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Fulfilment of the Essential Requirements of the Control-command and Signalling Trackside Subsystem on the Railway Infrastructure of Transhipment Terminals

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Summary
The implementation of many railway investments indicates as the main goal increasing the efficiency of the railway system, and thanks to its features it becomes easier to integrate it in the competitive transport market. Increasing the integration of the transport sector is one of the cornerstones of the completion of the internal market and rail is an important part of the transport sector moving towards sustainable mobility. The modernized railway lines, which are part of the Trans-European Transport Network (TEN-T) or European Rail Traffic Management System (ERTMS) corridors, also constitute the network of rail freight corridors (RFC). Pursuant to the requirements of European law, setting the dates for implementing interoperability, the infrastructure of comprehensive networks will be forced to adapt to these requirements. Using the example of the control-command and signalling subsystem, this article outlines the scale of the problem related to the implementation of interoperability in relation to rail-road terminals constituting the comprehensive network of the RFC network.

Keywords: core network, comprehensive network, certification, control-command and signalling subsystem, ETCS, GSM-R

1. Rail freight corridors (RFC)

1.1. Origin

The rail freight corridor is a project implemented in the European Union and its objective is to increase the attractiveness of rail transport in relation to other modes of transport. For such a development to be possible, rail transport service providers must strive for sustainable mobility in their operations. To this end, the available infrastructure must be of a high quality for which sufficient funding is provided. This rail infrastructure should also guarantee proper conditions for freight transport in terms of commercial speeds and journey times.

The legal regulations introduced in the following years, among others [1, 2] were the basis for the creation of the internal rail market, which opened up the transport of goods by rail in Europe. However, in order to optimise the use of the railways and ensure its reliability, it was necessary to introduce additional procedures defining the principle of cooperation between infrastructure managers for the allocation of international paths for freight trains. In this context, the creation of international rail corridors that meet the needs of a European railway network for competitive freight would be very advantageous. By providing good running conditions for freight trains, such as facilitating transit between national rail networks, it would improve the conditions for use of the infrastructure.

Successive legal initiatives concerning railway infrastructure show that, as regards the creation of international rail corridors for a European rail network for competitive freight, the most appropriate method is to create international corridors which meet the specific needs of one or more clearly defined segments of the freight market. Consequently, in addition to these legal regulations, a separate legislative act was adopted in the form of a regulation on matters relating to a European rail network for competitive freight [3].

An important factor to be taken into account when designing a transport corridor should be the aspect of ensuring continuity along the corridor(s) by enabling the required interconnections between existing rail infrastructure and, where appropriate, the need to provide better connections to the rail infrastructure of

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European third countries. At the time of planning, there should be coordination between the Member States of the European Union and the infrastructure managers concerned in order to consider rail freight as the principal mode of transport which provides efficient and satisfactory links with other modes of transport while maintaining conditions conducive to the development of competition between service providers.

The international rail freight corridors that are being developed should be consistent with the Trans-European Transport Network (TEN-T) [4] or the European Rail Traffic Management System (ERTMS) corridors [5]. Subject to clearly defined transparent procedures and criteria, the basic network of rail freight corridors [3] may be extended, following approval at Union level at the request of the Member States and infrastructure managers, as an adjustment to their needs and so that they can take into account existing initiatives for special corridors, e.g. ERTMS, RailNetEurope (RNE) [6] or the TEN-T network. Alongside the creation of corridors, the development of intermodal freight terminals is also necessary.

The establishment of freight corridors indicated an additional characteristic of the new offer to applicants through the designation or creation of a *one-stop shop* (OSS[2]). At these points, following a train path request, the applicant shall receive a response in one place, for one operation, concerning goods trains crossing at least one border on the freight corridor.

1.2. Railway line markings

The carriage of passengers or goods between specified points shall be performed on a railway track designated by the infrastructure manager, which is suitable for carrying out rail traffic and which is called a railway line [7]. Railway lines can be classified using a number of variables, e.g.: properties, technical (operational) parameters:

- main line,
- primary line,
- secondary line,
- line of local importance

or economic and social functions in relation to:

- track gauges:
  - standard-gauge (with a rail gauge between the inner edges of the tracks of 1435 mm),
  - broad-gauge (more than 1435 mm wide),
  - narrow-gauge (less than 1435 mm wide);
- number of tracks: single-track, double-track and multiple-track;
- type of traction: electrified and non-electrified;
- terrain:
  - plain (with longitudinal gradients of 5 to 10‰ and curve radii ranging from 500 to 2000 m),
  - submountain (with longitudinal gradients of 10 to 15‰ and curve radii ranging from 300 to 1500 m),
  - mountain (with longitudinal gradients of up to 30‰ and curve radii between 300 and 800 m);
- location in relation to the surface of the terrain:
  - ground-level, elevated, underground,

or assignment to transport networks (AGC, AGTC, TEN-T, as a comprehensive or core passenger/freight network).

Each railway line has its own number – specific to the territory of the Republic of Poland, one, two or three digits - a name and a mileage (hectometres), used to define the location of structures and equipment in relation to the position of the hectometres. The Infrastructure Manager shall determine the beginning, the direction and the end of the mileage.

Another functioning way of designating a railway route, in this case erroneously referred to as a *railway line*, is that set out in the AGC *European Agreement on Main International Railway Lines* [8]. According to this document, the railway network is defined as the *international E-railway network*, which consists of a system of main lines and complementary lines. According to the agreement, the numbering of lines of major international importance shall be done according to the following criteria:

- Principal lines, comprising reference lines and intermediate lines, called class-A lines, have two-digit numbers (*E xx*); supplementary lines, called class-B lines, have three-digit numbers (*E xxx*).
- North-south oriented reference lines have two-digit odd numbers ending in 5 and increasing from west to east. West-east oriented reference lines have two-digit even numbers ending in 0 and increasing from north to south. Intermediate lines have respectively two-digit odd and two-digit even numbers falling within the numbers of the reference lines between which they are located.
- Class-B lines have three-digit numbers, the first digit being that of the nearest reference line to the north of the B-line concerned, the second being that of the nearest reference line to the west of the B-line concerned and the third being a serial number.

The AGTC *European Agreement on Important International Combined Transport Lines and Related*

[2] It is also common to refer to the corridor and use the C-OSS [6]. *One Stop Shop* (OSS) it is point for application for infrastructure capacity.

Installations is an extension of the above-mentioned method of numbering the railway route [9]. According to this document, the network of important international combined transport lines and associated facilities is referred to as the *international combined transport network* and consists of specific railway lines, combined transport terminals, border crossing points, gauge interchange stations and ferry links/ports. According to this agreement, a set of railway lines (compatible with the national numbering) shall be designated *C – E xx* or *C – E xxx* for railway routes which are essentially identical to the E lines according to the AGC agreement, while the symbol *C xx* or *C xxx* shall denote other important international combined transport lines. The international combined transport network numbers C are identical to those of the nearest international E-railway network and are sometimes supplemented by a series number (e.g. *C xx/x*).

According to the provisions of guidelines [4] on the Trans-European Transport Network (*TEN-T*), which is part of the Trans European Networks (*TEN*), its scope includes road, rail, water and air networks, which are defined on maps [4] and the way they are numbered is in accordance with the rules adopted in a given country.

Between 2009 and 2016, the documents implementing the technical specifications for interoperability for the *control-command and signalling* subsystem defined six corridors, identified by letters *A*–*F*, with a multivariate route through the national territory.

Nowadays, new classifications for the designation of rail freight corridors are emerging (RNE RailNetEurope) [6], which introduce a different way of indicating the set of rail routes included in a given corridor.

1.3. Rail freight corridors within the European Union

With the publication of the regulation concerning a European rail network for competitive freight [3], the first nine RFCx corridors listed in Table 1 were identified.

According to the provisions of the aforementioned Regulation [3], it is possible to establish new freight corridors which, once they have met the relevant criteria, may be approved for operation and should cross the territory of at least three Member States or two Member States, if the distance between the rail terminals used in the corridor is greater than 500 kilometres.

Over the years, these criteria have been met by two further corridors (listed last in Table 1) and there are now 11 rail freight corridors in Europe (Figure 1).

Table 1

List of rail freight corridors

No.	Symbol	Name	Route
1.	RFC1	Rhine – Alpine	Netherlands (Amsterdam/Rotterdam/Vlissingen), Belgium, Germany, Switzerland, Italy (Genoa)
2.	RFC2	North Sea – Mediterranean	Netherlands (Amsterdam/Rotterdam/Terneuzen)/Belgium (Zeebrugge)/France (Dunkirk/Calais), France, Luxembourg, Switzerland (Geneva/Basel)/France (Fos-sur-Mer/Marsille)
3.	RFC3	Scandinavian – Mediterranean	Norway (Oslo)/Sweden (Stockholm), Denmark, Germany, Austria, Italy (Palermo/Augusta)
4.	RFC4	Atlantic	Portugal (Lisbon/Sines)/Spain (Algeciras), Spain, France, Germany (Mannheim)
5.	RFC5	Baltic – Adriatic	Poland (Świnoujcie/Gdynia), Czech Republic/Slovakia, Austria, Slovenia (Koper)/Italy (Trieste/Venice/Ravenna/Bologna)
6.	RFC6	Mediterranean	Spain (Algeciras/Almeria/Lorca/Cartagena)/France (Fos-sur-Mer/Marsilles), France, Italy, Slovenia/Croatia, Hungary (Záhony)
7.	RFC7	Orient/East – Med	Germany (Wilhelmshaven/Bremerhaven/Hamburg/Rostock), Czech Republic, Slovakia, Hungary, Serbia, Romania, Bulgaria (Burgas/Svilengrad)/ Greece (Patras)
8.	RFC8	North Sea – Baltic	Netherlands (Amsterdam/Rotterdam)/Belgium (Antwerp)/ Germany (Wilhelmshaven/Bremerhaven/Hamburg/Rostock), Germany, Czech Republic (Prague), Poland (Katowice/Terespol), Lithuania, Latvia, Estonia (Tallinn)
9.	RFC9	Rhine – Danube	France (Strasbourg), Germany, Austria/Czech Republic, Slovakia, Hungary, Romania (Constanța)
10	RFC10	Alpine – Western Balkan	Austria (Salzburg/Weles), Slovenia, Croatia, Serbia, Bulgaria (Svilengrad)
11.	RFC11	Amber	Poland (Warsaw/Malaszewicze), Slovakia, Hungary (Kelebia)/Slovenia (Koper)

[Own study].

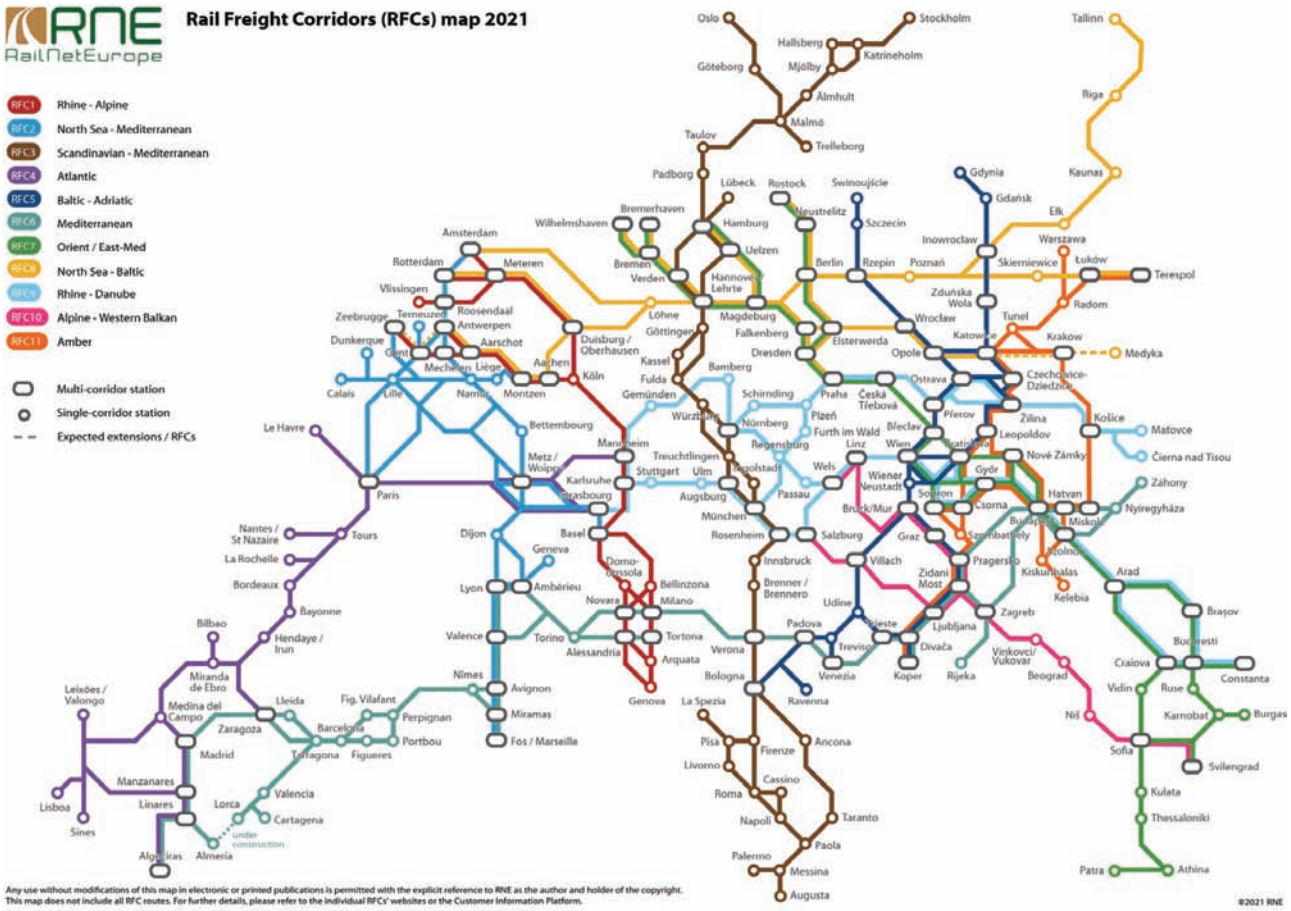

Fig. 1. Map of rail freight corridors [6]

1.4. Rail freight corridors in Poland

Rail Freight Corridor 5 (RFC5)

The Rail Freight Corridor Baltic – Adriatic [10] runs through six Member States of the European Union (Poland, the Czech Republic, Slovakia, Austria, Italy, Slovenia). The length of the RFC5 corridor is 1800 kilometres, which makes it possible to create more routes between the Baltic and Adriatic Sea basins: from north to south, starting either at the ports of Szczecin and Świnoujście, via Poznań and Wrocław, or at the ports of Gdynia and Gdańsk directly to Katowice or via Warsaw and Łódź, connecting the Polish urban and logistic nodes of the core network with nodes located in the Czech Republic, Slovakia and Austria, reaching Vienna via Bratislava or Ostrava. Road and railway lines of the corridor continue from Austria via Ljubljana in Slovenia or via Udine, to Venice and Bologna in Italy and the Adriatic Sea ports of Trieste in Italy, Venice and Ravenna and Koper in Slovenia.

This corridor includes a total of 13 urban nodes and airports, 10 seaports and nearly 24 active railroad terminals The foundation of the Baltic – Adriatic transport axis is formed by rail and road routes. In fact, it is one of the few corridors that does not include inland waterways, even though this corridor connects to the TEN-T inland waterways core network at various sections. Its rail network mainly corresponds to the Rail Freight Corridor 5 Baltic – Adriatic.

RFC5 crosses five other corridors. In Poland, the corridor crosses the North Sea – Baltic corridor west to east, while in the Czech Republic, Austria and Slovakia it is crossed by the eastern Mediterranean and the Rhine – Danube corridors. Further south, in Italy and Slovenia, the corridor largely runs parallel to the Mediterranean corridor. In addition, there is one crossing with the Scandinavian – Mediterranean corridor between Bologna and Faenza along the Bologna –Ravenna railway route, which also includes urban and logistical nodes in Bologna.

On the territory of Poland 32 freight terminals are assigned to RFC5 [11]: BCT Bałtycki Terminal Kontenerowy (Terminal BCT Gdynia) (Gdynia Główna); Gdynia Container Terminal (Gdynia Główna); Terminal Kontenerowy DCT Gdańsk (Deepwater Container Terminal) (Gdańsk Port Północny); Gdański Terminal Kontenerowy (Gdańsk Zaspa Towarowa);

PCC Intermodal – Terminal PCC Kutno (Stara Wieś); Erontrans Terminal Kontenerowy w Strykowie (Stryków); Terminal Kontenerowy Spedcont Łódź (Łódź Olechów); Terminal Centrostal Łódź S.A. (Łódź Żabieniec); Loconi Terminal Kontenerowy (Radomsko); Erontrans Terminal Kontenerowy w Radomsku (Radomsko); METRANS Terminal Dąbrowa Górnicza (Dąbrowa Górnicza); Euroterminal Sławków (Sosnowiec Maczki); PCC Intermodal – Terminal PCC Brzeg Dolny (Brzeg Dolny); OT Port Świnoujście – Terminal Kontenerowy (Świnoujście); DB Port Szczecin (Szczecin Port Centralny); Terminal Kontenerowy Schavemaker Kąty Wrocławskie (Kąty Wrocławskie); Terminal kontenerowy Siechnice – Baltic Rail (Siechnice); PKP Cargo Connect – Terminal Kontenerowy Poznań Franowo (Gądki); Centrum Logistyczno-Inwestycyjne Poznań II CLIP Logistics Sp. z o.o. (Swarzędz); Rail Hub Terminal Gądki – Matrans Polonia (Gądki); Ostsped Intermodal – Terminal Kontenerowy Szamotuły (Szamotuły); Terminal Kontenerowy Gliwice – PKP Cargo Connect Sp. z o.o. (Gliwice); PCC Intermodal – Terminal PCC (Gliwice); Rail Terminal Rzepin sp. z o.o. (Rzepin); BALTCHEM S.A. – Zakłady Chemiczne w Szczecinie (Szczecin Port Centralny); Bałtycka Baza Masowa (Gdynia Port); Brzeski Terminal Kontenerowy (Brzesko Okocim); Bulk Cargo-Port Szczecin (Szczecin Port Centralny); CARGO-SPED Terminal Braniewo Sp. z o.o. (Braniewo); Euro-Terminal Świnoujście (Świnoujście); Śląskie Centrum Logistyki S.A. Gliwice (Gliwice Port); Port Gdański Eksploatacja S.A (Gdańsk Zaspa Towarowa).

Rail Freight Corridor 8 (RFC8)

The Rail Freight Corridor North Sea – Baltic [12] covers 5986 km of rail track, 4092 km of road and 2186 km of inland waterways. It is one of nine core network corridors and the only one that runs exclusively in northern Europe. The corridor exemplifies the main objective of the new TEN-T policy, which is to link east to west and to improve the accessibility of eastern Member States. It is the northernmost corridor connecting the markets of Western Europe with those of the East. It connects the Baltic Sea region with the Netherlands via Helsinki, the Baltic States, Poland and Germany.

This corridor connects the seaports of Belgium (Antwerp), the Netherlands (Rotterdam, Amsterdam), Germany (Wilhelshaven, Bremenhaven, Hamburg/Aachen) with the terminals in Hanover, Berlin, Warsaw, Terespol on the Polish-Belarusian border and further to Kaunas, as well as Riga, Tallinn / Falkenberg and Katowice and Prague. The route of this corridor may be further extended from Kraków to Medyka on the Polish-Ukrainian border.

An important feature of the North Sea – Baltic corridor is the connection to other corridors through multimodal crossing points (nodes). Helsinki is connected to the Scandinavian – Mediterranean corridor, Warsaw, Łódź and Poznań to the Baltic – Adriatic corridor and Berlin and Hannover to the Orient/East – Med corridor and Scandinavian – Mediterranean corridor. In the western part of the corridor, Cologne, Nijmegen and Liège are the points where the corridor crosses the Rhine – Alpine corridor, and Antwerp, Brussels, Rotterdam and Amsterdam are the points where the corridor crosses the Rhine – Alpine and North Sea – Mediterranean corridors.

In Poland, 14 freight terminals are assigned to RFC8 [13]: Euroterminal Sławków (Euroterminal Sławków) (Jaworzno Szczakowa); Terminal Gądki (METRANS «Polonia» Sp. z o.o.) (Gądki); Terminal Gliwice (PCC Intermodal S.A.) (Gliwice); Terminal Gliwice (port) (Śląskie Centrum Logistyki S.A.) (Gliwice port); Terminal Kąty Wrocławskie (SCHAVEMAKER INVEST Sp. z o.o.) (Kąty Wrocławskie); Terminal Kutno (PCC Intermodal S.A.) (Stara Wieś k. Kutna); Terminal Pruszków (METRANS «Polonia» Sp. z o.o.) (Pruszków); Terminal Kontenerowy Spedcont Łódź (Spedycja Polska Spedcont Sp. z o.o. w Łodzi) (Łódź Olechów); PKP Cargo Centrum Logistyczne Małaszewicze PKP Cargo (Małaszewicze Południe); Centrum Logistyczne Łososna (Centrum Logistyczne w Łosośnej) (Sokółka); Terminal Kontenerowy Poznań Franowo (PKP Cargo Connect Sp. z o.o.) (Poznań Franowo); Centrum Logistyczno-Inwestycyjne Poznań II (CLIP Logistics Sp. z o.o.) (Swarzędz); PCC Intermodal – Terminal PCC Brzeg Dolny (PCC Intermodal S.A.) (Brzeg Dolny); Terminal Dąbrowa Górnicza (METRANS «Polonia» Sp. z o.o.) (Dąbrowa Górnicza Towarowa).

Rail Freight Corridor 11 (RFC11)

The Rail Freight Corridor Amber [14] links south-eastern Poland, Slovakia, Hungary and Slovenia with the Belarusian border at Terespol and also includes the capital cities of Budapest, Bratislava and Ljubljana as well as industrial centres around Kraków, Katowice (Upper Silesian Industrial Region), Warsaw, Kosice and Miskolc. The southern end of the corridor reaches the port of Koper on the Adriatic Sea in Slovenia. The corridor completes the European rail freight corridor network with connections to corridors 5, 6, 7, 8 and 9.

In Poland 22 freight terminals are assigned to RFC11 [15]: PKP Cargo Centrum Logistyczne Małaszewicze (Małaszewicze); EUROPORT Małaszewicze Duże (Małaszewicze Duże); Terminal Przeładunkowy Wólka (Wólka); Transgaz S.A. (Zalesie); Terminal Kontenerowy Warszawa – PKP Cargo Connect Sp. z o.o. (Warszawa Praga Towarowa); Loconi Intermodal Terminal Kontenerowy Warszawa (Warszawa Praga Towarowa); Polzug Terminal Kontenerowy Pruszków (Pruszków); Terminal Kontenerowy Warszawa

Główna Towarowa SPEDCONT Sp. z o.o. (Warszawa Główna Towarowa); Terminal Kontenerowy Gliwice – PKP Cargo Connect Sp. z o.o. (Gliwice); PCC Intermodal – Terminal PCC Gliwice (Gliwice Port); Terminal Sosnowiec Poludniowy (Spedycja Polska Spedcont Sp. z o.o.) (Sosnowiec Południowy); Euroterminal Sławków (Jaworzno Szczakowa); Polzug Terminal Dąbrowa Górnicza (Dąbrowa Górnicza); Brzeski Terminal Kontenerowy – Karpiel Sp. z o.o. (Brzesko); Terminal Kontenerowy Włosienica (Włosienica); PCC INTERMODAL – Terminal Kolbuszowa (Kolbuszowa); Lubelski Terminal Kontenerowy (Nałęczów); Erontrans Terminal Kontenerowy w Radomsku (Radomsko); Loconi Intermodal S.A. Terminal Kontenerowy Radomsko (Radomsko); Erontrans Terminal Kontenerowy w Strykowie (Stryków); Terminal Kontenerowy Łódź Chojny (Łódź Chojny); SPEDCONT Terminal Kontenerowy Łódź Olechów (Łódź Olechów).

2. Basic information about the „control--command and signalling" subsystem

The control-command and signalling subsystem is defined in current European legislation as all track-side equipment necessary to ensure safety and to control traffic on the network and all on-board equipment necessary to ensure safety and to control traffic on the network. The word 'all' plays an important role here because it clearly indicates that the *Control-Command and Signalling* subsystem is not limited to the equipment defined in the Technical Specification for Interoperability (TSI) *control-command and signalling* [16], but also covers equipment defined in national legislation [7, 17]. I The *control-command and signalling* subsystem consists of the following equipment:

- signal boxes for interlocking,
- marshalling control equipment, including primary rail-brakes,
- block system equipment,
- level crossing traffic protection system equipment,
- detecting emergency conditions of railway vehicles during train movement and incorrect loading of wagons,
- for track and turnout occupancy detection:
  - track circuits,
  - axle-counters,
- reversing or controlling the moving parts of a turnout,
- signals,
- vehicle/track interaction
- train control,
- CCTV for traffic control,
- control-command and signalling system equipment adapted to the railway area structure for automatic control-command and signalling or by operators (e.g. signalmen), which must be developed in accordance with the rules in force and which are also part of the subsystem:
  - wired and wireless communication, including dispatch communication, train dispatcher-to-crossing guard communications and intrastation traffic communication, with the exception of the digital radio communication system equipment (GSM-R),
  - wireless communication, including train, manoeuvring, road and maintenance, with the exception of the digital radio communication system equipment (GSM-R),
  - a recorder for communication related to traffic control,

other equipment supporting operators and their documentation where necessary.

In addition, this interpretation of the subsystem can be complemented by the statement that the *control-command and signalling* subsystem is a system which, under all operating conditions, is intended to ensure safe control-command and signalling, i.e. in particular to prevent rear-end collisions, collisions of trains at turnouts, including incursions of railway vehicles from sidings to main tracks, derailments due to throwing-over the points under a running train, collisions with road vehicles at level crossings, exceeding speed limits and the crossing of railway vehicles beyond the end of the road made available to them. In summary, the control-command and signalling system specifies the equipment necessary to ensure safety and to control the movement of trains on the railway network, together with the communication equipment and software of the control-command and signalling equipment, including the equipment for generating and transmitting information on the train movement restrictions to train drivers (road speed limits) as well as the voice and data communication equipment. The area of control-command and signalling is divided into the following parts:

- the control-command and signalling baseline (includes track-side and on-board equipment) including: clear track and turnout reporting and systems using information about the presence of vehicles on the track – signal boxes, wayside (signalling) equipment and level crossing protection equipment,
- the superior layer based on digital safe data transmission downloaded from the baseline and transmitted to vehicles for the purpose of driving conformity control and supervision in relation to speed and distance restrictions, according to the received data resulting from the information downloaded from the baseline.

3. Development of the railway network within the European Union

As mentioned in the introduction, one of the directions for the development of the rail transport network within the territory of the European Union was the creation of a network of rail freight corridors in accordance with Regulation [16]. The document indicates that the development of the corridors should be carried out in a manner consistent with the Trans-European transport network or the European rail traffic management system corridors. Such development should be coordinated in particular in terms of integration into the existing TEN-T or ERTMS network.

3.1. Trans-European Transport Network (TEN-T)

With regard to transport, the European Union is guided by the main objective, described, among others, in strategy papers such as the "White Paper" [18], of the long-term planning, development and operation of Trans-European transport networks. This objective contributes to achieving a competitive and resource-efficient transport system through a smoothly functioning internal market and strengthened economic, social and territorial cohesion. In addition, the specific objectives include ensuring the unimpeded, safe and sustainable movement of people and goods, ensuring the accessibility and connectivity of all regions of the European Union and boosting further global economic development and competitiveness. Such action must support the international mobility of persons and goods by optimising the capacity of the Trans-European transport network and the way in which it is used and, where necessary, increasing capacity by resolving bottlenecks and filling in missing infrastructure links within and between Member States and, in specific cases, with neighbouring third countries. In these efforts, ensuring better modal integration across the network in terms of infrastructure, information flows and procedures cannot be overlooked.

The *White Paper* also points to the need to implement information and communication technologies in the field of transport to ensure better and integrated traffic management and to simplify administrative procedures by improving freight logistics, tracking and tracing, and optimising schedules and traffic flows. The implementation of such measures shall be ensured by the application of legal provisions concerning the development of the Trans-European transport network [4].

Any legal aspects relating to Trans-European transport network policy must take into account both developments relating to transport policy and the characteristics of the infrastructure which Member States are responsible for establishing and maintaining. These changes should also take account of activities relating to the implementation of the multimodal Trans-European transport network and related investment projects by other entities, including private companies, regional and local authorities, infrastructure managers, concessionaires or port and airport authorities.

The Trans-European transport network should be developed through the creation of new transport infrastructure, through the rehabilitation and modernisation of existing infrastructure and through measures promoting its resource-efficient use. If a rehabilitation process is chosen, i.e. the restoration of the infrastructure to its original construction parameters combined with the long-term improvement of the quality of this infrastructure, all works must be carried out in accordance with the requirements and respect of the provisions of Regulation 1315/2013 [4]. The most suitable way to develop the Trans-European transport network is to build it using a dual-layer structure consisting of a comprehensive network and a core network.

The comprehensive network should be a Europe-wide transport network ensuring the accessibility and connectivity of all regions in the Union, including the remote, insular and outermost regions (as also pursued by the Integrated Maritime Policy) and strengthening social and economic cohesion between them. According to the requirements set out in Regulation [4], support for the development of comprehensive network infrastructure must remain guaranteed until 2050.

The core network should be identified by 2023 and the review of the implementation of the core network (taking into account national implementation plans and future enlargements) should be completed by that time, and by 2030 as a priority within the framework provided by the comprehensive network, appropriate measures should be taken for its development. The core network should constitute the foundation for the development of a sustainable multimodal transport network and should stimulate the development of the entire comprehensive network. It should also enable EU action to concentrate on those components of the Trans-European transport network with the highest European added value, i.e., in particular cross-border sections, missing links, multimodal connecting points and major bottlenecks serving the objectives set out in the White Paper.

In order to establish the core network in a coordinated and timely manner, thereby making it possible to maximise the network benefits, Member States concerned should ensure that appropriate measures are taken to finalise the projects of common interest by 2030. With respect to the comprehensive network,

Member States should make all possible efforts with the aim of completing it and complying with the relevant provisions of the guidelines by 2050. Therefore, it is necessary to identify projects of common interest which will contribute to the achievement of the Trans-European transport network and which contribute to the achievement of the objectives and correspond to the priorities established in the guidelines. Their implementation should depend on their degree of maturity, on their compliance with Union and national legal procedures and on the availability of financial resources, without prejudging the financial commitment of a Member State or of the European Union. Projects of common interest should demonstrate a European added value. Cross-border projects typically have a high European added value, but may have lower direct economic effects compared to purely national projects. Such cross-border projects should be the subject of priority intervention by the Union in order to ensure that they are implemented. However, before applying to the European Union for funding, projects of common interest should be the subject of a socio-economic cost-benefit analysis based on a recognised methodology, taking into account the relevant social, economic, climate-related and environmental benefits and costs.

Some parts of the Trans-European transport network can be managed by actors other than Member States. In such cases, Member States are responsible for ensuring that the rules governing the network are correctly applied within their territory. As the development and implementation of the Trans-European transport network requires a common application of the Regulation [4], all parts of the network should be subject to the rights and obligations provided for by this Regulation, as well as to those laid down in other relevant Union and national law. What is more, cooperation with neighbouring and third countries is necessary in order to ensure connection and interoperability between the respective infrastructure networks. In addition, in order to achieve modal integration across the network, adequate planning of the Trans-European transport network is required. This also entails the implementation of specific requirements throughout the network in terms of infrastructure, telematic applications, equipment and services. It is therefore necessary to ensure adequate and concerted deployment of such requirements across Europe for each transport mode and for their interconnection across the Trans-European transport network and beyond, in order to obtain the benefits of the network effect and to make efficient long-range Trans-European transport operations possible. Telematic applications are necessary in order to provide the basis for optimising traffic and transport operations and traffic safety and improving related services.

Due to the large scale of the Trans-European transport network, the basis for the large-scale deployment of new technologies and innovation, which, for example, can help to enhance the overall efficiency of the European transport sector and reduce its carbon footprint should be provided. This will contribute to achieving the objectives of European Union's strategy papers, including the *White Paper*, defining the percentage reduction in greenhouse gases in a given year. In doing so, Member States and other project promoters should give due consideration to the risk assessments and adaptation measures adequately improving resilience to climate change and environmental disasters.

The individual elements constituting core network should be a subset of the comprehensive network overlaying it. It should represent the strategically most important nodes and links of the Trans-European transport network, according to traffic needs. The core network should be multimodal, i.e., it should include all transport modes and their connections as well as relevant traffic and information management systems. The core network has been identified on the basis of an objective planning methodology, identifying the most important urban nodes, ports and airports, as well as border crossing points. In order to implement the core network within the given timescale, a *corridor* approach could be used as an instrument to coordinate different projects on a transnational basis and to synchronise the development of the corridor, thereby maximising network benefits. By adopting such approach, core network corridors should help to develop the infrastructure of the core network in such a way as to address bottlenecks, enhance cross-border connections and improve efficiency and sustainability. Furthermore, it should contribute to cohesion through improved territorial cooperation.

Core network corridors should also address wider transport policy objectives and facilitate interoperability, modal integration and multimodal operations. This should allow creating specially developed corridors which are optimised in terms of emissions, thus minimising environmental impacts and increasing competitiveness, and which are also attractive on account of their reliability, limited congestion and low operating and administrative costs. The corridor approach should be transparent and clear and the management of such corridors should not create additional administrative burdens or costs.

The core network corridors should be in line with the rail freight corridors set up in accordance with Regulation 913/2010 [3] as well as the European Deployment Plan for the European Rail Traffic Management System (ERTMS) provided for in Commission Decision 2009/561/WE [19] (as amended).

3.2. European Rail Traffic Management System (ERTMS) corridors

According to the current approach, the railway system is broken down into both structural and operational subsystems. For both types of subsystems a set of Technical Specifications for Interoperability (TSIs) has been developed. Each TSI indicates the strategy for implementing the TSI and the stages to be completed in order to make a gradual transition from the existing situation to the final situation in which compliance with the TSI shall be required.

In accordance with the legislation approved for implementing the technical specification for interoperability relating to the control-command and signalling subsystem (both trackside and on-board parts), Member States have established national implementation plans for the TSI relating to the *control-command and signalling* subsystem and have submitted these plans to the European Commission for approval and agreement on the target ERTMS deployment plan. The strategy for implementing the TSI relating to the *control-command and signalling* subsystem should not only rely on compliance of subsystems with the TSI at the time of their placing in service, upgrading or renewal but also on coordinated implementation along pan-European corridors linking the main European freight transport areas. As interoperability can only be achieved when corridors are fully equipped, it is therefore crucial that the European deployment plan sets appropriate deadlines for renewing or upgrading the subsystems.

In principle, European Rail Traffic Management System (ERTMS) projects, and in particular lines identified in the European deployment plan, may receive Community support from the TEN-T programme or other Community financial aid programmes.

The aim of the ERTMS European deployment plan is to gradually provide access to an increased number of lines, ports, terminals and marshalling yards for locomotives, wagons and other railway vehicles equipped with ERTMS, without the need for additional equipment. To this end, the plan does not require the removal of the applicable Class B systems (non-interoperable national systems) on the lines covered by the plan. However, by the date specified in the plan, equipment with Class B systems shall not be a condition for track access for locomotives, railway wagons and other railway vehicles equipped with ERTMS for lines included in the plan. If a terminal area, for example a port or specific lines in a port, is not equipped with a Class B system, the requirements to connect such terminal areas do not necessarily imply the need to equip such a terminal or line with ERTMS, provided that equipment with a Class B system is necessary for track access. According to the requirements, a line is equipped when at least both tracks are equipped. If there is more than one line on a corridor section, at least one line must be equipped with ERTMS on that section; the whole corridor is considered to be equipped when at least one line is equipped on the whole length of the corridor.

The network of corridors to be equipped with ERTMS according to a specific timetable shall be defined in the technical specifications for interoperability relating to the *control-command and signalling subsystem.* This document also indicates the ports, marshalling yards, freight terminals and freight transport areas that will be linked to at least one of the six corridors specified in the TSI [19] at the date and under the conditions specified in this document.

4. Meeting the essential requirements of the *control-command and signalling* subsystem on the infrastructure of transport corridors

The following part of the article emphasises the connections of the provisions of individual legislative acts, for which the interpretation and verification of the correlation of the provisions between the indications resulting from the observance of European law or the provisions of national law are not subject to analysis. The regulations cover the various areas relating to rail transport and are intertwined with one another. From legislation describing the creation of a single European railway area or the development of the railways in the Community, to legislation on the allocation of railway infrastructure capacity and on rail infrastructure charging, the foundations are being laid for these to be important steps towards the creation of an internal rail market. Such a market can be described by, e.g.: the legal provisions on the creation of a Trans-European transport network [4] or the creation of freight corridors [3] presented earlier.

Market analyses in the European Union have recognised that the efficiency of the railway system should be improved, in order to integrate it into a competitive market, whilst taking account of the special features of the railways. Greater integration of the transport sector is an essential element of the completion of the internal market, and the railways are a vital part of the transport sector moving towards achieving sustainable mobility. In recognition of these needs, Directive 2012/34 [20] establishing a single European railway area, which refers to the promotion of ERTMS by infrastructure managers, was adopted. The use of ERTMS on the vehicle side could be differentiated in the infrastructure access charges incurred.

It is appropriate to enable citizens of the Union, economic operators and competent authorities to

benefit to the full from the advantages deriving from the creation of a single European railway area, in particular by improving the links and interoperability of the national rail networks as well as access thereto through the implementation of any measures that may prove necessary in the field of technical standardisation [1]. This can be achieved by applying Directive 2016/797 [21] on the interoperability of the rail system within the European Union. The pursuit of interoperability within the Union rail system should lead to the definition of an optimal level of technical harmonisation and make it possible to facilitate, improve and develop international rail transport services within the Union and with third countries, and contribute to the progressive creation of the internal market in equipment and services for the construction, renewal, upgrading and operation of the Union rail system. The commercial operation of trains throughout the rail network requires, in particular, excellent compatibility between the characteristics of the infrastructure and those of the vehicles, as well as efficient interconnection of the information and communication systems of the different infrastructure managers and railway undertakings. Performance levels, safety, quality of service and cost depend upon such compatibility and interconnection, as does, in particular, the interoperability of the Union rail system.

To ensure that the interoperability requirements are met, technical specifications for interoperability have been drawn up for each structural and operational subsystem. The TSI relating to the *control-command and signalling* subsystem [16], which specifies the conditions to be complied with by the interoperability constituents and the conformity assessment procedures, is applicable to the problem under consideration. According to the TSI, there should always be compatibility with existing subsystems. The Directive on the interoperability should apply to the entire Union rail system and the scope of the TSIs should be extended to cover the vehicles and networks not included in the Trans-European rail system taking into account the conditions of the Directive that apply to the design, construction, placing in service, upgrading, renewal, operation and maintenance of the parts of that system as well as the professional qualifications of, and health and safety conditions applying to, the staff who contribute to its operation and maintenance.

The legal acts presented describing the single railway system in the Union are not the only ones that cover areas related to the handling of freight traffic both in logistics centres and in the network of transport corridors. Other legislative acts are those concerning a European rail network for competitive freight transport.

One such act, among others, is the one that by its provisions brought the rail freight corridors into existence, i.e. Regulation 913/2010 [3] – supplemented by Decision 2017/177 [22]. This regulation is oriented towards the creation of international rail freight corridors forming a European rail network for competitive freight transport. Their creation should be conducted in a manner consistent with the Trans-European Transport Network (TEN-T) as defined in Regulation 1315/2010 [4] and/or the European Railway Traffic Management System (ERTMS) corridors with reference to Decision 2009/561/EC [19]. To that end, the coordinated development of the networks is necessary, and in particular as regards the integration of the international corridors for rail freight into the existing TEN-T and the ERTMS corridors. Furthermore, harmonising rules relating to those freight corridors should be established at Union level. Their aim is to encourage projects aimed at reducing noise caused by freight trains. If necessary, the establishment of those corridors should be supported financially within the framework of the TEN-T, research programmes, and other Union policies and funds. Such funding for the TEN-T network was guaranteed by Regulation 1316/2013 [23] as amended and replaced by Regulation 2021/1153 [24], including funding for the deployment of ERTMS on the main routes of rail freight corridors in accordance with the Annex to Regulation 913/2010 [3].

Regulation 1315/2010 [4] on the development of the Trans-European transport network is another legislative act laying down guidelines for the development of a Trans-European transport network with a dual-layer structure, comprising a comprehensive network and a core network based on the comprehensive network. This document specifies the requirements to be met in terms of governance and sets out the priorities for the development of the infrastructure of the Trans-European transport network. The Trans-European transport network comprises transport infrastructure and telematic applications as well as measures promoting the efficient management and use of such infrastructure and permitting the establishment and operation of sustainable and efficient transport services. The infrastructure of the Trans-European transport network consists of the infrastructure for railway transport, inland waterway transport, road transport, maritime transport, air transport and multimodal transport.

According to the provisions of this regulation, elements of railway infrastructure include, inter alia, sidings as well as freight terminals and logistic platforms for reloading of goods within the railway transport and between rail and other transport modes. This regulation also defines the requirements to be met by the transport infrastructure, which are formulated as follows:

(…)

1) *Freight terminals shall be connected with the road infrastructure or, where possible, the inland water-*

way infrastructure of the comprehensive network.

2) *Member States shall ensure that the railway infrastructure:*
   a) *save in the case of isolated networks, is equipped with ERTMS;*
   b) *complies with Directive 2008/57/EC of the European Parliament and of the Council*[3] *and its implementing measures in order to achieve the interoperability of the comprehensive network;*
   c) *complies with the requirements of the TSIs adopted pursuant to Article 6 of Directive 2008/57/EC, except where allowed by the relevant TSI or under the procedure provided for in Article 9 of Directive 2008/57/EC;*
   d) *save in the case of isolated networks, is fully electrified as regards line tracks and, to the extent necessary for electric train operations, as regards sidings;*
   e) *complies with the requirements laid down in Directive 2012/34/EU of the European Parliament and of the Council, as regards access to freight terminals.*
3) *At the request of a Member State, in duly justified cases, exemptions shall be granted by the Commission in respect of requirements that go beyond the requirements of Directive 2008/57/EC concerning ERTMS and electrification.* (…)

In the provisions for all Member States, the Regulation also provides precise indications as to the nodes of the core network to which the rail-road terminals are included in relation to the comprehensive network.

Referring to the provisions of the above-mentioned European legislative acts, it can be noted that each of them indicates that the infrastructure (including sidings) which is designed, constructed, upgraded or renewed should be implemented in such a way as to ensure the implementation of interoperability. In accordance with the provisions of legislative acts, it is possible to take appropriate legal measures to obtain exceptions, the implementation of which rests with the entity requesting such an exception.

5. Target solutions in terms of national strategy papers

Any investment project carried out on the territory of the Republic of Poland, apart from meeting the requirements of European law resulting from Poland's membership in the European Union, must also meet the basic requirements of national law. This also applies to the infrastructure identified in Regulations 913/2010 and 1315/2013 as elements of the railway system presented in the acts describing the requirements for rail [7], implementing interoperability [25], requirements for signalling [26] or obtaining authorisation for placing in service certain types of equipment [17].

Referring to the provisions of the Act [7], it can be noted that it transfers the implementation of the directives related to the railway area and by its provisions it is indicated to ensure the implementation of interoperability on the designed, constructed, upgraded or renewed railway network, ensuring the fulfilment of the requirements in accordance with the acts implementing the Act.

In addition to legislative acts, various types of strategy papers approved by state administration bodies are in formal circulation. One such document, which might be perceived as a tool for implementing the interoperability of the Community's railways, is the document drawn up by the competent minister responsible for rail transport, and its supplements [27, 28], updating the national assumptions concerning the national plan for the implementation of the technical specification for interoperability relating to the *control-command and signalling* subsystem [29].

The basic aim of the plan drawn up by the Ministry was to provide railway undertakings with information on the schedule for the deployment of the ERTMS system in Poland so as to enable them to plan their business activities accordingly in the context of the gradual equipping of their traction units with the system's on-board equipment. The national plan for implementing the TSI relating to the *control-command and signalling* subsystem has been developed in such a way that the implementation of these specifications in Poland in respect of the *control-command and signalling* subsystems is directed towards increasing the coherence of the whole railway system of the European Union and positively influencing the profitability of the railway system in Poland.

In addition, details [27] were developed for this document, the main reason for which was to create a roadmap for railway market participants ahead of the expected migration from the analogue VHF radio communication system in the 150 MHz band to digital GSM-R. The detailed provisions on the strategy for transition to the GSM-R subsystem intended for the trackside subsystem have defined, among other

[3] Directive not in force, it is replaced by Directive [21] (author's note).

things, requirements (including for railway sidings) which may be relevant for freight terminal operators:

(…)

1. *On lines included in the national implementation plan for ERTMS, the target solution for . train communication is to use GSM-R, except for networks that are functionally separate from the railway system and to which the requirements for interoperability of the railway system and for shunting communication do not apply. A total of about 15,300 km of railway lines will eventually be equipped with GSM-R (GSM-R network project together with other projects);*

(…)

7. *Simultaneous operation of 150 MHz analogue VHF radio communications and GSM-R on the railway network is not expected.*

(…)

13. *As shunting communications require high radio resources beyond the capacity of GSM-R, they will continue (indefinitely) to be carried out using the 150 MHz VHF system currently in operation.* (…)

6. Guidelines for terminal operators to meet essential requirements

On the basis of the analysis of the provisions of the legislative acts which indicate the necessity of meeting the essential requirements of the TSI relating to the *control-command and signalling* subsystem, in accordance with the formulations of European and national law contained therein, the manager of the infrastructure in the locations indicated in the regulations cited should strive to implement interoperable Class A systems on the operated infrastructure. The decision on the scope of such implementations, according to the legal provisions, rests with the infrastructure manager. At this point it should also be pointed out that the decision taken will have different effect for every manager – it will be different for an operator of one track on a siding and completely different for managers of a transhipment area located on the border of different railway track gauges. In this respect, in their internal analyses, managers should keep a reasonable adjustment to their own needs.

Given that the infrastructure in operation is subject to cyclical works, which are classified into phases: design, construction, upgrading, renewal of existing infrastructure, according to Article 7 of Regulation 1315/2010 [4], such works constitute a project of common interest. Therefore, when making a final decision on whether to recommend implementation and fulfilment of the essential requirements for interoperability, managers of such infrastructure should refer to documents indicating whether the draft requirements of the Regulation [4]:

(…)

a) contribute to the objectives falling within at least two of the four categories set out in Article 4;
b) comply with Chapter II, and if it concerns the core network, comply in addition with Chapter III;
c) be economically viable on the basis of a socio-economic cost-benefit analysis;
d) demonstrate European added value. (…)

According to the aforementioned Regulation [4], the fulfilment of the interoperability requirement (see subsection b)), for areas designated as nodes of the core network, among which rail-road terminals are mentioned, for operators of such terminals in the locations referred to in the text, obliges to meet the deadline of 31 December 2030, while for the comprehensive network such objectives should be met by 31 December 2050. The cut-off dates do not apply to design, construction, upgrading and renewal, which means that when work is carried out in this area, the adjustment time is reduced to the date on which the investment project carried out is completed and the infrastructure is authorised to be put into operation.

For the Trans-European transport network, these objectives described in terms of added value shall be achieved by implementing, in accordance with Article 4 of Regulation 1315/2010 [4], certain parameters in the following four categories:

(…)

a) cohesion through:
  (i) accessibility and connectivity of all regions of the Union, including remote, outermost, insular, peripheral and mountainous regions, as well as sparsely populated areas;
  (ii) reduction of infrastructure quality gaps between Member States;
  (iii) for both passenger and freight traffic, interconnection between transport infrastructure for, on the one hand, long-distance traffic and, on the other, regional and local traffic;
  (iv) a transport infrastructure that reflects the specific situations in different parts of the Union and provides for a balanced coverage of all European regions;
b) efficiency through:
  (i) the removal of bottlenecks and the bridging of missing links, both within the transport infrastructures and at connecting points between these, within Member States' territories and between them;
  (ii) the interconnection and interoperability of national transport networks;
  (iii) optimal integration and interconnection of all transport modes;

(iv) the promotion of economically efficient, high-quality transport contributing to further economic growth and competitiveness;
(v) efficient use of new and existing infrastructure;
(vi) cost-efficient application of innovative technological and operational concepts;

c) sustainability through:
(i) development of all transport modes in a manner consistent with ensuring transport that is sustainable and economically efficient in the long term;
(ii) contribution to the objectives of low greenhouse gas emissions, low-carbon and clean transport, fuel security, reduction of external costs and environmental protection;
(iii) promotion of low-carbon transport with the aim of achieving by 2050 a significant reduction in CO_2 emissions, in line with the relevant Union CO_2 reduction targets;

d) increasing the benefits for its users through:
(i) meeting the mobility and transport needs of its users within the Union and in relations with third countries;
(ii) ensuring safe, secure and high-quality standards, for both passenger and freight transport;
(iii) supporting mobility even in the event of natural or man-made disasters, and ensuring accessibility to emergency and rescue services;
(iv) the establishment of infrastructure requirements, in particular in the field of interoperability, safety and security, which will ensure quality, efficiency and sustainability of transport services;
(v) accessibility for elderly people, persons of reduced mobility and disabled passengers. (…)

These criteria are evaluated and analysed in the socio-economic cost-benefit analysis documents, which constitute the basis for decisions by infrastructure managers on the scope and extent of the works to be carried out on the operated infrastructure and, in the absence of an exemption, will confirm the need to carry out works to bring the infrastructure of rail transshipment terminals into line with the essential requirements of the trackside *control-command and signalling* subsystem.

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