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Network access challenges following the deployment of ERTMS

May 2024

Introductory remarks

This paper details the main results of the investigation initiated in 2023 by IRG -Rail to get a better understanding of the implication of ERTMS deployment for network access across Members States.

The paper focuses especially on ERTMS deployment modalities ("National Implementation Plans" publication, coordination of trackside and on-board implementation, financing plan), on its added value for the development of the Single European Area and on potential barriers to market entry (incompatibilities, costs, lack of information, lack of international coordination, etc.).

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Introduction

A key principle in railway regulation is the promotion of *"interoperability of the national rail networks"*[1] to improve the efficiency and competitiveness of the Single European Railway Area[2] (SERA). As far back as 2001 it was already clear to the European Commission that: "*no railway system can be fully competitive unless all matters relating to the removal of technical barriers to trade in trains and to their interoperability (…) are resolved first*"[3].

Although freight wagons and a large proportion of coaches have, for several decades, been technically capable of travelling throughout Europe, the same cannot be said still today of locomotives and self-propelled trains, which suffer numerous constraints concerning electrification and signalling systems (see Annex 1 for more details). In fact, significant differences remain among the railway networks in Europe, most of which have been built from a national perspective. However, it should be noticed that in other means of transport there is a high degree of harmonisation of safety rules (aviation, road, inland navigation, etc.) even in presence of national systems and networks. By its very essence, this lack of harmonisation in the railway sector acts as a brake on competition. The quest for competitiveness therefore presupposes harmonisation of standards, particularly those relating to safety.

To close gaps, remove bottlenecks and technical barriers, the EU has been developing the trans-European transport network (TEN-T) based on common planning of infrastructure and regulatory measures to facilitate investment and funding support. Moreover, different legislative "railway packages" were issued with the aim of gradually opening rail transport service markets to competition and making national railway systems interoperable.

Regarding signalling systems, the European Commission promotes the European rail traffic management system (ERTMS) designed to replace all existing signalling systems within Europe. In addition to interoperability, the potential advantages of ERTMS are expected to reduce maintenance costs of the signalling systems as well as

[1] According to Article 2 of 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 European Union (Recast of Directive 2008/57/EC) "*interoperability means the ability of a rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance*".

[2] According to Directive (EU) 2016/797 "*In order to enable citizens of the Union, economic operators and competent authorities to benefit to the full from the advantages deriving from the establishment of a single European railway area, it is appropriate, in particular, to improve the interlinkage and interoperability of the national rail networks as well as access to those networks and to implement any measures that may be necessary in the field of technical standardisation as provided for in Article 171 of the Treaty on the Functioning of the European Union (TFEU)*".

[3] White paper - European transport policy for 2010 - Time to decide (Commission of the European Communities, 2001, page 29). This document included some 60 measures intended to "*refocus Europe's transport policy on the demands and needs of its citizens*" over the next 10 years.

increased speed of trains, capacity of infrastructure and level of safety in rail transport. However, in certain cases, such as the 1:1 replacement of the existing signalling system with ETCS, there may also be a reduction in capacity.

Despite these potential advantages and vigorous political pushes at EU level, ERTMS implementation is still, after several decades of work, a great unfinished idea: the expected and desired level of implementation is far from being reached, resulting in patchy applications at European level and a potential fragmentation of national versions of ERTMS[4]. In addition, ERTMS deployment is affected by a lack of financial and human skilled resources and delays in infrastructure modernization, as well as Member States' failure fail to coordinate networks' developments, hampering cross-border interoperability[5].

In this context, IRG-Rail aims with this paper to:

- set out a short overview, from the regulatory bodies' perspective, on the deployment of ERTMS and the existing and ongoing challenges at the European level (section 1);
- investigate the main administrative, technical, and economic issues impacting the ERTMS deployment (section 2); and
- describe the measures put in place by some regulatory bodies to mitigate the market issues and facilitate the ERTMS implementation (section 3).

Data and information reported in this document stem from an extensive questionnaire circulated within IRG-Rail. Answers were received from 17 countries.

[4] See:

- *ERTMS Second Work Plan of the European Coordinator*, Matthias Ruete, July 2022, page 60: "*We need to make sure that for all this, we have the appropriate governance in place. With ERA, we now have a European ERTMS system authority. ERA, as the ERTMS system authority, prevents national ERTMS deployments from undermining interoperability and especially addresses the issue of implementation of additional national requirements.* […]. *We also need to make sure that the current ESC/RSC process will result not only in the identification of many ERTMS dialects but also in the identification of shortcomings in the ERTMS testing and validation phases*".
- *A single European rail traffic management system: will the political choice ever become reality?* European Court of Auditors (2017), paragraph 59: "*The lack of compatibility of the ERTMS equipment is also the result of the fact that the industry prepares tailor-made solutions adapted to the specific requirements of each Member State, which are not always compatible. Potential problems and errors are usually not publicly communicated, and this affects the learning curve and makes it difficult to find common solutions*".

[5] See also the report "Costs of Non-Interoperability" ERA Briefing Note, March 2023

1 European law aims at harmonizing control-command and signalling (CCS) systems

The railway infrastructure and transport services operating on it have been developed historically at regional and national levels through different technical specifications and operating rules, leading to a heterogeneous railway system across Europe and complex cross-border operations between Member States.

From the 1990s onwards, to foster the opening of the rail transport market to competition, the EU has carried out a continuous process of technical and legal regulations with the aim to achieve a common and interoperable railway system in Europe. This includes standardisation of safety and signalling subsystems, mainly through the Control Command and Signalling Technical Specifications for Interoperability (CCS TSI)[6]. In that sense, cab signalling and radio based ERTMS are key for achieving generic CCS solutions, helping to reduce complexity, costs and national requirements of the European railway system.

1.1. CCS systems are fragmented across Europe leading to interoperability challenges

Historically, it was simply the train driver's responsibility to follow the signals, but as train speeds and safety requirements have increased over time, automatic train protection systems (CCS systems) have been developed to ensure a high level of safety and efficient performance of rail traffic.

In essence, CCS subsystems[7] are train protection systems that rely on the technical compatibility between onboard and track equipment to:

i. allow data communication between the track and the train;
ii. supervise train movements;
iii. transmit orders to the driver; and
iv. enforce a speed reduction or a stop order if there is no adequate response from the driver when the permitted speed on a given section is exceeded, and if necessary, emergency brakes are activated automatically.

As outlined above, common technical solutions are also necessary to overcome cross-border (even domestic) technical barriers created by the different stand-alone and non-interoperable national signalling systems. Indeed,

[6] Commission Implementing Regulation (EU) 2023/1695 of 10 August 2023 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union. This Regulation has recently repealed the Commission Regulation (EU) 2016/919 of 27 May 2016.

[7] Definition of the CCS subsystems, both trackside and onboard, is established in Annex II to Interoperability Directive (EU) 2016/797 as well as in chapter 2 of the Annex I to 2023 CCS TSI, including the parts of which it is composed.

legacy systems (also called class B systems) were usually developed by a national or a single manufacturer[8] for a single client, entailing a sort of proprietary "locked-in system", creating untransparent technical specifications, low onboard upgradeability and, therefore, dependence on the initial suppliers. Even the fact that two or more Member States use the same legacy system does not imply that they are compatible as the same systems could have different versions.

Currently there are roughly 30 different national signalling systems still in place[9], as shown in figure 1 below, with sometimes different developments for conventional lines and high-speed lines:

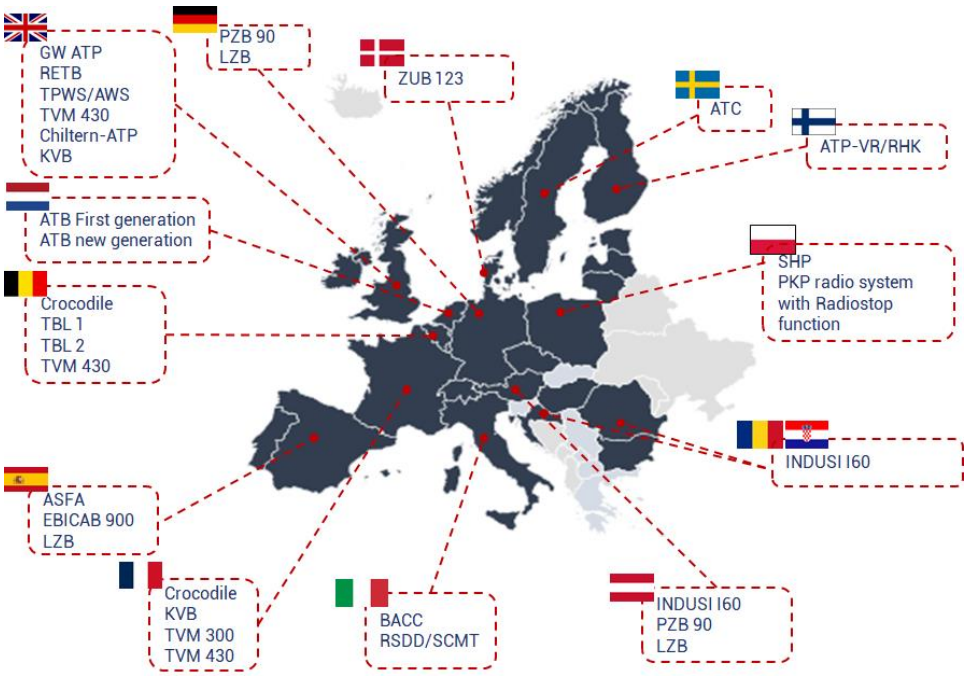

Figure 1 - Class B safety systems within Europe (source data: transport.ec.europa.eu)

For these reasons, ERTMS, which will gradually replace these legacy systems, is one of the key enablers for the completion of the Single European Railway Area as well as for the digital and sustainable rail transition in Europe.

[8] For example, in France, the high-speed lines class B system has been developed by Hitachi and the conventional lines class B system by Alstom.

[9] The latest List of Class B train protection systems and voice radio systems can be found in chapters 3.3 and 3.4, respectively, of Annex II to the 2023 CCS TSI.

1.2. ERTMS aims to overcome interoperability issues related to signalling systems

ERTMS is a major industrial project being implemented in Europe based on a complex software system which has required an active specifications' development and revision in EU rail legislation since the first research projects in the 1980s. The initial ERTMS version was created in 1990. Since then, requirements and technical specifications have been progressively introduced and amended over time.

ERTMS is composed of the Class A train protection system called ETCS (European Train Control System) and the Class A radio system called GSM-R (Global System for Mobile Communications-Railway)[10]. Depending on how the trackside is equipped and how information is transmitted to the train, different ETCS/ERTMS levels[11] are defined. Currently, there are two implemented levels, both providing continuous supervision onboard:

- Level 1 is a spot transmission of information between the train and the trackside via Eurobalise (which is a transponder deployed on the trackside and connected to the signalling equipment).
- Level 2 provides a continuous transmission of information between the train and the trackside via radio. The train reports its position and direction of travel to the control center automatically and receives movement authorities; Eurobalises (fixed) serve mainly as position references. It allows the complete removal of lineside signals.

Figure 2 below gives an overview of the scope of the main legislation directly related to ERTMS at the European level.

[10] Draft release specifications relating to the Future Railway Mobile Communication System (FRMCS) and automated train operation (ATO) were included in the 2023 CCS TSI.

[11] If a trackside included in the scope of the CCS TSI is not equipped with the Class A train protection system, the Member State shall ensure the availability of a Specific Transmission Module (STM) or products and/or specifications that would allow the integration of its legacy Class B train protection system with the Class A on-board system. STM is a version of an onboard class B safety system that allows standardised interfacing with the ERTMS-equipped rolling stock to run on an infrastructure equipped with a class B safety system.

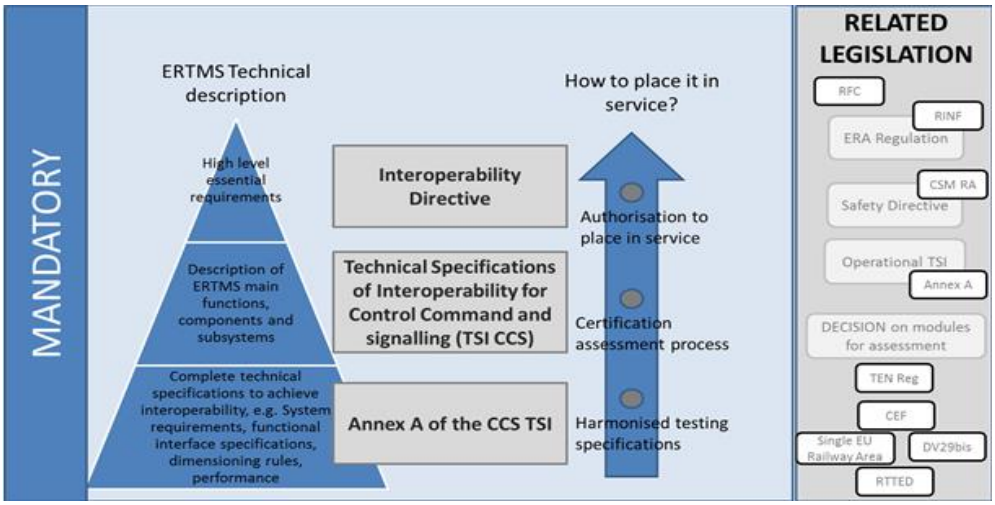

Figure 2 - ERTMS legislation (source: transport.ec.europa.eu)

In terms of specification of ERTMS, the CCS TSI (Technical Specifications of Interoperability for Control Command and Signalling) represents the legal basis. It considers the 2016 ERTMS Memorandum of Understanding between the European Commission[12], the European Union Agency for Railways (ERA) and the European Rail Sector Associations[13] that sets up the objective to achieve and maintain legal and technical compatibility between different versions or baselines[14].

In terms of deployment of ERTMS, on the one hand, the CCS TSI states that Member States shall draw up a National Implementation Plan (NIP) describing their actions to comply with the CCS TSI and their deployment strategies

[12] https://transport.ec.europa.eu/document/download/77d0de7c-0279-4dc6-98b9-594a876f1427_en?filename=ertms-mou-2016.pdf

[13] CER, EIM, EPTTOLA, ERFA, the ERTMS Users Group, GSM-R Industry Group, UIC, UNIFE and UNISIG.

[14] As indicated in https://transport.ec.europa.eu/transport-modes/rail/ertms/faq-ertms_en *"The baseline is a stable kernel in terms of system functionality, performance and other non-functional characteristics. As the ETCS has evolved over time and new functions and corrections have been added, different baselines have been defined:*

- *"Baseline 2'' was the first set of requirements, considered interoperable, and to be adopted at European level.*
- *"Baseline 3" was a further development of Baseline 2 that includes additional functions and backward compatibility.*
- *"Baseline 4" is a further development of baseline 3 and encompasses the set of requirements currently included in the 2023 CCS TSI regarding ATO and FRMCS*".

(see also §2.1.1). On the other hand, the Trans-European Transport Network Regulation (EU) 1315/2013[15] has been recently revised[16] to make the network greener, more efficient and more resilient, in line with the European Green Deal and the Sustainable and Smart Mobility Strategy[17]. It establishes ERTMS as one of the priorities for railway infrastructure development and sets out a deadline for its deployment on the Core Network by 2030, on the extended Core Network by 2040 and on the Comprehensive Network by 2050[18].

Moreover, the 2017 European Deployment Plan (EDP), adopted by the European Commission, sets out deadlines for deploying ERTMS on some sections of the Core Network Corridors (CNC) covering the 2017-2023 period[19]. As the ERTMS deployment is linked to the TEN-T network development, both timetables prioritise the cross-border rail links considered strategic at European level.

1.3. ERTMS deployment status

In July 2022 the European coordinator for ERTMS, Matthias Ruete, published the "*ERTMS Second Work Plan of the European Coordinator"*. The plan includes a stocktaking of the ERTMS trackside and rolling stock deployment and analyses the progress made, measured against the 2017 EDP, with a cut-off date of June 2022[20].

[15] Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on the Union guidelines for the development of the Trans-European Transport Network.

[16] A provisional agreement on a revised TEN-T regulation has been reached on 18 December 2023 by the Council presidency and European Parliament's negotiators.

[17] These EU documents call for a major modal shift to rail and set the milestones to double high-speed rail traffic by 2030 and rail freight traffic by 2050, which requires an increase in rail transport capacity that cannot be obtained without a large-scale acceleration of the roll-out of the ERTMS throughout the EU.

[18] The TEN-T consists of the following layers:

- The Core Network mainly includes the high-speed lines.
- The Comprehensive Network aims to ensure the connectivity of all regions in the EU.
- With the revision of the TEN-T Regulation, a third layer – the extended Core Network – has been added as an intermediate milestone, to be completed by 2040. Together with the Core Network, they will form nine European Transport Corridors which are the most strategic part of the network with highest EU added value, integrating the former Core Network Corridors with the Rail Freight Corridors. ERTMS shall also be deployed by 2040 on the entire TEN-T extended Core Network and, as a novelty, national systems shall be removed.

[19] In July 2021, CNC was extended by 9680 km according to Regulation (EU) 2021/1153 of the European Parliament and of the Council of 7 July 2021 establishing the Connecting Europe Facility and repealing Regulations (EU) No 1316/2013 and (EU) No 283/2014 (CEF 2 Regulation).

[20] The analysis does not cover sections of the CNC that were included by the CEF 2 Regulation, resulting in a total length on the CNC of 59,055 km.

In terms of rolling stock deployment, the paper shows that the number of vehicles equipped with ERTMS is increasing but it is still relatively small and very different from the objectives set by the EU and Member States. The report estimated that, by the end of 2019, around 5,700 vehicles, "representing only 12.5% of the European commercial fleet" were equipped with ERTMS (40% new, i.e. 2,300 vehicles, and 60% retrofitted) and that this percentage had increased up to around 17.2% at the end of 2020. Moreover, between 2015 and 2019, around 54% of new vehicles were put on the market without ERTMS despite the CCS TSI obligations requiring that, starting from 2015, every new purchased rolling stock must be equipped with ETCS, with limited exemptions.

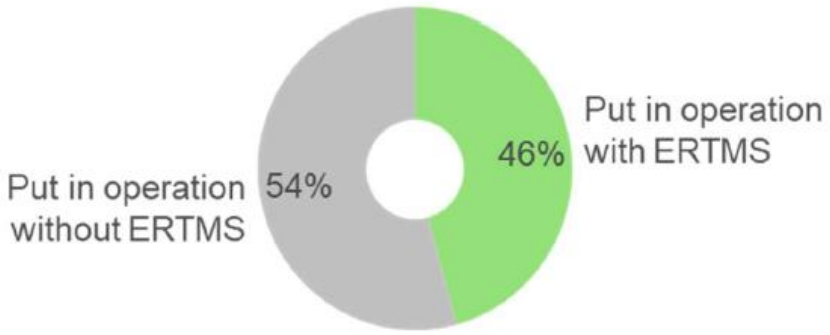

Figure 3 - Renewal fleet between 2015 and 2019 (source: ERTMS 2nd Work Plan of the European Coordinator)

In terms of track deployment, 14% of the revised CNC network (i.e. 59,055 km) was in operation in 2022 with ETCS (i.e. 7,965 km), which means 4,600 km were delayed (although 87% of them are under construction). Furthermore, only 7 out of 70 CNC cross-border sections were equipped with ETCS on both sides of the border compared to 23 cross-border sections that should have been equipped with ETCS by 2023[21]. Based on the Member States data, 40,875 km on the CNC are supposed to be equipped with operational ETCS by 2030 (i.e. 69% of the revised CNC network). The following map presents the current status of the ETCS deployment on the CNC.

[21] Additionally, the ERTMS Deployment Plan sets that railway infrastructure managers should sign an agreement on technical and operational aspects of the deployment for each cross-border section, but only 7 cross-border agreements have been received.

Figure 4 - ETCS deployment status in CNC – 06.2022 (source: ERTMS 2nd Work Plan of the European Coordinator)

Track deployment data shows large discrepancies among Member States. According to IRG-Rail Eleventh Annual Market Monitoring Report[22], the average ERTMS/ETCS-enabled route in 2021 between 16 Member States reporting data is equal to 6% (see figure 5).

[22] Eleventh annual market monitoring working document, April 2023, https://irg-rail.eu/download/5/958/IRG-Rail-11thMMReport-WorkingDocument.pdf

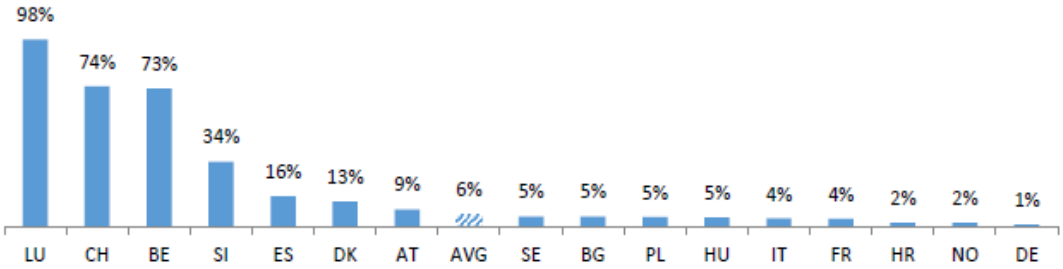

Figure 5 - ERTMS/ETCS-enabled route share of total route length in 2021 (in percent)

As pointed out in the report of the European Commission about a business case for ERTMS deployment on the nine corridors[23], ERTMS can only bring the expected benefits[24] if both trackside and onboard equipment are installed in a coordinated way. According to the paper, a dual onboard strategy, which consists of processing in parallel the ERTMS trackside deployment and equipping the whole fleet with ERTMS on top of the legacy system, in a given period, is expected to be the best migration strategy in term of benefits and economic outcome, even if this involves more costs. This would allow keeping only one trackside system once ERTMS is deployed on a given line. However, the decommissioning of the Class B systems trackside[25] is only possible if almost the entire fleet is equipped with ERTMS.

[23] *ERTMS business case on the 9 core network corridors – Second Release,* DG Move, 2019

[24] In addition to the creation of an interoperable European railway system, the ERTMS has the following advantages in comparison to national Class B systems:

- Greater safety, reducing the possibility for human error.
- Increased traffic capacity by reducing the headway between trains.
- Competitive transport mode, enabling the development of cross-border rail services.
- Lower production, implementation and maintenance costs by standardisation and single CCS subsystem.
- Higher speeds, reliability, and punctuality rates.
- Decarbonisation, digitalisation, and innovation key enabler.

[25] Class B decommissioning plans have been announced in many Member States with deadlines between 2025 and 2040.

2. Administrative, technical, and economic issues could affect the ERTMS deployment

2.1. ERTMS deployment differs across Europe with weak coordination between Member States

This section provides an overview of the investigations carried out by the IRG-Rail in 2023 to get a better understanding of the deployment process of the ERTMS across Members States.

The findings of IRG-Rail questionnaire corroborate the fact that the deployment strategy of the ERTMS varies significantly from one Member State to another depending on various considerations related to the characteristics of the rail network, the performance of the existing Class B system as well as the cost-benefit balance of the ERTMS deployment at a nationwide level.

These differences mainly concern national implementation plans (§2.1.1), ERTMS roll-out strategies put in place by each country (§2.1.2) as well as funding policies (§2.1.3) with weak coordination between Member States (§2.1.4).

2.1.1. The visibility of national plans for ERTMS implementation could be improved

Under the CCS TSI, National Implementation Plans (NIP) are expected to be critical instruments for the roll-out of ERTMS across Member States. NIPs can help predict the direction of ETCS rollout in specific countries and are fundamental in forming a vision and preparing for future system integration. However, as pointed out in the responses to the questionnaire, the NIP does not appear to perform this function in several countries.

According to the new CCS TSI adopted in 2023, Member States must notify their updated NIP to the ERA and the European Commission by 15 June 2024[26]. The NIP must cover at least 20 years and be updated at least every 5 years. It must include:

- the general migration strategy, including the assessment of the needs expressed by the railway undertakings (RU) and the infrastructure managers (IMs);
- the description of the status, including Class B systems and their remaining economic lifetime with a description of the measures taken to ensure open market conditions; and
- a technical migration strategy with detailed timelines for equipping lines with ERTMS and decommissioning Class B systems to set out "*steps to be followed for the implementation of fully interoperable 'control-command and signalling' (CCS) subsystems*"[27].

[26] According to the article 5(4) of new the TSI CCS which were adopted in 2023, with EC Regulation 2023/1695, "*Member States shall notify their national implementation plan drawn up in accordance with point 7.4.4 of the Annex I to the Commission and the Agency by 15 June 2024.*"

[27] Article 6 of Commission Regulation (EU) No. 2016/919 of May 27, 2016 (CCS TSI).

The answers of the IRG-Rail members have shown that for a little over half of respondents (Austria, Croatia, Denmark, France, Germany, Lithuania, Luxembourg, the Netherlands, Spain, Sweden – 10 out of 18) the official version of the NIP is available on the European Commission's website in accordance with Section 7.4.4. of the CCS TSI (see also Figure 6).

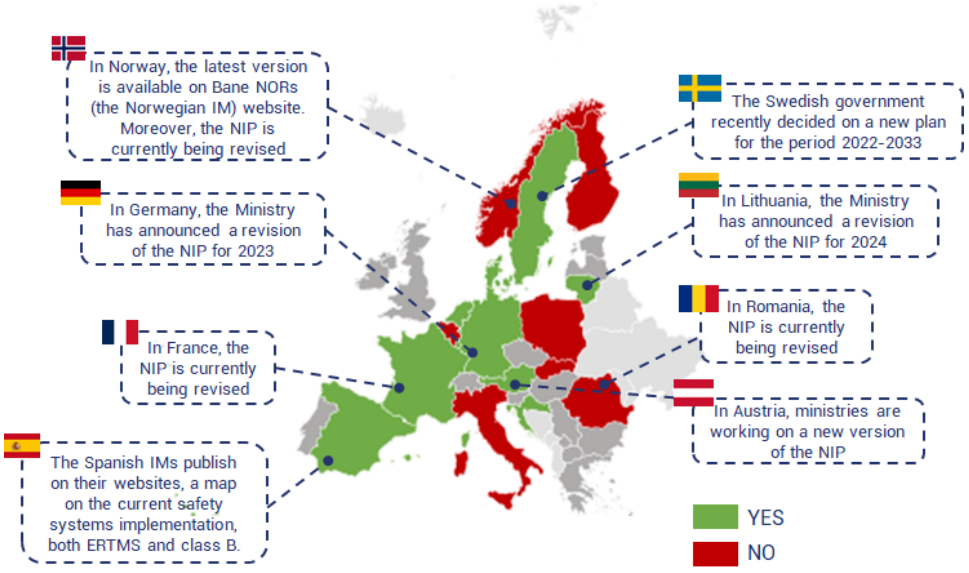

Figure 6 - Is the NIP communicated to the European Commission the latest official version?
(Source: data collected by the IRG-Rail in April 2023)

However, due to the consultations between different parties which are needed to elaborate this plan, the official NIP is not frequently updated (the latest version generally refers to the 2017-2019 period). For instance, in Germany, France, Austria and Sweden, a revision of the NIP data has been announced but there is still no update published in the European Commission's document. In Germany according to information provided by DSD project group (Digitale Schiene Deutschland), the updated NIP should be published by summer 2024.

Moreover, in some cases the document content is quite general, and the deployment plan timeline is not in line with the real situation (for instance Croatia and Sweden).

For this reason, to provide transparency and visibility to industry players (railway companies, manufacturers, etc.) on the future ERTMS developments and their deadlines, updated information can be found and is provided by:

- the IM in the Network Statements (Austria, Denmark, France, Germany, Italy, Norway[28], Slovakia, Spain[29]). For instance, the Italian IM (RFI) periodically updates the implementation plan of ERTMS on its network, publishing each updated revision on its e-Pod database[30];
- the government (Italy[31], Poland);
- or on a website dedicated to ERTMS deployment. This is the case for example of Austria[32], Denmark[33], Belgium[34], Sweden[35] and Finland[36]. In the Netherlands[37] a progress report on the rollout of ERTMS is often published twice a year.

The publication of centralised and updated information is necessary to improve the transparency that operators need to anticipate installation of their onboard equipment in a manner compatible with that of the trackside equipment.

[28] Link to the latest Norwegian NIP (in English)
https://www.banenor.no/contentassets/6c4adecaa39541b7acc39389ae122de3/national-signalling-plan-2023_english.pdf

[29] The Spanish IMs publish on their websites, apart from the relevant national statement, several maps including one on the current safety systems implementation, both ERTMS and class B. Additionally, chapter 2.6.1 of the national statement refers to the works planned on the railway infrastructure, including those related with ERTMS.

[30] Link to NIP is available inside the Network Statement.

[31] Last NIP version is available inside the NS of IM.

[32] https://infrastruktur.oebb.at/en/partners/rail-network/documents-and-data/etcs-train-control

[33] https://uk.bane.dk/en/Projects/About-the-Signalling-Programme

[34] https://infrabel.be/fr/project/etcs

[35] https://bransch.trafikverket.se/en/startpage/suppliers/ertms--european-rail-traffic-management-system2/

[36] https://digirata.fi/en/

[37] https://www.ertms.nl/english/default.aspx

2.1.2. National strategies for ERTMS deployment should be much more harmonized between Member States and the deadline for decommissioning class B systems should be clearly set out

Member States set out, under their NIPs, different approaches for both trackside and onboard deployment to meet the key timelines for ERTMS deployment plan on the TEN-T network (cfr. §1.2).

ERTMS trackside strategies

Different implementation strategies have been adopted by Member States to reach the objectives of EU law mentioned in §1.2. The answers to the questionnaire from IRG-Rail members corroborate and integrate existing information.

- In terms of deployment scope, many countries (Austria, France, Germany, Italy, Spain, Sweden, etc) adopted a "prioritised deployment" strategy[38] which consists of prioritising the deployment in some sections considered of higher importance (for example, high-speed lines on TEN-T and interconnection lines between corridors) due to economic and/or technical difficulties to intervene on the whole network. However, not all Member States limit themselves to the Core, Extended Core and Comprehensive Network of the TEN-T and the corresponding deadlines by prioritizing sections. Indeed, some countries (such as Belgium, The Netherlands, Denmark, and Switzerland), have chosen a more ambitious strategy and decided to go for a "whole network deployment".
- In terms of transition strategy, several countries[39], especially those following a prioritised deployment strategy, have considered dual onboard migration strategy, where, unlike the dual trackside migration strategy, every line is either equipped with ERTMS or a legacy system. Thus, there is an obligation for RUs seeking access to these networks to follow the roll-out plan for trackside deployment. ERTMS-equipped rolling stock can run on class B-lines if a class B system is installed onboard. Moreover, some Member States (such as Luxembourg) have set out decommissioning deadline for class B systems, even if the class B system has not been removed to maintain cross-border railway service.

One of the findings of the impact assessment for the revision of the TEN-T-regulation is that **national approaches based on a prioritised deployment** or a **dual trackside migration without a coordination** can delay or even

[38]See the *Analysis accompanying the impact assessment for the revision of Regulation (EU) N° 1315/2013 on Union guidelines for the development of the trans-European transport network*.

[39] Such as France, Italy, The Netherlands, Denmark, Sweden, and Switzerland)

diminish the economic and technical benefits due to the implementation of the ERTMS system [40]. Indeed, a dual track-side deployment strategy can extend the period for removing the track-side legacy system, leading to additional renewal and maintenance costs and a loss of potential advantages connected to an increase in the capacity available. Moreover, even if a dual on-board strategy can create additional costs for RUs, economic outcome can appear earlier than in the dual track-side strategy where it is necessary to equip at least 90 % of the fleet to collect benefits.

ERTMS onboard strategies

Regarding onboard deployment, the latest version of CCS TSI[41] establishes obligations for ERTMS equipment:

- in the case of newly built vehicles "*that shall be equipped and ready for operation with ETCS*"[42]; and
- for existing vehicles in operation not already equipped, when requesting an extension of the area of use.

However, the regulation does not impose any upgrading obligations for vehicles already in service and already equipped with a previous baseline of ERTMS except where required for technical compatibility.

Just like ERTMS trackside strategies, Member States have introduced different onboard equipment plans. Some further information has been provided by the respondents to the IRG-Rail questionnaire:

- In Austria, new locomotives must be compatible with ETCS in order to be authorised to enter the network. The introduction of new vehicles with PZB 90 systems only is not possible, exceptions are generally not applied. Dismantling of LZB systems on the network of the main IM is targeted for 2030. In Belgium, it will be mandatory to have ETCS on rolling stock with the most advanced version starting from December 2025.
- In the Netherlands, the class B system will be removed with the ERTMS roll-out from the end of 2026 onwards. The possibility for parties to receive subsidies to prepare themselves for the roll-out has also been considered.
- In Luxembourg, class B systems have already been decommissioned. Only locomotives equipped with ERTMS have been allowed since 2020.

[40] ERTMS business case on the 9 core network corridors – Second Release

[41] According to the article 7.4.2 of the new TSI CCS adopted with EC Regulation 2023/1695 of 10 August 2023

[42] However, according to the Article 7.4.3.3 of the Commission Implementing Regulation (EU) 2023/1695 of 10 August 2023 "*Member States may decide to exclude from the obligation to equip with ETCS passenger trains reserved to a strictly local use in accordance with Article 1.4 b) of Directive (EU) 2016/797 and shunting locomotives in service for more than 20 years that operate exclusively on a part of the national network where no ETCS exists and no ETCS deployment is planned for the next 5 years.*"

- In Slovakia, a condition for running a train at speeds higher than 160 km/h is a functional ERTMS (both onboard and trackside).

In most countries there are no legal obligations that imply an ERTMS roll-out plan and the onboard ERTMS deployment for existing rolling stock. Therefore, the decommissioning of Class B systems is moving at a slow pace and only a few countries have included it in their NIPs. The report on the impact assessment of the CCS TSI regulation[43] recommends that "*EU should set out a deadline for decommissioning class B systems, which will contribute on the one hand to push for ERTMS onboard deployment",* so that *"RU will be forced to equip their fleet to run in the European network – and on the other hand to cut maintenance costs*".

2.1.3. Funding for ERTMS varies between countries and public support constitutes the main factor to promote deployment

ERTMS deployment represents a very large investment, and a financial burden for both railway undertakings and infrastructure managers. According to the European Coordinator for ERTMS[44], it is estimated that a total of €37.2 billion is needed to deploy ERTMS trackside on the entire TEN-T Network, while €5 billion are needed for rolling stock deployment. However, the investment conditions have the effect that international trains benefit more than national trains. For example, in Germany only 10-15% of all trains are international trains, so that in this case the national trains would have no advantage without the financing of the ERTMS migration. In addition, the Work Plan indicates that "*in many instances, additional investments are needed to effectively deploy ERTMS (new track circuits, upgrade of the interfaces of the existing interlockings, etc)*". Therefore, the total cost to deploy ERTMS can increase up to €74 billion or even €111 billion, depending on the different scenarios concerning the status of the different national networks.

For this reason, public funding support was put in place at EU level, but also in some Member States to achieve a successful onboard and trackside ERTMS deployment.

First, regarding EU support, two main funding sources have been made available:

- The Connecting Europe Facility (CEF) for which the Commission is responsible for approving each project submitted by Member states; and
- The European structural and investment funds (ESIF) for which projects are selected by the national managing authorities and the financial contribution is approved by the Commission.

[43] CCS TSI Revision – revised ERTMS deployment requirements (Impact Assessment), September 2021

[44] See on page 55 table 4 of the Work Plan 2020 of the European Coordinator for ERTMS

The table below indicates the estimated available budget for supporting ERTMS deployment for 2007 – 2020 period. In 2021, a new multiannual programme was approved by the CEF providing for 2021-2027[45] the same budget as for the 2014-2020 period.

	2007 - 2013	2014-2020	Co-financing Rate
CEF Transport -ERTMS	645	850	Up to 50 %
ESIF	570	1900	Up to 85 %

Table 1 – Main financial supports (in million euro). Source: European Court of Auditors

However, as indicated in a 2017 report by the European Court of Auditor[46], the original allocations to ERTMS projects had been subject to significant decommitments since "*EU financial provisions are not aligned with the life cycle of ERTMS projects, which can be affected among others by long procedures or changes in the technical specifications and national implementation strategies*". Therefore, EU support will not be sufficient to bridge the funding gap for stakeholders.

Moreover, infrastructure managers and railway undertakings are often reluctant to invest in ERTMS due to the expenses entailed and the lack of individual business cases. This is mainly the case for onboard equipment where owners or operators of rolling stock are often entities relying on their own resources, especially for non-PSO services.

Therefore, support from Member States and local authorities remains and will remain a fundamental factor to foster the deployment of ERTMS. This is confirmed by the responses to IRG-Rail questionnaire which indicate that, in a significant number of Member States, trackside ERTMS deployment is backed by a long-term comprehensive state financing plan and/or subsidies from EU (Austria, Belgium, Denmark, Italy, the Netherland, Norway, Romania, Slovakia). Some respondents also indicated that state funding is available for the retrofitting of existing rolling stock.

For other countries, deployment is financed through specific projects. This is the case in Germany, for example, where there are no general subsidies for on-board-equipment, but there are three pilot projects for migration to ERTMS, "Digital Node Stuttgart (DKS)", RFC3 and Cologne-Rhine/Maine (Intercity Express traffic only). Only for the DKS project funding is provided for the retrofitting of existing vehicles for suburban and local train-services and the deployment of the related lines with ERTMS. In Spain, the plan for promoting rail freight transport foresees 12 million euros of state aid for installing ERTMS in freight locomotives.

[45] Commission Implementing Decision of the CEF 2021 call for proposals under the multi-annual work program 2021-2027.

[46] Special Report of the European Court of Auditor n. 13/2017 *"A single European rail traffic management system: will the political choice ever become reality?"*

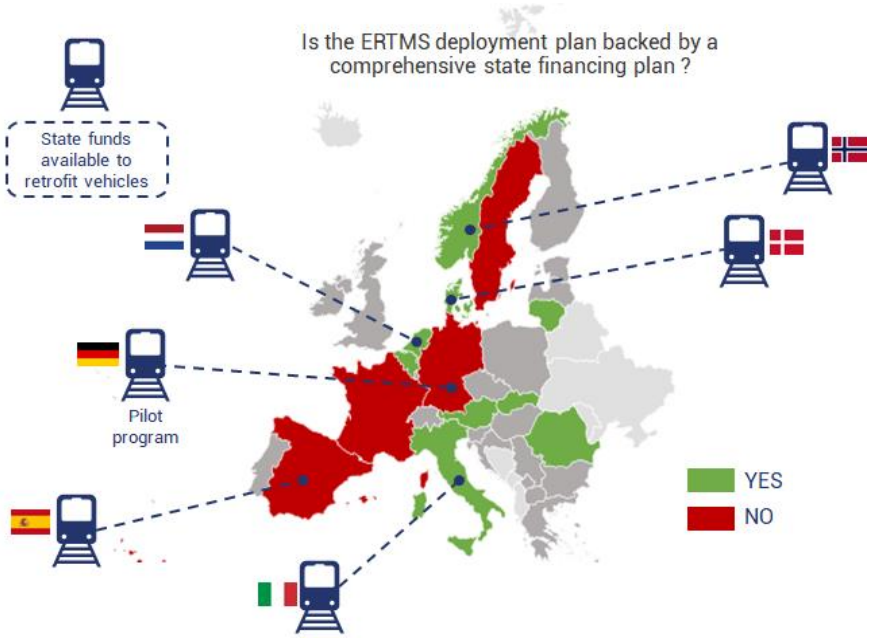

Figure 7 – *Is the ERTMS deployment plan backed by a comprehensive state financing plan?*
(Source: Data collected by IRG-Rail in April 2023)

2.1.4. All parties need to be involved to guarantee better coordination across borders

Article 2 (3) of the 2017 ERTMS Deployment Plan stipulates that IMs should, after having consulted the RUs affected, sign an agreement on technical and operational aspects of the deployment for each cross-border section. Accordingly, there should be a joint effort in cross-border agreements to avoid bottlenecks at the operational stage.

Indeed, the decision by IMs to install ETCS on a line, or part of their networks, often depends on the signalling strategy of their neighbouring countries for their respective infrastructure networks. Taking this into consideration, a single stakeholder cannot deploy ERTMS in isolation.

Most respondents of the IRG-Rail questionnaire have indicated that IMs of neighbouring countries are in contact for coordination purposes or for exchanging information even if there are no written agreements on details of ERTMS configuration, and only a minority of countries have concluded formal coordination agreements.

Moreover, to foster the deployment in a controlled and transparent manner, some respondents have indicated that they have established an entity in charge of the roll-out-coordination between IMs, RUs, and the industry. It can be either a specific agency (Austria, Lithuania), an entity within the IM (Denmark) or the Government (Italy, the Netherlands, Slovakia, Spain, Romania). In Sweden, there is a transparent procedure run by Trafikverket (the Swedish Transport Administration), but the responsibility is divided between different stakeholders.

Nevertheless, for approximately half of the respondents there is neither a governance nor a coordination- specific entity in charge of ERTMS deployment and rollout. This could make it harder to manage large-scale ERTMS project with different parties involved and facing different operational, technical, and economic issues.

2.2.Technical issues generate complexities and delays for ERTMS onboard deployment

According to the CCS TSI[47] "*particular attention shall be given to assessing the conformity of the on-board ETCS interoperability constituent since it is complex and plays a key role in achieving interoperability*".

The investigation carried out by IRG-Rail revealed technical difficulties regarding onboard deployment:

- RUs often face long waiting time to get hold of a new vehicle or upgraded old vehicles.
- Retrofitting is sometimes challenging for old vehicles because of technical and economic reasons.
- In Italy, the regulatory body has been informed by stakeholders about the significant time spent and extra costs coming from the implementation of ESC[48] types on the national network;
- France has indicated difficulties faced by new entrants regarding the equipment of their rolling stock with class B safety systems. The main difficulties concern : i) the lack of transparency regarding class B systems due to poorly accessible documentation, scattered among many players and sometimes insufficiently updated; ii) the possibility in acquiring the "onboard" equipment necessary to replicate the proven high-speed architecture of the incumbent operator; and iii) the know-how and skill asymmetry between the new entrants and the incumbent operator due to its long-term collaboration with manufacturers and its experience in the sector;
- The Working Group Charges met with AERRL (association of European rail leasing companies) and four rail leasing companies. Both AERRL and the leasing companies expressed important concerns on implementation of ERTMS in Europe and on the lack of stability of ETCS due to endless upgrades. Most of the leasing companies are requesting to freeze the upgrades of ERTMS at baseline 3. for at least 10 years. Regarding the issue related to the multiplicity of ERTMS versions, different baselines may coexist together in vehicles and trackside equipment, if there is backward compatibility of the most recent baselines.

[47] Article 6.2.4.1 of the EU Regulation 2023/1695 of 10 August 2023

[48] "ETCS System Compatibility (ESC) shall be the recording of technical compatibility between ETCS onboard and the trackside ETCS part of the CCS subsystems within an area of use. An "ESC type" is the value assigned to record the technical compatibility between an ETCS on-board subsystem and a section within an area of use. All sections of the Union network which require the same set of checks for the demonstration of ESC shall have the same ESC type." (link: https://www.era.europa.eu/content/etcs-and-radio-system-compatibility-escrsc).

In this regard, respondents to the IRG-Rail questionnaire indicated that lines under construction are usually equipped with baseline 3 and that, except in Denmark, existing lines are generally equipped with baseline 2 or a mix of baselines 2 and 3.

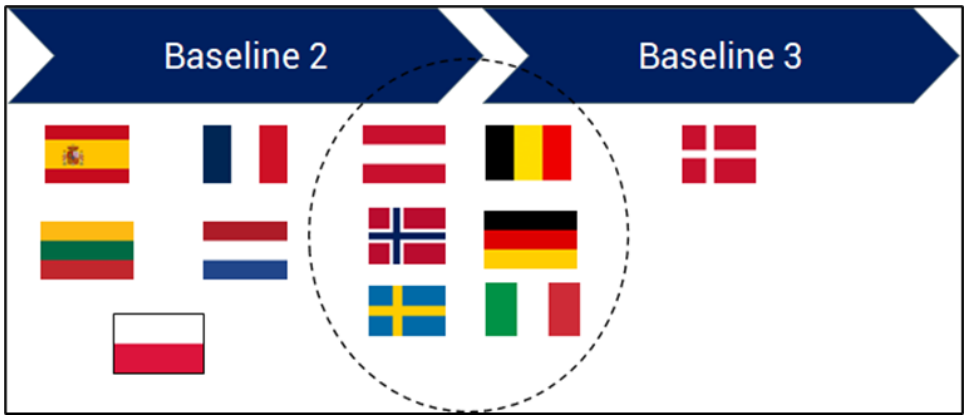

Figure 8 – *What are the ERTMS baselines deployed in your country?*
(Source: Data collected by IRG-Rail in April 2023)

The coexistence of different baselines can generate compatibility issues as baseline 2 rolling stock cannot circulate on baseline 3 tracks. So a first baseline compatibility assessment is necessary to check the compatibility between ETCS baseline 3 and ETCS baseline 2.

Moreover, due to variance in national control-command and signalling equipment, engineering and operational rules, deficiencies in the specifications, different interpretations, design errors, or equipment being installed incorrectly, the interaction between on-board and trackside subsystem can be challenging.

Therefore, ETCS systems compatibility (ESC) checks need to be carried out to demonstrate the technical compatibility of the control-command and signalling subsystems in the area of use for a vehicle.

Responses to the IRG-Rail questionnaire indicate that ESC types appear to be well documented on the ERA website[49]. In general, for a given network, a different ESC type has been defined for each section equipped by each engineering supplier, and, in some cases, even for the same supplier in different sections or in case of sections belonging to different IMs. This can lead for some Member States (such as Italy) to have many ESC tests[50] with high costs for RUs to implement each single ESC type by the supplier (about 600-800 k€ per test). Moreover, there are no common ESC types along the RFC or TEN-T routes.

[49] See reference: https://www.era.europa.eu/content/etcs-and-radio-system-compatibility-escrsc

[50] https://www.era.europa.eu/system/files/2023-05/esc-rsc_technical_document_en.pdf?t=1706276859

2.3. Onboard equipment could be costly depending on the type of vehicle, the quantity of train units, the ETCS version installed and unavailability of the locomotive

The cost for onboard ERTMS retrofitting on a second-hand rolling stock is around 550-600k€ per train unit, which is mainly influenced by the quantities of train units and the type of train[51]. However, on small fleets the costs can be completely uneconomic with one-off costs reaching more than one million Euros even for a single country locomotive. As with the liberalisation of the rail freight market, some small fleets which are sized to meet foreseeable opportunities have developed. This essential market supply support and enabling is now being heavily penalized, according to the opinion of leasing companies.

At their meeting with AERRL and rail leasing companies, the Working Group Charges raised questions about the costs for implementing the ETCS on locomotives. The rail leasing companies contacted offer locomotives in an important number of countries (some of them in more than 17 countries) and can provide a global view on the rolling stock market and the costs of ETCS equipment across Europe.

It is important to distinguish the costs for installing an ETCS system (with the latest version) on a locomotive without any ETCS system from the costs for upgrading a locomotive with already an onboard ETCS system but not in the latest version. There are also other costs related directly or indirectly to the equipment of locomotives in ETCS that are specified below. It is also important to consider the subsidies that the owners of locomotives can receive when they proceed to retrofitting their locomotive in order to install or upgrade the ETCS.

Cost for installing ETCS on locomotives not equipped with ETCS

The leasing companies indicated a range between 800 k € and 1 million € per locomotive – if the locomotive is prepared for an ETCS equipment. Costs could increase for older locomotives, especially if the ETCS equipment has to be developed.

Cost for upgrading the locomotive to the latest ETCS version

The cost for upgrading depends on the level and baseline already installed on the locomotives.

For upgrading a locomotive from the baseline 2.3 to the latest version (SRS 3.6), the cost is in the range of 300 to 350 k €. For upgrading a locomotive already equipped with the baseline 3.4 to the latest version, the cost is in the range of 200 to 300 k €. This last figure is theoretical as in practice, the industry, according to AERRL will not have baseline 3.6 products before 2027 and it is likely that the price will be inflated.

[51] Data from the questionnaire issued by WG Access

Other costs

There are other costs to be borne by the leasing companies related to the ETCS retrofit, such as unavailability costs.

Unavailability costs occurs during the retrofit, as locomotives are no longer operational. This cost is either borne by the owner or by the user of the locomotives. This unavailability period is assessed to last a few weeks during which there is no income generated by the locomotives.

A specific case of the Bombardier locomotives came up due to the merger of Bombardier Transport and Alstom. Bombardier with EBICAB and Alstom with ATLAS both developed their own ETCS platform strategy. After the merger, Alstom decided that there should only be one ETCS system for Bombardier and Alstom locomotives, and it would be the Alstom system called Atlas. Therefore, it is now mandatory for the owners of Bombardier locomotives TRAXX to schedule a retrofit of their locomotives in order to install the Atlas system. This retrofit is mandatory in order to enable these locomotives to receive further ETCS upgrades and thus implies additional costs (for the retrofit) and an additional unavailability period. Swapping ERTMS onboard unit from one brand platform to another brand platform is extremely expensive as the existing gateway between vehicles and ERTMS OBU are not standard and not open source.

New TSI regulations impact the ETCS system. A new TSI was adopted in March 2023. This new TSI mainly relates to the CCS (Command Control signalling) specification and modifies homologation criteria from ERA for locomotives. All locomotives that are retrofitted with an ETCS installation or that have to be upgraded will need to be homologated again (for a second/next time) - before being brought back in service. This raises the concern that older locomotives (10 years and more) will have to be modified to be compliant with the new TSI, even though they have been designed, and homologated based on an earlier version of the TSI. This will therefore require additional retrofitting times for rolling stock materials, thus implying additional costs and unavailability periods. This is viewed as an additional burden and costs for the owner of locomotives.

Regarding subsidies, the owners of locomotives installing or upgrading ETCS on their locomotives can receive subsidies mainly from the European Union representing 10 to 15% of their costs.

3. Several regulatory bodies across Europe have launched investigations regarding signalling systems, with a strong focus on ERTMS

3.1. Some regulatory bodies have completed or launched studies about signalling systems

Several countries have carried out or are planning to carry out general investigations related to network access, signalling systems and ERTMS deployment.

- The Belgian regulatory body is currently carrying out an investigation into network access following the deployment of ERTMS.
- The Spanish regulatory body has recently launched a study on the main technical barriers hampering new entrants in operating passenger and freight services on the national railway network. In terms of signalling systems, the Spanish regulatory body is carrying out investigations on potential difficulties that new entrants may have to deal with, both regarding: (i) the liberalisation process of commercial services on the high-speed lines, such as the Madrid-Seville corridor, which is still equipped with legacy systems (LZB) and (ii) the installation of ERTMS in freight locomotives.
- The UK regulatory body published a study on the signalling market in 2021[52] raising concerns regarding the significant power of two main players on the market and the struggle of alternative companies to compete with them on a level playing field. The report contained recommendations aimed at opening up the railway signalling market and encouraging suppliers to compete on cost, quality, and innovation. A report was published in 2023 updating on progress since July 2022. The report concludes that the mainline infrastructure manager had addressed the majority of the recommendations and that the regulatory body would continue to monitor the market to ensure the changes are working in practice and suppliers are not behaving anti-competitively.
- In France, the regulatory body published in July 2022 a study[53] with recommendations to overcome difficulties related to legacy systems on high-speed lines. It shows that, on the one hand, the deployment of ERTMS in France is lagging compared to neighbouring countries and may be very gradual and, on the other hand, the transitional solutions[54] provided for in the European legislative texts to ensure network interoperability has not yet been fully implemented, leading to difficulties for new entrants[55]. Therefore, the report makes recommendations to remove the entry access barriers to onboard safety equipment, such as:
    i. Designation of an entity responsible for legacy safety systems in France;

[52] Signalling market study – Final report, November 2021, https://www.orr.gov.uk/sites/default/files/2021-11/signalling-market-study-final-report.pdf

[53] Onboard safety equipment, at a time when rail transport services on high-speed lines are being opened to competition, July 2022, https://www.autorite-transports.fr/type-rapport/etude-sur-les-equipements-de-securite-embarques-2/

[54] Transitional solutions are based on the provision of specific transmission modules or, failing that, the adoption of mitigating measures, aimed at facilitating the movement of trains from other European operators on infrastructures equipped with legacy safety systems.

[55] These difficulties affect the design of suitable onboard safety architectures and their implementation under the right conditions, with a view to obtaining the required authorizations.

ii. Establishment of a transparent framework for new players, starting with the design of safety architectures for legacy systems.

iii. Encouraging the opening of legacy systems to ensure the availability of safety equipments;

iv. Maintaining access to the know-how and skills needed to implement safety equipments;

v. Accelerating the deployment of ERTMS on the national rail network and ensuring visibility of the timetable for the players

3.2.Other regulatory bodies have intervened to facilitate the ERTMS implementation

In several countries, regulatory bodies intervened or are planning to intervene to facilitate the ERTMS implementation, either in collaboration with the national safety authority (NSA) or directly:

- The Norwegian regulator provided some recommendations to the NSA to facilitate the award of temporary vehicle authorisations for rolling stock equipped with ERTMS onboard systems in accordance with article 56(3) of the directive 2012/34/EU.
- The Polish regulator proposed a request to changes of the CCS TSI, submitted comments on the draft revised CCS TSI and participated in the CCS TSI revision working groups organised by ERA.
- In Romania, the regulatory body monitors the on-track ERTMS implementation process on the national network as well as on RFC 7, RFC 9 and the TEN-T routes crossing the country.
- In Germany, the regulatory body supervises the Network Statements and the access rules proposed therein for the deployment of ERTMS as well as the information published on the technical specifications of the Network Statement.
- The Swedish regulatory body (Transportstyrelsen) dealt with three cases in 2012-2013 concerning the recent rollout of ERTMS on three lines. Transportstyrelsen found that the Network Statement and the infrastructure managers' procedures contained insufficient information on exemptions and other use conditions.
- The Italian regulatory body, with its opinion n° 227/2022 on the 2024 NS has engaged in discussions with the main IM (Rete Ferroviaria Italiana, or RFI) regarding the excessive number of ESC types and the negative impact it may have on the vehicle authorization process. During these discussions, it appeared that the need for verification of integration between onboard and trackside ESC Type emerged from the specific ERA and NSA obligations[56] (see the box below for more details). Moreover, these obligations also

[56] ERA: "Application Guide GUI/CCS TSI/2020 "Guide for the application of the CCS TSI In accordance with Article 19(3) of Regulation (EU) 2016/796 of the European Parliament and of the Council of 11 May 2016'"; LG ANSFISA (Italian NSA): "Guidelines for the granting of authorizations for vehicles, vehicle types, structural subsystems, and generic applications. Rev. 1".

apply to RUs on the foreign side and the problem of proliferation of ESC types seems to be present in many European countries.

Regarding difficulties arising from the continuation of class B systems, in Austria, the authorisation for the introduction of new locomotives equipped with PZB 90 systems in 2022 was declined due to non-compliance with TSI CCS standards, notwithstanding the railway undertaking's explicit intention to confine their operation within domestic borders and on specifically delineated routes (not equipped with ERTMS), with plans for subsequent retrofitting with ETCS technology in the foreseeable future. The Austrian regulatory body asserted that such an exemption could have been justified under the provisions delineated in paragraph 7.4.3 subparagraph (2) of the Annex of Commission Regulation (EU) 2016/919. However, the NSA refused to grant the necessary authorisation, citing security concerns as the main reason for its decision.

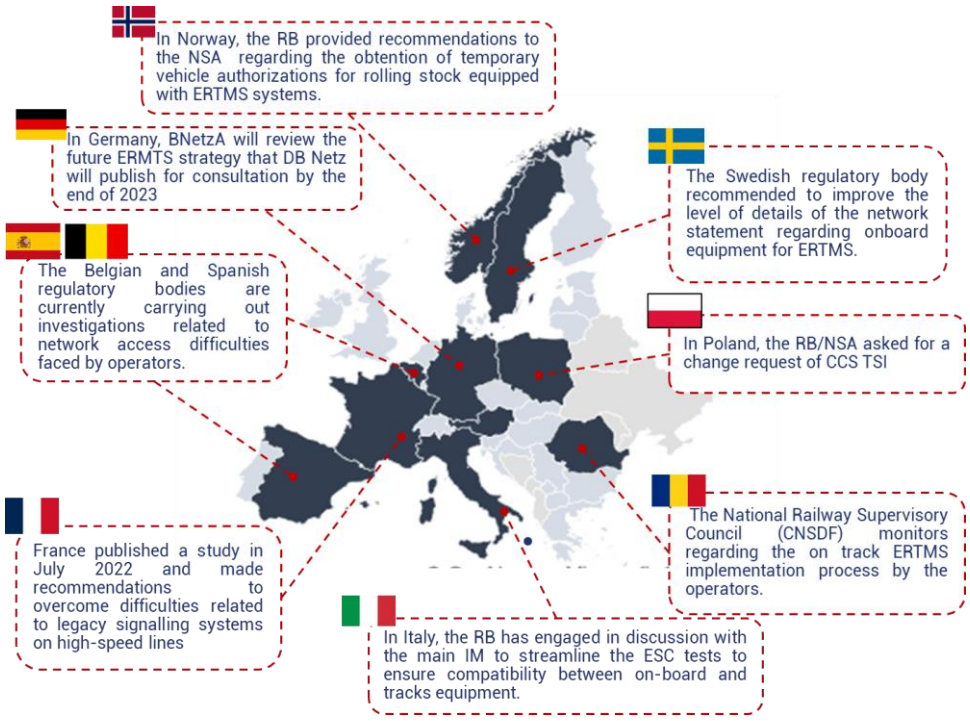

Figure 9 – As a regulatory body, have you carried out work (or are you planning to carry out work) to overcome difficulties arising from (i) the deployment of ERTMS (referring to onboard equipment) or (ii) from the continuation of class B systems in your country? (Source: Data collected by IRG-Rail in April 2023)

The Italian RB experience concerning the ESC Types

The "ERTMS/ETCS and GSM-R Development Plan" (Italian NIP) must be considered essential for the definition and pursuit of the industrial policies of each economic operator in the railway sector. Therefore, ART-IT, with the decision n° 227/2022, has requested the integration of the link to this plan into the Network Statement, for the purposes of transparency, fairness, and non-discrimination towards not only current but also potential applicants. In 2023, during the annual review process of the NS, the Italian RB has requested to the national IM to have a specific update on the status of the ESC Type which is nowadays one of the most important technical/financial barriers to complete and obtain the ERTMS onboard authorization.

The document listing ESC Type is periodically updated; a new update is expected to be published by early 2024, providing for a reduction from 22 to 11 test scenarios. The number of ESC Types is related, among other things, to the presence of different suppliers of the trackside subsystems (SSTs) in the market and the presence on the national railway infrastructure of different ERTMS-ETCS baselines implemented over time (B2, B3 MR1 and B3 R2 (CCS TSI 2016/919/EU)); the number of ESC Types is also related to the continuous updating of ERTMS specifications and products by suppliers.

In this context, the breakthrough program (on TEN-T corridors), which involves the overlay of ERTMS-ETCS to the national Class B system, must also be considered. Starting from 2024, the implementation of ERTMS L2 Stand Alone system is planned, with the simultaneous deactivation of the national class-B system and the gradual upgrading with ERTMS of trains ("accelerated plan").

The national IM has set the goal of defining a single ESC Type for the L1 level for border stations and a single ESC for L1 with RIU (Radio infill United) as on the Novara-Domodossola and Vicenza-Villa Opicina lines; for the L2 level (currently B2) on the HS/HC lines, activated from 2005 to 2009, the aim is to define only two ESC Types (one per trackside equipment supplier) and two ESC Types for the breakthrough program lines (on TEN-T corridors).

Furthermore, the national IM intends to pursue the goal of arriving at a supply market situation such that, at the level of each individual onboard system and trackside system supplier, mutual compatibility between these subsystems is already guaranteed upstream; at a more general level, on the other hand, for new lines, new trackside suppliers will have to ensure integration with the onboard systems produced by at least 6 suppliers (4 different suppliers plus an additional 2 suppliers for certification of the trackside technology).

4. Conclusions

ERTMS is a key component of the European strategy to bring out the Single European Railway Area, where interoperability and market opening would allow seamless transport services across Members States. From the 1990s onwards, the EU has carried out a continuous process of technical and legal regulations, including standardisation and interoperability of safety and signalling subsystems, mainly through the Control Command and Signalling Technical Specifications for interoperability.

Regulatory bodies have a great interest in monitoring signalling systems installed in the network as they are key features for network access. This paper highlights for the first time their work related to ERTMS as well as their concerns. The main conclusions can be summarised as follow:

- Despite vigorous political initiatives at EU level, the progress of ERTMS deployment is slow following. The IRG-Rail Eleventh Annual Market Monitoring Report shows that only 6% of the routes were equipped with ERTMS in 2021 across 16 Members States, with large discrepancies (98% in Luxembourg, 16% in Spain, 4 % in France and Italy).
- The market lacks visibility regarding ERTMS deployment across countries. A wide variety of more or less up-to-date planning documents are published to allow operators to anticipate installation of on-board equipment in a manner compatible with that of the track equipment.
- ERTMS deployment shows a high degree of fragmentation across countries, in terms of deployment strategies, funding discrepancies, national ERTMS versions, or test procedures.
- Onboard equipment for retrofitting and upgrading can be costly for railway undertakings, depending on the type of vehicle, the quantity of train units, the ETCS version installed and unavailability of locomotives.

These difficulties impact network access with various implications across Member States. Therefore, some regulatory bodies have started to investigate this topic, including its impact on new entrants, and have taken actions to improve network access conditions:

- The French regulatory body published a study in July 2022 and made recommendations to overcome difficulties related to legacy signalling systems on high-speed lines.
- The Swedish regulatory body recommended improving the level of details of the Network Statement regarding onboard equipment for ERTMS.
- The Belgian and Spanish regulatory bodies are currently carrying out investigations related to network access difficulties faced by operators.
- The Italian regulatory body has engaged in discussion with the infrastructure manager - RFI - to streamline the tests that have to be carried out to ensure compatibility between onboard and trackside equipment.
- The Polish regulatory body collaborated with the NSA regarding ERTMS.

- The Norwegian regulatory body has provided recommendations to the NSA regarding ERTMS, in accordance with art. 56 (3) of Directive 2012/34/EU.
- In Germany, the regulatory body supervises the Network Statement and the access regulations proposed therein for the ERTMS deployment.
- The Romanian regulatory body supervises ERTMS deployment.

5. Annex 1: Are all these technical issues solved today? (thoughts)

On 12 September 2001, the European Commission adopted a "*White Paper on the Union's future transport policy. European transport policy for 2010: time to decide*" that included some 60 measures intended to "refocus Europe's transport policy on the demands and needs of its citizens" over the next 10 years.

The European Commission indicated several important issues to address regarding railway transport in EU, the first of which was the lack of infrastructure suitable for modern transport and of interoperability between networks and systems. Other issues included the constant search for innovative manufacturing technologies, the non-transparency of costs and the patchy productivity and shaky reliability of rail services, failing to meet customers' legitimate expectations.

In the White paper, some examples of malfunctions affecting railway transport were reported: "

- **Trains don't run properly**: It takes thirty or forty minutes to replace the locomotive on a goods train and to check that the train is in proper working order (changing the locomotive, filling out the composition form, checking the brakes, changing over the driver and crew, inspecting the train, carrying out checks on dangerous materials, checking documents, making up the train, labelling the wagons, train report, checking the rear light). All this work is obviously wasted if the locomotive and crew are not ready on time. According to Werner Kuiper, President of the UIRR, 9 of 20 000 full combined international transport trains investigated, only half were on time.
- **Missing information**: At borders, one network hands over the train to another. They exchange information on loads, destinations, and train composition. Computer links between systems do exist but are not used systematically because they are not particularly reliable, so information is often exchanged on paper. This information may arrive too late, or it may not be accurate, and will need to be checked.
- **"Ghost trains"**: A goods train stops to change locomotive, but it may then be held up even longer while waiting/or a train path to become free on the neighbouring network. A locomotive may have to wait for a train: a train may have to wait for a locomotive. Often there is no information on when they will arrive, which just makes matters worse.
- **One train - lots of drivers**: Relief crew requirements also undermine the productivity of international rail services. Even Louis Gallois, Chairman of the SNCF, has said "I think the Charleroi-Paris route needs five driving crew members: two in Belgium and three in France.
- With all the various delays, the average speed of international rail haulage is only 18 km/hour, **which is slower than an ice-breaker opening up a shipping route through the Baltic Sea!".**

Regarding the interoperability challenges which can hinder cross-border services, the same document reported that with the use of new interoperable rolling stock the **dwelling time** between two frontiers (Italy and France) "*could be cut to 15 minutes for some trains, compared with an average of an hour and a half for the rest*". However, the potential of this new rolling stock were limited, and still today limited by other factors: two drivers are needed for freight trains on the Italian side while one is enough on the French side; obligation of knowledge of the national

language to drive a train; passing tracks have different lengths and sometimes it is necessary to split trains in two, wasting considerable time; there is a difference in maximum tonnage of the trains admitted.

Many of these reported issues are still live after several decades and among them the fragmentation between the various signalling systems even though progress has been made in the direction indicated by the same *White paper* of complete uniformity of such systems among the various States.

Although these problems are often of a technical nature, regulatory bodies can also give their contribution by monitoring and accompanying the work of the NSAs with the goal of achieving the SERA.