Master Plan targets 2022

ROLL-OUT Work is well underway on a comprehensive programme to equip the entire Belgian network with ETCS in little more than a decade, driven by the need to raise capacity and improve safety while lowering costs.

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Infrabel commissioned this test car from Geismar to support the introduction of GSM-R and ETCS across the Belgian rail network.

Within the next few weeks a preferred bidder is due to be announced for the supply and installation of ETCS Level 2 equipment on principal routes in Belgium. Tenders for the contract were invited in April 2011, and five bidders have been shortlisted.

As a small network at the crossroads of western Europe, Infrabel has made a huge commitment to become one of the leading infrastructure managers in terms of safety, and to work towards 100% interoperability. Our ERTMS Master Plan is now fully funded by the government, with some European support, and we have made a good start. Although there will undoubtedly be challenges along the way, Infrabel has committed to complete the network-wide implementation of ETCS by the end of 2022.

Like many infrastructure managers, we are starting from a very mixed legacy of signalling and train control systems. Traditionally, train protection in Belgium was provided by a 'crocodile' automatic warning system. This stops a train if the driver fails to acknowledge a warning signal in the cab, but it does not prevent a train from passing a red signal.

From 1982 onwards around 15% of the network was equipped with TBL1 (*Transmission Balise-Locomotive*), which added a train stop function. This is a proprietary ATP overlay to the lineside signalling, using active balises between the rails. It triggers an automatic brake application if a train passes a red signal.

A variant known as TBL2 was developed by Alstom for the 70 km LGV2 between Leuven and Liège, rather than the TVM430 installed on Belgium's first high speed line linking Brussels with the French border. Functionally, TBL2 was similar to the later ETCS Level 1, but it relied on proprietary hardware which was not compatible with ETCS.

When the high speed lines from Liège to Aachen (LGV3) and from Antwerpen to the Dutch border (LGV4) were being planned, the then SNCB board decided to fit them with ETCS Level 2 (RG 3.06 p00). At the same time, it was agreed that Level 1 should be implemented across the conventional network, following a number of ATP-preventable accidents.

That was the position on January 1 2005 when the former national railway was split between Infrabel as the infrastructure manager and SNCB as the train operator. Responsibility for the ATP programme then had to be divided between the two entities.

Infrabel finds a stop-gap

Right from its creation, Infrabel has regarded safety as a primary objective. However, by the early 2000s the development of ETCS was not proceeding as quickly or as well as had been expected. Infrabel and SNCB agreed to try and find an intermediate stop-gap. Thus TBL1+ was born. This essentially provides the same basic functionality as TBL1 but with the addition of an overspeed function, which stops a train if it is travelling at more than 40 km/h at a distance of 300 m ahead of a red signal. TBL1+ is based on standard ETCS hardware, using the configurable Packet 44 of the ETCS data message. As the hardware is already 100% compliant, TBL1+ was seen as a first step towards the introduction of ETCS Level 1.

Once the concept had been authorised by the national safety authority, DVIS, Infrabel and SNCB were able to start rolling out TBL1+ at the beginning of 2009. But on February 15 2010, the whole of Belgium was shaken by a head-on collision between two rush-hour trains at Buizingen, just south of the capital. This killed 19 people and

Following the head-on collision at Buzingen in February 2010, the government agreed to fund widespread implementation of automatic train protection.

injured many more, and it brought the topic of automatic train protection to the top of the public agenda. Although the line had been equipped with TBL1+, the train which passed a signal at danger had not.

Master plan approach

Following the Buizingen accident, the government and the rail sector agreed to develop and implement as soon as possible a major programme to improve safety across the entire national network (RG 3.11 p28). This led to the drawing-up of the ERTMS Master Plan.

The plan is also intended to improve ergonomics for train drivers, to maintain — or enhance where possible — the capacity of the network, and to improve the reliability and availability of the signalling system. And of course, last but not least, to guarantee interoperability with the wider European rail network.

In contrast to previous policy, our analysis indicated that these goals would best be met by the widespread adoption of ETCS Level 2. However, a network-wide roll-out would require the replacement of all remaining relay interlockings, and affect the ongoing implementation of Level 1.

Quite apart from the time needed to complete the introduction of Level 2, wholesale relay replacement would exceed the budget available. So Infrabel proposed a three-pronged approach:

- complete the implementation of Level 1 where this had been decided or started;
- install Level 2 on all major routes, except where Level 1 was already being implemented, or in areas which could be considered as an infill to existing Level 1 sections;
- equip other lines with Level 1 Limited Supervision, as a customised variant to be implemented as a 'quick win' on lines where a safety assessment showed that full supervision was not needed.

At the end of this programme, the network would have 2 300 track-km equipped with Level 2, 1 200 track-km with Level 1 and 2 400 track-km with Limited Supervision (p35).

We calculated the cost and safety impact of the various scenarios, with operational risk indexed at 100% for 2010, given that at the time there had been virtually no significant ATP implementation on the conventional network.

The do-nothing scenario would see the risk level rise to 170% by 2022, simply because of the projected increase in traffic on the rail network. Implementing TBL1+ would reduce the risk to 42%, but this was generally considered to be unacceptable.

Implementing ETCS Level 2 with full supervision across the network would cut the risk to 8·5%. However, this would require a budget of €4·7bn, and could not be completed by the 2022 deadline. Adopting the three-phase master plan approach would reduce the risk to 9·6%. It could also be completed by 2022, at the lower cost of €2bn.

Infrabel therefore recommended this mixed approach. Along with SNCB's plan for equipping its rolling stock, the ERTMS Master Plan was approved by parliament at the end of 2012. The necessary funding was included in the multi-annual railway investment plan agreed by the government at the end of 2013.

Migration strategy

Fig 4 shows the migration strategy as it is currently being implemented. As envisaged, we are continuing to install ETCS Level 1 on those projects that have already started. Meanwhile, Infrabel and SNCB have accelerated the installation of TBL1+; all trains had been equipped by the end of 2013, along with 93% of the infrastructure. The entire network should be fitted with TBL1+ by the end of 2015.

Under the Master Plan, the entire network will have ETCS by the end of 2022. All of SNCB's trains should be fitted with onboard equipment by the end of 2023. Our intention is that from the end of 2025, only trains equipped with ETCS (to Baseline 3 standards) will be allowed to operate on the Belgian network.

A fourth step known as 'convergence' still being considered. This would see Level 2 rolled out across the rest of the network over the longer term (potentially 2020-35), with a view to ensuring homogeneity of train control. Once that has been achieved, it would be possible to eliminate any remaining lineside signalling.

Implementation makes progress

At present 541 km of conventional track has been equipped with Level 1, notably on the routes towards Luxembourg and Metz. This amounts to around 8% of the total 6 900 track-km, which is quite impressive given the short time since the start of work. Infrabel has committed to installing ETCS on its portion of European freight corridor C by the end of 2015, and selected connecting routes by 2020. A complete ETCS corridor from Brussels to the German border should also be ready by the end of 2016.

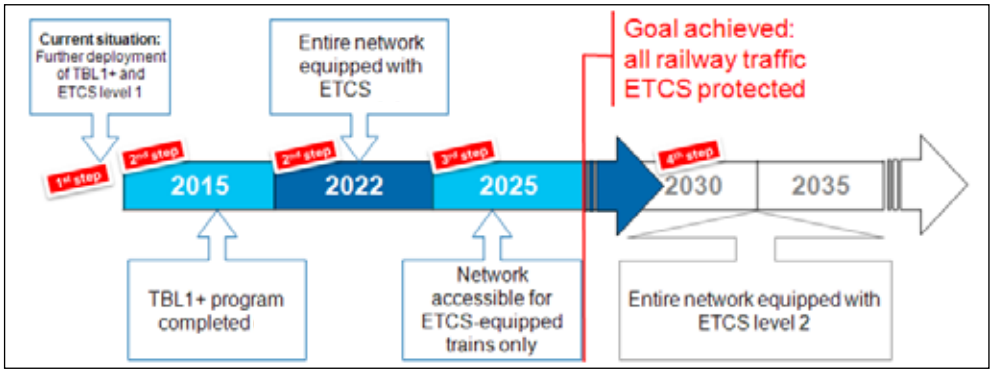


Fig 1. Infrabel has idenfified a four-stage programme to improve train protection and move to a network-wide use of ETCS Level 2 by 2030-40.

In 2011 we called tenders for the installation of Level 2 on around 2 300 track-km, together with the interlocking renewals needed to support deployment up to 2022. The initial responses confirmed the Danish experience that ETCS Level 2 was a good solution from both the technical and economic perspectives.

Over half of the Level 2 implementation (1 200 track-km) can be integrated with our existing electronic interlockings. These are mostly Alstom's Smartlock 400, or older solid-state interlockings which will be upgraded. They will be connected to the Radio Block Centres using an open Euroradio+ protocol. No changes to the Smartlock interlockings will be permitted other than to implement the RBC interface protocol.

The remaining 1 100 track-km will need new electronic interlockings, which will be sourced from the same supplier as the Level 2 equipment. In fact, almost half of the total budget is allocated for interlocking replacement. However, we expect this will bring other performance improvements, notably a reduction in the minimum headway from 3 min to 2 min through the revision of track layouts and signal block sections.

GSM-R enhancement

GSM-R has been already implemented across the network, providing full coverage for voice communications. On LGV3 and 4, GSM-R is also used to carry ETCS Level 2 data messages. The interface between LGV4 and HSL-Zuid at the Dutch border is unique in Europe, with trains crossing the border at 300 km/h while changing between RBCs and GSM-R networks at the same time.

Based on performance monitoring and practical experience, Infrabel has recognised that the GSM-R network will need further enhancement to support the Level 2 roll-out. Whereas the ETCS and interlocking programme is essentially based on individual routes, the GSM-R work will by its nature be area-based. As a consequence the upgrading of GSM-R must precede the introduction of ETCS.

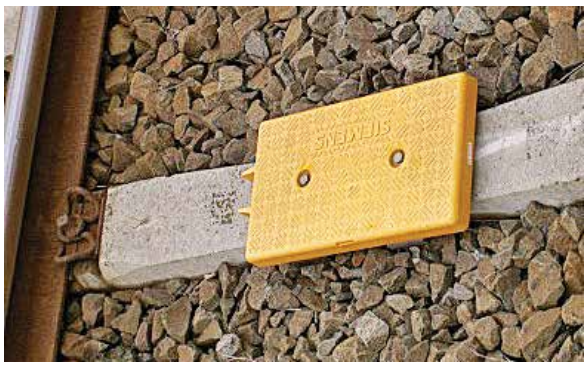
On the one hand, this has the advantage that GSM-R can be upgraded separately. On the other, it will not be possible to make use of the new data communication facilities at the outset, so hiccups might arise later to affect the ETCS implementation stage. However, we believe that we will be able to control these issues through careful management of the interfaces between the two programmes.

Over the next eight years, around 2 300 track-km will be fitted with ETCS Level 2, 1 200 km with Level 1 and 2 400 track-km on secondary lines will use a Limited Supervision variant.

Limited Supervision

The decision to adopt ETCS Level 1 Limited Supervision will require the use of Baseline 3 specifications. This does not just affect the infrastructure manager, but also has implications for the passenger and freight operators and DVIS. SNCB has already equipped some trains with onboard equipment using Baseline 2. However, Infrabel believes that a migration to Baseline 3 would have been necessary in the longer term, to ensure interoperability.

Infrabel is planning to take full responsibility for the implementation of the Limited Supervision areas, based on the experience that we have already gained introducing Level 1. The procedures adopted for these projects can be applied with minimal adaptation. The only external deliveries will be the Lineside Equipment Units, for which we already have two suppliers: Siemens and Alstom. Infrabel has created its own tools for data preparation, verification and validation activities, so we believe that it should be feasible to implement Limited Supervision in a relatively short period.



Infrabel has already started installing ETCS Level 1 on several routes, using Eurobalises supplied by Siemens.

Table I. Levels of authorisation and certification in the 'general approach' to the ETCS implementation programme

A. Authorisation for Placing in Service of the CCS trackside subsystem.
B. System integration activities and assessment under Article 2 of CSM-REA and Article 15 of the Interoperability Directive.
C. Verification of the trackside subsystem, including the quality and safety assessments required by the CENELEC RAMS standards 50126, 50128 and 50129.
D. Certification of the interoperability constituents, including the required CENELEC safety assessments.
E. All other certification required by EU legislation.
F. Acceptance of the Infrabel Safety Management System by the National Safety Authority as a basis for executing the programme.

System integration

One of the key issues with ETCS is system integration between the many deliverables, and Infrabel is well aware of the risks. We have therefore decided to implement a risk-oriented system integration strategy that builds on the results of the projects we have already completed.

This strategy will make maximum use of laboratory testing during system development, and also to provide proof of functional compliance for individual projects. The tests will include ensuring the compatibility of trackside equipment with onboard units from different manufacturers. Laboratory testing will be complemented by field trials using Infrabel's ERTMS test vehicle.

Further testing will be undertaken in conjunction with the train operators, to verify that the trackside deliverables and operational rules will work in a practical situation. It should also ensure that all of the risks for all parties can be mitigated or controlled. This approach complies with the Common Safety Method for Risk Evaluation & Analysis as referred to in TSI CCS, in line with the requirements of Safety Directive 2004/49/EC.

Assessment and certification

Our approach to assessment and certification was considered at the earliest stage of the programme. To minimise the risk of delays in the final project stages, we needed to ensure that all legal obligations would be met, so that the results could not be questioned. To this end, we ensured that the assessment bodies were involved as soon as possible. We also decided to involve DVIS at an early stage, to ensure that the national safety authority would be adequately informed about the approach being taken and the decisions made.

The scope of the assessment and certification processes has been specified as precisely as possible, in order to identify and minimise any risks. Responsibilities are shared between Infrabel and the manufacturers.

A logical model was developed on the basis of European legislation, using six levels in a top-down 'general approach' (Table I). It can be seen as part of this hierarchy that the Infrabel Safety Management System has to be updated for the operation of each trackside subsystem before that subsystem can be placed into service.

All assessment and certification activities will be covered by two contracts. One is between Infrabel and the manufacturer. The other is between Infrabel and the assessor, which acts as the Independent Assessment Body under CSM-REA, as Independent Safety Assessor for the CENELEC standards and as Notified Body for European TSI verification.

Specifications have been drafted for both work packages and the first was integrated into the tender for the suppliers. The second was tendered separately, and will be awarded at the same time as the main supply contract.

Interior of the ETCS test car, showing the workstations used to monitor the performance of the system.

Regulatory anomalies

COMPLIANCE: A further complication affecting the ERTMS Master Plan is the lack of clarity in the regulatory framework. Working with Walenberg Rail Assessment to develop the approval and certification programme, Infrabel identified anomalies in the published requirements of different bodies within the EU.

Although the three CENELEC standards (EN 50126, 50128 and 50129) are essentially used for 'day-to-day business' in the signalling and train control sector, the European Commission introduced some confusion by defining the CSM-REA at a generic level, without reference to these standards. TSI CCS refers to them as mandatory standards in Table A3, but they are not mentioned in the actual text. In relation to RAMS, the TSI requires the NoBo to verify the 'application of procedures specified in the Common Safety Method'.

We believe that using the CENELEC standards would demonstrate 'compliance of the system with the identified safety requirements', in line with CSM-REA, but we are concerned that Regulation 402/2013 is not explicit in this respect.

Another problem with ETCS at present — which affects infrastructure managers and train operators across Europe — is that vehicles have to be modified and re-tested every time there is a version change. Train operators are already faced with the challenge and cost of equipping their rolling stock in time for the initial introduction of ETCS, but the problem is compounded by the need to modify onboard equipment whenever there are changes to the trackside equipment, such as Infrabel's intended move from Version 2.3.0d to Baseline 3.

One possible answer might be a more flexible architecture, which determines the required functionality for a given configuration based on an exchange of version information between trackside and onboard components. However, unlike other modern communications and IT systems, the current ETCS architecture and compatibility strategy seems to be driven by a desire to apply completely deterministic solutions. Presumably, signalling engineers want to be sure about the configuration and functionality and have not yet considered how safety could be managed in a more flexible system.