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COMMISSION STAFF WORKING DOCUMENT

**Delivering an effective and interoperable European Rail Traffic Management System
(ERTMS) – the way ahead**

Delivering an effective and interoperable European Rail Traffic Management System (ERTMS) – the way ahead

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1. Introduction

Scope and involved stakeholders

Train control systems are the mechanisms put in place to ensure that trains stop where necessary and travel at the safe speed for the line. Historically it was simply the train driver's responsibility to follow the signals, but over time automatic systems were developed to ensure trains stopped automatically when a signal was red. These systems were different in each national railway network and were thus a major barrier to cross border operations. ERTMS is a major industrial programme to harmonise the automatic train control and communication system and underpin interoperability throughout the rail system in Europe. As the differences among the large variety of national legacy train control systems constitute a very significant barrier to interoperability of the European rail system, deployment of ERTMS will provide the backbone for a digital, connected Single European Rail Area.

ERTMS consists of:

- The ETCS (European Train Control System), a train control standard, based on in-cab equipment, an On-Board Unit able to supervise train movements and to stop it according to the permitted speed at each line section, along with calculation and supervision of the maximum train speed at all times. Information is received from the ETCS equipment beside the track. The driver's response is continuously monitored, and if necessary the emergency brakes would be taken under control.
- GSM-R (Global System for Mobile Communications - Railways) is the second ERTMS system, the European radio communications standard for railway operations. Based on GSM radio technology, GSM-R uses exclusive frequency bands to communicate the train with traffic control centres and devices beside the track.

The ERTMS Baseline corresponds to the version of the technical specifications designed and validated for this project. Most of the systems in operation today are based on the Baseline 2 specification (version 2.3.0d¹). The Baseline 3 specification has been developed to incorporate the return of experience from Baseline 2, include new functions, and implement a mechanism (System Version Management) to allow future add-ons preserving compatibility. The Commission adopted the new Technical Specification for Interoperability relating to control-command and signalling (CCS TSI)² in 2016 that gives legal status to the ERTMS specification and that is considered functionally complete.

This document sets out the necessary steps for rail stakeholders to address identified barriers to ERTMS implementation and to achieve ERTMS interoperability.

The main stakeholder groups that this document is addressed to include:

- Member States (MSs): MSs are responsible for the transport policy and investments implemented at national level. Given the significant costs of ERTMS deployment, and implications for the rail network, MS commitment is crucial for a successful ERTMS deployment.
- Infrastructure Managers (IMs): IMs are critical to the success of ERTMS deployment, as they are responsible for the planning and implementation of the system at a national level, and further must cooperate to manage cross-border operations and overcome infrastructure interoperability barriers.
- Railway Undertakings (RUs) and train owners: RUs (both freight and passenger) and train owners are the parties responsible for fitting ERTMS On-Board Units in a timely manner. ERTMS elements both trackside and on-board are required for the system to operate.

¹ Commission Decision of 23 April 2008 modifying Annex A to Decision 2006/679/EC concerning the technical specification for interoperability relating to the control-command and signalling subsystem of the trans-European conventional rail system and Annex A to Decision 2006/860/EC concerning the technical specification for interoperability relating to the control-command and signalling subsystem of the trans-European high-speed rail system

² Commission Regulation (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union

- Suppliers: The Suppliers are the companies responsible for manufacturing and installing the ERTMS systems, both on-board and trackside.
- European Union Agency for Rail (ERA): ERA has been established to provide the EU Member States and the Commission with technical assistance in the fields of railway safety and interoperability.
- European Commission (EC): The Commission is responsible for the legislative framework and EU-wide policy direction for ERTMS deployment. It also provides considerable financial support to ERTMS deployment via the Connecting Europe Facility (CEF) and regional development funds.
- National Safety Authorities (NSAs): bodies tasked with the responsibility for safety on the rail network, including the authorisation of infrastructure and rolling stock.
- Notified Bodies: bodies authorised to assess the compatibility of works or equipment with Technical Specifications for Interoperability (TSI) as part of the system to effectively and safely allow the interoperability of railway services within the European Union.

The Core Network Corridors and Rail Freight Corridors, which have as their constituent members certain of the stakeholder groups above, should also be used effectively to support ERTMS deployment.

Associations and groups representing the various stakeholders are also important, in particular to synthesise and coordinate individual stakeholder actions to support ERTMS deployment.

Current progress and barriers

At the end of 2017 almost 4.500 kilometres of Core Network Corridors lines will be operational with ERTMS and almost 7.000 vehicles are equipped or contracted today with ETCS in the EU, a substantial part of which has been supported by EU funding. Nearly the totality of the Italian and Spanish high-speed networks are supervised and protected by ERTMS; so are significant parts of the Swiss, Dutch and Belgian networks. Trains operate in commercial service at 320 km/h with ETCS. ETCS controls freight trains on conventional lines, and on dedicated routes (e.g. Betuwe line). The longest alpine tunnel is operated exclusively with ERTMS. The system is in service in suburban lines with commuter traffic (e.g. Madrid). Expected progress on ERTMS lines in operation by 2023 is at Appendix A.

INTEROPERABILITY

DIRECTIVE (EU) 2016/797 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on the interoperability of the rail system within the Community defines 'interoperability' as the ability of a rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance for these lines. This ability depends on all the regulatory, technical and operational conditions which must be met in order to satisfy the essential requirements.

The 2016 Memorandum of Understanding between the European Commission, the ERA and the European Rail Sector Associations set out the definition of interoperability with regard to ERTMS deployment, which means achieving and maintaining compatibility, where compatibility is the legal and technical certainty that a compliant Baseline 3 (Maintenance Release 1 and Release 2) ERTMS On-board Unit, provided that it has the necessary options installed, can safely run on any ERTMS line compliant with the TSI with an acceptable level of performance.

Baseline 3 Release 2 is functionally complete and should be kept stable in the coming years (including error correction) – therefore it is a legitimate reference for deployment.

Despite this progress much work is still required to achieve an EU-wide deployment of an interoperable system as the ERTMS systems deployed so far do not yet constitute an interoperable system. Barriers to achieving interoperability include:

- Uncoordinated ERTMS trackside deployment between and within Member States.
- Requirements introduced on to On Board Units, for example by national rules, the necessity of running on different infrastructures, interactions with legacy systems in Member States (Class B

systems) – these changes can result in On-Board Units that can run in one Member State but not another and can increase costs through customisation.

- Different engineering rules within and between Member States, with a high variety of trackside configurations impacting testing procedures and leading to higher costs.
- Inefficiencies in conformity assessments and authorisation, for example differing assessments by NSAs on whether modifications are minor or major (with reauthorisation being needed for major modifications).
- Market inefficiencies, where short-term economic incentives for suppliers and customers may work against the goal of interoperability.
- Different interpretations of the ERTMS specifications during the rollout of projects that may lead to errors and incompatibilities between ETCS subsystems.

The benefits in addressing these barriers – reducing costs and increasing efficiencies of deployment - to achieve an interoperable signalling and control system are considerable, making rail a more competitive transport mode. Similarly, the costs and risks of not addressing these barriers and deploying in a fragmented fashion are large.

Ultimately all involved parties need to work constructively to achieve in a business-relevant time horizon the desired goal of interoperability.

Legislative and policy context

Significant steps have been taken in recent years to address core issues relating to the achievement of an interoperable rail system.

This document builds on the regulatory and policy framework which is in place and focusses on the critical next phase of implementation, with a view to highlighting the actions needing to be taken, by whom, and by when to deliver an interoperable Baseline 3 deployment.

It encompasses the commitment in the 2016 Memorandum of Understanding to provide a detailed plan with concrete actions and defined deadlines.

The relevant legislative and policy elements are as follows:

- **Fourth Railway Package:** The technical pillar of the Fourth Railway Package³ introduces important changes concerning ERTMS. It enhances the role of the European Union Agency for Railways (ERA) as the ERTMS system authority in order to maintain, monitor and manage the corresponding subsystem requirements, including the technical specifications for the European Train Control System (ETCS) and the Global System of Mobile Communications – Railway (GSM-R). It also transfers tasks that today are carried out by the National Safety Authorities to ERA regarding authorisation of rolling stock (including ERTMS on-board subsystems) and safety certificates for Railway Undertakings (RUs). Finally, a new process has been introduced by the Fourth Railway Package concerning the approval by ERA of trackside implementations. The set of measures introduced by the Fourth Railway Package will enable more efficient authorisation processes and lead to enhanced interoperability and compatibility between on-board and trackside subsystems. A number of actions in this document relate to the necessary steps to ensure that ERA is well-placed to efficiently deliver on its new powers.
- **Stability of specification:** A substantial element of ERTMS is the software code used to define the messages between train and infrastructure, and what the train should do in response to those messages. Like all software, this provides the possibility to deal with many

³ The 'technical pillar', which was adopted by the European Parliament and the Council in April 2016, includes:

- [Regulation \(EU\) 2016/796 on the European Union Agency for Railways and repealing Regulation \(EC\) n° 881/2004](#)
- [Directive \(EU\) 2016/797 on the interoperability of the rail system within the European Union \(Recast of Directive 2008/57/EC\)](#)
- [Directive \(EU\) 2016/798 on railway safety \(Recast of Directive 2004/49/EC\)](#)

scenarios and allows for rapid development – but also introduces the risks of errors and barriers to interoperability. The stability of the specification is frequently mentioned as the most critical element for a wide-scale deployment. Evolution of the specification has been driven by the request of the users to introduce new functionalities and by the need to correct errors. The Baseline 3 is considered functionally complete and that should be kept stable in the coming years. The adoption of the Regulation (EU) 2016/919 was a major milestone in the development of the specification and of the ERTMS breakthrough programme. This specification includes the main Change Requests that the Member States (MSs) have been identifying in the last years as a pre-requisite to deploy ERTMS in their territories. The main changes in this Regulation are the following:

- Adequate legal instrument: CCS TSI is no longer a Decision but a Regulation that is not only addressed to the Member States but individually to all actors referred to in the legal act.
 - TSI Compliance: obligation to suppliers, applicants for an authorisation, Notified Bodies and National Safety Authorities (NSAs) to produce/implement TSI compliant products (Article 6).
 - Transparency towards Railway Undertakings (RUs): Member States will notify a National Implementation Plan including planned dates for decommissioning of Class B systems. These plans will be publicly available to support RUs to adapt their business plans (Article 6 and Annex point 7.4.4).
 - Transparency of trackside testing procedures: notification of engineering rules and operational test scenarios in order to increase transparency of testing processes and prepare for further harmonisation of operational rules (Article 5 and Annex point 6.1.2.3).
 - Compatibility tests: possibility to include the results of the compatibility tests, in case they are requested by the applicant, in the technical file to be submitted to the NSA for facilitating compatibility checks (Annex point 6.5).
 - Updated ERTMS Specification: Release 2 of Baseline 3 introduces functional aspects agreed by the sector in the 2012 “Memorandum of Understanding”. These include GPRS, in order to address problems of spectrum capacity in areas with high frequency of trains the spectrum has limited capacity, a higher level of protection against radio interference, and online key management to protect the messages between the infrastructure and the train from cyber-attacks. This specification is backwards compatible with the currently applicable version of the TSI and will allow a standardised compliant on-board unit to be produced allowing trains to circulate on any ERTMS line.
- **The ERTMS European Deployment Plan:** On 5 January 2017 the European Commission adopted an Implementing Regulation (EU) 2017/6 on the new ERTMS European Deployment Plan⁴. It sets target dates until 2023 by which time about 30-40% of the Core Network Corridors should be equipped. In 2023, the ERTMS European Deployment Plan will be updated again setting out the precise implementation dates. The implementation of the European Deployment Plan, including the critical cross-border infrastructures, is a specific action addressing the delivery of interoperable and compliant infrastructure highlighted within this document.
 - **The 2016 Memorandum of Understanding (MoU):** The 2016 MoU⁵ signed between the European Commission, the European Union Agency for Railways and the European rail sector associations concerning the cooperation for the deployment of the European Rail Traffic Management System. The main focus of this MoU is to engage the sector to deploy an interoperable system based on a stable specification (Release 2 of Baseline 3) including error correction. The MoU in particular contains a definition of compatibility, which on the one hand provides for interoperability, but also enables controlled evolution by being open to innovative solutions. It also requires mature management of this software based system, with customers and suppliers introducing appropriate clauses for software maintenance in their contracts. Infrastructure managers (IMs) commit to include the effect of legacy systems to ensure free circulation of vehicles equipped with ERTMS, and commit to co-operate, on voluntary basis, with the requirements of the Agency for the approval of trackside projects in advance of the deadline of 2019.

⁴ OJ L 3, 6.1.2017, p. 6.

⁵ https://ec.europa.eu/transport/sites/transport/files/mou_for_signatures.pdf

- Karel Vinck's (European Coordinator for ERTMS) Breakthrough Programme for ERTMS⁶, which defines a limited number of principles to support and accelerate ERTMS deployment:
 - Users first and not Designers first.
 - https://ec.europa.eu/transport/sites/transport/files/themes/infrastructure/news/doc/2015-05-28-coordinator-work-plans/wp_ertms_final.pdf A cost structure which supports the competitiveness of the railway system.
 - Standardised on board equipment.

Further, the European Court of Auditors has recently released a report⁷ setting out the challenges of ERTMS deployment with associated recommendations. This document forms part of the Commission's response to those recommendations.

Innovation

Beyond supporting the delivery of the Single European Rail Area, ERTMS will provide the backbone to enable the introduction of innovative technologies to the rail sector in an effective manner.

ERTMS/ETCS Baseline 3 is software-based, and its design includes the possibility for evolution. Innovative solutions will come to market in the coming years and the ERTMS/ETCS specifications should adapt to innovative solutions (modular approach) and additional services, in particular those realised through research and innovation within the Shift2Rail Joint Undertaking (S2R JU). The integration of innovative solutions to the system should be as smooth as possible, allowing systems with different performance and capabilities to operate on the same Baseline 3 compliant infrastructure. Accordingly, several "game changers" are entering their demonstration phase, for example automated train operation.

The aim of S2R JU and the proposed innovative solutions is to contribute to cutting the life-cycle cost of railway transports by as much as 50%, doubling railway capacity, and increasing reliability and punctuality by as much as 50%.

ERTMS: a European success story

Despite the complexities of EU deployment, ERTMS is now a global standard for train control and communication. The development of ERTMS has provided excellent opportunities for developing high value business and expertise within Europe and for export around the world. ERTMS is being deployed in almost 50 countries around the world, with over 21,000 km deployed.

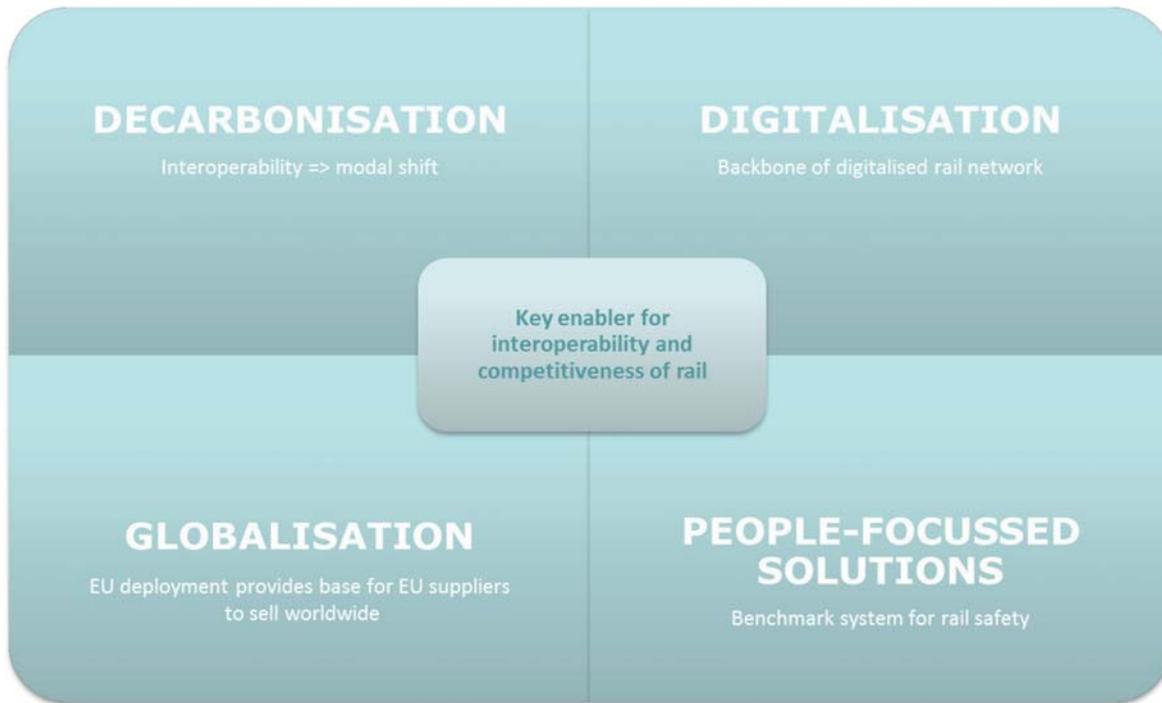
In terms of current ERTMS deployment, this document sets out the steps to achieve a more standardised and effective rail system, supporting European trains to run on a European rail infrastructure, after having been tested through standardised and automated procedures, in synergy with a strong simplification of national rules. This process paves the way for a real "industrialisation" of CCS systems, delivering economies of scale.

Going forward, cooperation with the sector to build upon the existing ERTMS functionalities within Shift2Rail will support the EU industry in keeping its competitive edge in the sector worldwide.

⁶ https://ec.europa.eu/transport/sites/transport/files/themes/infrastructure/news/doc/2015-05-28-coordinator-work-plans/wp_ertms_final.pdf

⁷ Special report no 13/2017: A single European rail traffic management system: will the political choice ever become reality? <https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=41794>

ERTMS: a key enabler for interoperability and competitiveness of rail



2. Actions and associated objectives to achieve interoperability and drive ERTMS deployment

ERTMS Baseline 3 Deployment Vision

Suppliers and railways are delivering within a clear deployment calendar. A coordinated deployment is driving down costs and delivering significant benefits helping rail to be more competitive. The elements to deliver this are as follows:

- **Interoperable and compliant infrastructure**

Infrastructure is delivered according to the European Deployment Plan, and beyond that national implementation plans are produced based on a coordinated deployment, including cross-border considerations.

For new projects, the vision is for trackside installations to be deployed using modular pre-tested configurations, according to engineering rules valid for entire networks: this allows for a cost effective contracting out of field works, at the same time maintaining tight control over the final results in terms of quality, safety and interoperability. For existing ERTMS infrastructure, the necessary investments are made to ensure interoperability.

The infrastructure managers are responsible for safe, interoperable and reliable track-side installations. ERA ensures via the ERTMS Trackside Approval the interoperability of trackside ERTMS and that the application of engineering rules are progressively more and more extended in terms of geographical coverage. By 2030, almost 51,000km of railway lines on Core Network Corridors in Europe will be in service with ERTMS.

- **Standardisation of On-Board Unit**

Vehicle authorisations issued by ERA ensure compliance to the ERTMS specifications and interoperability of the On-Board Unit. Locomotives and trainsets installations are based on generic, pre-tested and pre-validated kernel (software and hardware) proprietary for each supplier (i.e. a standardised On-Board Unit

per supplier): interfacing to the specific vehicle wiring, and the relevant data parametrisation have been also pre-validated by using generic rules and outsourced to workshops and/or the original vehicle manufacturer.

- **Efficient Testing and Validation**

Efficient cross tests of (the standardised) On-Board Unit of each supplier with the (limited possible configurations of) trackside in the different networks. The tests are performed mostly in laboratories giving certainty on time and costs for RUs concerning their area of operation.

- **Maintaining ERTMS in a reliable and consistent manner**

The software installed on board (in On-Board Unit) or trackside are maintained as software products: regular, scheduled updates with pre-tested configurations ensure errors and shortcomings are eliminated, maintaining all the products and system throughout EU in line with the interoperability specifications. This avoids the problems of the early 2000s, where different “islands” of specifications were kept “frozen” creating interoperability barriers and fragmenting the market.

The EU specifications themselves are managed by ERA with the contribution of the Sector to ensure on one hand error-free stable set of requirements for interoperability, and on the other hand to introduce in a compatible (add-on) manner business-driven innovation. Whenever possible compatibility shall be kept and evolution should be considered through a modular approach.

Vehicle authorisations issued by ERA, including the ERTMS on-board, ensures smoothly that ERTMS Software changes do not lead to re-authorisation of the vehicle. In the frame of the 4th Railway Package, Directive (EU) 2016/797 provides TSIs that will define the level of change in the parameters which will trigger a reauthorisation process in the case of renewal or upgrading.

- **Funding/financing support**

Funding support at both EU and Member State level is targeted and deployed in a manner ensuring a coordinated deployment, taking into account both necessary trackside and on-board investment.

2.1 An interoperable and compliant infrastructure

2.1.1 New trackside projects: ERA approval

The 4th Railway Package introduces new tasks for the ERA, in particular Article 19 of Directive (EU) 2016/797 provides that ERA will, from June 2019, approve ERTMS trackside projects.

The aim of the ERTMS trackside approval is to ensure an interoperable implementation of ERTMS i.e. mitigating any compatibility risk for newly commissioned ERTMS trackside equipment and therefore contributing to a reduction of costs for rail operators and making it easier for new operators to enter the rail market

The Agency approval process introduces an opportunity to identify issues on trackside projects at an early stage and can be applied in all different types of tenders and contracts. The approval process will facilitate the sharing of knowledge and will avoid solving issues too late that are common to ERTMS trackside projects. The applicants and national safety authorities will benefit from the checks and information related to the design phases of the ERTMS. These checks can enhance the interoperability of the projects and facilitate the authorisation processes.

Similar to other new tasks of the 4th railway package, such as the vehicle authorisation process, the approval process should be managed at various levels, including application guide and internal procedures as well as cooperation agreements to be signed between the Agency and national safety authorities.

The Agency, the applicant and the authorising entities will make use of a single and coherent tool throughout the entire approval process, called the one-stop shop (OSS).

Action	Responsible	Involved	Timeline
Signature of Letters of Intent by RUs and IMs committing to follow the MoU in particular their engagement in the 4RP process before 2019	IMs, RUs	ERA	End 2017
IMs to engage with ERA in learning cases on current procurements anticipating the 4RP process	ERA, IMs	Rail Freight Corridors (RFCs), Deployment Management Team (DMT)	From now to end 2018
Successful definition of practical arrangements for trackside approval process in good cooperation with stakeholders to be issued as a Commission Recommendation	ERA, EC	IMs, Interoperability and Safety Committee (RISC), NSAs, DMT	1H18

2.1.2 TSI Revision

For future TSI revision, the removal of Baseline 2 from the TSI should be considered in order to focus future deployment on Baseline 3.

It is recognised that this will encounter significant resistance from Member states where deployment (and contracts) is based on Baseline 2. However, the significant investments in ERTMS Baseline 2 will be protected:

- As existing ERTMS infrastructure will not be affected by the revision, and on-going projects may benefit from derogation
- Through the maintenance of the Baseline 3 specification, EC and ERA will protect the investments already made in Baseline 2 and will ensure that future trackside implementation can still use Baseline 2 functionalities, and allow running of Baseline 2 units.

Action	Responsible	Involved	Timeline
Consideration of conditions linked to removal of Baseline 2 from the TSI	EC, ERA	RISC	Recommendation end 2018

2.1.3 Existing infrastructure: Achieving Baseline 3 compatibility

A key objective of the MoU is to have ERTMS infrastructure allowing the safe operation with an acceptable level of performance for all trains equipped with Baseline 3.

The vast majority of lines in service today are based on pre-Baseline 3 (i.e. Baseline 2) specifications.

Existing infrastructure must be assessed against the Baseline Compatibility Assessment reports and in cases of identification of incompatibilities, the corrections must be implemented. Such rectifications will allow Baseline 3 equipped trains to run on such lines, preserving investments in Baseline 2 infrastructure.

To date, this review of trackside implementations against Baseline Compatibility Analysis has been done only in a limited number of cases (we note that ADIF completed it for their entire ERTMS network, Level 1 and Level 2). This review should be carried out by all concerned infrastructure managers. The RISC, the Single European Railway Area Committee (SERAC), and Management Boards of the rail freight corridors are well placed to steer among their members the development of Baseline Compatibility Analysis on the cross borders sections of their corridor and on their lines.

Action	Responsible	Involved	Timeline
Identification of existing ETCS infrastructure with issues to resolve (i.e. check infrastructure is compliant with ERTMS specifications and compatible with Baseline 3 (Maintenance Release 1 and Release 2) ERTMS On-Board Unit	IMs, ERA, EC	ERTMS Users Group (EUG) with INECO, RFCs, RISC	To report December 2017
Baseline Compatibility Analysis validation of existing Baseline 2 trackside applications	IMs	ERA	1H19
Development of strategy to address infrastructure which does not currently accept Baseline 3 On-Board Unit:	ERA, EC, DMT,	RFC, IMs, RISC, RUs, suppliers	Approach to be developed by 1H18
<ul style="list-style-type: none"> • Identifying most relevant technical examples of trackside interoperability issues and guidelines on how to recognise and avoid them. • Prioritising those infrastructure situations, which are leading to wider interoperability issues • Collaboration with IM, RU and suppliers to implement this strategy 			

2.1.4 Resolving incompatibilities between trackside and On-Board Unit, promoting the standardisation of the On-Board Unit

Where incompatibilities between a compliant Baseline 3 On-Board Unit and trackside are identified, for example through testing or where national rules or requirements are in place, it is general practice to make changes either to the On-Board Unit or to the trackside. If such changes are implemented on an individual project basis, they may result in incompatibilities with other (On-Board Unit/trackside) implementations which could have adopted other solutions to solve the problem.

A key action therefore is to consider the process for addressing incompatibilities which ensures interoperability of the involved On-Board Unit and trackside, including through greater emphasis of addressing incompatibilities in a coordinated way at European level.

This will require a set of matching commitments from IMs, RUs, and suppliers so that, if it is agreed at European level that the solution - on the basis of an assessment on the whole system at the European level through the ERTMS Stakeholder Platform (a forum of rail stakeholders, ERA and the EC) - requires a change to the trackside or the on-board, the IM, RU, and suppliers can commit to implement in the short term the necessary measures on their implementations coupled with a credible commitment and planning of suppliers to deliver upgraded products and systems compliant with future planned releases of the specifications.

Action	Responsible	Involved	Timeline
Establish a process for reporting incompatibilities and ensuring efficient reaction including:	ERTMS Platform	ERA, EC, IMs, RUs, NSAs, RFCs (Railway Undertakings Advisory Group)	First cases to be considered 2H17
<ul style="list-style-type: none"> • Prioritisation of cases, drawing on inter alia identification of National Rules exercise • Understanding of technical and financial requirements to address the changes • Development of process to work with all stakeholders to address incompatibilities 			

2.1.5 Realistic and committed European Deployment Plan and National Implementation Plans

After more than two year's consultation and intensive exchange of views with Member States, Infrastructure Managers and other stakeholders the reviewed European Deployment Plan was adopted with realistic target dates in January 2017. The aim of this reviewed European Deployment Plan is to provide greater clarity on deployment and to ensure that ERTMS equipped locomotives can have access to ERTMS equipped lines. Therefore it is essential that equipment of locomotives goes in parallel with trackside equipment in order to achieve full benefits of interoperability. The focus now turns to Member States and the Infrastructure Managers committing to timely implement the European Deployment Plan with the essential objective that Baseline 3 equipped locomotives can run on those lines.

The recently adopted ERTMS European Deployment Plan sets out the implementation dates on Core Network Corridors (CNC) by 2023. It also provides that a review procedure should be carried out by 2023 (most probably in 2021/22) with the objective to define the implementation dates of the remaining CNC sections to be implemented between 2023 and 2030.

A new element of the European Deployment Plan is to find technical solutions for cross-border sections. Agreements between the IMs concerned should be signed for cross-border sections with different implementation dates, such that a year before the earliest implementation date there will be an agreement on the technical and operational solution for the transition period. Cross-border sections are not only an efficient tool to identify any of the remaining barriers to interoperability; they also allow any procedural issues related to authorisation of the on-board system to be uncovered.

The close follow-up of timely European Deployment Plan implementation is crucial in particular to ensure transparency towards RUs on availability of ERTMS on Core Network Corridors. Beside the progressive notification about implementation via TENtec to be done by Member States (which will be publicly available), the Deployment Management Team is responsible for close follow-up of the progress made and will provide a detailed report about it on a yearly basis. This report will be published by the Commission.

According to point 7.4.4. of the Annex to Regulation (EU) 2016/919 Member States are obliged to notify their National Implementation Plan (NIP) by July 2017 (as of October 2017, 15 NIPs had been submitted). NIP will further contribute to transparency on the required signalling systems on-board for operation on the entire EU railway network, since it will include ETCS implementation dates and Class B decommissioning dates on all railway lines under the Interoperability Directive (Directive (EU) 2016/797). Furthermore the significant benefits of Level 2 operation should be considered when Member States and Infrastructure Managers are considering their deployment plans. Based on the received NIPs, DMT is preparing a synthesis about the availability of ERTMS and removal of Class B systems that will be publicly available and help define European, national and local migration strategies.

In addition, the rail freight corridors should, in accordance with the Article 11(1)(b) of Regulation (EU) No 913/2010, publish a plan for the deployment of the interoperable system ERTMS. Therefore, considering the compulsory basis of the European Deployment Plan for the core network corridors on the one hand and the rail freight corridor traffic on the other hand, the rail freight corridors are well placed to collect the data for the ERTMS roll-out on their principal, diversionary and connecting lines in order to provide a more complete overview relevant both for decision makers and RUs.

Action	Responsible	Involved	Timeline
Implementation of the European Deployment Plan. Agreement between the affected infrastructure managers should be signed for cross-border sections (agreements should be notified to the Commission by Member States). List of cross-border sections can be found at Appendix B.	IMs, EC	DMT, ERA, MSs, NSAs, RFCs	Progressively: one year before the earlier of the deployment dates for the given cross-border section
Notification of progress of implementation via TENtec	MSs	IMs	Progressively, one month after putting into operation
Synthesis of NIPs	EC	DMT, IMs	Publication of synthesis by end 2017
Report on implementation progress of European Deployment Plan	EC	DMT, IMs	First report to be published in the beginning of 2018, then on a yearly basis

Action	Responsible	Involved	Timeline
Review and extension of European Deployment Plan for the CNC sections to be carried out between 2024 and 2030.	EC	MSs	Review procedure should be finalised not later than 31 December 2023, it should start in 2021

2.1.6 Decommissioning Class B systems

Currently, even in situations of ERTMS deployment, the national (Class B) system often runs in parallel. More complete removal of Class B systems would give a decisive push towards migration of ERTMS system in Europe depending on the specific economic circumstances of the Member States.

In addition to the benefit of simplifying technical complexity while withdrawing one of the signalling systems, decommissioning will have a positive impact on the overall ERTMS business case, notwithstanding costs for systems which have not yet reached end of life.

Some Member States that are switching completely their system into ETRMS - like Luxembourg, Belgium, and Denmark – will remove their national system shortly after their network-wide ERTMS implementation. Similarly to those countries – but within a longer time frame - the Czech Republic has an ambitious plan for the removal of its national system: five years after ERTMS deployment the Czech Class B system will be removed (network wide deployment is planned for longer period of time, highest priority is given to Core Network). Consequently, only ERTMS equipped locomotives will be able to run on those railway lines already before 2030. This will require an acceleration of the deployment of on-board equipment in those and neighbouring countries. Larger Member States will likely have a more complex decommissioning process due to the size of the existing networks. In these larger networks, a focus on discrete sections of the network where "ETCS-only" trains could run should be considered.

With the introduction of the National Implementation Plan in Point 7.4.4 of the Annex of CCS TSI, the Commission took the first step to have an overview on the decommissioning strategies of the MSs. MSs have to notify their NIP by July 2017 including the decommissioning date of their Class B system.

The clear solution for European wide acceleration of ERTMS migration would be – next to the legally binding plan for ERTMS deployment (European Deployment Plan) – the consideration of adoption of legally binding target dates for removal of Class B systems. The definition should be carried out in the frame of the European Deployment Plan review (2021/22), as a first step for the already deployed lines.

This objective may be challenging in those Member States with large networks or with Class B systems with long expected lives. But this approach, would lead to genuine cross-EU interoperability, operational savings for both IMs and RUs, and streamline MS specific rules and requirements.

Action	Responsible	Involved	Timeline
Based on synthesis of NIPs, information on programmed Class B decommissioning dates from MSs	EC		1H18
Identify dates for meaningful operational services (on CNCs, RFCs, etc) when "ERTMS only operation" is possible	ERTMS Platform	ERA, NSAs, RFCs	IMs, EC, 2H18

2.1.7 Process to identify and address National Rules and requirements that impact interoperability

ERA has been working on an action to clean up National Rules that hinder interoperability. This activity includes all rules impacting vehicle authorisation, with ERA prioritising signalling-related rules.

The aim is to identify and prioritise those National Rules that are most impacting the interoperability of the network.

The identified National Rules and requirements fall into 3 broad categories:

- "redundant" rules;
- Issues where a different approach to the TSI is being taken (e.g. safety issues);
- Rules which are needed, primarily due to the Class B system.

The challenge is to identify and prioritise those rules and requirements that most impact the interoperability of the network, in particular those requiring changes to the On-Board Unit which can work against the goal of a more standardised On-Board Unit product, or where there are significant contradictions between Member States or along a corridor. Work is then needed on a case by case basis to determine the process for potential mitigation and removal of the rules or requirements.

Action	Responsible	Involved	Timeline
Communication and publication of rules used or in development	ERA, MSs	NSAs, RFCs	Ongoing to December 2017
Identification, categorisation and prioritisation of rules	ERA, EC	RUs, IMs, Suppliers	Process begins 2H17 completing 1H18
Case by case discussions on mitigation and potential removal	NSAs	ERA, IMs	Ongoing

2.1.8 Harmonisation of Engineering Rules

Engineering rules are the rules that govern the designing principles of the network. Today there are a set of EU-harmonised engineering rules available in the application guide of the TSI but they are not used in practice. In a number of MS ERTMS implementations follow different engineering rules for different lines and projects within the same Member State.

Engineering rules do not necessarily lead to technical incompatibilities but the high variety of trackside configurations between and within MSs lead to higher costs and impacts the testing procedures as it is not possible to test all configurations in a laboratory setting.

Nevertheless, a considerable part of the engineering rules are linked to Class B systems that will remain for the foreseeable future. Therefore the set of engineering rules that can be realistically harmonised is to be identified.

The first priority is to achieve that in the same network consistent engineering rules are applied. This approach is defined in the Practical Arrangements and the EC Recommendation for the 4RP ERTMS trackside approval. IMs are encouraged to develop generic rules that can be applied in a repeatable manner in all specific implementations. This will facilitate verification of conformity, testing and authorisation: it will also make possible a more "industrialised" process to deploy ERTMS at the ambitious pace required by EU objectives for European Deployment Plan and Core Network.

The rules identified as rules that realistically can be harmonised at European level should be discussed in the ERA CCS TSI working party and included in a recommendation to the EC with a view to change the TSI, according to the process set out in the ERA Regulation and Interoperability Directive.

The set of engineering rules that are already included in the application guide should be considered in this action and determined if they should be included as mandatory in the TSI.

Action	Responsible	Involved	Timeline
Identification of the existing sets of ERTMS-related engineering rules including transitions between systems (Class B/ERTMS, ERTMS Level 1/ERTMS Level 2, etc)	ERA learning cases	in IMs, NSAs, EUG	From now to June 2018
Analysis of existing material, as well as CCS TSI and operation and traffic management TSI (OPE TSI) national implementation plans to determine potential harmonisation and at what level (regional, MS, EU)	ERA, ERTMS Platform	IMs, NSAs, suppliers, RFCs	End 2018
To consider whether incentives should be provided for Infrastructure Managers using a single and transparent set of rules, such as in CEF calls for proposals and 4th Railway Package trackside approval process.	ERA, EC	MSs	From 2H18

2.2 Standardisation of On-Board Units

2.2.1 ERA authorisation of vehicles

As set out in Article 21 of Directive (EU) 2016/797, from June 2019 ERA will authorise vehicles, including ERTMS on-board (both new and retrofit), for international traffic and at the request of the applicant for national traffic. This process also relies on the trackside approval process to ensure harmonised trackside implementations.

Overall these processes will ensure that On-Board Units display equivalent behaviour enabling interoperability over the compliant network.

Action	Responsible	Involved	Timeline
Participation of ERA in learning cases	ERA	RUs, Suppliers, RFCs, IMs, NSAs	From now to 2019
Publication of complete process for authorisation, including the necessary test regime both in laboratories and with real configurations to determine on board products with equivalent behaviour	ERA	EC, RISC	2018
Process to ensure interoperability of On-Board Units which will continue to be authorised by the NSAs (e.g. NSA monitoring, Notified Bodies monitoring)	ERA	EC	2018 (4RP general planning)
Monitoring and audits of Notified Bodies	ERA	Notified Bodies	Adoption of Guidelines June 2017

2.2.2 Minimising impact on On-Board Unit through standardisation of interactions with Class B systems and other on-board subsystems

One of the key measures to achieve interoperability is to develop and maintain standardised On-Board Unit software per supplier, with interfacing to the vehicle and Class B system that does not impact the compatibility of the On-Board Unit.

Such an approach is complex however and some optionality within the TSI which can work against this aim.

The current TSI CCS (Point 7.2.5) states:

“The Class B train protection systems may be implemented:

- (1) using a specific transmission module (STM) operating via the standard interface ('external STM');
or
- (2) integrated within the ETCS equipment or connected via a non-standard interface; or
- (3) independently from the ETCS equipment, for example via a system that enables switching between equipment. The railway undertaking must then ensure that the transitions between Class A and Class B train protection are carried out in conformity with the requirements of this TSI and with the national rules for the Class B system.”

The existing Class B systems have different restrictions.

In the longer term the deployment of ERTMS in EU can deliver its full potential benefits only when coupled with a defined strategy to allow trains to operate without the need to maintain Class B systems on-board.

In the meantime, however, because of the above complexities and difference among legacy systems there is a need to consider solutions on a case by case basis according to the circumstance of the RU and the system(s) being run, including whether the configuration is for retrofitting or for new trains (for retrofitting, more distinct systems may be cost effective to avoid removal of the existing Class B

architecture). Further the situations will need to be evaluated to determine whether the proposed solutions have an impact on the compatibility of the On-Board Unit.

Additionally, for economic reasons, the CCS TSI allows the Railway Undertakings to “opt-out” of some non-mandatory equipment that might not be needed in the networks where the train is intended to operate, e.g. euroloop is only needed in Austria and Switzerland.

Action	Responsible	Involved	Timeline
Production of strategy map to achieve standardised On-Board Units (i.e. identification of useful technical solutions and light impact assessments) including:	ERA	DMT, EC, RUs, suppliers	
▪ Analysis of European Deployment Plan and NIPs to determine where problems/priorities are for transitions, Class B interaction, optional requirements (Level 2, Euroloop)	DMT		From now to end 2018
▪ Definition of most relevant geographical areas or sectors (e.g. freight)	EC, ERA, DMT		From now to end 2018
▪ Engagement with IMs to explore possible changes to requirements/plans to provide a more attractive case for RUs with standard On-Board Unit	ERA, EC ERA	RFCs, IMs	From 2018
▪ Potential systematised descriptions of interfaces between Class B systems and ETCS and Class B systems and other on-board sub-systems	Suppliers		From now to end 2018
Consideration of prioritisation in CEF calls to support ERTMS-only operation	EC, INEA		Timing dependent on CEF calls
Investigate conditions for an open market of STM	EC, MSs	ERA, suppliers	To commence 2018

2.2.3 Contractual/commercial issues

There are a number of measures relating to contractual and commercial issues that can promote interoperability in particular to promote standardisation through development and use of tender template, in particular to ensure that such contracts include services to upgrade/maintain software where errors are identified in products or specifications.

Action	Responsible	Involved	Timeline
Production of structured On-Board Unit tender checklist	CER	ERA, EC, EUG, ERFA, EPTTOLA, ERTMS platform, suppliers, IMs	November 2017
Consideration of market adaptation of user expectations	ERTMS stakeholder platform	ERA, EC, suppliers, CER, RUs	1H18
Development of strategy to promote use of the tender checklist and templates by RUs and working method to resolve RUs issues and opportunities	ERTMS stakeholder platform	ERA, EC, RUs, suppliers	From November 2017
Production of relevant guidance supporting optimised purchasing strategy for ERTMS on board	CER	ERTMS platform	From November 2017

2.3 Efficient Testing and Validation

Whereas manufacturer's in-house labs and third party accredited labs test all the functionalities installed in the on-board units, additional testing is still considered necessary by the sector to prove compatibility with infrastructure. Due to the potential non-compliances of the ERTMS systems, compatibility needs to be tested between the On-Board Unit and the specific implementation trackside. These additional tests can mostly be done in the laboratories of the trackside supplier or of the infrastructure manager. Nevertheless transparency on the scenarios to be tested and a process to guarantee that the tests are done in a timely manner are still needed to reduce testing costs and therefore improve the overall business case.

Action	Responsible	Involved	Timeline
Test sequence for Baseline 3 Release 2 to be published	Working group with accredited labs and Unisig	ERA, EC	Agency's Opinion by October 2017
Transparency and publication of test scenarios for testing, in accordance with Chapter 6 of the TSI, including the examination of National Rules requiring tests	IMs, NSAs, ERTMS Platform, ERA	suppliers, EUG, NSAs, Labs,	From now to June 2019
Develop common understanding on and define a commonly agreed "generic" process for testing and certification, that could subsequently be used by the relevant approval entities (Notified Bodies, NSAs, ERA), with a view to consider in the revision of the TSI	ERTMS Platform	ERA, EC, UNISIG, IMs, RUs	December 2017
S2R "Zero on-site testing" project	S2R	S2R members	Finalised August 2022
Review conditions of access and capacity for test facilities with a view to ensure that they are non-discriminatory	IMs/suppliers/Labs	IMs, NSAs, ERTMS Platform	Mid 2018

2.4 Maintaining ERTMS in a reliable and consistent manner

The stability of the ERTMS functionality is the means to ensure protection of investments and to achieve compatibility as defined in the 2016 ERTMS MoU. The additional functionalities of the identified Game Changers as defined in the ERTMS Long Term Perspective (such as full automatic train operation – ATO) will be developed in a way ensuring they can be implemented in a cost effective manner. Whenever possible compatibility should be kept and evolution should be considered through a modular approach.

In complex systems like ETCS, it is inevitable that there will be deficiencies (errors or ambiguities in the specifications) that can lead to different implementations in projects/products, potentially affecting the interoperability of the system. Therefore an efficient and coordinated process to address these is required.

Due to the rich set of functions and parametric options offered to the trackside implementations, not all theoretical errors can lead to concrete interoperability problems. In general, the solution for an error in the specifications can result in modified requirements for the implementation of the function in the on-board product, and/or in the manner the function is implemented trackside.

The proposed strategy with regard to mitigation/correction measures is to give priority to ensuring interoperability and promoting a standardised On-Board Unit (see Section 2.1.4).

The complementary part of the strategy, addressed here, is that consolidated error corrections, leading to On-Board Unit software updates, will be scheduled at appropriate intervals in the future.

This will enable the vision where the software installed on board (in On-Board Unit) or trackside are maintained as software products: regular, scheduled updates with pre-tested configurations to ensure errors and shortcomings are eliminated, maintaining all the products and system throughout EU in line with the interoperability specifications. This avoids the problems of the early 2000s, where different "islands" of specifications were kept "frozen" creating interoperability barriers and fragmenting the market.

The EU Specifications themselves are managed by ERA with the contribution of the Sector to ensure on one hand error-free stable set of requirements for interoperability, and on the other hand to introduce in a compatible (add-on) manner business-driven innovation. Whenever possible compatibility shall be kept and evolution should be considered through plug and play add-on.

Vehicle authorisations issued by ERA, including the ERTMS on-board, ensures smoothly that ERTMS software changes do not lead to re-authorisation of the vehicle.

Article 21(12) of Interoperability Directive sets out the conditions when a new authorisation is required: in particular it is required for the relevant TSI to define the conditions when a change of the subsystem triggers a new authorisation ("how big is big"). The error corrections implemented in the software kernel embedded in the ERTMS On-Board Unit must be managed by the original equipment manufacturer under its own responsibility: there is no practical possibility for a third party to assess the relevance of those changes in a proprietary, safety critical, real time architecture. Under the conditions of full responsibility of the manufacturer (in fact as required by the interoperability legislation for the applicant), the CCS TSI revision can explicitly exclude the requirement for a new authorisation.

A structured change control management (CCM) is defined for the ERTMS specification, and applied since 2006. The Agency maintains the accessible database of all changes requested by sector and NSAs, and processed according to the CCM in the different working groups. The CCM process deals with requests for clarification or requests for change of the specification. This is a well-established process that is efficient if individual suppliers notify as soon as they find potential issues while the products are still in development phase. In that case the ERA responds within 2 months and there is no impact on real products. Otherwise, an impact on product quality and project costs is likely to occur.

At the moment, there are a number of change requests registered in the CCM database that are linked to potential errors in the Baseline 3 specification that will need to be addressed in the near future. In addition there are likely to be new change requests raised as lessons are learnt through the widespread deployment of Baseline 3. The solutions defined above in the regulatory domain are in principle enforceable for new projects and products.

This is not sufficient to ensure the interoperability of the harmonised system throughout Europe: this goal requires that also existing on-board products and trackside implementations are maintained in a planned and pre-established manner.

To this effect, the ERTMS MoU 2016 identifies the management of software releases as an essential element to ensure all the products and system throughout EU are maintained in line with the interoperability specifications, avoiding the different "islands" of specifications "frozen" creating interoperability barriers and market fragmentation.

Action	Responsible	Involved	Timeline
Agency's Opinion on error corrections of Baseline 3 with publication of the error corrections	ERA	EC	2H17
Supervision that Agency's Opinion is implemented (correction and mitigation in applicable configurations)	ERA	NSAs, IMs, MSs, RUs, suppliers	In place from 2018
To ensure that ongoing maintenance and upgrade provisions are included in commercial arrangements	RUs, IMs	Suppliers	Ongoing
Regular Agency's Opinion on error correction raised as lessons are learnt through the widespread deployment of Baseline 3, with consideration to define duration of appropriate intervals for software update	ERA	EUG, suppliers, EC	2H18 onwards
Monitor optimisation of On-Board Unit upgrade cost	ERTMS Platform	DMT, RUs, suppliers	To monitor from 2018

2.5 Funding/financing of ERTMS: trackside and on-board

Considerable support for ERTMS deployment has been offered through the TEN-T and CEF programmes since 2007, with over EUR 1.2 billion having been committed to date. In addition the cohesion policy (currently ESIF) funds have been used extensively to support ERTMS in cohesion Member States and regions.

Grant support through these funding mechanisms will remain vital for rapid ERTMS deployment, both trackside and on-board, across the EU and will need to be targeted to achieve maximum impact. EU funding support beyond grant funding, for example through blending, deployment funds, EFSI or increased use of private finance, should be considered more actively by the rail industry.

Work through the ERTMS business case has identified that RUs, in particular those operating in international environments, can have difficult business cases for deployment as retrofitting costs can be high, and benefits (seen at system level) difficult to capture in a competitive environment. Additionally cross-border infrastructure will continue to be an important EU priority in order to drive technical solutions between two different Member States.

Cohesion Member States rely substantially on ESIF funds, and notably on the Cohesion Fund, for overcoming their infrastructure gap and being better integrated into the internal market – it is therefore crucial to ensure an adequate level of support from the Cohesion Fund, with the direct supervision of the Commission, to the deployment of interoperability in those Member States.

In the broader picture, Member State support will continue to be vital to deliver ERTMS deployment. There are considerable opportunities to support RU deployment to a significant extent, assisting in deploying ERTMS more quickly. In general, for interoperability measures, Member States can provide support up to 50% of eligible costs. This threshold can be exceeded if Member States demonstrate the need and proportionality of the measures in question. For example, as part of a broader investment package, the Czech Republic are potentially providing very significant support for an on-board retrofitting programme, with potential support of up to 85% of eligible costs⁸.

Further, there may be opportunities through joint purchasing schemes or investment platforms to enable RUs, in particular smaller organisations, to achieve economies of scale in purchasing.

Action	Responsible	Involved	Timeline
Finalise business case study in order to anticipate RUs non ability to invest on time and identify success conditions to achieve a business case for each impacted actors	DMT	RUs, IMS, EC	1H18
Analysis of future guidelines for ERTMS support, in particular in the context of the next multiannual financial framework	EC	DMT, MS, RUs, IMs, Unisig, suppliers	1H18

⁸ The DG COMP case is at http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=3_SA_44621

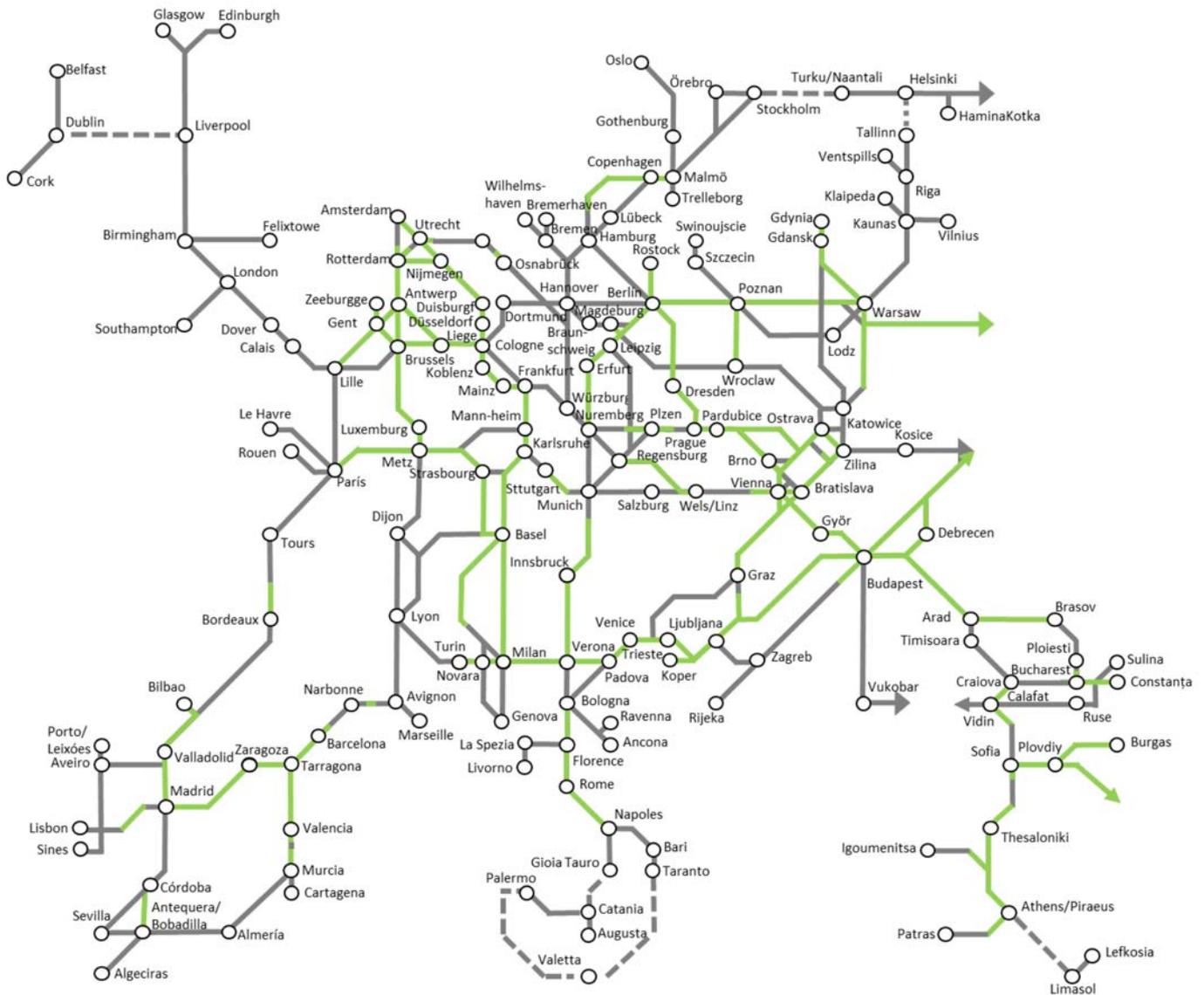
3. Implementation and monitoring

Monitoring and coordination of this plan set out in this document will primarily be carried out by the ERTMS Stakeholder Platform Coordination subgroup, with unresolved issues being flagged to the ERTMS Stakeholder Platform Board.

The Terms of Reference of the Coordination subgroup describe the role of the group and may be amended and updated as appropriate.

Appendix A: ETCS in operation by 2023

ETCS operational lines (either passenger or freight) shown in green on the schematic map of the Core Network Corridors.



Appendix B: Cross-border sections complete by 2023

Corridor	Country 1	Country 2	Cross-border section	Date country 1	Date country 2
BAC - OEM	Austria	Czech Republic	Wien - Breclav	In operation	2018
BAC	Austria	Slovenia	Wendorf - Maribor	2023	2023
MED	France	Spain	Le Soler - Barcelona	In operation	In operation
MED	Slovenia	Hungary	Hodos	2017	2018
NSM - NSB	Belgium	Netherlands	Antwerpen - Breda	In operation	In operation
NSM	Belgium	Luxembourg	Ciney - Luxembourg	2022	In operation
NSM	France	Luxembourg	Thionville - Bettembourg	In operation	In operation
NSM	Luxembourg	Germany	Outrange <--> Bundesgrenze	2017	Corridor ends here
NSM	France	Switzerland	Mulhouse - Basel	2020	2017
NSB	Poland	Germany	Poznan - Frankfurt Oder	2023	2020
NSB - RALP	Germany	Belgium	Aachen - Boetzelauer border	2020	2020
NSB - RALP	Germany	Belgium	Aachen - Herengrath	2022	In operation
OEM	Czech Republic	Slovakia	Breclav-Devinska Nova Ves	2018	2023
OEM -RDN	Hungary	Austria	Parndorf - Hegeyshalom	2022	2022
OEM -RDN	Hungary	Romania	Budapest-Curtici	2018	2018
OEM	Bulgaria	Romania	Vidin-Calafat	In operation	2018
RALP	Germany	Switzerland	Basel node	2017	2017
RALP	Switzerland	Italy	Raron - Domodossola	2017	2017
RDN	Germany	Czech Republic	Schirnding <--> Cheb	2023	2023
RDN	Germany	Austria	Passau - Wels	2020	In operation
SCM	Germany	Denmark	Snoghoj - Flensburg	2020	2023
SCM	Austria	Italy	Innsbruck-Brennero	In operation	2020
RALP	Switzerland	Italy	Veza - Chiasso	2017	2018