EUROPEAN UNION AGENCY FOR RAILWAYS

Moving Europe towards a sustainable and safe railway system without frontiers.

# OPINION

*ERA/OPI/2024-03*

# OF THE EUROPEAN UNION AGENCY FOR RAILWAYS

# for

# THE EUROPEAN COMMISSION

# regarding

## ETCS-FRMCS Compatibility

Disclaimer:

The present document is a non-legally binding opinion of the European Union Agency for Railways. It does not represent the view of other EU institutions and bodies, and is without prejudice to the decision-making processes foreseen by the applicable EU legislation. Furthermore, a binding interpretation of EU law is the sole competence of the Court of Justice of the European Union.

# Contents

# 1. General Context

## 1.1. Introduction

The European Union Agency for Railways (hereinafter "the Agency" or "ERA") received from the European Commission a request[1] for a technical opinion in accordance with Article 10 Regulation (EU) 2016/796 and pursuant to Article 6 of Directive (EU) 2016/797. The request was to analyse proposals from the CTO Council WG (see references [1] to [6]) in relation to the ETCS-FRMCS compatibility for a number of vehicles which are already equipped with ETCS B3MR1 or ETCS B3R2 products. In addition, the Agency received in Q1 2024 an additional proposal in relation to the same topic which will be added for completeness reasons to provide full transparency and ensure stability of the regulatory framework. In response, the Agency has provided some additional recommendations which are linked to the initial objectives of the CTO Council WG.

## 1.2. References

| Reference | Name of document/presentation | Title of document |
|---|---|---|
| [1] | 24E009-1-_Baseline_Light(clean).docx | ETCS FRMCS Baseline Light concept |
| [2] | 20240426_ETCS-FRMCS_Finalresults WG V2.pdf | CTO Council – Working Group<br>ETCS-FRMCS Compatibility/Final results |
| [3] | CTO_Group_Adapter_D_draft.docx | ETCS FRMCS Adapter D concept |
| [4] | CTO-council FRMCS – ETCS Solution Stream Report final April 2024.docx | FRMCS - ETCS Baseline 3 (non-)compatibility / Technical Report |
| [5] | CTO WG2 LA output slides 03052024 FINAL.pptx | ETCS-FRMCS Compatibility<br>Legal & Authorisation Working Group Output |
| [6] | 20240606_FRMCSupgrade-delta cost estimation_v1.0.ppt | CTO Council WG presentation on Delta cost estimation |

## 1.3. Abbreviations

| Abbreviation | Description |
|---|---|
| ASBO | Assessment Body |
| ATO | Automatic Train Operation |
| BDC | Basic Design Characteristic |
| CCS | Control Command Signalling |
| CS | Circuit Switched |
| CTO | Chief Technology Officer |

[1] Letter signed on 16.02.2024 from Brussels MOVE.DDG2.C/KS to the Executive Director of the Agency with reference Ares (2024) 1239302-19/2/2024.

| Abbreviation | Description |
|---|---|
| EECT | Extended ERA Core Team |
| ERTMS | European Rail Traffic Management System |
| ETCS | European Train Control System |
| FRMCS | Future Radio Mobile Communication System |
| GSM-R | Global Communication System for Railways |
| IM | Infrastructure Manager |
| MT | Mobile Terminal |
| NoBo | Notified Body |
| OB | On-Board |
| OBapp | On-Board application |
| PS | Package Switched |
| RBC | Radio Block Centre |
| RU | Railway Undertaking |
| SIL | Safety Integrity Level |
| SRS | System Requirements Specifications |
| SV | System Version |
| TMT | Transition Mode Table |
| TSI | Technical Specifications for Interoperability |
| UNISIG | Union industry of signalling |
| WG | Workgroup |

## 2. Legal Background

The request for this opinion to the Agency was made by the European Commission pursuant to Article 6 of the Interoperability Directive (EU) 2016/797, in accordance with Article 10 of the Regulation (EU) 2016/796 (the Agency Regulation).

According to the provisions of Article 10 of the Agency Regulation, the Commission has the possibility to request the opinion of the Agency. It is on this basis that the Agency should analyse the alternative solution(s) proposed by the CTO Council WG.

# 3. Analysis

## 3.1. Issue description

In anticipation of GSM-R obsolescence, a new radio class A system (FRMCS) is being defined and will be deployed in Europe as a successor to GSM-R. In the CCS TSI 2023/1695[2], FRMCS was partially introduced defining the so called OBapp interface between ERTMS/ETCS and ERTMS/ATO-on-board subsystems (respectively named ETCS-OB and ATO-OB in the rest of the document), and the FRMCS on-board.

This interface is preparing the future evolution of the railway system by defining an IP- interface between signalling and telecom subsystems. With this new interface, it will be possible to update in future the telecom subsystem (e.g. 6G, satellite as new components in FRMCS) without the need to update the signalling subsystem. This interface also enables new subsystems, such as ATO.

The implementation of that interface requires however an upgrade of the ETCS-OB. This solution was validated by a sector agreement in 2019 to implement FRMCS only with a future ETCS system version (i.e. SV 3.0), because the introduction of FRMCS was assessed as a non-compatible evolution in the sense that an on-board only fitted with GSM-R cannot operate on a trackside only fitted with FRMCS, and vice-versa.

This is nevertheless raising concerns from railway stakeholders currently implementing ETCS-OB Baseline 3: tight schedule for retrofit of several thousands of vehicles (ETCS-OB upgrade + FRMCS-OB equipment installation), availability of products, sunk costs. A working group sponsored by the CTOs of several European Railway Undertakings and Infrastructure Managers has been working on an alternative enabling the support of the OBapp interface on ETCS-OB B3 to be able to communicate over FRMCS.

The Agency was provided by the CTO Council WG with alternatives[3] to an upgrade to Baseline 4 (up to SV3.0) as per CCS TSI 2023/1695. This opinion is analysing the inputs from three angles: technical, legal and policy/migration stream, as per the structure of the CTO Council WG. Recommendations for the different items are summarised in section 0.

## 3.2. Technical assessment

### *3.2.1. Assessment of concept 1 'the adaptation of the ETCS-OB B3 enabling the FRMCS function into the vehicle'*

#### *3.2.1.1. Introduction*

First of all, the term "Baseline Light", even if it is nice marketing naming, is misleading because it could be misunderstood as an ETCS-OB, for which the referential would be as close as possible to the ETCS B4R1 (up to SV3.0) referential. The concept is summarised in paragraph 3 of Ref [4] by the CTO Council WG as follows:

*'Regarding the "Baseline Light" solution it was also decided that such a solution should limit itself to the existing ETCS functionality of BL3 SV 2.0 and SV 2.1 vehicles, that is no change requests other than what is*

[2] Commission Implementing Regulation (EU) 2023/1695 of 10 August 2023 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union and repealing Regulation (EU) 2016/919

[3] The CTO Council submitted two alternatives, Baseline Light solution and Adapter solution, referred to in this Opinion as Baseline Light concept and Adapter concept.

*required to introduce FRMCS should be considered. Furthermore, the introduction of FRMCS should be possible in such a manner that SS-026 (the core ETCS application) is not affected.'*

It must be noted that the input received from the CTO Council WG is only a high-level description of an alternative concept and is **not a solution**, as admitted in section 1.1.1.3 within Ref [1]: *'1.1.1.3 This document is not a full specification of the Baseline Light solution. It only defines the principles of the concept (see chapter 2) and the operational consequences when it is used to adapt a Baseline 3 (SV2.0 or 2.1) ETCS on-board for fitment of FRMCS equipment (see chapter 3).'*

In fact, the Baseline Light description is deemed to be "very light" for the following reasons:

1. It only presents an alternative concept and by no means a fully-fledged solution. It merely only retrieves some parts of the CR1359 solution implemented in ETCS B4R1 as defined in the CCS TSI Appendix A (link: CCS TSI Appendix A – Mandatory specifications (ETCS B4 R1, RMR: GSM-R B1 MR1 + FRMCS B0, ATO B1 R1)).
2. It excludes:
    - all other error change requests which could prevent normal service which are resolved in the ETCS B4R1;
    - all enhancement change requests implemented in ETCS B4R1 (up to SV3.0) which are requested by the sector, such as e.g. ATO GoA1/2;
    - all error change requests resolved in B3R2 and enhancement requests implemented in B3R2 (e.g. online key management), if the referential is B3MR1
    - any subset of change request(s) when having used the clause on partial fulfilment available within the CCS TSI 2016/919, if the referential is B3R2.

Therefore, the term "Baseline Light" must rather be understood as an ETCS-OB B3 tinkered, no more no less.

The above exclusion list for the Baseline Light concept does not require a technical assessment but requires mainly an assessment linked to the migration stream ('policy' opinion linked to partial fulfilment) in case these change requests would be postponed or not implemented. The evaluation of this aspect of the Baseline Light concept is managed in section 3.4.4.2, while this section 3.2.1. evaluates the alternative concept within Ref [1] aimed at retrieving and adapting some parts of the CR 1359 solution.

#### *3.2.1.2. Assessment*

First, the document [Ref 1], by keeping on using the Euroradio centred (and misleading) terminology "ETCS application = SUBSET-026", disregards the important clarification made by ERA (and neither challenged by EUG nor by UNISIG) in the course of the CR1359 discussion:

*"Euroradio is part of ETCS and is not part of the telecom world, it is just a functional module that ensures the interface between ETCS and the radio systems FRMCS and/or GSM-R. In other terms, the ETCS application includes Euroradio. Actually, the EUG+UNISIG alternative concept does not make any difference with respect to the above mentioned interface and mostly consists of a functional re-apportionment between the so called ETCS on-board kernel (the "signalling" layer) and Euroradio, with the only real goal to eradicate the ETCS radio related trackside orders"*

The alternative concept indeed intends to make the ETCS-OB B3 ready for FRMCS and capable to operate on any trackside without the need for the ETCS trackside to inform the on-board about which type(s) of radio network (GSM-R only, GSM-R + FRMCS or FRMCS only) the train must consider for its mission.

To that effect, some of the requirements which are stipulated in the SUBSET-026 are "deported" in the sense that they would be fulfilled by the Euroradio functionality, through its so-called "Coordinating Function" and its related Transmission Mode Table (TMT). For some basic functionality (e.g. Start of Mission), this could only work because the Euroradio would fool what is called the "application" by the document [Ref 1]. As a result, some of the important "signalling" decisions (e.g. in the frame of an RBC-RBC Handover) made by the ETCS-OB are left to the Euroradio functional module and based on a try-and-see mechanism inside the Euroradio.

Actually this alternative concept presented in [Ref 1] is nearly identical to the concept which has already been extensively discussed during EECT ETCS in the framework of CR1359. During the discussion, this alternative concept has been dismissed because the representatives could not demonstrate that their concept flew for certain operational scenarios and above all because this alternative concept included a significant number of important shortcomings, one of them being safety related.

In short, the document [Ref 1] just tries to come back on some of these shortcomings by minimising their operational consequences but unfortunately also completely hides one of them which was safety related.

The table below lists some of the shortcomings which are not successfully challenged by the document [Ref 1]. The content of this table is on purpose not exhaustive, because the severity of the safety and operational consequences for some of them does in our view exempt this Opinion from digging out and vulgarising all the other detailed technical aspects that were properly traced in the CR1359.

| [Ref 1] - clause(s) | ERA Technical pre-assessment | ERA Economic pre-assessment |
|---|---|---|
| 2.2.1.2 The Coordinating Function contains the Transmission Mode Table (TMT). This table stores for every RBC the telecom system(s) by which the on-board can contact this RBC.<br>4.2 SoM with valid position – table 4<br>4.3 SoM with unknown position – table 5 | During a Start of Mission, the sole use of a Transmission Mode Table limits the decision to let the train proceed in a normal operation or not to a basic check of the ability of the on-board to contact the first RBC of the mission (RBC granularity). However, during the development of the CR1359 solution, this was judged as insufficient to prevent a train from being stuck at the entry of any next RBC, which requires the other on-board radio system, but this latter is not successfully registered or not installed on-board.<br>In case both radio systems are installed on-board (which is the primary purpose of the Baseline Light concept) while one of them is not successfully registered (e.g. single on-board failure), the Baseline Light undifferentiated indication to the driver (“Radio network registration failed”), based on the sole “Euroradio try-and-see” connection attempt with one single RBC where the train starts its mission, makes impossible the decision to start the mission or not.<br>This situation cannot arise with the CR1359 solution since it uses the type of radio network(s) needed to start the mission, in conjunction with the possibility to discriminate which on-board radio system is unsuccessfully registered to this radio network. In the scenario depicted above, no deadlock would occur since the radio network type would be FRMCS+GSM-R and should one of the radio systems not be registered, | It is irrelevant to economically assess the impact of such operational deadlock. |

| [Ref 1] - clause(s) | ERA Technical pre-assessment | ERA Economic pre-assessment |
|---|---|---|
| | the train would not depart in a normal operation in the first RBC to be then stuck in a further one maybe few kilometres afterwards. Such situation can de facto not be tackled with only an RBC per RBC Transmission Mode Table mechanism. | |
| 2.2.2.5 If the RBC contact order comes first, the right telecom system is known by the on-board when the level transition order is received. The on-board checks if this system is in working condition. If that is the case, the condition in 5.10.2.4.1a is fulfilled. | The TMT (Transmission Mode Table) must be populated and up to date. In the frame of the CR1359 review, this concept of the TMT always up to date was disqualified, because to chase all the trains each time a new RBC is put into service is hopeless. Conversely, to pre-configure correctly any on-board after maintenance operation in the workshop would be as hopeless. | The alternative concept exports an almost unpracticable constraint from the IM to the RUs because all trains need to be updated each time an RBC is migrated to FRMCS (change in TMT) or each time there is a maintenance operation and the TMT is uploaded in the on-board, it should be ensured that it is the right one up to date. |

| [Ref 1] - clause(s) | ERA Technical pre-assessment | ERA Economic pre-assessment |
|---|---|---|
| 3.3.3.1 The driver will have three options to contact the RBC:<br>a) Contact last RBC,<br>b) Use short number,<br>c) Enter RBC data.<br>3.3.3.3 The option b) is a feature in GSM-R to connect with an RBC based on the radio cell to which the EDOR is connected. Such a feature would also be useful in FRMCS, but it is expected that the first operational version of FRMCS will not support it. **Operational consequence**: If the driver selects option b) while an FRMCS only RBC has to be contacted, the attempt will not be successful. The connection failure indication will appear on the DMI. The route book should instruct the driver not to use this option in this situation.<br>3.3.3.4 If the driver selects option c), he will have to enter/revalidate both the RBC ID and telephone number. Operational consequence: If an FRMCS only RBC must be contacted, the driver can ignore the telephone number, because it is not used for FRMCS. The route book should explain this to the driver. | The workaround proposed in the clause 3.3.3.3 breaches the basic ergonomic principle that if a button is enabled, depressing it cannot lead to a deadlock or mislead the driver.<br><br>The assertion in the clause 3.3.3.4 *"the driver can ignore the telephone number"* is false. If the driver must enter the RBC data (e.g. Start of Mission after a cold movement), both RBC ID and telephone number must be entered and validated at once (see ERA_ERTMS_015560). In other terms, it is impossible to enter an RBC ID without entering a telephone number.<br><br>The only way out, without modifying what is called the "application" by the document [Ref 1], is to instruct the driver to enter a fake telephone number. | As a minimum, the alternative concept has a negative ergonomic impact or necessitates a modification of the ETCS on-board part, having to fulfil the SIL4 based THR target. |
| 3.4.1.7 If the trackside engineering is such that the RBC contact order was not yet received before the level transition order announcement, the ETCS on-board does not know yet if the right telecom | The clause 3.4.1.7.2 overlooks the fact that no L2 Movement Authority sent by the RBC before the train | In order to avoid these unacceptable operational consequences, the alternative concept might lead to significant additional re-engineering costs at IM-side. |

| [Ref 1] - clause(s) | ERA Technical pre-assessment | ERA Economic pre-assessment |
|---|---|---|
| system is in working condition when the evaluation of clause 5.10.2.4.1a is made. Therefore, according to the principle defined in 2.2.2, the on-board will consider level 2 as not available (to avoid a potentially unwanted transition to level 2).<br><br>3.4.1.7.1 **Operational consequence** : No level transition announcement is displayed to the driver in case the current level continues as underlying system in the level 2 area (e.g. current level is LNTC and after the transition it is L2 on top of LNTC), or a transition to the next system in the table of priorities is announced to the driver if this system is different from the current level (e.g. current level is LNTC and after the transition it is L2 on top of L1).<br><br>3.4.1.7.2 When the train passes the border balise group, the transition order to level 2 is repeated. At that moment the on-board knows if the telecom system for the RBC is in working condition and if level 2 is available. If the answer is yes, the transition to level 2 is still made and the current level is included in the table of priorities, unless it is a conditional level transition. **Operational consequence**: In that case the current level is maintained, which should not be problematic because the level transition was implemented as "conditional". | crosses the border will be taken into account by the On-Board.<br><br>**Real operational consequence**: All the Baseline Light trains will be systematically tripped on passing the border, unless the entered radio equipped area is a mixed level 2/level 1 area, and a level 1 MA could be stored on-board beforehand; however this is rather speculative. | |

| [Ref 1] - clause(s) | ERA Technical pre-assessment | ERA Economic pre-assessment |
|---|---|---|
| 3.4.1.7.3 If the underlying level across the border is different from the current level, and in case the announced border is reached before the train passes the border balise group (this depends on the trackside engineering of the announcement), the on-board would switch to the underlying level, immediately followed by the transition to level 2 when the train passes the border balise group. Operational consequence: In this situation the driver would be confronted with two level transitions immediately following each other. | The clause 3.4.1.7.3 ignores the operational consequence that in baseline 3 the train driver will have to acknowledge the level the on-board is ordered to switch to in case of level transition level NTC => level 1, and that it does not correspond to the level 2 actually executed on passing the border. Most likely the train driver will not notice the glitch L1 => L2 because it will occur at the same time the mode transition to FS is executed. It is inacceptable from ergonomic and operational point of view, since it is highly likely that the operating rules in ETCS L2 are not the same as in ETCS L1. | The alternative concept has a negative ergonomic impact. In addition, the alternative concept has not analysed the necessary impact of the potential additional hazards related to misleading the train driver including the associated mitigation measures. |
| 3.5.1.1 GSM-R network transitions are defined in SRS [2]. No specific consequences due to the Baseline Light concept. | The important SUBSET-026 3.15.1.3.2 feature stipulates the condition to delay the connection to the Accepting RBC as the ETCS-OB being no longer able to handle more than one communication session at a time. With the introduction of FRMCS, this condition must obviously to be refined (and has been so in SUBSET-026 v4.0.0, taking into account the type of radio network and the type of radio equipment of the RBC) in order to avoid that the remaining GSM-R Mobile Terminal is wrongly pre-empted while the train is still under the supervision of the Handing Over RBC.<br><br>A specific consequence in case RBC/RBC handover between GSM-R only RBCs has been duly identified | The preliminary analysis indicates that any future potential solution to be developed for this alternative concept without affecting the ETCS on-board part, having to fulfil the SIL4 based THR target, is of low probability. |

| [Ref 1] - clause(s) | ERA Technical pre-assessment | ERA Economic pre-assessment |
|---|---|---|
| | and extensively described in the CR1359 (shortcoming #8 in EETC 19/04/23 minutes), and is neither mentioned nor challenged by the document [Ref 1].<br><br>**Safety related consequence:** It is in our view safety related because the pre-emption of the second GSM-R MT by the connection to the accepting RBC could prevent definitively the Handing Over RBC from sending restrictive information, while it is still the supervising RBC. Upon such single on-board failure (one GSM-R Mobile Terminal out of order), the Infrastructure Manager(s) may not have foreseen any specific safety provision because the engineering did not expect such “Euroradio on its own triggered” Mobile Terminal pre-emption for the connection to the Accepting RBC.<br><br>Example: communication with HO RBC through GSM-R is lost and only 1 GSM-R MT in working condition. If FRMCS is installed on-board, B3 version of SUBSET-026 3.15.1.3.2 will be interpreted as not fulfilled and the on-board would wrongly pre-empt the only MT left, see new note 3.15.1.3.2.1 in SUBSET-026 4.0.0. | |

#### *3.2.1.3. Conclusions on concept 1 'the adaptation of the ETCS-OB B3 enabling the FRMCS function into the vehicle'*

The statement by the CTO Council WG that this alternative concept would not affect the SIL-4 part is evaluated as being an incorrect statement (see at least comments on clause 3.5.1.1).

The statement by the CTO Council WG that this alternative concept is a low-risk solution is considered as a premature and incorrect statement as there is no exhaustive analysis done by the CTO Council WG and the preliminary assessment identified some additional hazards which are overlooked.

In addition, the preliminary assessment identifies a scenario (see comments on clauses 3.4.1.7 to 3.4.1.7.2), which prevents any operation of a Baseline Light train on lines where the level transition order is transmitted before the RBC contact order. As a matter of fact, this Baseline Light concept does breach the SUBSET-026 clause 1.7.1.5 *'Not specified requirements and solutions shall only be permitted as long as they do not generate any interoperability problems.'*

In addition, the preliminary assessment identifies an almost unpracticable shift of responsibility (and hence resulting costs) from IMs to RUs: every time an RBC is put in service with FRMCS, all the ETCS-OB must be reconfigured before they can operate under the supervision of this RBC and all the maintenance workshops must ensure that the ETCS-OB are reconfigured with most up to date information with regards to the new RBC or to the upgraded RBC.

Based on the above observations, the recommendation is to disqualify definitively this alternative concept, even in the form of a proprietary solution submitted in the frame of the Vehicle Authorisation process.

All in all, it appears that the Baseline Light concept is only motivated by the sole shift of (negligible) costs from the IMs (to add a reduced number of packets 245 (Radio Network type) to existing balise groups in the vicinity of borders where the FRMCS would be installed) towards significantly underestimated costs for the RUs, and on top of that without avoiding inevitable ergonomic, operational and safety related consequences.

Therefore, the Agency rather considers evaluating the implementation of the CR1359 solution (as integrated in B4R1) in the Baseline 3 ETCS-OB and recalls that a similar way forward has already been used in Switzerland, for the Limited Supervision functionality. This technical alternative to Baseline Light of only implementing the CR1359 solution is analysed in section 3.4.4.

### *3.2.2. Assessment of concept 2 'Adapter Concept'*

#### *3.2.2.1. Introduction*

In the Technical Report on FRMCS - ETCS Baseline 3 (non-)compatibility submitted by the CTO Council to ERA in April 2024, the Adapter concept initially considered in their Analysis of the issue released in October 2023, is further developed in Ref [3].

A substantial review of 7 variants for that solution is provided in the report, all elaborating on the same basic design principles that the solution should act as an ETCS Data Only Radio (EDOR) emulator, without impacting the Euroradio protocols/software already installed on Baseline 3 ETCS equipped vehicles, hence enabling "legacy" ETCS on-boards to support the OBapp interface from a trackside perspective. Those variants present pros and cons in terms of complexity and impact for both ETCS-OB and ETCS-TS, as well as draft solution for

performing the ETCS coordinating function (selection of either GSM-R or FRMCS bearer) outside of the ETCS protocol stack.

However, the Technical Report concludes that this Adapter concept would entail considerable complexity and multiple challenges and risks for creating a one-size-fits-all solution. In particular, it is summarised that two Adapter Solutions would be needed: solution (D) for SV2.1 vehicles and solution (A) for SV2.0 vehicles[4].

The report also concludes that, although technically feasible, the foreseeable supplier ecosystem would be at question, and that specific development would be needed for a railway tailored Adapter Solution, potentially leading to several solutions for each relevant vendor combination of ETCS onboard and telecom onboard equipment.

The report is therefore putting aside the Adapter Solution from the review to be performed by ERA (although a draft proposal for Adapter Solution (D) was submitted) and recognises that Adapter Solution would have to be studied in more detail if Baseline Light would not be considered viable.

For the sake of completeness, ERA reviewed the maturity of this solution in the next sections.

#### *3.2.2.2. Assessment*

While reviewing in detail the draft proposal for Adapter Concept (D), ERA noted the following preliminary remarks:

- The solution is only applicable to SV2.1 vehicles (GPRS fitted) and therefore only addressing partly the issue highlighted by the CTO Council WG
- The solution defines a quite complex implementation of the coordinating function to select either FRMCS or GSM-R bearers: the function is split between the untouched part inside the ETCS Euroradio for the selection between GSM-R CS & PS mode and a new part hosted by the adapter dealing with the FRMCS selection; some of the assumptions (e.g. this new coordinating function will be informed by the FRMCS onboard gateway whether it is registered in an FRMCS network) are questionable
- The solution needs to implement an on-board DNS proxy with some extended functionalities
- For the support of online key management via FRMCS, a specific adapter coordinating function would be needed in addition
- The possibility for the adapter to “fake a GSM-R registration” is not sufficiently described
- Although the objective is to keep the Euroradio part of the ETCS-OB untouched, it is acknowledged that several error correction Change Requests would need to be implemented (e.g. CR 1415, 1429)
- Because it is functionally the same concept with the so called Coordinating function split between Euroradio and the Adapter, the same safety related and operational consequences (RBC-RBC handover, SoM,…) drawbacks as depicted for the Baseline Light should exist

Based on the remarks above, ERA notes some lack of maturity and estimates that the complexity of the Adapter Solution would lead to uncertain timing for development of specifications (incl. test specifications)

[4] Adapter Solution (A) would apparently work for both SV2.0 and 2.1 vehicles, but risks remain regarding the complexity of protocol conversion. For SV2.0, some change requests from Baseline 3R2 (e.g. online key management) would not be covered.

and for the development of products. This could in addition have a negative impact on availability of FRMCS On-Board products (as the resources for developing FRMCS On-Board products are similar to the ones who would develop the adapter solution).

The concept, while promoted by Industry partners in the CTO Council WG, is also questioned in terms of short-term supply capability and mid-term industrial ecosystem.

Based on the above observations, the recommendation is to disqualify definitively this alternative concept, even in the form of a proprietary solution submitted in the frame of the Vehicle Authorisation process

Assessment of performance compared to solution of CR1359

- Performance loss 1: Additional hardware with high complexity will lead to performance loss
- Performance loss 2: No benefit of using 5G-functionalities within FRMCS
- Performance loss 3: No benefit of using IP interface for new applications (e.g. ATO)

#### *3.2.2.3. Conclusions on concept 2 'Adapter concept'*

ERA confirms the conclusion (already made in 2019) to exclude this Adapter concept mainly due to the high technical risks.

### *3.2.3. Assessment of concept 3 'FRMCS+2G concept'*

#### *3.2.3.1. Introduction*

In the context of this Opinion an alternative scenario focusing on the prolongation of GSM-R trackside coverage has been discussed in the sector: this concept proposes to extend GSM-R trackside availability until all ETCS-OB Baseline 3 vehicles are naturally upgraded, e.g. maintaining GSM-R trackside until 2040-2045. In this scenario, there would be no need to upgrade ETCS-OB to Baseline 4, as normal GSM-R service would be kept. This concept also considers the possibility of dual-system trackside (trackside assets capable of offering GSM-R and FRMCS coverage at the same time).

To provide for a complete assessment of all scenarios mitigating the issue referred to in the Opinion, ERA has distributed a questionnaire about this alternative trackside scenario to some Infrastructure Managers and Industry covering this trackside focused scenario (see ANNEX 1). This document represents a compilation of answers received.

In summary, Infrastructure Managers and Industry see more risks in prolongating the lifecycle of GSM-R to cope with the need to upgrade existing ETCS-equipped vehicles: economical and technical risks for extending availability of trackside GSM-R assets, strategical risk of delaying the adoption of FRMCS.

The scenario where trackside solutions would be considered for mitigating the need to upgrade existing vehicles equipped with ETCS Baseline 4 is therefore considered by ERA as non-realistic.

#### *3.2.3.2. Assessment*

The maturity of the concept is considered low. See in detail answers from Infrastructure Managers and Industry in ANNEX 1. The associated risk is that FRMCS introduction will be likely to be postponed.

The impact (performance) of the concept is evaluated as providing the same performance as GSM-R.

#### *3.2.3.3. Conclusions on concept 3 'FRMCS+2G' concept*

ERA considers the trackside concept (including the 'FRMCS+2G' solution) as an initiative not supported by the railway telecom industry and the IMs. Regulatory provisions defined in the CCS TSI 2023/1695 are however not preventing initiatives to extend the lifetime of GSM-R services at trackside to be implemented on a voluntary basis. However, ERA would like to express its view that this initiative about new trackside equipment enabling simultaneous support of GSM-R and FRMCS could also cause delay to the initial objective of development of FRMCS (5G) specifications.

## 3.3. Legal Assessment of impact on certification/authorisation processes

### *3.3.1. Input provided by the CTO Council WG on the legal stream*

Following key findings are provided by the CTO Council WG:

**High level Problem Statement:**
Technical and legal non compatibility of FRMCS with existing and pre 2030 planned fitment on board subsystems

**L&A Key findings:**

SV2.y do not account for the existence of FRMCS. The proposed changes (adaptor and BS-Light with FRMCS) do not change ETCS functionality but only change the communications options and maintain or exceeding existing levels of reliability

It is our opinion that the current TSI is not compatible with existing subsystems which are already commercially available in relation to the above problem statement. In line with Article 7 of EU 2016/797 the updating of existing subsystems would compromise the economic viability or compatibility of the subsystem.

From an authorisation view in relation to Article 21 EU 2016/797, item 12(b) highlights the requirement for authorisation whenever the safety of the subsystem is adversely affected by the works or 12(c) required by the TSI. The proposed solutions do not directly alter the ETCS safety function. TSI 7.2.2.2 item (2) would be deemed to be met, i.e. that the introduction of BS Light or adapter would not change the state expected during the original authorization. Moreover, the technical compatibility with the network is not affected.

Change Request (CR1359) would need to be amended legally to enable compatibility. (Review of error correction impact is still required but expectations are these are ETCS maintenance updates only and non impacting).

Articles 24 EU 2016/797 provides the detail on vehicle type authorisation following change. Article 25 allows for authorisation of a series of vehicles which are in conformity with an existing authorised vehicle type without further checks.

There are no recommendations from the L&A WG to suggest the need for alterations to the directives

Following proposals are provided by the CTO Council WG:

**Proposals:**

**Align TSI27 activities to incorporate the necessary changes to legally and technically allow the compatibility and use of the baseline light solution to interface FRMCS with SV2.0 & 2.1** *(EU 2018/545 Article 17 3.)*

If timelines (2027/8) permit changes to TSI: *(ref. 7.2.4.1.2-(4) Permissible to use the most recent version of any TSI)*

- Introduce the TSI changes required as part of TSI27 that will enable FRMCS compatibility with baseline 3 system versions
- Introduce the differentiation of safety and non-safety functions and define that changes of the non-safety part do not require new authorisation. Non safety changes would reduce the requirement for NOBO verification and allow ASBO system compatibility verification only.
- Amendment of CR1359 (packet 245) to account only for the changes necessary for FRMCS compatibility to the baseline light solution.
- Indicate that ATO is out of scope for baseline light.

If timelines do not permit:

- Request the provision of a Technical Opinion on the backwards compatibility of FRMCS with Baseline 3 system versions.
- Member states could submit derogation requests for the allowance of backwards compatibility of FRMCS with Baseline 3 system versions in reference to partial fulfilment as detailed in Appendix G (1) and (2)(c).

**Request that wherever possible, the vehicle series type compatibility with an authorised vehicle of the same type is applied with no further testing requirements for subsystem compatibility**

### *3.3.2. Assessment in relation to the specific proposals by the legal stream*

Key findings: *From an authorisation view in relation to Article 21 of Directive (EU) 2016/797, item 12(b) highlights the requirement for authorisation whenever the safety of the subsystem is adversely affected by the works or item 12(c) required by the TSI. The proposed solutions do not directly alter the ETCS safety function. TSI 7.2.2.2 item (2) would be deemed to be met, i.e. that the introduction of BS Light or adapter would not change the state expected during the original authorization. '*

ERA answer on key findings:

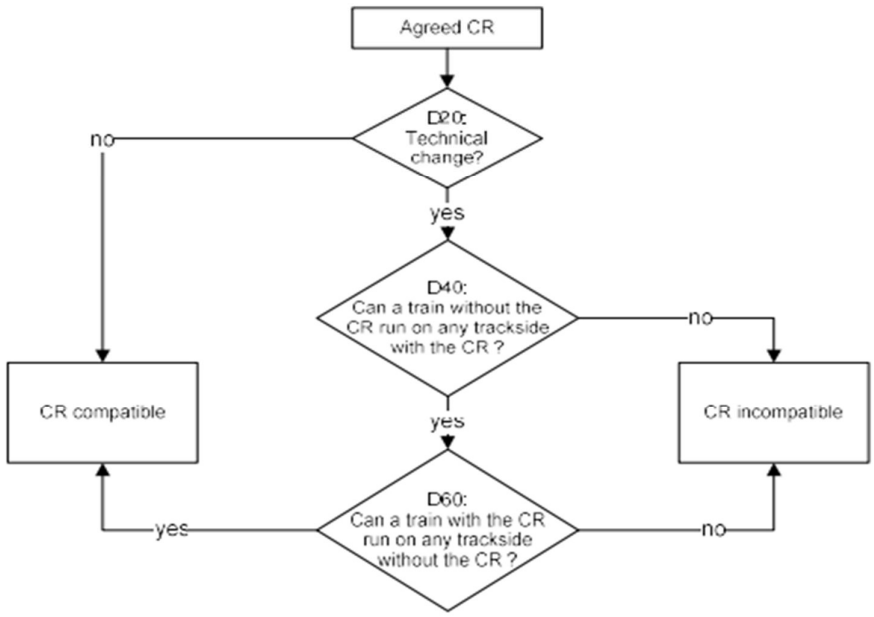
- the assessment in the technical stream demonstrates that safety might be adversely affected. As there is no solution provided by the CTO Council WG, it is not possible to conclude that the safety is not adversely affected, so not fulfilling requirements from Commission implementing Regulation (EU) 2018/535 Art 21, 12 (b);

- the TSI concludes that re-authorisation is needed for the ETCS-OB due to a Basic Design Characteristic (BDC) being out of margin. 7.2.2.2 item (1) and (2) are not fulfilled as Euroradio-functionality is part of the ERTMS/ETCS subsystem and also item (2) of 7.2.2.2 is not fulfilled as the interfaces relevant for safety & technical compatibility remain unchanged;

Analysis of proposal 1: ***'Introduce TSI changes required as part of TSI 27 that will enable FRMCS compatibility with baseline 3 system versions'***

Background: According to the analysis stipulated in the ETCS system version management, each change request is analysed according to following decision chart as described in section 5.3.1 of the SUBSET-104:

**5.3.1 Decision chart**




Both the existing CR 1359 inside ETCS B4R1 (up to SV3.0) or the ETCS Baseline Light concept change the functionality of the ERTMS/ETCS subsystem. Should a BCA analysis run for any solution derived from this

concept by applying the above SUBSET-104 decision chart, we see no ground from the evaluation of this alternative concept that would change the conclusions reached for the CR1359 solution implemented in the ETCS B4 R1 and RMR B1R1 (see extract of CR 1359 within the BCA 2018-report below).

| CR n° | Headline | Type | Analysis | | |
|---|---|---|---|---|---|
| | | | Q1a | Q2a | Explanation/Justification |
| 1359 | Evolution of the interface between signalling applications (ETCS and ATO) and the radio communication system onboard | Enhancement | no | no | Q1a: An on-board only fitted with FRMCS cannot operate on a trackside only fitted with GSM-R. Q2a: An on-board only fitted with GSM-R cannot operate on a trackside only fitted with FRMCS. |

Important note: the wish expressed by the CTO Council WG to introduce the FRMCS as a compatible change request through an ETCS Baseline light concept implies that either the GSM-R is never decommissioned or that an FRMCS system with a built-in backward compatibility feature, which allows the FRMCS to fool the GSM-R only on-board or trackside, would be created. This could be compared with the introduction of GPRS (using ETCS B3R2) as compatible change where it remains mandatory for an IM to continue to provide GSM-R services with circuit-switching mode even if GPRS is available.

In the CCS TSI amendment 2019/767, following Directive (EU) 2016/797 Article 4.3 (h) it was introduced the section about Basic Design Characteristics (BDC) Table 7.1. In that table and the subsequent sections, it is indicated which changes of the CCS on-board subsystems require a new authorisation. In CCS TSI 2023/1695 section 7.2.2 point (1) indicates that the target functionality shall remain unchanged, and point (2) indicates that interface shall remain unchanged. None of these conditions will be fulfilled since modifications to the ETCS-OB as well as the interface towards FRMCS need to be introduced.

Conclusion of proposal 1: The proposal from the legal stream '*CR 1359 would need to be amended legally to enable compatibility*' is not coherent with the fact that the ETCS Baseline Light requires also a mandatory ETCS upgrade. The proposal from the legal stream is also not coherent with the technical or migration stream for the Baseline Light concept as it would require in any case a mandatory change to the existing B3MR1 or B3R2 products in operation when GSM-R is decommissioned.

Analysis of proposal 2: ***'Introduce the differentiation of safety and non-safety functions and define that changes of the non-safety part do not require new authorisation. Non safety changes would reduce the requirement for NoBo verification and allow ASBO verification only.'***

Directive (EU) 2016/797 Annex III defines the Essential Requirements that shall be fulfilled. The Directive does not establish any priority or difference among all those, so the same treatment shall be applied to the essential requirement "safety" than to the "technical compatibility" one. It shall also be highlighted that the lack of communication in a vehicle may contribute to a safety critical incident.

ERA assessment of proposal 2: The proposal from the legal stream is not coherent with Directive (EU) 2016/797 as authorisation is not only focused on safety but also on interoperability. The proposal from the legal stream is also not coherent within itself, as it does not question that FRMCS (which is also a non-safety related system) would require an authorisation.

Analysis of proposal 3: ***'Amendment of CR 1359 (packet 245) to account only for the changes necessary for FRMCS compatibility to the baseline light solution';***

ERA assessment of proposal 3: This depends on the technical evaluation of the alternative concept implying an adaptation of the ETCS-OB B3 enabling the FRMCS function into the vehicle (see section 3.2.1).

Analysis of proposal 4: ***'Indicate that ATO is out of scope of baseline light'.***

ERA assessment of proposal 4: See results from the policy and migration stream in section 3.4.4.2.

Analysis of proposal 5: **'If timelines do not permit changes to TSI, request the provision of a Technical Opinion on the backwards compatibility of FRMCS with Baseline 3 system versions'.**

ERA assessment of proposal 5: See conclusions from technical assessment in sections 3.2.1 and 3.2.2.

Analysis of proposal 6: **'If timelines do not permit changes to TSI, Member States could submit derogation requests for the allowance of backwards compatibility of FRMCS with Baseline 3 system versions in reference to partial fulfilment as detailed in Appendix G (1) and (2) (c).**

ERA assessment of proposal 6: From a legal point of view, EU Member States are fully entitled to submit a non-application request to the EC in accordance with Directive (EU) 2016/797 Article 7.1 (c) economic viability. From an economic point of view, this depends on the results from the migration stream (see section 3.4.4.2) and recommendation 1.

Note on appendix G: Appendix G. Point (1) and (2)(c) are not generic cases for which all change requests can be excluded on an ad-hoc base. The partial fulfilment is restricted to the "defined cases in the table underneath". So far, the assumption is that all change requests within ETCS B4 (up to SV3.0) are only one-off software related with the exception of providing the IP-interfaces for ATO and FRMCS which is also required in the Baseline Light description.

Analysis of proposal 7: ***'Request that wherever possible, the vehicle series type compatibility with an authorised vehicle of the same type is applied with no further testing requirements for subsystem compatibility.'***

As indicated in the analysis of proposal 1, there are fundamental changes impacting the technical compatibility and the BDC of the CCS on-board subsystems, so a new vehicle type authorisation will be required, before requesting the vehicle authorisation for placing on the market.

The re-certification and re-authorisation time and cost of the CCS-subsystem depends on the number of cases where partial fulfilment is used and its associated conditions and restrictions in use which need to be assessed by the Notified Body, Assessment Body and the authorising entity (i.e. ERA/NSA). Today, the return of experience within ERA demonstrates that the effort for vehicle authorisation is substantially higher for ETCS B3MR1 products and ETCS B3R2 products which use the partial fulfilment clause compared to fully compliant ETCS B3MR1 and ETCS B3R2 products. It is predicted that the same scenario will happen for the ETCS Baseline Light (i.e. not solving certain error corrections) compared to the ETCS Baseline 4 (i.e. which solves the error corrections). So, the proposal of Baseline Light is contradictory to the request of having an industrialised approach where a generic case covers the demonstration of compatibility.

Note: In order to limit the re-certification and re-authorisation time and cost for integrating the ETCS-part within a vehicle type, ERA proposes in section 3.3.4 a detailed solution and process for further investigation which should substantially reduce the certification and authorisation cost in case of FRMCS roll-out.

### *3.3.3. Assessment of concept 2 'Adapter Concept'*

Reminder: The technical stream from the CTO Council WG is not promoting the Adapter Solution.

The Technical Report does not have a specific section for the legal assessment of the Adapter Solution, presumably because this solution does not require a re-authorisation of the ETCS-part, however this is in contradiction with the error corrections chapter in the draft proposal for Adapter Solution (D).

Nevertheless, in case a technical solution could be defined, this would also require additional effort to define certification and authorisation scenarios for this Adapter Solution (additional test specifications for adapter, interface with ETCS and its integration into a vehicle type/vehicle). As the Adapter Solution is evaluated as a complex technical solution, it is also expected that the certification and authorisation process will create additional complexity in the FRMCS roll-out.

### *3.3.4. The Agency's proposal to reduce certification and authorisation time and costs*

In order to limit the re-certification and re-authorisation time and cost of the ETCS-part, there is a possibility that ETCS on-board suppliers request to the Agency a chargeable service[5] to provide support and guidance preliminary to formal application for vehicle authorisation to be placed on the market or vehicle type authorisation under Art. 21 & 24 of Directive (EU) 2016/797. This has already been done for some ETCS-OB products with a positive return of experience and this method could be explored for further extension when assessing the ETCS-part (ETCS B4R1 up to SV3.0) for FRMCS roll-out into the different vehicle types.

Such a chargeable service's purpose consists of providing a guidance by the ERTMS system authority on the CCS TSI compliance of the ETCS-part. This guidance is provided in an early phase, being at the start of the certification and authorisation of a vehicle type project (pre-engagement phase) instead of involving the authorising entity at the end of the process. This guidance can also be provided on request of the ETCS On-Board supplier.

This guidance of CCS TSI compliance of the ETCS-On Board product issued by the ERTMS system authority should create trust to the different stakeholders involved in the certification and authorisation process, such

[5] https://www.era.europa.eu/agency-you/procurement/chargeable-services_en

as the NoBos, AsBos and authorising entities which might have less in-depth knowledge of the ERTMS specifications and for which the effort (time and cost) is more substantial to evaluate such CCS TSI compliance of the ETCS On-Board part. These NoBos, AsBos and authorising entities should use the guidance as reference during their certification and authorisation activities. This concept of providing guidance has already been implemented for some ETCS On-Board products where ERA covers this activity as a chargeable service. The estimated savings would be significant as there are only a limited number of ETCS On-Board products (i.e. less than 10 suppliers which have normally 1 to max. 3 product branches) compared to the high number of CCS-subsystems and vehicle type designs (i.e. ERA has already assessed more than 100 vehicle designs where ETCS is integrated). t is roughly estimated that the overall cost savings per vehicle type can be reduced by 50% as it will make the process more efficient when such guidance is available from the start and it will avoid the re-certification or re-authorisation due to restrictions issued by the authorising entity issued at the end of the project. Besides the time and cost savings, it is expected that the quality and the number of deviations of the ETCS On-Board part will progressively decrease as the deviations, temporary mitigation measures and a plan for corrections can be identified and agreed in this early 'pre-engagement' phase.

The impact of such proposal should be endorsed by the sector and Member States and if deemed useful, the workload and organisational consequences should be considered to allocate resources towards the ERTMS system authority for providing such guidance (estimation of around 20 guidance documents to be delivered with 200 manhours per guidance document).

It is roughly estimated that the issuing of such guidance represents an additional cost of approximately 50 [kEUR/ETCS On-Board] (200 manhours) to the applicant or ETCS On-Board supplier (depending who requested for this chargeable service). As example and based on some indicative figures reported by the CTO Council WG, this would represent following benefits and costs:

a) Benefits for certification and authorisation time:
   110 vehicle types x 600 [kEUR/vehice type] x 50% (cost savings) = 33 MEUR

   Note: the CTO Council WG indicated that 110 vehicle types are considered in their analysis, for which an additional delta cost of 600 [kEUR/vehicle type] is reported for Baseline 4 compared to Baseline Light (in the case that no ETCS HW change is required). See Ref [6].

b) Additional cost for issuing guidance by ERTMS system authority:
   4 ETCS On-Board products x 50 [kEUR/ETCS-product] = 200 [kEUR/guidance of ETCS On-Board product]

   Note: the CTO Council WG indicated that 4 ETCS On-Board products are considered in their analysis for the 110 concerned vehicle types. See Ref [6].

Note: a similar recommendation could be considered for providing guidance of CCS TSI compliance of the FRMCS-On Board product issued by the ERTMS system authority. This would further facilitate the overall certification and authorisation process for the FRMCS roll-out.

## 3.4. Policy & Migration stream

### *3.4.1. Introduction*

At the start of the initiative, it was indicated that the ETCS part (up to SV3.0) introduces both a time issue and a cost issue in the roll-out of FRMCS. Both items are separately addressed in the analysis based on the limited inputs provided within the presentation from the CTO Council WG.

### *3.4.2. Analysis of potential time savings*

#### *3.4.2.1. Input related to time savings*

On the time issue, the following statements were made (see Reference [5] - slide 23):

- ***Overall feasibility remains in danger***

 *None of the three solutions (SV3.0, BL Light, Adapter) will ensure a feasible FRMCS migration within the set timeframe*

ERA answer: Statement is noted. FRMCS-specifications are on the critical path, while ETCS-specifications for FRMCS are ready.

- ***There is no significant time gain between any of the solutions related to the starting point of mass retrofit/upgrade***

 *Development of all solutions is depending on final FRMCS specifications (1st edition), foreseen beginning 2027*

 *Start of FiC phase for all solutions is depending on availability of RBC trackside SV2.3 and it's system integration period, foreseen earliest end 2030*

 *FiC will take 1,2-1,8 years for each fleet type, depending on the complexity for integration in the vehicle, scope and effort needed for re-authorization*

 *Mass ETCS/FRMCS retrofit/upgrade is foreseen to start no earlier then 2032, leaving a remaining timeframe of 4 years until foreseen GSM-R out of service*

 *GSM-R service stop by IM could be possible from mid 2032 onwards (IM notification period of 5 years starting earliest in 2027), leaving no time for mass retrofit/upgrade for the involved operators.*

ERA answer: Statement is noted, however the development of the ETCS-part can be done before the final FRMCS specifications are included. This time gain for ETCS B4 is not reflected in the analysis.

- ***Shorter FiC phase (for each vehicle type) for BL Light could lead to overall reduction in time needed for retrofit/upgrade of the fleet***

 *significance is related to the ratio of FiC per vehicle*

ERA answer: See detailed analysis in section 3.4.2.2, however the development of the ETCS-part might be delayed in case new specifications for the Baseline Light need to be developed. This time loss is not reflected in the analysis.

- ***No significant difference between solutions expected related to the time needed in the workshop***

 *It is assumed that most time in the workshop is needed for integrating the cables and mounting of the antennas*

 *Time needed for ETCS hardware change is considered not significant / time path critical during FRMCS integration*

ERA answer: Statement 'ETCS HW change' is noted. In the input from the CTO-analysis, it is indicated that ETCS SV3.0 will be implemented in case there is no ETCS HW change needed. Therefore, it is assumed that the request for Baseline Light is mainly linked to economic costs and less to time savings in general.

- ***Development of Adapter solution could – to a certain extent – be done in parallel with development of other solutions***

- *Adapter development could be mainly done by telecommunication experts with support of signaling experts*
- *BL Light development relies mainly on signaling experts*
- *However, no commitment by industry so far for Adapter*

ERA answer: statement is analysed as part of section 3.2.2.

#### *3.4.2.2. Analysis of input related to potential time savings for Baseline Light*

The CTO Council WG assumes that the re-certification and re-authorisation time of upgrading the ETCS-part for the Baseline 4 (up to SV3.0) compared to the Baseline Light is significantly longer due to scope extension for the ETCS-part. During the impact assessment, the CTO Council WG confirmed that Baseline 4 (up to SV3.0) is the preferred solution in case there would be no additional hardware required compared to Baseline Light solution. This would indicate that there is no time issue for the software upgrade and the action to identify and manage those CRs which cause a hardware impact are sufficient (see section 3.4.3 and recommendation 1).

In addition, in order that Baseline Light is a workable solution, following problem drivers are not considered in the proposal submitted by the CTO Council WG:

**Problem driver/answer 1 (non-implementation of error corrections resolved in B4R1 and B3R2):**

In case infrastructure managers would notify change requests for the implementation of certain error change requests according to the process defined in CCS TSI 2023/1695, the Baseline Light solution would not be acceptable on this network. Some of these errors have already been requested through NTRs, e.g. CRs 887,1170,1251,1252,1288,1306 on the Dutch network, CR 1335 on the French network, CR 1313 on the German network. It is expected to have this transparency for B4R1 errors by IMs in the first half of 2026 (6 months after the ETCS BCA-B4R1 report).

This issue is indirectly raised by the CTO Council WG if they refer to BL4 SV2.1 as option for further study which includes all error corrections: (see [Ref 4] - section 6 – Basic Design Principles – point 3): *'ETCS functionality is limited to functionality of the existing BL3 SV 2.0 or SV 2.1 vehicles, with BL4 SV 2.1 as an option for further study.'*

Note: The return of experience from vehicle authorisations has demonstrated that the partial implementation of the requirements within B3MR1 and B3R2 complexify the overall certification and authorisation process due to the multiple conditions and restrictions on use of the CCS subsystem and associated vehicle type. The time (and cost) linked to the analysis of conditions and restrictions for use can be reduced in case the ETCS On-Board IC is fully compliant to the ERTMS specifications (industrial approach). In such case, the NoBo assessment of a fully compliant Baseline 4 R1 On-Board product (up to SV3.0) and the authorisation done by the authorising entity requires less time and effort because the system is fully described in a specification document (which is not the case for the Baseline Light which could lead to a proprietary – thus non interoperable- behaviour) and in addition, it does not require the analysis of exported constraints and the analysis of mitigation measures. In addition, the ESC-tests linked to the checks if error corrections are implemented can be avoided.

**Problem driver/answer 2 (non-implementation of enhancements integrated in B4R1 (up to SV3.0)):**

In addition, the enhancement change requests (introduced in B4R1) which are linked to existing non legal NTRs (e.g. CR 1370, CR 1379) are fully specified and do not require additional checks by the DeBo or NSA.

It is acknowledged that these existing NTRs might already be implemented in some B3 products, however there could be new requests by Member States or IMs to mandate certain new functionalities (enhancements) which are part of the ETCS B4R1 (up to SV3.0). During the initial pre-assessment of change requests and the scope setting of change requests to be processed for the CCS TSI 2023/1695, input (see table 1 of ANNEX 2) has been provided to indicate which IMs have the intention to implement certain change requests. You will find in following table 1 some examples of enhancement change requests requested by specific IMs. The change requests which are marked in green are reported as change requests with high priority for which a solution is requested as soon as possible. As it was clear that there would be an ETCS software upgrade for FRMCS, it was considered useful to include these additional change requests within ETCS B4R1 (up to SV3.0) of the CCS TSI 2023/1695.

It is uncertain if enhancement CRs within ETCS B4R1 will lead to different Baseline Light product evolutions and lead to a fragmented approach where IMs or Member States will use national technical rules, access criteria or ESC-checks to enforce the implementation of these change requests, reported as high priority. In addition, there is an additional risk that the specification of the NTRs, access criteria or ESC-checks could differ from the initial change request solution within ETCS Baseline 4 (up to SV3.0) which would mean that the Baseline Light with the different rules lead to an uncoordinated intermediate step towards the ETCS Baseline 4 (up to SV3.0).

**Problem driver/answer 3 (partial fulfilment of Baseline 3 functionality):**

There is no transparency on the scope of Baseline Light as the clause of partial fulfilment within the CCS TSI 2016/919[6] could have been used. Therefore, the uncertainty of the scope of the Baseline Light solution might trigger additional ESC-checks by IMs to be performed on these Baseline Light products in order that the IM has certainty that specific change requests are not excluded through partial fulfilment.

In addition, the Baseline Light also refers to B3MR1 products which does not implement B3R2 functionality, e.g. online key management in B3R2. This online key management might become a critical functionality for trackside ETCS L2 implementers for operational reasons.

**Problem driver/answer 4 (implementation of specific customer requirements in addition to TSI requirements):**

Based on interviews with individual suppliers, there might also be a high effort to implement additional customer specific requirements. Suppliers prioritise the development of these customer specific requirements instead of providing a fully TSI compliant product usable for the complete EU-network). From a commercial point of view, this is a logical approach from the individual suppliers, however this customer specific requirements are a barrier towards a full industrial approach. During interviews with some individual

[6] 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

ETCS On-Board suppliers, it has been reported that there are no major concerns to upgrade Baseline 3 products to Baseline 4 products, however there are major concerns that these additional customer requirements on top of the CCS TSI requirements prevents an industrial approach.

### *3.4.3. Analysis of potential cost savings*

See reference [6] and recommendation 1.

During the impact assessment, the CTO Council WG confirmed that Baseline 4 (up to SV3.0) is the preferred solution in case there would be no additional hardware required compared to Baseline Light solution.

The action to identify the change requests and associated hardware upgrades required should be categorised by the ETCS On-Board suppliers as there is no real technical evidence so far that an upgrade towards Baseline Light would create hardware savings compared to an upgrade towards Baseline 4 (up to SV3.0).

In addition, some hardware upgrades might be an easy hardware upgrade, while other hardware upgrades might be more complex. Following potential hardware upgrades have so far been identified in relation to the hardware upgrade from Baseline 3 Release 2 towards Baseline 4 (up to SV3.0):

| **ETCS On-Board Hardware Upgrade** | **Cost impact** | **Associated CRs** |
|---|---|---|
| Additional connection and cabling incl. interface card to enable IP-interface for ATO and FRMCS | Medium/high impact.<br>Note: this impact is also relevant in case of Baseline Light solution. | CR1238 (ATO GoA1/2);<br>CR1359 (ETCS readiness for FRMCS); |
| Replacement of CPU-board to improve CPU-power capabilities | Low/medium impact for replacing of CPU-boards. | Not identified which Baseline 4 CRs could trigger a CPU-board upgrade. |

Note: The real prices (commercially driven) will in any case differ significantly from the fictive cost figures presented by the CTO Council WG. Therefore, it is advised to request legally binding contract prices before considering any derogation request. A generic derogation request can be considered if the inputs demonstrate that it would lead to many individual derogations for multiple Member States and for multiple ETCS-OB suppliers (e.g. generic derogation request to allow Baseline 3 with CR 1359 or generic derogation request to allow Baseline 4 up to SV2.1 with CR 1359). Such generic derogation request should implement all necessary conditions that the excluded CRs from Baseline 4 are not mandated through other means (e.g. NTRs, access criteria, ESC-checks).

### *3.4.4. Assessment of concept 1 'the adaptation of the ETCS-OB B3 enabling the FRMCS function into the vehicle'*

#### *3.4.4.1. Assessment of key messages from CTO Council WG related to Baseline Light*

The presentation from the request indicated following key messages from the CTO Council WG from reference [5]:

Key Message 1: *'To what extent costs and migration time can be reduced, will – among other factors – depend on the future certification regime for this solution which unlike BL4 SV3.0 does not affect the SIL4 core.'*

ERA answer from the legal assessment (see section 3.2): there is no such benefit. Both the alternative concept and the existing CR 1359 solution require a

- one-off software upgrade of the ETCS-part

- require the same hardware interface based on Ethernet

- require a re-certification and re-authorisation of the ETCS On-Board part.

Key Message 2: *'Baseline light is a low-risk solution with limited operational and trackside impact for which industry support can be expected. It is an intermediate step to SV3.y.'*

ERA answer: The statement of low-risk solution is not correct for the Baseline Light alternative (see section 3.2.1 and recommendation 2). In addition, the Baseline Light excludes change requests which have been requested by the sector (see problem-drivers 1, 2 and 3) and for which the CTO Council WG has not presented any coordinated migration plan.

Key Message 3: *'The detailed change requests for baseline light have not yet been written. First the regulatory framework must be agreed with ERA. However, the concept document provides a comprehensive basis for detailed change requests.'*

ERA answer: It is incorrect to state that first the regulatory framework must be agreed with ERA. There must be first a safe, reliable solution before considering it into the regulatory framework. The alternative concept as described in Ref [1] is rejected due to the negative operational consequences and low maturity (see section 3.2.1).

#### *3.4.4.2. Analysis of only implementing CR 1359 implementation in the Baseline 3 ETCS-OB*

The conclusion in section 3.2.1 from the Agency technical assessment states:

*'Therefore, the Agency rather considers the implementation of the CR1359 solution in the Baseline 3 ETCS-OB and recalls that a similar way forward has already been used in Switzerland, for the Limited Supervision functionality.'*

1. Consequence 1: Product suppliers, testing labs and NoBos require a comprehensive set of consolidated specifications.

In case product suppliers would try to develop a product based on Baseline 3 specifications and CR1359 without a formal consolidation of requirements, there will be many interpretations of individual requirements which could create a safety and interoperability risk. Without such consolidation of specifications, AsBos and NoBos will also not be able to assess the safety and interoperability correctly.

In case of B3MR1-specifications, the CR 1359 solution would not be sufficient as the IP-stack defined in B3R2 should also be added.

The development time for specifications and testing procedures for on-board specifications for B3 with CR 1359 is considered high. It is not as simple to indicate that B3MR1 and B3R2 specifications and the additional specifications from CR1359 can be easily consolidated into 2 new set of specifications. The potential collision of requirements between B3MR1 and B3R2 specifications and individual requirements within change request CR1359 will require a substantial analysis as such collisions in requirements/clauses have to be identified and -if detected- solved by newly developed requirements. This workload to define a comprehensive set of requirements will create an additional time loss to start developing ETCS OB-products for FRMCS roll-out. The return of experience with SUBSET-153 and its impact on the testing specifications (SUBSET-076) is an example of this substantial workload which is needed to avoid future misinterpretation of colliding requirements.

It is also not clear if these specifications should be maintained in case of future error corrections.

2. Consequence 2: Risk of different Baseline 3 products per area of use.

Although it might be technically feasible to implement CR1359 only on top of the B3MR1 or B3R2 ETCS-OB and to develop a set of specifications for this (taking into account the substantial workload described above), there is no certainty at all that this will be a workable set of specifications (see problem-drivers elaborated in section 3.4.2.2).

This is indirectly confirmed by the statement from the CTO Council WG that *'ETCS functionality is limited to functionality of the existing BL3 SV 2.0 or SV 2.1 vehicles, with BL4 SV 2.1 as an option for further study'*. Even in case BL4 (up to SV2.1) with CR 1359 would be considered as an option, the delta between BL4 (up to SV2.1) with CR1359 and BL4 (up to SV3.0) is limited to a restricted set of enhancement CRs, of which there are only some major CRs (CR 1238: ETCS ready for ATO; CR 1367: ETCS ready for DAC 'Cab Anywhere Supervision'; CR 1344 'Improvement of conversion model') for which the creation of a separate Baseline (set of specifications) and product market segment is not justified in the analysis.

3. Conclusion

Although the technical alternative to Baseline Light of only implementing the CR1359 solution on top of B3MR1/B3R2 is a technical workable solution, the associated consequences raise considerable concerns that this will be an inefficient (see consequence 1) and a not effective (see consequence 2) policy and migration solution. Therefore, the policy and migration objective of having ETCS On-Board products usable for the EU-market and not tailor made to individual national needs should remain the target. The transition framework to phase out 'partial fulfilment' is considered sufficient to develop fully TSI compliant products.

#### *3.4.4.3. Other recommendations for steering an EU industrial approach*

It is recommended to steer for an EU-wide industrial approach in particular in case EU-funding is granted. Therefore, following action is recommended for future efficient use of EU-funding of ETCS On-Board products used within vehicle projects.

EU-funding for the upgrade of the ETCS On-Board part could be considered towards a fully compliant ETCS B4 (up to SV3.0) usable as generic IC-type for all vehicle types. The output of this action should be a fully

compliant ETCS On-Board IC usable on the EU-market and should avoid multiple variants tailored to the area of use (incl. additional customer requirements as indicated in problem-driver 4, or deviations/partial fulfilment as indicated in problem-driver 1, 2 and 3).

As such, potential EU-funding for upgrades of the ETCS On-Board Baseline 3 product into a vehicle type towards ETCS On-Board Baseline 4 (up to SV3.0) should not be used for implementation of additional customer specific requirements or for corrections done due to previous deviations or due to the previous use of partial fulfilment. This should avoid the re-funding of prototype costs for the ETCS On-Board part within different vehicle projects where ETCS has already been integrated into the vehicle.

## 4. The Agency's opinion (Executive Summary and recommendations)

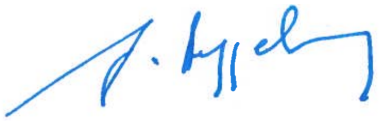
The Agency's opinion on the topic requested by the Commission is included in the following table, which contains the analysis linked to the technical, legal and migration stream and represents the conclusions of the proposals issued by the CTO Council WG:

| Number | Opinion – recommended actions |
|---|---|
| 1 | The light impact assessment concludes that:<br><br>*The most efficient option based on the provided economic data by the railway sector is Baseline Light if a hardware impact can be avoided and that there are no additional future mandatory on-board migration cycles to implement the not implemented Baseline 4 only software related change requests.*<br><br>Recommendation from the impact assessment (further considerations):<br><br>*As an alternative to the Baseline Light option, the specification of Baseline 4 could be kept, however the critical change requests identified within BL4SV3.0 triggering a hardware upgrade shall be identified.*<br>*Once identified, these can be handled as:*<br>- *Generic cases applicable to all B3 products: items to be listed in the CCS TSI Appendix G for which partial fulfilment is allowed until 28th September 2030 in case of upgrading an existing ETCS part (similar example as done for DMI HW upgrade).*<br>- *Product specific cases: in case the potential HW-impact is only linked to specific suppliers/products, it might be preferable to manage these product specific limitations with derogation requests (through economic viability) instead of providing generic deviations within Appendix G.*<br>Note: see detailed analysis in Annex 3 (light impact assessment).<br><br>**Action 1 (UNISIG/CCS TSI 2027)**: UNISIG shall provide an in-depth analysis which change requests -which are part of Baseline 4 (up to SV3.0)- cause a potential hardware upgrade and what are the associated costs related to the hardware upgrade (see detailed categorisation of hardware upgrades in section 3.4.3).<br><br>Note: the real prices (commercially driven) will in any case differ from the cost figures presented by the CTO Council WG. Therefore, it is advised to request legally binding contract prices before considering any specific or generic derogation request. |
| 2 | Technical stream on developing an adaptation of the ETCS-OB B3 enabling the FRMCS function into the vehicle:<br><br>Based on the preliminary assessment, this low maturity of the Baseline Light concept should be definitively disqualified due to its negative safety related and operational consequences. This disqualification stands not only for the future CCS TSI framework but also for any proprietary solution that would be submitted in the frame of the Vehicle Authorisation process.<br><br>Note: see detailed analysis in section 3.2.1. |

| Number | Opinion – recommended actions |
|---|---|
| 3 | Technical stream on Adapter concept: this concept should be definitively disqualified not only due to its low maturity, technical complexity and high risks, but especially due to its negative safety related and operational consequences. This disqualification stands not only for the future CCS TSI framework but also for any proprietary solution that would be submitted in the frame of the Vehicle Authorisation<br><br>Note: see detailed analysis in section 3.2.2. |
| 4 | Technical & Migration stream on FRMCS (5G+2G) concept: this concept is not supported by the railway industry and sector. If an individual IM develops this solution on voluntary base as add-on to FRMCS 5G, this does not require any modification to the CCS TSI 2023/1695 framework.<br><br>Note: see section 3.2.3 and Annex 1. |
| 5 | Legal stream (limit certification and authorisation time and cost):<br><br>The CTO Council WG statements/proposals are analysed in section 3.3, however these proposals are not considered compliant within the framework of the Safety and Interoperability Directive.<br><br>The Agency has positive feedback on the reduction of certification and authorisation time and costs by the issuing of guidance by the ERTMS system authority on the CCS TSI compliance of ETCS products. Such action should be further evaluated by the sector including its impact on the resources.<br><br>**Action 2:** evaluate the activity of extending the 'guidance issued by the ERTMS system authority on CCS TSI compliance of ETCS-products' in case of FRMCS roll-out.<br><br>Note: see detailed analysis in section 3.3.4. |
| 6 | Policy and Migration stream:<br><br>Although the technical alternative to Baseline Light of only implementing the CR1359 solution on top of B3MR1 or B3R2 is technically a workable solution, the associated consequences (see section 3.4.4.2) raises considerable concerns that this will be an inefficient (see consequence 1 on specification workload and time loss) and not effective (see consequence 2 on fragmentation of individual change requests) policy and migration solution, and as such should be disqualified to be incorporated in the CCS TSI framework.<br><br>Note: see detailed analysis in section 3.4.4.<br><br>In order to avoid fragmentation it is recommended to steer for an EU-wide industrial approach to preserve investments in SV2.0 and SV2.1 based solutions (SV2.0 onboard systems would in addition need an upgrade with an IP stack). |

| Number | Opinion – recommended actions |
|---|---|
| | If the inputs demonstrate that a solution based on Baseline 3 (SV2.0 and SV2.1) with CR 1359 would lead to many individual derogations for multiple Member States and for multiple ETCS-OB suppliers, a generic derogation request should be considered. Such generic derogation request should implement all necessary conditions that the excluded CRs from Baseline 4 are not mandated through other means (e.g. NTRs, access criteria, ESC-checks). |

Valenciennes,



Digitally signed by:
JOSEF DOPPELBAUER (EUROPEAN UNION AGENCY FOR RAILWAYS (ERA))
Date: 2024-10-15 05:54:03 UTC

Josef DOPPELBAUER
Executive Director

**ANNEX 1**

# FRMCS Migration: prolongation of GSM-R lifecycle

## *Questionnaire to Infrastructure Managers and Industry for consultation*

### 1. Introduction for the questionnaire

In anticipation of GSM-R obsolescence, a new radio class A system (FRMCS) is being defined and will be deployed in Europe as a successor to GSM-R. In CCS TSI 2023 update, FRMCS was partially introduced in the new ERTMS Baseline 4, defining the OBapp interface between ETCS/ATO and FRMCS. This interface is preparing the future evolution of the railway telecommunication system by defining an IP interface between signalling and telecom layers, allowing for the separation of signalling applications (ETCS/ATO) from the underlying telecommunication layer (FRMCS, in a first step based on 5G technology). With this new interface, it will be possible to modify the telecom layer (e.g. 6G, satellite as new components in FRMCS) without the need to update the signalling layer.

The implementation of that interface requires however an upgrade of ETCS-OB to Baseline 4 and this is raising concerns from railway stakeholders currently implementing ETCS-OB Baseline 3: tight schedule for retrofit of several thousands of vehicles (ETCS-OB upgrade + OB-FRMCS equipment installation), availability of products, sunk costs. A working group sponsored by the CTO of several European Railway Undertakings and Infrastructure Managers is working on alternative scenario enabling the support of the OBapp interface on pre-Baseline 4 ETCS-OB to be able to communicate over FRMCS. ERA has been tasked by the European Commission to deliver an Opinion on this alternative scenario.

Another concept, not yet considered by CTO WG nor by ERA, would be to focus on trackside equipment to avoid the need for ETCS-OB upgrade. This concept would require prolonging GSM-R trackside availability until all ETCS-OB Baseline 3 vehicles are naturally upgraded, e.g. maintaining GSM-R trackside until 2040-2045. In this scenario, there would be no need to upgrade ETCS-OB to Baseline 4, as normal GSM-R service would be kept. However, as some vehicles would possibly migrate to FRMCS earlier, GSM-R and FRMCS would need to be deployed in parallel for a longer period of coexistence (option 1). A variant of that concept would be to consider, whenever GSM-R trackside is due to renewal, the installation of a dual-system trackside (option 2), i.e. Multi Standard Radio equipment capable of emitting at the same time GSM-R and FRMCS radio signal.

In order to assess this concept (option 1 and 2), ERA would like to understand your perception as Infrastructure Manager and Industry on the GSM-R lifecycle prolongation possibility and its dual-system trackside variant.

## 2. Questionnaire and summary of answers received from Infrastructure Managers

*1. What is the timeline for FRMCS migration in your network?*

Responding IM considers the target of 2035 for completing a nationwide FRMCS rollout.

*2. Provided the rationale for this migration is GSM-R obsolescence, what is the expected end of life support of your GSM-R trackside equipment and/or target date for GSM-R decommissioning?*

IM take into consideration both the announced GSM-R end of life by Industry (ie. no further support after 2035) and their target to have FRMSC rollout completed in 2035: GSM-R trackside decommissioning should occur closely to FRMCS availability (although GSM-R operation on some lines beyond 2035 could be considered, reusing GSM-R spare parts from decommissioning).

IM highlight the risk of GSM-R expertise vanishing, impacting the availability of good GSM-R services after 2030 and consequently having negative effect on overall availability of railway operations.

*3. Have you considered the prolongation of this trackside equipment (option 1), and what was the feedback from your vendor(s)?*

The assumption that GSM-R may be supported longer is not seen as a reasonable option for IM (e.g. obsolescence risk being too high). Some IM managed to get GSM-R extension of support up to 2035, others only until 2030, at significant costs and with reduced visibility on service level agreements.

*4. What is your opinion on the feasibility to develop and to implement a dual-system trackside (option 2: GSM-R + FRMCS) based on Multi Standard Radio Base Stations?*

IM consider the development of a dual-system trackside as unrealistic. Main issues highlighted are the coexistence between the two systems, increased complexity of operation, possible negative effects on re-authorisation of GSM-R system when deploying new assets, questions on strategy to reinvest in 2G assets in case of Multi Standard Radio Base Stations.

IM assume that such Base Stations would require a significant railway specific development effort contradicting the design goals of FRMCS, and have serious doubts having finding a supplier ecosystem capable to deliver such a solution.

*5. Provided that complete specifications for dual-system trackside (option 2) would be available, do you consider there would be a benefit for your organisation?*

IM do not see any direct benefits in this option: having to roll-out a dual-system would create high risks of impact on legacy railway operations, while option 1 leaves some degree for not impacting existing GSM-R deployment and operations.

IM also criticised the assumption that complete specifications for dual-system trackside could be finalised any time soon.

*6. Do you see specific challenges in having a longer coexistence period for GSM-R and FRMCS?*

Irrelevant of option 1 or 2, the challenges to extend parallel GSM-R/FRMCS operation beyond 2035 are numerous: 2G technology obsolescence, economic aspects, operational issues, technical limitation in coexistence (e.g. spectrum sharing between GSM-R and FRMCS).

The scenario of a longer GSM-R/FRMCS coexistence period is seen as a major drawback from both technical and financial aspects, especially as IM don't believe that GSM-R lifecycle can be extended after 2035 for economic and expertise aspects. IM would prefer to see a short coexistence period.

*7. Do you have economic evaluation about keeping the GSM-R network operational for each additional year in parallel to FRMCS implementation (option 1)? (e.g. yearly maintenance)*

IM reminds that GSM-R costs are mainly for maintenance and support: those costs contribute significantly to the below estimation in comparison to installation costs.

Extrapolation from initial propositions received from supplier considers a double-digit MEUR amount per system and year for a mid-size EU country equipped supporting ETCS Level 2. Those costs would very likely increase over time while extending GSM-R support.

*8. Do you have economic evaluation concerning the relative cost increase of a dual-system trackside compared to a single system trackside (option 2 versus option 1)?*

As option 2 considers extending GSM-R lifecycle with new dual-system trackside equipment, additional costs for developing, procuring, testing and deploying those assets would need to be added to the maintenance costs detailed in answer 7 for. Option 2 is seen as more expensive than option 1.

*9. What is your opinion on the impact that dual-system trackside (option 2) would have on supplier's ecosystem?*

IM highlight several drawbacks: suppliers resources to develop dual-trackside equipment could prevent them from focusing on FRMCS development; misleading signal in direction of Railway Undertakings that FRMCS introduction on vehicles could be delayed; same misleading signal in direction of Industry that FRMCS deployment is not a priority; possible decrease of the suppliers ecosystem.

*10. Do you know if, at National level, a strategy for dialogue between your organisation and the Railway Undertakings is planned to anticipate the need for OB-FRMCS installation?*

IM are already in dialogue with Railway Undertakings to help them anticipate the upgrade and on-board installation of the FRMCS in their roadmap as soon as possible. Some EU countries have in addition a national sector coordination group (including railway regulator) to raise awareness on this matter.

## 3. Questionnaire and summary of answers received from Industry

*1. About GSM-R onboard equipment*

*a. Have you been requested by a customer to prolong GSM-R onboard equipment support, in particular the support to provide maintenance to existing vehicles already being equipped with GSM-R onboard equipment?*

*b. What is currently the furthest date to guarantee support to these existing vehicles?*

*c. What would be the expected economic impact in terms of additional investment and operational and maintenance costs for on-board?*

No answer received from UNITEL.

*2. About GSM-R onboard equipment*

*a. Have you been requested by a customer to prolong GSM-R trackside equipment support (option 1)?*

At least one GSM-R trackside equipment supplier has received requests to support already deployed GSM-R products beyond the milestone communicated by UNITEL.

*b. What is currently the furthest date to guarantee support to this equipment?*

UNITEL refers to their Statement document on "the railway telecommunications supply industry's long-term support of GSM-R"[7].

GSM-R products support is generally guaranteed until 2035. In some cases, at least one supplier agreed specific terms and conditions on a bilateral basis to extend the support date beyond 2035.

*c. What would be expected economic impact in terms of additional investment and operational and maintenance costs for trackside?*

Suppliers indicate that costs for maintaining GSM-R support would increase for several reasons: maintaining expertise on GSM-R, ensuring components supply (including 3rd party software), potential hardware stocking, securing ability to fix and install railway products. Suppliers add that providing in parallel FRMCS would require doubling the effort.

*3. What is your opinion on the feasibility to develop and to implement a dual-system trackside (option 2: GSM-R + FRMCS) based on Multi Standard Radio Base Stations?*

Scenario of dual-system trackside has been studied by at least one supplier. While technically feasible with significant cost and efforts, this scenario was facing a detrimental business case considering the volume of

[7] https://www.unife.org/wp-content/uploads/2021/07/UNITEL-Committee_GSM-R-Long-term-Support-Statement_v28072021Final.pdf

new Base Station expected. Consequently, no supplier indicates a plan on hardware renewal on GSM in general and on GSM-R radio in particular.

Suppliers highlighted in addition the potential further delay on FRMCS introduction if specifications for dual-system trackside assets need to be developed.

*4. Would a dual-system trackside (option 2)be comparable to the parallel use of two GSM-R and FRMCS systems, or would it have additional pros and cons?*

Several drawbacks for dual-system trackside assets are highlighted by suppliers: time-consuming validation and certification process for new products, longer than needed coexistence of GSM-R/FRMCS technologies, strategy question on re-investing in 2G technology for new trackside assets, potential new for adaption on GSM-R products along the evolution of FRMCS products, limitations in term of Base Station sites re-use.

Suppliers consider that parallel operation of legacy GSM-R and FRMCS is a preferrable scenario. Suppliers further recognise that dual-system trackside implies a single vendor strategy for both technologies, which might not be in the favour of all Infrastructure Managers.

*5. Provided there would be a railway market demand for a dual-system trackside (option 2), where would specifications for such a system be best defined (e.g. UIC and/or ETSI), and how long would this take?*

Suppliers are not in favour of defining new specifications for a dual-system trackside, but rather keep the two sets of specifications (EIRENE and FRMCS) and leave some flexibility for implementation in the products. Would some specific function be needed, ETSI should be considered.

Suppliers highlighted the fact that using Multi Standard Radio for RMR spectrum would require substantial effort in 3GPP for frequency bands introduction (MSR currently not applicable to RMR spectrum).

*6. What would be expected economic impact in terms of additional investment and operational and maintenance costs for trackside (option 2)?*

Suppliers foresee significant investments need and challenges for this scenario: increased costs for extended GSM-R lifecycle and for longer operational use of GSM-R and FRMCS, difficulty to secure expertise on both GSM-R and FRMCS at the same time, question on overall railway telecom business case, dual site deployment complexity.

*7. How do option 1 and 2 respectively impact trackside one-off investment costs and yearly operational/maintenance costs?*

Suppliers are globally in favour of option 1 as it has lower investment and operational/maintenance costs (e.g. . use of proven and established technology without the need for retesting/reapprovals), although acknowledging that option 1 costs would increase beyond 2030. This should be mitigated by a timely transition to FRMCS in the 2035 timeframe.

*8. Do you see specific challenges in having a longer coexistence period for GSM-R and FRMCS? Would a dual-system trackside (option 2) improve it?*

Suppliers believe that a longer coexistence period will drive higher operational cost on the supplier and infrastructure manager side (i.e. expertise, knowledge, resources). Related costs of development, validation, certification, deployment of dual-system trackside are too significant.

## ANNEX 2

1. Table 1: EUG input related to the priorities of the B4 enhancement change requests

**NOTE: This table is just one aspect of all the criteria which are necessary to decide if the CR should be included in the TSI 2022 or not.**
**The benefit which is shown in this table should be balanced against factors such as the workload and impact on specification.**
**All CRs in this list are supported by the EUG but the categories provide a more detailed view of the benefit for the individual members.**

| CR | Title | ProRail | Network Rail | SNCF | ADIF | DB | Infrabel | SBB | RFI | BDK | CFL | TRV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 968 | Session establishment failure | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 3 | 1 | 2 | 1 |
| 988 | Unsufficient specification regarding BMM | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 2 | 1 |
| 1238 | Automatic train operation over ETCS | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 3 | 3 | 3 | 1 |
| 1244 | PBD functional needs | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 |
| 1302 | SB feedback for multiple targets | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 1 |
| 1344 | Improvement of conversion model | 3 | 1 | 3 | 3 | 1 | 3 | 1 | 3 | 1 | 1 | 1 |
| 1346 | Radio remote control shunting under ETCS | 1 | 3 | 3 | 2 | 1 | 3 | 1 | 2 | 3 | 1 | 1 |
| 1350 | Always connected, always reporting | 1 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| 1357 | Eurobalise for three rail tracks | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| 1363 | Standstill report to trackside | 3 | 1 | 3 | 2 | 3 | 3 | 1 | 1 | 2 | 2 | 1 |
| 1367 | Cab anywhere supervision | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 3 | 1 | 2 | 3 |
| 1370 | Relocation without linking | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| 1373 | Balise metal free volume | 3 | 3 | 1 | 2 | 1 | 2 | 1 | 1 | 3 | | 3 |
| 1379 | Technical range check during data entry | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 1 | 1 | | 3 |

| Categorie | Explanation |
|---|---|
| 1 | High priority, will actively use, or benefit from, the solution asap |
| 2 | No current benefit |
| 3 | Not a high priority but useful |

Extract from source: Enhancement CRs EUG 26_05_2020.xls

**ANNEX 3**

# Light Impact Assessment

## Technical Opinion: ETCS-FRMCS compatibility

# *Contents*

## 1. Context and problem definition

### 1.1. Problem and problem drivers

The imminent obsolescence of GSM-R in the 2030-2035 timeframe requires the compatibility of ETCS and FRMCS onboard equipment. Mature FRMCS specification are expected to be released mid 2027 in the TSI. ETCS BL4 SV3.0 will ensure FRMCS compatibility. For fleets with earlier ETCS versions new investments are required and timewise feasibility is challenging (additional authorization process, product availability and resources shortages). It will require considerable investments and time, workshop capacity etc.

The aim of the TO is to propose technical solutions which reduce time and costs compared to an upgrade to ETCS BL4 SV3.0.

### 1.2. Evidence of the problem

After the adoption and entry into force of CCS TSI on 28 September 2023, the Commission has been informed by railway stakeholders that they face a challenge related to the upcoming integration of the new railway radio FRMCS (Future Mobile Railway Communication System) with existing vehicles already equipped with ETCS BL 3. Only BL4 SV3.0 of ETCS, as specified in the 2023 CCS TSI, seems compatible with FRMCS. Existing vehicles equipped with GSM-R and lower ETCS baselines would require complex and potentially expensive upgrading to FRMCS. There seem to be no CCS TSI provisions allowing for simple upgrades or out of the box compatibility of Baseline 3 ETCS equipment with FRMCS. According to several railway undertakings, notably the ones gathering in the Chief Technology Officers Council (represented by ÖBB, SBB, NS, DB, Network Rail and SNCF, supported on specific topics by UNIFE, UIC, EUG and CER), this situation creates a risk of considerable cost for upgrading recent vehicles that still have a significant expected economic lifetime. These railway undertakings started, therefore, technical discussions on potentially more affordable solutions deviating from the CCS TSI provisions currently in force.

For this reason, on 16-02-2024 the EC requested ERA to draft a technical opinion.

### 1.3. Baseline scenario

All vehicles need to be equipped with an ETCS onboard compliant to BL4 SV3.0 to support FRMCS. There are no other solutions to ensure support for FRMCS.

FRMCS is the successor of GSM-R and will be rolled out in Europe along the railway network until 2035 as GSM-R will be obsolete latest in 2035.

### 1.4. Main assumptions

Technical input as well as economic data were provided by UNIFE and the representatives of Chief Technology Officers Council to ERA via E-Mail from 06-06-2024 (see annex of this document):

<u>Technical alternative Solutions:</u>

Only one alternative solution, called BL (Baseline light) was identified as an option with acceptable, low implementation risks. Other potential technical solutions exist as well, such as an adapter solution for existing ETCS on-boards or a hybrid trackside communication solution offering support for FRMCS and GSM-R. However, they are not considered due to their high and unacceptable implementation risks.

Note: the Baseline Light in this impact assessment should be interpreted as the implementation of the existing CR1359 solution in the Baseline 3 ETCS-OB.

Concerned fleet data:

The impacted fleet in eight European Member States covers approx. 11.000 vehicles. Considering a conservative ratio of 1 type per 100 vehicles, this results in 110 different vehicle types.

For 10% - 20% of this vehicle fleet, the upgrade to BL4SV3.0 is the only feasible option, this fleet is therefore out of scope of the impact assessment.

Economic data:

The economic cost impact was expressed as differential cost impact for the option compared to the baseline scenario. For this reason, there is no data available for the cost impact of the option as well as for the BL. However, this is not needed for an impact assessment to identify the most economic option.

A) Concerning one-off impact:

The concerned fleet is equipped with ETCS on-boards, manufactured by 2 different suppliers. Each supplier has 2 different ETCS on-board product types. (see annex, presentation slide 2, k=n=2)

The additional one-off costs, to make the existing product types compliant to the “BL” option, 0,6 MEUR per type. This results in a one-off cost impact of 2*2*0,6 MEUR = 2,4 MEUR for the complete railway industry.

These costs mainly cover the re-certification of the existing product types (ICs).

B) Concerning Savings of option BL per vehicle type (compared to Baseline Option)

It is assumed that a hardware upgrade is required in most cases (80%-90%) if an existing B3 ETCS on-board is upgraded to BL4SV3.

The savings of the option “BL” mainly depend on the fact if a hardware upgrade of the existing ETCS on-board is not necessary for the upgrade to the BL option. This is assumed for 60-70% of the vehicle fleet. The savings are estimated with 3.5 MEUR per vehicle type. The savings result from less efforts for the engineering and integration of ETCS into the vehicle type as well as the re-certification of the ETCS subsystem in each vehicle type.

If the upgrade of an existing ETCS on-board system to the option BL would require a hardware upgrade as well, the savings are much lower and estimated with 0.6 MEUR. This can be considered as a worst-case. It is more likely that in such cases, the cost difference would be marginal and an upgrade to BL4 SV3 would be chosen. However, this is only for 10-20% of the vehicle fleet assumed.

C) Concerning Savings of option BL per vehicle (compared to Baseline Option)

Savings are only applicable in case a HW upgrade of the existing ETCS on-board can be avoided. They are estimated with 0.05 MEUR per vehicle and only applicable for 60% – 70% of the vehicle fleet. The savings result from reduced commissioning and documentation efforts.

### 1.5. Stakeholders affected

| | | | |
|---|---|---|---|
| Railway undertakings (RU) | ☒ | Member States (MS) | ☐ |
| Infrastructure managers (IM) | ☒ | Third Countries | ☐ |
| Manufacturers | ☒ | National safety authorities (NSA) | ☒ |
| Keepers | ☒ | European Commission (EC) | ☐ |
| Entity Managing the Change (EMC) | ☐ | European Union Agency for Railways (ERA) | ☐ |
| Notified Bodies (NoBo)<br>Assessment Bodies (AsBo) | ☒ | Citizens living nearby railway tracks | ☐ |
| Associations | ☐ | Persons with reduced mobility (PRM) | ☐ |
| Shippers | ☐ | Passengers | ☐ |
| Ticket vendors | ☐ | Other (Please specify) … | ☐ |

Mainly, the manufacturers of existing ETCS on-systems as well as Railway Undertakings or the owner of the concerned ETCS equipped vehicles are concerned.

### 1.6. Subsidiarity and proportionality

The problem concerns specific provisions in the CCS TSI 2023. The proposed option to mitigate the problem requires changes within the CCS TSI 2023. For this reason, it requires EU action.

## 2. Objectives

### 2.1. Specific objectives

The imminent obsolescence of GSM-R in the 2030-2035 timeframe requires cost-efficient solutions to make existing ETCS equipped vehicle fleet compatible with FRMCS

## 3. Options

### 3.1. List of options

<Baseline Light (BL)>

The EUG/UNIFE has created the concept for a Baseline Light. This Baseline Light proposal is based on implementing only the change request necessary for FRMCS (i.e. CR 1359 revised) on the existing B3MR1 and B3R2 vehicles without considering any of the other change requests within the ETCS B4 envelope or alternatively not having implemented certain CRs from B3MR1 and B3R2 for which conditions and restrictions in use are applicable.

Note: the Baseline Light in this impact assessment should be interpreted as the implementation of the existing CR1359 solution in the Baseline 3 ETCS-OB.

# 4. Impacts of the options

## 4.1. Qualitative analysis

***Stakeholder assessment***

| *Option 0 (Baseline)* | | | |
|---|---|---|---|
| *Category of stakeholder* | *Impact type* | *Description* | *Overall Impact* |
| Railway Undertaking | Positive | Less diversity within the fleet of ETCS equipped vehicles with regards to compliance with ETCS system versions.<br>Train drivers profit from less mitigation measures linked to implemented error corrections in the on-board. | Rather negative |
| | Negative | Extensive costs to upgrade existing ETCS onboard systems. | |
| Manufacturers (ETCS on-board suppliers) | Positive | Less efforts with regards to implementation and support to future ETCS system versions | Rather positive |
| | Negative | Long migration cycle with regards to the upgrading of exiting ETCS equipped vehicles will require a longer support for existing products compliant with BL3 | |
| Infrastructure Managers | Positive | IMs profit from the implemented error correction CRs in BL4SV3.0 avoiding mitigation measures or exported constraints. | Neutral |
| | Negative | A delayed on-board migration to FRMCS might lead to limited operations on the railway network during trackside migration to FRMCS | |

| *Option Baseline Light* | | | |
|---|---|---|---|
| *Category of stakeholder* | *Impact type* | *Description* | *Overall Impact* |
| Railway Undertakings | Positive | Significant lower efforts to ensure that the existing ETCS equipped vehicles are compatible with FRMCS | Rather positive |
| | Negative | BL compliant vehicles will require a further specific upgrade to profit from specific features of ETCS SV3.0<br>Train drivers suffer from mitigation measures linked to non-implemented error corrections in the on-board. | |
| Infrastructure Managers | Positive | Smoother/faster on-board migration to FRMCS will allow a better usage of the railway network during trackside migration to FRMCS | Neutral |
| | Negative | IMs suffer from the non-implemented error correction CRs in BL4SV3.0 causing mitigation measures or exported constraints. | |
| Manufactures (ETCS on-board suppliers) | Positive | Faster upgrading of exiting ETCS equipped vehicles will require shorter support for existing products compliant with BL3 | Neutral |
| | Negative | One-Off efforts to make existing on-board products compliant with ETCS Baseline Light. | |

***Railway system assessment***

| | *Option 0 (baseline)* | *Option Baseline Light* |
|---|---|---|
| *Safety* | Not concerned | Not concerned |
| *Interoperability* | One single SV offers compatibility with FRMCS | Several SVs allow system compatibility with FRMCS |
| *Market access* | Not concerned | Not Concerned |
| *Competitiveness* | High costs to make existing ETCS fleet compatible with FRMCS can be considered a market barrier to FRMCS operated lines. | Reduced costs to make existing ETCS fleet compatible with FRMCS will remove such market barrier to FRMCS operated lines. |
| ***Effectiveness*** | Neutral | Rather high |

***Coherency assessment***

The coherence of an option vis-à-vis the wider legal framework, especially at EU level is assessed.

| | *Option 0 (baseline)* | *Option Baseline Light* |
|---|---|---|
| *Policy analysis* | | |
| ***Coherence*** | Neutral | Rather low |

A higher number of potential system versions allowing compatibility with FRMCS reduces the coherency of the European framework. In the current framework one dedicated system version (SV3.0) covers such compatibility, however it includes necessary additional error corrections and full ETCS functionality as well, which would not be reflected in the other system versions with FRMCS support.

## 4.2. Quantitative analysis

| *Category of stakeholder* | *Impact type* | *Option 0 (baseline)* | *Option Baseline Light* |
|---|---|---|---|
| Manufacturers | One Off Costs for Re-Certification of Products | 0 (Reference) | +2.4 MEUR |
| Railway Undertakings | One-Off Costs for all Vehicle Type | 0 (Reference) | -230 MEUR to -270 MEUR |
| | One Off Costs for all Vehicle | 0 (Reference) | -330 MEUR to -385 MEUR |
| Overall | | 0 (Reference) | -557 MEUR to -652 MEUR |

## 5. Comparison of options and preferred option

### 5.1. Preferred option(s)

The most efficient option based on the provided economic data by the railway sector is Baseline Light if a hardware impact can be avoided and that there is no future mandatory on-board migration cycle to implement the not implemented B4 'only SW related CRs.

### 5.3. Risk assessment

*Non-identified CRs triggering a hardware upgrade*

The positive impact for the option Baseline Light results from the assumption, that a majority of ETCS equipped vehicle would require a hardware upgrade to be compliant with BL4SV3.0 and compatible with FRMCS. However, no specific CR within BL4SV3.0 could be identified, triggering such hardware upgrade.

*Benefits of certain CRs inside BL4 SV3.0*

In this assessment, the benefits resulting from certain CRs inside BL4 SV3.0 and not-implemented BL3 CRs (in case partial fulfilment is applied) are not taken into account, as they are not in the scope of FRMCS. Railway Undertakings and Infrastructure Managers would profit from these benefits.

*Non-substantiated cost assessment of a OBU hardware upgrade*

The main negative cost impact for the baseline scenario results from high-cost savings (3.5 MEUR per vehicle type) if a hardware upgrade of the existing B3 onboard system is required. This cost impact is not substantiated by the railway sector in detail and there is a risk that such assessment is too negative.

### 5.4. Further considerations

*HW upgrade vs SW upgrade*

As an alternative to the Baseline Light option, the specification of Baseline 4 could be kept, however the critical change requests identified within BL4SV3.0 triggering a hardware upgrade shall be identified.

Once identified, these can be handled as:

- Generic cases applicable to all B3 products: items to be listed in the CCS TSI Appendix G for which partial fulfilment is allowed until 28th September 2030 in case of upgrading an existing ETCS part (similar example as done for DMI HW upgrade).
- Product specific cases: in case the potential HW-impact is only linked to specific suppliers/products, it might be preferable to manage these product specific limitations with derogation requests (through economic viability) instead of providing generic deviations within Appendix G (i.e. derogation request limited to 4 cases, 2 ETCS On-Board suppliers both for their B3MR1 and B3R2 product).

*Development time and costs for B4 SV3.0*

The input provided by the railway sector indicates that B4 SV3.0 SW upgrade is not an issue for 10-20% of existing B3 vehicles and B4 SV3.0 SW upgrade would be implemented even if Baseline Light would be allowed. This indicates that following 2 considerations should be addressed in the follow-up analysis:

- the overall time for developing B4 (SV3.0) for an ETCS OBU IC is not the main problem-driver as this SW upgrade is possible for the ETCS OBU ICs integrated into 10-20% of existing vehicles
- in addition, the overall time to develop the CR 1359 solution as part of ETCS B4 (SV3.0) is not the main problem-driver, and as such the alternative solution CR 1359 is of minor importance in relation to the overall potential time or cost savings;

## 6. Monitoring and evaluation

### 6.1. Monitoring indicators

CRs in BL4SV3 triggering a hardware upgrade of existing ETCS on-boards.

### 6.2. Future evaluations

It might be relevant to revise this IA, if the content of BL4SV3 is modified lowering the upgrade requirements for existing ETCS onboards.

## 7. Sources and methodology

### 7.1. Sources

| | | | |
|---|---|---|---|
| Desk research | ☐ | Interviews | ☒ |
| ERA database | ☐ | Meetings | ☐ |
| External database | ☐ | Survey | ☐ |

Main source for economic data – see reference [6]. All economic data was provided by UNIFE via E-Mail and discussed in bilateral meetings between ERA, UNIFE and members of the CTO group.

### 7.2. Methodology (optional)

The cost impact was assessed based on the differential cost impact analysis proposed by UNIFE in ESG meeting.