In search of the game changers

With the adoption of the latest Baseline 3 revision promising stability for the core ETCS functions, research is now focusing on innovations that can add additional functionality without affecting backwards compatibility. Chris Jackson investigates.

January 5 saw another milestone in the long-running saga of the European Rail Traffic Management System, when the European Commission formally adopted a revised European Deployment Plan, setting out a timetable for the roll-out of ERTMS across the TEN-T Core Network over the next decade.

Drawn up over the past two years by ERTMS Co-ordinator Karel Vinck, the new timetable replaces an earlier deployment plan adopted in 2009. That had sought to bring together the national commitments from EU member states into a co-ordinated plan covering the six designated ERTMS priority corridors. However, by mid-2015 it had become apparent that the original deadlines would not be achievable. According to the Commission, they had become 'unrealistic' for a range of reasons, including a shortage of financing, a limited number of 'qualified experts' and ongoing technical problems.

As Vinck explained to stakeholders during the TEN-T Days conference in Rotterdam last June, the revised plan includes changes to the timetable in the light of experience over the past seven years. The geographical scope has also been aligned with the requirements of Regulation 1315/2013 on the development of the TEN-T core network.

ERTMS implementation dates for each of the nine Core Network Corridors are set out in an appendix. The Commission anticipates that around 50% of the total route length will be equipped by 2023, with the remainder to follow in 2024-30. However, the implementing regulation provides for a further update in 2023 to determine precise dates for the second phase.

The Commission hopes that this new plan will provide 'a greater degree of certainty' over ERTMS migration, facilitating investment and resource planning by both infrastructure managers and train operators. According to Vinck, 'all member states have accepted ERTMS as the signalling system in Europe. It is ready to be implemented from a technical point of view and through implementing the recently-adopted plan we can ensure timely deployment.'

Slow progress across borders

In fact, one of the biggest concerns among train operators has been the piecemeal introduction of ETCS in different member states. Although ERTMS was envisaged as a key element in enhancing European interoperability, almost all projects so far have been standalone islands within individual countries — either on new high speed lines or on parts of the conventional network.

Only on December 11 was Belgian infrastructure manager Infrabel able to announce the successful commissioning of the first conventional cross-border route in Europe, when ETCS Level 1 was commissioned over the 5 km between Aubange in Belgium and Rodange in Luxembourg (RG 1.17 p9).

High speed trains have been crossing

Top: Following the commissioning of the cross-border section by Infrabel and CFL in December, the Antwerpen – Athus – Luxembourg route is Europe's longest conventional line equipped with ETCS and the only one with an active border crossing.

TRAIN CONTROL ERTMS

The Memorandum of Understanding signed by rail industry representatives in September 2016 is intended to ensure stability to encourage rapid deployment of ERTMS, yet allow for further evolution.

the border between Belgium and the Netherlands using ETCS since Level 2 was commissioned on HSL Zuid in December 2009, while Level 2 is also used on the Perpignan – Figueres link between Spain and France. Elsewhere, Railjet trains between Praha and Wien are using ETCS in both countries, while testing is underway for the ETCS interface between Sweden and Denmark on the Øresund fixed link.

Last year, Switzerland agreed to fund the installation of ETCS Level 1 Limited Supervision on selected DB Netz routes around Konstanz and Schaffhausen, allowing Swiss ETCS-only trains to operate through southern Germany within the next few years.

While the Commission is encouraging member states and their infrastructure managers to press ahead with ETCS deployment on the core corridors, industry insiders have pointed out that the revised plan is still a compilation of individual countries' commitments, rather than an integrated strategy. A glance at the maps still shows many gaps labelled 'beyond 2023'.

This piecemeal implementation will be of concern to international train operators, particularly in the freight market. As they have been arguing for years, the cost of installing ETCS onboard equipment is not yet being balanced by the savings from eliminating any legacy national train control systems.

Technical stability

Another concern from this history of piecemeal implementation has been the number of variations in ERTMS deployment, as the early adopters sought to address the 'open points' in the ETCS specifications in order to get their trains running. The multiplicity of versions has been gradually reducing since the European Railway Agency was appointed as System Authority, leading to the adoption of the 'debugged' Version 2.3.0d of the System Requirement Specification as a compatible standard, to which most countries have been gradually migrating with EU funding assistance.

Version 2.3.0d remains the baseline for backwards compatibility, but for new installations it has been superseded by the Baseline 3 specifications, which make provision for additional functionality. These have now reached Version 3.6.0 (Baseline 3 Release 2), which was formally adopted in July.

The importance of technical stability was underlined in a fourth Memorandum of Understanding between ERA and representatives from across the rail sector which was signed in Berlin on September 20 in the presence of Transport Commissioner Violeta Bulc.

Endorsed by suppliers, infrastructure managers, operators and institutional stakeholders, the MoU is intended to ensure long-term stability of the ERTMS specifications, following the adoption of Baseline 3 Release 2 and the related update of the Control Command Signalling TSI. Along with a reduction of national rules, this is expected to 'further promote the swift and co-ordinated deployment of ERTMS in Europe'.

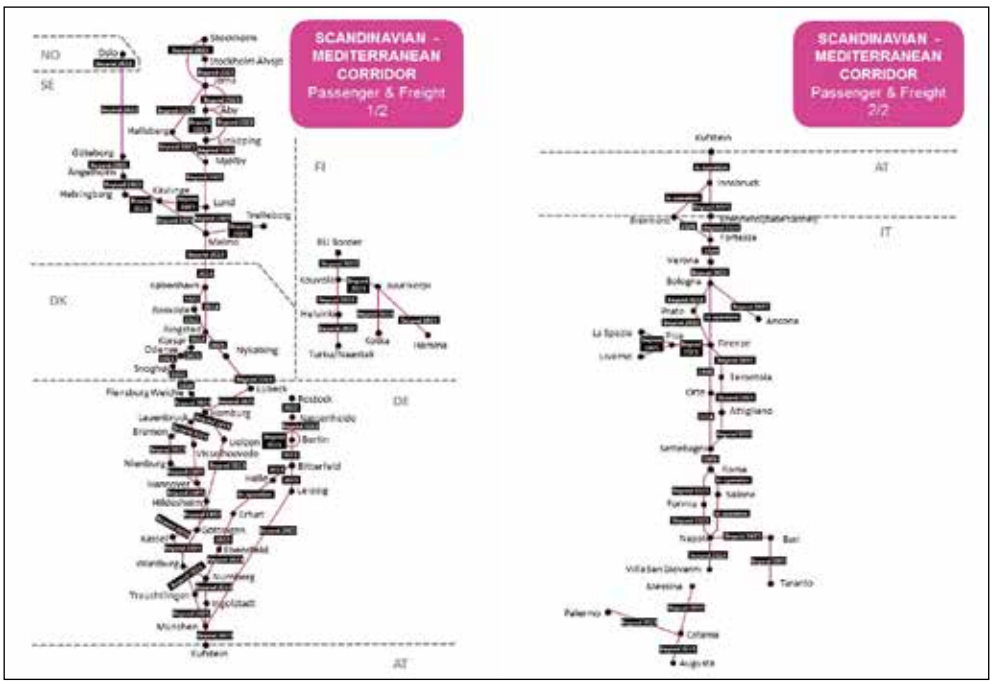
It is notable that the MoU includes a commitment to TSI compliance and 'no national add-ons'. UNIFE Director-General Philippe Citroën was not alone in emphasising the need for 'discipline within the sector to ensure full interoperability across Europe, which remains the main objective'. UNISIG General Manager Michel van Liefferinge also highlighted the importance of backwards compatibility 'to protect the investments already made by several member states'.

However, it is clear that signalling and train control systems will never be able to stand still as the demand for transport and the role of rail continue to change. Hence the provision in the MoU for further evolution of ERTMS.

The ERA recommendations underpinning Baseline 3 Release 2 include a longer-term strategy through which the system authority is looking to manage future technical development. According to van Liefferinge, the signalling sector has already identified four 'game changers' which offer significant benefits in terms of additional functionality and/or lower costs: automatic train operation, ETCS Level 3, satellite positioning and the next-generation telecommunications system (RG 12.16 p38).

Many of these initiatives have been incorporated into the IP2 workstream for the Shift2Rail research programme. The big challenge for ERA and the other stakeholders will be to work out how the different technologies can be overlaid on the stable core specifications without impacting on backwards compatibility (Fig 1).

An annexe to the ERTMS European Deployment plan sets out member states' target dates for implemention on each section of the nine TEN-T core corridors up to 2023.



Automatic Train Operation

Automation is increasingly common in the urban rail sector, and several countries are already working on main line applications. Draft specifications for interoperable ATO to Grade of Automation 2 (keeping a driver in the cab) were developed by UNISIG and the ERTMS Users Group under a TEN-T project, but provision for ATO was not included in Release 2 as initially envisaged. Nevetheless, ERA is still looking for some 'quick wins' by 2018-19.

Last year ERA's Head of Corporate Management Jens Englemann told a plenary meeting in Brussels that ATO needed to be a 'plug and play' option which was 'functionally decoupled' from the train protection and safety functions of ETCS. The agency is looking for ATO functionality that can be applicable for urban rail, high speed and freight trains, in a mixed-traffic environment, although it recognises that the business case might be different in each market segment.

Urban and suburban applications offer the promise of a crossover from established metro automation. In the UK, the cross-London Thameslink corridor is currently being equipped with ATO over ETCS (RG 9.15 p33), which is due to come into service in 2018. The Siemens Class 700 EMUs now being introduced are equipped with ETCS, and functional testing has been underway for some time. A first test Class 700 operated through the central core under ATO in December.

Siemens is also supplying equipment to Deutsche Bahn, which has launched a pilot project to trial automated operation of freight trains on the Erzgebirgsbahn (RG 9.16 p78). Meanwhile, CAF Signalling is pioneering interoperable ATO over ETCS on the Mexico City – Toluca suburban line on the basis of the draft specifications (RG 9.16 p107).

One of the largest applications of ATO to main line railways in Europe has been in the Czech Republic, where ČD has been running suburban services under ATO for more than 20 years. Today the operator has more than 240 multiple-units, locomotives and driving trailers equipped with the AZD-developed digital AVV, representing around 10% of its fleet.

According to Rolling Stock Director Jan Plomer, automated control of traction and braking has brought energy savings of between 10% and 30%, while improving punctuality, ensuring on-time arrivals to an accuracy of ±5 sec.

While AVV uses train positioning information from both balises and GPS, it can also take this information from ETCS. One Class 471 unit was fitted with ETCS in 2008 (RG 3.11 p37), and operated successfully until 2014. The ETCS provided train positioning and speed profile data to the AVV, as well as interfacing with the brake controls.

Plomer says AVV is now required for all new and refurbished rolling stock. Meanwhile, ČD went out to tender last year for a five-year programme to retrofit ETCS across much of its fleet. The base order will cover 663 vehicles of 33 classes, with options for a further 400.

ATO development

Following on from the Berlin MoU and discussions with ERA, the Community of European Railways & Infrastructure Managers issued a position paper in December calling for the rail sector to agree 'a common ambition' for ATO over ETCS. Recognising 'the compulsory need to achieve soon harmonised solutions', CER argues that development must be done 'in an efficient, co-ordinated and interoperable way on a European scale', to capitalise on the experiences of the pioneers, reduce development time and ensure the economies of scale from standard products.

CER feels that ATO development must not 'negatively affect' the deployment of ERTMS. Perhaps reflecting the Czech experience, it says some railways may seek to implement ATO ahead of ETCS, but any implementations should support a subsequent migration. From a technical perspective, it should be possible for an ATO-fitted train to be driven conventionally on a non-equipped line.

While most railways are currently looking at GoA2, CER says the ATO specifications must allow for future upgrading to driverless operation under GoA4 as a 'key strategic objective in the second stage'. Recognising that ERA must 'orchestrate' ATO development and provide a suitable certification framework, CER also argues that ATO and ERTMS development should proceed in parallel with clearly defined interfaces. 'Collective work' on ATO should be co-ordinated through Shift-2Rail, within IP2 Work Package 4.

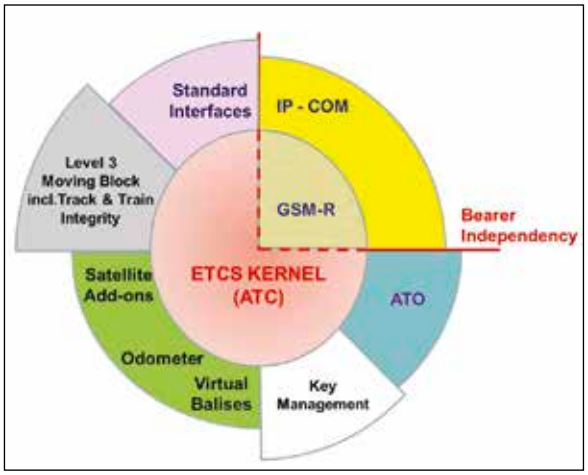


Fig 1. The ERTMS future evolution strategy envisages that additional functionality can be added without affecting the backwards compatibility of the core ETCS Kernel.

As few train operators or infrastructure managers are directly represented in Shift2Rail, CER is planning to establish a 'dedicated network of experts' to feed into the research. It will also liaise with ERA's ATO stakeholder platform 'to ensure transparency of decisions and strategic steering of solutions.'

According to the WP4 timetable, the ATO over ETCS specifications are to be finalised by mid-2017, with product development to be completed a year later. A GoA2 reference test-bed will pave the way for a pilot line demonstration in 2018-19. A feasibility study for GoA3 and GoA4 is to be undertaken over the next two years, with the specifications to be ready by mid-2021 and

A Siemens Class 700 EMU began test running through London in December using the ATO over ETCS Level 2 being installed as part of Network Rail's Thameslink Programme.

TRAIN CONTROL ERTMS

Under the 3InSat research programme a Trenitalia test train was successfully operated on the Cagliari – San Gavino line in Sardinia with a satellite train positioning system running in shadow mode.

product development to be completed by the end of 2022. A pilot line demonstration of GoA3/GoA4 is envisaged in 2023-24.

Moving towards Level 3

Another development stream is ETCS Level 3, which would do away with the fixed train detection systems that still underpin the block management and train protection functions in Level 2. The rail industry has been debating for almost three decades the desirability of eliminating lineside equipment, reducing both the cost of maintenance and the safety risk to the staff undertaking that work.

A key driver for research in this area is the need to increase capacity on busy routes, where train operators are looking at introducing moving block to optimise headways. Although the Level 3 architecture does not explicitly specify moving block, the elimination of fixed train detection is a key step towards that objective. Several infrastructure managers, including ProRail in the Netherlands, Network Rail in the UK and Italy's RFI have opted to install a form of Level 2+, by splitting the sections between fixed signals. While NR and ProRail are using separate track circuits or axle-counters (RG 9.15 p44), RFI has opted for 'virtual blocks' based on the train reporting its own location and train integrity (RG 4.16 p41).

Satellite positioning

One possible route to the elimination of fixed detection is the use of satellite-based train positioning. RFI has been a partner in the 3InSat consortium testing this concept in Sardinia, along with the European Space Agency which has now launched the Space4Rail initiative 'to develop and commercialise space-based technology for the rail industry'.

In February 2016 3InSat undertook successful trials of a satellite-based 'integrated signalling system' on the Cagliari – San Gavino line, during which the test train ran for 7300 km with the equipment operating in shadow mode.

The 3InSat system follows ERTMS standards, but instead of fixed balises uses a GNSS-based Location Determination System developed by Ansaldo STS. This combines satellite positioning from EGNOS, GPS or Galileo with an onboard track database to determine the train's position in relation to 'virtual balises'. Two local reference stations were installed at Decimomannu and Samassi, along with a Vital Safety Server in the Cagliari control centre combining the RBC functions with those of the LDS Track Area Server. The train was equipped with an ETCS European Vital Computer linked to the LDS onboard unit. The trial used a combination of 3G/4G, a TETRA private radio network and satellite communications. The 3InSat consortium also tested an IP-based multi-bearer radio telecommunications subsystem as an alternative to GSM-R.

The project saw the ETCS operating in Full Supervision Mode, including automatic train protection. According to the Head of Satellite Projects at Ansaldo STS Salvatore Sabina, 'the successful outcome of the demonstration campaign confirms the viability of GNSS technology for rail. We are now ready to implement the virtual balise concept.' The company has already supplied a SIL-4 compliant satellite-based train control system for the Roy Hill iron ore line in Western Australia, which is based on the same technology.

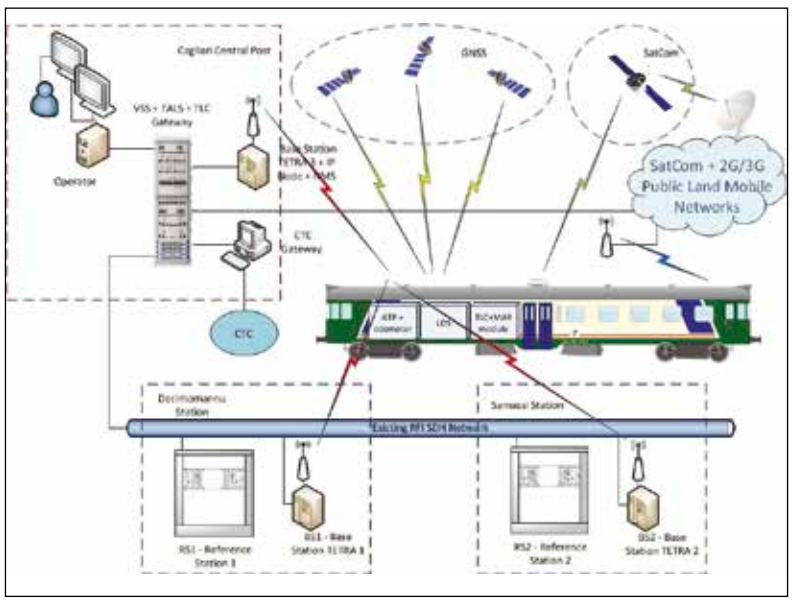
ESA's Space4Rail Co-ordinator Michele Castorina believes that satellite train location 'should significantly reduce the cost of implementing ERTMS'. Ansaldo STS suggests that the lifecycle cost could be reduced to between 20% and 40%, including a saving of up to 60% in the telecommunications component.

Contradictory requirements

As ever, ERTMS progress in the coming years must seek to balance the slightly contradictory objectives of rapid deployment, which requires stability in the technical specifications, with the need to accommodate the continuing evolution of the functional capabilities.

Funding remains a challenge, although the Commission has allocated substantial support for infrastructure investment through the Connecting Europe Facility. Wider deployment of ETCS should improve the case for train operators to install onboard equipment, and eventually enable the elimination of some legacy signalling systems.

Meanwhile, industry stakeholders will be watching to see what the four emerging 'game changers' can contribute to improving the efficiency and competitiveness of railway operations. ■



Right: Fig 2. The 3InSat test train was equipped with an ETCS European Vital Computer linked to a GNSS-based Location Determination System developed by Ansaldo STS.