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1918-2018 | SĂRBĂTORIM ÎMPREUNĂ

No.: 8748

Brussels, _____ October, 2018

Ref.: National Implementation Plan of TSI CCS - Commission Regulation (EU) 2016/919

Dear Mr. Hololei,

I have the pleasure to convey to you the letter of Mr. Lucian Șova, the minister of transport, and the *National Implementation Plan of technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union*, adopted according the provisions of article 6 of Commission Regulation (EU) 2016/919.

Yours sincerely,

Luminița Odobescu
Ambassador

Mr. Henrik Hololei
Director General
DG MOVE- European Commission

Dear Sir,

Pursuant to Article 6 of *Commission Regulation (EU) 2016/919 on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union*, please find enclosed the National Implementation Plan relating to the European Rail Traffic Management System – ERTMS.

Yours faithfully,

MINISTER FOR TRANSPORT
LUCIAN ȘOVA
/Signature illegible/
/Round stamp applied/

To Mr HENRIK HOLOLEI
Director-General for Mobility and Transport

GOVERNMENT OF ROMANIA

MINISTRY OF TRANSPORT

NATIONAL IMPLEMENTATION PLAN PURSUANT TO 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

-2018-

Contents

Glossary

Acronym	Meaning
ATP	Automatic Train Protection
APB	Integrated automatic Absolute Permissive Block
EI	Electronic Interlocking
ERTMS	European Railway Traffic Management System
ETCS	European Train Control System
GSM-R	Global System for Mobile Communication - Railway
RBC	Radio Block Centre
STM	Specific Transmission Module
TSI	Technical Specification for Interoperability

1. Plan stability

This implementation plan was prepared pursuant to Article 6(4) of Commission Regulation (EU) 2016/919, will be applicable for a period of 15 years and may be updated after a period of five years. The plan includes all the elements referred to in point 7.4.4 of the Annex to the Regulation.

2. Objectives of the implementation plan

The Implementation Plan falls under the strategic objective of Romania's National Strategic Reference Framework for the transport sector and will be applicable in the period 2018-2033. The Plan focuses on making available a modern, sustainable and properly developed infrastructure, which is maintained in line with the applicable requirements, is able to facilitate safe and efficient railway operations both at national and at European level and contributes in a positive and significant way to Romania's economic development.

This document aims at establishing the conditions to be fulfilled in order to ensure that the above-mentioned requirements are met, with special focus on the interoperability of the lines in CFR's (Romania's national railway company) network defined as interoperable. The conditions refer to the design, construction, placing in service, upgrading and renewal of the system in place. Railway lines in CFR's network are conventional lines.

Interoperability means the capacity of a rail system to allow the safe and continuous movement of trains which meet the required standards of performance.

This document represents Romania's ERTMS implementation plan. Its general objectives are:

1. Defining ERTMS implementation options and scenarios within CFR's network.
2. Defining the philosophy of ERTMS implementation within CFR, which comprises: the principles, the necessity and the requirements that must be met to ensure the successful migration to ERTMS and the safe and economically efficient operation of the system.
3. Supplying the basic infrastructure data relating to ERTMS implementation in Romania.
4. Defining the basic elements allowing the timely planning of ERTMS implementation.
5. Estimating ERTMS implementation costs.
6. Describing the outstanding issues at national or international level.

The strategic objective of the national railway company CFR SA is to promote competitiveness, the development of the railway infrastructure and its openness to all national and European rail operators, the development and effective use of human resources with a view to reducing the social and economic development differences between Romania and other Member States.

In this regard, the plan aims at establishing the general framework to create an environment compatible with ERTMS within the Romanian rail infrastructure, defined as interoperable, in accordance with the European Union law.

An environment compatible with ERTMS is created through the migration from the systems currently in place (traffic safety systems – interlocking systems, automatic absolute permissive block and the train protection system) to ERTMS,

The final goal is to define and implement, by 2025, an interoperable network in Romania, as part of the European railway network.

3. International context

3.1. EU policy in the area

The European Commission considers that railway transport has a key role within the trans-European transport system. In order to reach this goal, all technical and operational issues must be reconsidered by shifting the focus from a national perspective to a European scale. A crucial element of this process is, for the European Union, the development of a European system of corridors that is efficient and able to ensure competitive and high-quality services. Interoperability is the core of the development of this system of corridors.

ERTMS, through its command and control component (ETCS) and its telecommunications component (GSM-R), is a key factor in this process.

At the core of this strategy lies the development of a European railway network equipped with ETCS and GSM-R systems, which focuses on the major trans-European passenger and freight transport corridors and ultimately aims at ensuring continuity in terms of the signalling and information services.

According to the European Union, the phases required to create this network are:

1. Designing an initial mandatory core serving as 'trigger' of ERTMS implementation;

2. Creating national ERTMS implementation plans derived from this core. They must lead to the implementation of the ERTMS network within a timeframe of five to seven years. The objective of these plans will be the analysis of the national components of the ERTMS network from the perspective of each railway corridor. ERTMS implementation plans will be prepared by the Member States in line with the technical specifications for interoperability (TSIs);

3. Devising a general plan at the level of the European Union, which defines a coherent strategy for continuing ERTMS implementation. This general plan must include and harmonise all national ERTMS implementation plans.

4. Designating an ERTMS Authority to manage the system configuration and control its evolution in the long run. This role has been assigned to the European Railway Agency – ERA – pursuant to Regulation (EC) 881/2004 and maintained pursuant to Regulation (EU) 2016/796.

3.2. European law

3.2.1. Legal framework

In order to establish the legal framework which ensures the application of the National Implementation Plan and aims at achieving operational, technical and functional railway interoperability within the European Union, the following Directives and Regulations have been issued:

1. Directive 2008/57/EC and Directive (EU) 2016/797 on the interoperability of the rail system;

2. Directive 2004/49/EC and Directive (EU) 2016/798 on railway safety;

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

4. Commission Implementing Regulation (EU) 2017/6 on the European Rail Traffic Management System European deployment plan.

3.2.2. Technical framework

The technical issues related to the implementation of the ERTMS system are regulated in the System Requirement Specifications – SRSs, drawn up by the manufacturers of signalling equipment and validated by the European Commission.

The minimum version that may be applied at ground level, in line with CCS TSI is the set of specifications number 1 (ETCS reference 2 and GSM-R reference 1), while the latest version is the set of specifications number 3 (ETCS reference 3 – maintenance, version 2 and GSM-R, reference 1).

For this reason, CFR SA has required that ground systems contracted or subject to tender procedures must comply with one of the three sets of valid specifications within this CCS TSI, while, for future systems, the compliance with the set of specifications number 3 will be required.

Furthermore, in respect of the full technical details concerning the design, manufacturing and installation of systems on site, equipment manufacturers have issued technical system rules referred to as subsets, validated by the European Commission through their inclusions in CCS TSI.

3.2.3. Operational framework

The operational requirements of the ERTMS are prepared by the rail infrastructure manager, together with the rail operators in line with the relevant TSIs.

4. Current domestic situation

4.1. Technical condition of equipment

All traffic signalling devices within CFR's network are equipped with the national train protection system INDUSI I 60. This refers to:
  ➢ total traffic signalling devices – 20 044
  ➢ total inductors – 27 428
  ➢ total length of railway equipped with ATP (in kilometres) – 9 904

Other characteristics of the rail infrastructure in Romania:
  ➢ electronic interlocking systems – 37 with 1 800 switches
  ➢ electrodynamic interlocking systems – 608 with 15 825 switches
  ➢ track circuits – 27 217
  ➢ switch electrical mechanisms – 17 714
  ➢ APB kilometres – 6 636
  ➢ BAT-type automatic signalling systems at level crossings – 191
  ➢ SAT-type automatic signalling systems at level crossings – 882

Within the programme aiming at the rehabilitation of European corridors, the traditional strategy relating to the train protection system, ATR, has been updated to envisage the implementation of ERTMS systems. The main reasons for this decision were:
1. the need to comply with the European legislation on interoperability;
2. the need to implement a system that allows for the safe traffic of trains operating at speeds of up to 160 km/h.

4.2. Legislative and institutional framework

With the exception of Directives 2016/797 and 2016/798, the European directives referred to under point 3.2.1. have been partially transposed into national law. A legislative framework is also in place for implementing the Technical Specifications for Interoperability. The relevant national legislation includes the following legislative acts:

1. Government Decision No 877/18 August 2010 on the interoperability of the rail system (updated on 12 May 2015);

2. Order No 648/14 May 2015 of the Minister for Transport on the authorisation of the placing in service of structural subsystems and vehicles part of the rail system in Romania (in force starting with 21 June 2015);

3. Law No 55/16 March 2006 on railway safety (published in the Official Gazette of Romania No 322/10 April 2006).

The following issues must be taken into consideration in relation to the implementation of ERTMS in Romania:

4.2.1. Certification of products which cannot be included in the category of interoperability elements

For a certain product or service to be able to be used for interoperability purposes, it must be certified by a notified body authorised to confirm compliance with the essential requirements and to ensure compatibility with the subsystem in which that product or service is incorporated.

4.2.2. Authorisation of structural subsystems

The Directives of the European Union require that any subsystem or part thereof to be built, upgraded or renewed should be authorised to be placed in service by the national safety authority, which, in Romania, is the Romanian Railway Safety Authority − ASFR, established in accordance with Article 16 of Law No 55/2006, which transposes Directive 2004/49/EC on railway safety.

The authorisation for placing in service issued by ASFR is based on the EC Certificate of Verification and the technical file prepared by a notified body, as well as the EC Declaration of Verification issued by the contracting entity or its authorised representative.

4.3. Status of ERTMS implementation

The railway sections on which the system equipment has been installed are:

1. ETCS Level 1 without GSM-R, as follows:
   - 92 km on the route Bucharest − Câmpina, ETCS Level 1, version 2.2.2., which is incompatible with the current CCS TSI;
   - 225 km on the route Bucharest − Constanța, ETCS Level 1, version 2.3.0d., which is compatible with the current CCS TSI, partially installed (except for the stations Ciulinița, Fetești and adjacent APBs;
   - 22 km on the route Golenți − Vidin, ETCS Level 1, version 2.3.0d., which is compatible with the current CCS TSI
2. ERTMS (ETCS Level 2 and GSM-R), as follows:

- 37 km on the route Buftea - Brazi, ERTMS/ETCS Level 2, version 2.3.0d, which is compatible with the current CCS TSI;
- 41 km on the route Border - Arad - km 614, ERTMS/ETCS Level 2, version 2.3.0d, which is compatible with the current CCS TSI:

The railway sections where the implementation of the control-command and signalling subsystems is ongoing:
- 306 km on the route km 614 – Sighişoara: ongoing implementation of ERTMS (ETCS Level 2 and GSM-R), version 2.3.0d, which is compatible with the current CCS TSI;
- 128 km on the route Sighişoara – Braşov: ongoing tender procedure, ERTMS Level 2 (ETCS Level 2 and GSM-R), minimum version 2.3.0d, which is compatible with the current CCS TSI.

Both the ETCS Level 1 and Level 2 and the GSM-R system are not currently operating as the subsystems involved have not been certified for interoperability purposes and do not have an authorisation for placing in service.

4.4. Operational pilot project for ERTMS Level 2

The ERTMS system (ETCS Level 2 and GSM-R) was implemented on the route Buftea – Brazi, with works accepted on 18 December 2015. Currently operating tests are ongoing and these tests will represent the basis for establishing the ERTMS operating rules.

An application for the analysis relating to the advisability of the authorisation for placing in services was submitted with ASFR pursuant to Article 20 of Government Decision No 877/2010, with a successful outcome. After the issuance of the authorisation for placing in service, it will be published in ERADIS,

4.4.1. Identification and analysis of the issues

The focus is on the identification and analysis of the issues and difficulties encountered during the ERTMS implementation, which could not be foreseen and included in the specific requirements of the beneficiary.

The ERTMS system implies the design and implementation of three distinct subsystems:
1. electronic interlocking systems and integrated absolute permissive block;
2. the GSM-R system;
3. Radio Block Centre (RBC).

It is a difficult and complex process to correlate the operation of the three subsystems while ensuring railway safety.

4.5. Environmental protection

The national and European environmental legislation has been taken into account in respect of the implementation of the ERTMS system.

4.6. Priority actions

The following actions must be carried out as a matter of priority in respect of the activities related to ERTMS:

1. Updating of the technical specification for the ERTMS system (ETCS Level 2 and GSM-R) and approval by the Technical and Economic Committee of CFR SA;

2. Updating of the technical specification for the GSM-R system and approval by the Technical and Economic Committee of CFR SA.

3. Initiation of the procedure for certification and authorisation for placing in service of the railway control-command and signalling subsystems of the ERTMS system;

4. Drafting of the operating and maintenance instructions for the ETCS and GSM-R subsystems;

5. Installation of the GSM-R system on the sections only equipped with ETCS Level 1 to ensure interoperability or analysis of the advisability of upgrading the current ETCS Level 1 system to ERTMS (ETCS Level 2 and GSM-R).

5. SWOT analysis

The implementation of the ERTMS system brings about new circumstances and rules. Therefore, this issue must be taken into account and new rules must be laid down.

5.1. 'S' – Advantages (Strengths)

➢ CFR already has experience with the implementation of the ETCS Level 1 system on the railway line sections Bucharest - Câmpina and Bucharest - Constanţa and ERTMS (ETCS Level 2 and GSM-R), which was implemented during the pilot project on the route between Buftea and Brazi and in the rehabilitation project related to pan-European corridor IV – the section between the border, Curtici and Arad - Km 614;

➢ Funds have been allocated under the Sectoral Operational Programme 'Transport' and the Operational Programme 'Large Infrastructure' for the implementation of the ERTMS system (ETCS Level 2 and GSM-R);

➢ CFR's network is equipped at ground level with a single train protection system: INDUSI I 60; traffic includes trains equipped with the PZB protection system, which is compatible with the trackside protection system. This makes it possible for an STM to be selected (for the operators who will choose this option), which results in lower acquisition prices.

5.2. 'W' – Disadvantages (Weaknesses)

➢ The funds allocated from the Sectoral Operational Programme 'Transport' and the Operational Programme 'Large Infrastructure' do not fully cover the costs of the implementation of the ERTMS system (ETCS Level 2 and GSM-R);

➢ Since the lines of CFR's network are equipped with two systems (INDUSI and ERTMS) and that signalling is maintained at trackside level, certain advantages of ERTMS implementation cannot be maximised (for example, lower maintenance costs);

➢ ATP expenditure will increase if both above-mentioned systems are in place;

➢ Due to the lack of the necessary funds, CFR adopted a low-cost simplified technical solution, while, however, maintaining system safety:
  – only the direct lines from the stations were equipped with the system on the railway sections Bucharest - Câmpina and Bucharest – Feteşti, while only the direct lines and the first secondary lines were equipped with the system on the route Feteşti – Constanţa.
  – the infill balises were installed only in relation to entry signals;

- an exit signal uses the balises of the exit signal at the other end of the storage siding for the infill information;
- block signals have no infill balises.

This results in certain shortcomings, such as:

➢ the reduced capacity of the line compared to the theoretical capacity ensured by ETCS;

➢ the occurrence of many transitions between ETCS and INDUSI for the on-board equipment;

➢ the malfunctioning of a balise in a station will affect two traffic signals;

➢ simultaneous dispatching cannot be carried out from a storage siding in the ETCS system.

➢ ETCS Level 1 cannot introduce speed restrictions into a central station in line with operating needs. This can only be done locally by adding balises, which requires additional works by CFR (balises, installation kits, machinery, etc.), software/hardware in addition to that supplied in the project, as well as qualified employees able to send those messages, which are currently not envisaged by CFR's organisational structure.

In order to ensure the interoperability and the fulfilment of the obligations in respect of ERTMS implementation on the European corridors, the GSM-R system needs to be installed on the railway sections equipped with ETCS Level 1.

The acquisition cost of ETCS Level 1 is close to ETCS Level 2, but ETCS Level 1 offers fewer features compared to Level 2 (for example, information updated only in certain points – upon the reading of trackside balise groups; the risk of vandalism as the cables are located along the track and the LEUs are located in the APB cabinets; emergency train stops cannot be ordered at any moment etc.).

5.3. 'O' – Opportunities

5.3.1. General information

➢ The implementation of the ERTMS system (ETCS Level 2 and GSM-R) ensures the interoperability on CFR's lines declared to be interoperable;

➢ Two European corridors cross CFR's network (Rhine – Danube and Orient/East Med), for which Regulation (EU) 2017/6 of 5 January 2017 requires the implementation of the ERTMS systems. Thus, these lines must be equipped with ERTMS systems and such actions are supported at European level.

➢ The neighbouring countries, Hungary and Bulgaria, also have in place programmes aiming at the implementation of the ERTMS to ensure interoperability along the European corridors.

5.3.2. ETCS Level 1

➢ A well-defined and mature system;
➢ Rapid design, installation and placing in service;
➢ Easy interfacing with the relay or electronic interlocking systems and the automatic absolute permissive block systems or the integrated automatic absolute permissive block systems;
➢ Low design and installation costs.

5.3.3. ETCS Level 2
- ➢ Minimum number of field installations;
- ➢ Safety systems (RBC) are located inside buildings;
- ➢ Minimum risk of vandalism since there are no outside cables;
- ➢ Increased performance compared to ETCS Level 1;
- ➢ Certain speed restrictions and limitations may be defined very precisely in the central station;
- ➢ Lateral signalling and the national ATP system may be removed;
- ➢ Technical and functional conditions are created to implement dispatching units and to ensure railway traffic management at minimum costs;
- ➢ Maintenance costs for interlocking and block systems decrease (Level 2 requires installation of low-maintenance electronic systems compared to traditional ones).

5.4. 'T' – Risks

5.4.1. General information

- ➢ Romania has no experience with the operation of ERTMS systems as ground systems have not been placed in commercial service up to the present time.
- ➢ The delay in implementing ERTMS systems within CFR's network may result in European rail operators deciding to look for bypass routes which ensure interoperability.

5.4.2. ETCS Level 1

- ➢ High maintenance costs;
- ➢ Large volume of cables to connect transparent balises and encoders;
- ➢ High risk of theft and vandalism;
- ➢ An infill system needs to be installed; otherwise, line capacity may decrease.
- ➢ It does not lead to an increase in the capacity of the lines on which it is installed;
- ➢ In order to reach a performance close to Level 2, more equipment is required and infill radio needs to be installed, which results in a considerable increase in price;
- ➢ There are no dispatching or railway traffic management features;
- ➢ Speed restriction and limitation areas can be precisely defined only at high costs (additional software and hardware, balises and qualified staff are required).

5.4.3. ETCS Level 2
- ➢ High design and development costs;
- ➢ A highly complex system due to the three subsystems which must operate as a whole (EI/APB - GSM-R - RBC).
- ➢ Electronic interlocking and integrated automatic absolute permissive block systems need to be implemented, which results in high costs for the overall investment;
- ➢ Designing/ developing the system is difficult;
- ➢ The successful operation essentially depends on the GSM-R: the availability of the GSM-R, the coverage of the radio network, of the lines equipped with Level 2 and the capacity of the radio system to send all required messages.

6. ERTMS system

6.1. Principles concerning the implementation of ERTMS systems

6.1.1. Priority in respect of equipment for the European corridors

The top priority is to ensure interoperability in relation to the European corridors (Rhine – Danube and Orient/ East Med).

The final ETCS version must ensure, as much as possible, the reduction in trackside equipment and the implementation of ETCS Lever 2 or higher.

The funds allocated to the rehabilitation projects in respect of the European corridors which pass through Romania are major investments for these lines in the years to come, which also justifies the implementation of ERTMS (ETCS Level 2 and GSM-R). Any other solution at lower technical standards will result in its obsolescence by the end of the estimated timeframe.

6.1.2. Systems already in place or contracted

The systems already in place or contracted (ETCS Level 1) require updates of the software version (for those which are no longer compatible with the current CCS TSI) and the installation of the GSM-R system to ensure an interoperable system.

The upgrading of the ETCS Level 1 system in place will be carried out on the basis of the second scenario described in this document.

6.1.3. Implementation conditions

The technical, economic and operational conditions must be specified for each ETCS application.

6.1.4. Independence of ETCS projects

As much as possible, ETCS and GSM-R projects (including the electronic interlocking and the integrated automatic absolute permissive block systems) will be undertaken as separate projects/ completed independently from the usual rehabilitation projects related to the European corridors. Integrated EI-APB- ERTMS (ETCS Level 2 and GSM-R) have been also considered.

6.1.5. Size of ETCS projects

As much as possible, ETCS and GSM-R will be considered large-scale projects particularly if the conditions governing the principle of independence of ETCS projects are met. For the purpose of this document, large-scale shall mean sections of 60 to 90 km.

6.1.6. Dual ETCS equipment

CFR will not equip a line with both ETCS Level 1 and 2 at the same time (for the purpose of using Level 1 as fall-back for Level 2).

6.1.7. Maturity and stability of solutions proposed

ETCS solutions proposed must be completely defined, mature and stable.

6.1.8. Shunting movements

CFR SA has decided that shunting will not be controlled by the ERTMS system (both Level 1 and Level 2) to avoid the useless overburdening of GSM-R channels.

6.2. ETCS

6.2.1. Description of the basic system

ETCS is formed of two main elements: the trackside component and the component fitted on the locomotive (the on-board equipment). ETCS is structured on three levels. One ETC level is characterised by the manner in which the trackside subsystem and the on-board subsystem communicate. The following issues must be taken into account:
1. the type of trackside equipment;
2. the manner in which information is sent from the trackside equipment to the on-board equipment;
3. the functions processed within the trackside and on-board equipment.
The ETCS system may be configured to operate at one of the following levels:

6.2.1.1. Level 0

Level 0 is defined to ensure system coherence. Level 0 operation implies that the locomotive is equipped with ETCS and moves on a track that is not equipped with ETCS or an ETCS system that is not operational. Traditional signalling systems are used to convey movement authorisations to train drivers. The on-board ETCS system only controls a minimum number of parameters (allowed maximum design speed) and ignores the national ATP protection system.

The ETCS system does not detect train position and does not supervise its integrity. The interlocking systems, the automatic APB and trackside circuits ensure these functions. The only transmissions taken into consideration by the on-board system are those of transition balises (transmissions commanding transitions among ETCS levels).

The indications on the MMI (the monitor of the OBU located in the locomotive) display only train speed. Minimum information may be displayed on demand.

6.2.1.2. STM Level

The STM level implies that a locomotive is equipped only with ETCS (without a national ATP system) and moves on a track equipped with the national ATP system, with which the on-board ETCS system communicates by means of a specific transmission module - STM.

The information required to command/ control the locomotive occurs in the national system. It is transmitted to the locomotive by means of the specific national devices (for example, trackside inductors). Once on board (which implies that the locomotive must be also equipped with the national system – unit for specific information collection from the trackside – as part of the STM), information is processed and transformed into information which may be interpreted by the ETCS.

The ETCS system does not detect train position and does not supervise its integrity. The interlocking systems, the automatic APB and trackside circuits ensure these functions. The only transmissions taken into consideration by the on-board system are those of transition balises (transmissions commanding transitions among ETCS levels). It should be

mentioned that, in both Level 0 and Level STM, all balises are read, but the only information considered is the information relating to level transitions.

The information displayed to the train driver on the MMI largely depends on the national system with which the ETCS is interfaced through the STM. The screen displays that the locomotive is in STM mode. Full train data need to be entered to control maximum train speed and to stop the locomotive at transition points.

6.2.1.3. Level 1

ETCS Level 1 implies that a locomotive is equipped with ETCS and moves on a track equipped with balises. Infill function is optional and may be attained by means of infill balises, infill loop or radio infill. It is a train command system based on point transmission (in certain pre-established points) of information collected from the existing interlocking systems, automatic APB or level-crossing systems. In this way, movement is authorised outside ETCS (by national systems) and the authorisation is transmitted to the locomotive through balises.

ETCS Level 1 ensures continuous train speed control, which, in turn, ensures that the movement limit authorised is not exceeded. The ETCS system does not detect train position and does not supervise its integrity. The interlocking systems, the automatic APB and trackside circuits ensure these functions. Another characteristic at this level is that the trackside equipment does not recognise the train with which it communicates. It should be therefore mentioned that, on principle, balises provide unidirectional 'trackside – locomotive' communication.

After a signal clears the way, the locomotive becomes aware of this information only after it has passed over the balises/group of balises of the signal in question, when the information related to the movement authorisation is updated as the message is read. For this reason, the train is allowed to move close to stopping point at a speed referred to as 'release speed', which allows the train to pass over and read the balise. To diminish the effects of this system behaviour, infill elements may be used (balises, loop or radio) to ensure the transmission of the information related to the signal indication at higher distances (approximately 500 m at present, with an infill balise or infill loop and practically unlimited with radio infill). The disadvantage of using the infill balise is that, after the locomotive has passed, the on-board equipment can no longer be informed of a possible change of signal indication until the balise/group of balises of the signal has been read.

It can be noted that the advantages of using a certain type of infills are proportional to their price. It is considered that, at Level 1, the existing signals must be retained, except for one circumstance, where the locomotive operates in ETCS FS (Full Supervision). In this case, the train driver may operate the train only based on the instructions of the MMI. It should be, however, taken into account that certain instructions are not or are very hard to be transmitted to the ETCS (for example, the whistle indicator or the information supplied by the command 'disconnect circuit breaker'). Even under these circumstances, the train driver must look outside.

Balises must be able to transmit multiple messages depending on the status of the equipment they are linked to through the LEU.

The functions of the on-board equipment must ensure the correct reception of the movement authorisation and physical data concerning the track section ahead, the selection of the most restrictive speed in a certain location, the calculation of the dynamic speed profile depending on train characteristics, the comparison of the current train speed with the maximum allowed speed and braking, when required, as well as the full signalling of system status and functionality on the MMI for the train driver.

In order for the ETCS Level 1 to meet the interoperability conditions, a GSM-R system

for voice communications needs to be installed.

6.2.1.4. Level 2

ETCS Level 2 implies that a locomotive equipped with ETCS moves on a track on which traffic is controlled by an RBC. The track is equipped with balises and the GSM-R system.

ETCS Level 2 is a train command system based on the radio transmission of information collected from the electronic interlocking systems, the integrated automatic APB or automatic signalling at existing level crossings. In this way, movement is authorised outside ETCS (by the national systems) and the authorisation is transmitted to the locomotive through the radio system.

ETCS Level 2 ensures continuous train speed control, which, in turn, ensures that the movement limit authorised is not exceeded.

The ETCS system does not detect train position and does not supervise its integrity. The interlocking systems and the integrated automatic APB through rolling stock detection systems, namely trackside circuits, ensure these functions.

Balises are mainly used to reduce odometry errors of the on-board equipment for train location purposes. RBC recognises each train in its command range, which is more than necessary, as movement authorisations are transmitted by means a radio system.

The trackside subsystem functions must ensure that each train in RBC range is recognised, that the position of each train operating in RBC range is known and that movement authorisation is carried out for each train, in line with the status of the interlocking systems, as well as that the authorisations and the description of the line are sent to each train and that the 'delivery-receipt' of a train is carried out safely from one RBC to the other.

The functions of the on-board equipment must ensure the receipt of the information related to position from the balises and its transmission to RBC, the reception of the movement authorisation from the RBC via radio – by reference to a balise, the selection of the most restrictive speed in a certain location, the calculation of the dynamic speed profile depending on train characteristics, the comparison of the current train speed with the maximum allowed speed and braking, when required, as well as the full signalling of system status and functionality on the MMI for the train driver.

6.2.1.5. Level 3

ETCS Level 3 implies that a locomotive equipped with ETCS moves on a track on which traffic is controlled by an RBC. The track is equipped with balises and the GSM-R system.

ETCS Level 3 is a train command system based on radio transmission. In this way, movement is authorised by the trackside equipment and is transmitted to the locomotive through the radio system.

The system ensures continuous train speed control, which, in turn, ensures that the movement limit authorised is not exceeded.

Train position is detected and train integrity is supervised by the RBC together with the on-board equipment, which sends information on train position and integrity. Balises are used at Level 3 mainly for train location purposes (from the perspective of the on-board equipment). RBC recognises each train in its command range.

No signals are foreseen for Level 3.

The trackside subsystem functions must ensure that each train in RBC range is recognised, that the position of each train operating in RBC range is known, that routes are

locked and unlocked based on the information received from the train, that movement authorisation is carried out for each train, that the authorisations and the description of the line are sent to each train and that the 'delivery-receipt' of a train is carried out safely from one RBC to the other.

The functions of the on-board equipment must ensure the receipt of the information related to position from the balises and its transmission to RBS, the monitoring of train integrity and the transmission of this information to the RBC, the reception of the movement authorisation from the RBC via radio – by reference to a balise, the selection of the most restrictive speed in a certain location, the calculation of the dynamic speed profile depending on train characteristics, the comparison of the current train speed with the maximum allowed speed and braking, when required, as well as the full signalling of system status and functionality on the MMI for the train driver.

6.3. GSM-R

The ERTMS system implies the implementation of the GSM-R system, as follows:
➢ for ERTMS Level 1, the implementation of GSM-R is required to ensure voice communications;
➢ for ETCS Level 2, the implementation of GSM-R is required for data and voice transmissions. ERTMS Level 2 cannot operate without GSM-R, as the latter ensures the support for the transmission of information between RBC and the on-board equipment.

7. Priorities in implementing ERTMS within CFR's network

In line with the principles of this document, ERTMS (ETCS Level 2 and GSM-R) is planned to be implemented along the European corridors crossing Romania. Moreover, special attention is paid to the lines connecting the two corridors (Rhine – Danube and Orient/ East Med) in Romania and the rest of the TEN network in Romania.

A mature and stable ERTMS environment must be created and maintained within the European corridors crossing Romania.

8. Implementation

8.1. Categories of lines

For the purposes of this document, the lines to be equipped with ETCS are divided into five categories (Annex No 1):

I. Rhine – Danube corridor: Curtici - Deva - Alba Iulia - Sighişoara - Braşov Predeal – Bucharest – Constanta/ Craiova.

II. Orient/East Med corridor: Curtici - Arad - Timişoara - Lugoj - Caransebeş – Filiaşi Craiova – Calafat.

III. Lines of national importance, part of TEN-T central network:

− Coşlariu - Câmpia Turzii - Cluj-Napoca - Dej - Suceava - Paşcani/ Vicşani
− Bucharest North - Jilava - Giurgiu North - Giurgiu North Border
− Ploieşti - Buzău - Bacău - Paşcani - Iaşi – Ungheni
− Timişoara - Stamora Moraviţa

IV. Lines of national importance, part of the TEN-T global network:
−   Războieni - Cluj Napoca - Oradea – Bihor Bishopry
−   Beclean pe Someş - Deda - Ciceu - Adjud
−   Dej - Baia Mare - Satu Mare - Halmeu/Carei
−   Oradea – Arad
−   Oradea - Satu Mare
−   Buzău - Făurei - Feteşti
−   Feteşti – Galaţi
−   Bucharest (Chitila) - Piteşti - Vâlcele - Rm. Vâlcea - Sibiu – Vinţu
−   Videle - Giurgiu Nord
−   Filiaşi - Turceni/Cărbuneşti - Târgu Jiu – Simeria

V. Other lines of national importance:
−   Bucharest - Urziceni – Făurei
−   Făurei - Tecuci - Iaşi
−   Negru Vodă - Medgidia - Tulcea
−   Râmnicu Vâlcea – Caracal
−   Mărăşeşti - Tecuci – Barboşi
−   Craiova – Piteşti
−   Timişoara – Jimbolia
−   Constanta - Mangalia
−   Deda - Târgu Mureş – Războieni.

8.2. Implementation scenarios in respect of ERTMS (ETCS Level 2 and GSM-R)

8.2.1. Scenario 1 – direct implementation of ERTMS/ETCS Level 2

The scenario foresees the direct implementation of ERTMS/ETCS Level 2 in respect of the lines concerned.

8.2.2. Scenario 2 – upgrading of ERTMS/ETCS Level 1 already in place to ERTMS (ETCS Level 2 and GSM-R)

The scenario foresees the upgrading of the ERTMS/ETCS Level 1 already in place to ERTMS (ETCS Level 2 and GSM-R).

8.3. ETCS Level 1 with GSM-R

8.3.1. Necessity

The elements that require the implementation of ETCS Level 1 are:
1. the compliance with European legislation on the rehabilitation of railway lines;
2. ensuring interoperability in accordance with the European legislation;
3. the need to implement a system that ensures the safe traffic of trains at speeds of maximum 160 km/h:
4. the elimination of certain shortcomings of the current train protection system (INDUSI 60), such as: non-detection of absent equipment on the trackside or on board, discontinuous speed control, impossibility of signalling the maximum allowed speed on

board, etc.:
5. the increase in traffic safety;
6. the decrease in operating costs.

8.3.2. Implementation conditions

The installation of ETCS Level 1 requires the following systems:
- in the stations: electrodynamic interlocking systems or electronic interlocking systems;
- on the block: automatic APB systems or integrated automatic APB systems;

In order that ETCS Level 1 meets the interoperability conditions, the GSM-R system needs to be installed for voice communications.

8.3.3. Lines to be equipped

The following lines are planned to be equipped with ERTMS/ETCS - ETCS Level 1 with GSM-R or ERTMS Level 2 (ETCS Level 2 and GSM-R): lines included in category III and IV, for which, on the date of the validation of this document, feasibility studies are being prepared. A decision on whether ETCS Level 1 or Level 2 will be selected will be made after the technical and economic analysis has been completed.

8.3.4. Line capacity

ERTMS/ETCS Level 1 with infill balises does not ensure the increase in line capacity compared to the current capacity.
ERTMS (ETCS Level 2 and GSM-R) ensures the increase in line capacity compared to the current capacity.

8.4. ETCS Level 2

8.4.1. Necessity
The elements that require the implementation of ETCS Level 2 are:
- the compliance with European legislation on the rehabilitation of railway lines;
- ensuring interoperability;
- the need to implement a system that ensures the safe traffic of trains at speeds of maximum 160 km/h:
- the elimination of certain shortcomings of the current train protection system (INDUSI 60), such as: non-detection of absent equipment on the trackside or on board, discontinuous speed control, impossibility of signalling the maximum allowed speed on board, etc.:
- the increase in traffic safety;
- the decrease in operating costs;
- the correlation of ERTMS implementation with the strategies of neighbouring Member States (Hungary and Bulgaria);
- continuous transmission of information to and from the locomotive;
- railway traffic management (ETCS Level 1 does not ensure this function);
- increased functionality compared to ETCS Level 1;
- additional services ensured by the GSM-R system (data and voice transmissions);
- increase in capacity compared to the current capacity.

8.4.2. Implementation conditions

The installation of ETCS Level 2 requires the following systems:
– in the stations: electronic interlocking systems;
– on the block: integrated automatic APB systems;
– automatic electronic signalling systems at level crossings or RBC interfaces with the automatic signalling systems at level crossings;
– GSM-R system for voice communications and data transmission;
– financial support for system implementation and the above-mentioned conditions.

8.4.3. Lines to be equipped

The following lines are planned to be equipped with ERTMS (ETCS Level 2 and GSM-R):
– lines included in category I for which, on the date of the validation of this document, contracts have been already concluded or feasibility studies are being prepared;
– lines included in category II, for which, on the date of the validation of this document, feasibility studies are being prepared.

8.5. GSM-R

8.5.1. Necessity

The GSM-R is necessary to ensure a safe channel of communications among rail users.

8.5.2. Implementation conditions

GSM-R does not require changes to or additional signalling systems, as it is an independent system.

8.5.3. Lines to be equipped

The lines included in category V are proposed to be equipped only with GSM-R, after the technical and economic analysis has been completed.

8.6. Planning of implementation

The planning in respect of the implementation of ERTMS within the European corridors crossing Romania is influenced by the rate at which the activities prior to the performance of the works are completed (tender procedures, feasibility studies, correlation of implementation with the European ERTMS implementation plan etc.).

8.7. On-board equipment

The details regarding the equipment of locomotives with specific ERTMS and GSM-R on-board units will be handled by the rail operators together with the railway infrastructure manager, under the coordination of the Ministry of Transport.

8.8. Removal of the national ATP system

After a European corridor is fully equipped with ERTMS and is placed in service, the current national ATP equipment on the corridor in question will be removed.

9. Financial plan

9.1. Budget

The financial sources required to continue the implementation of the ERTMS will be identified in future versions of this document. The impact on projects is significant as the financial side is major factor in determining the choice of the solution.

9.2. Financial support

The financial support required for the implementation of ERTMS and appropriate technical conditions must be ensured from European funds and from the State budget. The value of the financial support will directly influence the period required for the ERTMS implementation plan, as well as the scenario.

For the purposes of this document, 'project' shall mean an ERTMS system and all elements (for example, new interlocking systems and automatic APB, GSM-R etc.) required for system operation.

Future updates of ERTMS due to changes to European regulations will also have to be financially supported.

9.3. Estimated costs

Based on the data obtained so far, estimated costs per kilometre for trackside equipment are:
 – ERTMS/ETCS Level 2, including GSM-R and implementation of electronic interlocking systems (including integrated automatic APB), RBC and GSM-R – EUR 815 000;
 – ERTMS/ETCS Level 1, including GSM-R – EUR 540 000;
 – GSM-R – EUR 100 000.

The price could be lowered further to better project planning. Thus, the GSM system could be less expensive and easier to install in one single project, which will eliminate a part of the costs, such as the purchase of BSCs for each project, integration works etc. The same is valid for ETCS. Creating large-scale projects that maximise the use of RBC or multiple of the same size (an RBC may control only a certain number of objects) results in lower costs with interfaces and hardware generated by the implementation of smaller projects which involve underused RBC equipment.

10. Coordination with neighbouring Member States

10.1. Coordination with Bulgaria

As the Romanian railway network is part of the European corridors Rhine-Danube and Orient/ East Med and the central and global TEN-T railway networks, CFR SA has emphasised during technical meetings with railway managers and relevant ministries in

Romania and Bulgaria that the ERTMS system must be implemented in respect of the following cross-border sections:

- Calafat (România) – new bridge over the Danube - Vidin (Bulgaria);
- Giurgiu North (Romania) – Friendship Bridge in Ruse (Bulgaria).

10.2. Coordination with Hungary

A technical solution has been established in respect ETCS Level 1 and GSM-R in respect of border crossing for the route Curtici (Romania) - Lokoshaza (Hungary).

A technical GSM-R interconnection solution has been established, alongside a protocol between the two countries. Romania has signed the following documents:

- **GIRA - GSM-R Interconnection and Roaming Agreement (GIRA) between MÁV and CFR;**
- **Operation and Maintenance Agreement (OMA) for GSM-R (RO) and GSM-R (HU) interconnection**
- **Agreement between GSM-R operators MÁV and CFR relating to the use of GSM-R frequency in the border area.**

Once the CFR frequency issues have been solved, an agreement will be signed with ANCOM (National Authority for Management and Regulation in Communications of Romania) for the use of frequencies in the border area, which must be then ratified by the Hungarian authority NMHH.

CFR is currently conducting integration activities in relation to ENIR (European Network Integration for Railways) in respect of inter-European roaming.

CFR is scheduled to be interconnected when the next works are carried out.
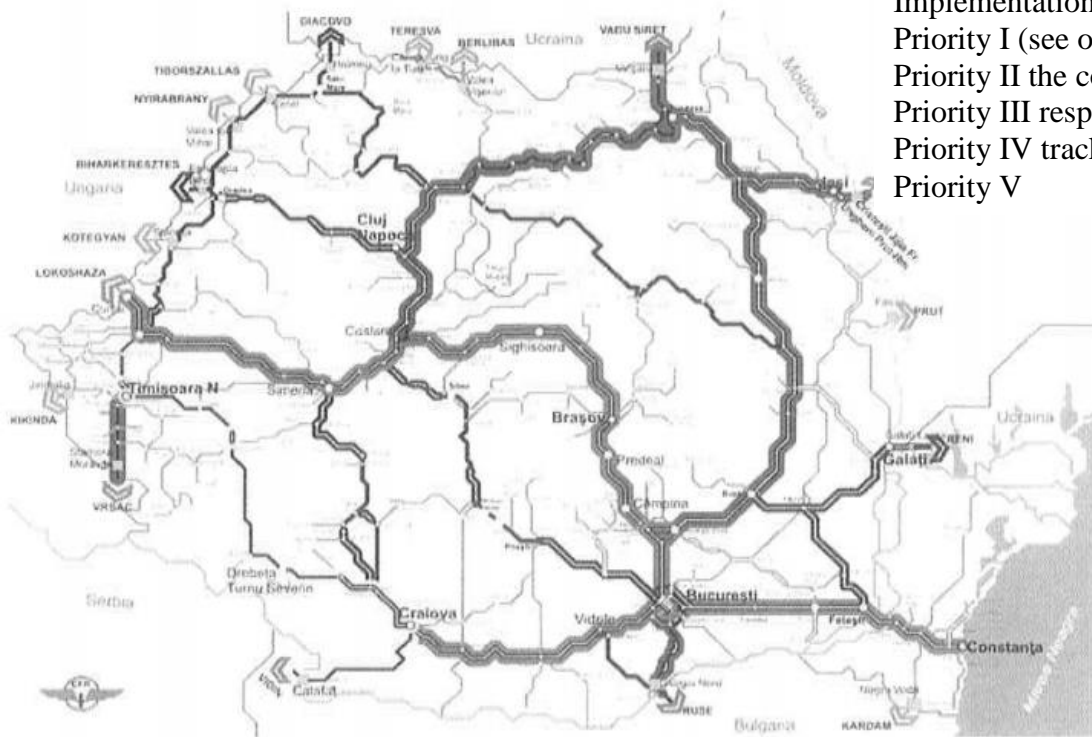
ERTMS development plan
Implementation priorities
Priority I (see original for
Priority II the colour of the
Priority III respective
Priority IV tracks)
Priority V

Annex No 1 – ERTMS development plan – implementation priorities