Report

ERTMS Longer Term Perspective

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Contents

1. Summary

The main objective of this report is to identify and analyse the different mid and longer term strategic challenges related to the ERTMS specifications roadmap. The main challenge is how the optimal balance between stability on one side and the evolution of ERTMS specifications (enhancements and errors) and ERTMS products on the other side can be achieved, while safeguarding interoperability in the most economic way.

Stability is expressed in a different way by the different stakeholders. It includes in particular that vehicles which are fully compliant with the latest set of specifications of the CCS TSI have sufficient guarantees that they can operate during a long period without additional upgrade costs.

The strategic challenges linked to the evolution are mainly linked to developments which support the need for further capacity increase and to developments that decrease the overall life cycle costs of the ERTMS implementations. Five main contributors have been identified that significantly support these strategic challenges.

The organisational changes identified within the technical framework shall contribute in balancing the needs for stability and evolution. The organisational changes focus on developing a more harmonised operational and technical concept for the identified main contributors. This will be supported by a validation process of specifications which includes the return of experience of pilot projects. This will lead to more stability and maturity for each set of specifications and well defined cycles between the different ERTMS legal releases.

These changes in the technical framework are necessary, however may not be sufficient to guarantee the optimal balance between the stability and evolution needs for all railway actors. There is a remaining risk of unequal distribution of benefits, costs and risks between the involved actors for these business opportunities (e.g. ETCS L3 with significant benefits at IM-side while additional costs at RU-side). Today, Member States handle in different ways the impact on the different categories of vehicle owners and railway undertakings being affected by infrastructure changes. Therefore, the need for a stricter financial framework shall be investigated that goes beyond this technical framework. When a change is expected to provide a global benefit for the sector, this financial framework should guarantee that such change can be introduced for the benefit of some stakeholders without increasing costs and risks for the other railway actors.

The next legal release of specifications as part of CCS TSI revision shall be planned in relation to the required time to develop mature specifications (incl. validation of specifications) of the identified main contributors.

2. Objectives

The main objectives of this report are to identify and analyse the different mid and longer term strategic challenges related to the ERTMS specifications. This report will be used as supporting document to define the ERA multi-annual work programme for the activities linked to the ERTMS Specifications roadmap and for other supporting activities within the ERTMS Longer Term Perspective.

This report has to address the following 3 topics :

- Evolution of ERTMS Specifications
- Improvement of specification release procedures
- Methodology how to introduce the retained change requests (enhancements and errors)

The main challenge in the ERTMS longer term perspective is how the optimal balance between stability on one side and the evolution of ERTMS specifications and ERTMS products on the other side can be achieved, while safeguarding interoperability in the most economic way. The evolution of specifications is linked to the ongoing technical innovations being developed and includes the remaining set of change requests in the ERTMS specifications database.

This report has been drafted by the defined rapporteurs of EIM, CER, UNISIG, EUG and ERA. The role of the rapporteurs was to establish a common strategic view for the ERTMS longer term perspective. The rapporteurs have collected information from the members of their organisation by organising multiple workshops and bilateral meetings.

The role of the rapporteurs is not to present a formal position of their organisations or to replace the standard consultation processes for decision making, but to create a common view between the rapporteurs.

3. Identification of strategic challenges

3.1. Need for stability

Stability is expressed in a different way by the different stakeholders.

For vehicle owners (RUs/ROSCOs), stability means ensuring cost certainty during a sufficient long period (i.e. avoiding further retrofitting/upgrade costs for already ETCS equipped vehicles and having no additional network access criteria on top of the latest CCS TSI ERTMS specifications (Baseline 3 Release 2 to be voted in 2016). Stability also means no remaining error corrections in the specifications or products which could lead to restrictions in the interoperable operation of on-board equipment.

Stability for Infrastructure Managers means no restrictions in ERTMS deployment at trackside or Operational work arounds due to not fully compliant ERTMS on-board units or due to remaining errors in the specifications.

Stability for suppliers means sufficient time between two ERTMS system versions in order to have sufficient market volume and avoiding national additional requirements on top of the CCS TSI ERTMS specifications in order to apportion the non recurrent development, certification and authorisation costs to a sufficiently high number of projects.

3.2. Need for evolution

3.2.1. Evolution in the ERTMS Specifications Roadmap

As part of the specifications roadmap, the users have been requested to identify the main contributors (potential 'game changers') which can have a significant impact on the ERTMS business case (due to significant increase in operational performance and/or due to significant cost reduction for the overall ERTMS system). The strategic challenges that have been reported are mainly linked to the need for further capacity increase and to the need for decrease of the overall life cycle costs of the ERTMS implementations.

Following main contributors have been identified and are identified as key elements of the future signalling system/concept (see target concept in annex 1.1.):

Main contributor	**Impact - Business case**
ETCS L3	Potential increase of capacity and/or reduction of trackside life cycle costs due to less train detection systems to be installed;
ATO	Potential reduction in energy consumption costs and/or increase in capacity due to optimal train speed setting and/or more robustness in operation (better respect of timeplan);
Braking curves model	Increase of capacity due to further optimisation/balancing the safety and capacity requirements in different operational scenarios;
Next Generation Communication System(s)	Obsolescence management and potential reduction in costs due to non dedicated railway radio communication technology/network model and/or potential use of capacity increase due to increased spectrum efficiency;
Satellite positioning	Potential reduction in deployment and maintenance of balises and improved performance due to more accurate odometry;

For each main contributor in the list, there are specific strategic options/questions to be answered (see also annex 1.1).

3.2.2. Other evolutions in the ERTMS Longer Term Perspective

Other elements that have been reported as risks are the cyber-security topic, the migration and high integration costs of Class B-systems (which hinders the full opening of the ETCS on-board market), the increasing complexity of the system, and the high costs for (re-) certification and (re-)authorisation.

4. Identification of organisational challenges - Balancing the needs for stability and evolution

4.1. Technical framework for new functions

Following main risks and actions have been listed as part of the organisational challenges for new functions:

a) Risk of development of diverging solutions in Shift2Rail Program: four of the five main contributors are part of the Shift2Rail IP2 research program (see annex 1.2), therefore an organisational challenge is that ERA, with the support of the ERTMS Users Group and UNISIG, shall control from the beginning these elements of the Shift2Rail IP2-program (cooperation/coordination with IP2-Shift2Rail Program);

b) Risk of immature specifications in a legal release: the current early adoption of a set of specifications in a legal release of the specifications with limited validation of specifications or no return of operational experience can lead to multiple error corrections cycles in the specifications. Therefore, a proposed set of new specifications for new functions shall be validated by an enforced validation process before this new function is integrated in a next legal release. This validation process can include:

- Use of formal methods: supporting tool to develop specifications (no ambiguities in specifications and increase of the business continuity for the ERTMS system authority);
- Use of simulation: supporting tool to test specifications (opportunity due to mature ERTMS simulation tools available on the market);
- Use of early implementers: operational feedback of new function in an early implementation project; A common integrated project between the early implementers and the ERA (supported by the EUG/UNISIG as technical bodies and supported by the representative organisations fulfilling their roles as defined in the CCM-process) for the development of the main contributors should be established and enforced by a strong commitment to get an interoperable solution; the use of early project implementations in the validation of specifications process creates some specific risks for IMs and RUs (detailed description of risks can be found in annex 2.2). The operational feedback of early implementation projects for all new functions avoids also the inclusion of specifications not being used or not being deployed after unsatisfactory results of an early implementation project (due to less than expected operational benefits or due to higher technical complexity than envisaged in the business case or operational concept).

Based on this process, two periods and geographical scopes can be distinguished for a new function:

- the period of development of a new function is limited to early implementation projects (limited geographical scope);
- the period when a new function is mature and incorporated in a next legal release in which all Railways can deploy these new functions on their network;

c) Risk of increasing complexity of the ERTMS system: the high complexity of the ERTMS system (due to the high number of functionality and the need for backwards compatibility) is reported as one of the main reasons for the high costs (see annex 2.1 on the evolution of the ERTMS specifications). The high number of functionality being integrated is mainly caused by:

- bottom-up (technically driven) change requests;
- driven by the different (national) operational concepts (normal train operation, shunting, maintenance);
- wide variety of trackside application engineering (due to the different concepts for regional to high-speed lines);

Therefore, following changes in the principles of the process are recommended to limit the technical complexity in the longer term for new functions:

- a stronger top-down (business and operational concept driven) change control management process;
- compliant with a harmonised operational concept (including operational rules for degraded modes - dependency on TSI OPE);
- supported by a set of standardised engineering rules for the trakcside and in the long term with the possible support of standard system architecture for the onboard.

The next legal release of specifications as part of CCS TSI revision shall be planned in relation to required development period for the identified main contributors. Some other change requests can be included in the next legal release if an assessment has demonstrated that the operational benefits for the railway sector (operational concept driven approach) are higher than the additional complexity being introduced into the ERTMS system (operational benefits are higher than marginal cost of adding the change request into next release). Simulation tools can also be used to assess the benefits and complexity of the change request.

4.2. Technical framework for error corrections

This revised validation process will create a longer time between successive legal releases of the specifications, in particular if the V-cycle project concept is applied including feedback from early implementations and commercial operation.

As a consequence, a process for the transparency of new detected errors and for the fast publication of the related error corrections will be required in order not to propagate these errors in other projects and in order to avoid diverging national technical rules for the error corrections being implemented in the different Member States.

The publication of the error corrections shall not lead to mandatory product upgrades. The error correction of the specifications itself can be integrated in a legal framework in a later stage (next legal release of specifications as part of CCS TSI revision) if the safety and interoperability impact of the error is non-critical.

In the exceptional case of a critical error correction which could require mandatory upgrades, a technical opinion process can be used according to Article 7 'Deficiencies in TSIs' of the Interoperability Directive 2008/57/EC.

The process for ERTMS product upgrades shall also be optimised by providing guidance towards Notified Bodies and NSAs on optimising the (re-)certifcation and (re-)authorisation process in order to facilitate ERTMS product upgrades. The Agency role in the 4RP will implement this approach.

4.3. Financial framework

A technical framework with the objective of creating a further increase in developing mature and stable ERTMS specifications is necessary, however additional elements may be needed that go beyond this technical framework. This is necessary to guarantee towards vehicle owners (ROSCOs or railway undertakings) that ERTMS on-board vehicles being fully compliant with the latest legal set of specifications (B3R2 being voted beginning of 2016) will be able to operate on ERTMS lines during a sufficient long time period before upgrades/retrofittings are needed.

The evolution of ERTMS specifications shall be driven by business opportunities (so overall positive financial impact on the railway sector), however there is a risk of unequal distribution of benefits/costs/risks between the involved actors for these business opportunities (e.g. ETCS L3 with significant benefits at IM-side while additional costs at RU-side).

Today, Member States handle in different ways the (financial) impact/consequences on railway undertakings being affected by infrastructure changes (different levels of guarantees, if any, provided towards the different categories of railway undertakings/vehicle owners).

Depending on the technical solution, two financial schemes can be distinguished:

- the function remains optional (no mandatory upgrade required for B3R2) and performance schemes can be used to incentisive in a non-discriminatory way the implementation on-board;
- the development of a function becomes mandatory (mandatory upgrade required for B3R2) and a financial framework has to be developed to establish a fair compensation scheme between IMs and RUs;

Questions that should be investigated how such financial schemes can be implemented:

- Should an EU-legal instrument(s) be developed to enforce such financial framework? (part of Access Directive?)
- How can such framework be constructed with compliance to State Aid Regulations?
- Who should build the financing scheme and/or validate the non-discriminatory aspect of such financing scheme? Role of railway regulatory body? Should there be guidance at EU-level by the development of a generic financial scheme which can be implemented at national level (using national data)? How long should such scheme be needed?

5. Strategic Planning – Balancing commercial needs and standard development cycles

The commercial needs (and plannings) have been collected during a workshop. The first (most urgent) commercial needs have been expressed for four of the five main contributors and indicate that for some specific lines a commercial need is expressed to have the new function already operational by 2018/2019 (see annex 3.1).

Based on the return of experience on the development of new functions (e.g. ETCS over GPRS; ETCS Limited Supervision), the development cycle of new functions (incl. changes in operational/technical concept) is estimated in average to be more than seven years (see annex 3.2) which creates a planning conflict (if the assumption is based on starting in 2016 with the main development of these functions at EU-level).

Therefore, a common integrated project planning is important to detail the different project phases and the different project gate reviews in the development of specifications in order to achieve an optimised planning between the EU-project planning (incl. technical bodies and representative organisations) and the early implementation projects (which are part of the validation of the specifications).

6. Recommendations

Based on the analysis above, the following recommendations are formulated:

- Existing ERTMS investments shall be protected. Trackside investments shall be protected by guaranteeing backwards compatibility in the evolution of ERTMS specifications, while Baseline 3 Release 2 on-boards shall be protected by providing stability of ERTMS specifications for a long period (period required for mature development of main contributors) and by establishing a financial framework which guarantees fair allocation of benefits, costs and risks in case a new function would globally improve the railway business case after this long period of stability;

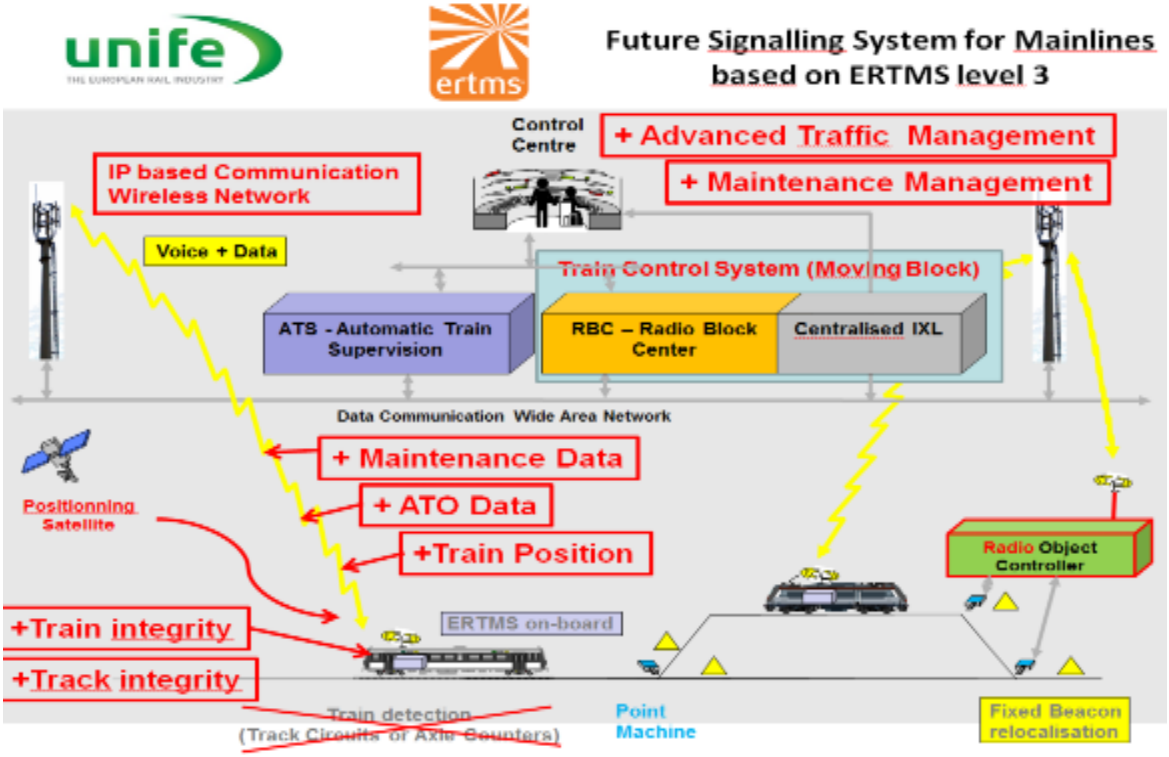
- The technical framework shall prioritise the development of the identified 5 main contributors which focus on the strategic challenges of capacity increase and cost reduction of the ERTMS system; The technical framework for these 5 contributors shall develop a harmonised operational concept, a standard engineering concept and shall include a testing and validation of specifications (incl. the potential use of early implementation projects);

- In the period between the ERTMS B3R2 release (voted in beginning of 2016) and the next release (incl. main contributors), the technical framework shall support the maintenance of existing ERTMS specifications in case of detecting new errors after the B3R2 release. This shall avoid the propagation of errors in projects or the development of diverging solutions being developed in ERTMS projects which could negatively affect safety or interoperability;

Annex 1 - Additional elemens linked to strategic challenges

Annex 1.1 Main Contributors

Four of the five main contributors are the key interoperability elements (track-train interface) of the future signalling system strategic concept previously defined by UNIFE (see red items).



The main strategic items to be considered for these main contributors are:

Main contributor	Strategic elements to be considered
ETCS L3	The significant benefits of ETCS L3 are mainly linked to reduction of costs due to less train detection systems to be installed or linked to increase in capacity. Potential of 10-25% decrease in overall Signalling Programme Budget for Infrastructure Manager have been reported in case of renewal of signalling systems due to less train detection systems to be installed (source : input from different IMs). The additional costs at RU-side are not yet estimated, however depend for passenger trains (fixed composition) on additional software for train integrity function and depend for freight trains with variable composition on the development of a safe/mature train integrity device. The strategic questions to be considered are: - Operational concept: How are responsibilities related to train integrity functions being managed (incl. degraded modes) between RUs and IMs?

	- Is it possible and necessary to develop a fully harmonised operational concept if the operational concepts for ETCS Level 2 (with partially national specifities) are already defined? - What is the required performance level of the train integrity function and can trains without train integrity function be allowed on ETCS L3 infrastructure?
ATO	The potential benefits of ATO are linked to a substantial (between 10 upto 30%) decrease in energy consumption for main lines with a potential additional increase in capacity. Source: http://www.irse.org/knowledge/publicdocuments/2.06%20Bienfait%20-%20Automatic%20Train%20Operation%20for%20ETCS.pdf The main strategic options to consider are the optimal level of standardisation/interoperability to be mandated for ATO-functions (linked to interoperability benefits expected from ATO) and how can the technical impact on ERTMS on-board equipment be optimised in order to limit further complexity of the ETCS systems (system concept and ETCS/ATO interface). Legal framework: Can ATO be mandated for interoperability on-board of vehicles or is it allowed to run on ATO-infrastructure without ATO on-board for cross border operating RUs? - If ATO would be a mandatory for interoperabiliy function, what is the operational and technical concept to be defined? - If ATO would be a no mandatory for interoperability function, what is the financial framework that could be used to incentivise RUs to be equipped and what could be done to enforce a standardised solution for RUs (in order to protect cross border RUs in case of operating on different ATO-equipped networks)? System concept : What is the appropriate system architecture for ATO-ETCS (taking into account the different ATO-levels from GoA1 upto GoA4)?
Braking curves	Objective: solve existing operational problems reported by multiple Infrastructure Managers and Railway Undertakings in balancing safety and capacity requirements. Following problems have been reported linked to braking models which are linked to some requests for specific CRs: - Loss of capacity (ETCS compared with Class B-system) due to higher safety margin within braking curves models. Different CRs have been implementented (train categories, …), however additional CRs have been submitted (CR 1186 'target speed extension')

	- Loss of capacity due to not optimised braking curve model for some types of trains in specific speed areas (open point from the development of the braking curve model) - Rail Freigth Corridor 2 : Risks related to potential non harmonised operational rules for train data preparation (and train data entry). The main strategic solution will depend on the overall risk assessment of the railways in different operational scenarios. The root cause of the problem relates to identifying the appropriate safety margins within the national concepts in different scenarios (including degraded modes). The main strategic options are: - Operational Option 1: a harmonised operating concept for the operational scenarios will be defined (with the acceptance of one overall risk assessment for the different operational scenarios including degraded modes). - Technical Option 2: ERTMS has to provide a toolbox of solutions to cover the optimisation of capacity/safety for different national concepts;
Next Generation Communication System(s)	Objective: the shift towards a technology neutral (future proof) IP-based radio bearer platform. Impact of standard technology/sharing of network models for mission-critical applications can be found in SCF-report: See http://www.era.europa.eu/Document-Register/Documents/FinalReportEN.pdf The strategic options for the railway sector are analysed in detail in following report (http://www.era.europa.eu/Document-Register/Pages/Study-for-the-evolution-of-GSM-R-(by-IDATE-WIK).aspx). The main strategic options are linked to the choice of different network models (dedicated railway network; shared network (e.g. with PPDR; use of public networks (radio or satellite)) taking into account the feasibility that these network models fulfil the railway communication requirements. Ongoing activity: this activity is already part of the the ERA Work Programme 2015 as project 3.2 *'Development of the requirement for the evolution of the railway communication system'* (see http://www.era.europa.eu/Document-Register/Pages/Work-programme-2015.aspx)

Satellite positioning	Objective: to develop a fail-safe, multi-sensor train positioning system (by applying GNSS technology to the current ERTMS/ETCS core and introducing, as possible add on for fulfilling the scope, the use of other new sensors (e.g. inertial sensor), or of other on board existing sensors (e.g. accelerometers, odometry sensors). This development could boost the quality of the train localization information (the accuracy of odometry systems has been raised in the past as one of the weaknesses in the ERTMS-systems) and of the train integrity information. The main strategic item is if satellite positioning can fulfil the (safety) requirements of the railway environment.

Annex 1.2 Shift2Rail IP2 Program

Four of the five identified main contributors in the ERTMS specifications roadmap are included in the Research program of Shift2Rail included in IP2 (ETCS L3 linked to TD2.3/TD2.5; ATO linked to TD2.2; Next Generation communication systems linked to TD2.1; Satellite Positioning part of TD2.4).

The (transversal) items reported in the ERTMS Longer term perspectives such as 'Cyber security' (linked to TD2.11), 'use of lab demonstrators/simulation (linked to TD 2.6)' and 'formal methods' (linked to TD2.7) are also included in Shift2Rail.

Research and Innovation Area	Proposed Technology Demonstrator
Smart, fail-safe communications and positioning systems	TD2.1 - Adaptable communications for all railways (quality of service, interfaces to signalling) TD2.4 - Fail-Safe Train Positioning (including satellite technology) TD2.10 - Smart radio-connected all-in-all wayside objects
Traffic Management Evolution	TD2.9 - Traffic management evolution
Automation	TD2.2 - Railway network capacity increase (ATO up to GoA4 - UTO)
Moving block (MB) and train integrity	TD2.3 - Moving Block TD2.5 - On-board Train Integrity
Smart procurement and testing	TD2.6 - Zero on-site testing (control command in lab demonstrators) TD2.7 - Formal methods and standardisation for smart signaling systems
Virtual coupling	TD2.8 - Virtually - Coupled Train Sets
Cyber security	TD2.11 - Cyber Security system

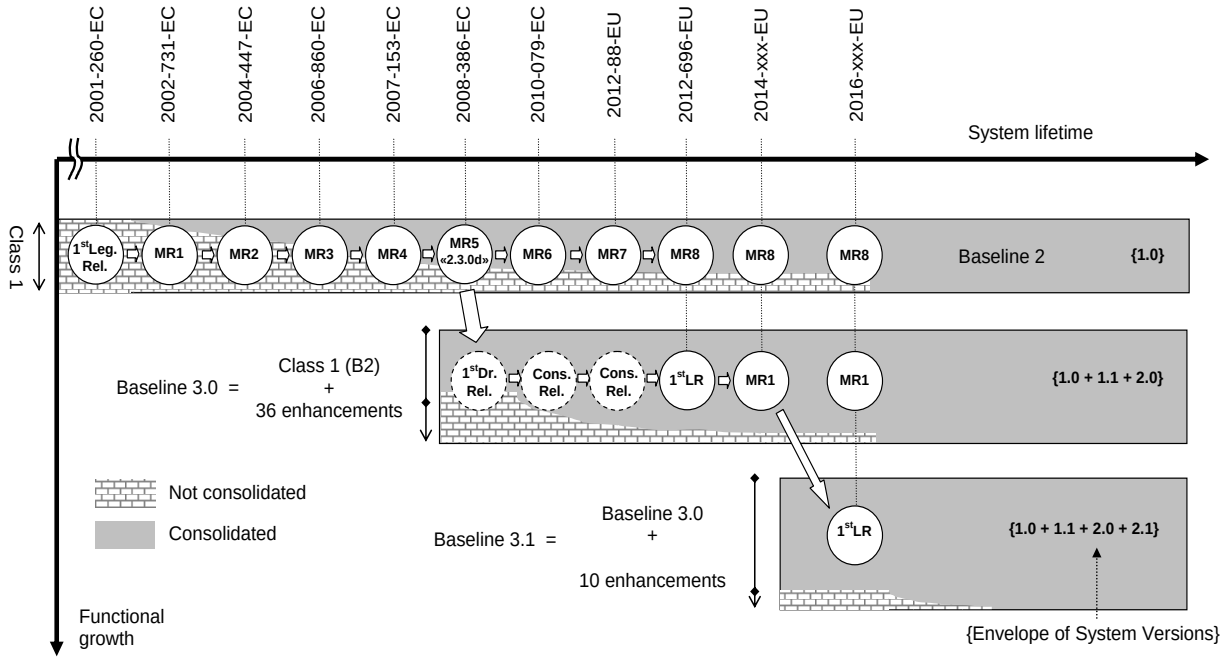
Annex 2 – Additional elements linked to organisational challenges

Annex 2.1 Evolution of ERTMS specifications

6.1.1. Evolution of ERTMS releases

This paragraph is an extract from the baselines releases document explaining the background and history of the different Baselines/Releases.

The picture below gives an overview of the different system versions and maintenance releases in the past two decades.



To better understand the different perspectives offered to the decision makers it is necessary to recall and use the basic definitions and decision tools that are defined in both the ERTMS CCM procedure (see http://www.era.europa.eu/Document-Register/Pages/ERAERTMS0001v12.aspx) and in the SUBSET-104, and also to consider the past experience in the management of the ETCS specifications.

- Baseline: a stable kernel in terms of system functionality, performance and other non-functional characteristics.
- Baseline release: a specific version of each of the documents listed in the TSI CCS annex A that describe the system
- Two types of legal releases are possible:
    - 1st legal release of a new baseline
    - Maintenance release of an existing baseline, made of error corrections only
- Draft or consolidation releases (not published in the official journal) are also possible, if intermediate steps are necessary to build a new baseline (e.g. ETCS baseline 3)

Based on these definitions, the current update of the ETCS specifications cannot be simply called the B3 MR2, because it is has already been agreed (MoU 2012) that the ETCS functional kernel will grow by some new functions (e.g. Packet-Switched transmission).

Actually, the incorporation of new functions by definition entails the creation of a new baseline accompanied by the increment of the ETCS system version, which allows technically identifying the ETCS functional kernel with two digits (X.Y). The ETCS system version is transmitted by the ETCS trackside to:

- Prevent trains not having a function from running on trackside infrastructures where this function is required (safe on-board reaction).
- Ensure that all trains operating on a given infrastructure will behave as expected, in an harmonised way

To achieve that the ETCS system version materializes the so-called compatibility between baselines:

- If at least one function of a new baseline is said incompatible, the new baseline is only backward compatible with the previous one (their system versions differ by X)
- If all the functions of a new baseline are said compatible the new baseline is fully backward and upward compatible with the previous one (their system versions only differ by Y)

Unfortunately the X increment is often automatically assumed to have negative implications (baseline incompatibility), while it is just an important safety feature of ETCS, inherent to the creation of most of the new functions meant to be used by the IMs.

Moreover, this simple ETCS system version mechanism does only cover the functional enhancements brought to the ETCS specifications and not the error corrections, which (it is an ineluctable fact of the life cycle of complex systems) can be expected to accompany the incorporation of new functions.

While the “compatible” errors by principle do not pose any problem (a train with or without the error correction can run a normal service on track with or without the error correction), the “incompatible” errors must be handled with a lot of care.

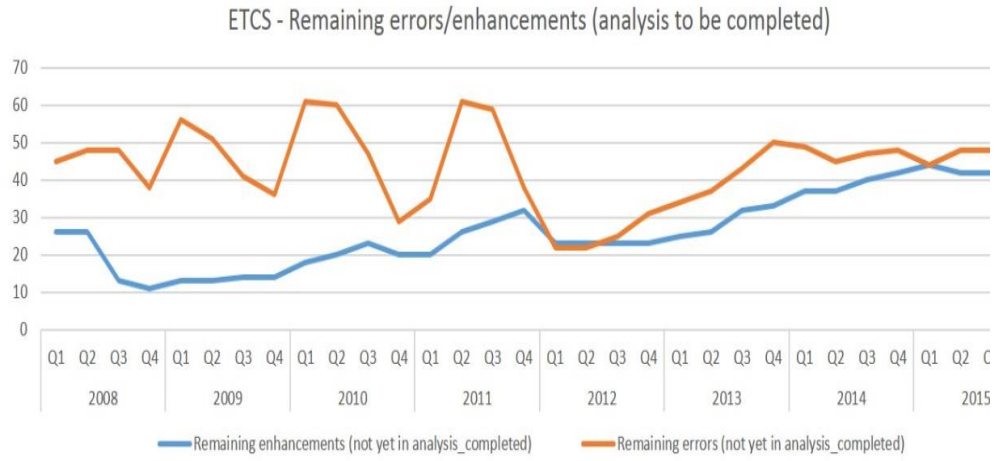
For what concerns the maintenance releases within a given baseline, the simple fact that they contain “incompatible” error corrections makes mandatory to at least define local workarounds to a certain extent and to migrate both on-board and trackside subsystems to the new maintenance release (assuming that a set of error CRs will always impact both subsystems) to ensure interoperability in the long run. This is why such maintenance releases are called “cancel & replace”.

In addition “incompatible” error corrections can even jeopardise the backward compatibility between two baselines differing by X if they are not corrected at the same time in the two concerned baselines. This is exactly what happened to the compatibility between baseline 3 and 2. According to the CCM procedure, the annex A.1 should systematically be applied to detect whether an issue is relevant in former baseline(s) and to either enforce mitigation measures or to update the mandatory set of specs via maintenance releases of **all** relevant baselines. As a result, the BCA (Baseline Compatibility Assessment) analysis should take place simultaneously and not after the introduction of a new release with error corrections. For instance the fact that the BCA B3 vs B2 took so long is also the result:

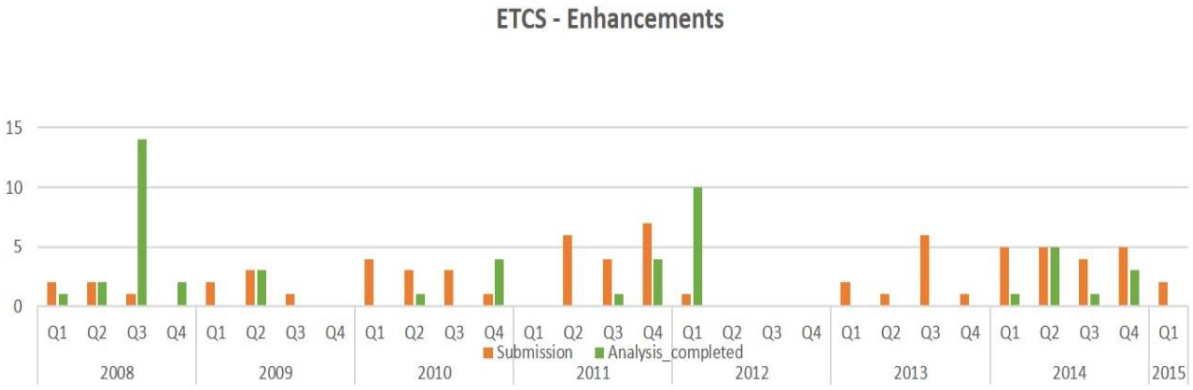
- of a decision not to introduce any maintenance of the B2 from 2007 to 2012 and
- from 2012 to 2014, of the lengthy search of workarounds to preserve B2 avoiding any B2 maintenance release.

6.1.2. Indicators on evolution of errors and enhancement in the ERTMS specifications

The evolution of the ETCS specifications is graphically shown in the picture below.



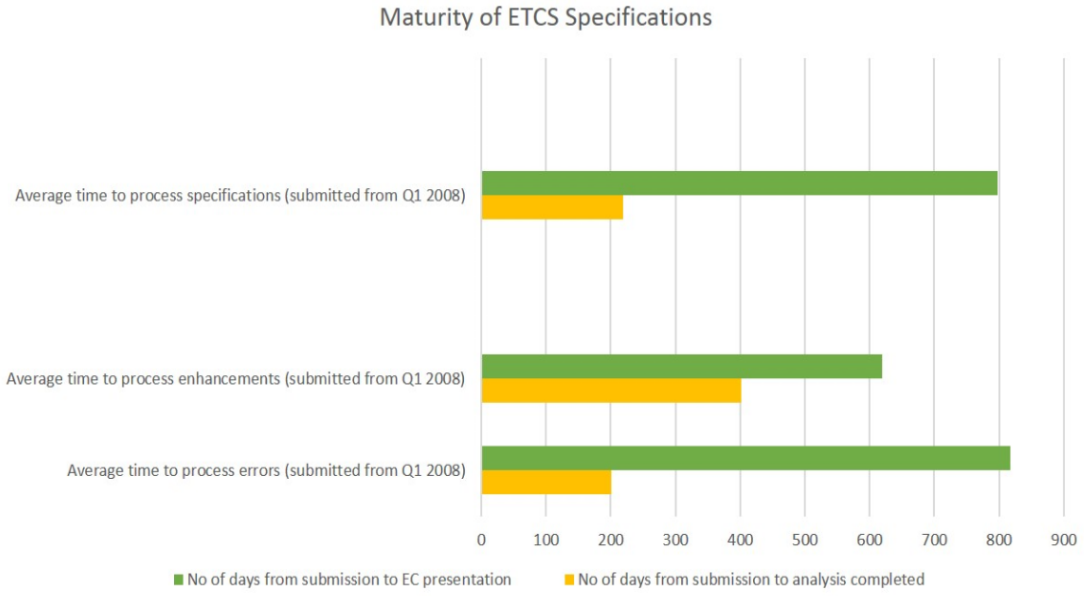
The picture below shows in orange the average number of new submitted change requests received by the ERTMS system authority during the period 2008-2015:



Observations:

- The number of requested enhancements (new functions) is not decreasing over time. The underlying reason could be more ERTMS deployment in the Member States with different national concepts (leading to more change requests).
- The remaining number of errors has to be monitored and further classified according to their criticality and linked to the Baseline version (as most errors could be linked to Baseline 2).

The average time to process error corrections and enhancements is shown in the graph below.



Observation: In particular for publication of errors, the average time to publish errors is substantially high in comparison to the time required to technically solve errors.

Annex 2.2 Technical framework for early project implementations – risks and mitigation measures

The table below is used to demonstrate a preliminary analysis of the specific risks linked to including early project implementations as part of the validation of specifications process. The second column is used to demonstrate some examples of potential mitigation measures. These potential mitigations measures have to be discussed further.

Risks	Potential Mitigation Measures
Financial risk: e.g. early implementer could have additional financial costs in case the specifications are changed during or after the implementation of the early implementer project (these changes might not be directly needed for the early implementer project itself);	(e.g. common agreed project between ERA, technical bodies, representative organisations and early implementation partners with formal project gatereviews at EU-level; An EU-common solution (operational, system concept and detailed specifications) has to be developed before an early implementer can start to implement a solution which will contribute to the validation of the specifications.
Procurement risk: e.g. in case a dedicated contract is signed for a specific line to develop the new function, some national procurement rules might exclude these suppliers who were involved in the early implementation project for later deployment projects due to the potential competitive advantage of being part of the early implementation project. This might limit the interest of some suppliers to join an early implementation project. e.g. how to ensure the capacity/efficient competition in case of requiring an on-board for testing a new function in an early implementation project	TBD
Authorisation risk: e.g. the certification and authorisation of the early implementation (trains and network) has to be compliant to the legal release being in force at the time;	(e.g. use of temporay derogation suitable to do an early implementation or by introducing the new function as an optional function);
Operational risk: e.g. fleet being affected by multiple early implementation projects for different main contributors;	(e.g. right selection and geographical definition of early implementation projects for the development of new functions in order to avoid fleet being affected by multiple different early implementations);
Coordination risk between EU/ERA workstream and early implementer: e.g. not sufficient transparency on performance or results of early implementation projects;	(e.g. selection of early implementation partners with the duties of providing transparency);

Annex 3 – Additional elements linked to strategic planning

Annex 3.1 Reported first commercial needs for main contributor/pilot partners

Following commercial needs have been reported by the main contributors during a workshop held with Infrastructure Managers (EUG-meeting 12/11/2015).

Main contributor	Potential early implementers
ETCS L3	Potential early implementation: NL; UK; (LT) UK: first reported commercial need in 2018/2019;
ATO	Potential early implementation (as part of Shift2Rail): UK, DE UK: first reported commercial need in 2018/2019;
Braking models/curves	Potential early implementation partners: SE; DK; (+ UK, CH, CZ, FI, IT) DK: first reported commercial need in 2018/2019;
Next Generation Communication System(s)	Potential early implementation partner: TBD Migration study ongoing to identify first commercial needs.
Satellite positioning	Potential early implementation partner: Italy; (France?) In research and development phase. IT: first reported commercial need in 2018/2019;

Annex 3.2 Development cycle for main contributor

In the past, the development cycle of new complex functions has demonstrated that the overall lifecyde between the start of a feasibility study until the legal release of a set of specifications into the CCS TSI takes in reality a development cycle of around 4 years (based on examples such as Limited Supervision, ATO, GPRS).

In the pictures below, the examples of 'ETCS over GPRS' and the planning of the 'next generation communication system(s)' is demonstrated which covers the period from the feasibility study until the set of specifications being incorporated in the next system version (so the phase of first implementation within a project is not included).