CTO Extended Group Proposal

ETCS FRMCS Adapter D concept

Ref:	Adapter_D
Version:	0A
Date:	26/04/2024

Modification history

Version	Date	Modification / Description	Editor
0A	26-04-2024	Initial version	AB

Table of Contents

1 Introduction

1.1 Purpose

1.1.1.1 This document is a first draft of the CTO group proposal for the Adapter D solution according to the CTO council working group remit [1]. It is based on the EUG/UNISIG proposal for baseline light [8], as there are significant commonalities between these two approaches, with changes to [8] visible as revision marks. Since the group decided to propose only baseline light as an alternative to SV3.0, this document was not finalized. In some places the adapter D concepts are formulated, in other places text in “<>” brackets highlighted in yellow indicate that the text of [8] would have to be adapted based on further studies. If Adapter D is to be reconsidered, then this document may serve as a starting point but would have to be thoroughly revised.

1.1.1.2 The following prerequisites have been considered for the development of the Adapter D concept:

- No specific Adapter D related modifications in the ongoing development of the FRMCS specifications.
- No modifications to the safety part of the ETCS on-board, i.e. no modifications to the ETCS SRS [2].
- No modifications to the non-safety part of the Euroradio protocol [3].

1.1.1.2.1 Note: When the word “application” is used in this document, it refers to the ETCS application as defined in the SRS [2].

1.1.1.3 This document is not a full specification of the Adapter D 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). Further information on certain aspects of the adapter solution can also be found in [7].

1.1.1.4 These operational consequences will need to be evaluated by the involved stakeholders, together with other aspects, e.g. legal and migration.

1.1.1.5 If this evaluation leads to a positive result, the detailed specifications of the Adapter D solution will need to be prepared, based on this concept.

1.1.1.6 To facilitate this evaluation, the Adapter D concept is compared to a standard Baseline 3 (SV2.0 or SV2.1) on-board as well as to a TSI 2023 SV3.0 compliant on-board. The operational differences are highlighted in chapter 4.

1.2 Reference documents

[1] *CTO Council working group remit V1.0.*

[2] *ERTMS/ETCS Subset-026: System Requirements Specification 3.6.0.*

[3] *ERTMS/ETCS Subset-037 V320 Euroradio FIS.*

[4] *ERTMS/ETCS Subset-023: Glossary of Terms and Abbreviations 3.3.0.*

[5] *20E136-2- ETCS FRMCS principles.*

[6] *TOBA-7515: FRMCS Migration Variants for ETCS V1.2.*

[7] *CTO Solution Stream Technical Report V 1.0, April 25th, 2024.*

[8] *EUG / UNISIG Baseline Light Concept Document V 1.0, March 28th, 2024*

1.3 Abbreviations

Note: Abbreviations already defined in [4] are not repeated in this section.

CS	Circuit Switched
KM	Key Management
OBU	ETCS on-board unit
PS	Packet Switched
SoM	Start of Mission
TMT	Transmission Mode Table
TSE	ERTMS Trackside Entity (e.g. RBC, KMC, ATO trackside)
TS	Trackside

2 The Adapter D solution concept

2.1 Application context

2.1.1.1 The Adapter D solution adapts a Baseline 3 (SV2.1) ETCS on-board for fitment of FRMCS on-board equipment in parallel to the standard GSM-R on-board equipment (EDORs).

2.1.1.2 The Adapter D train is then able to run on the following lines:

- lines equipped only with GSM-R, where all RBCs are reachable via GSM-R,
- lines equipped with both GSM-R and FRMCS, where RBCs are reachable by GSM-R and/or FRMCS,
- lines equipped only with FRMCS, where all RBCs are reachable via FRMCS.

2.2 Concept description

2.2.1 ETCS Coordinating Function and Adapter Coordination Function

The selection of the communication system, GSM-R or FRMCS, to be used for a specific connection to an RBC, is performed in a two step approach by the ETCS Coordinating Function, which is an internal function in the Euroradio protocol, not known by the communication systems and the adapter coordination function. The functionality is described in the following clauses.

2.2.1.1 The ETCS Coordinating Function contains the Transmission Mode Table (TMT) for GSM-R. This table stores for every RBC the GSM-R telecom system(s) by which the on-board can contact this RBC. See Table 1 for details.

System	TMT	Description
GSM-R	unknown	It is yet unknown if the RBC can be reached by GSM-R
	CS	RBC can be reached by GSM-R CS
	PS	RBC can be reached by GSM-R PS and CS

Table 1 Transmission Mode Table in ETCS Coordination Function

2.2.1.2 The Adapter Coordinating Function contains the Transmission Mode Table (TMT) for FRMCS. This table stores for every RBC whether it can be reached by FRMCS. See Table 2 for details.

System	TMT	Description
FRMCS	No	RBC cannot be reached by FRMCS, or it is yet unknown
	Yes	RBC can be reached by FRMCS

Table 2 Transmission Mode Table in the Adapter

2.2.1.3 Note: Since adapter D “converts” (or rather conveys) only PS data to the FRMCS gateway, when an RBC can and should be reached by FRMCS, it must be made sure that the value “PS” is stored in the ETCS coordination function for this RBC. How this can be achieved is explained in [7].

2.2.1.4 The TMTs can be pre-configured at the time of implementation in the ETCS on-board and the adapter. If a new RBC is encountered during the lifetime of the on-board, the initial status of FRMCS will be set to "No" and GSM-R to "unknown" (also known as "empty table"). The Coordinating Functions will then attempt to reach the RBC according to the procedure described in the following clauses.

2.2.1.5 The order of preference by which the Coordinating Functions will try to contact an RBC, taking into account the status in the TMTs, is from high to low:

- FRMCS,
- GSM-R PS (GPRS),
- GSM-R CS.

If the adapter TMT has stored “FRMCS=No” for a given RBC, the Adapter Coordinating Function will establish the connection using GSM-R and will perform a parallel check to see if the RBC can be reached by FRMCS. If successful, the status in the adapter TMT will be updated accordingly and the next time the connection with this RBC will be established by FRMCS.

2.2.1.5.1 Note: This is relevant if the trackside communication system is upgraded to FRMCS, and the RBC is enabled for FRMCS.

2.2.1.5.2 Note: A similar check exists for the potential upgrade from GSM-R CS to PS, but that is already part of the B3R2 (SV2.1) specifications.

2.2.1.5.3 Note: A precondition is that the TMT of the ETCS coordinating function is set to “PS” for this RBC. See [7] on how to achieve this.

2.2.1.6 There shall be an automatic fallback from FRMCS to GSM-R if the FRMCS connection cannot be established. This will not affect the stored telecom system and the principle defined in 2.2.2.5 will bring the communication back to the stored system (FRMCS) as soon as it is available again.

2.2.1.7 The principle of the Coordinating Function is shown in Table 2.

2.2.1.7.1 Note: These Euroradio attempts take place within one application call.

Start conditions		**first attempt**			**if first attempt fails, second attempt**			**if first attempt works, Background check**		
Registration	**TMTs**	wait registration	call via	**TMT update**	wait registration	call via	**TMT update**	wait registration	call via	**TMT update**
FRMCS [4]	FRMCS=yes GSM-R=CS|PS	NA [1]	FRMCS	NA [2]	wait GSM-R	GSM-R	NA [2]	NA [3]	NA [3]	NA [3]
	FRMCS=yes GSM-R=unknown	NA [1]	FRMCS	NA [2]	wait GSM-R	GSM-R	GSM-R=CS|PS	NA [3]	NA [3]	NA [3]
	FRMCS=no GSM-R=CS|PS	wait GSM-R	GSM-R	NA [2]	NA [1]	FRMCS	FRMCS=yes	NA [1]	FRMCS	FRMCS=yes
	FRMCS=no GSM-R=unknown	NA [1]	FRMCS	FRMCS=yes	wait GSM-R	GSM-R	GSM-R=CS/PS	NA [3]	NA [3]	NA [3]
GSM-R [4]	FRMCS=yes GSM-R=CS|PS	wait FRMCS	FRMCS	NA [2]	NA [1]	GSM-R	NA [2]	NA [3]	NA [3]	NA [3]
	FRMCS=yes GSM-R=unknown	wait FRMCS	FRMCS	NA [2]	NA [1]	GSM-R	GSM-R=CS/PS	NA [3]	NA [3]	NA [3]

	FRMCS=no GSM-R=CS|PS	NA [1]	GSM-R	NA [2]	wait FRMCS	FRMCS	FRMCS=yes	wait FRMCS	FRMCS	FRMCS=yes
	FRMCS=no GSM-R=unknown	NA [1]	GSM-R	GSM-R=CS/PS	wait FRMCS	FRMCS	FRMCS=yes	wait FRMCS	FRMCS	FRMCS=yes

First attempt via GSM-R, second attempt via FRMCS (TMT update)

First attempt via FRMCS, second attempt via GSM-R (fall back)

Table 2 Principle of the Coordinating Function <for Baseline Light, to be reworked for the adapater D)>

[1] No waiting time, telecom system already registered.

[2] No change in the TMT (to standardise the procedure it may be overwritten with the existing value).

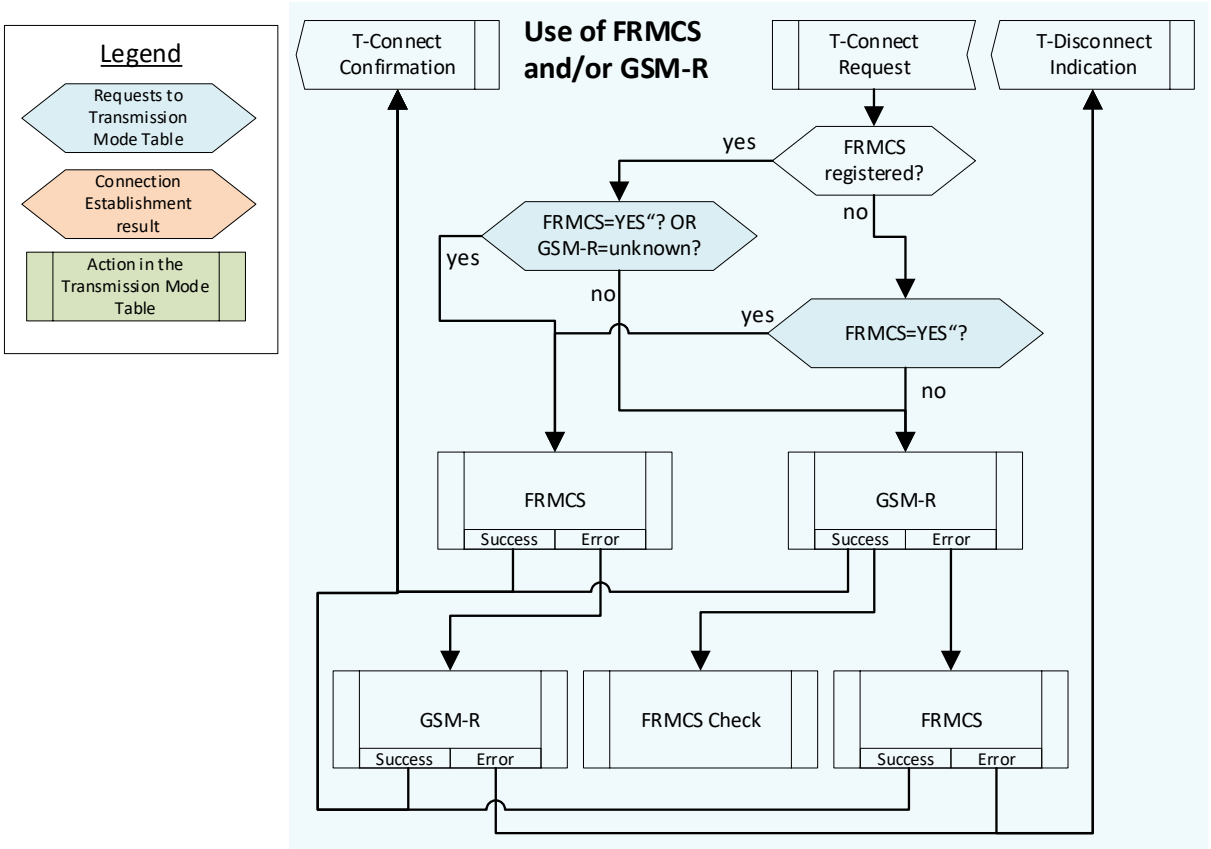
[3] First attempt successful via FRMCS, therefore background check not needed.

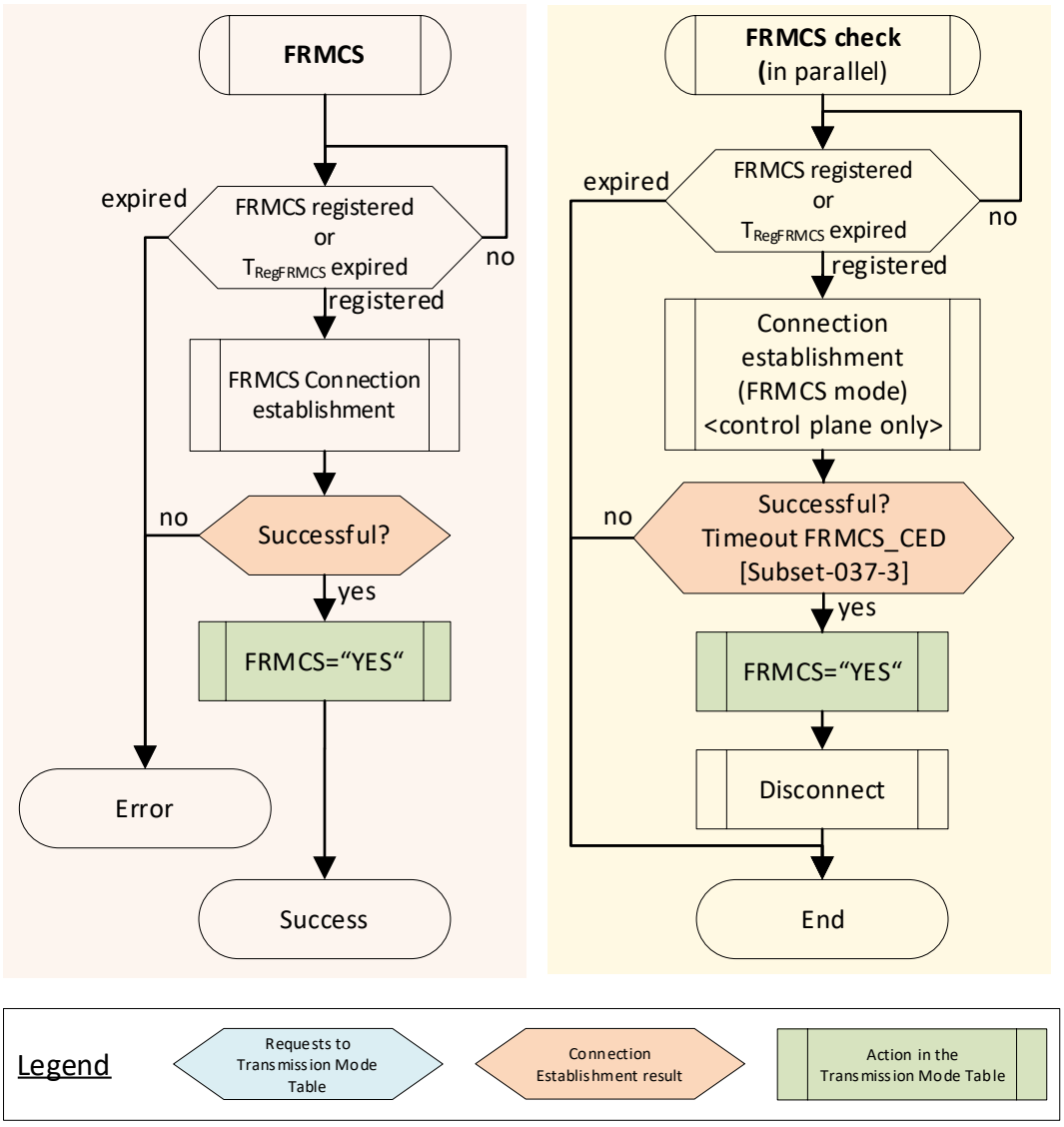
[4] This is the telecom system that was registered at the moment when the call was initiated by the application (first successfully registered system). The registration of the other telecom system may still come later.

< the table above from BL light will have to be checked in detail for applicability for adapter D, in particular relating to note 2.2.1.5.3. See also section on "*Making Sure Euroradio delivers PS Data to the Adapter when FRMCS Transport is to be Used"* in [7] and also what happens if GSM-R is unknown, cf also clause 2.2.5.5>

2.2.1.8 The Coordinating Function, including the fallback mechanism, is shown in Figure 1.

Note: Figure 1 is fully applicable to a SV2.1 Baseline Light on-board. <It will have to be redrawn for the adapter as noted below>




FRMCS
expired
FRMCS registered
or
T RegFRMCS expired
no
registered
FRMCS Connection
establishment
no
Successful?
yes
FRMCS="YES"
Error
Success
FRMCS check
(in parallel)
expired
FRMCS registered
or
T RegFRMCS expired
no
registered
Connection
establishment
(FRMCS mode)
<control plane only>
no
Successful?
Timeout FRMCS_CED
[Subset-037-3]
yes
FRMCS="YES"
Disconnect
End
Legend
Requests to
Transmission Mode
Table
Connection
Establishment result
Action in the
Transmission Mode Table

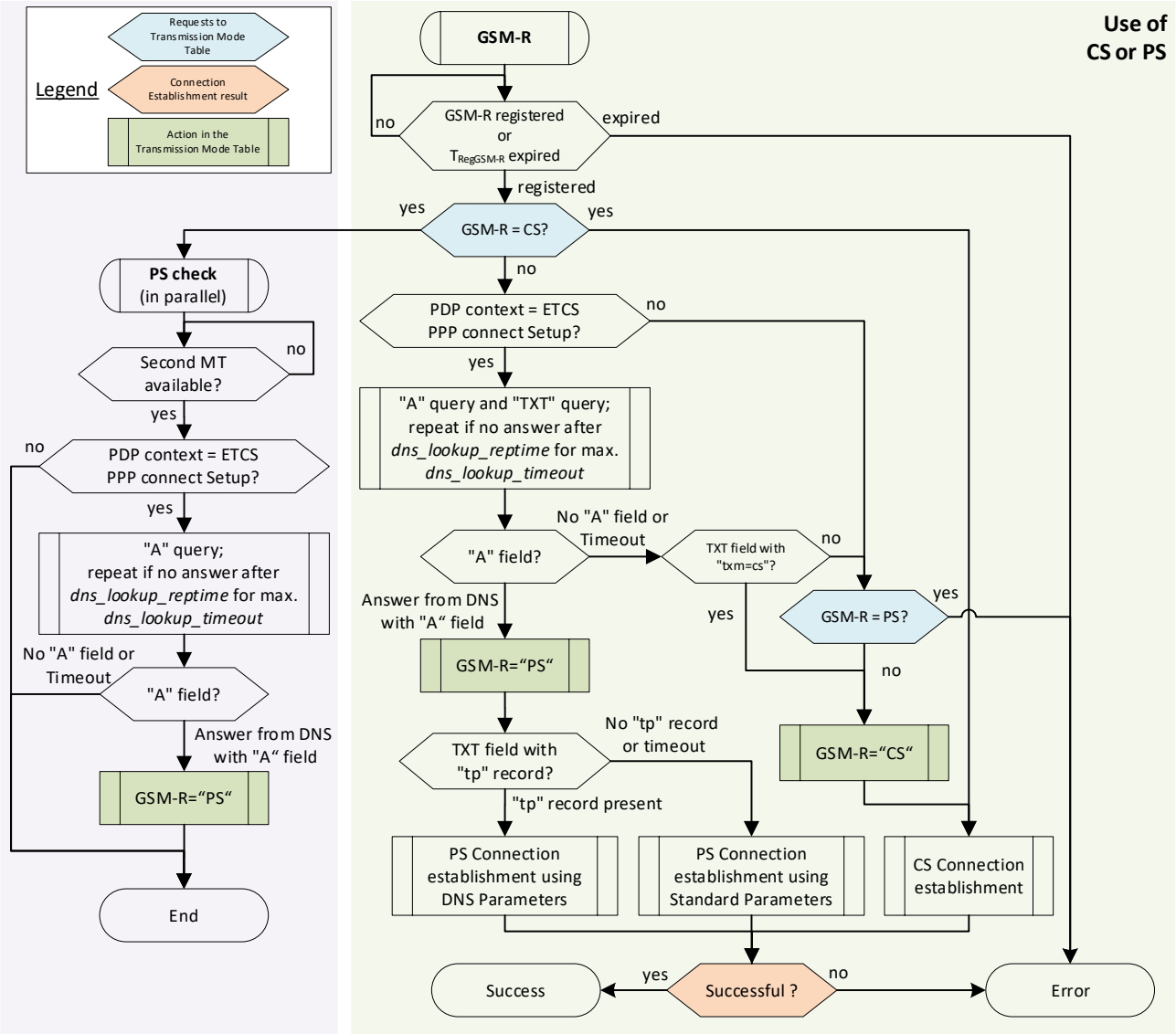


Figure 1 Coordinating Function

< Figure needs to be checked re applicability to adapter D. The first part would have to be adapted, attributing the various boxes to the right coordinating function, making sure that the adapter handles GSM-R fallback according to clause 3.2.1.11 and adapt further if necessary. The second part on FRMCS should in theory be the same and represents the adapter coordinating function. The third on GSM-R should also remain the same, since this depicts the situation of the ETCS coordinating function in an SV 2.1 vehicle which is not to be altered by basic adapter design principle. It has also to be checked whether the process that makes sure that the ETCS coordinating function is set to "PS" when FRMCS is to be used by the adapter needs to be explicitly drawn or can be implicitly derived.>

2.2.2 Telecom system availability

2.2.2.1 For a transition to ETCS level 2 it is required, according to [2] clause 5.10.2.4.1a, that at least one Mobile Terminal is in working condition, independently whether it is registered to a network or not.

2.2.2.2 In addition to the condition for GSM-R, the adapter on-board should also consider this condition for FRMCS. The onboard will be notified that at least one Mobile Terminal is in working condition when either a GSM-R EDOR or an FRMCS gateway is in working condition. For the level 2 entry scenario, two orders from trackside are relevant: the RBC contact order and the level transition order (announcement for further location).

2.2.2.3 There is no engineering requirement which defines the sequence of these orders. .

2.2.2.4 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 and adapter check if this system is in working condition. If that is the case, the condition in 5.10.2.4.1a is fulfilled.

2.2.2.5 If the level transition order comes first, the on-board has no knowledge of the right telecom system. However, as long as at least one GSM-R EDOR or an FRMCS gateway is in working condition, condition 5.10.2.4.1a is all the same fulfilled, since Euroradio will be told by the adapter that the necessary telecom system (GSM-R) is in working condition.

2.2.2.6

2.2.2.7 The operational consequences of this principle are explained in chapter 3.4.1.

2.2.3 Online Key Management

2.2.3.1 If the adapter on-board will have to support online key management via FRMCS, a specific adapter coordinating function for this purpose is needed, separately from the adapter Coordinating Function defined in 2.2.1.

2.2.4 Network registration during SoM

2.2.4.1 This section describes the adapter behaviour with respect to the network registration and the list of available networks. See [2] chapter 5.4 (SoM procedure), box D7, S3, S4.

When receiving a network registration order from the application, Euroradio will forward the order to the EDOR if it is a GSM-R network, but not to FRMCS if it is "FRMCS", because FRMCS registration will be automatic. <Note: it needs to be checked whether there is a case that Euroradio orders FRMCS when an adapter is installed as per clause 3.2.1.4.1. See also clause 2.2.4.3.>

When this registration order is received by Euroradio, it is not yet known which RBC will need to be contacted and therefore it is not known which radio system, GSM-R or FRMCS, is needed to contact the RBC.

In order not to penalise the performance by waiting for the registration of a not needed telecom system, the adapter will indicate successful registration as soon as one system, GSM-R or FRMCS, is registered (box D7/S4 in the SoM procedure). If FRMCS is registered, the adapter will fake a GSM-R registration.

2.2.4.2 When the application sends the RBC connection order to Euroradio (box A31 in the SoM procedure), Euroradio will check if, according to the TMT, GSM-R is registered (see Table 2 for the situation of an empty TMT). If that is the case, the connection order is forwarded via adapter to the right system. If it is not (yet) the case, the adapter waits for the registration of the right system. If that is successful, the connection order is forwarded to the right system. If the registration to the right system is not successful within a defined time (TregGSM-R or TregFRMCS), the connection order will not be forwarded to any

telecom system and the adapter will report via Euroradio a connection failure to the application. See chapter 2.2.1 for details of the Coordinating Function.

2.2.4.3 When requested by the application to provide the available networks (box S3 in the SoM procedure in [2]), Euroradio will provide the list of available GSM-R networks received from the EDOR plus FRMCS (if available), independent of the FRMCS registration. See [3] chapter 5.8 "Service primitives for Permitted Mobile Networks". <Note: it is assumed that an FRMCS network name can be delivered to Euroradio by the Adapter D via AT commands, so that the behavior of Adapter D would be very similar to Baseline Light. This would have to be checked in more detail. If not, an alternative workaround is required.>

2.2.4.3.1 Note: The inclusion of FRMCS in the list of available networks is a new feature in the Euroradio protocol of the adapter on-board. For the application it is just another network name, treated in the same way as the GSM-R networks. Therefore, no impact on the SIL4 part of the on-board. <As per above it is to be checked whether this works. If so, the wording might have to be adapted, since given that Euroradio is untouched with an adapter solution it cannot be “a new feature in the Euroradio protocol.”>

2.2.5 Network registration in a level 2 entry scenario

2.2.5.1 In [2] clause 3.5.6.7 stipulates that an order to contact the RBC shall be rejected by the on-board if no mobile terminal is duly registered to a radio network.

2.2.5.2 The expression "duly registered to a radio network" is not unambiguously clear. It could be interpreted by the supplier in two ways:

a) According to the expression "a radio network", registration to any radio network is sufficient to fulfil the condition,
b) According to the expression "duly registered", registration to the right network is needed to fulfil the condition.

2.2.5.3 In the entry scenario, the trackside will first send the registration order (to GSM-R) and, sufficient time later, the connection order to the RBC.

2.2.5.4 When the registration order is forwarded by the application to Euroradio, Euroradio will report the registered networks to the application.

2.2.5.5 The line may be fitted with FRMCS, and the ordered GSM-R network could have been removed. Assuming that FRMCS is indeed registered, the application will have to fake the existence of the requested GSM-R network towards the Euroradio which will then include the requested GSM-R network in the response to the application. Otherwise, the on-board would always reject the connection order on an FRMCS only line.

2.3 High-level Architecture

2.3.1 General

2.3.1.1 This chapter describes the high-level on-board architecture.

2.3.1.2 The description of the trackside architecture is out of scope for the adapter concept, which is only an on-board solution. Information on trackside architecture is provided in the principles document [5] which has been used as the basis for the overall development of ERTMS data applications over FRMCS.

2.3.2 Architecture of the OBU as chosen for the FRMCS evolution

2.3.2.1 The on-board architecture of the adapter concept conforms to the variant 1b described in the migration document [6]. See Figure 2 which is an enhanced version of the corresponding figure from [6].

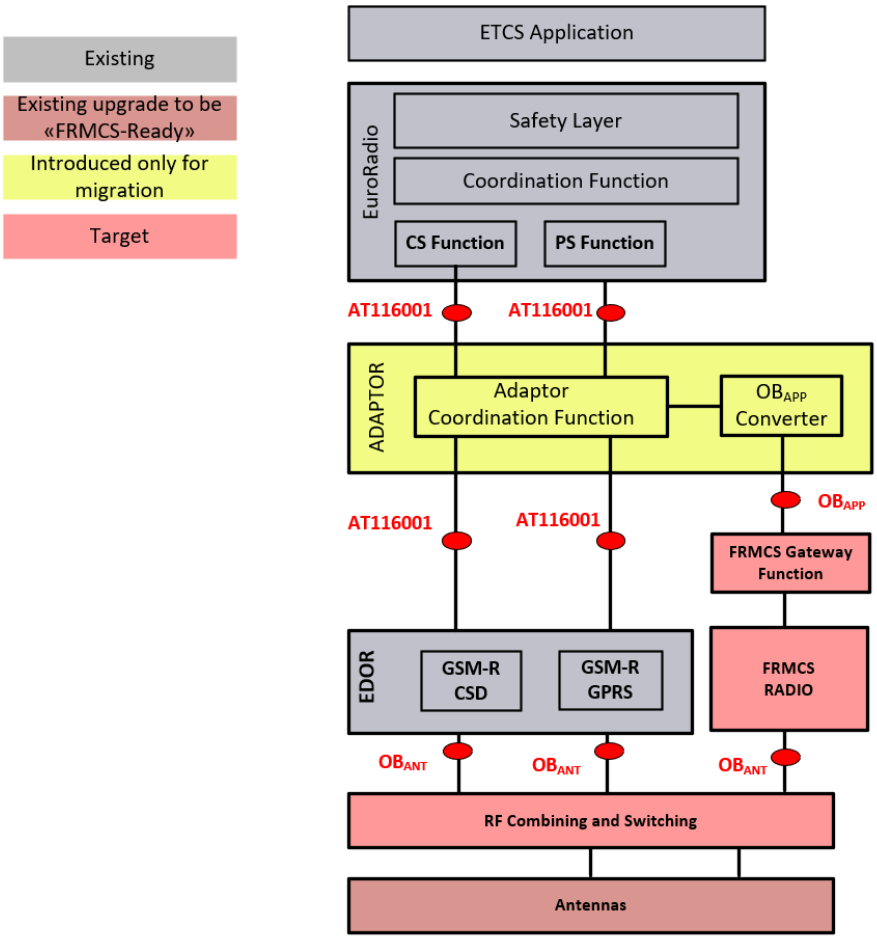


Figure 2 On-board logical architecture

2.3.2.2 A possible implementation of an adapter D would look as shown in Figure 3. For further details of the adapter coordination function with the extended DNS proxy refer to [7].

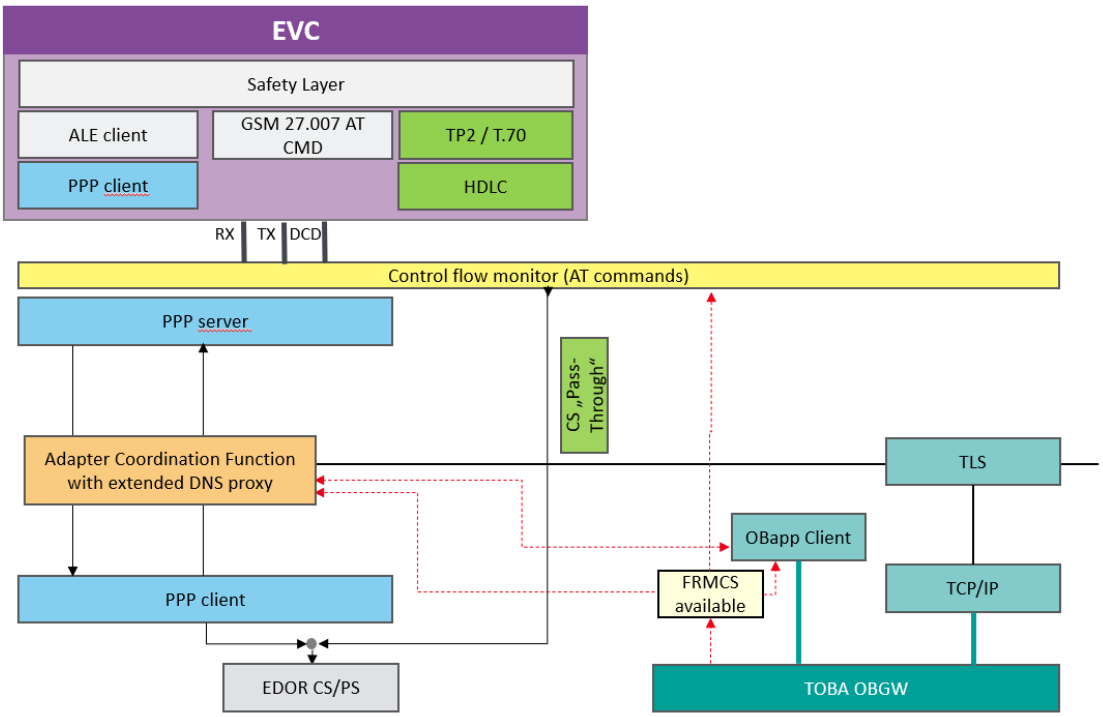


Figure 3: Possible Implementation of Adapter D

2.4 Error corrections

2.4.1.1 In the Baseline 4 specifications several shortcomings in Baseline 3 have been resolved. Some of these corrections, which are relevant for the radio communication via FRMCS, are also relevant for adapter on-board. It concerns the following CRs (list to be completed later on):

- CR 1415 - KMS protocol issue
- CR 1429 - Harmonisation of the FQDN
- ...?

3 Operational consequences

3.1 General

3.1.1.1 This chapter describes the operational consequences for a train which is fitted with the adapter D solution.

3.1.1.1.1 The main purpose of the adapter concept is to fit a (existing) Baseline 3 train with FRMCS. The focus of the operational analysis is therefore on situations where the behaviour would be different compared to the same (Baseline 3) train without the adapter solution, obviously only running on GSM-R lines. For completeness, the adapter solution is also compared with the Baseline 4 SV3.0 solution. See the table in chapter 4.

3.1.1.2 The possible trackside implementation variants on which the adapter on-board will have to run are listed in Table 2.

Nr	Radio Network	RBC	Remark
0	GSM-R	GSM-R	standard Baseline 3
1	GSM-R+FRMCS	GSM-R	Note 1
2	GSM-R+FRMCS	GSM-R+FRMCS	
3	FRMCS	GSM-R+FRMCS	Note 2
4	GSM-R+FRMCS	FRMCS	Note 2
5	FRMCS	FRMCS	

Table 3 Trackside implementations

3.1.1.2.1 Note 1: It is assumed that the RBC will only be connected to FRMCS when the line is fitted with a reliable (good coverage) FRMCS network, to avoid bad connections via FRMCS. Therefore, the combination "network GSM-R" and "RBC GSM-R+FRMCS" is not foreseen for normal operation. During the fitment of FRMCS network, it could be necessary to perform tests of the FRMCS connection. In that case the RBC could be connected to FRMCS during the test, e.g. at night, and disconnected again from FRMCS for normal operation.

3.1.1.2.2 Note 2: These are two variants to migrate from variant 2 to 5, depending on the migration plans of the IM and RU.

3.1.1.3 It is assumed that a trackside of ETCS system version X=2 can be fitted with FRMCS only. The GSM-R network should of course be removed only when all trains running in the relevant area are fitted with FRMCS. A GSM-R only train would not be able to contact the RBC in this area.

3.1.1.3.1 Defining the RBC in the FRMCS only area as X=3 would not give any technical benefit to prevent a GSM-R train from entering the area, because this train is anyway not able to contact the RBC.

3.1.1.3.2 Defining the RBC as X=3 would however prevent an FRMCS fitted X=2 train to enter the area. That is obviously not the intention of the adapter concept.

3.1.1.3.3 If the GSM-R network is removed from a line, the order to register to GSM-R network is still relevant. See chapter 2.2.5 for the reason and 3.4.2 for the operational consequence.

3.1.1.3.4 If an adapter train will be running only on lines where GSM-R has been removed, the EDORs could in principle be removed and the adapter ETCS on-board could be configured as "FRMCS only". The analysis of the operational consequences of such an implementation are not described in detail, but the results are indicated in the summary table in chapter 4.

3.1.1.4 The following operational scenarios have been analysed:

- Start of Mission, both with valid position and unknown position,
- Entry into ETCS level 2,
- Radio network handover.

3.1.1.4.1 Degraded situations, e.g. network unavailability, have been addressed in the analysis.

3.1.1.5 When the communication session with an RBC is established via FRMCS, the use of High Priority data is not possible. This is the same as for GSM-R PS (GPRS) because High Priority data is not supported in a PS communication session.

3.2 Start of Mission with valid position

3.2.1.1 This scenario is defined in [2] chapter 5.4 (SoM procedure) by the network registration in box D7, S4 and the session establishment in box A31.

3.2.1.2 For a SoM procedure after warm start (not after power-up) the network registration was already performed for a previous mission. In this case there is no impact for the adapter solution.

3.2.1.3 For a SoM procedure after power-up (with position confirmed by the Cold Movement Detector), there is in the application a maximum of 40 seconds foreseen for network registration (see [2] box S4 in the SoM procedure).

3.2.1.3.1 Note: When powered up, the ETCS and telecom on-board systems first need some time (e.g. for self-test) to get ready. This time is application dependent and is estimated at about 40s in this chapter. The 40 seconds registration time defined in [2] starts when the implementation dependent power up time has elapsed.

3.2.1.4 The ETCS on-board application will order the registration of the network which it has in memory from a previous mission. See [2] clause 3.5.6.2. This might be a GSM-R network or FRMCS. <For adapter D it has to be checked whether this will work, see also comments to clause 2.2.4.3.>

3.2.1.4.1 Note: A memorised FRMCS network can only come from a network entry by driver during a previous SoM procedure. The reason is that the trackside will never order the registration to FRMCS, because FRMCS registration is done automatically, not on order from ETCS. <Again provided that the solution according to clause 2.2.4.3. works also for the adapter. Otherwise, this has to be reviewed / changed.>

3.2.1.4.2 Note: If no radio network could have been memorised, the on-board will order the registration to a default network as defined in [2] chapter 3.5.6.

3.2.1.5 On reception of the registration order from the application, Euroradio and adapter will do the following:

a) Euroradio will order the registration to the EDORs via adapter for all ordered GSM-R networks.
b) Euroradio will start a GSM-R registration timer TregGSM-R of 40 seconds,
c) adapter will start a FRMCS registration timer TregFRMCS of 40 seconds.

3.2.1.5.1 The two registration timers are used in the Coordinating Functions. See Figure 1 for the details.

3.2.1.5.2 Note: The 40 seconds for the TregFRMCS is just an initial value. Can be adjusted when better knowledge about FRMCS registration will be available.

3.2.1.6 Note: If the application orders the registration to FRMCS, Euroradio will not order anything to FRMCS onboard, because FRMCS network will be registered automatically. <Unlike in Baseline Light Euroradio does not know anything about FRMCS but depending on the findings to clause 3.2.1.4 the application might order FRMCS. It will be checked wheter Euroradio conveys this to the adapter or there will be some other behavior.>

3.2.1.7 Note: When the registration order is received from the application, Euroradio does not know yet which RBC must be contacted but will always assume that the telecom system needed to connect to this RBC is GSM-R.

3.2.1.7.1 Note: The memorised network might not be the one needed to contact the RBC and not be available in the SoM area. See chapter 3.5.2 for an explanation how this could occur. It would not create an operational problem, because the network that is needed for the RBC will be available in the SoM area. See the scenario with one available network in 3.2.1.9 onwards. <Applicability of this statement needs to be checked for the adapter…>

3.2.1.8 If the application registration timer of 40 seconds expires without having received successful registration from the adapter or the Euroradio (neither GSM-R nor FRMCS registration was successful), the message "Radio network registration failed" will appear on the DMI. See [2] chapter 4.7.2 row Radio network registration. This is the same as today with GSM-R only. See Figure 3.

3.2.1.8.1 Note: A TSI 2023 compliant on-board would display two different messages: "FRMCS network registration failed" and "GSM-R network registration failed"

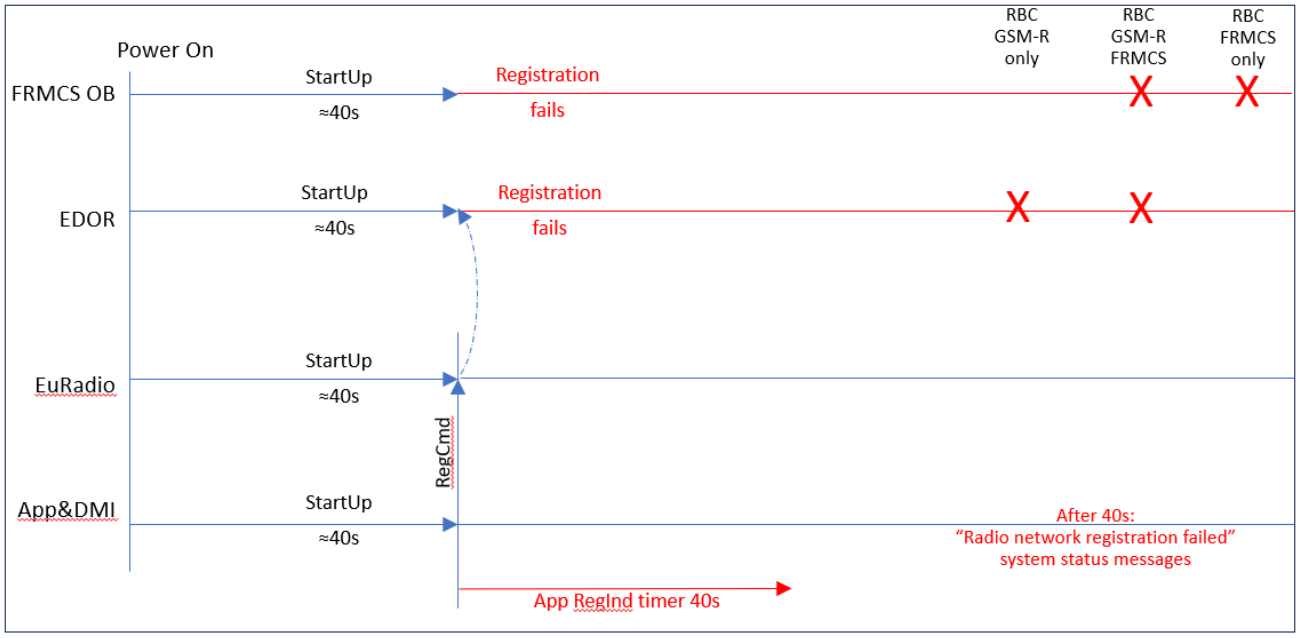


Figure 3 No GSM-R / No FRMCS available <An additional "adapter lane" should be added to the Figure>

3.2.1.9 As soon as the first system is successfully registered, Euroradio will confirm registration to the application. If this event occurs before the application registration timer has expired, the application will request a connection with the RBC ID which was stored from a previous mission. See [2] chapter 4.10 row "RBC ID/Phone Number" and chapter 4.11 column "RBC ID/Phone Number".

3.2.1.9.1 Note: if the first successfully registered is FRMCS, then the adapter will fake a successful GSM-R registration to Euroradio.

3.2.1.9.2 Note: There is a maximum of 3 attempts for the RBC connection. See [2] clause 3.5.3.7a.

3.2.1.9.3 For each connection attempt there is a maximum of 40 seconds available in Euroradio. See [3] section 7.3.2.3.

3.2.1.10 If, according to the Euroradio and the adapter TMT, the right network for this RBC was registered, the connection will be immediately set up. See the example in Figure 4 where the total time via FRMCS is 25 seconds (10 for registration and 15 for the connection) and via GSM-R it is 30 seconds (15 for registration and 15 for the connection).

3.2.1.10.1 Note: if the right network according to the adapter TMT is FRMCS, then the connection will only be immediately set up, if the right network according to the Euroradio TMT is GSM-R PS. <Text should be added to explain what happens in case Euroradio TMT is GSM-R CS based on explanations in [7]>

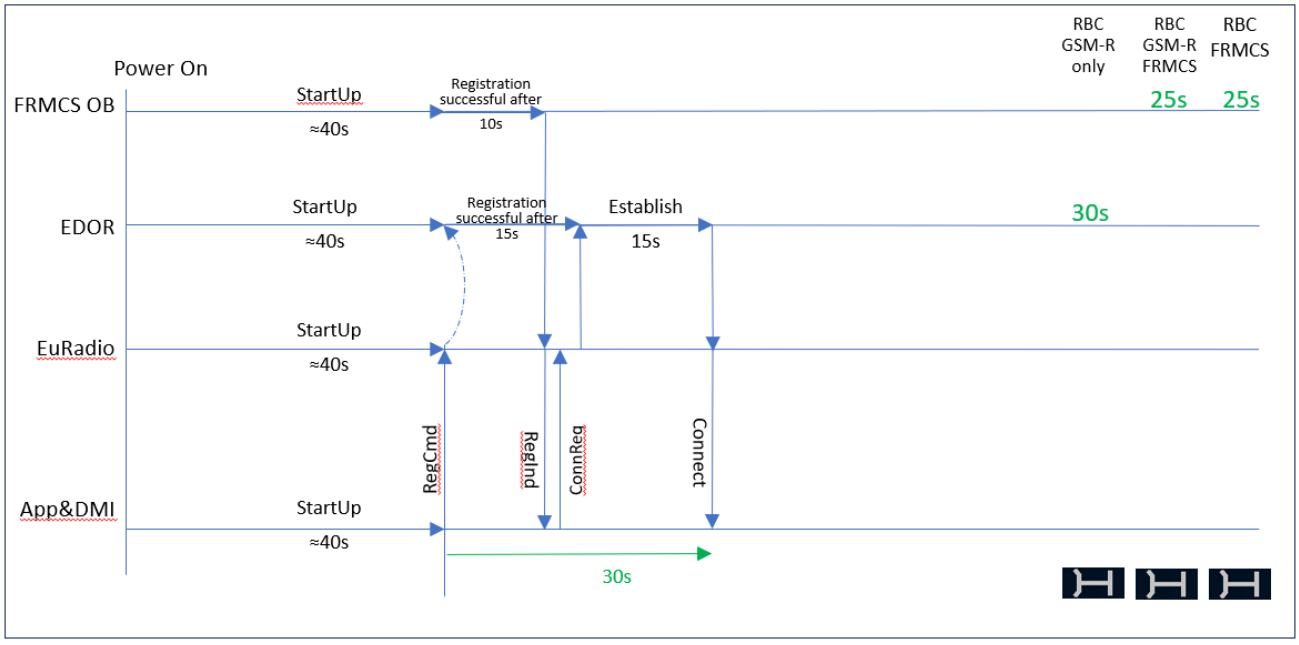


Figure 4 GSM-R / FRMCS available; normal scenario
<An additional "adapter lane" should be added to the Figure>

3.2.1.11 If, according to the adaptor TMT, the right network for this RBC was not (yet) registered, the adapter will wait until it is registered and then try to contact the RBC. **Operational consequence**: The first connection attempt might fail if there was substantial registration delay. In that case the second attempt will succeed. See Figure 5.

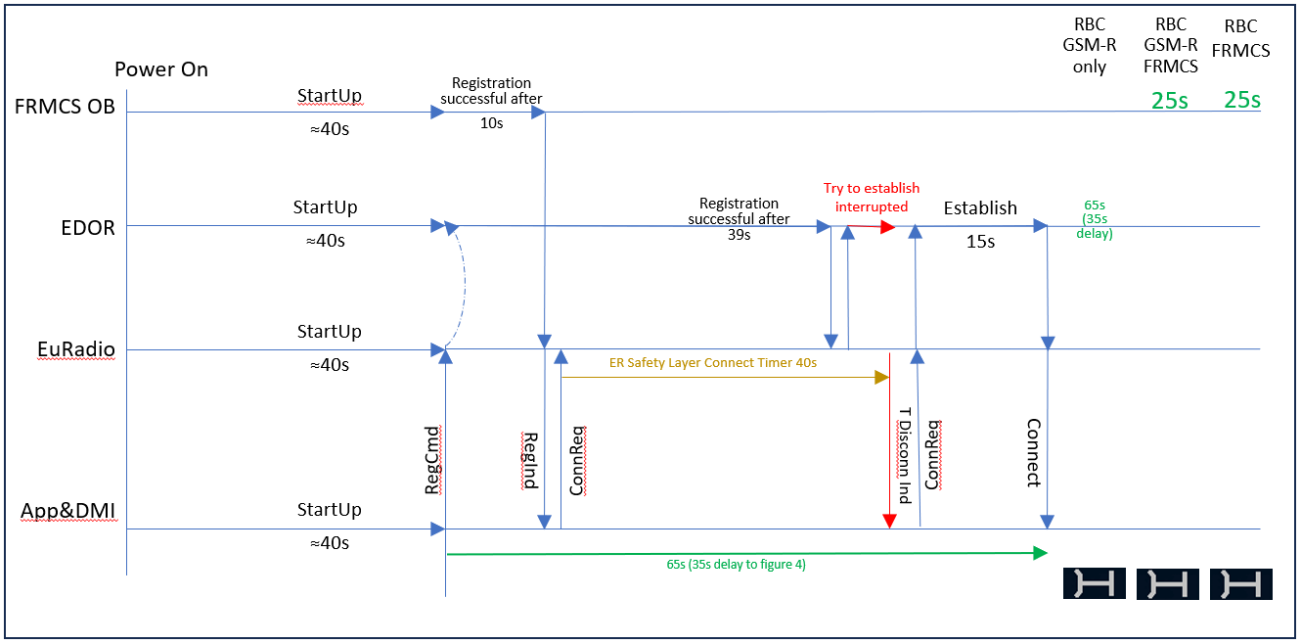


Figure 5 GSM-R / FRMCS available, but GSM-R registration late

<An additional "adapter lane" should be added to the Figure>

3.2.1.11.1 If, according to the adapter TMT, the right network for this RBC is FRMCS, but also reachable by GSM-R, and FRMCS registration was not successful before the adapter timer T-RegFRMCS expires (40 seconds from the moment when the adapter received the registration order via Euroradio from the application, exact value to be confirmed), the adapter will consider FRMCS as not available and fall back to GSM-R. For details of the fallback mechanism see Figure 1 in chapter 2.2.

3.2.1.12 If, according to the Euroradio TMT, the right network for this RBC is GSM-R and GSM-R registration was not successful before Euroradio timer T-RegGSM-R expires (40 seconds from the moment when Euroradio receives the registration order from the application), Euroradio will consider GSM-R as not available. In that case it will check if FRMCS is registered and if the answer is yes, try to connect via FRMCS. If that is successful, the TMT will be updated. If not, Euroradio will reply disconnect to the application. See the Coordinating Function in Figure 1 for details. Because T-RegGSM-R is expired, this disconnect reply will immediately be repeated on any subsequent connection request from the application. **Operational consequence**: The radio connection failure icon will appear on the DMI, not the message that the radio network registration failed. See Figure 6. <This clause has to be carefully reviewed for Adapter D. Behaviour might be different since for Euroradio the right network is always GSM-R in an adapter solution.>

3.2.1.12.1 Note: The attempt to connect via FRMCS is useful because the train may not have been in connection with the RBC for some time, while in the meantime the RBC became reachable via FRMCS.

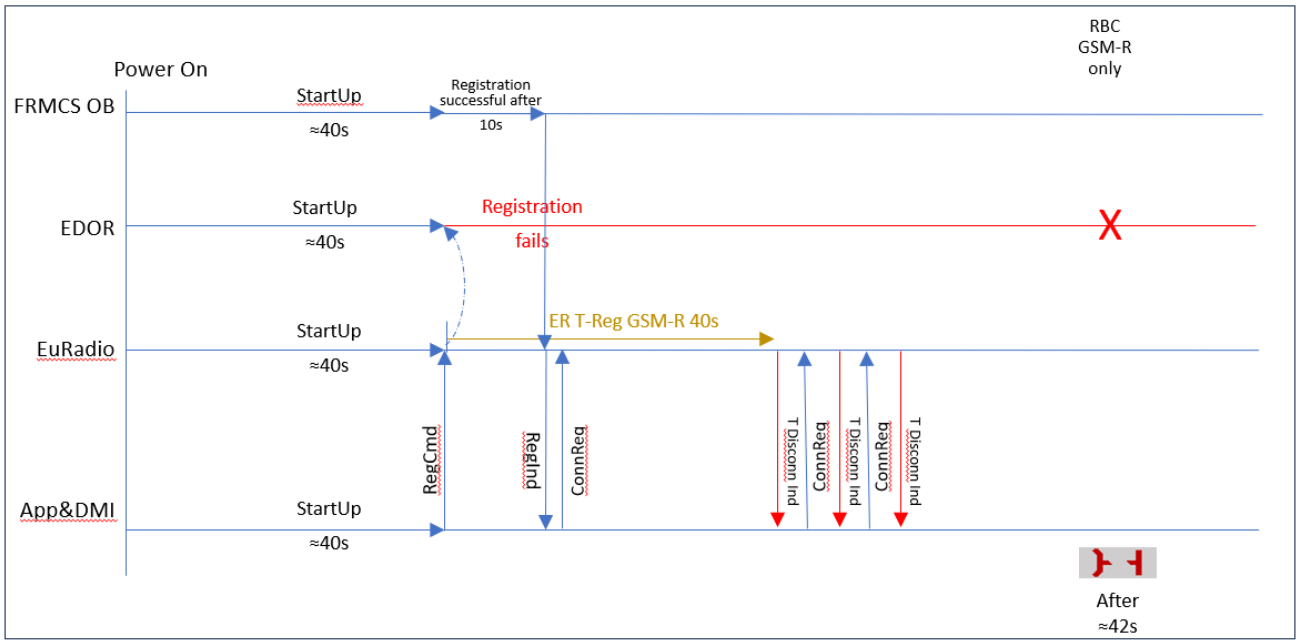


Figure 6 No GSM-R, FRMCS available, GSM-R only RBC

<An additional "adapter lane" should be added to the Figure. It needs to be checked whether the radio connection failure symbol appears also in the adapter case.>

3.3 Start of Mission with unknown position

3.3.1 General

3.3.1.1 This scenario is defined in [2] chapter 5.4 (SoM procedure) by the network and RBC selection in box S3.

3.3.2 Radio network selection by driver

3.3.2.1 The driver will have the possibility to stay with the currently registered network or to select the radio network, which is needed to reach the RBC, from a list of available networks on the DMI. This list includes the GSM-R networks received from the EDOR(s) and "FRMCS" (see 2.2.4.6). <As discussed previously, e.g. clause 2.2.4.3, it needs to be checked whether the DMI will show FRMCS and if so, what happens if the driver selects FRMCS. Depending on the result, another workaround might have to be implemented.>

3.3.2.2 The driver will make the selection of the specific network according to the route book. This is the same as today with GSM-R only.

3.3.2.3 **Operational consequence**: If the SoM procedure is performed on a line which is fitted with GSM-R and FRMCS, and where the RBC is reachable by GSM-R and FRMCS, the driver should select the relevant GSM-R network and not FRMCS. This will allow the entry of the GSM-R network details, enable the registration of this GSM-R network, and enable the GSM-R fallback. <It is assumed but needs to be checked in more detail that this is the same with the adapter, only that the GSM-R fallback has to be implemented in the adapter.>

3.3.3 RBC contact details

3.3.3.1 The driver will have three options to contact the RBC:

a) Contact last RBC,
b) Use short number,
c) Enter RBC data.

3.3.3.2 If the driver selects option a), the contact details of the last known RBC will be used. This is the same as today with GSM-R.

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.

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.

3.4 Entry into ETCS level 2

3.4.1 Level transition

3.4.1.1 As a condition for the transition to level 2, the SRS [2] clause 5.10.2.4.1a requires at least one Mobile Terminal in working condition, independently whether it is registered to a network or not.

3.4.1.2 On a pure level 2 line (no other level implemented), according to SRS [2] clause 5.10.2.7 the transition will take place anyway, even if no Mobile Terminal is in working condition.

3.4.1.3 If there is an underlying level 1 or class B system, it is relevant to know if the right telecom system is in working condition, to avoid an unwanted transition to level 2. The operational analysis in this chapter is therefore only relevant for such mixed level lines.

3.4.1.4 If both telecom systems are in working condition, level 2 is considered available in clause 5.10.2.4.1a. If no telecom system is in working condition, level 2 is considered not available in clause 5.10.2.4.1a.

3.4.1.5 If only one telecom system is in working condition, the following considerations apply.

3.4.1.5.1 Note: The probability that a telecom system is not in working condition is very low. It is mandatory to implement two GSM-R Mobile Terminals in the train. Therefore, the likelihood that both will fail is very low. Due to similar availability requirements the same applies to FRMCS.

3.4.1.6 If the trackside is engineered in a way that the RBC contact order is sent to the train before the level transition order announcement, there is no problem because in that case the ETCS on-board knows if the telecom system, which is needed to contact the RBC, is in working condition or not. It can therefore make the decision to switch to level 2 in the same way as today with GSM-R only. <As soon as one telecom system is in working condition,

for Euroradio GSM-R is in working condition and 5.10.2.4.1a is satisfied. On the other hand, if the adapter then figures out that the right system is not in working order, what happens? Depending on the outcome another operational consequence might have to be added here.>

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 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). <Applicability of this clause to Adapter D to be checked. It is assumed that the onboard will transition to level 2, even if the wrong system is in working order, but since this is only the level announcement, there might be no real operational consequence.>

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). <Applicability to Adapter D to be checked. Clause might have to be deleted.>

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". <Applicability of this clause to Adapter D to be checked>.

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. <Applicability of this clause to Adapter D to be checked>.

3.4.1.7.4 Note: The Infra Manager can mitigate this operational consequence by engineering the announced border some distance in advance of the border balise group. Whether that is feasible (new or existing trackside implementation) is outside the scope of this document.

3.4.2 Network registration

3.4.2.1 The registration procedure and the related adapter behaviour is described in chapter 2.2.5. **Operational consequence**: The GSM-R network registration order needs to be maintained in the trackside, also when the GSM-R network has been removed.

3.5 Radio network handover

3.5.1 General

3.5.1.1 GSM-R network transitions are defined in SRS [2]. No specific consequences due to the adapter concept.

3.5.1.2 If Baseline 4 network type information from trackside (packet 245) would be implemented on the trackside, it will be ignored by the adapter on-board.

3.5.2 GSM-R to FRMCS

3.5.2.1 It is assumed that the FRMCS coverage is such that when the RBC contact order is received, the FRMCS network registration has been completed.

3.5.2.2 If the adapter TMT contains FRMCS for this RBC, the FRMCS network will be selected to contact the RBC and the handover will be performed in the same way as a GSM-R handover.

3.5.2.3 If the RBC is not yet known in the adapter TMT (empty table, RBC contacted for the first time), the on-board will by default first try to contact the RBC via FRMCS. If the RBC is not (yet) reachable by FRMCS, this attempt will fail and adapter will make a second attempt via GSM-R. The adapter TMT will be updated according to the result of these attempts.

3.5.2.4 Note: This scenario is also applicable for entry into level 2. See also 3.4.2 for the operational consequence.

3.5.3 FRMCS to GSM-R

3.5.3.1 This transition is performed in the same way as a GSM-R to GSM-R transition. No specific adapter aspects.

4 Summary of the operational consequences

4.1 General

4.1.1.1 This chapter summarises the operational consequences which are described in chapter 3 and compares them with the behaviour of a standard Baseline 3 on-board and a TSI 2023 SV3.0 compliant on-board.

4.1.1.1.1 Note: For the SV3.0 on-board behaviour it is assumed that the trackside is fitted according to the Baseline 4 SV3.0 specifications, i.e. with the network type packets implemented. These packets are not needed by the adapter on-board, which will just ignore them.

4.1.1.2 The status of the telecom network in this chapter is indicated as follows:

yes	The network is implemented and works correctly
no	The network is not implemented
failed	The network is implemented but registration is not successful

4.2 SoM with valid position

4.2.1.1 Table 3 gives an overview of the different situations regarding the radio networks by which the RBC can be reached.

4.2.1.2 The indication "failed" in the implemented radio network columns means that the network is implemented, but it is in a failure state.

4.2.1.3 The radio networks at the top of the columns under the on-board variants indicate the telecom systems implemented in these on-board variants.

Situation	implemented radio network		RBC	B3 on-board	Adapter on-board		SV 3.0 on-board		
	GSM-R	FRMCS		GSM-R	FRMCS + GSM-R	FRMCS	GSM-R	FRMCS + GSM-R	FRMCS
SoM with valid position on a line where RBC is reachable by GSM-R only	yes	no	GSM-R			NA [1]			NA [1]
	yes	yes	GSM-R			NA [1]			NA [1]
	yes	failed	GSM-R			NA [1]			NA [1]
	failed	no	GSM-R	Registration failed	Registration failed	NA [1]	GSM-R registration failed	GSM-R registration failed	NA [1]
	failed	yes	GSM-R	Registration failed		NA [1]	GSM-R registration failed	GSM-R registration failed	NA [1]
	failed	failed	GSM-R	Registration failed	Registration failed	NA [1]	GSM-R registration failed	GSM-R registration failed FRMCS registration failed	NA [1]

Situation	implemented radio network		RBC	B3 on-board	Adapter on-board		SV 3.0 on-board		
	GSM-R	FRMCS		GSM-R	FRMCS + GSM-R	FRMCS	GSM-R	FRMCS + GSM-R	FRMCS
SoM with valid position on a line where RBC is reachable by GSM-R and FRMCS	yes	no [3]	GSM-R + FRMCS	NA [2]	NA [2]	NA [2]	NA [2]	NA [2]	NA [2]
	yes	yes	GSM-R + FRMCS						
	yes	failed	GSM-R + FRMCS			Registration failed			FRMCS registration failed
	failed	no	GSM-R + FRMCS	NA [2]	NA [2]	NA [2]	NA [2]	NA [2]	NA [2]
	failed	yes	GSM-R + FRMCS	Registration failed			GSM-R registration failed		
	failed	failed	GSM-R + FRMCS	Registration failed	Registration failed	Registration failed	GSM-R registration failed	GSM-R registration failed FRMCS registration failed	FRMCS registration failed
	no	yes	GSM-R + FRMCS	NA [1]			NA [1]		
	no	failed	GSM-R + FRMCS	NA [1]	Registration failed	Registration failed	NA [1]	FRMCS registration failed	FRMCS registration failed

Situation	implemented radio network		RBC	B3 on-board	Adapter on-board		SV 3.0 on-board		
	GSM-R	FRMCS		GSM-R	FRMCS + GSM-R	FRMCS	GSM-R	FRMCS + GSM-R	FRMCS
SoM with valid position on a line where RBC is reachable only by FRMCS	no	yes	FRMCS	NA [1]			NA [1]		
	yes	yes	FRMCS	NA [1]			NA [1]		
	failed	yes	FRMCS	NA [1]			NA [1]		
	no	failed	FRMCS	NA [1]	Registration failed	Registration failed	NA [1]	FRMCS registration failed	FRMCS registration failed
	yes	failed	FRMCS	NA [1]		Registration failed	NA [1]	FRMCS registration failed	FRMCS registration failed
	failed	failed	FRMCS	NA [1]	Registration failed	Registration failed	NA [1]	GSM-R registration failed FRMCS registration failed	FRMCS registration failed

Table 4 SoM with valid position

<Applicability of table for adapter yet to be checked. In particular it needs to be checked whether the icon "radio connection failure will appear.>

[1] Not applicable because the train is only expected to run on lines which are fitted with the telecom system (network and RBC) supported by the on-board.

[2] Not applicable, see 3.1.1.2.1.

[3] This combination is included in the table for completeness of the overview, but according to Table 2 it is in practice not foreseen.

4.3 SoM with unknown position

4.3.1.1 Table 4 gives an overview of the different possibilities regarding the selection/entry of radio network and RBC related input by driver. See [2] box S3 of the SoM procedure.

4.3.1.2 The radio networks at the top of the columns under the on-board variants indicate the telecom systems implemented in these on-board variants.

Item	B3 on-board	Adapter on-board		SV3.0 on-board		
	GSM-R	FRMCS + GSM-R	FRMCS	GSM-R	FRMCS + GSM-R	FRMCS
Radio Network type	NA [1]	NA [1]	NA [1]	GSM-R OR FRMCS+GSM-R OR FRMCS [6]	GSM-R OR FRMCS+GSM-R OR FRMCS	GSM-R OR FRMCS+GSM-R OR FRMCS [6]
Radio Network selection	Available GSM-R networks	Available GSM-R networks AND FRMCS	FRMCS	Available GSM-R networks	Available GSM-R networks [2]	NA [2]
RBC selection	Last stored RBC OR Short number OR RBC ID+phone	Last stored RBC OR Short number [3] OR RBC ID+phone [5]	Last stored RBC OR Short number [3] OR RBC ID+phone [5]	Last stored RBC OR Short number OR RBC ID+phone	Last stored RBC OR Short number [4] OR RBC ID+phone	Last stored RBC OR RBC ID

Table 5 SoM with unknown position

<Applicability of table for adapter yet to be checked. In particular it needs to be checked whether the DMI can also show FRMCS.>

[1] The Radio Network type exists only in SV3.0.

[2] GSM-R networks not available if either on-board or trackside is FRMCS only.

[3] Short number should only be selected if it is permitted by the route book.

[4] Short number will only be selectable if the GSM-R is registered.

[5] Phone number is not relevant if the selected network is FRMCS. In that case the driver can either revalidate the stored number or enter a dummy number.

[6] It may seem useless that the options for the driver include the network for a telecom system which is not implemented on-board. However, this is the way it is defined in the ETCS specifications for SV3.0.

4.4 Entry into ETCS level 2

4.4.1.1 As explained in chapter 3.4.1, the operational consequence for the level transition is only relevant for an entry scenario to a mixed level line with level 2 overlay on top of level 1 or level NTC, if the level transition order is engineered before the radio network registration order. Table 5 shows the DMI indication and the actual transition for such an entry scenario. <Applicability of this clause for the adapter to be checked.>

4.4.1.2 The columns "GSM-R working" and FRMCS working" indicate whether the on-board system is in working condition, as far as it is implemented on-board.

4.4.1.3 The radio networks at the top of the columns under the on-board variants indicate the telecom systems implemented in these on-board variants.

Item	GSM-R working	FRMCS working	B3 on-board	Adapter on-board		SV3.0 on-board		
			GSM-R	FRMCS + GSM-R	FRMCS	GSM-R	FRMCS + GSM-R	FRMCS
Level transition announced on DMI	yes	yes	yes	yes	yes	yes	yes	yes
	yes	no	yes	no	no	yes	yes	no
	no	yes	no	no	yes	no	yes	yes
	no	no	no	no	no	no	no	no

Item	GSM-R working	FRMCS working	B3 on-board	Adapter on-board		SV3.0 on-board		
			GSM-R	FRMCS + GSM-R	FRMCS	GSM-R	FRMCS + GSM-R	FRMCS
Level transition with conditional order at the border	yes	yes	yes	yes	yes	yes	yes	yes
	yes	no	yes	no	no	yes	yes	no
	no	yes	no	no	yes	no	yes	yes
	no	no	no	no	no	no	no	no
Level transition with unconditional order at the border	yes	yes	yes	yes	yes	yes	yes	yes
	yes	no	yes	yes	no	yes	yes	no
	no	yes	no	yes	yes	no	yes	yes
	no	no	no	no	no	no	no	no

Table 6 Entry level 2 scenarios

<Applicability of table for adapter yet to be checked, in particular the highlighted table entries. The behavior is expected to be slightly different.>