Provision of Services to the European Commission
in the field of nº MOVE/B2/2014-670:

"Services of technical support for the deployment
of ERTMS along the core network corridors"

Examples of variations and rules hindering ERTMS deployment

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DOCUMENT CHANGE LOG

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0	20.09.2016	All	Draft
1.1	04/10/2016	All	Updated draft based on comments received from ERA
1.2	10/10/2016	All	Updated draft based on comments received from ERA
1.3	26/10/2016	All	Update document based on ERA and EC comments
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3.0	21/11/2016	Title and 3.2	Update document based on EC comments
4.0	21/11/2016	0 and 2.1.7	Updated draft based on comments received from ERA

0 Executive summary

The full benefits of ERTMS are only obtained if the deployment of the system is done in an interoperable way.

This report provides recommendations to facilitate this interoperable ERTMS deployment, from the feedback of the technical follow up that Deployment Management Team (DMT) performs for the EU funded projects.

Variations and rules that hinder ERTMS deployment can be found in projects for very different reasons, during any of the stages of the project and involving different stakeholders. They can be avoided by applying the ERTMS specifications and procedures included in the European legislation.

From the different projects technically followed by DMT, we would like to underline that ERTMS can be deployed everywhere while ensuring compatibility between networks and the rolling stock equipped with ERTMS.

Regarding trackside projects, in order to facilitate an interoperable and successful ERTMS deployment, it is strongly recommended that the Infrastructure Manager identifies at the early stages of the projects, the operational and technical needs to be covered by ERTMS. These needs should be translated into the technical design of the ERTMS system for the project, i.e. ERTMS functions chosen, engineering rules and operational test scenarios. These engineering rules and operational test scenarios shall be compliant to the ERTMS requirements included in the Technical Specifications for Interoperability Control Command and Signaling (CCS TSI). In addition, it is recommended that special attention is paid to specific ERTMS functions that could be considered as more complex. This report includes a list of the main functionalities that have been identified as more difficult to implement in an interoperable way, based on the feedback from different EU funded projects that have been technically followed. For each of them, a specific recommendation is included in the next sections.

ERTMS onboard projects should also aim for 100% compliant products while ensuring a transparent dialogue with NSA and Notified Bodies in case of any deviation, , and reporting to the European Agency for Railways (the Agency) and the Commission. This transparency throughout all the stages of the implementation, together with the understanding of the added value of the third party assessment and the awareness of the situation of implementation in the networks they intend to run is essential to achieve successful ERTMS projects. This report includes the specific recommendations for Railway Undertakings regarding how to obtain all the information that an operator needs to identify ERTMS conditions and restrictions of their vehicles.

Technical follow up of ERTMS deployment performed by DMT provides lessons learnt to the new ERTMS deployment projects as well as feedback from the actual implementation of the system to the policy makers and the Agency.

1 Introduction

Since 2009, the ERTMS deployment projects managed by INEA under TEN-T and CEF have been technically followed by the Agency with the collaboration of INECO. In 2015, the European Commission launched the ERTMS Deployment Management Team (DMT), which is composed of a consortium of 2 companies: INECO and EY. The objective of the DMT is to support the ERTMS deployment in Europe, including economic and technical focuses. The technical follow-up of EU funded projects by INECO is an important activity of the DMT, lead by the Agency and the Commission, enabling the continuation of the support established for the TEN-T and CEF projects.

This report contains feedback and lessons learnt from the EU funded projects that have been technically followed. These lessons learnt are aimed to facilitate ERTMS deployment in a synchronised, timely and interoperable way. Transparency of the projects that have been technically followed by DMT regarding their technical information is the first important step towards this facilitation of interoperable deployment.

This report on return of experience is based on the feedback of the currently deployed projects that have been technically followed. This means they are all corresponding to Baseline 2 implementations. Further update of the document is recommended in order to include the return of experience of projects that are now being started.

This report is divided into the following sections:

Section 2 contains the list and categories for each of the ERTMS functionalities that have been identified to be more complex within the ERTMS trackside projects. In addition, specific recommendations for each functionality are made in order to facilitate the interoperable deployment of the system.

Section 3 contains feedback on the ERTMS onboard projects as well as specific proposals to facilitate a transparent management of ERTMS product deviations.

This report is accompanied by several annexes that contain the technical details of the specific projects that support the conclusions reached in this report. This information is considered confidential and will only be used internally with the Commission and the Agency.

2 Trackside: List of main ERTMS functions considered more complex.

The Technical Specifications for Interoperability of Control Command and Signalling include the mandatory technical requirements both for ERTMS trackside subsystem and ERTMS onboard subsystem. Whereas the onboard subsystem has to comply with all the mandatory requirements of the specifications, trackside subsystem can select which functions of ERTMS to implement, i.e. trackside subsystem shall comply with all the technical requirements in case the corresponding function is implemented.

During these 8 years of technical Follow up of ERTMS trackside EU-funded projects, INECO has set a list of technical issues that are technically followed in order to facilitate interoperability in the ERTMS trackside deployment. This list is enlarged based on the information obtained during the meetings and the analysis of the technical documentation received.

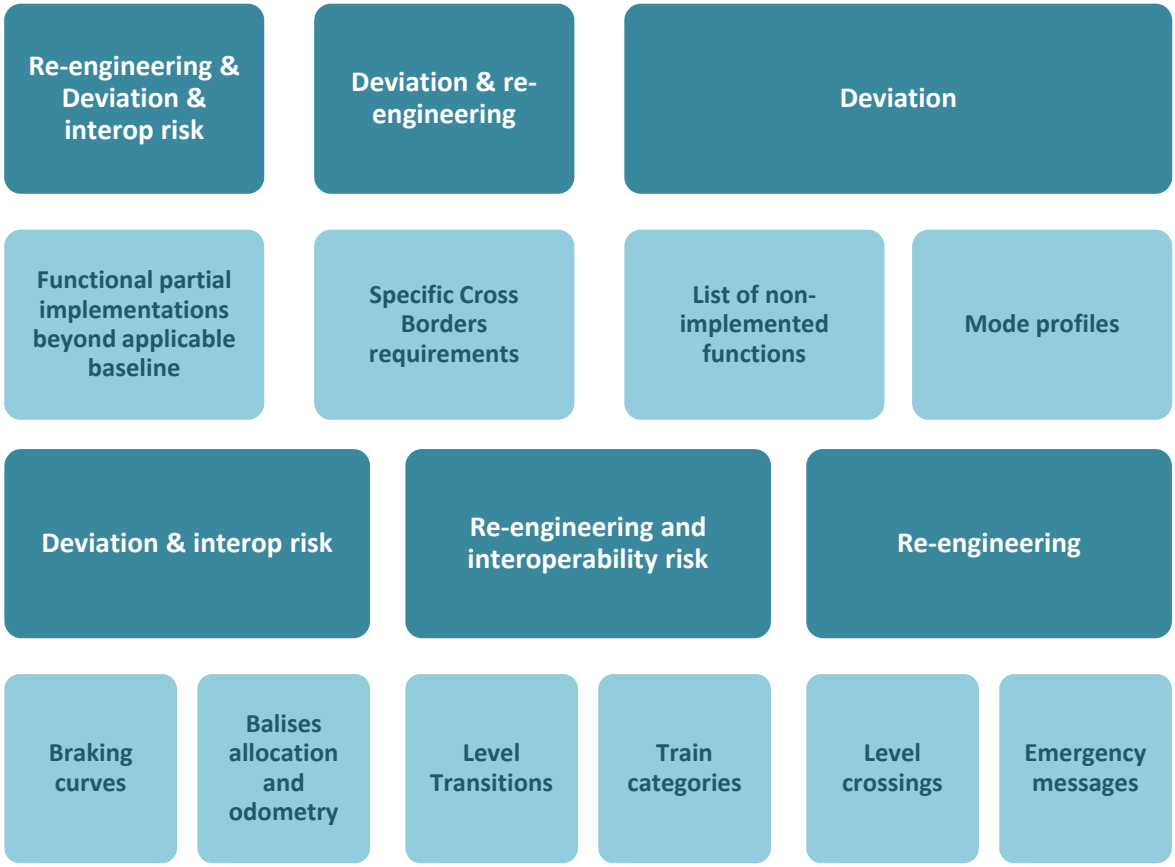
This direct and close contact of DMT with both onboard and trackside ERTMS projects allows identifying tendencies of the general status and common difficulties within the trackside ERTMS projects.

The list contained in this report includes the main functionalities that are technically followed in the trackside projects due to the fact that they have caused one of the following categories of issues in one or more specific projects.

Type of issues		
	Deviations of the CCS subsystem	These are any Non-conformity to the technical specifications included in the applicable CCS TSI according to the certificates of the projects. They shall be avoided in order to achieve interoperability
	Interoperability risk identified between trackside and onboards	ERTMS functionalities classified within this type are those that due to a specific engineering (even if compliant with the CCS TSI), have led in some projects to an additional request for a specific behaviour of the onboard subsystem not included or deviating from the technical requirements included in the CCS TSI.
	Re-engineering	Functions that have suffered changes in the design at different stages of the ERTMS deployment in specific networks. They are included in the list because their technical follow up is considered beneficial to facilitate successful and more efficient ERTMS interoperable deployment projects.

The specific examples that apply to each of the functions are included in Annex A.

2.1 List of functions



#Recommendation

Trackside Design:

It is recommended that the Infrastructure Managers include these functionalities in their network design specifications if applicable (e.g. depending on the level deployed.)

2.1.1 Functional partial implementations beyond applicable baseline

Mandatory technical requirements applicable for a specific project are contained in the subsets from a unique set of documents included in the Annex A of the applicable Control Command and Signalling Technical Specifications for Interoperability (CCS TSI).

Projects requiring the ERTMS equipped vehicles to comply with specific functionality not mandatory in the applicable baseline (M_VERSION) can lead to interoperability risk, deviation to the applicable CCS TSI and need to re-engineer. Exception: for braking curves functionality see section 2.1.5 of this report.

In most of the technically followed projects, these requirements for functional partial implementations beyond the applicable baseline are translated in the list of Change Requests (CR) included in the project/constituent definition.

Functional partial implementations beyond applicable baseline:

Within the design of the network it is strongly recommended to the Infrastructure Managers not to require a partial implementation that is not included in the Baseline applicable to the project.

In addition, to facilitate the use of the system, it is also strongly recommended for the IM to request to their suppliers for any specific functional partial implementation implemented in the product. It is not considered sufficient to have a list of the CR applicable to the products, but a clear functional description of any partial implementations beyond the applicable baseline to the project, including any optional functionality.

To facilitate engineering and avoid interoperability risks, it is strongly recommended to include the mitigation measures defined in the Baseline Compatibility Assessment (BCA) report within the network design, or to analyse and provide alternative measures that cover the risks identified in the BCA report.

2.1.2 Specific Cross Borders requirements

Engineering at cross border sections is in general more complex due to the dependencies between projects that can even include a mismatch in the timeframe of execution. The main specific functions that have created more difficulties for the projects that are technically followed have been:

I. Management of National Values
   Definition and sending of these values in order to achieve smooth transition has in some cases needed re-engineering.

II. RBC Handover
   Design and implementation of the connection between 2 adjacent RBC have in some cases deviated from the technical requirements included in the CCS TSI that can derive in interoperability risks. Also, the Handover implementation presents in most cases complex engineering for which collaboration with adjacent RBC is necessary.

Specific cross border requirements:

Collaboration between the IM at the border is considered useful, including both technical and operational aspects in the discussion.

Any deviations from the specifications, including deviations on the optional requirements, have a big impact in these cross border requirements, so they must be avoided.

If the projects from the different sides of a border in level 2 are developed in a different timeframe, the first project should provide all the information and options used from the subset 39 within the interface of the RBC.

2.1.3 List of non-implemented functions

The list of non-implemented functions is included as application condition/ deviations to the CCS TSI in many RBC Certificate of Conformity or trackside subsystem Certificates of Verification. Even if trackside subsystems can choose the functionalities that are needed for the specific networks, it shall be avoided that a non-implemented function would require specific action from the onboards or that it would imply a strong limitation of use.

List of non-implemented functions:

For better readability of the certificates, NoBos could include the list of non-implemented functions that do not cause interoperability risks within the definition of the system and those that can derive in interoperability risks within the deviations/application conditions section.

Trackside constituents or subsystem should be able to accept the messages for all the functions included in the ERTMS technical specifications that can be initiated by the onboard equipment, even if the information is not used for any specific action by the trackside.

2.1.4 Mode profiles

The design of the technical functionality related to the operation in on sight or shunting mode have been found complex and in some projects to derive in deviation to the applicable CCS TSI.

Mode profiles:

IM are recommended to include from the early stages in the design, the technical requirements necessary to operate the system according to the operational rules applicable.

2.1.5 Braking curves

Baseline 2 specifies the basic principles for the braking curves and the associated information displayed to the driver, but defines no harmonised method/algorithm to compute them. This can lead to different braking distances for a given type of rolling stock and for cross border trains, the differences through national rules/practices may require the implementation in the ETCS on-board of several national braking curves.

Projects that have been technically followed, cope with this lack of harmonised algorithm in different ways, e.g. by specifying a national requirements for braking curves, by requesting specific safety

analysis, requesting a specific algorithm or by including in the network access criteria the minimum requirements for the acceptance of the ETCS equipped vehicles.

It has been found that transparency regarding the technical information for this functionality is necessary to mitigate any potential interoperability risks. Early management of this issue can minimise the need to re-engineer.

Braking curves:

Specific definition of the requirements related to this function or the necessary tests to verify the technical compatibility should be identified and made available to the users in the early stages of the ERTMS deployment in a network.

For their definition, it is recommended to use the document ERA/ERTMS/040022 'Baseline 2 requirements for implementation of braking curves functionality'.

To define the specific values, the analysis should include the experience from performance of previous signaling systems and the impact in the network to use the default ETCS values

2.1.6 Balises allocation and odometry considerations

The specific allocation of the balises (e.g. compliance with the ETCS engineering rules or their location in relation with other signaling elements) and odometry considerations can derive in interoperability risks or deviation to the applicable CCS TSI.

Balises and odometry:

Within the design of the network, the engineering rules of subset 40 shall be considered

2.1.7 Level Transitions

This functionality covers the transitions between the different ERTMS levels defined, i.e. Level 0, NTC (supervision of the train with an existing National Train Control system), 1, 2 or 3. Level transitions are in general technically complex functionality. However, the following more specific level transitions issues have been seen as more complex within different of the EU-funded projects.

I. Dynamic transition between Class B national system and ETCS

Technical specifications of the STM/Class B system are responsibility of the Member State. Engineering of these transitions shall avoid mandating ERTMS onboards, technical requirements that are not included or deviate from the technical requirements from the CCS TSI.

Examples have been found in projects that may have led to interoperability risk due to specific requests not included in the CCS TSI for the onboards running in these networks.

Transition between Class B systems and ETCS:

For their design, analyse the subsets describing the ETCS behavior and also the subset 35 describing STM behavior. There shall be no mandatory requirement to the onboards that is not included in these subsets.

For the transitions from level NTC to Level 1 and Level 2, it is recommended to apply the following guidelines: ERA_ERTMS_040039_V2.0 and ERA_ERTMS_040058_V1.0.

II. Conditional level transitions

Through this functionality, the onboard checks whether the current level is contained in the list of allowed levels and if it is not, a transition is made. This function is complex to use, mainly near level transition areas due to the combination of information from the conditional level transition and the order to a level transition.

Complex engineering and need to re-engineer has been detected within projects.

Conditional Level transitions:

If used, the objective of the function in the network has to be clearly defined. It is also necessary to avoid using it in the areas where level transitions occur

III. Transitions to enter the ETCS in case the trains are running in mode shunting (SH).

The complexity of level transitions is increased when they coincide with the area were shunting movements are possible.

They have been identified within projects as interoperability risk and with the need to re-engineer

Level transitions and shunting:

When possible, avoid design of level transitions in areas where shunting is allowed.

If this is not feasible, take into consideration the Hazard ETCS-H0035 included in Subset 128

2.1.8 Train categories

Train categories are types of trains to which the ERTMS equipped vehicle belong to and it is use to select the applicable static speed profile sent by the trackside subsystem.

Train categories:

IM are recommended to include from the early deployment or design projects, the technical requirements necessary to apply the different static speed profiles applicable to their network.

2.1.9 Level crossings

Baseline 2 includes no specific function to manage Level Crossings. Therefore the projects that have been technically followed implement such a protection by using and combining other functions included in the CCS TSI. In some projects, this has led to the need to re-engineering in order to fine tune the expected operation.

Level crossings:

There are some of the functionalities included in Baseline 2 that can be used to cover the technical and operational needs of most level crossings.

In case level crossings are unavoidable in an ERTMS equipped line, it is recommended to perform an (interoperability and safety) analysis of the technical and operational needs of the level crossing and to design the existing ERTMS functionality accordingly.

2.1.10 Emergency messages

They are defined in the specifications to allow trackside to stop a train with a conditional or an unconditional emergency stop message. When receiving an unconditional emergency stop the train shall be tripped immediately. When receiving a conditional emergency stop, the train will modify its end of authority accordingly if it has not yet passed the new stop location.

The use of such a function has been found as complex in some of the followed projects that have needed to re-engineer this functionality.

Emergency messages:

IM are recommended to include from the early deployment or design projects, the technical requirements necessary to apply this functionality. They are recommended to be avoided in level /RBC transition areas.

2.2 Main conclusions ERTMS trackside projects

For trackside projects, identification by IM of the operational and technical needs of the project to be covered by ERTMS is recommended. This document provides a list of functions that are considered more complex, as feedback from other ERTMS deployment projects. It is suggested that they are addressed in the design of the network.

It should be noted that most of the technical examples of potential interoperability risks used to create this return of experience report, do not correspond to deviations to the mandatory technical requirements specifications for the trackside. Interoperability risks can be created within the trackside deployment projects if due to the implementation, specific behavior of the onboard is required, that is not included/ deviate from the mandatory technical requirements included in the CCS TSI.

Functional partial implementations beyond the applicable baseline appear as requests in most of the projects. This can be due to specific project requirements, e.g. requiring functionality not applicable for set of specifications. Also, this can be due to variability of technical specifications, e.g. trackside requirements for specific onboard behavior while it is already the acknowledged behavior in the products. Any of these functional partial implementations might represent an interoperability/compatibility risk if technically necessary for the integration between the ERTMS vehicle and network.

Following mitigation measures will avoid the need to check that all products behave the way that the trackside project expects. Stability of the technical specifications will minimize the need for these mitigation measures in the ERTMS deployment projects.

3 Onboard: variations of the ERTMS onboard projects

3.1 Onboard product deviations

All the EU funded onboard projects that have been followed include deviations to the technical specifications for ETCS included in the CCS TSI and therefore present risks for interoperability.

This return of experience report provides recommendations on how to control deviations against the requirements from the CCS TSI, within the ERTMS onboard projects.

Annex B includes the lists of deviations included in the corresponding certificates of the ERTMS onboard products from the projects technically followed. Each table contains a progression of the different constituent SW versions and the traceability for the deviations that are included in the corresponding certificates of conformity.

During the technical evaluation of the mandatory deliverables as included in the TENT/CEF calls, finding the necessary information to monitor the compliance of the ERTMS onboard equipment with

the technical specifications and to assess interoperability risks is challenging, mainly for the following aspects:

A. Assess the consequences of non-conformities on operation and their impact
B. Review the completeness of the product deviations

A. Difficulties for assessing the consequences of non-conformities on operation

The following are examples of non-conformities from different suppliers that develop ERTMS onboard equipment and included in their corresponding certificates from different NoBo, their technical file associated or the EC Declaration by the suppliers:

1. Specific packet included in the applicable CCS TSI is not supported
2. Specific packet should not be received if the vehicle is under specific conditions, whereas this is foreseen in the ERTMS technical specifications.
3. Specific mandatory functionality not implemented;
4. List of functions beyond applicable baseline partial or completely implemented.

As it can be derived from the examples above, without further information, it is difficult to identify at least the following needed issues:

I. scope of the non-conformity; meaning the identification of the specific clauses from the technical specifications to which the system deviates. Also, the partial implementations are sometimes listed as CR or internal suppliers' documents not available for all stakeholders using the system.
II. the consequences of non-conformities on operation; e.g. does the ERTMS EVC not react when receiving this specific packet or does it command the brakes?
III. conditions for use derived; will these non-conformities mean that these onboards cannot run in the networks where they use these functions? or do these non-conformities imply that they will have safety/performance constraints?

It has only been after technical discussion and requesting further information that some of the project representatives have been able to provide the complete information, justification or mitigations for these non-conformities.

Deviations to the CCS TSI:

Operators are recommended to be aware of the deviations of the ERTMS onboard products installed in their vehicles and the situation of the networks they intend to run on.

The use of the ERA template of deviations (certification issues) is strongly recommended as mandatory deliverable for onboard projects.

B. Difficulties for reviewing the completeness of the product deviations

According to CCS TSI, the execution of subset 76 tests is mandatory for the constituent certification. Although the availability of this report for the EU funded projects has improved during the last years, there are still projects that are not able to present the complete test report for the execution of these tests or the test report applicable to the ERTMS SW version relevant for the project, which in itself could be considered as a deviation against the CCS TSI. For those projects in which this report has been received it is in most cases difficult to find traceability between the non-conformities detected in these tests and the non-conformities included in the certificates.

It is anticipated that the NoBo that analyses the test report within the evaluation of the constituent, does have such an internal traceability and there is a justification for them not to be included in the final non-conformities included in the certificates. On the other hand, it would be useful for the transparency of the authorization process that this information/ justifications are provided so that there is a clear traceability throughout the complete process for all the non-conformities identified during the different stages of evaluation.

Transparency in the validation process:

Railway undertakings are recommended to request transparency of the findings of deviations of the CCS TSI throughout the complete process of validation.

This traceability is expected at least from the subset 76 test reports to the constituent certificate, then the subsystem certificate and the technical file sent to the NSA for authorization of the system.

3.2 Main conclusions ERTMS onboard projects

To solve the difficulties mentioned above and since the applicant for EC verification is responsible for ensuring that the technical file provides all the information that an operator needs to identify such conditions and restrictions, the following actions are recommended:

A. Assess the consequences of non-conformities on operation and their impact

Include as mandatory deliverable for ERTMS onboard projects the ERA template for deviations both for the ETCS onboard interoperability constituent and the complete ERTMS onboard subsystem. This template provides the fields so that the beneficiary (or the supplier/NoBo from the project) provides the necessary information to monitor the interoperability.

This is recommended as mandatory since it will facilitate to comply with the CCS TSI condition to accept non-conformities (i.e. *ensuring that the technical file provides all the information that an operator needs to identify such conditions and restrictions)*.

B. Review the completeness of the product deviations

Include as a recommendation for ERTMS onboard projects to provide a table of traceability for the deviations from the testing phases (i.e. subset 76 test reports), through the certificates of conformity, certificate of verification and technical file presented to NSA for authorization.