ERTMS Regional was selected and the line went into operation on 21 February 2012. The line is the pilot in a frame agreement with the Swedish Transport Administration and has been followed by a further call-off for the Skellefte Line in Northern Sweden.

SUMMARY OF ROUTE ROLLOUT

Which lines will be equipped with ERTMS?

Sweden will gradually introduce ERTMS on the basis of a plan for the period of 2008 to 2030:

- **Implementation plan 2008 - 2015**
  - **Level 1 – Large stations**
    - Malmö C
  - **Level 2 – Lines and medium-sized/small stations**
    - Bothnia Line
    - Ådal Line
    - Haparanda Line
    - City Tunnel
    - Öresund Link
    - Malmö-Hässleholm
  - **Level 3 – Low-traffic lines**
    - Västerdal Line
    - 5 – 6 low-traffic lines

- **Implementation plan 2016 - 2019**
  - **Level 1 – Large stations and the Stockholm region**
    - Hallsberg
    - City Line
  - **Level 2 – Lines and medium-sized/small stations**
    - Iron Ore Line
    - Mjölby-Katrineholm
    - Hässleholm-Hallsberg
    - Hallsberg-Järna-(Stockholm)

- **Implementation plan 2020 - 2025**
  - **Level 2 – Lines and medium-sized/small stations**
    - Hallsberg-Gothenburg
    - East Coast Line
    - Arlanda Line
    - West Coast Line
    - Norway/Vänern Line (Gothenburg-Kornsjö)

- **Implementation plan 2026 - 2030**
  - **Level 2 – Lines and medium-sized/small stations**
    - According to the TEN network
ETCS AND STM ON ALL TRAINS

ERTMS will be introduced in accordance with the vehicle strategy. The strategy indicates that the majority of the train fleet will be equipped initially, followed by a deployment trackside. Since the transition to ERTMS cannot take place overnight, trains must be able to operate on ERTMS-equipped infrastructure as well as on existing ATC lines. A Specific Transmission Module (STM) is needed to achieve this. The STM unit can read data from the existing trackside equipment and can convert it into a format that is transmittable to the new onboard system. This makes it possible for a train equipped with ERTMS to run on both ATC lines and ERTMS lines, and the system can be introduced into the infrastructure gradually.

Implementation of the GSM-R has been undertaken based on the EIRENE standard. The work started in 2008 and will continue until 2015.

Sweden also constitutes a key section of the Corridor B. This section of line is expected to be appropriately fitted before 2020.

Three framework contracts, signed in June 2008, are now in place for the provision of both infrastructure and onboard equipment. The contracts will operate for eight years with an option for an additional eight years. This major step marks a significant technology shift for the Swedish railway industry. It means that Sweden is now well positioned to gain from increased competitiveness and is taking a major step towards improved cross-border operations and interoperability, reduced journey times as well as cutting Sweden’s carbon footprint. The transport sector as a whole contributes 40% of Sweden’s greenhouse gases. Sweden is justly proud of its efforts to maintain and improve the environment. ERTMS not only contributes to this, but brings with it the highly important benefits of rail safety and reduced costs.
ERTMS DEPLOYMENT IN DENMARK
ERTMS DEPLOYMENT IN THE ENTIRE NATIONAL DANISH RAILWAY NETWORK

Banedanmark, the state-owned rail network infrastructure manager in Denmark has committed to an ambitious and radical planned upgrade of its total main line network. In a first ever decision by a national Infrastructure Manager to modernise its total network (currently amounting to more than 3245 route-km, 307 stations and 750 level crossings) the vision is to see this modernisation completed by around 2024. This decision was facilitated by the Danish Parliament in January 2009.

ERTMS is the answer to the signalling challenge in Denmark?

Faced with huge challenges from many different systems, all of them very old, a situation of insufficient capacity and a lack of knowledgeable staff to maintain the existing systems topped with a monopolistic supply situation, the decision to install the state of the art European signalling system ERTMS Level 2, made in January 2012, makes total sense. The decision to totally renew/replace the legacy, life expired and obsolete signalling systems deployed in Danish soil, some of them dating back to the 1930s, and for which it has become progressively more difficult and expensive to find and acquire spares and to support and to maintain the Danish ATC, was based on the urgent need to overcome network signalling problems which accounted for more than 50% of train delays. Indeed, with a system considered to life-expire by 2020, the urgency became evident and the choice was made to adopt a global, mature and interoperable, world-class system.

How can ERTMS contribute to improve the existing system?

The decision will see a simplification of the national network, which will lead to a reduction of life cycle costs, maintenance costs, reduction of staff and provide the opportunity to simplify and update the national operating rules and optimise the national control organisation.

New interlockings will be introduced supported by the GSM-R technology thus allowing all old relay interlockings and the analogue radio systems to be replaced.

What are the benefits to implement ERTMS in the full network?

The introduction of ERTMS will facilitate the connectivity between major cities and capitals in Denmark. It will offer seamless travel within the EU. With ERTMS, the Danish network will be able to grasp the advantage of the inherent features of ERTMS, like increased and homogenous safety levels, allow high speed train movements, increased network capacity, improved punctuality as well as offering the basis for better information to passengers on the performance of the network and overall raising the attractiveness of rail transport. Overall, benefits include the adoption of EU standards, fewer safety standards to comply with, fewer traffic management sites, fewer interfaces and less system integration concerns apart from, of course, achievable economies of scale and, in the tender phase, greater competition.
How the implementation will be executed?

In an extended and thorough process, Banedanmark reviewed all options in detail and compared ERTMS offers/solutions from 6 UNISIG-member suppliers before reaching a decision with two consortia - one to implement the Eastern zone – Zealand, GFyn and Lolland-Falster amounting to 770 route-km and another in the Western zone in Jutland amounting to 1200 route-km. Both contracts will include a condition of an early test deployment of the offered solutions with both solutions demonstrating the same equipment, the same interfaces and the same workflows and ultimately a requirement of continuous engagement for 25 years of maintenance support.

A separate contract has been placed in July 2012 for the upgrade of all rolling stock amounting to more than 700 vehicles which will be led by an onboard Retrofit design contract to assure First in Class designs are fit for purpose.

The Banedanmark decision amounts to an investment of more than €3.3Bn over a period of 12 years including all infrastructure works, project management and the onboard elements.

The major benefits will see an 80% reduction in train related delays, higher train speeds and a reduction in travel times, capacity improvement and an increased (and from the operators viewpoint a single high) safety level regime applied to the whole network with better traffic information and finally a possible 25% reduction in maintenance costs.

Banedanmark set out to encourage more and open dialog with all potential suppliers, learning lessons from wherever possible from existing ERTMS/ETCS adopters, deep market research and introducing the concept of a dedicated internal team to drive the programme. The result of this early engagement was the receipt of better quality final bid submissions and finally the acknowledgement that all the old accumulated so-called best practices and old long held tenets of behaviour could be set aside.
ERTMS DEPLOYMENT IN THE MIDDLE EAST
ERTMS THE GATEWAY TO ASIA

The importance of the Middle East as a crossroads between Europe, Asia and Africa is being emphasized by the relocation of and the rapid development of major business and transport hubs in the region which are providing better and faster links than ever before for their people and their produce – and the latest developments in railway technology are set to accelerate this process.

What is the status of rail deployment in the Middle East?

As befits its key geographical position, Saudi Arabia is one of the main drivers of rail expansion in the region. It currently operates a 1,380km network comprising a 449km passenger railway from Riyadh to Dammam, a 556km freight route from Riyadh to Dammam and around 373km of industrial branches. This existing network is set to grow extensively with one of the most ambitious rail expansion plans in the world – an expansion plan which will have impacts far beyond the Kingdom's borders.

Are freight rail services important in the Middle East?

The 950km, approx. EUR 5.5 billion Land Bridge project linking the Red Sea port of Jeddah with Riyadh with a further 115km extension between Dammam and Jubail will allow onward journeys on existing routes to the Arabian Gulf Port of Dammam avoiding the need for goods to make lengthy sea voyages around the Arabian Peninsula or arduous journeys by road across the desert. Journey time savings for freight could be significant compared with the alternatives, thereby opening up new markets for high value and perishable goods.

Can rail passenger transport be an option in the Middle East?

Passenger services haven’t been forgotten either, with journey times from Jeddah to Riyadh of six hours becoming half of the current bus journey. If the Land Bridge demonstrates the potential of rail to improve logistics in the Middle East, the 360km/h Haramain railway proves how a well planned and considered passenger route can help provide a massive boost to capacity in response to growing demand.

The holy cities of Makkah and Madinah attract millions of pilgrims every year and neither currently have good public transport systems. With visitor numbers to Makkah forecast to rise by almost 10 million over the next 25 years, improvements are considered vital. This high-speed railway will cut journey times between Jeddah and Makkah to 30 minutes and between Makkah and Madinah to two hours. New trains will offer a modern passenger experience and transform the ease of travel to some of the holiest sites in the world.

Perhaps most impressive of all is the 2,400km North-South Railway from Riyadh to the Al Haditha in the North West of Saudi Arabia, with extensions to Hazm Al-Jalamid for bauxite, Al-Zubayrah for phosphate and the port of Ras Al-Zour on the Persian Gulf. Around 4 million tonnes of minerals per year are expected to be carried, helping to make Saudi Arabia the world’s second largest exporter of such minerals: it is hardly surprising that it has been given priority status. Although primarily envisaged for heavy haul freight operation, passenger services are planned too, and given Al-Haditha’s location near the Jordanian border, it would be surprising if in time trains did not run across national borders and with demand expected to be around 2 million passengers per year, it is clearly a genuinely mixed use railway.
What are the benefits of ERTMS?

Saudi Railways Organisation’s decision to deploy ERTMS in its most advanced Level 2 version is a compelling statement of its intent to strengthen connections across the Middle East by deploying the most advanced and capable technology available. The projects are impressive individually but it is only when they are connected together that the true scale of the opportunities emerges. It is doubtful whether the interoperability and capacity optimisation required would be possible without ERTMS.

Is ERTMS the preferred solution also outside Europe due to its interoperability capabilities?

This matters greatly because other countries in the Middle East are investing in rail too. Indeed, neighboring United Arab Emirates is already constructing sections of its long awaited Etihad rail, a 1,200 km new rail network connecting all main UAE cities and linking the North of the country with Saudi Arabia via Ghweifat and the South with Oman via Al Ain. Etihad rail foresees mixed traffic (freight and passengers) and will also be equipped with ERTMS allowing for seamless cross-border services.

Likewise, a bit further away, Turkey is also pushing ahead rapidly with new railways and ERTMS installations to provide better links with Europe. New High Speed Level 1 and Level 2 ERTMS lines radiating from Ankara are under rapid development. Turkey has also seen the development associated with the Marmaray Tunnel project now completed for commercial passenger service from October 2013, mixing both ERTMS with CBTC technology and providing a vital commercial and touristic link for Europe and Asia – and is in it’s own right a major engineering feat. The route is 74km with a 1.4 km “immersed or submerged” tunnel design.

With a straight line distance from Al Haditha to Turkey less than that from Jeddah to Riyadh, the obstacles to a through route from Arabia to Europe becomes political and financial rather than technical. The strategic, social and economic gains to be made from rail improvements in the Middle East have been unlocked by the capability of ERTMS to lower development, installation and operating costs of signalling systems in the longer term, allowing a massively capable traffic management system on routes in which conventional track circuit block signalling would have been prohibitively expensive and difficult to deploy.

Can ERTMS be a facilitator to increase the rail traffic between Europe and Asia?

ERTMS has opened up the prospect of genuinely efficient mixed mode operation on both the North-South Railway and Land Bridge, enhancing their economic and social viability dramatically. Furthermore, route upgrades - already provided for by the decision to build formations suitable for double tracks in the future - are made simpler, cheaper and less disruptive should traffic volumes increase ahead of expectations.

It all adds up to an exciting future for railways in the Middle East. The potential for increased traffic, seamless cross-border connections, greatly improved safety and economic growth is vast. And ERTMS is a fundamental building block in this process.
ERTMS DEPLOYMENT IN THE MAGHREB COUNTRIES
ERTMS TO PROMOTE ECONOMIC GROWTH IN NORTH AFRICA COUNTRIES

Three of the countries making up the Maghreb, Algeria, Tunisia and Morocco have been working together since 2005 on a common regional development plan to promote and accelerate economic growth and integration which naturally includes the development of the transportation sector and, of course, their railways. Investment plans for rolling stock, electrification and signalling have already been or are in the process of being drawn up, working to common standards and with a longer term view of raising standards and achieving interoperability not only from an operational point of view but also from a safety view point. The plans address both passenger and freight services.

A fourth country of the Maghreb, Libya, also with a coast line on the Mediterranean, has embarked on a wave of railway investment commencing from the unusual position of having no operational railways at all since 1964.

How can ERTMS increase the competitiveness of the Maghreb countries?

Growing external demand for natural occurring minerals and energy resources has attracted investment interest from both Europe and Far East all over the region. These investments have been done on a Government to Government basis and by direct Government investment in railway companies in order to support the extraction and transportation of minerals to suitable (upgraded) ports and international shipping thereafter. Investment is also provided for new intercity and urban services for cities with double digit population growth.

Such a situation with respect to the railways allows the incumbent railway companies to plan dramatic steps in adopting the latest, proven technology to provide a safe backbone transportation system that will provide life improving functionality to the local populations by opening up passenger and freight links into their neighbouring countries and open routes into the less populated interior territories.

ERTMS, as the globally accepted international signalling system with its advanced technology and safety features is present in the Maghreb railway development plans providing a significant long term planning of the region’s international network.
THE KINGDOM OF MOROCCO has a population of 31.7M. Railways in Morocco currently count 1,907km (1,537km single track, 370 km double track and 283 km of electrified track). Morocco has embarked on an ambitious Railway Network Development plan introducing new signalling and telecommunications systems including the doubling of some lines, providing the capability to operate at speeds of 160km/h on others and building new lines and electrifying existing lines.

ONCF is also a keen supporter of the Maghreb-Europe freight corridor plan that will see a freight connection from Tangier to Tunis on a corridor 2,337 km long - which will depend heavily on the Moroccan railway being suitably prepared.

Routes to be improved deploying ERTMS level 1 include the Casablanca - Rabat route, a distance of 80km with double track.

A very high speed line operating at 320 km/h is planned to link the cities of Tangiers and Casablanca, which should be ready for operation before 2020, cutting traveling time by more than half. The first phase of this line, almost 200km of double track from Tangiers to Kenitra are already under construction. ERTMS level 2 has been the chosen signalling system with ERTMS level 1 as fallback.
**LIBYA**, with a population of 6.6M has very recently embarked on a railway investment programme for a country that surprisingly in this day, has had no national railway lines since 1964. A line still exists for only freight services into Egypt.

A plan is being pursued to build 3,170 km of standard gauge track eventually forming a part of a line running parallel to the Mediterranean Coast as part of the North African Link, linking Tunisia to Egypt.

This line is much needed to boost economic activity and foster growth. The route to Misrata will promote the export of iron ore as well a delivering it to the steel plant located there.

The Libyan Government has used its good connections to link these developments with the Russian Railways RZD and the Chinese Railway Construction Corporation, CRCC.

A section of 450km double track from Ras Ejder via Tripoli to Sirt is under construction which will benefit from ERTMS Level 1/2. A further section of 352km from Sirt to Al Khum is also being constructed.

A single track line will run 800km from iron ore deposits at Wadi Sahti to the steel works and port of Misrata having ERTMS Level 1 and 2 cab signalling installed.

An additional line of 554km will be constructed from Sirt to Benghazi in the East, including ERTMS/ETCS cab signalling.

Looking further ahead, plans are being developed in Libya for a Trans-Sahara railway line to run down to Niger – which may mirror the plans of the Saudi Railway company in their aim to build a North-South line down to the Arabian peninsula. ERTMS would certainly appear to be a logical choice.

This “build from new” opportunity provides the Libyan Railway Authorities with a unique and ideal chance to adopt the most advanced rail technology. Indeed, ERTMS is being introduced as part of the solutions being provided.

**TUNISIA**, with a population of 10.2M has a rail network of 2,218 km (1,991 km in operation, 673 km of which are reserved for freight services with a mix of standard and metric gauge lines.

The network operated by SNCF - the Tunisian Railways National Company - has yet to commit to the introduction of ERTMS/ETCS in its network but located, as it is, between two ERTMS-equipped countries - Libya and Algeria - Tunisia will surely start to feel the need to adopt ERTMS into its network if only to support the introduction of interoperability for the North African Link and enhance interoperability.

There is an additional need to vastly improve the links into the interior to increase the competitiveness of the Phosphate mining industry.

All eyes are on Tunisia now to introduce ERTMS. A first contract has been awarded to Siemens but I cant see the cities or distance on the Bible. Rudi please complete.
SUMMARY

The development, availability and introduction of ERTMS has provided the ideal mechanism for railway operators across the globe to find an easy way to interconnect their networks. The railway companies of the Maghreb can look forward to potential simplified cross border operations, introduction of high speed services with greater levels of safety and the ability to mix traffic on their lines with much greater capacity thanks to the advanced features of ERTMS.

A technology of the future providing safety and the facility for increased capacity and higher speed, ERTMS is ideally positioned to provide the core signalling technology for many years to come in the Maghreb and beyond.

Africa – Maghreb and Middle East countries:

![ERTMS investment in Africa and Middle East](source: UNIFE)