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Brussels, *10* July 2017

Permanent Representation
of the Republic of Poland
to the European Union
in Brussels

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Mr Henrik Hololei
Director-General
DG Mobility and Transport
European Commission

~~Dear Mr Hololei~~, *Dear Henrik,*

Please find attached a report from Poland regarding the obligations arising from Article 6(5) of *Commission Regulation (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union.*

Enc.:

- TSI - National implementation plan_PL

Yours sincerely,

/illegible signature/

Sebastian Barkowski

Deputy Permanent Representative
of the Republic of Poland to the EU

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TECHNICAL SPECIFICATION FOR INTEROPERABILITY “CONTROL-COMMAND AND SIGNALLING” NATIONAL IMPLEMENTATION PLAN

Ministry of Infrastructure and Construction of the Republic of Poland

Warsaw, June 2017

Contents

List of abbreviations

No.	Abbreviation	Explanation
1.	CEA	Cost-effectiveness analysis
2.	CBA	Cost-benefit analysis
3.	CEF	Connecting Europe Facility
4.	ERTMS	European Rail Traffic Management System
5.	ETCS	European Train Control System
6.	GSM-R	Global System for Mobile Communications – Rail
7.	ERTMS NIP	ERTMS National Implementation Plan
8.	RBC	Radio Block Centre
9.	REC	Radio Emergency Call
10.	SHP	Automatic Train Braking
11.	RTC	Railway traffic control
12.	STM	Specific Transmission Module
13.	TEN-T	Trans-European Transport Network
14.	TSI CCS	Technical Specification for Interoperability relating to the "Control-Command and Signalling" subsystem – Commission Regulation (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union (OJ L 158, 15.06.2016, p. 1).

1. Introduction

1.1. Purpose of the Plan

The key document setting the development lines for the EU, that is “Europe 2020. Strategy for smart, sustainable and inclusive growth”, considers the creation of a single European transport area as one of the key strategic objectives for the united Europe.

After analysing the development prospects for the Community, the Commission found that effective transport is a prerequisite for maintaining the well-being of the European Union and maintaining its international position. Ensuring territorial cohesion of the EU and improving the free movement of people and goods contributes significantly to improving the single internal market, stimulating economic growth in regions, and enhancing the competitiveness of individual Member States and the EU as a whole.

Therefore, the European Union's policy in the context of developing the transport network is to create a coherent, interoperable and multimodal transport network offering uniform and high technical parameters across the EU. On the other hand, the key challenge to achieving the above objective is to remove existing barriers between the modes of transport and national systems. In this area, the European Commission intends to enforce actively the competition rules across the modes of transport, thereby creating conditions for achieving the above strategic objectives of the EU.

In identifying the key challenges to integrating the Member States’ transport systems at EU level, the White Paper “Roadmap to a Single Transport Area – Towards a competitive and resource efficient transport system” recognises effective implementation of interoperability in the rail sector as one of the key success factors. Railways are a mode of transport where the harmonisation of technical requirements is the most complicated aspect of creating a common transport market since it requires high funds and coordinated multi-stakeholder action across the areas of the railway sector.

This results from historical determinants because in the last few decades railway systems in the individual EU Member States have been evolving independently of each other, based on different technical solutions. The differences make it difficult for railway operators to provide services and requires them to incur higher operating costs (e.g. related to the purchase and maintenance of different types of rolling stock).

The deployment of interoperability, and the associated harmonisation of technical requirements at EU level, should lead to a situation where a train can cross the borders of many Member States without stopping to perform any technical operations (e.g. to change the locomotive).

Implementing interoperability is a gradual process, the implementation of which is planned for many years and requires high expenditure, in particular on the modernisation of railway infrastructure in individual Member States. For the process to be effective, the activities of various railway infrastructure managers must be coordinated at European level by setting common goals and principles for the implementation of interoperability of rail systems across the EU, and then by developing consistent implementation plans at the level of individual Member States and national railway systems so that the final effect is a single, coherent EU-wide rail transport system. The above task is a priority for the implementation of the EU transport policy as it will contribute to creating a single European railway area. Full interoperability of Community railways requires removing the technical, administrative and legal barriers that hinder entry into national rail markets.

In order to facilitate the implementation of interoperability the rail system has been divided into the following subsystems:

1. structural subsystems:
   a. infrastructure
   b. energy

    c. control-command and signalling
    d. rolling stock
2. functional subsystems:
    a. maintenance
    b. rail traffic
    c. telematics applications for freight and passengers

Each of the above subsystems is subject to technical harmonisation based on Technical Specifications for Interoperability.

This “Technical Specification for Interoperability Control-Command and Signalling National Implementation Plan” (hereinafter also referred to as the “Plan” or the “TSI CCS National Implementation Plan”) is one of the tools for deploying the interoperability of Community railways.

The main objective of this plan is to provide railway operators with information on the timeframes of ERTMS installation in Poland so as to enable them to plan their business accordingly, in the context of the gradual fitting of traction vehicles with onboard ERTMS equipment. The TSI CCS National Implementation Plan has been prepared with a view to orienting the implementation of TSI CCS subsystems in Poland to enhancing the coherence of the entire European Union rail system and improving the profitability of the Polish railway system.

Furthermore, this document is adopted to fulfil Poland’s commitments arising under Article 6(4) of Commission Regulation (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the ‘control-command and signalling’ subsystems of the rail system in the European Union (OJ L 158, 15.06.2016, p. 1), hereinafter referred to as “TSI CCS”.

1.2. Contents of the Plan

The TSI CCS National Implementation Plan replaces the “Polish National ERTSM Implementation Plan” adopted in March 2007, hereinafter also referred to as the “ERTMS NIP”. Since its adoption, the plan has become outdated. The major changes in the legal environment in which the ERTMS NIP was created, the changes in the railway traffic control systems of the railway network in Poland, and the planned directions for the development and modernisation of the railway sector require a new document to be prepared to define the key parameters for deploying technical solutions in the area of railway traffic control, command and signalling harmonised at Community level. Thus, the TSI CCS National Implementation Plan is a response to the challenges Poland faces as regards the building of a single European railway area in the context of the implementation of the technical specifications for interoperability relating to the “control-command and signalling” subsystems.

As required by paragraph 7.4.4 of TSI CCS, this Plan includes:

1) general and context description, including facts and figures on existing train protection systems, such as capacity, safety, reliability performance, remaining economic lifetime of the installed equipment and cost-benefit analysis of ETCS implementation – see Chapter 2 of the Plan;

2) definition of the technical migration strategy (overlay onboard or overlay at trackside) and the financial migration strategy (both at infrastructure and rolling-stock side) – see Chapter 3;

3) a description of the measures taken to ensure open market conditions for legacy Class B train protection systems – see Chapter 3;

4) planning, as described in Chapter 4, which includes:

    (i) the dates of ETCS deployment on the different lines of the network (when services are allowed to operate with ETCS);

(ii) the indicative dates of decommissioning of Class B systems on the different lines of the network (when services cannot operate anymore with legacy systems). If decommissioning of Class B systems is not foreseen within a period of 15 years, these indicative dates are not required;

(iii) the dates when existing cross-border vehicles will fully benefit from operation with ‘ETCS only equipped onboard’ on the high-speed network, corridors or other parts of the network. For high-speed services, this date depends on ETCS deployment on the high-speed network and on other parts of the network (e.g. stations being used by these high-speed services); For freight services, this date depends on the ETCS deployment on the corridors and on other parts of the network (e.g. last miles).

Bearing in mind the specific requirements concerning the content of the Plan, as established by TSI CCS, and in light of the fact that this document is not legally binding, the national requirements relating to ERTMS are not set forth in this plan.

In principle, the Plan covers the next 15 years, i.e. 2017-2032, which is in line with the requirements of TSI CCS. However, to provide a more complete overview of ERTMS implementation in Poland, the plan also outlines preliminary assumptions which go beyond the 15-year period and reach the 2050 perspective. However, the data in this respect should be considered as indicative only, given the significant risks associated with the planning of the deployment of the system for such a distant time horizon.

As required by TSI CCS, the Plan will be updated at least every 5 years. The key factors taken into account in the process will include progress in the investment projects, amendments of legislation related to rail transport, and the overall situation of the rail market.

1.3. Data sources

The preparation of this “TSI CCS National Implementation Plan” would not have been possible had it not been for the vital contribution of the actors in the rail industry, and for the information provided by them. The Plan is based on information obtained from:

- infrastructure managers PKP Polskie Linie Kolejowe S.A. and Pomorska Kolej Metropolitalna S.A., which are currently operating ETCS or GSM-R equipment;
- 11 passenger rail operators which represent a total share in the passenger rail transport market of approximately 97 %[1];
- 6 freight operators with a total market share of nearly 85 %;
- The Railway Research Institute (Instytut Kolejnictwa) – the notified body for Railway Interoperability;
- The Office of Rail Transport (Urząd Transportu Kolejowego) – the national safety authority.

The information was collected primarily for the needs of the cost-benefit analysis, which is described in Chapter 2.3 of the Plan. Thus the information concerns the general rolling stock upgrading and extension plans, including the purchase of new traction vehicles (mandatorily equipped with ERTMS) and the upgrading of existing ones. The above entities were also asked about the ERTMS assembly costs, both at onboard and trackside side, as well as the subsequent maintenance costs. Enquiries were also made about the benefits of ERTMS deployment from the perspective of the rail market and about previous experience with the use of existing equipment.

The Plan is also based on information from a number of other sources, such as applicable European or national laws, as well as studies on the rail market and ETCS prepared by the International Union of Railways

[1]Data on rail transport services based on Office of Rail Transport statistics for January-February 2017. Market share according to the number of passengers or weight of goods transported.

and the European Union Agency for Railways.

2. Context of ERTMS implementation

2.1. Description of existing Class B systems

According to TSI CCS, the CCS subsystem consists of the following parts: train protection, voice radio communication, data radio communication, and train detection. ETCS is a class A train protection system, whilst GSM-R is a class A radio communication system. The other systems used to date in individual Member States are referred to as Class B systems. Their list is included in Technical Document of the European Union Agency for Railways ERA/TD/2011-11 of 4 December 2015 (version 3.0).

In Poland, the Automatic Train Braking (Samoczynne Hamowanie Pociągu – SHP) system is the Class B train control system. By analogy, radio with the “radio-stop” feature is the Class B communication system.

2.1.1. Automatic Train Braking (SHP)

SHP is a point control system which is independent of semaphore indications and which ensures proper operation when the railway vehicle travels at speeds of up to 160 km/h, controlling the driver's vigilance. It triggers automatic train braking when the driver does not respond to system indications and fails to press the vigilance button, e.g. when the driver has fallen asleep while the train is approaching a semaphore. As is mentioned above, the system functions independently of the indications of a semaphore at a given moment so it responds in the same way regardless of whether the semaphore displays the “stop” signal or authorises the train to proceed.

The ATP system consists of the onboard part (SHP generator and locomotive electromagnet (resonator) in the right side of the cabin) and the trackside part (SHP trackside electromagnet – resonator). The devices are tuned to the 1000Hz frequency. The principle of operation is based on magnetic coupling of the onboard sensor when it passes the SHP trackside electromagnet (resonator). The coupling generates an impulse read and transformed by the SHP device into a light and acoustic signal which the driver is required to cancel with the vigilance button. If the driver fails to do so, the SHP will automatically apply emergency braking. The train will be able to proceed only after it comes to a halt.

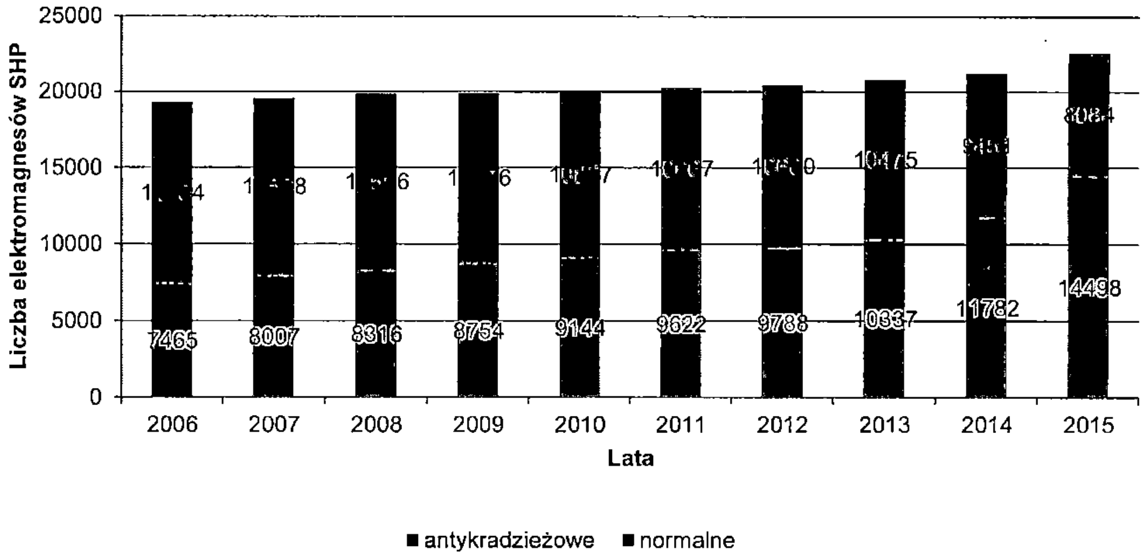
Trackside impact devices (SHP trackside electromagnets) are mounted on tracks, at a distance of 200 m (±5 m) before the signal, and within stations at semaphores (± 5 m). SHP trackside magnets may also be installed before dangerous spots at a braking distance, or additionally, when the distance between neighbouring SHP devices is more than 10 km. Detailed rules on SHP positioning are governed by internal requirements of infrastructure managers.

The SHP system has been installed along a vast majority of railway lines in Poland (about 16 thousand km), and is also mandatory onboard traction vehicles. In 2015, 22 582 SHP electromagnets were installed on the network of PKP PLK S.A., i.e. the main railway infrastructure manager in Poland, including 14 498 units of the anti-theft type, i.e. made of materials which make them less vulnerable to theft. In 2016, the number grew to 23 079 units. The number of SHP electromagnets and their breakdown by type in 2006-2015 is shown in Figure 1.

SHP devices improve rail traffic safety by controlling the driver's vigilance at critical points (at approaches to and exists from railway stations). The system does not affect in any way the capacity of railway lines, as it is role is not to control the train order.

SHP trackside magnets are simple devices, as a result of which their operation is highly reliable. The devices do not require adjustment. The system only needs to be inspected for the condition of the mount by which the device is fixed to the rail, the insulation resistance, and the Q factor of the resonant circuit. The annual failure rate of SHP trackside electromagnets under operating conditions is very low and is around 0.1 %. The table below shows the number of device failures in 2015 and 2016.

Fig. 1. Number of SHP electromagnets fitted on railway lines in 2006-2015 (number of units)



Liczba elektromagnesów SHP	Number of SHP electromagnets
Lata	Years
antykradzieżowe	anti-theft
normalne	regular

Source: “Raport o stanie urządzeń sterowania ruchem kolejowym, telekomunikacji kolejowej i detekcji stanów awaryjnych taboru w roku 2015” (Report on the condition of railway traffic control devices, railway telecommunications, and rolling stock failure detection in 2015”), PKP Polskie Linie Kolejowe S.A.

Tab. 1. Number of SHP trackside electromagnet failures in 2015 and 2016

No.	Nature of damage	Year	
		2015	2016
1.	failure of operation	23	20
2.	theft	11	5
3.	devastation	3	0
4.	for investment-related reasons	1	2
5.	Total:	38	27
6.	Total number of electromagnets:	22 582	23 079
7.	Failure rate	0.16 %	0.11 %

Source: PKP Polskie Linie Kolejowe S.A.

SHP trackside equipment will be in operation at least for the next 20 years. At this stage, dismounting them and decommissioning the system would be unreasonable because of the investments made to date both by infrastructure managers and railway operators, as well as the need for such investments to depreciate.

2.1.2. 150 Mhz radio

Radio communication is based on an analogue, simplex system using 150 MHz band frequencies. The equipment is used both onboard traction vehicles and at technical rail traffic management points of infrastructure managers. Currently, the system is the basic communication system on the Polish railway network used for communications between the dispatcher and the driver, as well as for communication during shunting operations.

For the purposes of train radio communication, 8 channels are used across the country. One specific radio channel is assigned to each railway line. Every vehicle moving on a given line must use only the specific radio channel for communicating with all other units using that channel and with dispatchers.

The ‘Radio-Stop’ area braking system relies on the train radio communications channels. After receiving the ‘Radio-Stop’ signal, each vehicle is stopped by emergency braking, regardless of the driver's will. The function is very important for ensuring safety of the Polish railway system since it can be used as a last resort to avoid a major accident when other risk management measures fail. In recent months, the system has prevented, for example, train collision in Serock in the Kujawsko-Pomorskie province, in January 2017.2

2.2. Legal context of the implementation

2.2.1. Railway infrastructure

The key requirements for the implementation of ERTMS on railway lines in the Member States of the European Union are set forth in the following legislation:

- Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 *on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU* (OJ L 348, 20.12.2013, p. 1, as amended).
- TSI CCS or Commission Regulation (EU) 2016/919 of 27 May 2016 *on the technical specification for interoperability relating to the ‘control-command and signalling’ subsystems of the rail system in the European Union* (OJ L 158, 15.06.2016, p. 1).
- Commission Implementing Regulation (EU) No 2017/6 of 5 January 2017 *on the European Rail Traffic Management System European Deployment Plan* (OJ L 3, 06.01.2017, p.6).

Ensuring the interoperability of the railway infrastructure which forms the Trans-European Transport Network (TEN-T) is essential for creating a single European railway area. Regulation No 1315/2013 specifies which railway lines within EU Member States are part of the TEN-T network. TEN-T is divided into the core network and the comprehensive network. The lines included in the various parts of the TEN-T network for freight traffic are shown in Figure 2. As regards passenger traffic, the system of TEN-T lines is the same, but there are differences in the allocation of individual lines to the core and comprehensive network.

TEN-T lines are subject to specific technical requirements and deadlines for their implementation. Pursuant to Article 39(2) of Regulation No 1315/2013, ERTMS is to be implemented fully on the core network. In accordance with Article 38(3) of the Regulation, the deadline for meeting the technical requirements applicable to the core network corridors, including ERTMS installation, is 31 December 2030. Pursuant to Article 12(2)(a) of Regulation No 1315/2013, the comprehensive network must also be equipped with ERTMS, but the timeframes are much longer here – 31 December 2050.

The two dates – the end of 2030 and 2050 – are the overarching objective as regards the implementation of the ERTMS on railway lines in Europe. The specific dates for the individual sections of the core TEN-T network are laid down by the “ERTMS European Deployment Plan”, i.e. by Commission Implementing Regulation No 2017/6. The document sets forth the deadlines for commissioning ERTMS on the various railway lines, and specifies the procedure for managing possible delays in the deployment of the system. It

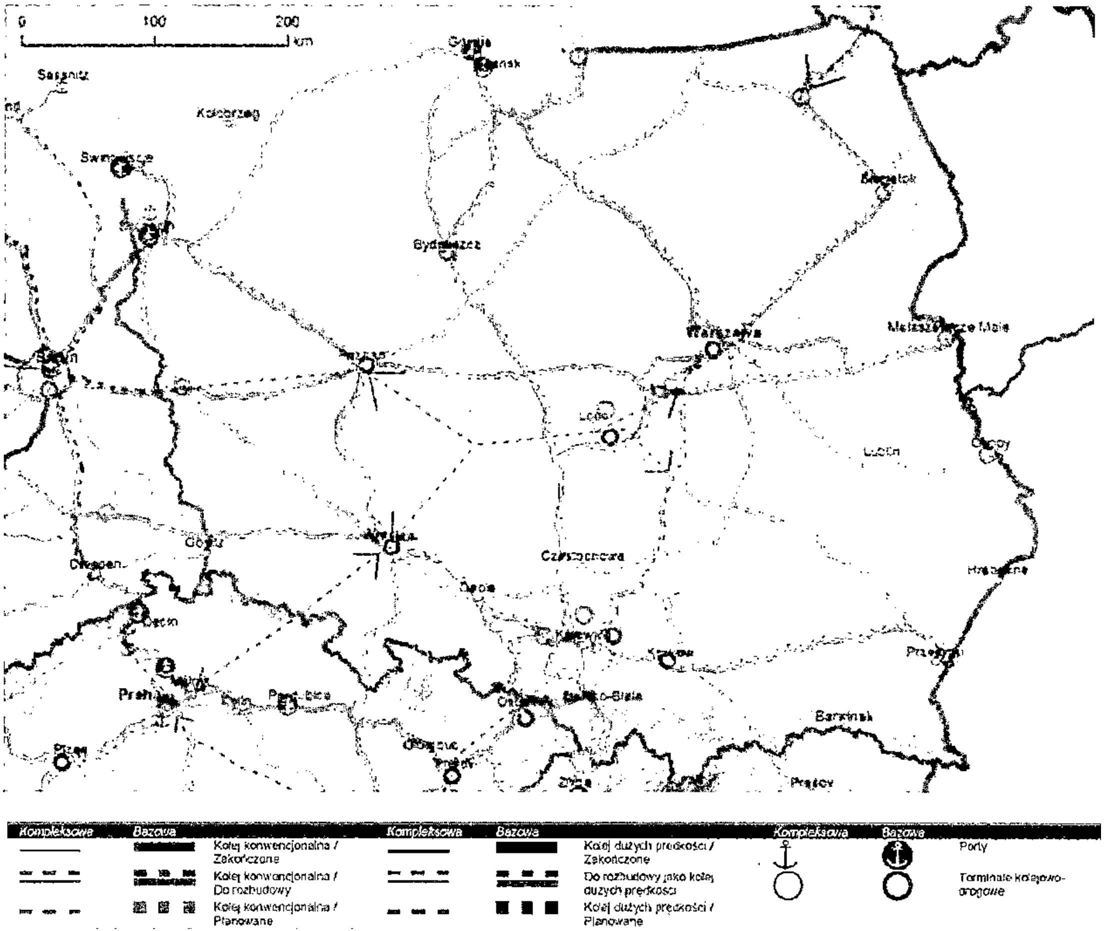
[2] „Dyżurny ruchu w Serocku zatrzymał Radio-Stopem jadące na siebie pociągi” (Train dispatcher in Serock prevents train collision using the ‘Radio-Stop’ feature”, *Rynek Kolejowy*, 12.01.2017, article available at http://www.rynek-kolejowy.pl/wiadomosci/dyzurny-ruchu-w-serocku-zatrzymal-Radio-Stopem-jadace-na-siebie-pociagi-79823.html

also specifies what conditions must be met for ERTMS to be considered deployed. For Poland, specific implementation dates are shown in the diagrams for the North Sea – Baltic Corridor and the Baltic – Adriatic Corridor in Annex I to the Regulation.

For the comprehensive TEN-T network, given the longer time limits for its implementation, no EU-level implementation plan has been prepared to define the deadlines for putting ERTMS into operation.

Additional legal requirements which determine the time frames of ERTMS implementation are also set out in TSI CCS. Pursuant to Article 9(1) of TSI CCS, ETCS must be installed in projects receiving financial support from European funds when the train protection part of a CCS subsystem is installed for the first time or when the train protection part of a CCS subsystem already in service is upgraded, where upgrading changes the functions or the performance of the subsystem. Derogations are available from the above rule for a maximum period of 5 years subject to the conditions set out in Article 9(2)-(5) of TSI CCS. Such derogations can be granted by the European Commission, inter alia, on condition that the system is installed on short and discontinuous lines and economic or technical advantage of the requested derogation is demonstrated.

Fig. 2. Map of TEN-T rail network in Poland for freight trains



Kompleksowa	Comprehensive
Bazowa	Core
Kolej konwencjonalna / Zakończone	Conventional rail / Completed
Kolej konwencjonalna / Do rozbudowy	Conventional rail / To be upgraded
Kolej konwencjonalna / Planowane	Conventional rail / Planned
Kolej dużych prędkości / Zakończone	High speed rail / Completed
Do rozbudowy jako kolej dużych prędkości	To be upgraded to high speed rail
Kolej dużych prędkości / Planowane	High speed rail / Planned
Porty	Ports

Terminale kolejowo-drogowe	Rail-road terminals

Source: Annex I to Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 *on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU*.

It should be noted that in addition to the above availability of derogation from the ETCS implementation deadline for EU-funded investments, there is also a separate procedure for obtaining a general derogation from the application of TSI requirements, including in the area of command-control and signalling. Specific requirements in this respect are provided for by Article 25f of the Rail Transport Act of 28 March 2003 (Journal of Laws of 2016, item 1727, as amended), which transposes Article 9 of 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* (OJ L 191, 18.07.2008, p. 1, as amended).

To sum up the above considerations related to legislation on the fitting of railway infrastructure with ERTMS, it must therefore be noted that:

- as a rule, all railway lines upgraded with EU funds should be equipped with ETCS;
- the lines included in the TEN-T core network should be equipped with ERTMS within the time limits specified in the ERTMS European Deployment Plan, but not later than 2030, whereas the lines included in the TEN-T comprehensive network should be fitted with ERTMS by the end of 2050.
- However, the ERTMS European Deployment Plan, as established by Regulation No 2017/6, may set forth more specific dates for the system implementation on individual line sections.

2.2.2. Traction vehicles

Pursuant to paragraph 7.4.2 of TSI CCS, new railway vehicles authorised to be placed in service for the first time must be equipped with ETCS. Legal provisions foresee derogations from the rule, which apply to:

- mobile railway infrastructure construction and maintenance equipment;
- shunting locomotives;
- other vehicles not intended for operating on high-speed lines:
  - if they are intended exclusively for national service operated outside the corridors defined in paragraph 7.3.4 of Annex III of Decision 2012/88/EU and outside the lines ensuring the connections to the main European ports, marshalling yards, freight terminals and freight transport areas defined in point 7.3.5 of the Annex of Decision 2012/88/EU; or
  - if they are intended for off-TEN cross-border service, i.e. service until the first station in the neighbouring country or to the first station where there are connections further in the neighbouring country.

It follows from the above provisions that the purchase of railway vehicles not equipped with ETCS should be incidental. Therefore it can be assumed that, in practice, all new traction vehicles will be fitted with ERTMS devices.

The legal situation related to the upgrading of existing vehicles is slightly different. Pursuant to paragraph 7.4.2.2 of TSI CCS, it is mandatory to fit ETCS onboard existing railway vehicles that are being upgraded or renewed only if installing any new train protection part of a control-command and signalling onboard subsystem on existing high-speed vehicles. It follows from the above that there is no obligation to install ETCS onboard existing conventional railway vehicles, i.e. on a large majority of vehicles currently used in Poland. Such vehicles will only be fitted with domestic Class B equipment. The decision whether to install ERTMS equipment on board of them will be left to the discretion of vehicle owners, who can decide to do so if they see any benefits of using the system.

2.3. Cost-benefit analysis

2.3.1. Conditions underlying the analysis

According to TSI CCS, when preparing their national implementation plans, Member States are required not only to take into account the need to ensure cohesion of the whole EU rail system, but also its profitability. The latter aspect is analysed in this cost-benefit analysis, which, in accordance with paragraph 7.4.4 of TSI CCS, is a mandatory element of the national implementation plans for the specification in question.

Since its accession into the European Union, Poland has benefited from the support of EU funds – for the 2023 time horizon, the plan of investment projects on the railway lines managed by PKP PLK S.A. (manager of a vast majority of Polish railway lines) is presented in the National Railway Programme, which envisages PLN 66.5 billion, a large proportion of which comes from the EU budget. Bearing this mind, the practice followed in the preparation of the cost-benefit analyses (hereinafter also referred to as "CBA") in Poland is based, for the most part, on the EU requirements and recommendations applicable to EU-funded projects.

The general rules applicable to CBAs are set out in the following EU legislation:

- Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 *laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006* (OJ L 347, 20.12.2013, p. 320, as amended).
- Commission Delegated Regulation (EU) No 480/2014 of 3 March 2014 *supplementing Regulation (EU) No 1303/2013 of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund* (OJ L 138, 13.5.2014, p. 5);
- Commission Implementing Regulation (UE) 2015/207 of 20 January 2015 *laying down detailed rules implementing Regulation (EU) No 1303/2013 of the European Parliament and of the Council as regards the models for the progress report, submission of the information on a major project, the joint action plan, the implementation reports for the Investment for growth and jobs goal, the management declaration, the audit strategy, the audit opinion and the annual control report and the methodology for carrying out the cost-benefit analysis and pursuant to Regulation (EU) No 1299/2013 of the European Parliament and of the Council as regards the model for the implementation reports for the European territorial cooperation goal* (OJ L 38, 13.02.2015, p. 1).

The requirements specified in the above legislation are supplemented and described in the "Guide to Cost-Benefit Analysis of Investment Projects", prepared at the request of the European Commission in December 2014. The objective of the guide is to offer practical guidance on major project appraisals, as embodied in the cohesion policy legislation for 2014-2020. Further clarification of the requirements applicable to CBA are presented in the JASPERS Blue Book – Rail Sector, Railway Infrastructure3. The document indicates the main categories of possible costs and benefits.

The CBA requirements specified by EU regulations and manuals point to (in line with the definition of cost-benefit analysis) the need to translate qualitative categories into calculable values, i.e. to express them in financial units, taking into account their value over time. However, for ETCS, certain categories of possible costs and benefits cannot be used to the full extent because of the lack of possibility of determining the effects

[3] „Blue Book. New edition 2014-2020. Rail Sector – Railway Infrastructure", JASPERS, September 2015, document available on the website of the EU Transport Projects Centre (www.cupt.gov.pl).

of ETCS installation or rather due to the absence of such effects. This makes it impossible for the financial values of the individual categories to be specified, and consequently, CBA is not a suitable tool for assessing the costs and benefits of using ETCS. This is also due to the fact that CBA is a suitable form of cost-benefit analysis for projects characterised by a long list of costs and benefits.

The above doubts as to CBA have also been identified by the services of the European Commission. The unsuitability of CBA for ERTMS projects was pointed to, inter alia, in a call for proposals under CEF (competition 2016[4]), which states in paragraph 7.2. that for projects involving ERTMS CBA should be replaced with a Cost Effectiveness Analysis (CEA).

Cost-Effectiveness Analysis is a tool for evaluating projects based on comparing the net effects of a programme with its total costs as expressed by the amount of funding engaged.

According to "Guide to the preparation of investment projects, including income-generating and hybrid projects, for the years 2014-2020"[5], for some projects, a cost-benefit analysis can be prepared in a simplified form as a cost-effectiveness analysis. Furthermore, the use of a cost-effectiveness analysis is advisable for projects implemented in connection with the need to adapt existing infrastructure to EU requirements and standards.

Even though CEA is the methodology recommended for ETCS projects, it cannot be applied to the "TSI CCS National Implementation Plan" because it is impossible to determine the costs, for example, of the adaptation of Local Control Centers (Lokalne Centra Sterowania) or of the upgrading of railway traffic control devices under long-term projects, i.e. those continuing beyond 2025, and in particular beyond 2030. The unavailability of the costs, which results both from the lack of detailed information on railway traffic control devices, among others, regarding their compatibility with ETCS, and the fact that capital expenditures cannot be broken down by years, renders the use of CEA for the needs of this document impracticable.

Given the nature of the document, which covers the 2050 time horizon, the unit cost has been chosen as the appropriate solution for estimating the cost of ETCS deployment on the Polish rail network. Similarly, the unit cost will be used with respect to the installation of onboard ETCS equipment. The benefits of the system implementation will be presented in a descriptive form.

The above assumptions will help avoid unjustified cost escalation which is likely to result from the growing lack of possibility of determining the variables for the individual tasks over the successive years of the system implementation. Even though the unit cost will only provide a very simplified mechanism for estimating the overall cost, both for trackside and onboard equipment, it will be the best method for assessing the level of system implementation costs because it will be based on previous experience both in Poland, and across Europe. Furthermore, the updating of the implementation plan at least every 5 years will allow the overall implementation costs to be updated based on the additional experience in this area.

At the same time, the descriptive form of presentation of the benefits arising from the implementation of the system will allow the benefits – despite their incalculability – to be verified and assessed by stakeholders.

2.3.2. ERTMS implementation costs

The following sections of this chapter describe the costs associated with the implementation of ERTMS, as broken down into:

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[4] „Call for proposals concerning projects of common interest under the Connecting Europe Facility in the field of trans-European transport network", Innovation & Networks Executive Agency, INEA, p. 10, document available at: https://ec.europa.eu/inea/sites/inea/files/2016-cef-transport_map_cohesion_call_text_1.pdf

[5] „Wytyczne w zakresie zagadnień związanych z przygotowaniem projektów inwestycyjnych, w tym projektów generujących dochód i projektów hybrydowych na lata 2014-2020", subsection 9.3, Minister of Development and Finance, January 2017, document available at: https://www.funduszeeuropejskie.gov.pl/media/35599/Wytyczne_PGD_PH_2014_2020.pdf.

- installation of trackside ERTMS equipment;
- maintenance of trackside ERTMS equipment;
- installation of onboard ERTMS equipment;
- maintenance of onboard ERTMS equipment;

As described in section 2.3.1, the cost analysis is based on the unit cost methodology.

2.3.2.1. Installation of trackside ERTMS equipment

It is very difficult to determine the estimated costs of fitting railway lines with ERTMS equipment as a consequence of the variable design-related conditions, in particular as regards the deployment of ETCS. This follows from the fact that the cost of the implementation of ETCS depends on:

- the level of application selected (Level 1, Level 1 Limited Supervision or 2);
- the characteristics and complexity of the project, which is connected, inter alia, with the length of the railway line to be fitted, the complexity of the system of tracks at stations and alongside the routes;
- degree to which the line is prepared for the deployment of the system, in particular on whether it is equipped with computer-based railway traffic control (srk) equipment and suitable srk-ETCS interfaces, as well as the availability of the GSM-R system;
- the contractual terms, including the scope and duration of the guarantee, the delivery dates or the need for coordination with other investment tasks carried out on the line.

The estimated costs of implementing ETCS, as outlined below, are limited to the costs of the system itself, with no account taken of the necessary prior adaptation costs. The latter result from the fact that deploying ETCS is only possible subject to the fulfilment of additional conditions, such as fitting modern railway traffic control equipment on the target system of tracks. For ETCS Level 2, consideration must also be given to the need to implement the srk-ETCS interface and the GSM-R system through a solution that ensures data transmission for the needs of ETCS at the required QoS (Quality of Services) level.

In order to determine the estimated cost levels of ERTMS installation in Poland, reference is made to experience gained in the course of the following projects:

- for ETCS Level 1:
    - o “Design and installation of ETCS Level 1 on a section of E65 railway line, Central Railway Line, Grodzisk Mazowiecki - Zawiercie” TEN-T 2009-EN-60151-P,
    - o “Installation of ERTMS/ETCS Level 1 on E20/CE20 line, section Kunowice - Warszawa” TEN-T 2011-PL-60002-P,
    - o “Design and installation of ETCS Level 1 Limited Supervision on railway line No 356, section Poznań Wschód - Wągrowiec”.
- for ETCS Level 2:
    - o “Modernisation of railway line E30, stage 2. Pilot implementation of ERTMS/ETCS and ERTMS/GSM-R in Poland on section Legnica - Węgliniec - Bielawa Dolna - ETCS Level 2”, Operational Programme Infrastructure and Environment 7.1-15,
    - o “Modernisation of railway line E 30, Stage 2. Implementation of ERTMS/ETCS and ERTMS/GSM-R in Poland on section Legnica - Wrocław - Opole”, Operational Programme Infrastructure and Environment 7.1-14,
    - o “Modernisation of the master layer for LCSs, ERTMS/ETCS/GSM-R, DSAT, and of the traction power system on railway line E65/CE65, section Warszawa - Gdynia”, Operational Programme Infrastructure and Environment 7.1-1.4,
    - o Task named “Design and implementation of ERTMS/ETCS level 2/ GSM-R on section Warszawa

Zachodnia - Miedniewice, km 3.900 - 61.350 of line No 1" as part of Project entitled "Modernisation of railway line Warsaw - Łódź, stage 2, Lot A - section Warszawa Zachodnia - Miedniewice", Operational Programme Infrastructure and Environment 7.1-24.1.

The ETCS installation costs estimated on the basis of experience gained in the course of the above projects are as follows:

- PLN 260 000 - ETCS level 1 implementation cost per kilometre of the line;
- PLN 485 000 - ETCS level 2 implementation cost per kilometre of the line;

Based on analyses of similar data on previous investments, the GSM-R implementation cost has also been estimated. It amounts to PLN 205 000 per kilometre of the line. The above value is close to the estimates in a report prepared at the request of the European Union Agency for Railways in 2016, where the GSM-R implementation cost is estimated at around EUR 60 000/km6, that is about PLN 250,000/km.

The table below presents the costs of the deployment of ERTMS on the railway lines covered by the TSI CCS National Implementation Plan.

Tab. 2. Costs of ERTMS installation on the railway lines covered by the Plan

	ETCS Level 1	**ETCS Level 2**	**GSM-R**
Line length	3555 km	4678 km	13 680 km
Unit cost	PLN 260 000	PLN 485 000	PLN 205 000
Total	PLN 924 000 000	PLN 2 260 000 000	PLN 2 800 000 000
Total for the Plan as a whole	**PLN 5 984 000 000**		

Source: authors on the basis of PKP Polskie Linie Kolejowe S.A. data

Thus, the total cost of the installation of the trackside part of ERTMS on the Polish railway network according to the assumptions presented in this Plan can be estimated at PLN 6 billion.

2.3.2.2. Maintenance of trackside ERTMS

Estimating the ERTMS maintenance costs as regards ETCS is only possible with reference to the maintenance of existing equipment on line No 4 Grodzisk Mazowiecki - Zawiercie (Central Rail Line) and on line No 64 Psary - Kozłów (Level 1 equipment) and on line E30 Legnica - Węgliniec - Bielawa Dolna (Level 2 equipment).

The assumptions made for ETCS are those included in the document named: „Implementing the European Train Control System. ETCS migration strategies on corridors and at national levels. Cost/Benefit analysis"7, where the annual ETCS maintenance costs are estimated at 4 % of the system installation costs.

Based on this, and taking into account the ETCS level 1 maintenance and service contract named: "Contract for ETCS level 1 maintenance and servicing on the section of the Central Railway Line between Grodzisk Mazowiecki and Zawiercie for 2016-2019", it can be assumed that the annual maintenance of ETCS Level 1 on 224 km of the railway line will not exceed PLN 3 million (assuming the basic scope of the service and the optional service clause). Thus, in the case of ETCS Level 1, the estimated equipment maintenance cost

[6] "Study on migration of railway radio communication system from GSM-R to other solutions", SYSTRA, May 2016, document available at www.era.europa.eu.
[7] "Implementing the European Train Control System. ETCS migration strategies on corridors and at national levels. Cost/Benefit analysis", International Union of Railways (UIC), 2004.

should not exceed PLN 13 400 per km of railway line. However, the cost does not take into account the costs of the personnel of the infrastructure manager working together with the third-party maintenance service provider as regards reporting failures, etc.

With regard to ETCS Level 2, no experience is available in Poland in this respect. As a consequence, estimating the maintenance costs is only possible based on the above 4 % ratio of the system installation costs. The cost of the installation of ETCS Level 2 per km of lines is net PLN 485 000, and the maintenance costs can be estimated at 19 400 per km of lines.

As regards GSM-R equipment maintenance, the costs are estimated on the basis of the funds for day-to-day operation of the infrastructure manager which will be allocated in the 2023-2033 budget for financing obligations arising under the optional service clause. Considering the 7-year infrastructure maintenance period and the planned length of 13 680 km of lines, this means maintenance cost of PLN 4300 per km of line equipped with the system per year.

Thus, the target network of ERTMS railway lines will generate maintenance costs of nearly PLN 200 million, including approx. PLN 60 million for GSM-R maintenance, while the remaining amount will consist of ETCS Levels 1 and Level 2 maintenance costs. However, the above costs will only appear after the system is fully installed, as foreseen in the Plan, i.e. after 2050.

Tab. 3. ERTMS maintenance costs on the railway lines covered by the Plan

	ETCS Level 1	**ETCS Level 2**	**GSM-R**
Line length	3555 km	4678 km	13 680 km
Unit maintenance cost per km annually	PLN 13 400	PLN 19 400	PLN 4300
Total	PLN 47.63 million	PLN 90.75 million	PLN 58.8 million
Total for the Plan as a whole	**PLN 197.2 million**		

Source: authors on the basis of PKP Polskie Linie Kolejowe S.A. data

2.3.2.3. Installation of onboard ERTMS

In order to provide a full overview of the ERTMS implementation costs in Poland, it is also necessary to take into account the costs associated with the onboard part of the system. Given the planned installation of the GSM-R system on about 80 % of the Polish railway lines in length terms, it is assumed that railway operators will incur a corresponding cost of installing the onboard equipment, regardless of whether the vehicle will move on lines equipped with ETCS Level 1 or Level 2. This follows from the fact that a vehicle without GSM-R devices will not be allowed to run on the rail network. In addition, given the absence of plans to discontinue the use of Class B train control devices, all vehicles equipped with onboard ETCS equipment must be fitted with the “Specific Transmission Module” (STM). Considering this, further estimates are based on the assumption that the cost of the installation of onboard equipment will be the same irrespective of whether it is used on ETCS Level 1 or Level 2 lines.

According to information received from Polish railway operators, the estimated cost of onboard ERTMS equipment installation on one vehicle ranges from PLN 1 million to as much as PLN 2.7 million. To a large extent, the amounts depend on the following factors:

- vehicle type,
- adaptation of the vehicle by the manufacturer for the installation of ERTMS equipment (most new vehicles are factory-designed for later ERTMS installation, which reduces the costs);

- scale of the project itself (number of vehicles where equipment is to be fitted).

It should be emphasised that in many cases national railway operators do not have their own experience in installing onboard ERTMS equipment or rely on data for individual vehicles, which may potentially increase the investment costs. Therefore, further calculations are based on a standardised average unit cost of the installation of equipment on an upgraded vehicle of PLN 1.5 million per vehicle. The amount represents an average of all the values communicated by railway operators, adjusted slightly downward to account for the fact that operators will seek to install ERTMS only on relatively new vehicles, which are factory-designed for the purpose, and thus the costs will be slightly lower. Additionally, it is to be expected that given the foreseen benefits, at least in the early stage of ERTMS deployment, passenger rail operators with relatively new rolling stock will likely be the operators most interested in the installation of ERTMS. For currently manufactured vehicles, it is assumed that the value of ERTMS equipment is approximately PLN 1 million.

Assessing the number of vehicles that will be fitted with onboard devices is a more complex issue in the context of estimating onboard equipment installation costs. As is declared by operators, by the year 2023, the purchase of approx 300 new traction vehicles (locomotives or traction units) is to be expected. Because of the legal requirements described in paragraph 2.2.2 of this Plan, the factory design of the vehicles will allow them to be fitted with ERTMS.

As regards railway vehicle modernisation, the data provided by operators suggest that around 150 vehicles will be upgraded until 2023. However, the above data mainly include the passenger rail market, reflecting to a very limited extent the situation of freight operators (more about the problem of data acquisition see paragraph 2.3.2.5 of the Plan). In addition, most operators point out that it is far too early to state whether or not upgraded vehicles will be fitted with ERTMS since legislation leaves this to the discretion of the operators.

According to information provided by operators, most of them do not see any point in installing ERTMS aboard their vehicles due to the high cost and insignificant benefits. In fact, the only market segment offering more significant benefits for operators is transport at speeds above 130 km/h, which actually means passenger transport, as freight transport companies do not operate at such speeds. As a consequence, further analyses are based exclusively on data for a specific market segment – passenger transport at speeds of more than 130 km/h (more about the benefits of using ERTMS see paragraph 2.3.3 of the Plan). Thus, it is estimated that a total of only about 30 vehicles (locomotives or traction units) will be equipped with onboard ERTMS as part of upgrading projects.

Tab. 4. Costs of ERTMS installation on railway vehicles

	New vehicles	**Upgraded vehicles**
Number of vehicles	300	30
Unit cost	1 000 000	1 500 000
Total	PLN 300 million	PLN 45 million
Total for all vehicles	**PLN 345 million**	

Source: authors on the basis of data received from railway operators.

At the same time, it must be remembered that the above data apply to the 2023 perspective, since only such information is currently available. A vast majority of operators declare that their plans related to the rolling stock do not go beyond the next few years, which is to be attributed to the fast changes in the rail transport market.

2.3.2.4. <u>Maintenance of onboard equipment</u>

None of the railway operators active currently on the market have sufficient experience to estimate the onboard ERTMS maintenance costs. This follows from the fact that the devices are installed on new rolling stock, covered by warranties and maintained by manufacturers. Consequently, operators do not incur any costs connected with the purchase and replacement of parts, adjustments, testing, etc. Thus they have no information that would allow them to evaluate the cost of such maintenance. Another problem is the fact that in the case of some vehicles ERTMS devices are not currently in use because trackside equipment of the subsystem has not been installed on the lines served by the vehicles.

For the purpose of further calculations it is therefore assumed that the maintenance cost will represent 3 % of the equipment installation costs. The above value has been declared by the operator which currently has the largest share of ERTMS-equipped rolling stock, and thus has the best knowledge in this respect compared to other operators. This translates into maintenance costs of approximately PLN 45 000 per vehicle annually. It should be noted here that it does not matter whether the system is installed on a new or upgraded vehicle, so the assumption is that it applies to both vehicle categories.

With the assumed total number of 330 vehicles equipped with ERTMS, this translates into cumulative annual expenditure of railway operators of up to PLN 14.85 million.

2.3.2.5. Summary

The following table summarises the costs associated with the installation and maintenance of ERTMS in Poland.

Tab. 5. The costs of the installation and maintenance of ERTMS in Poland

Cost description		Value
Trackside equipment	**One-off trackside system equipment installation cost**	PLN 5 984 000 000
	Annual maintenance cost of trackside system equipment in its targeted version	PLN 197.2 million
Onboard equipment	**One-off onboard equipment installation cost**	PLN 345 million
	Annual maintenance cost of onboard system equipment in its targeted version	PLN 14.85 million

Source: authors on the basis of data received from PKP PLK S.A. and railway operators.

Information about the possibilities of financing the costs is presented in paragraph 3.3 of the Plan, in the section on migration strategies.

The ERTMS implementation cost analysis presented in this section of the Plan is associated with certain risks, which have been partly discussed above. However, it is worth summarising them to obtain a structured overview of the risks associated with the analysis:

- low current level of ERTMS implementation, both at trackside and onboard side;
- limited number of projects under way or completed for which data is available;
- inclusion of ERTMS maintenance costs in line modernisation or vehicle purchase contracts, which makes distinguishing the cost of ongoing system maintenance by railway operators and infrastructure managers impossible;
- lack of specific rolling stock-related plans by operators for the period covered by the Plan, both as regards purchasing new vehicles, and upgrading existing ones;
- the fact that operators are unable to provide data about their rolling stock-related plans because of the need to protect business secrecy and restrictions on disclosure of information by listed companies;
- uncertainty as to the long-term legal and market environment of the railway sector.

In view of the above, it must be concluded that the calculations in this part of the Plan should be regarded as highly indicative values, useful, in fact, as indicators of the order of magnitude of the costs, rather than a source of accurate figures.

2.3.3. Benefits of ERTMS implementation

When discussing the benefits of ERTMS implementation in Poland, one should bear in mind certain very important factors. This chapter outlines the benefits based on two approaches: first, it presents an overview of the benefits that are most frequently mentioned by railway operators and infrastructure managers. A large proportion of the data is a reflection of common knowledge about the advantages of ERTMS and refers to the benefits mentioned in studies concerning the system. Consequently, many of the thus signalled benefits are largely theoretical in nature and do not necessarily translate – in a direct and easily discernible way – into efficient operation of the railway system.

In order to present the approach of the rail market, in particular railway operators, to the implementation of ERTMS in a better way, the Plan also describes in broader terms the practical experience of railway operators in this regard. The information has been collected using data provided by the stakeholders for the needs of this Plan, which has provided an understanding of how the benefits of the system are perceived by the railway sector from the practical point of view.

The above two-pronged approach to identifying the benefits of the implementation of ERTMS – divided for the needs of this Plan into theoretical advantages and practical experience – is reflected by their presentation in two separate subchapters.

2.3.3.1. Benefits of ERTMS implementation

As mentioned above, owing to their being non-quantifiable in concrete financial terms, the benefits of the ERTMS deployment in Poland are presented in descriptive form.

The list presented below comprises the benefits associated with the use of infrastructure and vehicles equipped with ERTMS as indicated by railway infrastructure managers and railway operators. The following non-quantifiable benefits may be identified in terms of reliability, improvement of safety and operability, and interaction between onboard and trackside equipment:

1. Improvement in the attractiveness of the Polish railway network as an important component of the European policy towards eliminating barriers to transport, both as regards technical barriers on railway networks within the EU, and towards building a common market for railway products and services, which includes:
   a) achieving European standards on lines covered by the trans-European transport corridors crossing Poland,
   b) ensuring interoperability of railways and making it possible for operators from other countries to gain access to Polish railway infrastructure.

2. Improvement of transit transport between EU Member States and neighbouring countries (train/traction vehicle location).
   a) for passenger trains – access to foreign lines without the need to install Class B systems (after 2030),
   a) for international freight trains – access to foreign lines without the need to install Class B systems (after 2030); time savings (no need to change vehicle on the border).

3. Enhancing the development and competitiveness of railways compared to other transport sectors, as the most environmentally friendly mode of transport.
   a) traction energy savings (traffic flow resulting from the start-up of traction vehicles after unplanned stops),

   b) increasing the capacity of existing lines, since a system based on continuous transmission reduces train sequence times, allowing greater capacity to be achieved on existing infrastructure.

4. Reducing train control and protection system life-cycle costs – Europe-wide harmonisation of the system will be beneficial for the procurement market, which will reduce equipment purchase costs (both for trackside and onboard components).

5. Increasing the capacity of railways and improving the response to growing transport needs, both for passenger and freight transport. Depending on the level of use of ETCS, the maximum line capacity is estimated at 20 trains per hour (Level 1), 24 trains per hour (Level 2).
   a) reducing travel times on sections where introducing ERTMS is associated with a speed increase, especially for speeds above 160 km/h.

6. Increasing punctuality – the experience of other European countries indicate a 2-3 % increase in punctuality resulting from the deployment of ERTMS. Increased train punctuality improves the timeliness of passenger and freight transport and consequently – increases the competitiveness of railways compared to other modes of transport.
   a) possibility of increasing train speeds to above 160 km/h thanks to the use of cabin signalling and above 130 km/h for one-person operation.
   b) one-person operation also for speeds above 130 km/h, which saves personnel costs (reduced labour costs without compromising safety) and improves the delivery of tasks.

7. Improving train traffic safety – ERTMS can help eliminate events likely to endanger rail traffic, such as overlooking or disregarding the ‘stop’ signal and exceeding the speed limit.
   a) increasing safety by limiting human role in controlling and driving a railway vehicle – automatic limitation of vehicle speed depending on the distance ahead of the vehicle covered by the movement authority plus automatic vehicle stoppage before the point up to which the movement authority applies,
   b) increased safety, more supervision of the driver.

8. For the GSM-R system:
   a) significant improvement of communication between the driver and dispatchers,
   b) centralised management of services – depending on the function performed the user is assigned appropriate services (including voice communication services, specific rail services, text messages, data transmission services).
   c) systemic user identification – user authorisation through a profile stored on a SIM card, registration in the system by using the functional number, making voice calls using numbers reflecting the user’s function.
   d) user-blocking feature – users can be blocked remotely, for example, following SIM card damage or theft.
   e) limitation of area braking – a REC (response emergency call) is sent to a specific area spanning from one to several GSM-R base stations along the line, resulting in fewer trains being involved in the event, which reduces the delays of the other trains.

2.3.3.2. Practical experience of stakeholders

When data was being gathered for this Plan, some railway operators pointed to certain practical experiences and doubts regarding installation and deployment of ERTMS aboard traction vehicles. Such feedback helps illustrate in a better way how the operator market perceives the benefits of using ERTMS and the practical effects of its implementation. It must be remembered that the information presented in this section comes from operators and does not represent the official position of Poland. Undoubtedly, however, the information reflects in a good way the present-day attitude of the railway sector to the planned implementation of ERTMS.

During the data collection for the Plan, many operators stressed that they were not planning to mount ERTMS devices on their upgraded traction vehicles. This clearly indicates that the representatives of the railway sector do not see the associated benefits, such as to justify the high costs of the system installation and maintenance, with some stakeholders stating this point-blank.

Of all the benefits listed in the previous section, railway operators attach the greatest importance to two factors: one-person operation of ERTMS trains at more than 130 km/h, and the fact that ERTMS-equipped vehicles can travel at speeds above 160 km/h. The two factors translate into measurable economic benefits, including reduced operating costs for operators (staff use optimisation) and improving the attractiveness of service thanks to increased speed. However, it should be noted that, in practice, the above effects apply exclusively to undertakings operating at higher speeds, i.e. passenger railway companies, mainly those serving longer distances, and – to a lesser extent – regional operators. Given that currently freight transport is operated at speeds of up to 120 km/h, the above effect cannot be expected in this segment of the market.

The doubts raised by railway companies can be reduced to one common denominator, i.e. increased costs of operation. The operators suggest that ERTMS does not only require a high one-off cost to install the system, but also later maintenance, servicing and repair costs. Other costs include those related to personnel training and traction vehicle downtime during system failure. Operators emphasise that, in most cases, investing in the installation of ERTMS aboard their traction vehicles which are to be upgraded is not – in their view – economically viable.

In addition, there are voices calling into question the benefits of implementing the system. According to some undertakings, under the present-day conditions, the system will not replace existing national systems, as a result of which installing ERTMS would only increase the risk of a decrease in vehicle reliability due to system failures and resultant downtimes. It is also stressed that even in the future, as the ERTMS rail network continues to expand, existing systems will continue to be necessary to operate trains on the less-frequently used lines or sidings. Doubts are also raised as to the expected increase in the capacity of railway lines as a result of the system implementation.

From the perspective of infrastructure managers, certain additional conditions must be underlined. One of the key issues is the need to ensure compatibility of the trackside and onboard equipment. Previous experience in this area has demonstrated that there is a need for fine-tuning the interaction between the components, which requires time-consuming and costly test runs, as well as device modifications. It should be highlighted that this applies to vehicles and infrastructure certified for compliance with TSIs. As a consequence it can be expected that, as transport using ERTMS evolves, problems in this area may intensify.

In the context of the other experiences on the part of the infrastructure manager which also indirectly add to the scale of the benefits of the system implementation, the following issues should be also stressed. The use of ERTMS Level 1 requires maintaining trackside infrastructure, including the signalling lights. On the infrastructure side, ERTMS Level 1 plays the role of a “cabin signalling system”, i.e. it is responsible for transmitting the signals displayed by trackside signalling equipment to onboard components. However, ERTMS Level 1 devices do not require legacy railway traffic control systems (srk) to be replaced since ERTMS L1 can be easily combined with virtually any standard railway traffic control system that includes light signalling. In addition, the experience of other European countries indicates that ERTMS Level 1 can also be combined with shape-based signalling.

As regards line capacity and impact on rail traffic, it should be observed that the possibilities of increasing speeds to more than 160 km/h using ERTMS Level 1 is limited by existing block lengths and the vehicle braking distances adopted, which determine the location of semaphores on the line, and consequently, also of ERTMS devices. The same applies to increasing permissible speed to 160 km/h in the vicinity of rail crossings both for ERTMS Level 1 and Level 2. This is connected with the fact that in such cases, ERTMS devices force earlier braking than it follows from applicable legislation and the braking distances adopted for non-ERTMS operation. Furthermore, in certain cases, the use of ERTMS Level 1 can decrease track capacity and lead to traffic perturbations as a result of vehicle braking in front of a signal despite the signal having changed to 'proceed' – this may be the case following a failure to update data in ERTMS. But even seeing to it that the function is implemented will not always eliminate the phenomenon.

Another major problem is the likelihood of railway traffic disturbances due to the fact that the ETCS Specification (Baseline 2 - SRS 2.3.0d) allows different parameters to be used for calculating the braking curves in the onboard equipment of the system. As a consequence, there may be situations where vehicles on which different types of ETCS Baseline 2 onboard equipment are installed may respond differently to information transmitted by the trackside equipment as regards attaining the target speed. In practice, this may lead to situations where a vehicle travelling on a given line applies braking to early when approaching a reduced-speed area due to more restrictive rules for calculating the braking curve. By contrast, a vehicle equipped with a different type of onboard equipment will travel more effectively in the same situation. If such vehicles were operated on the same heavy-traffic railway line, this could result in unnecessary extension of distances between trains and travel regularity disturbances, thus limiting the capacity.

2.3.4. Summary of the cost-benefit analysis

Undoubtedly, the main incentive for the implementation of ERTMS in Poland is existing legal framework, which clearly indicates situations where the installation of the system is required – both on the side of the infrastructure and the rolling stock. Were it not for the requirements, it is doubtful that the undertakings would decide to implement the system on their own initiative, given the enormous costs of such investments for the railway sector, which are nearly PLN 6 billion for the infrastructure and approx. 0.5 billion for the rolling stock. Expending such high sums would be impossible without significant external financial support, mainly by EU funds.

The benefits of the implementation of ERTMS as described in this Plan have very limited effect on operators' business decisions on equipping railway vehicles with ERTMS. This clearly follows from the replies provided by the entities surveyed as regards their willingness to equip existing vehicles with the system in so far as this is not required by applicable legislation. Most of them declare that they do not see any need for installing ERTMS on upgraded vehicles because of the high costs of such an operation, the limited usability of the system after its installation (lack of properly equipped lines in Poland and abroad), and the insignificant benefits.

The sole area where significant economic benefits for operators may indeed be expected is rail transport operation at speeds exceeding 130 km/h since onboard ERTMS equipment allows passenger transport at speeds above 160 km/h and permits one-person operation with speeds above 130 km/h. In the former case, this translates into improved attractiveness of rail transport thanks to shorter travel times, and in the latter, it paves the way for actual savings for operators thanks to more efficient use of train drivers.

However, the above benefits are only available to a limited number of operators, i.e. mainly passenger operators with rolling stock capable of travelling at higher speeds, as well as interurban rail traffic operators. Regional passenger trains will benefit to a lesser extent because of the shorter distances travelled and more frequent intermediate stops.

For the freight segment, deploying ERTMS does not currently promise any significant benefits. Freight transport is operated at lower speeds (up to 120 km/h, with speeds typically ranging between 80 and 100 km/h). Therefore savings on account of increased staff productivity will not be available. On the other hand, the benefits related to increased interoperability of vehicles (no need to install domestic class B systems or change the locomotive on the border) will depend on the scale of ERTMS deployment on railway lines across Europe, as well as the efficiency and reliability of the system. However, the prospects for large-scale deployment of the system and elimination of class B systems are so distant that, currently, operators do not see any reason for investing in a system the cost of which will subsequently undermine their position on the competitive European and domestic freight market.

3. Migration strategy

3.1. Trackside subsystem

3.1.1. GSM-R

As regards GSM-R, the assumption is that the system will be deployed on about 15.2 thousand km of railway lines – a vast majority of the railway lines of the PKP PLK S.A. network, whereby:

- approximately 1.6 thousand km have been equipped or is being equipped with the system as part of on-going investment tasks of the EU 2007-2013 perspective (including tasks phased for the next EU financial perspective of 2014-2020),
- approximately 13.6 thousand km of lines will be equipped under a horizontal project of the 2014-2020 perspective.

The rail sections to be equipped with the GSM-R system have been selected on the basis of the following general criteria:

- Criterion 1 – the section is assigned to one of the two top-level maintenance categories;
- Criterion 2 – according to traffic statistics for 2014, the average daily number of trains on the section is higher than or equal to a specific traffic intensity level. Seasonal variations in train traffic intensity are not taken into account.

However, the above criteria do not exclude individual assessment of the suitability of installing the equipment on individual sections. Furthermore, on some railway sections which do not meet the criteria, but which nevertheless served railway traffic in 2014, optical fibre cables are planned to be provided to increase the reliability of the transmission network by closing the “loops”.

For the horizontal project of the 2014-2020 perspective, after applying Criterion 1 (i.e. after analysing the line significance), it was found that GSM-R needs to be provided for approximately 15 km of railway lines. Following this, Criterion 2 was applied, with the traffic intensity limit set preliminarily at 10 trains per day. Based on the above limit value, the length of lines to be fitted with GSM-R infrastructure would be approximately 11 thousand km. Given the need to provide the largest possible proportion of the railway network with a modern and reliable system, the daily traffic limit value was reduced from 10 to 7 trains. As a result, the length of lines in need of being equipped with GSM-R infrastructure under the 2014-2020 EU horizontal project was set at approximately 13.6 thousand km.

In order to build the GSM-R network in Poland efficiently, the GSM-R system will be deployed across the network rather than on individual lines, as has been the case previously. This works towards the ultimate decommissioning of the legacy analogue 150 MHz radio communication system. **It is assumed that the implementation of GSM-R across the railway network will have been completed by the end of 2023, following which actions will be taken to decommission the 150 MHz system. Information about the decision in this respect will be presented at least five years in advance.**

The ‘Radio-Stop’ function will be used until the 150 MHz system is decommissioned. Ultimately, the ‘Radio-Stop’ function will be replaced with the priority alarm connection served by the GSM-R network known as the Railway Emergency Call or REC.

Owners and users of traction vehicles will be obliged to equip their rolling stock with the necessary onboard GSM-R voice communication equipment within a time horizon suitable for meeting the scheduled 150 MHz system decommissioning date. The process will start around 2020, but is expected to be finalised once the GSM-R system is deployed.

3.1.2. ETCS

As far as ETCS is concerned, it is assumed that the system will be installed on the lines that are part of the core and comprehensive TEN-T networks, as well as on other selected lines to ensure network coherence. This means that ETCS will also cover lines subject to the other requirements (TSI CCS, freight corridors within the meaning of Regulation No 913/20108).

As to deciding what ETCS level to implement, it should be noted that each level of the system has its own set of advantages and disadvantages. ETCS Level 2 offers centralised, more efficient operation, which includes introducing and withdrawing speed limits from the level of the dispatcher's console and centralised information about the condition of all onboard equipment within areas equipped with the system. However, this requires greater funds, availability of an appropriately configured GSM-R system and prior centralisation of the railway traffic control systems. On the other hand, ETCS Level 1 is less capital-intensive compared to Level 2 since it does not require rail traffic control centralisation, and can also be used with older railway traffic control equipment by offering simpler interface with light signal circuits. However, the operation is more time-consuming at this level because of the higher number of units generating movement authority (LEU) compared to a single central unit (RBC) in ETCS Level 2. From the technical point of view, it is therefore advisable that the implementation of ETCS (in particular of Level 2) should be allowed to continue until the line has been fully upgraded, i.e. should be preceded by the remodelling of tracks to their target shape and installation of the new core railway traffic control equipment.

Bearing in mind that the breakdown of the core-level railway traffic control equipment at rail traffic control points of the Polish rail network is as follows:

- approx. 63 % are mechanically controlled interlocking systems,
- approx. 30 % are electrical interlocking systems,
- approx. 7 % are computer-based interlocking systems,

and given the assumption that the implementation process must take into account the financial capacity of the infrastructure manager, implementation of both ETCS Level 1 and Level 2 should be envisaged.

Choosing the ETCS system configuration (Level 1, Level 1 Limited Supervision or Level 2) will depend on the current and anticipated traffic needs on a given line, taking into account existing and foreseen core-level railway traffic control devices. From the technical point of view, lines can be equipped with the successive levels of the ETCS system in a gradual way, i.e. ETCS Level 2 system can replace existing ETCS Level 1. However, this would be not efficient in economic terms as a large proportion of investments made on dispersed installation of ETCS Level 1 would become pointless if ETCS Level 2 was to be installed. The solution could be to keep ETCS Level 1 on some lines as a reserve system for newly-built ETCS Level 2, if this proved reasonable in technical, operational and traffic-related terms.

In views of the above conditions, the sections of railway lines for ETCS Level 1 and Level 2 installation have been selected on the basis of the following criteria:

- Criterion 1 – the section has been qualified for the TEN-T network;
- Criterion 2 – to determine the level, existing and targeted core-level railway traffic control devices are considered. As a rule, for lines with centralised traffic control, i.e. those with Local Control Centers (Lokalne Centra Sterowania) and possibly Regional Railway Traffic Control and Management Centers (Regionalne Centra Sterowania i Zarządzania Ruchem Kolejowym), the installation of ETCS Level 2 is advisable, while in other cases, ETCS Level 1 is recommendable;
- Criterion 3 – for lines qualified under criteria 1 and 2 for ETCS Level 1, consideration is given – from the perspective of ETCS Level 2 installation – to current and anticipated traffic-related needs on a given line, bearing in mind the nature of the traffic (passenger – freight) and its intensity, as well as the associated

[8] Regulation (EU) No 913/2010 of 22 September 2010 of the European Parliament and of the Council concerning a European rail network for competitive freight; OJ L 276, 20.10.2010, as amended.

type of block signalling (semi-automatic or automatic signalling).

At the same time, without prejudice to the above criteria, it is assumed that the previous decisions on which lines to equip with the system and which level to choose will remain in force.

In light of the need to ensure the coherence of the railway network, transport corridors, and individual railway lines, derogations from the abovementioned rules are foreseen in justified cases.

Given that the existing detailed investment plans for the railway infrastructure cover the 2014-2020 perspective, the ETCS level defined should be considered binding for the part of the line for which the installation of new computer-based railway traffic control equipment is included in medium-term investment plans (i.e. lines to be equipped with ETCS by 2023). In other cases, it should be concluded that the determination of the level should be reviewed later on based on the development of the situation.

The following general assumptions for the selection of the (baseline) ETCS specification, as per SUBSET 026, for new trackside equipment implementation projects are made:

- in the EU financial perspective of 2014-2020, specification SRS 2.3.0d will be applied;
- for later projects, specification SRS 3.4.0 or higher will be used.

Regardless of the above, decisions regarding the choice of specifications for a given section or sections of railway lines may be tailored to individual conditions, as determined through consultations with railway operators and other stakeholders. In this context, the European Union Agency for Railways can play a vital role in the ERTMS trackside technical solution approval process (pre-authorisation of ERTMS), which will be launched by the entry into force of the technical pillar of the Fourth Railway Package.

For the needs of the SHP system, an STM (specific transmission module) has been developed to support the onboard functions of the SHP system and the 150 MHz ‘Radio-Stop’ feature of the radio communication system in onboard ETCS equipment. This is connected with the requirement that traction vehicles equipped exclusively with ETCS, running on lines not equipped with ETCS, but only with the SHP system, will need to receive and interpret correctly SHP signals. Receiving and interpreting correctly the ‘Radio-Stop’ signal will be required from traction vehicles moving on lines equipped with the 150 MHz system also after the line is equipped with GSM-R, until the 150 MHz analogue system is decommissioned on the line.

To date, ETCS implementation has been completed on 331 km of Polish railway lines. Detailed information in this respect is provided in the table below.

Tab. 6. List of lines on which ETCS implementation has been completed

Line number	Start station	End station	Length [km]	Level
4	Grodzisk Mazowiecki	Zawiercie	224	L1
64	Kozłów	Starzyny	33	L1
282	Miłkowice	Węgliniec	62	L2
295	Węgliniec	Bielawa Dolna	12	L2

Source: PKP Polskie Linie Kolejowe S.A.

At present, there are no plans to decommission Class B systems, and thus vehicles not equipped with ERTMS. If such a decision is taken, it must be included in the TSI CCS Implementation Plan at least 5 years in advance of the decommissioning.

3.2. Onboard subsystem

Currently, 145 traction vehicles (locomotives and traction units) equipped with ETCS[9] are authorised to run on the Polish railway network. In this context, it must be emphasised that, when the vehicle verification process was conducted, rolling stock manufacturers indicated problems related to limited availability of ERTMS-equipped infrastructure. As a result, in some cases, authorisations issued to date cover exclusively Level 1 subsystem certification.

According to TSI CCS, new vehicles, placed in service after 1 January 2019, must be fitted with baseline 3 onboard equipment. At the same time, when onboard equipment not subject to the requirement is installed, it is nevertheless advisable that baseline 3 should be deployed in order to improve interoperability and avoid the need to change the system version in the future.

3.3. Availability of funding

The costs of the deployment of ERTMS within Polish infrastructure is financed to a large extent by EU funds, with national contribution. The assumption is that further installation of the system will continue to be financed using a similar formula due to the unavailability of sufficient funds in the state budget or the budgets of infrastructure managers. Therefore the issue of ensuring adequate EU funding is crucial for effective ERTMS implementation in Poland and achieving the target benefits of the interoperability of the railway system.

Until 2023, the implementation of the system will be based on the Cohesion Fund. Some of the tasks related to ERTMS implementation will be financed within the framework of the line modernisation projects delivered by PKP PLK S.A. under the Operational Program Infrastructure and Environment and the Connecting Europe Facility (CEF). A horizontal project comprising sections of the E-30, E-59 and E-20 lines is also planned to be delivered with CEF co-financing. However, whether the horizontal task will be co-financed by CEF funds depends on the European Commission's decision to award the funding. If the Commission's decision is negative, resorting to alternative sources of financing (e.g. Operational Programme Infrastructure and Environment) will be analysed, or CEF funds will be applied for when a new call for proposals is announced.

At the present programming stage of the EU 2021-2027 financial perspective, no decisions have been taken yet on the model of EU support for infrastructure projects, including those dedicated to the installation of the system. Nevertheless, as indicated above, due to the limited budgetary resources and high costs required to complete the ERTMS implementation plan, non-availability of external funding for the system installation will seriously impede the completion of the Plan. In light of the above, Poland believes that it is reasonable to maintain the current model of funding infrastructure projects with EU funds under the 2014-2020 perspective. If continued application of the current funding model is impossible, consideration should be given to maintaining the rules for funding ERTMS with the general envelope of CEF (and earlier TEN-T), whereby support from EU funds can be received for up to 50 % of eligible costs.

In view of the above and given the initial phase of discussions about the 2021-2027 financial perspective, specifying the sources of funding for the implementation of ERTMS after 2023 is impossible. In the course of upgrading works on railway lines, efforts will be taken to secure funds for financing the implementation of ERTMS. In addition, analytical work will be conducted to assess the feasibility of obtaining financial support from any sources available. The need to secure adequate funds dedicated for financing ERTMS will also be taken into account in the course of the preparation of the negotiating position for the next EU financial perspective.

4. Implementation Plan

This part of the Plan specifies the dates of ERTMS implementation on the individual sections of Polish railway

[9]According to data of the Office of Railway Transport, as of 23 May 2017.

lines. In principle, this Plan spans the 2017-2032 perspective, but also identifies on an indicative basis the lines where the system will be implemented by the year 2050 to ensure the implementation of EU legislation related to equipping the comprehensive TEN-T network with ERTMS equipment.

As regards the dates indicated in the tables below, it must be clarified that they are deadlines for ETCS implementation on a given line. Given the technical conditions resulting from the need for prior modernisation of the line and its adaptation to the installation of ETCS equipment, the dates declared in the Plan are strongly correlated with the timelines of on-going investment processes on individual lines. The situation is quite different for GSM-R, the implementation of which is not correlated with earlier investment work on railway lines and can proceed in a fully independent manner. As a result, the GSM-R system will be deployed in Poland by a single horizontal project, which is scheduled to be completed by the end of 2023.

All the deadlines contained in this document will be updated in cycles of up to 5 years, in accordance with the requirements of TSI CCS.

4.1. Implementation in 2017-2023

The implementation of ERTMS in Poland largely depends on the availability of adequate funding, in particular from EU funds. Therefore the scale and details of the respective investment programmes will correspond to the sums of funding available. Detailed data in this respect is currently available only for the current EU financial perspective of 2014-2020, with the funds expended to be settled by 2023. Therefore this chapter distinguishes the deadlines for ERTMS implementation in the period covered by the current EU programming, i.e. the years 2017-2023.

The completion of a network-wide project for the installation of GSM-R on 13.6 thousand km of railway lines is planned to be completed by the end of 2023, which, in combination with previously implemented investment projects, will contribute to covering almost the entire Polish railway network with the GSM-R communication system. In effect, after 2023, the currently used analogue communications system is scheduled to be decommissioned, as a result of which railway operators will be forced to equip their vehicles with GSM-R radios to be able to operate on the rail network. However, as mentioned above, no specific decommissioning date has been specified and any possible information in this regard will be provided at the time when the Plan is updated.

With regard to ETCS, by 2023, 2480 km of Polish railway lines (including those which have already been equipped) are scheduled to be covered by the system. Detailed data on ETCS-equipped lines in the 2017-2023 time horizon is presented in the table below.

Tab. 7. Planned completion of ETCS implementation in 2017-2023

Line number	Start station	End station	Length [km]	Level	Completion year
132	Opole Zachodnie	Wrocław Brochów	72	L2	2017
275	Wrocław Nowy Dwór	Miłkowice	64	L2	2017
356	Poznań Wschód	Wągrowiec	51	L1 LS	2017
1	Warszawa Zachodnia	Koluszki	101	L2	2018
9	Warszawa Praga	Gdańsk Główny	311	L2	2018
17	Łódź Widzew	Koluszki	19	L2	2018
202	Gdańsk Główny	Gdynia Chylonia	27	L2	2018
226	Pruszcz Gdański	Gdańsk Port Północny	11	L1	2018
260	Pszczółki	Pruszcz Gdański	11	L2	2018

456	Warszawa Praga	Chotomów	14	L2	2018
2	Sulejówek Miłosna	Terespol (state border)	190	L2	2023
3	Warszawa Gołąbki	Kunowice (state border)	467	L2	2023
6	Zielonka	Białystok	164	L2	2023
7	Warszawa Wschodnia	Lublin	171	L2	2023
8	Warszawa Okęcie	Radom	94	L2	2023
17	Łódź Kaliska	Łódź Widzew	14	L2	2023
91	Podłęże	Rzeszów Główny	139	L2	2023
271	Wrocław Główny	Poznań Główny	165	L2	2023
273	Wrocław Główny	Grabiszyn	6	L2	2023
274	Zgorzelec	Zgorzelec (state border)	1	L2	2023
278	Węgliniec	Zgorzelec	27	L2	2023
351	Poznań Główny	Szczecin Dąbie	195	L2	2023
352	Swarzędz	Poznań Starołęka	13	L2	2023
449	Warszawa Rembertów	Zielonka	9	L2	2023

Source: PKP Polskie Linie Kolejowe S.A.

4.2. Implementation in 2024-2030

According to plans for the post-2023 period, works related to the implementation of ECTS will continue on more railway lines. However, it must be remembered that the period extends beyond the current EU financial perspective, as a result of which any plans in this respect are burdened with greater risks, which is primarily linked to the uncertainty surrounding the future financial perspective, the amount of funds available, and the conditions for their use. Therefore, the implementation dates specified in the table below should be considered as approximations. They will be updated along with the Plan as a whole at least every 5 years – as required by TSI CCS.

Between 2024 and 2030 ETCS is scheduled to be installed on 4069 km of railway lines. Thus, by the end of 2030, railway operators should have the system installed on 6549 km of lines.

Tab. 8. Planned completion of ETCS deployment in 2024-2030

Line number	Start station	End station	Length [km]	Level	Completion year
14	Łódź Kaliska	Zduńska Wola	43	L1	2024
25	Łódź Kaliska	Gałkówek	24	L1	2024
410	Grodzisk Mazowiecki	Zawiercie	224	L2	2025
91	Kraków Główny Osobowy	Podłęże	18	L2	2025
131	Chorzów Batory	Bydgoszcz Główna	364	L1	2025
131	Bydgoszcz Główna	Tczew	127	L2	2025
132	Bytom	Zabrze Biskupice	5	L1	2025
133	Jaworzno Szczakowa	Kraków Główny	55	L2	2025
134	Jaworzno Szczakowa	Sosnowiec Jęzor	7	L2	2025

[10] Expected improvement in ETCS level.

147	Zabrze Biskupice	Gliwice	13	L1	2025
161	Katowice Szopienice Północne	Chorzów Stary	12	L1	2025
165	Bytom Bobrek	Bytom Karb	1	L1	2025
188	Bytom Bobrek	Zabrze Biskupice	2	L1	2025
201	Nowa Wieś Wielka	Maksymilianowo	33	L1	2025
202	Gdynia Chylonia	Słupsk	105	L2	2025
226	Gdańsk Port Północny station		2	L1	2025
277	Opole Groszowice	Wrocław Brochów	85	L1	2025
300	Opole Główne	Opole Wschodnie	4	L1	2025
1	Zawiercie	Katowice	44	L2	2026
211	Warszawa Zachodnia	Sulejówek Miłosna	24	L2	2026
3	Warszawa Zachodnia	Warszawa Gołąbki	7	L2	2026
8	Warszawa Zachodnia	Warszawa Okęcie	5	L2	2026
9	Warszawa Wschodnia	Warszawa Praga	7	L2	2026
10	Legionowo	Tłuszcz	36	L1	2026
11	Skierniewice	Łowicz Główny	22	L2	2026
12	Skierniewice	Łuków	162	L2	2026
13	Krusze	Pilawa	56	L1	2026
19	Józefinów	Warszawa Główna Towarowa	4	L2	2026
20	Warszawa Główna Towarowa	Warszawa Praga	13	L2	2026
91	Rzeszów	Medyka (state border)	100	L2	2026
93	Trzebinia	Czechowice Dziedzice	46	L1	2026
93	Czechowice Dziedzice	Zebrzydowice (state border)	34	L2	2026
132[12]	Pyskowice	Opole Zachodnie	61	L2	2026
132	Wrocław Brochów	Wrocław Główny	5	L2	2026
133	Dąbrowa Górnicza Ząbkowice	Jaworzno Szczakowa	16	L1	2026
134	Sosnowiec Jęzor	Mysłowice	4	L2	2026
135	Gliwice Łabędy	Pyskowice	5	L2	2026
136	Kędzierzyn Koźle	Opole Groszowice	38	L2	2026
137	Katowice	Kędzierzyn Koźle	63	L2	2026
138	Oświęcim	Mysłowice	23	L1	2026

[11] By the year 2026, ETCS is planned to be installed within the entire Warsaw Railway Junction (Warszawski Węzeł Kolejowy) under a dedicated investment project; the deadline is based on the time needed to equip all traffic control points of the Warsaw Railway Junction with modern computer-based railway traffic control equipment.

[12] The plans include the delivery, in the years 2024-2026, of an investment project involving the construction of new core-level railway traffic control equipment together with ETCS level 2 on the E30/C-E30 railway line (section Opole Zachodnie - Kędzierzyn Koźle/Strzelce Opolskie - Gliwice - Katowice - Sosnowiec Jęzor); this should happen in parallel with the construction of ETCS for the lines included in the project “Works on core passenger routes (E 30 and E 65) within the Silesia region, stage 1: line E 65, section Będzin - Katowice - Tychy - Czechowice Dziedzice - Zebrzydowice”.

138	Mysłowice	Katowice	10	L2	2026
139	Katowice	Czechowice Dziedzice	43	L2	2026
139	Czechowice Dziedzice	Zwardoń (state border)	69	L1	2026
142	Staszic podg	Tychy	12	L2	2026
150	Most Wisła	Chybie	13	L2	2026
151	Kędzierzyn Koźle	Chałupki (state border)	53	L1	2026
160	Zawiercie	Dąbrowa Górnicza Ząbkowice	16	L2	2026
164	Chorzów Batory	Hajduki	2	L2	2026
168	Gliwice	Gliwice Łabędy	5	L2	2026
171/new	Staszic podg	Panewnik	4	L2	2026
180	Sosnowiec Jęzor	Mysłowice Brzezinka	7	L1	2026
186	Zawiercie	Dąbrowa Górnicza Ząbkowice	16	L2	2026
273	Grabiszyn	Wrocław Muchobór	4	L2	2026
275	Wrocław Muchobór	Wrocław Nowy Dwór	1	L2	2026
351	Szczecin Dąbie	Szczecin Główny	14	L2	2026
408	Szczecin Główny	Szczecin Gumieńce	4	L1	2026
409	Szczecin Gumieńce	Tantow (state border)	9	L1	2026
445	Warszawa Zachodnia	Warszawa Aleje Jerozolimskie	2	L2	2026
447	Warszawa Zachodnia	Grodzisk Mazowiecki	26	L2	2026
448	Warszawa Zachodnia	Warszawa Rembertów	14	L2	2026
6	Białystok	Kuźnica Białostocka (state border)	61	L1	2030
8	Radom	Kraków Główny	216	L1	2030
15	Bednary	Arkadia podg	4	L2	2030
38	Białystok	Ełk	104	L2	2030
39	Olecko	Suwałki	43	L2	2030
41	Ełk	Olecko	28	L2	2030
51	Suwałki	Trakiszki (state border)	29	L2	2030
61	Żelisławice	Fosowskie	116	L1	2030
95	Kraków Mydlniki	Podłęże	33	L1	2030
96	Tarnów	Nowy Sącz	88	L1	2030
new	Podłęże	Tymbark	45	L2	2030
104	Tymbark	Nowy Sącz	41	L2	2030
144	Fosowskie	Opole Główne	31	L1	2030
167	Szobiszowice	Gliwice Port	1	L2	2030
199	Rudziniec Gliwicki	Kędzierzyn Koźle	15	L2	2030
201	Gdynia Główna	Gdynia Port	5	L2	2030
204	Malbork	Braniewo (state border)	90	L1	2030
227	Gdańsk Główny	Gdańsk Zaspa Towarowa	5	L2	2030

249	Gdańsk Główny	Gdańsk Brzeźno	6	L2	2030
260	Zajączkowo Tczewskie	Pszczółki	4	L1	2030
265	Zajączkowo Tczewskie	Pszczółki	4	L1	2030
272	Poznań Starołęka	Poznań Główny	4	L2	2030
273	Wrocław Muchobór	Szczecin Główny	350	L1	2030
276	Wrocław Główny	Międzylesie (state border)	136	L1	2030
296	Wielkie Piekary	Miłkowice	12	L2	2030
349	Święta Katarzyna	Stadion	13	L1	2030
353	Poznań Wschód	Iława	229	L1	2030
394	Poznań Franowo PFC	Kobylnica	8	L1	2030
395	Zieliniec	Kiekrz	20	L1	2030
401	Szczecin Dąbie	Świnoujście Port	99	L1	2030
428	Szczecin Dąbie SDB	Szczecin Podjuchy	6	L1	2030

Source: PKP Polskie Linie Kolejowe S.A.

4.3. Perspective after 2030

In provide a long-term picture of the implementation of ERTMS in Poland – one that goes beyond the basic perspective of the TSI CCS National Implementation Plan – this chapter identifies the rail lines on which the system is scheduled to be implemented by 2050. The information takes into account the legal requirements related to the installation of ERTMS on the TEN-T comprehensive network by 2050. However, it must be remembered that the data presented below are indicative in nature, and that more specific implementation deadlines will be set along with the successive updates of the Plan.

Generally, in 2030-2050, ERTMS is planned to be installed on 1500 km of railway lines that are part of the TEN-T comprehensive network.

Tab. 9. Planned completion of ETCS implementation in 2031-2050

Line number	Start station	End station	Length [km]	Level	Completion year
1	Koluszki	Zawiercie	169	L2	2050
7	Lublin	Dorohusk (state border)	96	L1	2050
25	Gałkówek	Sandomierz	216	L1	2050
38	Ełk	Korsze	98	L1	2050
61	Kielce	Żelisławice	59	L1	2050
68	Stalowa Wola Rozwadów	Przeworsk	74	L1	2050
74	Grębów	Stalowa Wola Rozwadów	15	L1	2050
78	Sandomierz	Grębów	9	L1	2050
96	Nowy Sącz	Leluchów (state border)	58	L2	2050
140	Leszczyny	Rybnik Towarowy	11	L1	2050
141	Zabrze Makoszowy Kopalnia	Gliwice	7	L1	2050
148	Pszczyna	Rybnik	35	L1	2050
149	Mizerów	Leszczyny	21	L1	2050
158	Rybnik Towarowy	Chałupki	25	L1	2050

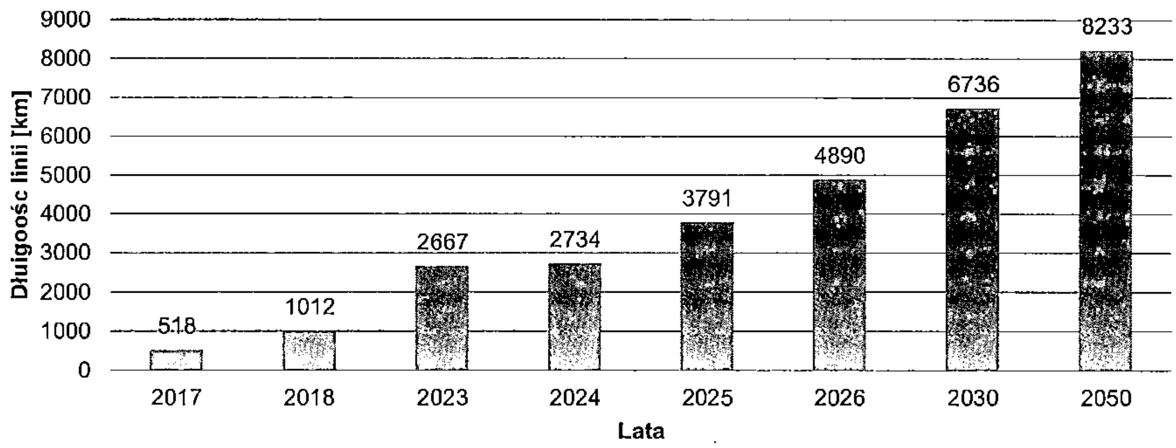
201	Maksymilianowo	Gdynia Główna	173	L2	2050
202	Słupsk	Stargard	202	L2	2050
203	Tczew	Łąg	59	L2	2050
228	Rumia	Gdynia Port	11	L2	2050
353	Iława Główna	Skandawa (state border)	159	L1	2050

Source: PKP Polskie Linie Kolejowe S.A.

5. Summary

According to the TSI CCS National Implementation Plan, the main Polish railway lines will have been equipped with ERTMS by 2050. In the years 2017-2050, ETCS Level 1, Level 1 Limited Supervision, or Level 2 will be installed on a total of 7900 km of lines, and the GSM-R system – on 13 680 km of lines. In addition to previous investments in this respect, this will lead to the modernisation of the railway traffic control system on a large part of the national railway network.

Fig. 3. Expected length of railway lines equipped with ETCS in individual years



Długość linii [km]	Line length [km]
Lata	Years

Source: authors.

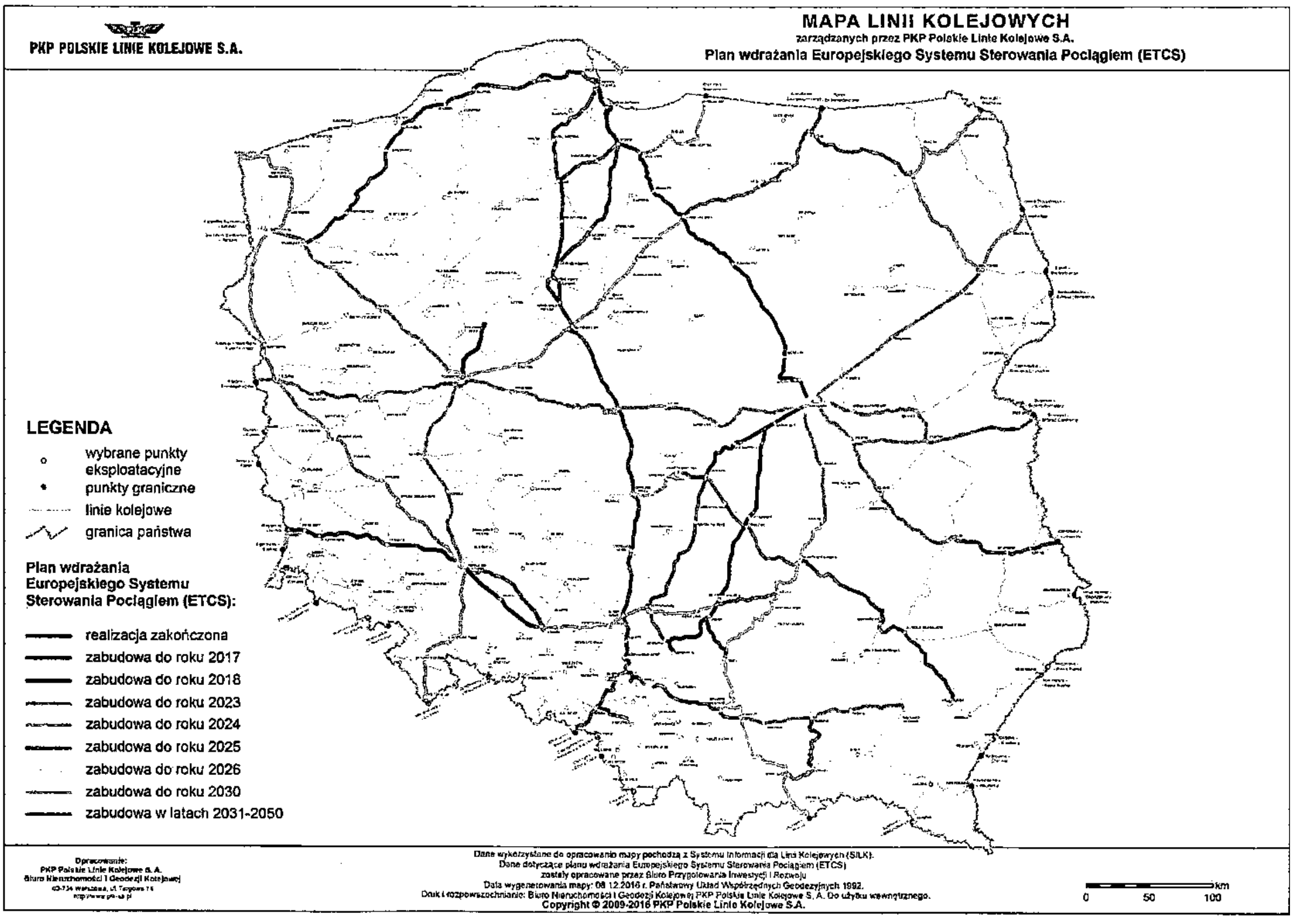
However, all these investments require considerable funds. It is estimated that the total cost of the installation of trackside ERTMS equipment will be as much as PLN 6 billion. Clearly, incurring such high expenditure will not be possible without substantial support from EU funds, not only for the implementation of the system as such, but also for the necessary prior modernisation of the lines to make them fit for the installation of the system.

Ensuring that ERTMS is deployed in an efficient manner will also require fitting railway vehicles with appropriate equipment. The costs in this respect are estimated at about PLN 350 million, a vast majority of which are the costs of ERTMS installation aboard new vehicles. However, it must be borne in mind that the estimates are subject to certain risks related to the availability of suitable data and only cover the limited time horizon until 2023. This is connected with the fact that railway operators do not have long-term plans for their rolling stock, and in addition, are not always willing to share them on legal or economic grounds. However, the data available demonstrates that the cost of ERTMS installation onboard vehicles is much lower than that for trackside equipment. On the other hand, it must be remembered that railway undertakings operate on a highly competitive market, where they compete for customers not only with other railway operators, but above all with other modes of transport. As a result, operators emphasise that under the present circumstances, in most cases, the balance of economic costs and benefits does not make the installation of ERTMS a viable option. However, it is to be hoped that this will gradually change since, with its expansion, the system will be available for use on a greater length of railway lines both in Poland and abroad.

In 2023, the GSM-R system is planned to be put into operation in Poland, following which the legacy analogue system based on 150 Mhz radio communications will be decommissioned. The operators (both Polish and foreign ones) will therefore be forced to equip their vehicles with GSM-R radios to be authorised to access the Polish rail network. However, to date no specific date for the decommissioning of the existing analogue radio communication system has been fixed – this will be done at the time of the successive updates of the Plan.

It is assumed that existing cross-border vehicles moving on Polish freight corridors will benefit fully from being equipped with onboard ETCS not earlier than in 2030. On some sections of the corridors, ETCS may be available even earlier, but full deployment of ETCS within the TEN-T core network is scheduled to be completed by 2030. For this reason, there are no plans as yet to eliminate the Class B system, i.e. Automatic Train Braking (SHP), from Polish railway lines.

Attachment



PKP Polskie Linie Kolejowe S.A.	PKP Polskie Linie Kolejowe S.A.
MAPA LINII KOLEJOWYCH zarządzanych przez PKP Polskie Linie Kolejowe S.A.	MAP OF POLISH RAILWAY LINES managed by PKP Polskie Linie Kolejowe S.A.
Plan wdrażania Europejskiego Systemu Sterowania Pociągiem (ETCS)	European Train Control System (ETCS) Implementation Plan
LEGENDA	KEY
wybrane punkty eksploatacyjne	selected points of network operation
punkty graniczne	border points
linie kolejowe	railway lines
granica państwa	state border
Plan wdrażania Europejskiego Systemu Sterowania Pociągiem (ETCS):	European Train Control System (ETCS) Implementation Plan:
realizacja zakończona	installation completed
zabudowa do roku 2017	to be completed by 2017
zabudowa do roku 2018	to be completed by 2018
zabudowa do roku 2023	to be completed by 2023
zabudowa do roku 2024	to be completed by 2024
zabudowa do roku 2025	to be completed by 2025
zabudowa do roku 2026	to be completed by 2026
zabudowa do roku 2030	to be completed by 2030
zabudowa w latach 2031-2050	to be completed in 2031-2050
Opracowanie: PKP Polskie Linie Kolejowe S.A. Biuro Nieruchomości i Geodezji Kolejowej	Prepared by: PKP Polskie Linie Kolejowe S.A. Biuro Nieruchomości i Geodezji Kolejowej
Dane wykorzystane do opracowania mapy pochodzą z Systemu Informacji dla Linii Kolejowych (SILK)	The data used for the preparation of the map have been retrieved from the Railway Information System (Systemu Informacji dla Linii Kolejowych – SILK)

Dane dotyczące planu wdrażania Europejskiego Systemu Sterowania Pociągiem (ETCS) zostały opracowane przez Biuro Przygotowania Inwestycji i Rozwoju	Data related to the European Train Control System (ETCS) Implementation Plan have been prepared by Biuro Przygotowania Inwestycji i Rozwoju
Data wygenerowania mapy: 08.12.2016 r. Państwowy Układ Współrzędnych Geodezyjnych 1992	Map generated on: 08.12.2016 r. Państwowy Układ Współrzędnych Geodezyjnych 1992
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