European Commission

EUROPEAN RAIL TRAFFIC MANAGEMENT SYSTEM

Deployment Action Plan

THE TRANS-EUROPEAN TRANSPORT NETWORK

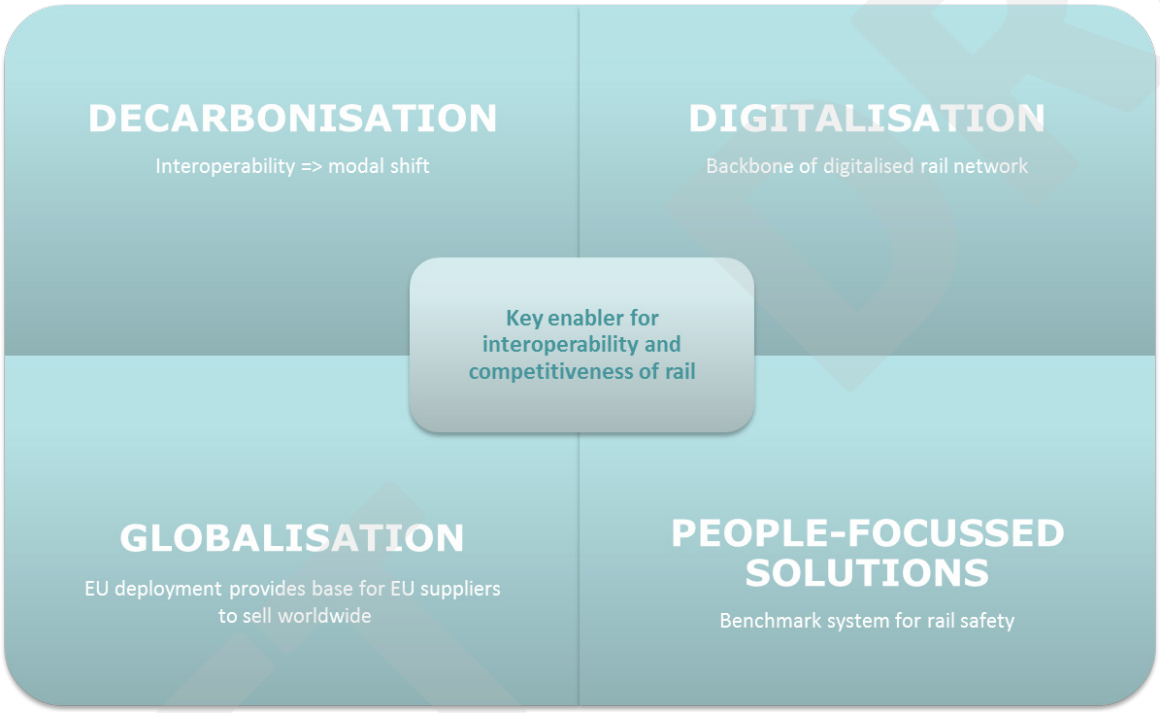
Mobility and Transport

THE EUROPEAN RAIL TRAFFIC MANAGEMENT SYSTEM (ERTMS) DEPLOYMENT ACTION PLAN

1. Introduction

ERTMS is a major industrial program to harmonise the automatic train control and communication system and ensure interoperability throughout the rail system in Europe.

As the differences among the large variety of national legacy train control systems constitute the single most important barrier to interoperability of the European rail system, deployment of ERTMS will be provide the backbone for a digital, connected Single European Rail Area. ERTMS will also be the key enabler to introduce innovative technologies in an effective manner.



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

• **Fourth Railway Package:** The technical pillar of the Fourth Railway Package 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. Finally, a new process has been introduced by the Fourth Railway Package concerning the pre-approval of the ERA of trackside implementations. The set of measures introduced by the Fourth Railway Package will lead to enhanced interoperability and compatibility between on-board and trackside subsystems

• **Stability of specification:** The stability of the specification is frequently mentioned as the most critical element for a wide-scale deployment. This remark refers to the fact that the previous specification

Interoperability

DIRECTIVE 2008/57/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 June 2008 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.

With regard to ERTMS deployment, interoperability means achieving and maintaining compatibility, where compatibility is the legal and technical certainty that a compliant Baseline 3 (R1 and R2) ERTMS On-board Unit (OBU), 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 2 (version 2.3.0d, legal since 2008) has been lacking some functionalities, which in turn have been implemented in member state or even project specific variations. The Commission adopted the new Technical Specification for Interoperability in June 2016 that gives legal status to the ERTMS specification that is considered functionally complete and that should be kept stable in the coming years. The adoption of this regulation was a major milestone in the development of the specification and of the ERTMS breakthrough program. This specification includes the main Change Requests that the Member States 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 will no longer be 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 NSAs to produce/implement TSI compliant products (Article 6).
- Transparency towards Railway Undertakings: 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: obligation 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 includes introduces different aspects agreed by the sector in the 2012 "Memorandum of Understanding". These include GPRS, in order to addresses problems of spectrum capacity in areas with high frequency of trains the spectrum has limited capacity, and key management to protect the messages between the infrastructure and the train from cyber-attacks. This specification is backwards compatible with the current versions in the TSI in force 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 (EDP):** On 5 January 2017 the European Commission adopted an implementing regulation on the new ERTMS EDP (Commission Implementing Regulation (EU) 2017/6). It sets targets dates until 2023 by which about 30-40% of the Core Network Corridors shall be equipped. In 2023, the ERTMS EDP will be updated again setting out the precise implementation dates for the remaining part of the Corridors between 2024 and 2030.

• **The 2016 Memorandum of Understanding (MoU)** 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 a truly interoperable system based on a stable specification (Second Release of Baseline 3). 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.

• **Karel Vinck's Breakthrough Programme for ERTMS**, which defines a limited number of principles to support and accelerate ERTMS deployment:

- Users first and not Designers first
- Entire priority and focus on deployment
- A cost structure which supports the competitiveness of the railway system
- Standardised on board equipment

• **At the end of 2017** almost 4.500 kilometres of lines will be operational on core Network Corridors 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 300 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).

Despite this progress much work is still required to achieve an EU-wide deployment of an interoperable system. However, the ERTMS systems deployed so far do not yet constitute an interoperable system.

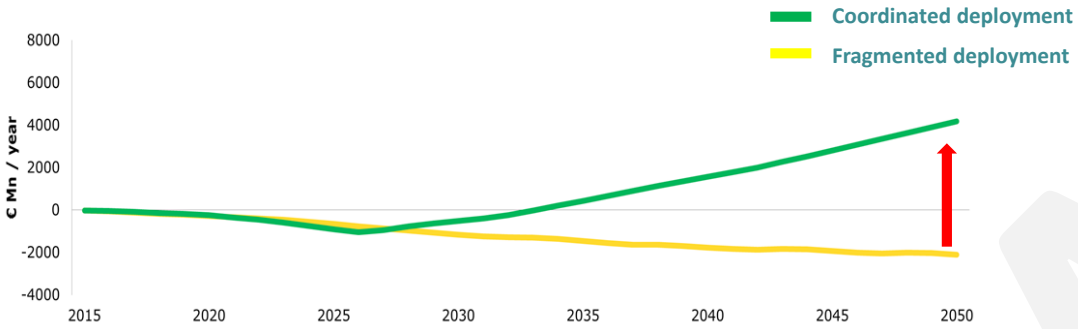
Barriers to achieving interoperability include:

- Uncoordinated ERTMS trackside deployment between and within Member States.
- Requirements introduced on to On Board Units (OBUs), for example by national rules, the necessity of running on different infrastructures, interactions with class B systems, or changes introduced by RUs – these changes can result in OBUs that can run in one Member State but not another and can increase costs through customization.
- 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.

The benefits in addressing these barriers – reducing costs and increasing efficiencies of deployment - to achieve an interoperable system are considerable.

Similarly, the costs and risks of not addressing these barriers and deploying in a fragmented fashion are similarly large. Ultimately all involved stakeholders need to work constructively to achieve the desired goal of interoperability.

Sample Corridor Business Case



Looking at the longer-term perspective, 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 allow the plug-in of innovative solutions (modular approach), in particular those realized through research and innovation within the 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.

This action plan is therefore a document addressing the necessary steps to address identified barriers and to achieve ERTMS interoperability. It builds on and incorporates the significant steps that have already been taken, recognising that the basic regulatory framework is in place, and focussed on the critical next phase of implementation. It encompasses the commitment in the MoU to provide a detailed plan with concrete actions and defined deadlines.

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 objectives to deliver this are as follows:

- **Interoperable and compliant infrastructure**

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

For new projects, trackside installations are deployed using modular pre-tested configurations, according to engineering rules valid for entire networks: this allows for a cost effective out-contracting 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.

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 in service with ERTMS, allowing a single train with a compatible ERTMS on-board unit to travel seamlessly across the whole European core network.

- **Standardisation of OBU**

  Vehicle authorisations issued by ERA ensure interoperability of the OBU.

  Locomotives and trainsets installations are based on generic, pre-tested and pre-validated kernel SW/HW proprietary for each supplier (i.e. a standardised OBU 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.

- **Testing and Validation**

  Efficient cross tests of (the standardised) OBU 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 OBU) or trackside (in RBC or RBC combined with IXL) 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.

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

- **Financing/financial 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

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

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2.1.1 ERA approval of trackside

The 4th Railway Package introduces a new task for the ERA that will, from June 2019, approve ERTMS trackside projects.

The aim of the ERTMS trackside approval is to ensure an harmonised interoperable implementation of ERTMS that will ensure interoperability and therefore contribute to a reduction of costs for rail operators and make 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 specific legislation, related 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 authorizing 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	November 2017
Engaging in learning cases anticipating the 4RP process before 2019	ERA IM		From now to 2018
Successful definition of practical arrangements for trackside approval process	ERA EC	IM RISC	1 H 2018

2.1.2 Addressing non-interoperable infrastructure

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 B3.

The vast majority of lines in service today are based on pre-B3 specifications. Their specific implementations must be assessed against the BCA (Baseline Compatibility Assessment) report, and if necessary, the mitigation measures defined in the BCA must be implemented to ensure the compatibility with B3 trains.

To date, this review of trackside implementations against BCA has been done only in a limited number of cases (we note that ADIF completed it for their entire ERTMS network, L1). This review should be carried out by more infrastructure managers.

Additionally for the next TSI revision, the removal of baseline 2 from the TSI should be considered, recognising that this will encounter significant resistance from Member states where deployment (and contracts) is based on Baseline 2.

Action	Responsible	Involved	Timeline
Identification of non-interoperable infrastructure	ERTMS Users Group, with INECO	IMs, ERA, EC	To report December 2017
Development of strategy to address currently non-interoperable infrastructure, including: • Defining general principles to address upgrades and changes • Prioritising those infrastructure situations, which are leading to wider interoperability issues • Understanding the technical and financial requirements to address the identified cases • Development of approach, technical and financial, to work with IMs to address the key infrastructures	ERA/EC	DMT, RFC	Approach to be developed by 1H18

2.1.3 Resolving incompatibilities between trackside and OBU preserving the interoperability of the OBU

Where incompatibilities between a compliant Baseline 3 OBU and trackside are identified, for example through testing or where national rules or requirements are in place, it is general practice to make changes to the OBU, potentially rendering it incompatible with other compliant infrastructures.

A key action therefore is to consider the process for addressing incompatibilities which does not impact interoperability of the OBU, including through greater emphasis of addressing incompatibilities at the trackside level.

This will require a set of matching commitments from IMs and suppliers so the IM can commit to implement n the short term the necessary measures on their implementations coupled with a credible commitment and planning of suppliers to deliver an upgrading procut and system compliant with future planned releases.

Action	Responsible	Involved	Timeline
• 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 MSs and NSAs to address	ERTMS Platform	ERA, EC, IMs, NSAs	First cases to be considered 2H17

2.1.4 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 (EDP) was adopted with realistic target dates in January 2017. The aim of this reviewed EDP 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 track-side equipment in order to achieve full benefits of interoperability. The focus now turns to Member States and the Infrastructure Managers committing to timely implementation of the EDP with the essential objective that Baseline 3 equipped locomotives can run on those lines.

The recently adopted ERTMS EDP sets out the implementation dates on Core Network Corridors (CNC) by 2023. It also stipulates that a review procedure shall 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 EDP is to find technical solutions for cross-border sections. Agreements between the affected IMs shall 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 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 EDP implementation is crucial in particular to ensure transparency towards railway undertakings 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 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. 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 Interoperability Directive. Based on the received NIP's DMT is preparing a synthesis about the availability of ERTMS and removal of Class B systems that will be publicly available

Action	Responsible	Involved	Timeline
Implementation of the EDP. Agreement between the affected infrastructure managers shall be signed for solution of cross-border sections (agreements shall be notified to the Commission by Member States). List of cross-border sections can be found at Appendix A.	IM, RFC	EC, DMT, ERA	Progressively: one year before the earlier of the deployment dates for the given cross-border section,
Notification of progress of implementation via TENtec	MS		Progressively, one month after putting into operation.
Synthesis of NIPs	EC	DMT	Publication of synthesis by end 2017
Report on implementation progress of EDP	EC	DMT	First report to be published in the beginning of 2018, then on a yearly basis
Review and extension of EDP for the CNC sections to be implemented between 2024 and 2030.	EC		Review procedure should be finalised not later than 31 December 2023, it should start in 2021.

2.1.5 Decommissioning class B systems

Currently, even in situations of ERTMS deployment, the 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.

In addition to the benefit of simplifying technical complexity while withdrawing one of the signalling systems, decommissioning has a huge economic potential and 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 locos 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.

With the introduction of the National Implementation Plan in the 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 (EDP) – the adoption of legally binding target dates for removal of Class B system. The definition of those target dates should be carried out in the frame of the EDP 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, in line with the users' first principle of the Breakthrough Programme, would lead to genuine cross-EU interoperability, operational savings for both IMs and RUs, and streamline MS specific rules and requirements.

2.1.6 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 or reliability 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 OBU which can work against the goal of a more standardised OBU product. 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 and MS	NSA	Ongoing to Dec 2017
Identification, categorization and prioritisation of rules,	ERA, EC		Process begins 2H17 completing 1H18
Case by case discussions on mitigation and potential removal	NSA	ERA	Ongoing

2.1.7 Harmonisation of Engineering Rules

Engineering rules are the rules that govern the designing principles of the network (for example the transition between Class B and ETCS L1). 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, we observe that ERTMS implementations follows different engineering rules for different lines/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 are to be identified.

The first priority is to avoid that in the same network different engineering rules are applied. This approach is defined in the draft Practical Arrangements and the draft EC Regulation for the 4RP ERTMS trackside approval. IMs are requested to develop generic rules that can be applied in a repeatable manner in all specific implementations. This will facilitate verification of conformity, testing and authorization: it will also make possible a more "industrialized" process to deploy ERTMS at the ambitious pace required by EU objectives for EDP and Core Network.

The rules identified as rules that realistically can be harmonised at EU 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.

Incentives should be provided for Infrastructure Managers using a single and transparent set of rules, such as in CEF calls and 4th railway package trackside approval process.

Action	Responsible	Involved	Timeline
Identification of the existing sets of engineering rules regarding transitions between systems (class B/ERTMS, ERTMS L1/ERTMS L2 etc)	IM in learning cases	DMT ERTMS User Group	From now to June 2018
To consider whether incentives should be provided for Infrastructure Managers using a single and transparent set of rules, such as in CEF calls and 4th railway package trackside approval process.	ERA, EC		From 2H18

2.1.8 Contractual / commercial issues

There are a number of measures relating to contractual and commercial issues that can promote interoperability in particular to promote standardization through development and use of tender templates.

Action	Responsible	Involved	Timeline
Production of tender template	CER	ERA, EC, ERTMS stakeholder platform, suppliers	Summer 2017
Development of strategy to promote use of template, including assessment of how fast the supply market can be adapted to users expectations	EC	Suppliers, RUs. IMs	November 2017

2.2 Standardisation of OBUs

Vehicle authorisations issued by ERA ensure interoperability of the OBU.

Locomotives and trainsets installations are based on generic, pre-tested and pre-validated kernel SW/HW proprietary for each supplier (i.e. a standardised OBU 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.

2.2.1. ERA authorisation of vehicles

As per 4RP, from June 2019 ERA will authorise vehicles, including ERTMS on-board (both new and retrofit), for international traffic and for national traffic at the request of the applicant. This process will ensure that vehicles are interoperable.

Action	Responsible	Involved	Timeline
Participation of ERA in learning cases	ERA	RUs, manufacturers	From now to 2019
Publication of complete process for authorization	ERA	EC, RISC	2018
Process to ensure interoperability of OBUs which will continue to be authorised by the NSAs (e.g. NSA monitoring, NoBos monitoring)	ERA	EC	2018 (4RP general planning)
Monitoring and audits of Notified Bodies	ERA	NoBos	Adoption of Guidelines June 2017

2.2.1 Minimising impacts on class B system interactions with the OBU

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

Such an approach is complex however, given the approaches taken by suppliers and requested by RUs, and some optionality within the TSI which can work against this aim.

Additionally, customised and bespoke interfaces create favourable conditions for suppliers (at least in the short term), and therefore changes to a more commoditised approach are not likely to be straightforward.

The current TSI CCS states:

"The Class B train protection systems may be implemented:

(1) using an 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 legacy systems onboard.

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 OBU.

Additionally, for economic reasons, the 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. GSM-R modem (EDOR) is only needed in Level 2 or euroloop is only needed in Austria and Switzerland. Trains running only on compatible Level 1 infrastructure without GSM-R modems would not be able to run on Level 2 infrastructure.

Considerations such as the "cold movement detection" function, where there are the potential for National Rules hindering interoperability based on potential interpretations of the TSI are dealt with in section 2.1.6.

Action	Responsible	Involved	Timeline
Production of route map to achieve standardised OBUs (i.e. identification of useful technical solutions and light impact assessments) including:	ERA	DMT, EC	
• Analysis of EDP and NIP to determine where problems/priorities are for transitions, class B interaction, optional requiremets (L2, Euroloop)	DMT		from now to end 2018
• definition of most relevant geographies or sectors (e.g. freight)	EC, ERA, DMT		from now to end 2018
• Engagement with IMs to explore possible changes to requirements/plansto provide a more attractive case for RUwith standard OBU	ERA, EC, RALP		2018 on
• Consideration of review of TSI including potential restriction of STM in TSI	ERA		from now to end 2018
Use RALP Deployment Fund to determine exact requirements in terms of Class B and ETCS OBU for RALP traffic	EC/IMs/ MSs/RUs	ERA, EIB	Final study results: 1H18
Consideration of priority in CEF calls to trackside implementations with pure ETCS, not legacy system in parallel/overlay/backup	EC/INEA		Timing dependent on CEF calls

2.2.3 Contractual/commercial issues

The production of the tender template outlined in Section 2.1.7 also has relevance to the approach to produce a more standardized OBU, in particular to ensure that such contracts include services to upgrade/maintain software where errors are identified in products or specifications.

15. Testing and validation

Efficient cross tests of (the standardised) OBU 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.

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. Due to the high variety of trackside implementations that is allowed by the system, compatibility needs to be tested between the on-board 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 operational 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	Technical Opinion by Septermber 2017
Transparency and publication of operational test scenarios for testing, in accordance with Chapter 6 of the TSI, including the creation of a template for facilitating the notification of the operational test scenarios for testing.	IM ERTMS Platform	ERA	June 2019
S2R "Zero on-site testing" project	S2R	S2R members	Finalised August 2022

2.4 Maintaining ERTMS in a reliable and consistent manner

The software installed on board (in OBU) or trackside (in RBC or RBC combined with IXL) 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.

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

The stability of the ERTMS functionality is the means to ensure protection of investments and compatibility as defined in the ERTMS MoU. The additional functionalities of the identified Game Changers will be defined in a manner ensuring they can be implemented as compatible "add-ons".

In complex systems like ETCS, it cannot be ruled out completely the possibility to detect deficiencies that can lead to different implementations in projects/products, potentially affecting the interoperability of the system. Therefore an efficient and coordinated process to address deficiencies 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 – in line with the users first principle - is to give priority to mitigation/correction measures trackside, avoiding modifications to the OBU (see section 2.1.3). The complementary part of the strategy, addressed here, is that consolidated error corrections, leading to OBU software updates, will be scheduled at appropriate intervals in the future.

Therefore, we will enable the vision where the software installed on board (in OBU) or trackside (in RBC or RBC combined with IXL) 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.

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

The Interoperability Directive article (21) defines the conditions when a new authorization is required: in particular it is required for the relevant TSI to define the conditions ("how big is big"). The error corrections implemented in the software kernel embedded in the ERTMS OBU must be managed by the OEM 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 TSI CCS revision can explicitly exclude the requirement for a new authorization.

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 (CR) requested by sector and NSA, 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 17 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.

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 harmonized 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.

To this end the Technical Opinion of the Agency will propose:

- That the Agency will publish immediately, and in the future will maintain regularly updated, the solutions and the mitigation measures identified for the error CRs logged in the database
- That the trackside mitigation measures identified for each CR must be implemented in existing projects where there is a risk to encounter the situation
- That the design, testing and certification of future products and systems take full account of all the CR solutions published in the Website of the Agency from the date of 1.1.2022

Action	Responsible	Involved	Timeline
Technical Opinion on error corrections of Baseline 3	ERA	EC	June 2017
Define process of the role that ERA/EC can play to facilitate the process of ERTMS software releases being managed in a consistent and regular fashion to take advantage of the current pre-deployment environment of Baseline 3 to avoid frozen islands of specification	Suppliers, RUs	ERA, EC	Finalised by December 2017
Use of tender template to ensure that ongoing maintenance and upgrade provisions are included in commercial arrangements.	Suppliers, RUs		Ongoing

2.5 Funding of ERTMS: trackside and on-board

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

Considerable support for ERTMS deployment has been offered through the TEN-T and CEF programmes since 2007, with over EUR 1.2 bn 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 lagging behind.

Future EU-level funding support is likely to be constrained, and will need to be targeted ever more effectively. EU funding support beyond grant funding, for example through blending or deployment funds, 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 countries rely substantially on ESI funds, and notably on the Cohesion Fund, for overcoming their infrastructure gap and being better integrated into the internal market – it seems therefore logical to ensure an adequate level of support from the Cohesion Fund, with the direct supervision of the Commission, to the deployment of interoperability in these countries.

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. For example, as part of a broader investment package, the Czech Republic are potentially providing very significant support for an onboard retrofitting programme, with potential support of up to 85% of eligible costs1.

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.

1 The public version of the DG COMP case is at http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=3_SA_44621

Corridor	Country 1	Country 2	Cross Border	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	Oetrange <--> Bundesgrenze	2017	Corridor ends here
NSM	France	Switzerland	Mulhouse - Basel	2020	Corridor ends here
NSB	Poland	Germany	Poznan - Frankfurt Oder	2023	2020
NSB - RALP	Germany	Belgium	Aachen - Boetzelaer 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	Kalsruhe - Basel	2022	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	Vezia - Chiasso	2017	2018

Appendix A: Cross-border sections complete by 2023