ERTMS in Denmark and the UK – and relay risks in Europe

George Raymond

Swiss Section event organiser Rolf Gutzwiller.
Photo Rolf Seiffert.

Thirty members and guests of the IRSE Swiss Section gathered in Olten on 3 June 2016 for presentations on ERTMS implementation in Denmark and the UK and on risk management for relays in Europe.

ERTMS in Great Britain: benefits and complexity

João Gaspar of Network Rail is originally from Portugal and earned a master's degree at the University of Birmingham with Professor Felix Schmid, who is originally from Switzerland.

Mr Gaspar is now a subject matter expert for traction and rolling stock supporting the ERTMS phase II programme of Digital Railway, a railway-sector partnership in Great Britain (i.e. the UK without Northern Ireland).

João Gaspar presented ERTMS deployment in Great Britain.
Photo Rolf Seiffert.

Ridership growth on constrained infrastructure

Mr Gaspar said that GB train ridership has doubled in the last 20 years. London's growing population of 8.7 million is not far from Portugal's 10.3 million. Other GB cities are also growing. The current annual GB train ridership of 1.7 billion in 2014-15 is expected to grow by an extra billion by 2030.

Unlike many continental railways, GB infrastructure doesn't allow double-decker trains and due to historic layouts in some routes, re-routing trains is not always possible if a disturbance occurs elsewhere in the network. The signalling system constrains speeds and capacity, and is the main source of delays.

ERTMS can help keep ahead of demand

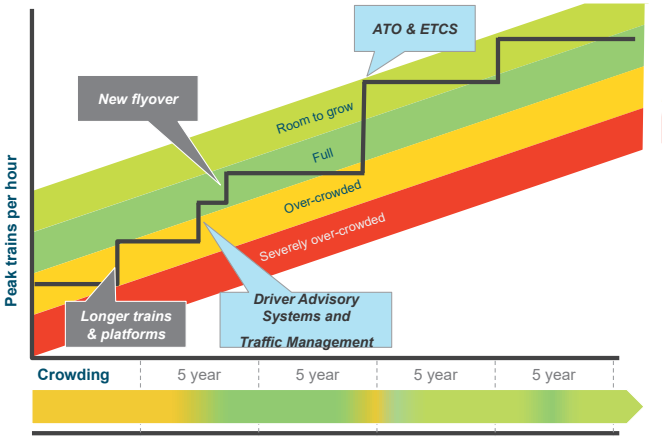
For Network Rail and its GB partners within Digital Railway, ERTMS includes ETCS and GSM-R, but also operational rules and traffic management.

In Europe, only the Swiss rail network sees more intense use than GB's. The battle to manage risk on Network Rail's complex patchwork of assets is constant. Lewisham, south-east London, 24 February 2015.
Photo Nick Slocombe.

One response to growing demand is longer trains and platforms, and more tracks and flyovers. However, these measures will merely keep up with demand. ERTMS will bring the digital enhancements that will enable the railway to get ahead of demand.

Digital integration – of which ERTMS is a major element – is expected to eliminate three of the current 34 months of annual infrastructure delay minutes, avoid the roughly 300 signals passed at danger annually, increase revenue, and lower operational costs.

GB has gained ERTMS experience through a pilot implementation on the Cambrian Line on the west coast of Wales and in tests on the London-Hertford line. Mr Gaspar noted that drivers new to ERTMS tend to drive too far inside the speed curve.



ERTMS implementation plans in GB include driver advisory and traffic management systems, ATO and ETCS. Their implementation within the next ten years will provide room for growth. These innovations will reduce disruption and meet rising demand faster, and at lower cost, than relying entirely on concrete-and-steel improvements such as longer trains and platforms plus more tracks and flyovers.
João Gaspar presentation.

The benefits of ERTMS on main line railways are foreshadowed, for example, by London Underground's Victoria Line, where digital signalling increased reliability by 50%, capacity by 30% and enabled moving 12,500 more passengers per hour.

However, ERTMS implementers face complex challenges in GB. Denmark, with 5.6 million people and a comparatively homogenous rail network, is rolling out ERTMS Level 2 throughout the country by 2021, as described below. Mr Gaspar contrasted this to GB with its 63 million people, 26 private train passenger operators, four main freight operators and much greater variety of trains.

Fitting Network Rail's own trains first

Now that ERTMS has been fitted on some lines, vehicles that must be able to run anywhere in GB – such as rescue locomotives and all of Network Rail's maintenance and measurement trains – must also be fitted.

One problem is finding space in the vehicle and especially in the cab for the ETCS equipment.

In contrast, the new Siemens class 700 trainsets come fitted

Will it fit?

Will ERTMS screens fit into the already cramped cabs of many on-track machines? *João Gaspar presentation.*

with ETCS, which was designed into the vehicle and the driver's desk.

Complexity and ambiguity

In addition to its five levels (National Train Control, Level 0, Level 1, Level 2 and Level 3), Mr Gaspar said, ERTMS has 17 different modes. In all cases, either the driver or the system has to tell the train to change level or mode.

Mr Gaspar described some difficulties with the Control Command and Signalling (CCS) part of the European Technical Specification for Interoperability (TSI), which specifies ERTMS:

- The CCS TSI is written in 'Euro-English', which differs from GB English. For example, section 3.15.3 the ERTMS Systems Requirements Specification refers to splitting/joining, whereas GB calls such train movements uncoupling/coupling;
- Some sections of the specifications simply say that particular issues are 'to be harmonised'. Such open points make balancing safety, performance and costs difficult;
- The lack of formal language for the requirements leads to differing interpretations;
- The CCS TSI doesn't say how ETCS interacts with other train systems. For example, the TSI doesn't explain the reasons for the brake system values it prescribes.

Another challenge is managing a large stakeholder population with varying knowledge of the system. A railway's ERTMS project managers must either have comprehensive knowledge themselves or be dependent on suppliers.

Network Rail is supporting GB's Digital Railway programme in delivering their requirements for ERTMS. On the basis of:

- national requirements and principles,
- experience from the Cambrian Line implementation and
- output requirements, which include the reference design documents that describe a day in the life of a train,

Digital Railway is providing sub-system requirements for trackside, on-board, telecommunications and operations.

Compatibility with the Continent – and at home

Although no timescales to fit the Channel Tunnel with ERTMS exist, Mr Gaspar said that ERTMS-fitted trains from the continent should be able to operate in GB. The European Railway Agency has said that they are satisfied that the operational version of the sub-system requirements is in the spirit of CCS TSI. These requirements are essential to guarantee compatibility of infrastructure and vehicle elements from all suppliers.

In Denmark: ERTMS and new traffic management

Felix Laube, a consultant with Swiss-based Emch+Berger, said that Banedanmark has made its system-wide implementation of ERTMS Level 2 part of a larger effort to implement a traffic management system (TMS). The target date for completion is 2021.

Felix Laube of Emch+Berger presented Denmark's new traffic management. *Photo Rolf Seiffert.*

All of the roughly 2500 mainline route-km in Denmark will be fitted. The Little Belt Bridge connects the East and West halves of the project. Banedanmark opted for such a large programme in order to attract more competition among suppliers than a small country's projects typically can.

Thales is performing the ERTMS infrastructure work in the West and Alstom in the East. Alstom is also supplying on-board systems, Mr Laube said, *"but it's not the same Alstom"*.

The nationwide changeover justifies replacing interlockings that are as little as five years old and fitting vehicles due to retire in five years. As part of the massive scheme, Banedanmark is also implementing a whole new traffic management system (TMS).

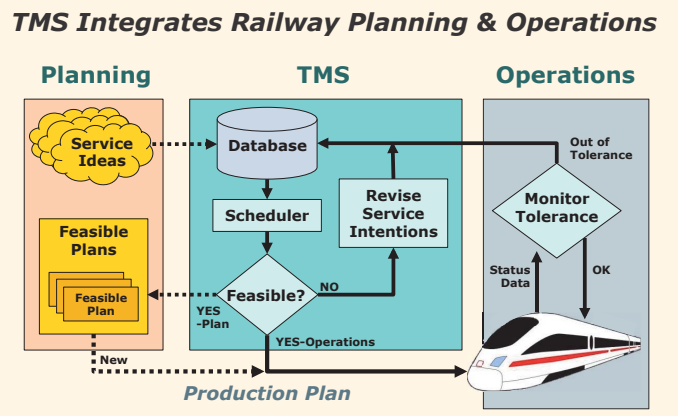
The focus of the new TMS is customer and services, not trains; integrated planning and execution; and precise definition and monitoring of tasks.

Focus on service intention, not the timetable

Travellers care about travel, not trains. The railway therefore needs to go from running trains to providing services. The focus of Denmark's new TMS is therefore the notion of 'service intention', which is a description of customer needs. This is not the timetable. Service intentions describe the elementary parts of what customers want. The timetable is only a means to meet service intentions.

Integrating planning and dispatching

Today, planning and operations are two islands linked only by the timetable. Today's timetables don't explicitly describe customer needs, don't include service intentions and don't provide support in case of disruptions. Planners say that planning is too expensive to foresee every detail, and operating people often say that the plan is wrong.

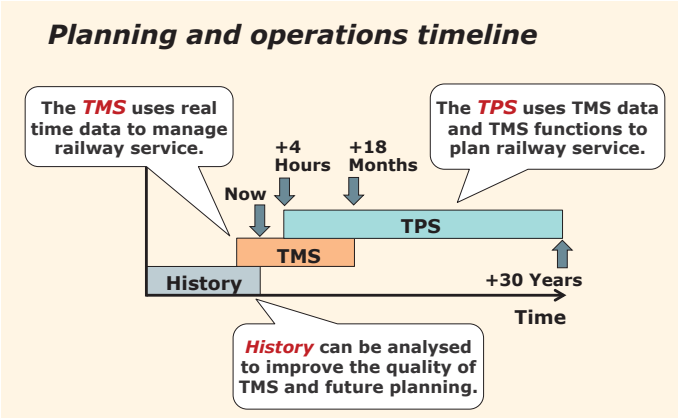


Traffic management system (TMS) for both planning and operations. *Felix Laube presentation.*

Banedanmark's new TMS will allow integrated planning that merges planning and dispatching on the basis of the same methods and data. Today's timetable planners will become service designers. Users will interact with:

- A traffic planning system (TPS) from Hacon that focuses on planning and can think in options;
- An Iconis traffic management system (TMS) from Alstom that focuses on operations management and thus only contains the current status of trains, infrastructure and resources.

Both TPS and TMS interface directly with an integrated database and jointly offer the following functions: a scheduler, task management, a condition registry, a booking process, a topology process, availability and activity times (A&AT), process tuning and a role concept.



Integrated planning, operation and history phases. *Felix Laube presentation.*

The TMS develops new production plans to address disruption. *"Our dispatcher does the same thing as the planner, just in real time"*, said Mr Laube.

Service intention is based on a booking process. It can include service processes for the next use of a resource, such as a person or vehicle. The condition registry can show, for example, that a set of points won't turn for the next 5 minutes.

Under the new TMS, Danish dispatchers will no longer give trains priorities, but instead manage service intentions. Service intentions can't be late – only fulfilled or not. There are no conflicts, just a modified plan. The TMS can deal with all degrees of disruption. The thinking is upgradable to include other modes.

Two IC3 trains pass Rødover, about 7 km west of Copenhagen Central station on 10 December 2010. The markers announce a main signal in 400m. *Photo Finn Møller.*

Precise definition and monitoring of tasks

In the new TMS, a precise central timetable goes beyond departure times to specify in detail how to operate – including, for example, seven steps for the departure of a train. Mr Laube calls this "*Japanising the timetable*".

The target tolerance for train operation tasks is 15 seconds. This is more precise than timetable delay. Data is visible to everyone affected and allows open dialogue about individual performance.

Role concept

The new TMS requires no hierarchy. The main job of a shift leader is to ensure that no one has too much work.

Roles may be fulfilled by people or systems. One new role is resource condition registrar. The following are examples of roles not to be mixed because of conflicts of interest:

- The **signal operator** provides safety: a track at the right time;
- The **dispatcher** fulfils service intentions.

Integration of topology

Topology – not to be confused with topography – is what the railway can do in terms of its layout, including forecast changes in interlocking logic and topology over the next ten years.

Today, topology products, even from one supplier, tend to be poorly integrated. In replacing all Danish interlocking systems, ERTMS provides a chance to integrate the topology process.

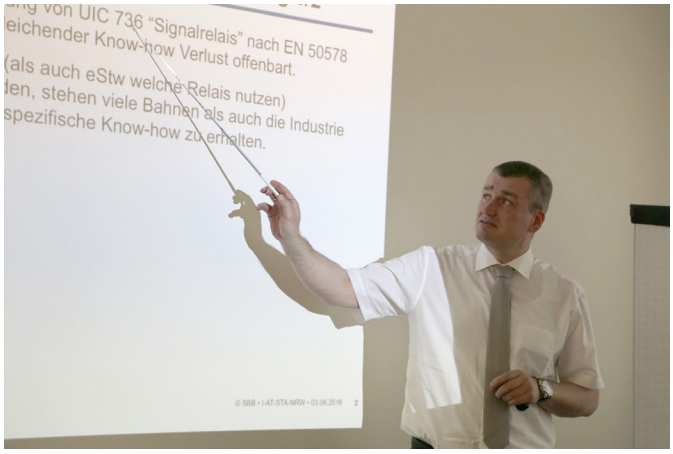
Ask users first

TMS designers first met with lower-level users so these users could say what would really make things better. The TMS designers obtained the buy-in of the lower-level employees and then got them to convince the higher-ups.

In Europe: Risk mitigation when using relays for signalling

Jens Schulz of Swiss Federal Railways (SBB) presented the work of the UIC Signalling Expert Group (SEG) on risk mitigation when using relays for signalling. UIC is the International Union of Railways, an international association of railway operators.

European railways plan to continue using relays in interlockings until 2030 and in some cases possibly to 2050. The UIC project identified relay and wiring failure modes, associated risks, and principles and measures for risk mitigation. It also found that relay failure rates have dropped over the last 40 years.



Jens Schulz on retaining European know-how on risk mitigation for relays. *Photo Rolf Seiffert.*

Supplier neutrality

For neutrality vis-à-vis suppliers, the project was open only to UIC member railways. The main infrastructure operators of Austria, Finland, France, Germany and Switzerland participated, while those of Japan (JR East), the Netherlands, Russia and Sweden were observers.

The project determined failure probabilities for relays, contacts and wires, including the effects of design, power supply, environment and maintenance. For example, it documented and compared contact systems and risk mitigation measures such as a double contact for the same circuit.

Project members examined historical literature and archives, including 1950-era studies found in people's cellars.

Safety and availability

The project examined risks for both safety and availability. One mitigation measure doesn't eliminate all risks, but each reduces some risks. The goal is not to avoid danger, Mr Schulz said, but avoid potential danger. Given that a mitigation measure popular in one country may be forbidden in others, the catalogue contains a variety of measures.

Training on relay use in the United States. *Photo Big J Railway Signal Enterprises.*

The objective of the UIC project, which will conclude four years of work in 2016, is to avoid know-how loss, conserve knowledge on relay use and disseminate it widely for the next generation.

Zurich airport and a significant vote

Swiss Section Chairman Daniel Pixley reminded us of upcoming 2016 events, including a visit to the cable-powered Zurich airport people mover on 11 November. He also said that former and founding IRSE Swiss Section Chairman Markus Montigel has been elected Junior Vice President of the IRSE.