

On-Board FRMCS
Functional Requirements Specification

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1 List of abbreviations

3GPP	3rd Generation Partnership Project
API	Application Programming Interface
ATO	Automatic Train Operation (i.e. [Semi]-driverless operation)
ASTP	Absolute Safe Train Positioning
CCTV	Closed Circuit Television
CS / PS	Circuit Switch / Packet Switch
CP	Control Plane
DSD	Driver Safety Device
EVN	European Vehicle Number
ETCS	European Train Control System
ERA	European Union Agency for Railways
FCAPS	Fault, Configuration, Accounting, Performance and Security
FRMCS	Future Railway Mobile Communication System
FS_{MPM}	FRMCS Service MultiPath Management
FW	Firmware
GNSS	Global Navigation Satellite System
GSM	Global System for Mobile Communications
GSM-R	Global System for Mobile Communications – Railway
GW	Gateway
HMI	Human-Machine Interface
HW	Hardware
IM	Infrastructure Manager
IP	Internet Protocol
LC	Loose Coupled
MCX	3GPP Mission Critical Services
MNO	Mobile Network Operator
MOTS	Modified Off the Shelf
MPF	MultiPath Function
OB_{ANT}	On-Board Antenna system reference point/interface
OB_{APP}	On-Board Application reference point/interface
O&M	Operations & Maintenance
OTA	Over-The-Air
PA	Public Announcement
PLMN	Public Land Mobile Network

QoS	Quality of Service
RAN	Radio Access Network
RF	Radio Frequency
RU	Railway Undertaking
SRS	System Requirement Specification
SW	Software
TCMS	Train Control and Management System
TCN	Train Communication Network
TOBA	Telecom On-Board Architecture
TSI	Technical Specification for Interoperability
TSI CCS	Control Command and Signalling TSI
UIC	Union Internationale des Chemins de Fer
UP	User Plane
URS	User Requirements Specification
WG	(UIC) Work Group

2 List of definitions

Accuracy

Accuracy (for location information parameters like positioning, speed and acceleration) is the difference between the calculated parameter and the actual parameter.

Adapter Function

An Adapter Function is a mechanism for protocol, command and parameter adaptation for connecting FRMCS Radio Module(s) with FRMCS Gateway Function.

Administrative Domain

A collection of resources and/or services owned and operated by a single administrative organization (e.g. a PLMN).

Application

Provides a solution for a specific communication need that is necessary for railway operations. In the context of this document, an application is interfacing with the On-Board FRMCS through the OB_{APP} reference point, to receive and transmit information to ground systems, (for example, ETCS, train voice radio, DSD, CCTV, passenger announcements, etc.). List of defined applications is available in [FRMCS FRS] and in [FRMCS SRS] Annex B.

Attached Configuration

A hardware component that is permanently connected to another hardware component.

Communication services

Communication services enable two-way communication between two or more authorised service users (i.e. applications) from applications towards other applications/entities reachable through various networks. Communication services encompass both Service and Transport strata.

Component

An entity that can consist of hardware, software or a combination of hardware and software.

Control plane

The control plane carries signalling traffic between stratum entities. Control plane and user plane are to be considered as separate however related entities.

Data communication

Exchange of information in the form of any digital information not being voice or video (e.g. voice and recorded video file communication).

Note: Specific communication types that in other contexts are defined as data communications such as Video and Voice are considered as separate communication types in the context of FRMCS.

Data Flow

Individual data stream with a single QoS requirement.

Detachable Configuration

A hardware component that can be disconnected and re-connected. This includes pluggable module and remote hardware components connected to each other via an interface.

Domain

The highest-level group of functional entities (e.g., FRMCS is a domain, whereas PLMNs operated by different operators are administrative domains).

Driver

A person capable and authorised to drive trains, including locomotives, shunting locomotives, work trains, maintenance railway vehicles or trains for the carriage of passengers or goods by rail in an autonomous, responsible and safe manner.

Driver safety device

An on-train system that monitors the alertness of the driver and provides warnings, alarms and action to other systems as appropriate.

Emergency operation

The operational state of the railway when a current unforeseen or unplanned event has occurred which has life threatening or extreme loss implication, and which requires immediate attention.

External system

A back-office type of system connected to the FRMCS system, such as traffic management systems, tracking systems, planning systems, weather report system, etc.

FRMCS Domain

A FRMCS Domain is an administrative domain which comprises a Service Domain and a Transport Domain under the control of an FRMCS Operator.

FRMCS Gateway Function

It is an on-board gateway responsible for the coordination and managing of access to the FRMCS transport services offered by the On-Board FRMCS system.

FRMCS Radio Function

An FRMCS Radio Function contains FRMCS Radio Module(s) and an Adapter Function which connects FRMCS Radio Module(s) with a FRMCS Gateway Function.

FRMCS Radio Module

Modem with one or more 3GPP or/and non-3GPP radio access technologies supported by the FRMCS system.

FRMCS Service Client

Client as defined in [TR 103 791]

FRMCS User

Human or machine making use of Communication Services and/or Complementary Services.

FRMCS Service Session Function

Processes the communication parameters (e.g. Identity, codec parameters) received from the Application stratum via corresponding reference point OB_{APP}.

FS_{OMR}

Reference Point/interface for remote management of Interoperable Context(s)

Function

A function is an autonomous and identifiable functional entity. The On-Board FRMCS contains identified component(s). A Function can be physical and/or logical.

Note: a function can be implemented by one or more system blocks in a system.

Functional identity

A description of the function performed by a called or calling party. The functional identity can include characters and numbers. This is used within the functional addressing scheme to identify an end user/system by function or identity rather than by a specific item of radio equipment or user subscription.

Harmonised FRMCS application

An FRMCS application specified in this FRS which is agreed among railway stakeholders to be used as the common way to fulfil the need for the functionality [FRMCS FRS].

Interchangeability

The capability of the On-Board FRMCS to add or replace HW components in the train without the need to send the equipment to a workshop, e.g. replacing a FRMCS Radio Function should be possible in place.

Interface

An interface represents identifiable implementation of a reference point. An interface exposes functionalities associated to Functions. An interface can be specified or unspecified in this specification.

Interoperability

As defined in DIRECTIVE (EU) 2016/797 [EU 2016/797].

Interoperable Context

An Interoperable Context encompasses On-Board FRMCS configuration data that pertains to Interoperability.

Location Services Common Function

Internal On-Board FRMCS function, collector of certain location and positioning information to be provided as input to other internal On-Board FRMCS Functions (e.g., Notification Function, O&M Function).

Non-Harmonised FRMCS applications

Applications that do not meet the criteria for Harmonised FRMCS applications.

Normal Operation

The state of the railway when it is fully functional and operating as planned. Normal operation also includes any maintenance activities that do not affect the ability to provide a fully functional operational railway.

Notification Function

The function within On-Board FRMCS Gateway which provides OB_{APP} notification services to the applications.

OB_{OM}

Reference Point/interface for On-Board Operation & Maintenance.

OB_{RAD}

On-Board FRMCS reference point/interface for FRMCS Radio Function(s).

On-Board FRMCS

System enabling FRMCS communication for on-board applications.

Note: FRMCS Onboard System, FRMCS on-board and On-Board FRMCS terms can be used interchangeably.

Operation and Maintenance (O&M) function

Provides functions for Operation and Maintenance purposes including SW Management and Configuration Management. O&M Function may also provide Performance Metrics and Events to applications.

Operation and Maintenance (O&M) User

An O&M User is a human or machine authenticated and authorized to operate on On-Board FRMCS O&M Function as an entity in charge of maintenance and operation.

Orchestration function

The orchestration has the task to direct and control various components of the TOBA in a way to help establish communications. It is part of the FRMCS gateway functions.

On-Board FRMCS Time Function

The On-Board FRMCS Time Function exposes date and time information to internal consumers (entities belonging to the FRMCS system), e.g., provides information on request or upon initial request (information is then pushed).

Package

Set of updates, upgrades or downgrades and/or changes to firmware and/or software and/or parameters for configuration.

Product

A product is a solution or system, composed of hardware, software, or a combination of both, designed to fulfil specific requirements and perform designated functions to meet user needs or solve particular problems.

Reference Point

According to ITU-T terminology ([ITU-T I.112]).

System Boundary

The system boundary separates On-Board FRMCS from its environment. It is defined by the external interfaces of the On-Board FRMCS.

System Context

The system context defines the part of the environment of a system, which is relevant for the definition of requirements for this system.

Targeted Time

Planned time to apply a change.

Trackside FRMCS

System supporting FRMCS communication to trackside applications. Trackside FRMCS is a sub-domain within the FRMCS System.

Note: FRMCS trackside and Trackside FRMCS terms can be used interchangeably.

Train Consist

Single vehicle or a group of vehicles that are not separated during normal operation.

Train Staff

Railway staff that are on-board a train but are not drivers, for example conductors, catering staff, security staff etc.

Transport domain

It is a set of Transport Services allocated to the same administrative domain (including for example the case of an IM's dedicated mobile network or an MNO's network).

A transport domain is uniquely identifiable, consists of access domain(s) (wireline and/or wireless) with the necessary central control (core domain), and authorizes its use (e.g., via SIM card).

Transport service

It is a service that provides transport of user information and control signals between corresponding reference points considering the required QoS for the individual communication. From a global perspective, the Transport Stratum provides services for both unicast and multicast transmissions for users within a transport domain and for users between different transport domains.

Transport stratum

It is the FRMCS stratum that provides Transport Services (see also [FRMCS SRS] Chapter 2 (List of definitions).

Update

Any major modification during service work on a subsystem or part of it which does not change the overall functional performance of the subsystem.

Upgrade

Any major modification during service work on a subsystem or part of it which results in a change which improves partial or overall functional performance of the subsystem.

User

The Users in the context of this document are the railway undertakings / infrastructure managers.

Note: User(s) are represented by one or more FRMCS User(s).

User plane

The user plane (sometimes called data plane or bearer plane) carries the user/application traffic. For the exchange of information between the communication partners (payload), the user plane provides the necessary mechanisms and data formats in order to provide the desired quality. Voice, video and data require different formats e.g. codec to enable communication between partners. This will be determined by the corresponding user plane instance on the application side and controlled accordingly.

Vendor Diversity

Use of a combination of HW components supplied by various vendors without the need for hardware / software adaption work other than configuration

Voice communication

Exchange of information in the form of voice (not a recorded voice file), regardless of the transmission method (voice is not considered as data in this document).

3 Introduction

3.1 Background

3.1.1 Globally, many railway infrastructure managers and railway undertakings currently use an interoperable radio communications network, GSM-R (Global System for Mobile Communications – Rail), for operational voice communications and to provide the data bearer for ETCS (European Train Control System). In the European Union this is legally mandated in the Technical Specifications for Interoperability that are applicable in the European Member States. Voice and data communications are also used for various other applications. (I)

3.1.2 GSM-R is a MOTS (modified off the shelf technology) system based around manufacturers' commercial GSM (Global System for Mobile Communications) offerings, enhanced to deliver specific "R" (railway) functionality. Due to the product modifications required to provide "R" functionality, and the need to utilise dedicated non-commercial radio spectrum, much of the equipment utilised for GSM-R comprises manufacturers' special-build equipment and/or software variants. (I)

3.1.3 The predicted obsolescence of GSM-R, combined with the long-term life expectancy of ETCS and the Railway business needs, have led to the European Railway community initiating work to identify a successor for GSM-R, and a new system architecture to cope with the technical evolution, which is the FRMCS (Future Railway Mobile Communication System). The successor has to be future proof, learn from past experiences / lessons and comply with Railway requirements. (I)

3.2 Categorization of requirements

3.2.1 The statements made in the TOBA FRS specification are assigned to the following categories: (I)

a) **Mandatory for the System** (indicated by '(M)' at the end of the clause). These requirements mean a condition set out in this specification that must be met without exception in order to deliver a system ensuring the fulfilment of essential functional and system needs, compliance to relevant standards and technical integration. The mandatory requirements are identified as sentences using the keyword "shall".

b) **Optional for the system** (indicated by '(O)' at the end of the clause). These requirements may be used based on the implementers' choice. When an optional requirement is selected, the related requirement(s) of this specification becomes mandatory for the system. The optional requirements are identified as sentences using the keyword "should".

c) **Information** (indicated by '(I)' at the end of the clause). These statements provide additional information to help the reader understanding a requirement.

Please note that NA is used to indicate that a particular item is not applicable and therefore not needed to be provided.

3.2.2 When a requirement clause contains a bulleted list, the categorisation precedes the bulleted list indicating that the FRMCS system shall/should support all items in the list. (I)

3.2.3 The following marking is applied to denote the applicability of clauses: (I)

a) Indications (M), (O) and (I) are used for clauses within the scope of the V2 specification, which is the minimum set of requirements for validation;
b) Indications (M-V3), (O-V3) and (I-V3) are used for clauses within the scope of the V3 specification. The V3 series of specification are the target version to be included in the TSI, to allow migration from the GSM-R system to the FRMCS system (FRMCS 1st edition). The V3 clauses are to be considered for information for V2;
c) Indications (M-Vx), (O-Vx) and (I-Vx) are used for clauses for a later version of the specification. These clauses are kept in the specification for readability and consistency purposes.
d) Indications (M-V3), (O-V3), (I-V3) and (M-Vx), (O-Vx), (I-Vx) may also be used for sub bullets within a clause to identify a different applicability. In this case each bullet will be indicated individually

Note: In a further step, appropriate identification of requirements as Mandatory for Interoperability (MI) will be carried out and recorded in Annex A of this document. In the current version of the document, it is included the identification of “Candidate MI requirements”.

3.3 Purpose of this document

3.3.1 The purpose of this document is to define functional requirements for the On-Board FRMCS in complement to the [FRMCS FRS]. (I)

3.3.2 This specification version focuses on the necessary requirements of the On-Board FRMCS enabling critical applications for the purpose of the next TSI (i.e., ETCS, ATO and critical voice). (I)

3.3.3 The requirements for the On-Board FRMCS are split into functional requirements (Chapter 7) and non-functional requirements (Chapter 8). The requirements are justified by giving a rationale. (I)

3.3.4 The On-Board FRMCS System Requirements are included in [FRMCS SRS] as depicted in Figure 3-1. (I)

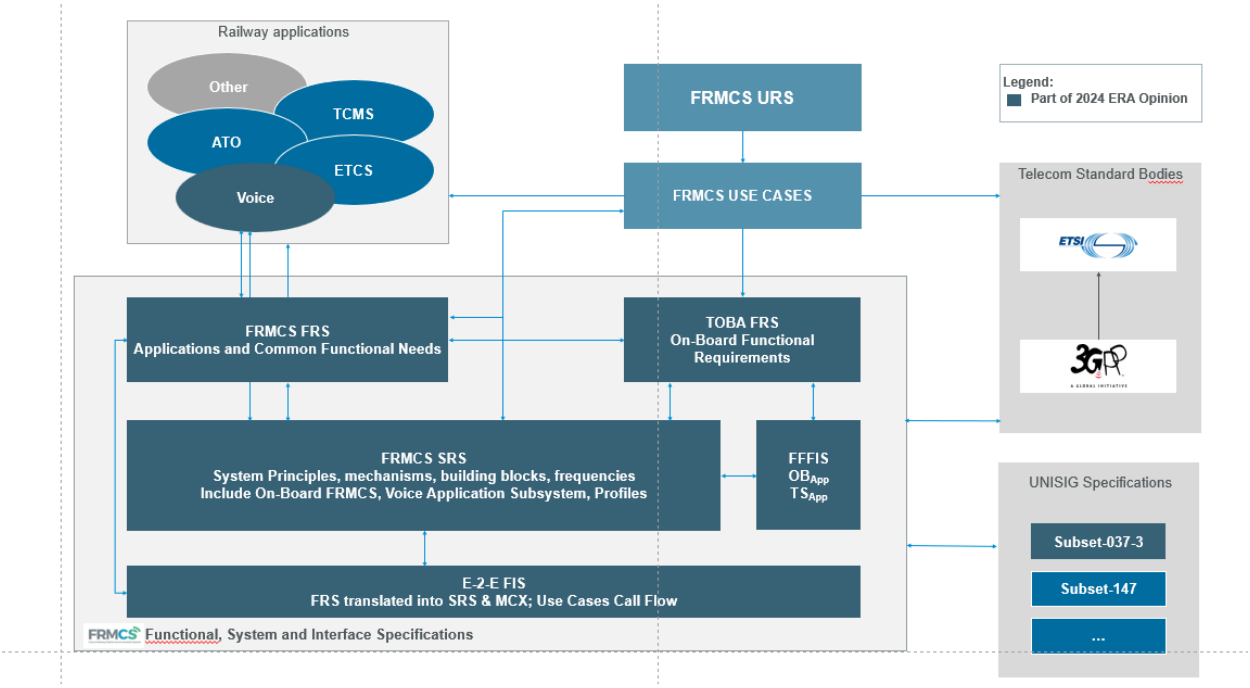


Figure 3-1: FRMCS Specifications

3.4 Fundamental Principles

3.4.1 The fundamental principles and associated guidance notes, which are applicable to the On-Board FRMCS, are defined in the FRMCS Functional Requirements Specification [FRMCS FRS]. (I)

3.4.2 FRMCS Architecture Principles are captured in [FRMCS SRS] which are applicable to the On-board FRMCS. (I)

4 Scope

This chapter defines the system context and system boundaries of the On-Board FRMCS(I)

4.1 On board context and On-Board FRMCS context

4.1.1 Below Figure 4-1 is derived from [FRMCS URS]. The green area depicts the on board context. The On-Board FRMCS context is further depicted by Figure 5-1. (I)

4.1.2 Any application residing stationary on-board of the train that exchanges information with the On-Board FRMCS is in the system context of the On-Board FRMCS. (I)

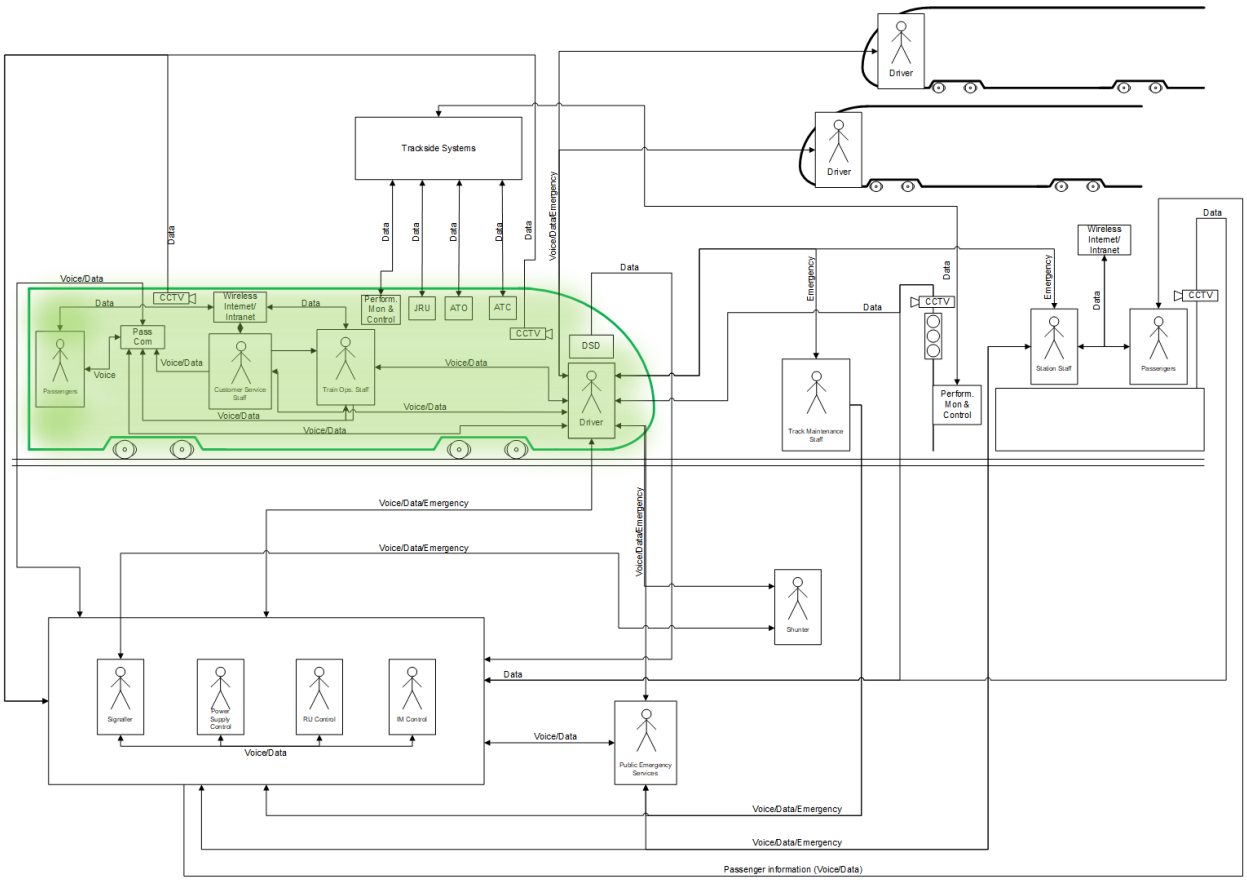


Figure 4-1: On board context (with examples of applications)

4.1.3 Applications (respectively FRMCS Users) moving inside or near the train (e.g. train staff with mobile devices) may connect to the FRMCS network via the On-Board FRMCS using a suitable local wireless access on-board. Using the On-Board FRMCS would overcome the penetration loss from outside to inside the train for FRMCS Users with mobile devices. (I)

4.1.4 The On-Board FRMCS provides communication transport services for any application on-board a train, regardless of the application category (critical, performance, business). (I)

Note: The decision as how many and which applications share one specific On-Board FRMCS is solely an implementation decision.

4.1.5 The On-Board FRMCS is focused on the specification of a suitable replacement for on board devices for GSM-R, which is a European requirement. The On-Board

FRMCS will enable on board equipment flexibility and scalability according to RU’s specific needs of communication and evolution. (I)

4.2 System boundary, relevant reference points and interfaces, modularity

4.2.1 This document covers requirements for the On-Board FRMCS itself and requirements for the identified reference points. (I)

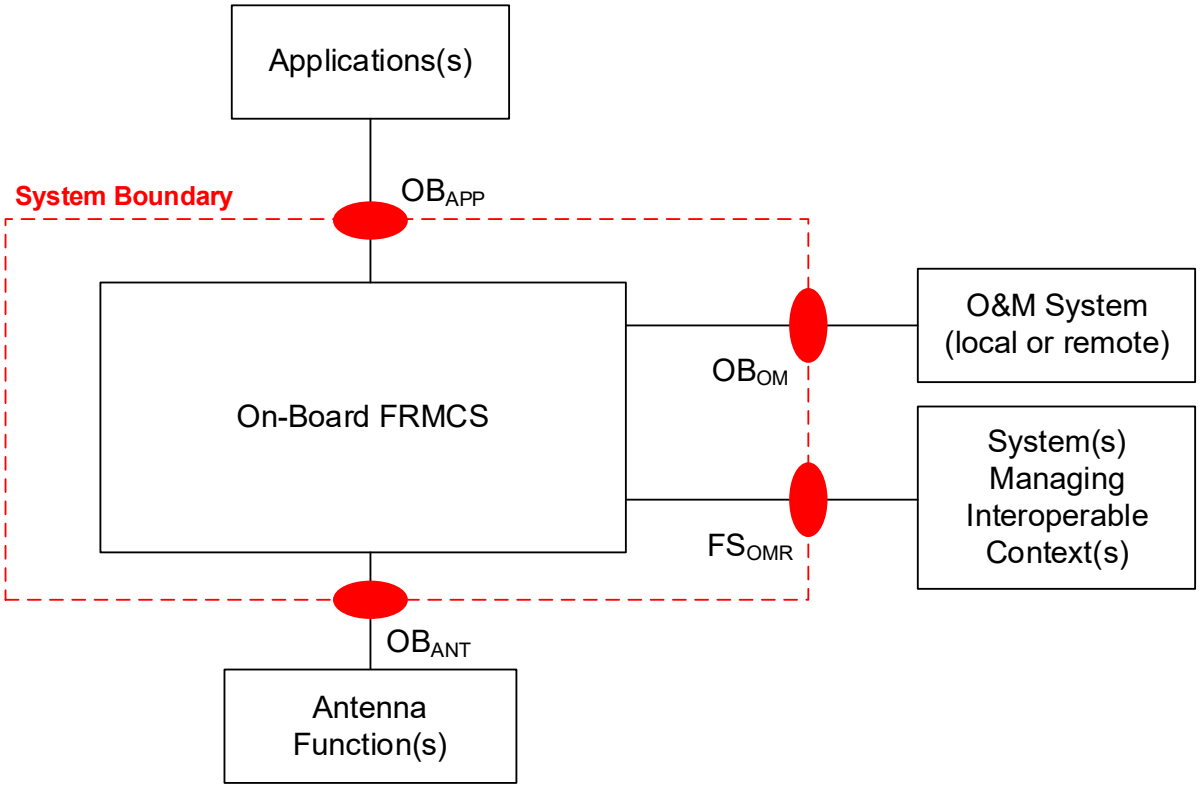


Figure 4-2: System Boundary of the On-Board FRMCS

4.2.2 The On-Board FRMCS shall implement the interfaces associated to reference points: (M-V3)

- OB_{APP} ([FRMCS SRS] chapter 7.1.4.1.1)
- OB_{ANT} ([FRMCS SRS] clause 7.1.4.1.2)
- OB_{OM} ([FRMCS SRS] clause 7.1.4.1.3)
- FS_{OMR} ([FRMCS SRS] chapter 7.1.4.1.4)

4.2.3 Intentionally deleted

4.2.4 Reference point OB_{APP} is between the On-Board FRMCS and the on-board application(s). (I)

4.2.4.1 OB_{APP} is the only reference point for the applications to access the On-Board FRMCS. (I)

4.2.4.2 User plane data from and to the applications(s) are carried over this reference point. (I)

4.2.4.3 Control plane data exchange between application(s) and On-Board FRMCS are carried over this reference point. (I)

4.2.5 Reference point OB_{ANT}

4.2.5.1 Reference point OB_{ANT} is between the FRMCS Radio Module(s) and the Antenna Function(s). (I)

4.2.6 Reference point OB_{OM}

4.2.6.1 The reference point between the On-Board FRMCS Operation & Maintenance Function (within the On-Board FRMCS) and a local or remote Operation & Maintenance system (O&M User) is OB_{OM}. (I)

4.2.6.2 Data related to any O&M activity is exchanged over this reference point. (I)

4.2.7 Other reference point(s) and interfaces relevant for On-Board FRMCS architecture

4.2.7.1 Reference point FS_{OMR}

4.2.7.1.1 Reference point FS_{OMR}, with its associated FS_{OMR} interface, is between the On-Board FRMCS Operation & Maintenance Function within the On-Board FRMCS and a remote Operation & Maintenance system (O&M User), using the FRMCS infrastructure to get connectivity. (I)

4.2.7.1.2 Data related to On-Board FRMCS Interoperable Context(s) are exchanged over this reference point. (I)

Note: a more detailed representation of the functional On-Board FRMCS architecture including other functional elements is provided in chapter 5.2 and also shown in Figure 7-1.

4.2.8 Intentionally deleted

4.2.8.1 Intentionally deleted.

4.2.8.2 Intentionally deleted

4.3 On-Board Application Agent

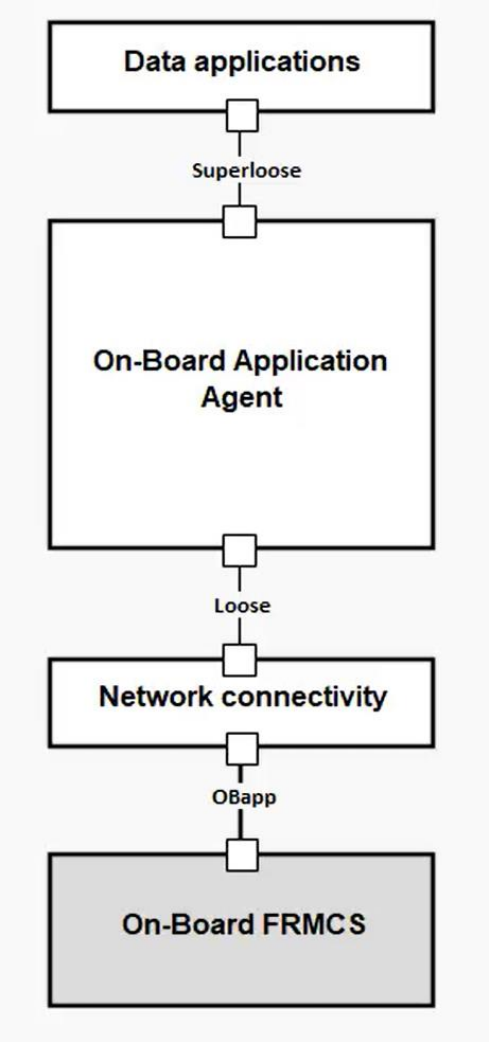


Figure 4-3: Interfacing with On-Board FRMCS using On-Board Application Agent

4.3.1 For data communication applications not fully supporting OB_{APP} a specific function, On-Board Application Agent, will implement OB_{APP} towards the On-Board FRMCS to enable such applications to interface with the On-board FRMCS and make use of its communication services. (I-V3)

4.3.1i Intentionally deleted.

4.3.2 Intentionally deleted.

4.3.2i The functions set provided by the On-Board Application Agent shall include (M-V3):

- Local Binding
- Session management
- Transport protocol management

4.3.2ii The functions set provided by the On-Board Application Agent should include (O-V3):

- Notification Function

4.3.3 Intentionally deleted

4.3.4 Intentionally deleted

5 Functional Architecture

5.1 Key Design Paradigms

5.1.1 Logical separation of applications from service and transport strata

5.1.1.1 The On-Board FRMCS provides a logical separation between application stratum and service stratum as well as transport stratum (Chapter 2). (I)

5.1.1.2 The strata separation follows the clauses in the [FRMCS SRS] chapter 5.1. (I)

5.1.2 General Requirements

5.1.2.1 Intentionally deleted

5.1.2.2 The On-Board FRMCS shall be capable of using a defined variety of over the air radio bearers simultaneously, as those listed in the list of bearers (per technologies and frequencies) specified in [FRMCS SRS] chapter 8. (M-V3)

5.1.3 Resource Sharing

5.1.3.1 The On-Board FRMCS shall provide mechanism(s) to apply QoS treatment as per 5.1.3.2 and 5.1.3.2i. (M)

5.1.3.2 The On-Board FRMCS shall provide an interface by which an Application Profile shall be associated. (M-V3)

Note: Management of QoS is under development in ETSI specifications.

5.1.3.2i Based on an associated Application Profile (as per 5.1.3.2) the On-Board FRMCS shall assign QoS parameters for individual Service Sessions as per [FRMCS SRS] chapter 14 and [FRMCS SRS] Annex A. (M)

5.1.4 ETCS Radio Communication Requirements

5.1.4.1 Intentionally deleted

5.2 Functional Entities and Architecture

5.2.1 Following the key design paradigms, the functional entities depicted below have been identified (I)

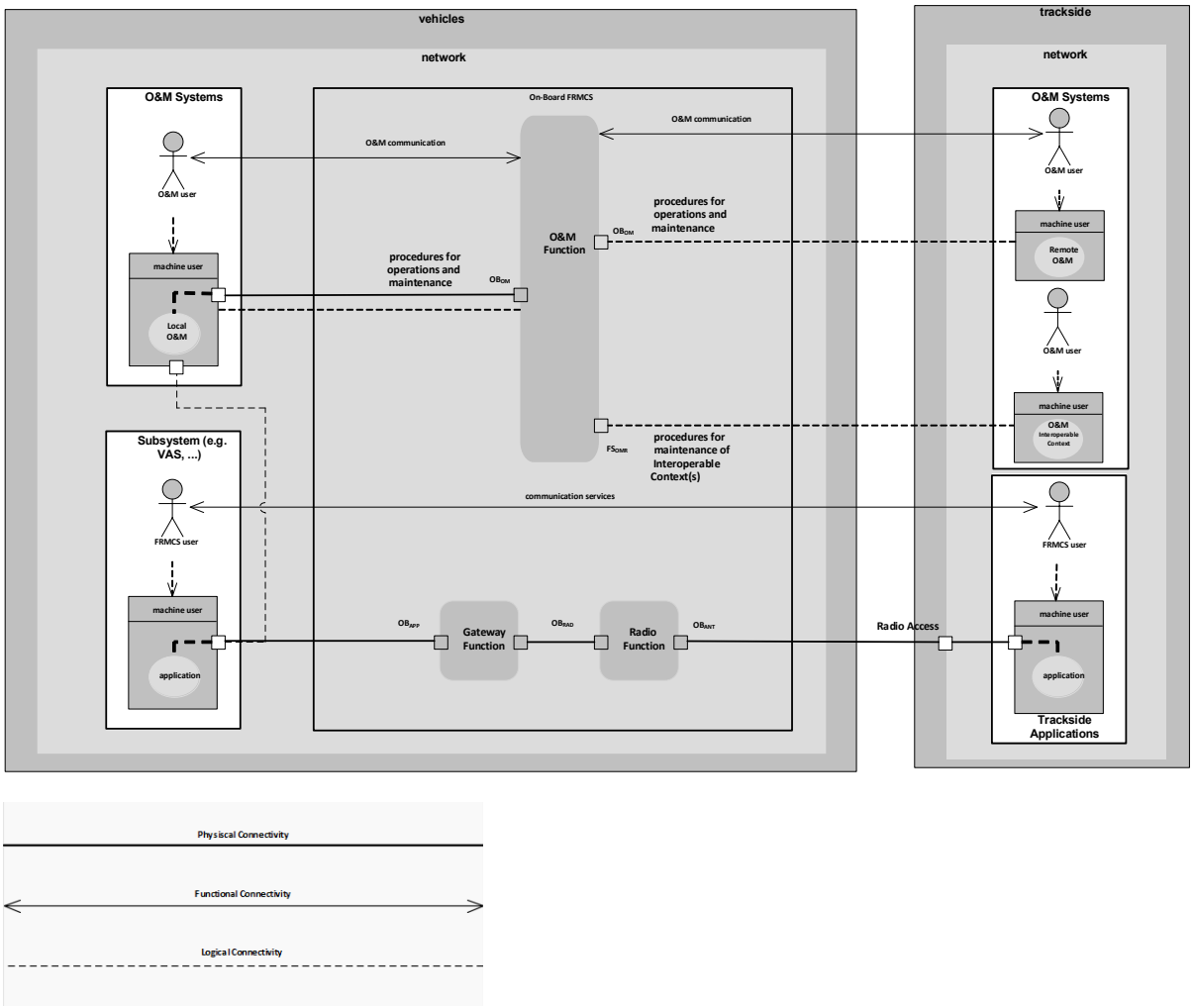


Figure 5-1: On-Board FRMCS Functional architecture in context of the FRMCS System

5.2.2 **FRMCS Gateway Function**: Manages the data flows stemming **from** the applications, has a control plane (OB_{APP} control plane, as per definition in [FRMCS SRS] document) for the applications, distributes the user plane data from applications over the various FRMCS Radio Module(s) depending on each application's QoS requirements and priorities between applications. (I)

5.2.3 **FRMCS Radio Function**: Provides radio access to the FRMCS Gateway Function using one or more FRMCS Radio Module(s) with 3GPP or/and non-3GPP radio access technologies supported by the FRMCS system. An On-Board FRMCS contains one or more FRMCS Radio Function(s). (I)

5.2.4 **O&M Function**: Implements the functionalities required for Fault Management, Performance Management and Configuration Management of the On-Board FRMCS, see chapter 7.7.3. (I)

5.2.5 **Reference Point OB_{APP}:** Reference point between the On-Board FRMCS and the on-board application(s). (I)

5.2.6 **Reference Point OB_{RAD}:** Reference point between FRMCS Gateway Function and FRMCS Radio Function. (I)

5.2.7 **Reference Point OB_{ANT}:** Reference point between the FRMCS Radio Module(s) and the Antenna Function(s). (I)

5.2.8 **Reference Point OB_{OM}:** The reference point between the On-Board FRMCS Operation & Maintenance Function (within the On-Board FRMCS) and a local or remote Operation & Maintenance system (O&M User) is OBOM. (I)

5.2.9 **Reference Point FS_{OMR}:** Reference point between the On-Board FRMCS and a remote Operation & Maintenance system, using the FRMCS infrastructure to get connectivity for procedures used to handle Interoperable Context(s). (I)

6 Intentionally deleted

7 Functional Requirements

7.1 Decoupling of application and transport

7.1.1 Rationale

In the GSM-R system, application and communication services, including transport, are serially and directly interlinked and bound to one specific control plane protocol. This combination does not allow an independent evolution. Evolution of the communication and transport systems causes changes in the applications, which in FRMCS is supported by the strata separation principle as per [FRMCS SRS] clause 5.1.4. (I)

7.1.2 Requirements

7.1.2.1 Usage of the On-Board FRMCS shall be enabled for applications through the defined OB_{APP} interface. (M)

7.1.2.2 Communication services provided by On-Board FRMCS shall be implemented using interface defined in FRMCS FFFIS. (M)

7.1.2.3 The way the On-Board FRMCS provides communication services and transport services shall be transparent to applications that use those services. (M)

7.1.2.4 Intentionally deleted.

7.1.2.5 The On-Board FRMCS shall, via the API, enable applications to request communication services that result in Application specific QoS treatment as per 5.1.3.2 and 5.1.3.2i. (M)

7.1.2.6 The On-Board FRMCS shall, via the information obtained from the API, provide mechanism(s) to manage priority and QoS treatment for all communication services as per 5.1.3.1. (M)

7.1.2.7 Based on the FRMCS E2E QoS and associated communication attributes (see [FRMCS SRS] chapter 14.4, Annex A.), the On-Board FRMCS shall be able to assess:

1. The need for using multiple transport services (increased reliability) ([FRMCS SRS] chapter 12.3) (M-V3)
2. The need for bandwidth aggregation (M-V3)
3. The suitable transport services/FRMCS Radio Modules (M-V3)
4. The preferred transport service/FRMCS Radio Module (M-V3)
5. Which transport service to offload in case of capacity limitations (M-V3)

7.1.2.8 The On-Board FRMCS shall be addressable on the basis of a unique set of identifiers. (M-V3) (refer to [FRMCS SRS] paragraph 11.4.5.3)

Note: This will be achieved, for example, with the Vehicle Identity (refer to [FRMCS FRS] 6.2.2.1).

7.1.2.9 The On-Board FRMCS shall enable communication for Harmonised FRMCS Applications. (M)

7.1.2.10 The On-Board FRMCS shall enable communication for Non-Harmonised FRMCS Applications. (M)

7.2 Bearer Flexibility

7.2.1 General Requirements

7.2.1.1 Intentionally deleted

7.2.1.2 The On-Board FRMCS shall support communication at least over a single transport domain. (M)

7.2.1.3 The On-Board FRMCS shall enable communication over multiple transport domains. (M-V3)

Note: The intention is here to distinguish between generic (FRMCS and non-FRMCS transport domains, defined in clause 6.3.6.5 of [FRMCS SRS]) and FRMCS Transport Domain(s) (defined in chapter 6.3.6 in [FRMCS SRS].

7.2.1.4 The On-Board FRMCS shall support communication over FRMCS transport domains. (M)

Note: in this requirement, FRMCS transport domain is explicitly referred to, whereas 7.2.1.2 refers to transport domains in general, be they FRMCS or not.

7.2.1.5 The On-Board FRMCS shall enable communication over non-FRMCS transport domains. (M-V3)

7.2.2 On-Board FRMCS Multipath Function for Bearer Flexibility.

7.2.2.1 The On-Board FRMCS shall enable communication concurrently over multiple transport domains (e.g., Multipath, as defined in [FRMCS SRS]). (M-V3)

7.2.2.2 The On-board FRMCS shall be able to notify the Trackside FRMCS of its MPF capability or lack of capability through the interface defined in [FRMCS SRS] 6.4.2.1. (M-V3)

7.2.2.3 The On-board FRMCS MPF should, whenever active, be able to contribute with information supporting the evaluation of data paths per data flow (e.g., availability, QoS) (refer to [FRMCS FRS], chapter 12). (O-V3)

7.2.2.4 The On-board FRMCS MPF should be able during operation to evaluate data paths per data flow in order to determine usable data paths (e.g., availability, QoS) (refer to [FRMCS FRS], chapter 12). (O-V3)

7.2.2.5 The On-board FRMCS MPF shall be able to switch any data flow from one data path to another, according to the configured MPF policy, data path availability and quality (refer to [FRMCS FRS], chapter 12). (M-V3)

7.2.3 Border Crossing (FRMCS to FRMCS / GSM-R to FRMCS)

7.2.3.1 Border Crossing procedures in this chapter cover FRMCS to FRMCS and GSM-R to FRMCS country border transitions, where the On-Board FRMCS needs to select the desired FRMCS Domain. (I)

7.2.3.2 The On-Board FRMCS shall support the following Border Crossing Operating Modes:

- Disabled (M-V3)
- Manual (M-V3)
- Auto (M-V3)

Editor's Note: The Border Crossing Operating Mode will be selected by the driver via HMI, which interface to use to convey the information to the On-Board FRMCS is FFS.

7.2.3.3 Border Crossing Operating Mode applies to the OB FRMCS and cannot be set differently for each application. (I)

7.2.3.4 When Border Crossing Operating Mode is set to Manual, the On-Board FRMCS shall provide the means to select the new FRMCS Domain from a list of FRMCS Domains. (M-V3).

Editor's Note: The border crossing procedures involve sending and receiving lists of FRMCS Domains to/from the HMI. Which interface to use to convey this information between the On-Board FRMCS and HMI is FFS.

7.2.3.5 When Border Crossing Operating Mode is set to Auto, the On-Board FRMCS shall determine and select the target FRMCS Domain autonomously. (M-V3)

7.2.3.6 When Border Crossing Operating Mode is set to Disabled, the On-Board FRMCS does not perform any action related to the change of FRMCS Domains. (I)

7.2.3.7 The On-Board FRMCS shall provide the means to inform on the outcome of the border crossing procedure. (M-V3)

7.2.3.8 In case of errors during the border crossing procedure, the On-Board FRMCS shall take error handling measures. (M-V3)

7.3 Providing transport services to multiple applications

7.3.1 Rationale

In order to reduce the number of components required for communication, the On-Board FRMCS is expected to provide connectivity to multiple applications, regardless of the category of application (critical, performance or business) by sharing the resources of the FRMCS Radio Modules. (I)

7.3.2 Requirements

7.3.2.1 The On-Board FRMCS shall have the capability to share FRMCS Radio Modules among different communication services (e.g. multiple applications using the same FRMCS Radio Module). (M)

7.3.2.2 The On-Board FRMCS shall provide transport services simultaneously to multiple communication services and their corresponding diversified applications, as defined in [FRMCS SRS]. (M-V3)

7.3.2.3 Multiple applications or application instances may simultaneously share On-Board FRMCS connectivity resources. (I)

7.3.2.4 Examples of such applications (I):

- ETCS on-board equipment;
- Passenger announcement system and intercom;
- Supervision, management and remote control of on-board systems;
- Driver Safety Device;
- CCTV;
- FRMCS cab radio voice function;
- Train-Borne Recorder;
- Applications related to passenger experience (e.g. passenger information system);
- Etc.

7.3.2.5 The On-Board FRMCS shall be able to handle data traffic congestion situations according to [FRMCS SRS] chapter 14.3. (M)

7.3.2.5i Intentionally deleted.

7.3.2.6 The On-Board FRMCS shall provide transport services with QoS profiles specific to applications as specified in [FRMCS SRS] Annex. A. (M)

7.3.2.7 The On-Board FRMCS shall manage traffic according to a priority order, according to [FMCS SRS] chapter 14.6.2.1. (M)

7.4 Intentionally deleted

7.4.1 Intentionally deleted.

7.4.2 Intentionally deleted.

7.5 Local Binding Function

7.5.1 Rationale

It is assumed that any application attempting to access the services provided by the On-Board FRMCS is considered as untrusted. (I)

In relation to the security of the connectivity to the On-Board FRMCS, protective mechanisms need to be defined that guarantee a certain trust level depending on the functionality of the on-board system that is accessed by an entity outside of the on-board system boundary. (I)

This function described in the Rationale paragraph is named “Local Binding Function”. (I)

7.5.2 Requirements

7.5.2.1 The On-Board FRMCS shall expose a function, called Local Binding Function, that ensures authentication and integrity of both communicating parties. (M)

Note: confidentiality requirements as specified in 7.9.2.10 are specified in [FRMCS FFFIS]

7.5.2.2 The invocation of the Local Binding Function shall be the subject of an explicit dedicated communication mechanism between the on On-Board Application and the On-Board FRMCS (e.g., by means of an API). (M)

7.5.2.3 For any application, the On-Board FRMCS shall prohibit access to its services prior successful invocation of Local Binding Function. (M)

7.5.2.4 After a successful invocation of the Local Binding Function, the requesting Onboard Application is Locally Bound. (I)

7.5.2.5 The On-Board FRMCS shall maintain a set of FRMCS On-Board Application Profiles (see also [FRMCS SRS] chapter 19.3). An FRMCS On-Board Application Profile contains rules (FRMCS On-Board Application Profile Rules) to determine whether to grant or prevent access to services provided by the On-Board FRMCS to an Onboard Application based on information provided at invocation of the Local Binding Function. (M-V3)

7.5.2.6 FRMCS On-Board Application Profile shall be used to determine the type of service provided to the application (Tight coupled, Loose Coupled). (M)

7.5.2.6i In case of a Tight Coupled application only access to and usage of transport resources shall be provided. (M)

Note: It is considered that the FRMCS Service Client embedded within the application environment in case of tight coupling is not part of the core of the application and therefore belongs to FRMCS.

7.5.2.6ii In case of a Loose Coupled application access to and usage of FRMCS Service Client shall be provided. (M)

7.5.2.6iii In case of an application connecting using an On-board Application Agent (see chapter 4.3), access to and usage of transport resources shall be provided that enables data communication for connectivity. (M-V3)

7.5.2.6iv Intentionally deleted.

7.5.2.6v Intentionally deleted.

7.5.2.7 FRMCS On-Board Application Profiles shall be configurable. (M)

Note: This is e.g. by means of the O&M functionality, locally or remotely by the appropriate organization, the identification of which is out of scope of this document.

7.5.2.8 FRMCS On-Board Application Profiles Rules may consist of sets of attributes that provide information to the On- Board FRMCS on modes of operation associated onboard applications, e.g. (I):

- Maximum number of instances of the Onboard Application currently Locally Bound
- Whether the Locally Bound Onboard Application is subject to railway interoperability (Harmonised FRMCS Applications vs Non-Harmonised FRMCS Applications)
- Type of the Locally Bound Onboard Application (ETCS, ATO, voice, …)

7.5.2.9 The On-Board FRMCS shall associate a Locally Bound Onboard Application to an FRMCS On-Board Application Profile. (M)

7.6 On-Board FRMCS Time Function

7.6.1 Rationale

7.6.1.1 An On-Board FRMCS Time Function is introduced to provide date and time of day information for, e.g.(I):

- Logging
- Association with location and positioning information for provision to Tight Coupled FRMCS applications

7.6.2 Requirements

7.6.2.1 The On-Board FRMCS Time Function shall accept various time sources than can be internal or external to the On-Board FRMCS. (M-V3)

7.6.2.2 The On-Board FRMCS Time Function shall provide the capability to obtain time of day.(M-V3)

7.6.2.3 The On-Board FRMCS Time Function shall provide the capability to distribute time of day to On-Board FRMCS Functions only (e.g., Notification Function, O&M Function). (M-V3)

7.6.2.4 The On-Board FRMCS Time Function shall provide the capability to inform On-Board FRMCS Functions on detectable degradations of the capability to provide time of day information. (M-V3)

7.6.2.5 If at least one time source is available, the deviation of the time of day information provided by On-Board FRMCS Time Function shall not exceed +/-10 ms compared to the time source in UTC. (M-V3)

7.6.2.6 The On-Board FRMCS Time Function should provide the capability to synchronize its time of day with an on-board time source external to the OB FRMCS using an IP-based protocol such as NTP or NTS. (O-V3)

7.6.2.7 If the train is equipped with the Train Time Service (TTS) as specified in subset-147 [SS147], the On-Board FRMCS Time Function shall provide the capability to synchronize its time of day with the Train Time Service (TTS). (M-V3)

7.6.2.8 The On-Board FRMCS Time Function shall maintain a reliable time of day in case of temporary loss of all its time sources with a deviation not exceeding 1s per 7 days compared to UTC. (M-V3)

7.6.2.9 When powered off, the On-Board FRMCS Time Function shall maintain the time for at least 7 days, with a deviation not exceeding 1s per 7 days compared to UTC. (M-V3)

7.7 Operations and Maintenance

7.7.1 Rationale

The On-Board FRMCS has an embedded O&M function that allows to operate and maintain all the components of the On-Board FRMCS via an open and fully documented interface. This function only deals with O&M of the On-Board FRMCS and not of the applications or other entities. (I)

Note: documentation needs to be thorough enough to enable use by third parties without help from the provider of the API.

7.7.2 Requirements

7.7.2.1 The O&M function shall provide information related to hardware and software modules of the On-Board FRMCS. (M-V3)

7.7.2.2 This information concerns for example supervision, monitoring, statistics, performance, security, … (I)

7.7.2.3 The information provided as per clause 7.7.2.1 shall be formatted and exchanged according to a specified and fully documented protocol (e.g., Json). (M)

7.7.2.4 The O&M function shall provide a way for an O&M User to send instructions related to hardware and software modules of the On-Board FRMCS (e.g. configuration, updates or upgrades, ...). (M)

7.7.2.4i The O&M function shall provide a way for an O&M User to manage Interoperable Context(s) (e.g. initial provisioning, configuration changes, updates or upgrades, ...). (M-V3)

7.7.2.5 Instructions shall use a fully documented API. (M)

Note 1: see note to the Rationale for “fully documented”.

Note 2: The O&M API is subject to implementation.

7.7.2.6 The transfer of the instructions to the components of the On-Board FRMCS shall use a fully documented protocol. (M-V3)

7.7.2.7 The functionalities provided by the O&M function (7.7.2.1, 7.7.2.4 and 7.7.2.4i) shall be available using the OB_{OM} interface for authorized O&M Users. (M-V3)

7.7.2.8 The FS_{OMR} interface shall enable management of the On-Board FRMCS Interoperable Context(s) (7.7.2.4i) for authorized O&M Users (M-V3)

7.7.2.9 The O&M function shall be the only function allowed to manage the On-Board FRMCS equipment (M)

7.7.2.10 Access to O&M function shall be secured (as specified in [FRMCS SRS] chapter 7.1.5.11). (M-V3)

7.7.2.11 The O&M function shall provide the possibility to define a role and access matrix. (M)

7.7.2.12 The role matrix shall identify access rights by allowing different actions and/or information retrieval capabilities to different O&M Users in relation to the following minimal list of functions:

- Logs from the FRMCS Gateway (M-V3)

- Logs from the Radio Function (M-V3)
- Logs from the OB_{APP} interface (M-V3)
    - Access Rights (FRMCS Application Profile and O&M Function)
    - O&M Function
    - Gateway Function
    - Radio Function
- Upgrade or update of a Radio Function (M)
- Upgrade or update of the FRMCS Gateway. (M)

Note: additional functions might be introduced in subsequent versions

7.7.2.13 In this document, the O&M function is described according to the structure of the ISO Network Management Model FCAPS (Fault, Configuration, Accounting, Performance and Security). (I)

7.7.2.14 Figure 7-1 shows the principle of the main O&M functions (I)

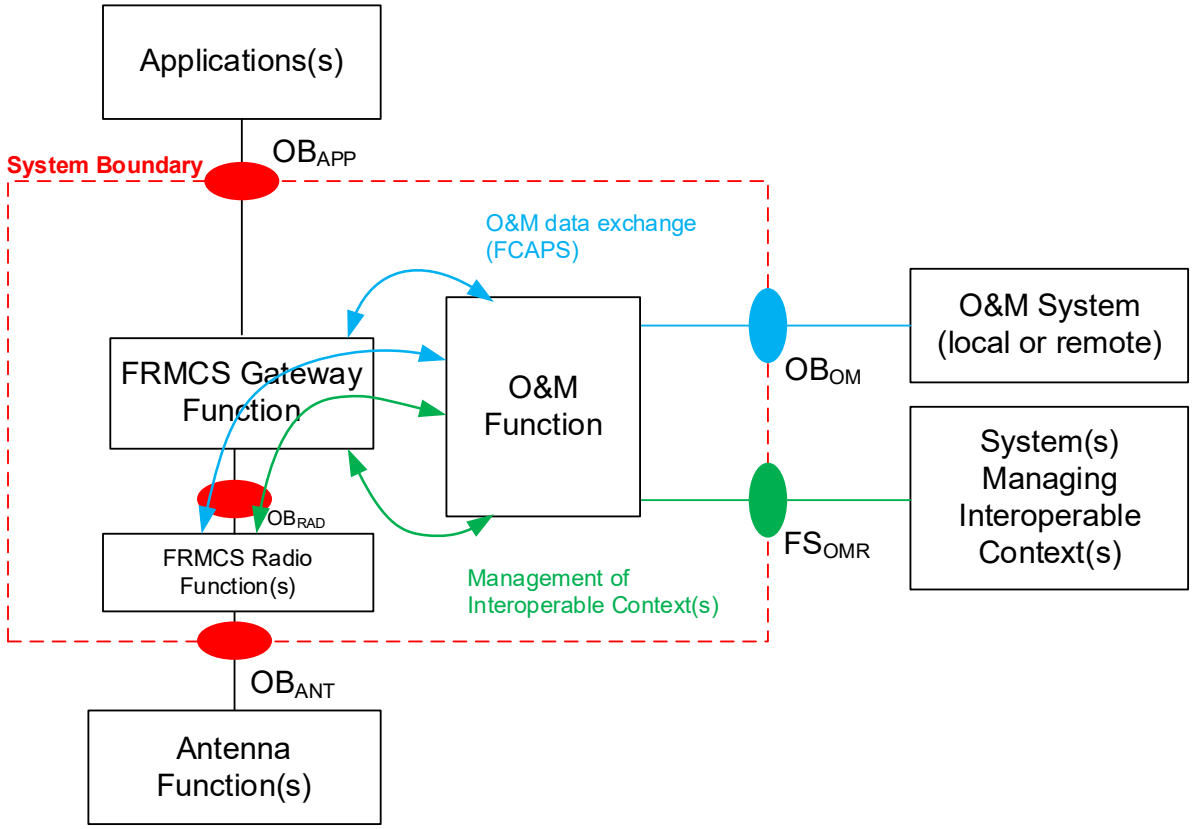


Figure 7-1: OB_{OM} as the reference point for any O&M activity (FCAPS); FS_{OMR} as the reference point for management of Interoperable Context(s)

7.7.3 O&M Functional Requirements

7.7.3.1 Generic functional requirements

7.7.3.1.1 O&M related data from components (e.g., logs, alarms, performance metrics) shall be reliably collected and stored by the O&M Function for a minimum amount of time defined in days. (M-V3)

7.7.3.1.1i The O&M Function shall be able to protect stored O&M related data from unintended and unwanted changes. (M-V3)

7.7.3.1.1ii The O&M Function shall be able to exchange O&M related data with a remote O&M system, using an interface associated to the OB_{OM} reference point. (M-V3)

7.7.3.1.1iii The O&M Function shall be able to exchange O&M related data with a local on-board O&M system, using an interface associated to the OB_{OM} reference point. (M-V3)

7.7.3.1.1iv The O&M Function shall be able to exchange Interoperable Context(s) related data with a remote O&M system, using a harmonised interface associated to the FSOMR reference point. (M-V3)

7.7.3.1.2 The log data provided by the components of the On-Board FRMCS shall allow the O&M Function to provide information enabling the support for configuration and/or service (including troubleshooting) of the On-Board FRMCS. (M-V3)

7.7.3.1.3 Log data includes for example the following (I):

- Physical ID of the engine
- Functional Alias of the engine on which the On-Board FRMCS is mounted (more generically, the Functional Identity, as defined in [FRMCS SRS], might be considered)
- Type of radio access and radio conditions (e.g., RF parameters) available
- QoS Profiles used
- Apps registered to the on-board system
- Type of radio access used by each app
- Faults detected on the radio interface of the on-board system
- Faults detected on the OB_{APP}, OB_{RAD} interface, OB_{OM} and OB_{ANT} interfaces
- Security logs
- …

7.7.3.1.4 All the events logged by the O&M function shall be associated with a time stamp allowing discrimination of events sequences. (M)

7.7.3.1.5 It shall be possible to associate events logged by the O&M function to the location information available via the Location Services Common function. (M-V3)

7.7.3.1.6 The log data shall be classified (by the O&M Function or the O&M System) according to Level categories of events (M-V3)

7.7.3.1.7 The considered log Level categories can be for example (I):

- Information

- Warning
- Minor
- Major
- Critical

Note: Further sub-categories to support finer granularity can be defined as an option when the logging system is implemented.

7.7.3.2 Fault Management Requirements

7.7.3.2.1 The O&M Function shall enable fault management of the On-Board FRMCS. (M)

Note: Fault Management is further specified in detail in [FRMCS SRS].

7.7.3.3 Configuration Management Requirements

7.7.3.3.1 The O&M function shall have the capability to distribute configuration and software updates to the components. (M)

7.7.3.3.2 It shall be possible to perform firmware, software or parameters upgrade/modification of the On-Board FRMCS. (M)

7.7.3.3.3 The O&M function shall be able to get package availability notification from O&M Users (M-V3)

7.7.3.3.4 The O&M function shall be able to retrieve packages (M-V3)

7.7.3.3.5 The O&M function shall be able to install packages related to components. (M)

7.7.3.3.6 The O&M function shall verify the packages compatibility against On-Board FRMCS HW and SW configuration prior their installation (M)

7.7.3.3.7 It shall be possible to specify conditions when a change is allowed (e.g., activation of operation and maintenance mode). (M-V3)

Note: A change is in this context to be understood as an activation of a package.

7.7.3.3.8 It shall be possible to store SW/FW versions and configuration sets on On-Board FRMCS and to choose which version to operate. (M-V3)

7.7.3.3.9 It shall be possible to schedule/reschedule the targeted time when the O&M function makes a change. (M-V3)

7.7.3.3.10 The On-Board FRMCS shall safeguard against an unsuccessful change of SW/FW, e.g. by reloading the previous version in operation. (M-V3)

7.7.3.3.11 On-Board FRMCS Integrity: the On-Board FRMCS shall check its own integrity after any change and inform the O&M Function of any deviation detected. (M-V3)

7.7.3.3.11i On-Board FRMCS Integrity: the On-Board FRMCS shall check its own integrity at boot time and inform the O&M Function of any deviation detected. (M-V3)

7.7.3.3.11ii The On-Board FRMCS shall prevent start-up of software with an identified integrity error, e.g. by reloading the previous version in operation. (M-V3)

7.7.3.3.12 It shall be possible to update configuration data to individual On-Board FRMCS hardware components. (M-V3)

7.7.3.3.13 The O&M function shall enable storage and maintenance of a list of all the components of the On-Board FRMCS and of their identifiers. (M)

7.7.3.3.14 The On-Board FRMCS shall have the capability to provide on demand information about the SW, HW and firmware versions and configuration. (M-V3)

7.7.3.4 System Administration Requirements

7.7.3.4.1 The O&M function shall enable storage, administration and management of identifiers, Authentication and Authorization for Local Binding. (M)

7.7.3.4.2 The O&M function shall enable storage, administration and management of identifiers, Authentication and Authorization for Operation and Maintenance Users. (M)

7.7.3.4.3 The O&M function shall enable storage, administration and management of identifiers, Authentication and Authorization for FRMCS Service Users, necessary for the operation of the On-Board FRMCS. (M)

7.7.3.4.4 The O&M function shall enable storage, administration and management of identifiers, Authentication and Authorization for FRMCS System Access and Transport Users, necessary for the operation of the On-Board FRMCS. (M)

7.7.3.4.5 The functionalities specified in clause 7.7.3.4.4 shall be protected according to a risk-based assessment regarding confidentiality, integrity, availability and non-repudiation. (M-V3)

Note: Requirement 7.7.3.4.5 is generic and targets the introduction of a given security level, which could be, e.g., implemented by:

- Requiring all O&M Users accessing administrative functions to be identified
- Restricting the type and number of tasks associated to administrative O&M Users
- Logging all access attempts to administrative functions
- Generating alerts for unsuccessful access attempts
- Introducing timeouts for access
- …

7.7.3.5 Performance Management Requirements

7.7.3.5.1 The O&M Function shall collect performance indicators from the On-Board FRMCS components and make them available to O&M Users. (M)

7.7.3.5.2 The O&M Function shall provide performance indicators obtained from the On-Board FRMCS components (see [FRMCS SRS] chapter 7.1.5.11.2.6 for components). (M)

7.7.3.5.3 The performance indicators shall concern external interfaces:

- The radio layer (M-V3)
- The transport layer (M-V3)
- The service layer (M-V3)
- OB_{APP}(M)
- OB_{OM} (M)

7.7.3.5.3i Performance indicators should concern interfaces:

- OB_{RAD} (O)
- OB_{ANT} (O)

7.7.3.5.4 Intentionally deleted

7.7.3.5.5 The O&M Function should identify performance problems that come from the On-Board FRMCS components. (O)

7.7.3.5.6 Performance monitoring functionality shall not prevent the normal operation of the On-Board FRMCS. (M-V3)

7.7.3.5.7 The performance monitoring functionality shall be configurable. (M)

7.7.3.5.8 Configurable parameters for the performance monitoring functionality can be for example (I):

- Maximum value for threshold
- Minimum value for threshold
- Nominal value for parameter

7.7.3.5.9 Performance data shall be logged by the O&M Function (see [FRMCS SRS] clause 7.1.5.11.2.6). (M-V3)

7.7.3.5.10 The O&M function should be able to acquire raw performance data from components of the On-Board FRMCS to be further processed. (O)

7.7.3.6 Supervision and Audit functional Requirements

7.7.3.6.1 The On-Board FRMCS logging information shall include information about the logging originator entity. (M)

7.7.3.6.2 In the case of a human originator, it shall not be possible the change or remove the audit log. (M)

7.8 The On-Board FRMCS Location Services Common function

7.8.1 The Location Services Common function shall be able to retrieve location and positioning information from any sources that are internal to the On-Board FRMCS system (see Figure 16-3, Chapter 16 of [FRMCS SRS] for details). (M)

7.8.1i The Location Services Common function shall be able to retrieve location and positioning information from sources that are external to the On-Board FRMCS system. (M-V3)

7.8.2 On-Board FRMCS Internal sources are (I):

1. Active Cell Id of the radio modules,
2. Radio Modules embedded GNSS information,
3. Stand-alone GNSS internal receiver information.

Note: 3GPP Positioning techniques information is considered here as external because it is hosted in the 5G core and not On-Board

7.8.3 An external source is any other source providing location and positioning information to the common function (e.g., external GNSS receiver, train-borne odotachymetry, ASTP system, …). (I)

7.8.4 The format of information from external sources needs to be non-proprietary, readable, and translatable into other formats. (I)

7.8.5 The Location Services Common function shall use at least one internal source. (M)

7.8.6 The Location Services Common function shall support internal On-Board FRMCS GNSS. (M)

7.8.7 The Location Services Common function should support external sources of location and positioning information (e.g., external GNSS source). (O-V3)

Note: Location sources located externally to the On-Board FRMCS Gateway Function (e.g., GNSS modules integrated in a Radio Module embedded in a FRMCS Radio Function) may need to transfer GNSS data through the OB_{RAD} interface.

7.8.8 The On-Board FRMCS shall associate an internal unique id to each source of location and positioning information used by the Location Services Common function. (M-V3)

7.8.9 The location services Common function shall be able to provide information to the O&M function for association of the log events with position. (M-V3)

7.8.10 The On-Board FRMCS Location Services common function shall provide the consumers the most accurate among the available sources of location and positioning information (further detailed in [FRMCS SRS]). (M)

7.8.11 Intentionally deleted

7.8.12 The On-Board FRMCS Location Services common function shall provide all the location and positioning information to the consumers. (M-V3)

7.8.13 The On-Board FRMCS shall have the capability to associate accuracy to parameters like position, speed and acceleration, when available. (M)

Note: Accuracy is mandatory at least ([FRMCS SRS] clause 16.3.16):

- For positioning correction when Train Component Geographic 2D Position is used
- For compensation when Train Speed is used

7.8.14 Accuracy of location shall be provided in units consistent with those of the provided location ([FRMCS SRS] clause 16.3.16). (M)

7.8.15 The Location Services Common function shall associate a nature to each source it serves a nature:

a) Cell Id (M)

b) 2D geographical coordinates (M)

c) 3GPP positioning information (M-Vx)

d) 1D coordinates (M-Vx)

e) 3D geographical coordinates (M-Vx)

f) Railway coordinates (M-Vx)

7.8.15i The Location Services Common function shall associate a type of information to each position and location it provides:

a) Direction (M)
b) Speed (M)
c) Acceleration (M-Vx)
d) Heading (M-Vx)

7.8.15ii The Location Services Common function should support a mechanism that can calculate the travelled distance between two points measured at different times. (O)

7.8.16 The location and positioning information shall be based on identified specifications that allow for extensibility of the information elements. (M-V3)

7.8.17 The Location Services Common function shall be able to locate the following train components: (M)

1. Train

7.8.17i The Location Services Common function will be able to locate the following train components: (M-Vx)

1. Train front end
2. Train rear end

7.8.18 Intentionally deleted

7.8.19 Intentionally deleted

7.9 Functional Interface between applications and On-Board FRMCS (OB_{APP})

7.9.1 Rationale

The On-Board FRMCS system will interface with several on-board applications as defined in [FRMCS FRS], for example, ETCS, DSD, PA, HMI, mobile handhelds of train staff etc. Consequently, this interface has to ensure management of and access to the communication services taking in consideration the priority and quality of service profile required by those applications. The interface is named OB_{APP} and is specified in detail in [FRMCS FFFIS]. (I)

7.9.2 Requirements

7.9.2.1 The interface shall provide three functions (M):

- Local Binding Function (see section 7.5 Local Binding Function)
- FRMCS Service Session Function: User plane data and related control plane data to be transmitted / received end-to-end between the applications (more details in [FRMCS SRS], [FFFIS]),
- Notification function: Provides information to the communication entities about the status of the communication service

7.9.2.2 The communication between the application/entity and the On-Board FRMCS is performed via an API. This API will encompass functions for (I):

- Local Binding Function
- FRMCS Service Session Function
- Notification Function
- (Potentially additional ones)

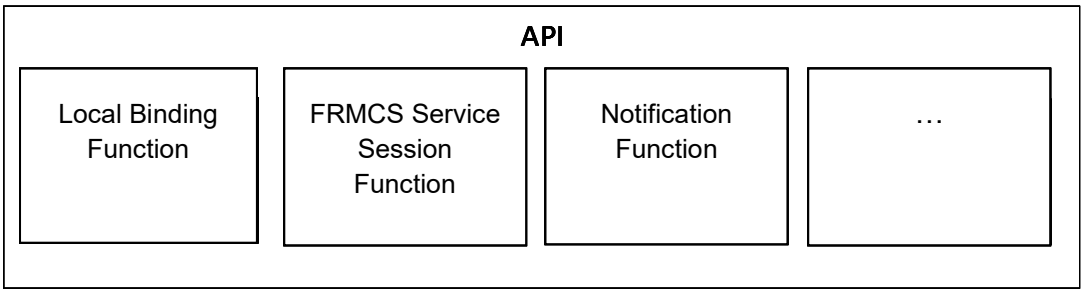


Figure 7-2: Example API blocks

7.9.2.3 The Local Binding Function, according to section 7.5 shall enable (M):

- Enable Authentication and Authorization of the On-Board Application against the On-Board FRMCS.
- Support Authentication and Authorisation of the On-Board Application to use FRMCS services provided by the On-Board FRMCS.
- Support Authentication and Authorization of On-Board FRMCS by Applications.

7.9.2.4 The OB_{APP} Service Session shall transparently carry user data for any locally bound application requesting a transport service. (M)

7.9.2.5 The Notification function is the collector of certain status information (e.g., FRMCS Service availability/link status) considered for a notification to the Application. Its functional requirements are specified in chapter 7.9.3 (I)

7.9.2.6 The OB_{APP} shall support two modes (M):

- Tight Coupled Mode
- Loose Coupled Mode

7.9.2.7 In Tight Coupled Mode the application or data host determines the communication parameters (e.g. Identity, etc) to be provided through the OB_{APP} to the On-Board FRMCS. The required communication parameters are further processed by the FRMCS Service Session Function (CP). Missing communication parameters are applied by defaults by the FRMCS Service Session Function. A local Orchestration Function manages the necessary interaction between CP and UP and is defined in [FRMCS SRS]. (I)

Note: Tight Coupled Mode is always used when signalling information also includes user information and the application is “MC service aware”.

7.9.2.8 The Loose Coupled Mode shall provide to the application or data host a way for UP data to be sent to corresponding host or network. (M)

7.9.2.8i In Loose Coupled Mode the application or data host is unaware about the FRMCS communication service parameters. In this scenario of LC mode, the parameters needed for the establishment of an appropriate FRMCS Service Session need to be provided locally by the Orchestration Function that manages the necessary interaction between CP and UP. (I)

Note 1: Loose Coupled Mode is used when the data host/application is unaware that the communication service uses MC functionality.

Note 2: “Non-MCX” on-board applications (e.g., IP-Camera…), or legacy applications that need to use FRMCS mobile access but cannot be updated, are not capable to perform Local Binding and use the API, need to use an agent (see chapter 4.3).

7.9.2.9 The On-Board FRMCS shall provide communication services only to Locally Bound applications (see 7.5.2.4). (M)

Note: The status of becoming locally bound can be obtained using an external agent.

7.9.2.10 For Control Plane data communication over OB_{APP}, the On-Board FRMCS shall enable support of confidentiality, integrity and availability. (see [FRMCS SRS] clause 7.1.5.5.2.1, [FFFIS] clause 6.3.3). (M-V3)

7.9.3 The OB_{APP} Notification Function

7.9.3.1 Rationale

7.9.3.1.1 The OB_{APP} Notification Function is a function realized by the OB_{APP} API that allows applications to receive all kind of notifications. The applications are not able to provide other information to the Notification Function parameters relative to subscription or request of the information conveyed by the Notification Function. (I)

7.9.3.1.2 The Notification Function gives information such as the connectivity status (e.g., for ETCS application according to [SS037-3]), location and positioning (acting as the way to pass information from the location services common function to the applications). (I)

7.9.3.2 Requirements

7.9.3.2.1 Intentionally deleted.

7.9.3.2.2 The Notification Function shall be able to provide to each application only the subsets of information it has subscribed to. (M)

7.9.3.2.3 The Notification Function shall be able to provide periodically information via the OB_{APP} API. (M)

7.9.3.2.3i The Notification Function shall be able to provide information on demand of an application via the OB_{APP} API. (M-V3)

7.9.3.2.4 The Notification Function shall allow applications to revoke their subscriptions via the OB_{APP} API. (M)

7.9.3.2.5 The Notification Function shall be configurable in order to categorize the different kind of information applications can subscribe to. (M)

7.9.3.2.6 The categories supported by the Notification Function shall contain:

- FRMCS Service Session and Connection Status, (M-V3)
- Connectivity at transport level, (M-V3)
- Service Availability State Transitions, (M)
- Transport Availability State Transitions, (M)
- Informative events or triggers, (M-V3)
- Location and positioning, (M)
- Identifiers and Notification Function information. (M)

7.9.3.2.7 The Notification Function shall be capable to include new kind of information in future versions (extensible category list). (M-V3)

Note: The goal of this requirement is to provide extensibility of the protocol for support of future use cases for the Notification Function.

7.9.3.3 The Notification Function subscription shall support different modes of information update (M):

- Periodic,
- Event triggered (e.g. value change of the subscribed parameter, Cell change, …).

7.9.3.4 Intentionally deleted.

7.9.3.5 The Notification Function shall support extension of the provided information by means of a protocol that supports adding new parameters and content (see clause 9.4.2 of [FFFIS]). (M)

Note: This requirement purpose it to support the evolution of the Notification Function. In case for example of additional categories of information added in subsequent versions of the protocol, if the protocol supports versioning, applications using it will be able to identify the information provided by the Notification Function.

7.9.3.6 Minimal list of information categories

7.9.3.6.1 For FRMCS Service Session and Connection Status categories, the Notification Function shall provide at least: (M)

- Connection status (relevant only for LC applications)
  - Connected if FRMCS Service client is registered at Trackside FRMCS
  - Disconnected if Service client is unregistered from Trackside FRMCS

7.9.3.6.2 For FRMCS Service Session and Connection Status categories, the Notification Function will provide: (M-Vx)

- FRMCS Service Session operational mode
  - Normal
  - Degraded

7.9.3.6.3 For Connectivity at transport level, the Notification Function shall provide at least: (M-V3)

- Connection status
  - Connected if at least one radio function has connectivity capability
  - Disconnected if none of the radio function has connectivity capability

7.9.3.6.4 For Connectivity at transport level, the Notification Function will provide: (M-Vx)

- Connectivity operational mode
  - Normal
  - Degraded

7.9.3.6.5 For Service Availability State Transitions category, the Notification Function shall provide at least:

- Service availability
  - Transition from Service Connected status to Service Disconnected status (M)
  - Transition from Service Disconnected Connected status to Service Connected status (M)
  - Service Domain Transition Reason (M-V3)

Note: Service availability, in accordance to chapter 10 clause 10.3.4 of [FRMCS SRS] implies service availability per service type, in line also with [FRMCS FFFIS], where “channels” are defined for the Notification Function information subscriptions.

7.9.3.6.6 For Transport Availability State Transition category, the Notification Function shall provide at least:

- Transport domain transition
    - Transition from Transport Domain Connected status to Transport Domain Disconnected status (M)
    - Transition from Transport Domain Disconnected to Transport Domain Connected status (M)
    - Transport Domain Transition Reason (M-V3)

7.9.3.6.7 For Location and positioning information, the Notification Function shall provide information as described in chapter 7.8 of this document and as specified by [FFFIS] (M)

7.9.3.6.8 The Notification Function shall support backwards compatibility across versions (see clause 9.4.2 of [FFFIS]). (M-V3)

7.9.3.6.9 For identifiers and Notification Function information, the Notification Function shall rely on: (M)

- Support for version number of API protocol

7.9.3.6.9i For identifiers and Notification Function API information, the Notification Function should provide: (O)

- Vehicle number (EVN) of the first cabin of the trainset

7.9.3.6.10 For Identifiers Notification Function API information, the Notification Function provides: (M-Vx)

- Operational Train Number.

7.10 Functional Interface between management system(s) and O&M Function of the On-Board FRMCS

7.10.1 Rationale

An industry-specified interface between the O&M Function of the On-Board FRMCS and management system(s) will enable and promote flexible implementation and business models in terms of fleet management with respect to the management of On-Board FRMCS. (I)

7.10.2 Requirements

7.10.2.1 The OB_{OM} interface shall support the O&M functionalities as specified in chapter 7.7 of this specification and in chapter 7.1.5.11 of [FRMCS SRS]). (M-V3)

7.10.2.2 User access to capabilities of the O&M Function shall be role based (e.g., Security Administrator, System Administrator, Maintainer, etc.). (M)

7.10.2.3 The O&M Function shall support local and remote access (see chapter 7 clause 7.1.5.11 of [FRMCS SRS]). (M-V3)

7.10.2.4 The O&M Function shall enforce secure authentication and authorization controls for the use of O&M functionalities (M)

7.10.2.5 Intentionally deleted

7.10.2.6 The O&M Function shall support integrity protection of any O&M communication. (M-V3)

7.10.2.7 The O&M Function shall support confidentiality of any O&M communication (M-V3)

7.11 Functional Interface between FRMCS Gateway Function and FRMCS Radio Function(s) (OB_{RAD} interface)

7.11.1 Rationale

A specified and standardized OB_{RAD} interface enables On-Board FRMCS modularity. Modularity is to be understood as the separation between the FRMCS Gateway Function and the FRMCS Radio Function(s). An OB_{RAD} interface that enables modularity has the following objectives (I):

- Use of products from different manufacturers fulfilling the same functional requirements for FRMCS Gateway Function and the Radio Function(s) also for replacement, extension or upgrade of existing equipment and installations.
- Facilitation of the deployment and integration on-board by allowing the antennas to be further away from the GW which enables a strongly needed efficient FRMCS retrofitting for the migration phase for a significant number of vehicles and also facilitates radio technology diversity and coexistence.
- Reduction of test complexity by component-based testing.
- Enable to: add, remove, update or change radio access technology of terrestrial or non-terrestrial class, and of 3GPP or non-3GPP type.

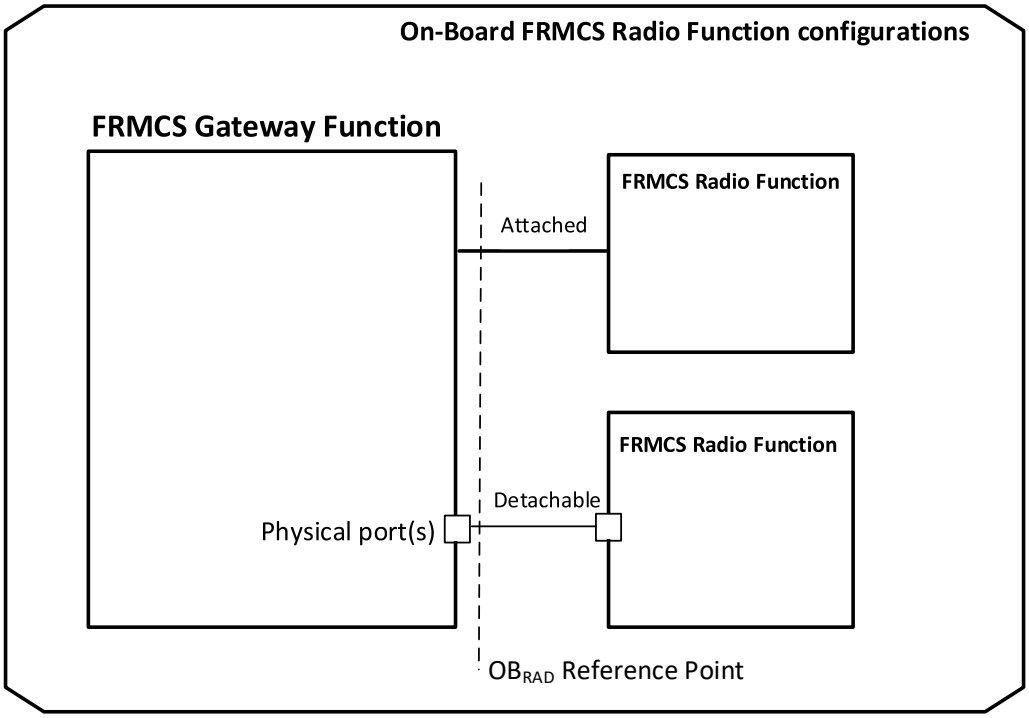


Figure 7-3: On-Board FRMCS Radio Function configurations

7.11.1.1 Figure 7-3 describes two possible configurations of Radio Functions (Attached Configuration or Detachable Configuration), related to the OB_{RAD} reference point. (I)

7.11.1.2)Intentionally Deleted

7.11.1.3 The case of FRMCS Radio Function Detachable Configuration implies the presence of a physical port. (I)

7.11.1.4 Intentionally deleted.

7.11.1.5 For Attached Configurations, the support of the interface associated to OB_{RAD} reference point, as per [FRMCS SRS] chapter 7.1.4.2.1 is an implementation choice. (I)

7.11.1.6 The support of FRMCS Radio Function Interchangeability is an implementation choice. (I)

7.11.2 Requirements

7.11.2.1i)Intentionally deleted.

7.11.2.1 For Detachable Configurations, the On-Board FRMCS should support FRMCS Radio Function Vendor Diversity by implementing the interface associated to OB_{RAD} reference point, as per [FRMCS SRS] chapter 7.1.4.2.1 (O-V3)

7.11.2.2 Intentionally deleted.

7.11.2.2i In case of Detachable Configuration the dependency on the distance and consequentially signal losses and propagation time between the On-Board FRMCS Gateway Function and On-Board FRMCS Radio Function(s) will be considered. (I)

7.11.2.3 Intentionally deleted.

7.11.2.4 Intentionally deleted.

7.11.2.5 It should be possible for the FRMCS Gateway Function and FRMCS Radio Function(s) to be located at different locations within the same train. (O)

7.11.2.6 Intentionally deleted

7.11.2.7 The OB_{RAD} functional interface shall support protocol(s) to retrieve FRMCS Radio Modules alarm state, log and specific performance data and transfer the data necessary for software and configuration changes in accordance with the functional requirements specified in chapter 7.7. (M-V3)

7.11.2.8 Intentionally deleted.

7.12 Intentionally deleted

7.12.1 Intentionally deleted

7.12.2 Intentionally deleted

7.12.3 Intentionally deleted

7.12.3.1 Intentionally deleted

7.12.3.2 Intentionally deleted

7.13 Intentionally deleted

7.13.1 Intentionally deleted

7.13.1.1 Intentionally deleted

7.13.1.2 Intentionally deleted

7.13.1.3 Intentionally deleted

7.13.1.4 Intentionally deleted

7.14 Intentionally deleted

7.14.1 Intentionally deleted

7.14.1.1 Intentionally deleted

7.14.2 Intentionally deleted

7.14.2.1 Intentionally deleted

7.15 Intentionally deleted

7.15.1 Intentionally deleted

7.15.1.1 Intentionally deleted

7.15.2 Intentionally deleted

7.15.2.1 Intentionally deleted

8 Non-Functional Requirements

8.1i Introduction

8.1.1i This chapter encompasses a number of non-functional requirements, e.g. cyber security, resilience, adaptability, accessibility, extensibility, maintainability, operability, reliability, durability, integration, upgradability, performance etc. (I)

8.1 Resilience

8.1.1 Rationale

The On-Board FRMCS provides the necessary means to eliminate single points of failure. (I)

8.1.2 Requirements

8.1.2.1 The On-Board FRMCS architecture shall enable availability concepts that eliminate single points of failure within the On-Board FRMCS itself. (M-V3)

8.1.2.2 OB_{APP} physical interface shall support resilience measures. (M-V3)

8.1.2.3 Modularity and implementation choices

8.1.2.3.1 Combination or duplication of functions, in software and/or in hardware, is an implementation choice, and depends on the user's needs, such as space restrictions, redundancy, used or foreseen applications, etc. (I)

9 References

9.1 Applicability

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, CCS TSI Annex A applies.

9.2 List of References

[FRMCS URS]	UIC, Future Railway Communications System, User Requirements Specification, FU-7100
[FRMCS SRS]	UIC, FRMCS, FRMCS System Requirements Specification, AT-7800
[FRMCS FRS]	UIC**,** Future Railway Communications System, Functional Requirement Specification, FU-7120
[FRMCS FFFIS]	UIC, FRMCS, FRMCS FFFIS Form Fit Functional Interface Specification, FFFIS-7950
[CCS TSI]	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
[EU 2016/797]	Directive (EU) 2016/797 of the European Parliament and of the Council of 11 May 2016 on the interoperability of the rail system within the European Union
[SS037-3]	UNISIG, EuroRadio FIS FRMCS Communication Functional Module, SUBSET-037-3
[SS147]	UNISIG, ERTMS Data Applications, FFFIS part : CCS Consist Network Communication Layers
TR 103 791]	Rail Telecommunications (RT); Future Railway Mobile Communication System (FRMCS);Terminology for FRMCS specifications
[ITU-T I.112]	ITU-T Recommendation I.112 : “General telecommunication terminology and definitions”

10 Annex A: Interoperability requirements in EU

This annex is the placeholder for identifying the requirements relevant for interoperability in the European Union, i.e. the requirements, with respect to the authorisation in the EU according to the TSI, that are considered in the European Directives to be relevant for interoperability as fulfilling the essential requirements for the Control- Command and Signalling (CCS) subsystem related to safety and technical compatibility which must be met by the rail system, the subsystems, and the interoperability constituents, including interfaces, according to the corresponding conditions set out in Directive (EU) 2016/797. It is mandatory that each railway subsystem in the EU meets these requirements on lines under the scope of the Directive and the CCS TSI to ensure technical compatibility between Member States and safe integration between train and track.

At this stage, the version of this specification is not considered complete for the purpose of tendering On-Board FRMCS equipment, and the final identification of all requirements relevant for interoperability is for further study.

This annex part is therefore only informative.

10.1 Scope and Purpose

10.1.1 This document lists a classification into categories of the clauses in the On-Board FRMCS Functional Requirements Specifications (FRMCS FRS).

10.1.2 The purpose of this document is to ease the assessment of the compliance of an On-board FRMCS equipment with the On-Board FRMCS FRS.

10.1.3 To that effect, this document identifies which clauses contain requirements allocated to the FRMCS on-board equipment that are relevant for interoperability and conversely which ones do not.

10.2 Definitions

10.2.1 The following categories are used to classify each On-Board FRMCS FRS clause:

10.2.1.1 Candidate MI requirement: a requirement that, as expressed in this FRMCS V2 specification, is considered to be related to interoperability (MI = Mandatory for Interoperability in Europe). This pre-assessment can be used to focus on the requirements that shall be completed in FRMCS V3 and also, to drive attention to the fact that a latter inclusion of the identified functionality will have to be done with careful attention to the compatibility between new and previous installations. Note that the identification of “candidate MI” requirements is just an indication to the reader, and, since this FRMCS V2 version is not to be part of a CCS TSI and the specifications are not yet ready for product production, it has no impact on the certification tasks of the Notified Bodies.

The following subcategories can be found in the table:

1.2.1.1. Candidate MI requirement for on-board FRMCS: a clause containing requirement(s) that are thought to be related to Interoperability; if confirmed in FRMCS V3, the requirement must be fulfilled by any CCS TSI compliant on-board FRMCS equipment.

10.3 List of MI Candidate clauses

The table below covers sections and individual requirements of the On-board FRMCS FRS.

Section	Requirements	Candidate MI for OB	Notes
4. Scope 4.2 System boundary, relevant reference points and interfaces, modularity	4.2.2	MI	Basic definition of the OB FRMCS boundaries. OB_{OM} (& FS_{OMR}) not MI, except the requirements related to update/configuration of Interoperability related FRMCS profile (FRIOP).
5.1 Key Design Paradigms 5.1.2 General Requirements	5.1.2.2	MI	It is a basic design principle. MI if multiple bearers are going to be implemented.
5.1 Key Design Paradigms 5.1.3 Resource Sharing	5.1.3.1	MI	It is a basic design principle. Needed for Interoperability to enable applications use of QoS. QoS principles have to be MI.
5.1 Key Design Paradigms 5.1.3 Resource Sharing	5.1.3.2 5.1.3.2i	MI	QoS and priorities are Interoperability related.
7.1 Decoupling of application and transport 7.1.2 Requirements	7.1.2.1 7.1.2.2	MI	It is a design principle. OB_{APP} is Interoperability related.
7.1 Decoupling of application and transport 7.1.2 Requirements	7.1.2.3	MI	It is a design principle.

Applies to TOBA FRS v2.1.1

Section	Requirements	Candidate MI for OB	Notes
7.1 Decoupling of application and transport 7.1.2 Requirements	7.1.2.5 7.1.2.6 7.1.2.7	MI	QoS and priorities are Interoperability related. They must be the same on-board and trackside.
7.1 Decoupling of application and transport 7.1.2 Requirements	7.1.2.8	MI	Addressing principles and identifiers are IOP related.
7.1 Decoupling of application and transport 7.1.2 Requirements	7.1.2.9	MI	Only for Harmonised applications.
7.2 Bearer Flexibility 7.2.1 General Requirements	7.2.1.2 7.2.1.3 7.2.1.4 7.2.1.5	MI	The ability to support different bearers is MI.
7.2 Bearer Flexibility 7.2.2 On-Board FRMCS Multipath Function for Bearer Flexibility	7.2.2.1 7.2.2.2 7.2.2.5	MI Multipath is MI for OB.	
7.3 Providing transport services to multiple applications 7.3.2 Requirements	7.3.2.5 7.3.2.6	MI	QoS and priorities are IOP related. MI only for QoS Profiles of CCS TSI applications.
7.3 Providing transport services to multiple applications 7.3.2 Requirements	7.3.2.7	MI	QoS and priorities are IOP related.
7.5 Local Binding Function 7.5.2 Requirements	All requirements marked M and M-v3: 7.5.2.1,	MI	Local Binding is needed to use OB_{APP}, Technical requirements are in FFFIS.

Applies to TOBA FRS v2.1.1

Section	Requirements	Candidate MI for OB	Notes
	7.5.2.2, 7.5.2.3, 7.5.2.5, 7.5.2.6, 7.5.2.6i, 7.5.2.6ii, 7.5.2.6iii, 7.5.2.7, 7.5.2.9		
7.6 On-Board FRMCS Time Function 7.6.2 Requirements	The following M requirements in the section: 7.6.2.1, 7.6.2.2, 7.6.2.3, 7.6.2.4.	MI	Linked to provision of info for Tight Coupled applications (Voice), also the understanding of time info both on-board and trackside shall be the same.
7.7 Operations and Maintenance 7.7.2 Requirements	7.7.2.7 7.7.2.8	MI	Functionality is MI only for FRIOP related functions (if any) (configuration, upgrade) (OB_{OM} not MI).
7.7 Operations and Maintenance 7.7.3 O&M Functional Requirements	All M requirements in section 7.7.3.4: 7.7.3.4.1, 7.7.3.4.2, 7.7.3.4.3, 7.7.3.4.4, 7.7.3.4.5	MI	MI only for FRIOP related functions.
7.8 The On-Board FRMCS Location services Common function	All M and M-V3 requirements in the clauses: 7.8.1i, 7.8.8, 7.8.10, 7.8.12 7.8.13,	MI	Function needed to achieve key functionality for Tight Coupled applications, also the understanding of Location info both OB and TR shall be the same. MI only for location information elements exchanged with trackside

Applies to TOBA FRS v2.1.1

Section	Requirements	Candidate MI for OB	Notes
	7.8.14, 7.8.15, 7.8.15i, 7.8.17.		
7.9 Functional Interface between applications and On-Board FRMCS (OBAPP) 7.9.2 Requirements	All M requirements in the Section 7.9.2: 7.9.2.1, 7.9.2.3, 7.9.2.4, 7.9.2.6, 7.9.2.8, 7.9.2.9, 7.9.2.10.	MI	OB_{APP} is needed for IOP and as interface of the IC On-board FRMCS.
7.9 Functional Interface between applications and On-Board FRMCS (OBAPP) 7.9.3 The OBAPP Notification Function	All M and M-V3 requirements in section 7.9.3: 7.9.3.2.2, 7.9.3.2.3, 7.9.3.2.3i, 7.9.3.2.4, 7.9.3.2.5, 7.9.3.2.6, 7.9.3.2.7, 7.9.3.3, 7.9.3.5, 7.9.3.6.1, 7.9.3.6.3, 7.9.3.6.5, 7.9.3.6.6, 7.9.3.6.7, 7.9.3.6.8, 7.9.3.6.9	MI	OB_{APP} is needed for IOP and as interface of the IC On-board FRMCS. AUX function is a key functionality for both LC and TC applications. Also linked to M requirements in FFFIS.
7.10 Functional Interface between management	7.10.2.3	MI	Functionality is MI only for FRIOP related functions (if any) (configuration, upgrade...).

Applies to TOBA FRS v2.1.1

Section	Requirements	Candidate MI for OB	Notes
system(s) and O&M Function of the On-Board FRMCS 7.10.2 Requirements			
8.1 Resilience 8.1.2 Requirements	The M-V3 requirements in the section: 8.1.2.1 8.1.2.2	MI	RAM requirements are essential requirements in TSI.

Applies to TOBA FRS v2.1.1

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