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# Foreword

This Technical Report has been produced by the 3<sup>rd</sup> Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

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# Introduction

The railway community is considering a successor communication system to GSM-R, as the forecasted obsolescence of the 2G-based GSM-R technology is envisaged around 2030, with first FRMCS trial implementations expected to start around 2020.

The Future Railway Mobile Communication System (FRMCS) Functional Working Group (FWG) of the International Union of Railways (UIC) have investigated and summarised their requirements for the next generation railway communication system in the Future Railway Mobile Communication User Requirements Specification (FRMCS URS) [2]. The present document is based on this input given by the UIC/ETSI TC-RT

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# 1 Scope

The present document analyses FRMCS Use cases, system principles of FRMCS and Interworking between GSM-R and FRMCS in order to derive potential requirements.

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# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- 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, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 36.213 V14.0.0, Technical Specification Group Radio Access Network; Evolved Universal Terrestrial radio Access (E-UTRA); Physical layer procedures, 2016.
- [3] 3GPP TS 23.179 V13.3.0, Technical Specification Group Services and System Aspects; Functional architecture and information flows to support mission critical communication services; Stage 2. 2016.
- [4] TTA TTA.KO-06.0437, LTE Based Railway Communication System Requirements (Conventional and High Speed Railway), Dec. 2016.
- [5] TTA TTA.KO-06.0370, User Requirements for LTE-Based Railway Communication System, Oct. 2014.
- [6] TTA TTA.KO-06.0-369, Functional Requirements for LTE-Based Communication System, Oct. 2014.
- [7] Y.-S. Song, J. Kim, S. W. Choi, and Y.-K. Kim, "Long term evolution for wireless railway communications: Testbed deployment and performance evaluation," *IEEE Comm. Mag.*, Feb. 2016.
- [8] J. Kim, S. W. Choi, Y.-S. Song, and Y.-K. Kim, "Automatic train control over LTE: Design and performance evaluation," *IEEE Comm. Mag.*, Oct. 2015.
- [9] UNISIG Subset-041 ERTMS/ETCS Performance Requirements for Interoperability
- [10] UIC FU-7100: "FRMCS User Requirements Specification".
- [11] UIC MG-7900: "FRMCS Use Cases".
- [12] UIC CODE 950: "EIRENE Functional Requirements Specification (FRS)".
- [13] UIC CODE 951: "EIRENE System Requirements Specification (SRS)".

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## 3 Definitions, and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**Automatic Train Operation (ATO):** Automatic Train Operation applications are responsible for acceleration to the permitted speed, speed reduction where necessary due to speed restrictions and stop at designated stations in the correct location.

**Automatic Train Protection (ATP):** Automatic Train Protection applications are responsible for giving Limit of Movement Authority to a train based on the train's current speed, its braking capability and the distance it can go before it must stop.

**Balise:** An electronic beacon or transponder placed between the rails of a railway as part of an automatic train protection or operation (ATP/ATO) system.

**Business communication applications:** communication applications that support the railway business operation in general, such as wireless internet, etc.

**Controller (Train Controller):** A Ground FRMCS User provided with special capabilities by the FRMCS System.

**Driver (Train Driver):** A Mobile FRMCS User provided with special capabilities by the FRMCS System.

**External System(s):** A general category of stationary FRMCS Users. For example, External Systems could be systems monitoring for trains passing a red light to initiate a railway emergency call.

**FRMCS Application:** The application on a 3GPP UE offering railway specific communication services to the FRMCS User by making use of the communication capabilities offered by the 3GPP UE and the 3GPP network.

**FRMCS Equipment Identity:** The identity by which a FRMCS equipment can be addressed.

**FRMCS Equipment Type:** Indicates the purpose the FRMCS equipment is being used for, FRMCS equipment of different equipment types do have different capabilities.

**FRMCS Equipment:** The FRMCS Equipment consists of a 3GPP UE and a FRMCS Application residing on it. It may be combined with legacy railway communication equipment (e.g. GSM-R or TRS)

**FRMCS Functional Identity:** The identity related to a user or related to the equipment, as specified in 9.3 "Role management and presence" indicating its special Role (e.g. as Driver of a specific train, usually a train number) can be addressed.

**FRMCS Network:** this is a sub-part of the FRMCS System.

**FRMCS Roaming:** The ability for a FRMCS User to make use of FRMCS Applications in a Visited (FRMCS) Network.

**FRMCS System:** The system providing railway specific communication constituted of the FRMCS Equipment, the 3GPP transport and the application servers in the network. Legacy networks are not included in the FRMCS System.

**FRMCS User Identity:** The identity by which a FRMCS User can be addressed.

**FRMCS User:** A human user or a machine making use of the railway specific communication. FRMCS Users can be connected via 3GPP RAT, wired connectivity or other radio technology

**Ground FRMCS User:** A general category of FRMCS Users that are predominantly stationary. Mostly they are connected via wired connectivity but may be using also wireless in certain conditions.

**Home FRMCS Network:** The Home FRMCS Network is the network in which the FRMCS User is engaged in a subscription.

**Mobile FRMCS User:** A general category of FRMCS Users that are mobile. Thus, they are connected via wireless connectivity all the time.

**Off-Network communication:** direct communication between FRMCS Users in proximity.

**On-Network communication:** indirect communication between FRMCS Users connected to FRMCS Network(s).

**Performance communication applications:** applications that help to improve the performance of the railway operation, such as train departure, telemetry, etc.

**Radio Block Centre (RBC):** A train sends its position and speed information periodically to the RBC. The RBC uses the received information to decide movement authority of the train.

**Rail Infrastructure Manager:** A company that owns or manages rail infrastructure; within this document the Rail Infrastructure Manager owns, administrates and operates the FRMCS Network.

**Railways Undertaking:** A company that offers train freight or passenger transportation services, making use of FRMCS network for their operational communication needs that is operated by a Rail Infrastructure Manager.

**Role (Functional Role):** The function a FRMCS User or a FRMCS Equipment is currently performing. Examples of Roles are Driver, Controller or shunting staff, etc. This is indicated by the FRMCS Functional Identity.

**Shunting:** manoeuvring trains in order to change their location or composition.

**Trackside staff:** Staff working as trackside maintenance and/or shunting members

**Trainborne equipment:** FRMCS Equipment which is physically embedded in train

**Visited (FRMCS) Network:** A Visited (FRMCS) Network can be either another FRMCS Network than the Home FRMCS Network, or a Public Land Mobile Network (PLMN).

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

ATO	Automatic Train Operation
ATP	Automatic Train Protection
AVC	Assured Voice Communication
DoS	Denial of Service
GNSS	Global Navigation Satellite System
LMR	Land Mobile Radio
MACN	Multi Access Core Network
NA	Naming Authority
OATP	On-board Automatic Train Protection
PSAP	Public Safety Answering Point
RBC	Radio Block Centre
REC	Railway Emergency Communication
TRS	Trunked Radio System
WATP	Wayside Automatic Train Protection

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## 4 Overview

The present document is an 800 series Technical Report (TR) written by 3GPP TSG SA WG1 (SA1). Such a TR is not normative, i.e. cannot be used for implementation directly and cannot be referred to by other 3GPP specifications. It was primarily written by SA1 to summarise the high-level communication needs of the railway community and to identify the corresponding requirements, which, in another step have been introduced into normative Technical Specifications (TS) of 3GPP.

An 800 series TR will not be updated when in the process of introduction of the requirements to TS changes are made to those requirements, i.e. the text of the requirements listed here in this TR will not be aligned with the requirements in the TS. Due to the fact that most of the requirements identified in this document were introduced in already existing Mission Critical Communication (MCX) TS, an alignment with the MCX terminology and functionality was made resulting in most of the requirements in here being reworded in the TS. Also, TS requirements changes due to future work affecting requirements stemming from this TR will not result in updates of this TR.

However, the columns “Comments” of the requirements tables listed below were updated to indicate the disposition of the requirement in the TS and most of the time summarising deviations and decisions taken when introducing those requirement into normative TS. By following these references into the normative TS the functionality provided by 3GPP for railway communication can be derived by the reader.

FRMCS will adapt 3GPP transport to provide communication to railway users. It eventually will resemble GSM-R and will additionally provide communication capabilities beyond what GSM-R has been able to. It will provide higher data rates, lower data latencies, multimedia communication, and improved communication reliability. FRMCS considers end-to-end use cases and also provides requirements that might or might not be in scope of 3GPP existing specifications. To facilitate smooth migration from legacy communication systems (e.g. GSM) to FRMCS, interworking requirements between legacy communication systems and FRMCS are provided.

FRMCS Equipment shall connect to application domain through 3GPP radio access or other access. It provides emergency group communication, low latency and high reliable data and video service in high speed train environment. Amongst others it has the following important features:

- Prioritized emergency group communication, train control data and video service
- Seamless connectivity in high speed railway moving environments
- Low latency and high reliable data and video service
- Real time train monitoring and management for safe train operation
- Reliable location tracking including in tunnel tracking
- Legacy railway communication interworking to GSM-R system

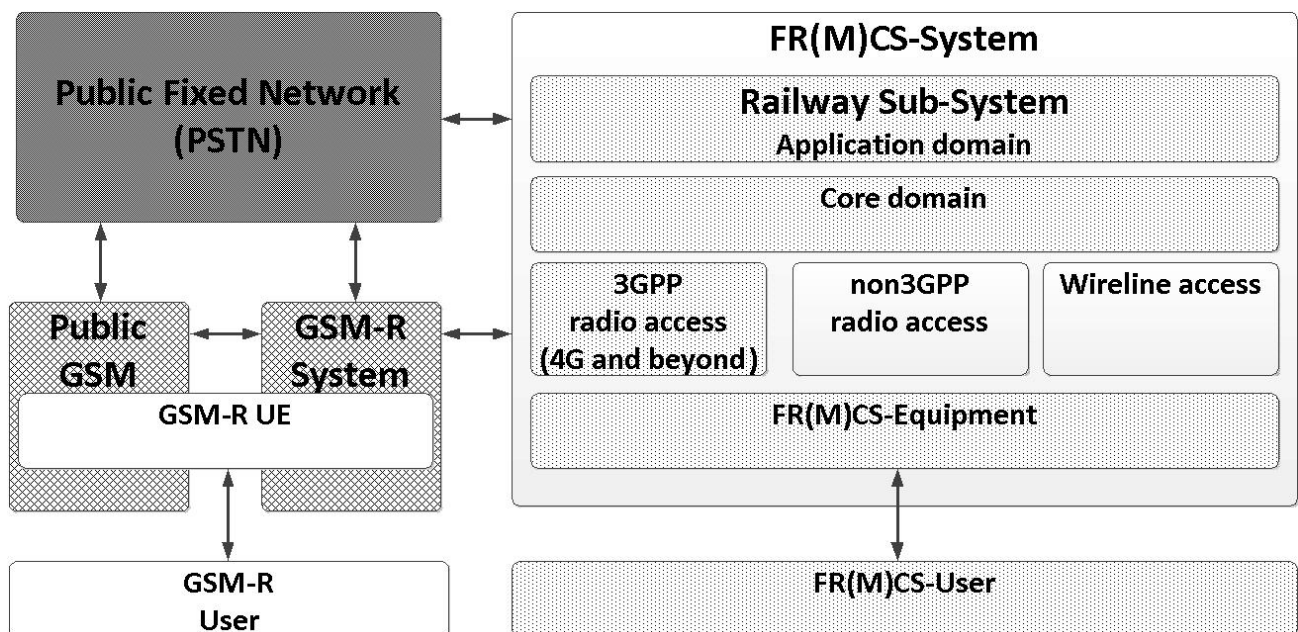


Figure 4-1: High-level relation of FRMCS and legacy systems

Basically, railway communication services [5] can be categorized into

- Train control services

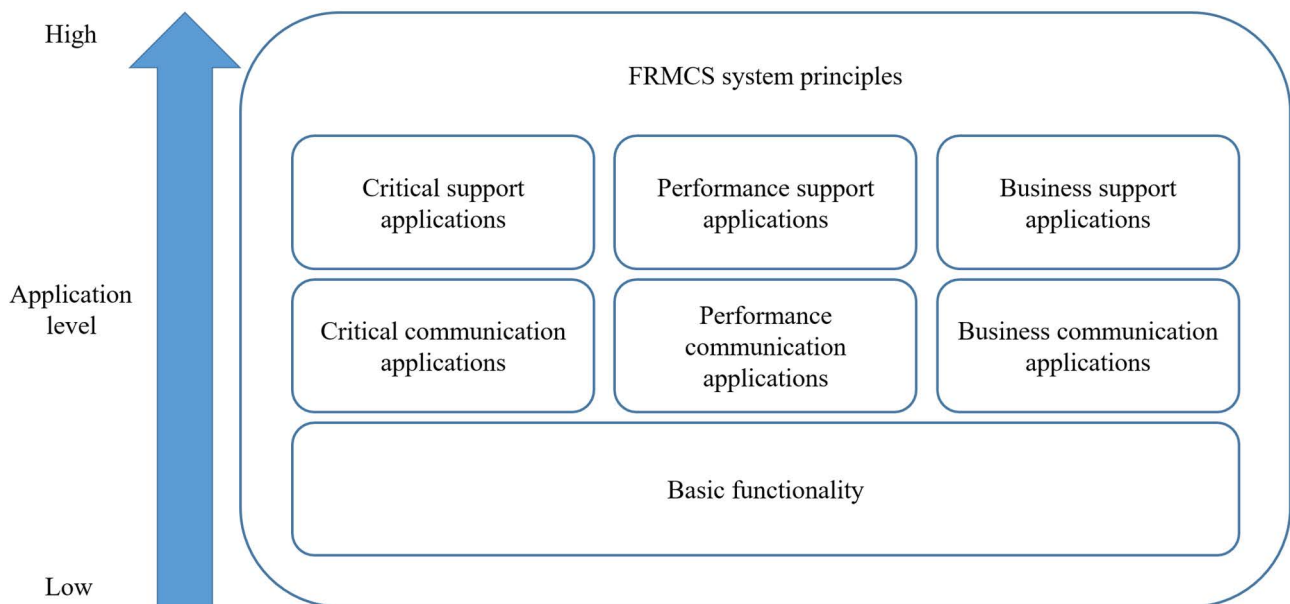


- Maintenance services
- Railway specific services (such as Railway Emergency Call, functional addressing, and location-based addressing)
- Other services (providing train crews or train Drivers with information of train operation and interworking with the existing railway communication systems)

This study categorizes all the use cases by considering inherent characteristics of railway applications. Specifically, the following categories of use cases are considered.

- Basic functionality
- Critical communication applications
- Performance communication applications
- Business communication applications
- Critical support applications
- Performance support applications
- Business support applications
- FRMCS System principles

The categories can be depicted conceptually as follows:



**Figure 4-2: Grouping of FRMCS Applications**

## 5 Basic functionality use cases

### 5.1 Introduction

The basic functionality use cases describe the behaviour of the FRMCS Equipment when powered up and down. For power up it takes the already powered up 3GPP UE as starting point conversely the same applies for power down.

## 5.2 Device power on and shut-down related use cases

In this chapter the use cases related to the function Initialisation and shut-down are defined.

- Power on the UE
- Access to the FRMCS System
- Controlled power down UE
- Uncontrolled power down UE

Note: Annex A provides examples of Role management (such as functional identities or FRMCS Equipment Identities) in the railway environment.

## 5.3 Use case: Power on the UE

### 5.3.1 Description

This use case provides the user with a powered-on UE.

### 5.3.2 Pre-conditions

The UE is switched off.

Note: In this use case and all the following it is assumed the UE contains a FRMCS Application, thus an UE with FRMCS Application is further referred to as FRMCS Equipment.

### 5.3.3 Service flows

#### **Successful self-test**

The user switches on the UE.

The FRMCS Application performs a self-test. If the test is successful, the user is informed about this.

#### **Unsuccessful self-test**

The user switches on the UE.

The FRMCS Application performs a self-test. If the test is not successful, the user is informed about this.

### 5.3.4 Post-conditions

The UE is switched on and attached to a 3GPP network following normal 3GPP defined network selection procedures but not logged into any FRMCS System. The user is informed about the results of the self-test.

### 5.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-5.3-001]	The FRMCS Application shall be capable to perform a self-test and inform the user about the results.	A	N/A	Implementation requirement

## 5.4 Use case: Access to the FRMCS System to activate the FRMCS Equipment

### 5.4.1 Description

This use case describes how the FRMCS Equipment registers to the FRMCS System.

### 5.4.2 Pre-conditions

The UE is powered on and attached to a 3GPP network but is not registered to the FRMCS System.

The UE has a subscriber identity.

### 5.4.3 Service flows

The FRMCS Equipment selects an applicable FRMCS System and logs on to it.

The FRMCS Equipment is initialised by the FRMCS System according to its type.

### 5.4.4 Post-conditions

The FRMCS Equipment capabilities are activated.

The FRMCS Application(s) are running on the device.

The FRMCS Equipment is logged in to the FRMCS System

### 5.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-5.4-001]	When a FRMCS Equipment registers to the FRMCS System, the FRMCS Equipment capabilities are activated and the FRMCS Equipment shall be reachable by its FRMCS Equipment Identity.	A	N/A	Implementation requirement

## 5.5 Use case: Controlled power down of UE

### 5.5.1 Description

The UE is powered down.

### 5.5.2 Pre-conditions

The UE is switched on and the FRMCS Equipment is registered to the FRMCS System.

### 5.5.3 Service flows

The user / FRMCS User initiates power-down of the UE.

If logged in, a FRMCS User is logged-out from the FRMCS System.

The FRMCS Equipment will deregister all identities which are active.

The FRMCS Equipment de-registers from the FRMCS System.

The UE is switched off.

### 5.5.4 Post-conditions

The UE is de-registered from the FRMCS System and switched off.

### 5.5.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-5.5-001]	When the UE is about to be powered down, a FRMCS User logged into the FRMCS System shall be logged off first.	A	N/A	Implementation requirement
[R-5.5-002]	By logging off the functional Role of a FRMCS User shall be deregistered from the FRMCS System.	A	N/A	Implementation requirement
[R-5.5-003]	After logging off the FRMCS User, the FRMCS Equipment capabilities shall be deactivated and the FRMCS Equipment shall be removed from the FRMCS System.	A	N/A	Implementation requirement

## 5.6 Use case: Uncontrolled power down UE

### 5.6.1 Description

This use case describes the case when the UE is powered down in an uncontrolled way e.g. due to battery failure.

### 5.6.2 Pre-conditions

The UE is switched on, the FRMCS Equipment is registered to the FRMCS System.

### 5.6.3 Service flows

The UE loses power probably without being able to notify the FRMCS System.

The UE is without power.

The FRMCS System will deregister all identities associated with the FRMCS Equipment.

### 5.6.4 Post-conditions

The UE is de-registered from the FRMCS System and switched off.

## 5.6.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-5.6-001]	When the UE is uncontrolled powered down, a FRMCS User logged into the FRMCS System shall be logged out from the FRMCS System.	A	N/A	Implementation requirement
[R-5.6-002]	By logging out the functional Role of the FRMCS User shall be deregistered from the FRMCS System.	A	N/A	Implementation requirement

# 6 Critical communication applications related use cases

## 6.1 Introduction

Critical communications applications are essential for train movements, safety, shunting, presence, trackside maintenance, legal aspects such as emergency communications, etc.

## 6.2 Multi-train voice communication for Drivers and Ground FRMCS User(s)

### 6.2.1 Introduction

In this chapter the use cases related to the function of Multi-train voice communication from the Drivers and/or a Ground FRMCS User towards the Driver and/or Ground FRMCS Users are defined. Ground FRMCS Users may include Controllers. The following use cases are defined:

- Initiation of Multi-train voice communication for Drivers and Ground FRMCS User(s) communication
- Termination of Multi-train voice communication for Drivers and Ground FRMCS User(s) communication
- Interworking GSM-R and FRMCS for Multi-train voice communication for Drivers and Ground FRMCS User(s) communication

### 6.2.2 Use case: Initiation of Multi-train voice communication for Drivers and Ground FRMCS User(s) communication

#### 6.2.2.1 Description

A Driver and/or a Ground FRMCS User shall be able to initiate a voice communication to other Drivers and/or Ground FRMCS Users.

#### 6.2.2.2 Pre-conditions

The Driver and the Ground FRMCS User are authorised to initiate the communication. This is managed by the authorisation of communication application.

The authorisation application authorises the Driver and the Ground FRMCS User to use the Multi-train voice communication for Drivers and Ground FRMCS User(s)

### 6.2.2.3 Service flows

The Driver and/or Ground FRMCS User initiates the voice communication to the (other) Driver(s) and/or Ground FRMCS Users. The priority of the communication is managed by the prioritisation application.

The FRMCS System determines the Driver(s) and the Ground FRMCS User(s) to be included in the communication, based on:

- location information of all users provided by the locations services application, and/or
- functional identity of all users provided by the Role management and presence application.

The FRMCS System establishes the voice communication within a setup time specified as NORMAL (see 12.10). The information from the Role management and presence application is used to present the identities for both Driver(s) and Controller(s). The initiating Driver is indicated to the Controller(s). Also the location of the Driver(s) in the voice communication is presented to the Controller(s) which is retrieved from the location services application.

If the Driver and/or Ground FRMCS User is connected to more than one Drivers and/or Controllers, the multiuser talker control application is used.

The precedence of the incoming voice communication at the Driver and the Controller is managed by the prioritisation application.

The voice communication is recorded by the Voice recording and access application.

### 6.2.2.4 Post-conditions

The Driver and/or the Controller is connected to requested Driver(s) and/or Controller(s).

## 6.2.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.2.2-001]	For a Multi-train voice communication for Drivers and Ground FRMCS User(s) the FRMCS Users shall be able to initiate the voice communication to FRMCS Users in trains or on ground.	A	22.280 22.179	TS 22.179 Floor Control clause 6.2.3.2 Req #1,  TS 22.280 clause 5.1 Req # 2
[R-6.2.2-002]	For a Multi-train voice communication for Drivers and Ground FRMCS User(s) the application layer priority of the communication shall be managed by the prioritisation application.	A	22.280	6.8.7 Application layer priority, 7.6 MCX Service priority requirements
[R-6.2.2-003]	For a Multi-train voice communication for Drivers and Ground FRMCS User(s) the FRMCS System shall be able to determine the FRMCS User(s) to be included in the voice communication, based, amongst others, on the following criteria: location information, speed and direction of travel provided by the locations services application, and/or functional identity provided by the Role management and presence application. System configuration on which Controller is responsible for which part of the track/station/etc.	A	22.280	6.4.9 req #6, 5.17 req # 3, 6.1 req #5, R-6.1.005, R6.6.5.2-00X 6.6.4.1.1, 6.6.4.1.2, 6.6.4.2-002a,002b 5.9a-006, 5.9a-008a
[R-6.2.2-004]	For a Multi-train voice communication for Drivers and Ground FRMCS User(s) the FRMCS System shall be able to add or remove FRMCS User from the communication once criteria are met or no more met, e.g. by a FRMCS User entering or leaving an area	A	22.280	6.4.9 req #6, 5.17 req # 3, 6.1 req #5, R-6.1.005, R6.6.5.2-00X 6.6.4.1.1, 6.6.4.1.2, 6.6.4.2-002a,002b 5.9a-006, 5.9a-008a
[R-6.2.2-005]	For a Multi-train voice communication for Drivers and Ground FRMCS User(s) the FRMCS System shall establish the communication within a setup time specified as NORMAL (see 12.10).	A/T	N/A	See section 12.10 below
[R-6.2.2-006]	The FRMCS System shall be able to mutually present the identities of all communication partners involved in a Multi-train voice communication for Drivers and Ground FRMCS User(s).	A	22.280	5.3 req #2, 5.7 req # 3, 6.4.3 req # 1 & #2 Presentation of the id of the speaker is sufficient See reqs in 6.4.5



[R-6.2.2-006a]	The FRMCS System shall be able to present the location of the Driver(s) to the Ground FRMCS Users involved in a Multi-train voice communication for Drivers and Ground FRMCS User(s).	A	22.280	5.11 001, 008, 015 6.12 001,006,007 6.4.5 001, 003, 004
[R-6.2.2-006b]	The FRMCS System shall be able to update the presentation of the location of the Drivers as they move.	A	22.280	5.11 007, 009, 013 6.12 006
[R-6.2.2-007]	For a Multi-train voice communication for Drivers and Ground FRMCS User(s), always includes more than two participants. If only two participants remain, the communication shall be treated as a user-to-user communication.	A	N/A	This is not a service requirement. It is up to 3GPP SA6 to decide whether a communication with only two has to change the mode of operation to 1-2-1 communication.
[R-6.2.2-008]	For a Multi-train voice communication for Drivers and Ground FRMCS User(s), multiuser talker control shall be used (See "9.7 Multiuser talker control related use cases").	A	N/A	This is not a service requirement. It is up to 3GPP SA6 to decide whether a communication with only two has to change the mode of operation to 1-2-1 communication.
[R-6.2.2-009]	For a Multi-train voice communication for Drivers and Ground FRMCS User(s) on the application layer the precedence of the incoming voice communication at the Driver and the Ground FRMCS User shall be managed by the prioritisation application.	A	N/A	See section 9.16 below
[R-6.2.2-010]	The FRMCS System shall be able to make available the speech and communication related data of a Multi-train voice communication for Drivers and Ground FRMCS User(s) for recording.	A	22.280	On-Net:6.15.4-001 – 010 Off-Net: Not implemented

### 6.2.3 Use case: Termination of Multi-train voice communication for Drivers and Ground FRMCS User(s) communication

#### 6.2.3.1 Description

The Driver shall be able to either put on hold, leave, or terminate the voice communication.

The Controller(s) shall be able to either put on hold, leave or terminate the voice communication.

#### 6.2.3.2 Pre-conditions

The Driver to Controller and/or Driver voice communication is ongoing.

#### 6.2.3.3 Service flows

##### Driver on hold

The Driver shall be able to put the voice communication on hold.

After the Driver has put the voice communication on hold, the communication remains in the FRMCS System, and the Driver is able to return to the communication again. When put on hold the other participants in the communication are informed and can continue the communication.

#### **Driver leaving**

The Driver shall be able to leave the voice communication. The Driver is not able to return to the communication after he has left. The Driver is not able to terminate the voice communication. When a Driver has left the other participants in the communication are informed and can continue the communication if there are still Driver(s) involved in the communication.

The FRMCS System terminates the voice communication if the last Driver has left (although (multiple) Controllers are still active in the communication). All involved users are informed.

#### **Ground FRMCS User on hold**

A Ground FRMCS User shall be able to put the voice communication on hold in the case that more than one Ground FRMCS User is part of the voice communication. The Ground FRMCS User is able to the communication again.

When put on hold the other participants in the communication are informed and can continue the communication.

#### **Ground FRMCS User leaving**

A Ground FRMCS User shall be able to leave the voice communication. The Ground FRMCS User is not able to return to the communication after he has left.

After the Ground FRMCS User has left the voice communication, the remaining users are informed.

#### **Controller termination**

Any Controller shall be able to terminate the voice communication.

The FRMCS System terminates the voice communication. All involved users are informed.

#### **Driver termination**

Only the Driver who initiates the call is able to terminate the voice communication with other Drivers.

The FRMCS System terminates the voice communication if only one Driver remains in the voice communication.

### **6.2.3.4 Post-conditions**

A Controller or the Driver has left the voice communication or the Controller or the system has terminated, put on hold or left the communication.

### 6.2.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.2.3-001]	For a Multi-train voice communication for Drivers including Ground FRMCS User(s) a Driver or a Ground FRMCS User shall be able to put the voice communication on hold. The voice communication between the remaining users shall not be affected by a Driver or Ground FRMCS User putting the voice communication on hold.	A	22.280	5.4.1, 5.4.2, 5.1.5 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is considered sufficient to mimic the desired behaviour.
[R-6.2.3-002]	For a Multi-train voice communication for Drivers including Ground FRMCS User(s) the Driver shall be able to leave the communication. Note: After a Driver has left the communication he is not able to return to it.	A	22.280	5.4.1, 5.4.2, 5.1.5 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is considered sufficient to mimic the desired behaviour.
[R-6.2.3-003]	For a Multi-train voice communication for Drivers including Ground FRMCS User(s) the Driver is not able to terminate the communication.	A	22.179	6.2.3.4, 6.2.3.5, 6.2.4
[R-6.2.3-005]	For a Multi-train voice communication for Drivers including Ground FRMCS User(s) the FRMCS System terminates the voice communication if the last Driver has left (although (multiple) Ground FRMCS Users are still active in the communication). All involved users are informed.	A	22.280 22.179	22.179 6.2.4 008 22.280 6.4.9 001 CR 22.280 0048 rev1: R-6.1-006, R-6.4.9-001
[R-6.2.3-006]	For a Multi-train voice communication for Drivers including Ground FRMCS User(s) a Ground FRMCS Users shall be able to leave the communication. After a Ground FRMCS User or a Driver has left the communication, the remaining users are informed.	A	22.280	6.4.4 002; 6.4.5 001; 5.1.5 003-008 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is considered sufficient to mimic the desired behaviour.
[R-6.2.3-007]	For a Multi-train voice communication for Drivers including Ground FRMCS User(s) any Controller shall be able to terminate the communication. All involved users are informed.	A	N/A	Due to the use of the affiliation mechanism and the burst-oriented nature of the MCPTT communication there is no such thing like a termination of a communication. It is simply not used anymore and the MCX Service deletes the identifiers and reservation for it after some time.

[R-6.2.3-008]	For a Multi-train voice communication between Drivers, the FRMCS System shall allow only the initiating Driver to terminate the voice communication.	A	N/A	Due to the use of the affiliation mechanism and the burst-oriented nature of the MCPTT communication there is no such thing like a termination of a communication. It is simply not used anymore and the MCX Service deletes the identifiers and reservation for it after some time.
[R-6.2.3-009]	For a Multi-train voice communication between Drivers, the FRMCS System shall terminate the voice communication if only one Driver remains in the voice communication.	A	N/A	Due to the use of the affiliation mechanism and the burst-oriented nature of the MCPTT communication there is no such thing like a termination of a communication. It is simply not used anymore and the MCX Service deletes the identifiers and reservation for it after some time.

## 6.2.4 Use case: Service Interworking and service continuation between GSM-R and FRMCS for Multi-train voice communication for Drivers and Ground FRMCS User(s) communication

### 6.2.4.1 Description

For migration purposes the service interworking and service continuation between the GSM-R system and FRMCS System for Multi-train voice communication for Drivers including Ground FRMCS User(s) communication needs to be defined.

Interworking between FRMCS and GSM-R shall not require any changes in the GSM-R system.

Depending on the migration scenario a Ground FRMCS User or a Driver can be attached to the FRMCS system, to the GSM-R system or both. The Driver can be attached either in the GSM-R system or in the FRMCS System. Functional identities are applicable in one system only.

This use case only applies to end user devices supporting both FRMCS and GSM-R systems.

### 6.2.4.2 Pre-conditions

None.

### 6.2.4.3 Service flows

#### Driver attached to GSM-R

When the Driver is attached to the GSM-R system and is initiating voice communication to other Drivers and Ground FRMCS User, the GSM-R system will route the voice communication to other Drivers the Ground FRMCS User (s) accordingly.

If the Driver or the Ground FRMCS User is located in the FRMCS System, the GSM-R system can only route the call if it can be reached by an address or identity understood by the GSM-R system. The Role management in FRMCS provides the appropriate address or identity e.g. by providing a mapping of GSM-R identities and FRMCS identities.

The information from the Role management and presence application is used to route the communication and to present the identities of both Driver and Ground FRMCS User.

#### Driver attached to FRMCS

When the Driver is attached to the FRMCS System and is initiating voice communication to other Drivers and Ground FRMCS User, the FRMCS System will route the communication to the Ground FRMCS User accordingly. The

information from the Role management and presence application is used to route the communication and to present the identities of both Driver and Ground FRMCS User. The Role management in FRMCS shall provide the appropriate address or identity e.g. by provide a mapping of GSM-R identities and FRMCS identities.

#### **Driver moving from GSM-R to FRMCS**

When the GSM-R user equipment of the Driver is detached from the GSM-R system the FRMCS end user device shall provide service continuation by setting up the communication via the FRMCS System. An interruption of voice communication is acceptable.

Note: This use case only applies to end user devices supporting both FRMCS and GSM-R systems, i.e. contains a FRMCS UE and a GSM-R UE. It is assumed the FRMCS Application on the FRMCS Equipment will have some control of the GSM-R part of the UE.

#### **Driver moving from FRMCS to GSM-R**

When the FRMCS User equipment of the Driver is detached from the FRMCS System the FRMCS end user device shall provide service continuation by setting up the communication via the GSM-R system. An interruption of voice communication is acceptable.

Note: This use case only applies to end user devices supporting both FRMCS and GSM-R systems, i.e. contains a FRMCS UE and a GSM-R UE. It is assumed the FRMCS Application on the FRMCS Equipment will have some control of the GSM-R part of the UE.

#### **6.2.4.4 Post-conditions**

None.

#### 6.2.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.2.4-001]	The FRMCS System shall provide the necessary means to allow FRMCS Users to be reachable from a legacy GSM-R system. Interworking between FRMCS and GSM-R shall not require any changes on GSM-R network side.	A	22.179	Covered in 6.18.4.2
[R-6.2.4-002]	The FRMCS System shall provide the necessary means to FRMCS Users to set up a Multi-train voice communication for Drivers and Ground FRMCS User(s) also to users in legacy GSM-R systems. Interworking between FRMCS and GSM-R shall not require any changes on GSM-R network side.	A	22.179	Covered in 6.18.4.2
[R-6.2.4-003]	For Multi-train voice communication for Drivers and Ground FRMCS User(s), when the GSM-R UE becomes detached from the GSM-R system, e.g. due to coverage problems, the end user device, if capable of making use of the FRMCS System shall be able set up the communication on the FRMCS System. An interruption of voice communication is acceptable. Note 1: This use case only applies to end user devices containing a FRMCS UE and a GSM-R UE. It is assumed the FRMCS Application on the FRMCS Equipment will have some control of the GSM-R part of the UE which is referred to here as end user device.	A	22.280	Covered by 6.6.4.1.2 and 6.6.5.2



[R-6.2.4-004]	<p>For Multi-train voice communication for Drivers and Ground FRMCS User(s), when the FRMCS Equipment, becomes detached from the FRMCS System, e.g. due to coverage problems, the end user device, if capable of making use of legacy GSM-R shall be able to set up the communication on legacy GSM-R. An interruption of voice communication is acceptable.</p> <p>Note 2: This use case only applies to end user devices containing a FRMCS Equipment and a GSM-R UE. It is assumed the FRMCS Application on the FRMCS Equipment will have some control of the GSM-R part of the UE which is referred to here as end user device.</p>	A		Covered by GSM-R "Late Entry"
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## 6.3 On-train outgoing voice communication from the Driver towards the Controller(s) of the train

### 6.3.1 Introduction

In this chapter the use cases related to the function of On-train outgoing voice communication from the Driver towards the Controller(s) of the train are defined. This use case allows the Driver to only communicate with Controllers. The following use cases are defined:

- Initiation of Driver to Controller(s) voice communication
- Termination of Driver to Controller(s) voice communication
- Interworking GSM-R and FRMCS of Driver to Controller(s) communication

### 6.3.2 Use case: Initiation of Driver to Controller(s) voice communication

#### 6.3.2.1 Description

The Driver shall be able to initiate a voice communication to the Controller(s) that was, is, or will be responsible for the movement of the train.

#### 6.3.2.2 Pre-conditions

The Driver is authorised to initiate the voice communication to the Controller. This is managed by the authorisation of voice communication application.

The Driver is authorised to use the On-train outgoing voice communication from the Driver towards the Controller(s) of the train application by the application authorisation of application.

### 6.3.2.3 Service flows

#### **Driver to responsible Controller(s)**

The Driver initiates the voice communication to the Controller. The priority of the communication is managed by the prioritisation application.

The FRMCS System determines the responsible Controller(s), based on:

- location information of the train provided by the locations services application, and/or
- functional identity provided by the Role management and presence application.
- system configuration on which Controller is responsible for which part of the track/station/etc.

The FRMCS System establishes the voice communication to the Controller(s) within a setup time specified as NORMAL (see 12.10). The information from the Role management and presence application is used to present the identities for both Driver and Controller. Also, the location of the Driver is presented to the Controller which is retrieved from the location services application.

If the Driver is connected to more than one Controller, the multiuser talker control application is used.

The precedence of the incoming voice communication at the Controller is managed by the prioritisation application.

The voice communication is recorded by the voice recording and access application.

#### **Driver to another Controller(s)**

The Driver initiates the voice communication to the Controller who was or will be responsible for the movement of the train. The addressing is performed by selecting an entry from a list or entered manually. The priority of the communication is managed by the prioritisation application.

The FRMCS System presents the list of Controllers to the Driver, based on:

- location information provided by the locations services application, and/or
- functional identity provided by the Role management and presence application.
- system configuration on which Controller is responsible for which part of the track/station/etc.

The FRMCS System establishes the voice communication to the Controller(s) within a setup time specified as NORMAL (see 12.10). The information from the Role management and presence application is used to present the identities for both Driver and Controller. Also, the location of the Driver is presented to the Controller which is retrieved from the location services application.

If the Driver is connected to more than one Controller, the multiuser talker control application is used.

The precedence of the incoming voice communication at the Controller is managed by the prioritisation application.

The voice communication is recorded by the Voice recording and access application.

### 6.3.2.4 Post-conditions

The Driver is connected to the requested Controller.

### 6.3.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.3.2-001]	For Driver to Controller voice communication, the Driver shall be able to initiate a voice communication to the Controller who is currently responsible for the train. The application layer priority of the voice communication shall be managed by the prioritisation application.	A	22.280	22.280 6.8.7.1, 6.8.7.2; 5.1.1 002 22.179 6.2.3.7.3 001
[R-6.3.2-002]	For Driver to Controller voice communication the FRMCS System shall be able to determine the responsible Controller(s), based on e.g.: location information, speed and direction provided by the locations services application, and/or functional identity provided by the Role management and presence application. System configuration on which Controller is responsible for which part of the track/station/etc.	A	22.280	CR 22.280 0049rev3, 6.6.4.1.1, 6.6.4.1.2, Req 6.6.4.2-002a,002b
[R-6.3.2-003]	For Driver to Controller voice communication the FRMCS System shall add or remove FRMCS User from the communication once criteria are met or no more met, e.g. by a FRMCS User entering or leaving an area.	A	22.280	CR 22.280 0049rev3, 6.6.4.1.1, 6.6.4.1.2, Req 6.6.4.2-002a,002b
[R-6.3.2-004]	For Driver to Controller communication the FRMCS System shall establish the communication to the Controller(s) within a setup time specified as NORMAL (see 12.10).	A/T	N/A	See section 12.10 below
[R-6.3.2-005]	The FRMCS System shall be able to mutually present the identities of all communication partners involved in a Driver to Controller(s) voice communication.	A	22.280	TS 22.280, 5.3 req #2, 5.7 req # 3, 6.4.3 req # 1 & #2 22.280 6.12-006 The id of the speaker is considered sufficient See reqs in 6.4.5
[R-6.3.2-006]	The FRMCS System shall be able to present the location of the Driver to the Controller(s) involved in a Driver to Controller(s) voice communication.	A	22.280	22.280 5.11 001, 008, 015 6.12 001,006,007 6.4.5 001, 003, 004 22.280 R-6.4.4-003, R-6.4.4-004
[R-6.3.2-007]	The FRMCS System shall be able to update the presentation of the location of the Drivers as they move.		22.280	22.280 5.11 007, 009, 013 6.12 006
[R-6.3.2-007 a]	For Driver to Controller communication, if the Driver is connected to just one Controller, the communication shall be considered as a user-to-user communication.	A	22.280	This is not a service requirement it is up to 3GPP SA6 to decide whether a communication with only two has to change the mode of operation to 1-2-1 communication

[R-6.3.2-008]	For Driver to Controller voice communication, if the Driver is connected to more than one Controller, the multiuser talker control shall be used (See "9.7 Multiuser talker control related use cases").	A	22.179	CRs 22.179 adding and CRs subsequently changing Section 5.9a
[R-6.3.2-009]	For Driver to Controller communication on application layer the precedence of the incoming voice communication at the Controller shall be managed by the prioritisation application.	A	22.280	See section 9.16 below
[R-6.3.2-010]	The FRMCS System shall be able to make available the speech and communication related data of a Multi-train voice communication for Drivers including Ground FRMCS User(s) for recording.	A	22.280	On-Net:6.15.4-001 – 010 Off-Net: Not implemented
[R-6.3.2-011]	For Driver to Controller communication the Driver shall be able to initiate the communication to the Controller who was previously or will be responsible next for the movement of the train. The selection shall be performed by selecting an entry from a list or entered manually. The priority of the communication on application layer shall be managed by the prioritisation application.	A	22.280	CR 22.280 0049rev3: 5.9a-006, 5.9a-008a, 6.6.4.1.1, 6.6.4.1.2, Req 6.6.4.2-002a,002b
[R-6.3.2-012]	For Driver to Controller communication the FRMCS System shall be able to present the list of Controllers to the Driver in order to select from, based on, amongst others, the following criteria: location information, speed and direction provided by the locations services application, and/or functional identity provided by the Role management and presence application. System configuration on which Controller is responsible for which part of the track/station/etc.	A	22.280	CR 22.280 0049rev3: 5.9a-006, 5.9a-008a, 6.6.4.1.1, 6.6.4.1.2, Req 6.6.4.2-002a,002b

### 6.3.3 Use case: Termination of Driver to Controller(s) voice communication

#### 6.3.3.1 Description

The Driver shall be able to terminate the Driver to Controller voice communication. The Driver is not able to leave the communication or to put on hold.

The Controller(s) shall be able to either put on hold, leave or terminate the Driver to Controller communication.

### 6.3.3.2 Pre-conditions

The Driver to Controller voice communication is ongoing.

### 6.3.3.3 Service flows

#### **Driver termination**

The Driver shall be able to terminate the voice communication. The FRMCS System terminates the voice communication. All involved Controllers are informed.

Note: The Driver is not able to leave the communication or to put on hold.

#### **Controller on hold**

A Controller shall be able to put the Driver to Controller voice communication on hold in the case that more than one Controller is part of the voice communication.

After the Controller has put the voice communication on hold, the communication remains in the FRMCS System, and the Controller is able to be part of the communication again.

#### **Controller leaving**

A Controller shall be able to leave the Driver to Controller voice communication in the case that more than one Controller is part of the voice communication.

After the Controller has left the voice communication he is not able to return to the communication and the remaining users are informed.

#### **Controller termination**

Any Controller shall be able to terminate the Driver to Controller voice communication.

The FRMCS System terminates the voice communication. All involved users are informed.

### 6.3.3.4 Post-conditions

A Controller has left the voice communication or the Driver to Controller voice communication is terminated.

### 6.3.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.3.3-001]	For Driver to Controller communication the Driver shall be able to terminate the communication.	A	22.280 22.179	22.280 6.4.9 001 22.179 6.4.9 002, 6.2.4 008
[R-6.3.3-002]	For Driver to Controller communication the FRMCS System shall allow the operator to configure whether a Driver shall be able to leave the voice communication.	A	22.280	CR 22.280: 5.9a-012a, 5.9a-012b
[R-6.3.3-003]	For Driver to Controller communication the FRMCS System shall allow the operator to configure whether a Driver shall be able to put the voice communication on hold.	A	22.280	22.280, 5.4.1, 5.4.2, 5.1.5 The affiliation mechanism is considered sufficient to mimic the desired behavior.
[R-6.3.3-004]	For Driver to Controller communication a Controller shall be able to put the voice communication on hold in the case that more than one Controller is part of the communication. The voice communication between the remaining users shall not be affected by a Controller putting the voice communication on hold.	A	22.280	22.280 6.4.4 002; 6.4.5 001; 5.1.5 003-008 22.280 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is considered sufficient to mimic the desired behavior.
[R-6.3.3-005]	For Driver to Controller communication a Controller shall be able to leave the Driver to Controller communication in the case that more than one Controller is part of the communication. After a Controller has left the communication, the remaining users shall be informed.	A	22.280	22.280 6.4.4 002; 6.4.5 001; 5.1.5 003-008 22.280 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is considered sufficient to mimic the desired behavior.
[R-6.3.3-006]	For Driver to Controller communication any Controller shall be able to terminate the Driver to Controller communication. All involved users shall be informed.	A	22.280 22.179	22.280 6.4.9 001 22.179 6.2.4 008

## 6.3.4 Use case: Service Interworking and service continuation between GSM-R and FRMCS of Driver to Controller(s) voice communication

### 6.3.4.1 Description

For migration purposes the service interworking and service continuation between the GSM-R system and FRMCS System for Driver to Controller(s) voice communication needs to be defined.

Interworking between FRMCS and GSM-R shall not require any changes in the GSM-R system.

Depending on the migration scenario a Controller can be attached to the FRMCS system, to the GSM-R system or both. The Driver can be attached either in the GSM-R system or in the FRMCS System. Functional identities are applicable in one system only.

This use case only applies to end user devices supporting both FRMCS and GSM-R systems.

#### 6.3.4.2 Pre-conditions

None.

#### 6.3.4.3 Service flows

##### **Driver attached to GSM-R**

When the Driver is attached to the GSM-R system and is initiating voice communication to Controller(s), the GSM-R system will route the voice communication to the Controller(s) accordingly.

If the Controller is located in the FRMCS System, the GSM-R system can only route the call to the Controller if the Controller can be reached by an address or identity understood by the GSM-R system. The Role management in FRMCS provides the appropriate address or identity e.g. by providing a mapping of GSM-R identities and FRMCS identities.

The information from the Role management and presence application is used to route the communication and to present the identities of both Driver and Controller.

##### **Driver attached to FRMCS**

When the Driver is attached to the FRMCS System and is initiating voice communication to Controller(s), the FRMCS System will route the communication to the Controller(s) accordingly. The information from the Role management and presence application is used to route the communication and to present the identities of both Driver and Controller. The Role management in FRMCS shall provide the appropriate address or identity e.g. by provide a mapping of GSM-R identities and FRMCS identities.

##### **Driver moving from GSM-R to FRMCS**

When the GSM-R user equipment of the Driver is detached from the GSM-R system the FRMCS end user device shall provide service continuation by setting up the communication via the FRMCS System. An interruption of voice communication is acceptable.

Note: This use case only applies to end user devices supporting both FRMCS and GSM-R systems, i.e. contains a FRMCS UE and a GSM-R UE. It is assumed the FRMCS Application on the FRMCS Equipment will have some control of the GSM-R part of the UE.

##### **Driver moving from FRMCS to GSM-R**

When the FRMCS User equipment of the Driver is detached from the FRMCS System the FRMCS end user device shall provide service continuation by setting up the communication via the GSM-R system. An interruption of voice communication is acceptable.

Note: This use case only applies to end user devices supporting both FRMCS and GSM-R systems, i.e. contains a FRMCS UE and a GSM-R UE. It is assumed the FRMCS Application on the FRMCS Equipment will have some control of the GSM-R part of the UE.

#### 6.3.4.4 Post-conditions

None.



#### 6.3.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.3.4-001]	The FRMCS System shall provide the necessary means to allow FRMCS Users to be reachable from a legacy GSM-R system. Interworking between FRMCS and GSM-R shall not require any changes on GSM-R network side.	A	22.179	Covered in 6.18.4.2
[R-6.3.4-002]	The FRMCS System shall provide the necessary means to FRMCS Users to set up a Driver to Controller voice communication also to users in legacy GSM-R systems. Interworking between FRMCS and GSM-R shall not require any changes on GSM-R network side.	A	22.179	Covered in 6.18.4.2
[R-6.3.4-003]	For Driver to Controller communication, when the GSM-R UE becomes detached from the GSM-R system, e.g. due to coverage problems, the end user device, if capable of making use of the FRMCS System shall be able set up the communication on the FRMCS System. An interruption of voice communication is acceptable. Note 1: This use case only applies to end user devices containing a FRMCS UE and a GSM-R UE. It is assumed the FRMCS Application on the FRMCS Equipment will have some control of the GSM-R part of the UE which is referred to here as end user device.	A	N/A	Call has to be re-established by UE. This is UE function outside scope of 3GPP standardization

[R-6.3.4-004]	<p>For Driver to Controller communication, when the FRMCS Equipment, becomes detached from the FRMCS System, e.g. due to coverage problems, the end user device, if capable of making use of legacy GSM-R shall be able to set up the communication on legacy GSM-R. An interruption of voice communication is acceptable.</p> <p>Note 2: This use case only applies to end user devices containing a FRMCS Equipment and a GSM-R UE. It is assumed the FRMCS Application on the FRMCS Equipment will have some control of the GSM-R part of the UE which is referred to here as end user device.</p>	A	N/A	Call has to be re-established by UE. This is UE function outside scope of 3GPP
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## 6.4 Railway emergency communication

### 6.4.1 Introduction

In this chapter the use cases related to Railway emergency communication are defined. The following use cases are defined:

- Initiation of the Railway emergency alert
- New entry to the Railway emergency alert
- Changing of the Railway emergency alert
- Merging of Railway emergency alerts
- Leaving of the Railway emergency alert
- Termination of the Railway emergency alert;
- Initiation of railway emergency voice communication
- Termination of railway emergency voice communication
- Initiation of Data communication during Railway emergency Alert
- Service interworking and service continuation with GSM-R
- Interface to train borne recorder

### 6.4.2 General overview

Railway emergency communication serves two main purposes in railway operation

- Alert Drivers or other railway staff about an emergency. Receiving such alert will result in immediate actions to be taken by the recipients. These actions are defined by operational rules, e.g. a Driver will slow down train speed to 40km/h, drive on sight, etc.

- Based on operational rules, additional information about the emergency can be exchanged using voice and/or data communication.

While the alert needs to be setup very fast, the information part that may follow is less time critical and not always required. The Railway emergency Communication consists of:

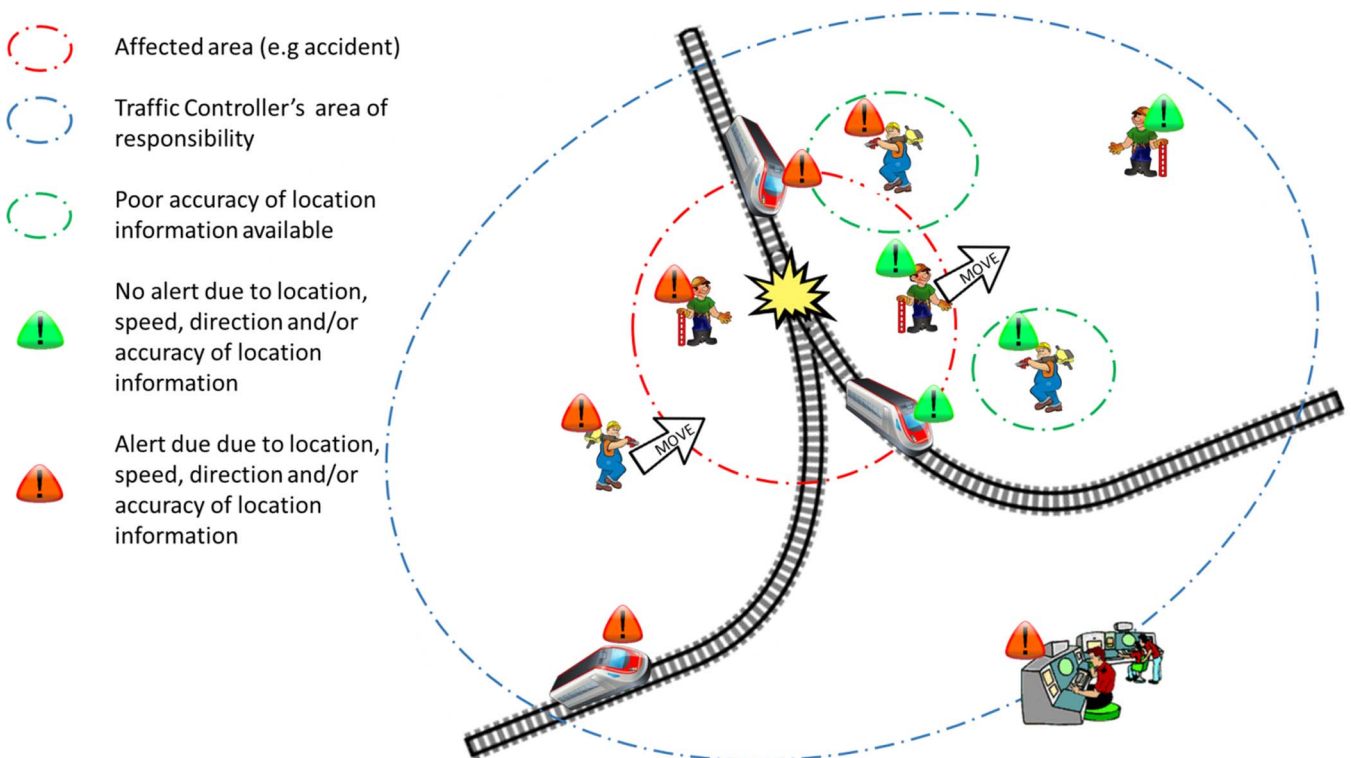
1. A mandatory alert phase indicating the emergency;
2. An optional voice and/or data communication phase depending on operational situation and / or operational rules.

Alert is the general term used that encompasses the different phases initiation, continuation and termination. This receives priority handling which is linked to the application category within the FRMCS System (see 12.10).

When a railway emergency alert is triggered by a FRMCS User, the FRMCS System determines which other FRMCS Users shall receive an alert, depending on following conditions:

- Location, accuracy of the location, track, functional identity, direction of movement, speed of the initiating entity
- Location, accuracy of the location, track, functional identity, direction of movement, speed of the FRMCS Users which are concerned of the emergency
- Any additional information provided by the initiating entity

By applying alert conditions, only FRMCS Users who are concerned by this emergency will receive an alert. Figure 6.4.2-1 outlines this principle.



**Figure 6.4.2-1 Illustration of FRMCS Users in an railway emergency alert area**

Independently of any ongoing interactions between the FRMCS User and the FRMCS Equipment, the railway emergency alert has to be continuously indicated to the FRMCS User until the railway emergency is over (alert is terminated).

While an alert is active, the FRMCS System shall continuously check:

- If additional FRMCS Users do match to the conditions of the railway emergency alert. FRMCS User entering the emergency area/location/etc. will receive the alert.
- If an FRMCS User does not fulfil the conditions to be alerted anymore, because the FRMCS User has moved away from the emergency area, the alert will be withdrawn from this FRMCS User.

A Controller is able to change the conditions to select the applicable FRMCS Users while an alert is active.

While an alert is active on a FRMCS Equipment, the FRMCS User is still able to establish and / or receive other types of communication. If a railway emergency voice communication is established by the FRMCS User of an ongoing alert, any other ongoing voice communications are terminated.

### 6.4.3 Use case: Initiation of the railway emergency alert

#### 6.4.3.1 Description

An FRMCS- user is able to initiate a railway emergency alert. Based on a set of conditions the FRMCS System will determine which FRMCS Users that shall be informed about the emergency.(see 6.4.2 General overview) The targeted FRMCS User can be e.g. a mobile FRMCS User, a Driver, an External System, a Controller, maintenance staff or a member of a shunting team.

#### 6.4.3.2 Pre-conditions

The initiating FRMCS User is authorised to establish a railway emergency alert.

#### 6.4.3.3 Service flows

In any service flow, a mobile FRMCS User, e.g. a Driver, a maintenance staff or a member of a shunting team, is not able to leave or terminate the railway emergency alert.

##### **Controller initiated**

The Controller provides the conditions (e.g. train number/area/track section/station) to the FRMCS System selecting the appropriate recipients of the railway emergency alert. The conditions (e.g. train number/area/track section/station) can be pre-configured for comfortable selection by the Controller. The Controller may need to confirm the selection.

The FRMCS System will determine, based on the conditions, which FRMCS Users are to receive the railway emergency alert.

The FRMCS System alerts the FRMCS Users within a setup time specified as IMMEDIATE (see 12.10). The alert notification can include additional information (e.g. text, voice prompts) which is presented to the FRMCS User.

The priority of the railway emergency alert is managed by the prioritisation application. The alert has the priority which matches the application category of CRITICAL DATA (see 12.10) within the FRMCS System.

In case a FRMCS User is already involved in another railway emergency alert, FRMCS System does not forward new alerts to this particular FRMCS User. The waiting alert is send as soon as the FRMCS User is no longer involved in the other railway emergency alert.

The Controller is informed about the alerted FRMCS Users.

The FRMCS Equipment of a Controller shows multiple alerts when active.

The communication is recorded by the Data recording and access to recorded data application.

##### **External system initiated**

FRMCS System receives the conditions from the External System (e.g. a list/train number/area/track section/station) to address/determine the appropriate recipients of the railway emergency alert.

The FRMCS System will determine, based on the conditions, which users will receive the railway emergency alert.

The FRMCS System alerts the FRMCS Users within a setup time specified as IMMEDIATE (see 12.10). The alert notification can include additional information (e.g. text, voice prompts) which are presented to the FRMCS Users.

The priority of the railway emergency alert is managed by the prioritisation application. The alert has the priority which matches the application category of CRITICAL DATA (see 12.10) within the FRMCS System.

In the case that a mobile FRMCS User is already active in another railway emergency alert, the FRMCS System does not forward new alerts to this particular FRMCS User. A waiting alert is sent as soon as the FRMCS User is no longer involved in an ongoing railway emergency alert. The Controller is informed about the alerted FRMCS Users and the alert initiating External System.

The FRMCS Equipment of a Controller shows multiple alerts when active.

The communication is recorded by the Data recording and access to recorded data application.

#### **Mobile FRMCS User initiated**

A FRMCS User, like a Driver, maintenance staff or a member of a shunting team, presses the railway emergency button.

The FRMCS Equipment requests the alert communication to the FRMCS System.

The FRMCS System determines the FRMCS Users to be included in the railway emergency alert. This is based on the location information of the initiator and certain conditions (e.g. functional identity, track area, accuracy of the location, maximum track speed, station, shunting yard, location/speed/direction of users).

The FRMCS System alerts the FRMCS- users within a setup time specified as IMMEDIATE (see 12.10). The alert notification can include additional information (e.g. text, voice prompts) which are forwarded to the concerned FRMCS Users.

The priority of the railway emergency alert is managed by the prioritisation application. The alert has the priority that matches the application category of CRITICAL DATA (see 12.10) within the FRMCS System.

In the case that a mobile FRMCS User is already active in another railway emergency alert, the FRMCS System does not forward new alerts to this particular FRMCS User. A waiting alert is sent as soon as the FRMCS User is no longer involved in an ongoing railway emergency alert. The applicable Controller(s) is informed about the alerted FRMCS Users, including which user initiated the alert.

The FRMCS Equipment of a Controller shows multiple alerts when active.

The communication is recorded by the Data recording and access to recorded data application.

#### **6.4.3.4 Post-conditions**

The applicable FRMCS Users are alerted.

#### 6.4.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.3-001]	The FRMCS System shall be able to deliver railway emergency alerts. Requests to initiate a railway emergency alerts may come from Controllers, External Systems or mobile FRMCS Users	A	22.280	R-5.6.2.4.1-002 ( etc.) R-5.6.2.1.2-002 R-6.8.8.4.1-006 (Using User regroup, not 5.6.2.4.1-005) R-6.6.4.1-XXX User regroup  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-001
[R-6.4.3-002]	For requests from Controllers or External Systems, the FRMCS System shall be able to determine which FRMCS Users shall receive the railway emergency alert, based on the conditions supplied with the requests (e.g. a list/train number/area/track section/station).	A	22.280	R-5.6.2.4.1-004 R-6.8.8.4.1-006 (Using User regroup, not 5.6.2.4.1-005) R-6.6.4.1-XXX User regroup  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-001 & R-6.15.5.2-014
[R-6.4.3-003]	For requests from FRMCS-users, based on the location information of the initiator and certain other conditions such as functional identity, track area, accuracy of the location, maximum track speed, station, shunting yard, speed and direction, the FRMCS System shall be able to determine which FRMCS Users shall receive the railway emergency alert.	A	22.280	R-5.6.2.1.2-002 R-5.6.2.4.1-004 R-6.8.8.4.1-006 (Using User regroup, not 5.6.2.4.1-005) R-6.6.4.1-XXX User regroup  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-001 & R-6.15.5.2-014
[R-6.4.3-004]	In case no FRMCS- users can be determined to be alerted the FRMCS System shall apply the behaviour as specified in 6.4.4 "New entry".	A	22.280	R-6.6.4.2-002b  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-014
[R-6.4.3-005]	The FRMCS System shall be able to provide additional information (e.g. text, voice prompts) in the railway emergency alert to be forwarded to the FRMCS Users	A	22.282	Using MCDData SDS and File Distribution for that - based on the same group i.e. after the MCX Emergency Alert a SDS is initiated and potentially a File Dist. as described in MCDData 22.282 R-5.2.2-XXX & 5.3.2-XXX
[R-6.4.3-006]	The FRMCS System shall be able to prevent FRMCS User(s), other than a Controller, involved in another railway emergency alert, to receive an additional railway emergency alert. In this case when the FRMCS User is no more involved in the other railway emergency alert, the FRMCS System shall forward the railway emergency alert to this FRMCS User.	A	22.280	5.4.2-XXX  [R-5.4.2-007a]



Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.3-007]	The FRMCS System shall be able to provide all applicable alerts to a Controller independent of whether involved in another alert or not to allow the Controllers to switch between different alerts.	A	22.280	5.4.2-XXX [R-5.4.2-007a]
[R-6.4.3-008]	The FRMCS System shall not prevent a FRMCS User to make use of other communication services while involved in a railway emergency alert.	A	22.280	Covered by the affiliation mechanism
[R-6.4.3-009]	The FRMCS System shall be able to deliver the railway emergency alert within a time specified as IMMEDIATE (see 12.10).	A&T	N/A	See section 12.10 below
[R-6.4.3-010]	For railway emergency alert the application layer priority of the communication shall be managed by the prioritisation application.	A	22.280	5.4.2-XXX 5.6.X, 6.8.7.X, etc  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-008
[R-6.4.3-011]	When setting up and during the alert, the FRMCS System shall inform the initiator and the involved Controller(s) which FRMCS Users are alerted and who initiated the railway emergency alert.	A	22.280	5.3 req #2, 5.7 req # 3, 6.4.3 req # 1 & #2 6.12-006 The id of the speaker is considered sufficient
[R-6.4.3-012]	The FRMCS System shall be able to make available the speech and communication related data of a railway emergency alert for recording.	A	22.280	6.15.4-001 - 010

## 6.4.4 Use case: New entry to the railway emergency alert

### 6.4.4.1 Description

The FRMCS System shall continuously check if additional FRMCS Users meet the conditions of the railway emergency alert. The FRMCS User can be e.g. a mobile FRMCS User, a Driver, maintenance staff, a member of a shunting team or a Controller. The additional FRMCS Users receive the railway emergency alert.

### 6.4.4.2 Pre-conditions

The FRMCS User is authorised (referring to authorisation of application) to receive the railway emergency alert. There is an ongoing railway emergency alert.

### 6.4.4.3 Service flows

The FRMCS System shall continuously check if additional FRMCS Users meet the conditions of the railway emergency alert. The FRMCS User can be e.g. a mobile FRMCS User, a Driver, maintenance staff, a member of a shunting team or a Controller.

The FRMCS System alerts the FRMCS- users within a setup time specified as IMMEDIATE (see 12.10). The alert notification can include additional information (e.g. text, voice prompts) which is forwarded to the FRMCS Equipment.

The priority of the railway emergency alert is managed by the prioritisation application. The alert has the priority that matches the application category of CRITICAL DATA (see 12.10) within the FRMCS System.

In the case of an ongoing railway emergency voice communication, the additional FRMCS User is added to the ongoing voice communication.

In case that a FRMCS User is already active in another railway emergency alert, FRMCS System does not forward the new alerts to this particular FRMCS- user. The waiting alert is sent as soon as the FRMCS User is no longer involved in an ongoing railway emergency alert.

A mobile FRMCS User, e.g. a Driver, maintenance staff or a member of a shunting team, is not able to leave or terminate the railway emergency alert.

The Controller is informed about additionally alerted FRMCS User.

The FRMCS Equipment of a Controller shows multiple alerts when active.

The communication is recorded by the Data recording and access to recorded data application.

#### 6.4.4.4 Post-conditions

The additional FRMCS Users are alerted.

## 6.4.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.4-001]	The FRMCS System shall continuously check if additional FRMCS Users meet the conditions of a railway emergency alert.	A	22.280	R-6.6.4.2-002b MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-014
[R-6.4.4-002]	The FRMCS System shall be able to deliver the railway emergency alert to the new FRMCS User(s) within a setup time specified as IMMEDIATE (see 12.10).	A&T	N/A	See section 12.10 below MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-008
[R-6.4.4-003]	The FRMCS System shall be able to forward additional information (e.g. text, voice prompts) in the railway emergency alert to the new FRMCS Users.	A	22.280	[R-5.2.2-014]
[R-6.4.4-004]	When added to a railway emergency alert a FRMCS User shall still be able to use other communications.	A	N/A	No requirements identified that might prevent a MCX User to receive other communication while in MEA
[R-6.4.4-005]	For railway emergency alert the application layer priority of the communication shall be managed by the prioritisation application.	A	22.280	5.4.2-XXX 5.6.X, 6.8.7.X MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-008
[R-6.4.4-006]	If a FRMCS User, other than a Controller, is involved in another railway emergency alert, the FRMCS System shall not forward the railway emergency alert to this FRMCS User. When the FRMCS User is no more involved in the other railway emergency alert, the FRMCS System shall forward the railway emergency alert to this FRMCS User.	A	22.280	5.4.2-XXX [R-5.4.2-007a]
[R-6.4.4-007]	The FRMCS System shall provide all applicable alerts to a Controller independent of whether involved in another alert or not to allow the Controllers to switch between different alerts.	A	22.280	5.4.2-XXX [R-5.4.2-007a]
[R-6.4.4-008]	The FRMCS System shall inform the initiator and the involved Controller(s) which FRMCS Users are additionally alerted.	A	22.280	5.3 req #2, 5.7 req # 3, 6.4.3 req # 1 & #2 22.280 6.12-006 See reqs in 6.4.5
[R-6.4.4-009]	The FRMCS System shall be able to make available the speech and communication related data of a railway emergency voice communication for recording.	A	22.280	6.15.4-001 - 010

## 6.4.5 Use case: Changing of the railway emergency alert

#### 6.4.5.1 Description

An authorised Controller or an External System is able to change the conditions selecting the appropriate recipients of the railway emergency alert. The change may result in an expansion or a reduction of FRMCS Users that shall be informed about the emergency.

#### 6.4.5.2 Pre-conditions

The FRMCS User is authorised to change the conditions of the railway emergency alert. This is managed by the application authorisation of application.

There is an ongoing railway emergency alert.

#### 6.4.5.3 Service flows

The Controller or an External System shall be able to change the conditional criteria selecting the appropriate recipients of the railway emergency alert.

The FRMCS System shall continuously check if FRMCS Users still meet the conditions of the railway emergency alert. The FRMCS User can be e.g., a mobile FRMCS User, a Driver, maintenance staff, a member of a shunting team or a Controller.

The FRMCS System shall forward the railway emergency alert to all additional FRMCS Users within a setup time specified as IMMEDIATE (see 12.10). The alert notification can include additional information (e.g., text, voice prompts) which are forwarded to the FRMCS User.

The priority of the railway emergency alert is managed by the prioritisation application. The alert has the priority that matches the application category of CRITICAL DATA (see 12.10) within the FRMCS System.

In case of an ongoing railway emergency voice communication, the additional FRMCS Users are added.

In case FRMCS User is already active in another railway emergency alert, the new alert is not forwarded by the FRMCS System to this particular FRMCS User. If the FRMCS User is no longer involved in an ongoing railway emergency alert, the waiting alert is forwarded by the FRMCS System.

The FRMCS System shall update the FRMCS Users for whom the railway emergency alert is no longer applicable and terminates the alert. The termination notification of the alert can include additional information (e.g., text, voice prompts) which are forwarded to the FRMCS User.

The priority of the railway emergency alert is managed by the prioritisation application. The alert has the priority that matches the application category of CRITICAL DATA (see 12.10) within the FRMCS System.

In case railway emergency alert conditions does not match any longer to a FRMCS User and if there is an ongoing railway emergency voice communication, the FRMCS User will remain in the ongoing railway emergency voice communication.

FRMCS System informs the Controller about the FRMCS Users who have left and have joined the railway emergency alert.

A mobile FRMCS User, e.g., a Driver, maintenance staff or a member of a shunting team, is not able to leave or terminate the Railway emergency alert.

The communication is recorded by the Data recording and access to recorded data application.

#### 6.4.5.4 Post-conditions

The appropriate recipients remain as alerted, while non-appropriate recipients are not alerted anymore.

## 6.4.5.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.5-001]	If alert conditions are changed by an authorised Controller or an External System, the FRMCS System shall check if additional FRMCS Users match the conditions of the railway emergency alert.	A	22.280	R-6.6.4.2-002b MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-014
[R-6.4.5-002]	The FRMCS System shall forward the railway emergency alert to new FRMCS Users that match the conditions and inform the initiating Driver and Controller(s) accordingly.	A	22.280	[R-5.2.2-014] MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-014
[R-6.4.5-003]	The FRMCS System shall withdraw the alert from those FRMCS Users who do not match the conditions anymore and inform them and the initiating Driver and Controller(s) accordingly.	A	22.280	R-5.3-XXX R-5.6.2.4.1-004 R-6.8.8.4.1-006 (Using User regroup, not 5.6.2.4.1-005) R-6.6.4.1-XXX User regroup MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-014
[R-6.4.5-004]	The FRMCS System shall be able to forward the railway emergency alert to new FRMCS User(s) within a setup time specified as IMMEDIATE (see 12.10).	A&T	N/A	See section 12.10 below MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-008
[R-6.4.5-005]	Void.			
[R-6.4.5-006]	The FRMCS System shall be able to forward additional information (e.g., text, voice prompts) in the railway emergency alert to new FRMCS Users.	A	22.280	[R-5.2.2-014]
[R-6.4.5-007]	For railway emergency alert the application layer priority of the communication shall be managed by the prioritisation application.	A	22.280	5.4.2-XXX 5.6.X, 6.8.7.X MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-008
[R-6.4.5-008]	The FRMCS System shall be able to prevent new FRMCS User(s), other than a Controller, involved in an ongoing railway emergency alert, to receive an additional railway emergency alert. In this case when the ongoing railway emergency alert has ended the FRMCS System shall forward the railway emergency alert to the new FRMCS User.	A	22.280	5.4.2-XXX [R-5.4.2-007a]
[R-6.4.5-009]	Void.			

## 6.4.5a Use case: Merging of Railway Emergency Alerts

### 6.4.5a.1 Description

An authorized FRMCS User (i.e., Controller) or an External System (e.g., Traffic Management System or Train Tracking System) is able to merge two or more existing Railway Emergency Alerts. The merging may result in changed alert conditions. The affected FRMCS Users are notified.

### 6.4.5a.2 Pre-conditions

An FRMCS User (i.e., Controller) is authorized to merge Railway Emergency Alerts. There are two or more ongoing Railway Emergency Alerts. FRMCS Users involved in those alerts have been regrouped into separate temporary groups for use during the alerts.

### 6.4.5a.3 Service flows

It has been determined that the alert area must be extended to include users involved in the ongoing alerts.

An authorized FRMCS User (i.e., Controller) or an External System is able to provide the FRMCS System with changed alert conditions (e.g., extension of the area or combination of track sections) including selection of the appropriate recipients of the new (i.e., merged) Railway Emergency Alert. The FRMCS Users involved in the new/merged alert are regrouped into a new temporary group.

The alert condition is declared by the Controller, or authorized FRMCS User, on this new temporary group. The FRMCS system sends the new/merged Railway Emergency Alert to all FRMCS Users in the new temporary group within a setup time specified as IMMEDIATE (see 12.10). The alert notification can include all relevant information including details of the merged alerts, if needed, (e.g., text, voice prompts) which is forwarded to and presented on the end user device of the regrouped FRMCS Users.

The FRMCS system continuously check's if FRMCS Users still meet the alert conditions of the Railway Emergency Alert. The FRMCS User can be, for example, a mobile user, a driver, maintenance staff, a member of a shunting team or a controller.

The priority of the Railway Emergency Alert is managed by the arbitration application. The alert has the priority which matches the application category CRITICAL DATA (see 12.10).

In the case that a mobile FRMCS User is already active in a Railway Emergency Alert, the new Railway Emergency Alert is sent by the FRMCS System to the end user device. The presentation of the alert(s) to the user is managed by the client arbitration application.

In case that a mobile FRMCS User is already active in an ongoing Railway Emergency Voice and/or Data communications of another Railway Emergency Alert (i.e., call in progress), the ongoing Railway Emergency Voice and/or Data communications is terminated either using normal termination condition (e.g., an authorized user terminate the call) or using configuration parameters of the FRMCS System (e.g., timeout when latest transmission ends).

When ongoing Railway Emergency Voice and/or Data communications of another Railway Emergency Alert are terminated, the next request to establish Railway Emergency Voice and/or Data communication is made on the associated merged Railway Emergency Alert (i.e., next call occurs on regroup group).

If a Railway Emergency Voice and/or Data communication is established by the FRMCS User of an ongoing Railway Emergency Alert, any other ongoing non-emergency-voice communications are put in the queue.

A FRMCS User - other than the initiating FRMCS User (i.e., Controller) - is not able to manually leave the temporary group of the new Railway Emergency Alert.

The FRMCS system notifies the FRMCS Users for whom the Railway Emergency Alert is no longer applicable and terminates the alert of these FRMCS Users. The termination notification of the alert can include additional information (e.g., text, voice prompts) which is presented on the end user device of the FRMCS Users. These FRMCS Users are removed from the merged alert temporary group.

In the case an FRMCS User no longer meets the conditions of the Railway Emergency Alert, but there is an ongoing Railway Emergency Voice or Data Communication, the FRMCS User will remain in the ongoing Railway Emergency Voice or Data communication.

The initiating FRMCS User (i.e., Controller) is notified which FRMCS Users are still part of the Railway Emergency Alert. FRMCS Users who have left the Railway Emergency Alert are separately indicated to the initiating FRMCS User (i.e., Controller).

The communication is recorded by the Data recording and access to recorded data application.

#### 6.4.5a.4 Post-conditions

The appropriate FRMCS Users remain in the temporary group of the merged Railway Emergency Alert, while non-appropriate FRMCS Users are returned to their previous condition.

#### 6.4.5a.5 Potential requirements and gap analysis

### 6.4.6 Use case: Leaving of the railway emergency alert

#### 6.4.6.1 Description

The FRMCS System shall continuously check if FRMCS Users do match to the condition of the railway emergency alert. If not, FRMCS System terminates the alert of the concerned FRMCS User.

#### 6.4.6.2 Pre-conditions

The FRMCS User is authorised to receive the railway emergency alert. This is managed by the application authorisation of application.

There is an ongoing railway emergency alert.

#### 6.4.6.3 Service flows

##### **Mobile FRMCS User**

The FRMCS System shall continuously check if FRMCS Users do match to the conditions of the railway emergency alert.

The FRMCS System shall update the FRMCS Users for whom the railway emergency alert is no longer valid and terminates the alert of these FRMCS Users. The termination notification of the FRMCS System can include additional information (e.g. text, voice prompts) which are forwarded to the FRMCS User.

A mobile FRMCS User, e.g. a Driver, maintenance staff or a member of a shunting team, is not able to leave or terminate the railway emergency alert.

The priority of the railway emergency alert is managed by the prioritisation application. The alert has the priority which matches the application category of CRITICAL DATA (see 12.10) within the FRMCS-System

In case a FRMCS User does not match to the conditions of the railway emergency alert and the particular FRMCS User is part of an ongoing railway emergency voice communication, the FRMCS User will remain in the ongoing railway emergency voice communication.

The Controller is informed by the FRMCS System about the remaining FRMCS Users of the railway emergency alert. The applicable Controller is updated by the FRMCS System about the particular FRMCS Users which do not match to the conditions of the railway emergency alert.

The communication is recorded by the Data recording and access to recorded data application.

##### **Controller**

An entitled Controller is able to leave the railway emergency alerts, unless the leaving Controller is the last Controller in the alert.

The Controller also leaves the ongoing railway emergency voice communication.

The FRMCS Equipment of a Controller shows multiple alerts when active.

The communication is recorded by the Data recording and access to recorded data application.

#### 6.4.6.4 Post-conditions

The appropriate recipients are still alerted, while non-appropriate recipients are not alerted anymore.

#### 6.4.6.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.6-001]	The FRMCS System shall continuously check if FRMCS Users do not match the conditions of the railway emergency alert anymore. The FRMCS System shall withdraw the alert from those FRMCS Users who do not match the conditions anymore and inform them and the initiating Driver and Controller(s) accordingly.	A	22.280	R-5.3-XXX R-5.6.2.4.1-004 R-6.8.8.4.1-006 (Using User regroup, not 5.6.2.4.1-005) R-6.6.4.1-XXX User regroup  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-014
[R-6.4.6-002]	The FRMCS System shall provide all applicable alerts to a Controller independent of whether involved in another alert or not to allow the Controllers to switch between different alerts	A	22.280	5.1.2, 5.1.5, 5.4.2, 6.8.8.4.1-005
[R-6.4.6-003]	The FRMCS System shall be able to ensure that at least one Controller is always involved in the railway emergency alert. Note: The FRMCS will prevent other FRMCS User, e.g. Drivers, maintenance staff or members of a shunting team, to leave railway emergency alert.	A	22.280	[R-6.6.4.2-002a/b] 6.4.6.1-002/003 R-6.4.4-003, R-6.4.4-004  MCX service Ad hoc Group Communication as an alternative to User regroup: not covered

#### 6.4.7 Use case: Termination of the railway emergency alert

##### 6.4.7.1 Description

The Controller is able to terminate the railway emergency alert.

##### 6.4.7.2 Pre-conditions

The Controller is authorised to terminate the railway emergency alert.

There is an ongoing railway emergency alert.

##### 6.4.7.3 Service flows

The Controller terminates the railway emergency alert. A mobile FRMCS User, e.g. a Driver, maintenance staff or a member of a shunting team, is not able to terminate the railway emergency alert via actions on the end user device.

Based on the alert termination request, FRMCS System forwards a termination notification to all FRMCS Users involved in the railway emergency alert. The alert termination notification can include additional information (e.g. text, voice prompts) which are forwarded by the FRMCS System presented on the FRMCS User.



The priority of the termination of the railway emergency alert is managed by the prioritisation application. The termination of the alert has the priority which matches the application category of CRITICAL DATA (see 12.10) within the FRMCS System.

When the Controller terminated the railway emergency alert, in the case of manual initiation of railway emergency voice communication, the related ongoing railway emergency voice communication remains unaffected. On the FRMCS Equipment this can be a separate action for the Controller or can be triggered as a combined action with the termination of the alert.

The communication is recorded by the Data recording and access to recorded data application.

#### 6.4.7.4 Post-conditions

The railway emergency alert is terminated.

#### 6.4.7.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.7-001]	The FRMCS System shall only allow a Controller to terminate the railway emergency alert.	A	22.280	R-6.8.8.4.2-XXX
[R-6.4.7-002]	The FRMCS System shall notify the FRMCS Users of the terminated railway emergency alert. The FRMCS System shall be able to forward additional information (e.g. text, voice prompts) as part of the alert termination.	A	22.282	R-5.6.2.4.2-003 R-5.2.2-014

### 6.4.8 Use case: Initiation of railway emergency voice communication

#### 6.4.8.1 Description

Based on operational rules, additional information about the emergency can be exchanged using voice communication. E.g. the initiator of the railway emergency voice communication may inform other involved FRMCS Users about the emergency.

Railway emergency voice communication is based on on-net communication.

#### 6.4.8.2 Pre-conditions

The railway emergency alert is active.

#### 6.4.8.3 Service flows

##### Automatic initiation of Emergency Voice Communication

Upon activation of the railway emergency alert, the FRMCS System automatically initiates voice communication.

FRMCS Users that are part of an active railway emergency alert shall be included in the voice communication.

The railway emergency voice communication does not interrupt the railway emergency, but is able to pre-empt any other ongoing voice communication.

The FRMCS System establishes the railway emergency voice communication within a setup time specified as IMMEDIATE (see 12.10). The information from the Role management and presence application is used to present the identities to the FRMCS Users involved in the communication.

The location of the initiator of the railway emergency voice communication is forwarded and presented to the Controller. The necessary location information is retrieved from the location services application.

Multiuser talker control application is used in railway emergency voice communication.

The precedence handling of the incoming railway emergency voice communication for the FRMCS User is managed by the prioritisation application. The railway emergency voice communication has the priority which matches the application category of CRITICAL VOICE (see 12.10) within the FRMCS System.

The communication is recorded by the FRMCS System voice recording and access to recorded data application.

The FRMCS Equipment of a Controller shows multiple railway emergency voice communications when active.

#### **Manual initiation of Emergency Voice Communication**

Any FRMCS User having an active railway emergency alert shall be able to initiate voice communication by a simple user action.

All the users receiving the active railway emergency alert shall be included in the voice communication.

The railway emergency voice communication shall not interrupt the railway emergency alert but shall pre-empt any other ongoing voice communication.

The FRMCS System establishes the railway emergency voice communication within a setup time specified as IMMEDIATE (see 12.10). The information from the Role management and presence application is used to forward the identities to the FRMCS Users involved in communication.

The location of the initiator of the railway emergency voice communication is forwarded to the Controller. The location information is retrieved from the location services application.

The multiuser talker control application is used in railway emergency voice communication.

The handling of the incoming railway emergency voice communication for both the Controllers and mobile FRMCS Users is managed by the prioritisation application. The railway emergency voice communication has the priority which matches the application category of CRITICAL VOICE (see 12.10) within the FRMCS System.

The communication is recorded by the FRMCS System voice recording and access to recorded data application.

The FRMCS Equipment of a Controller shows multiple railway emergency voice communications when active.

#### **6.4.8.4 Post-conditions**

The railway emergency voice communication is active.

#### 6.4.8.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.8-001]	Following a railway emergency alert the FRMCS System shall be able to automatically initiate a railway emergency voice communication.	A	22.282	R-5.6.2.4.1-013
[R-6.4.8-002]	The railway emergency voice communication does not interrupt the railway emergency, but is able to pre-empt any other ongoing voice communication.	A	N/A	Can be achieved by proper priority configuration further alert and (voice) communication do not compete for the same user interface resources
[R-6.4.8-003]	The FRMCS System shall also be able to initiate a railway emergency voice communication on manual request by FRMCS Users e.g. Controllers and External Systems	A	22.280	R-5.6.2.2.1-XXX
[R-6.4.8-004]	To determine which FRMCS Users have to be included in the communication the FRMCS System shall apply the mechanism as defined in [R-6.4.3-003]	N/A	22.280	R-5.6.2.1.2-002 R-5.6.2.4.1-004 R-6.8.8.4.1-006 (Using User regroup, not 5.6.2.4.1-005) R-6.6.4.1-XXX User regroup  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-001 & R-6.15.5.2-014
[R-6.4.8-005]	The FRMCS System shall be able to establish the railway emergency voice communication within a time specified as IMMEDIATE (see 12.10).	A	N/A	See section 12.10 below  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-008
[R-6.4.8-006]	For railway emergency voice communication the application layer priority of the communication shall be managed by the prioritisation application.	A	22.280	5.4.2-XXX 5.6.X, 6.8.7.X  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-008
[R-6.4.8-007]	The location of the initiator of the railway emergency voice communication is forwarded and presented to the Controller.	A	22.280	5.11 001, 008, 015 6.12 001,006,007 6.4.5 001, 003, 004
[R-6.4.8-008]	The FRMCS System shall be able to mutually forward and continuously update the location of all FRMCS Users involved in a railway emergency voice communication.	A	22.280	5.11 007, 009, 013 6.12 006
[R-6.4.8-009]	For railway emergency voice communication the FRMCS System shall apply multiuser talker control (See "9.7 Multiuser talker control related use cases").	A	22.179	6.2.3.7.2-XXX
[R-6.4.8-010]	The FRMCS Equipment of a Controller shows multiple railway emergency voice communications when active.		22.280	5.4.2-XXX [R-5.4.2-007a]

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.8-011]	The FRMCS System shall be able to make available the content and communication related data of the railway emergency voice communication for recording purposes.	A	22.280	6.15.4-001 - 010

## 6.4.9 Use case: Termination of railway emergency voice communication

### 6.4.9.1 Description

Only the Controller(s) shall be able to put on hold, leave or terminate the railway emergency voice communication.

### 6.4.9.2 Pre-conditions

The railway emergency voice communication is ongoing.

### 6.4.9.3 Service flows

In the case a user no longer meets the conditions of the railway emergency alert and if there is an ongoing railway emergency voice communication, the user will remain in the ongoing railway emergency voice communication.

#### **Controller on hold**

A Controller is able to put the railway emergency voice communication on hold.

After the Controller has put the railway emergency voice communication on hold, the communication remains active in the FRMCS System. The Controller is able to revert back to the communication again.

#### **Controller leaving**

An entitled Controller is able to leave the railway emergency voice communication unless the leaving Controller is the last Controller involved in the railway emergency voice communication.

#### **Controller termination**

An entitled Controller is able to terminate the railway emergency voice communication.

After termination request by the entitled Controller, FRMCS System terminates the railway emergency voice communication. All involved FRMCS Users are informed about the termination.

### 6.4.9.4 Post-conditions

A Controller has left, put on hold or terminated the railway emergency voice communication.

### 6.4.9.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.9-001]	In the case a FRMCS User no longer meets the conditions of railway emergency voice communication, the user shall be removed from the ongoing railway emergency voice communication.	A	22.280	R-5.3-XXX R-5.6.2.4.1-004 R-6.8.8.4.1-006 (Using User regroup, not 5.6.2.4.1-005) R-6.6.4.1-XXX User regroup  MCX service Ad hoc Group Communication as an alternative to User regroup: R-6.15.5.2-014
[R-6.4.9-002]	For a railway emergency voice communication only a Controller shall be able to put the voice communication on hold. The voice communication between the remaining users shall not be affected by a Controller putting the railway emergency voice communication on hold. The Controller is able to take up the communication again. All involved users are informed.	A	22.280	5.4.1, 5.4.2, 5.1.5 6.4.4-003, 6.4.4-004
[R-6.4.9-003]	For a railway emergency voice communication only a Controller shall be able to leave the communication unless the leaving Controller is the last Controller involved in the railway emergency voice communication. All involved users are informed.	A	22.280	6.4.4 002; 6.4.5 001; 5.1.5 003-008 6.4.4-003, 6.4.4-004
[R-6.4.9-004]	For a Railway emergency voice communication only a Controller shall be able to terminate the communication. All involved users are informed.	A	22.280	R-6.8.8.4.2-XXX

## 6.4.10 Use case: Initiation of Data communication during railway emergency alert

### 6.4.10.1 Description

Based on operational rules, additional information about the emergency can be exchanged using data communication. A system or a user is able to send the additional information (e.g. text, voice prompts).

### 6.4.10.2 Pre-conditions

The railway emergency alert is active.

### 6.4.10.3 Service flows

A FRMCS User, Controller or an External System is able to send additional information (e.g. text, voice prompts).

All the FRMCS Users shall receive the additional information.

The FRMCS System establishes the data communication within a setup time specified as IMMEDIATE (see 12.10). The information from the Role management and presence application is used to present the identities to the users involved in communication.

The location of the initiator of the data communication is presented to a mobile FRMCS User, Controller or to an External System. The location information is retrieved from the location services application.

The handling of the incoming data communication is managed by the prioritisation application. The alert has the priority which matches the application category of CRITICAL DATA (see 12.10) within the FRMCS System.

It shall be possible to receive data communication during railway emergency voice communication.

In the case of an ongoing Data communication during railway emergency alert, the additional user is added to the ongoing Data communication during railway emergency alert.

The communication is recorded by the FRMCS System Data recording and access to recorded data application.

#### 6.4.10.4 Post-conditions

Data communication is initiated.

#### 6.4.10.5 Potential requirements and gap analysis

Independently on any actions between the user and the end user device, the additional information provided by data communication is presented to the user.

The user shall be able to send additional information by data communication using simple user actions e.g. by selecting predefined messages.

### 6.4.9.10 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.10-001]	The FRMCS System shall allow a FRMCS User, Controller or an External System to send additional information (e.g. text, voice prompts) to FRMCS Users involved in a railway emergency alert or railway emergency voice communication.	A	22.282	R-5.2.2-014
[R-6.4.10-002]	The FRMCS System shall be able to deliver the additional data to a railway emergency alert or railway emergency voice communication within a time specified as IMMEDIATE (see 12.10).	A	N/A	See section 12.10 below
[R-6.4.10-003]	The location of the initiator of the data communication shall be presented to all participants in the railway emergency alert or railway emergency voice communication.	A	22.280	5.11 001, 008, 015 6.12 001,006,007 6.4.5 001, 003, 004
[R-6.4.10-004]	For railway emergency alert /railway emergency voice communication the application layer priority of the communication shall be managed by the prioritisation application.	A	22.280	5.4.2-XXX 5.6.X, 6.8.7.X
[R-6.4.10-005]	The FRMCS System shall be able to make available the content and communication related data of the railway emergency data communication for recording purposes.	A	22.280	6.15.4-001 - 010

## 6.4.11 Use case: Service interworking and service continuation with GSM-R

### 6.4.11.1 Description

For migration purposes, the service interworking and service continuation between the GSM-R system and FRMCS System for railway emergency alerts and railway emergency voice communication needs to be defined.

Service interworking between FRMCS and GSM-R shall not require any changes in the GSM-R system specifications.

Depending on the migration scenario, a Controller can be attached to the FRMCS System, to the GSM-R system or both. The mobile FRMCS User can be attached either to the GSM-R system or to the FRMCS System.

The service continuation use cases only apply where a FRMCS Equipment and a GSM-R UE are linked together.

### 6.4.11.2 Pre-conditions

None.



### 6.4.11.3 Service flows

#### **Mobile FRMCS User attached to GSM-R**

When the mobile FRMCS User is attached to the GSM-R system and is initiating a Railway Emergency Call, the GSM-R system, (in parallel to processing the railway emergency call internally according to GSM-R definitions), routes the Railway Emergency Call to the FRMCS System, which requires the FRMCS System to be reachable by identities that are understood by the GSM-R system. The FRMCS System will determine, based on configuration, if a railway emergency alert needs to be established. If a railway emergency alert is established a railway emergency voice communication is initiated automatically.

The Railway Emergency Call in the GSM-R system and the railway emergency voice communication in the FRMCS System are linked together and controlled by the FRMCS System.

Service interworking between the talker control in the GSM-R system and the FRMCS System is required, but without changing the GSM-R system.

When the Railway Emergency Call in the GSM-R system is terminated, the railway emergency alert and the railway emergency voice communication in the FRMCS System is terminated too.

When the railway emergency voice communication in the FRMCS System is terminated and there is a Railway Emergency Call in the GSM-R system linked together, Railway Emergency Call in the GSM-R system and railway emergency alert / the Railway emergency voice communication in the FRMCS System are terminated too.

When the railway emergency alert in the FRMCS System is terminated and there is a railway emergency Call in the GSM-R system connected, both the Railway Emergency Call in the GSM-R system and Railway emergency voice communication in the FRMCS System are not terminated.

The information from the Role management and presence application is used to forward the identities between the systems. The identity of the initiator of the Railway Emergency Call in the GSM-R system is made available to the FRMCS System.

#### **Mobile FRMCS User attached to FRMCS**

When the FRMCS User is attached to the FRMCS System and is initiating a railway emergency alert, and the railway emergency alert is also relevant for the GSM-R system based on configuration, the railway emergency voice communication becomes initiated in the FRMCS System and as railway emergency Call in the GSM-R system.

The railway emergency voice communication in the FRMCS System and Railway Emergency Call in the GSM-R system are linked and controlled by the FRMCS System.

Service interworking between the talker control in the FRMCS System and the GSM-R system is required, but without changing the GSM-R system.

When the railway emergency voice communication in the FRMCS System is terminated and there is a railway emergency Call in the GSM-R system linked, railway emergency Call in the GSM-R system and Railway emergency alert / the Railway emergency voice communication in the FRMCS System are also terminated.

When the railway emergency alert in the FRMCS System is terminated and there is a linked Railway Emergency Call in the GSM-R system, both the Railway Emergency Call in the GSM-R system and railway emergency voice communication in the FRMCS System remain active.

When the Railway Emergency Call in the GSM-R system is terminated, the railway emergency alert and the railway emergency voice communication in the FRMCS System is terminated.

The information from the Role management and presence application is used to forward the identities between FRMCS System and GSM-R system. The identity of the initiator of the railway emergency alert in the FRMCS System is made available to the GSM-R system to be used accordingly.

#### **Mobile FRMCS User moving from GSM-R to FRMCS**

When the GSM-R system becomes unavailable e.g. lack of coverage, the FRMCS Equipment should provide service continuation by setting up the communication via the FRMCS System. An interruption of voice communication is acceptable. It is up to the end user device implementation how this service continuation is as seamless as possible presented to the user.

### **Mobile FRMCS User moving from FRMCS to GSM-R**

When the FRMCS radio access becomes unavailable, the FRMCS Equipment shall be able to provide service continuation by setting up the communication via the GSM-R system. An interruption of voice communication is acceptable. It is up to the end user device implementation how this service continuation is as seamless as possible presented to the user.

Note: Both scenarios described above only apply when a FRMCS Equipment and a GSM-R UE are linked together. It is further assumed the FRMCS Application on the FRMCS Equipment to have some control of the GSM-R UE.

#### **6.4.11.4 Post-conditions**

None.

#### 6.4.11.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.11-001]	The FRMCS System shall provide the necessary means to allow FRMCS Users to be reachable from a legacy GSM-R system. Interworking between FRMCS and GSM-R should not require any changes on GSM-R network side	A/T	22.179	Covered in 6.18.4.2
[R-6.4.11-002]	The FRMCS System shall provide the necessary means to FRMCS Users to set up a railway emergency alert and / or railway emergency voice communication also to users in the legacy GSM-R system. Interworking between FRMCS and GSM-R should not require any changes on GSM-R system.	A	22.179	Partially covered in 6.18.4.2. Voice is covered, Alert not, as there is no Emergency alert functionality available in GSM-R.
[R-6.4.11-003]	In case of overlapping GSM-R and FRMCS serving the same geographical area the FRMCS System shall update GSM-R about ongoing Railway Emergency Communication/railway emergency alert in the FRMCS System. Note: To allow the FRMCS System to be updated of Railway Emergency Communication initiated in the GSM-R needs to be configured accordingly.	A	22.179	Basic functionality covered by 6.18.4.2. However, the areas in FRMCS and GSM-R will not exactly match, due to the fact that the capabilities wrt, to granularity of location in the two systems are different.
[R-6.4.11-004]	The FRMCS System shall provide service interworking between the talker control in the GSM-R system and the FRMCS System without changing the GSM-R system.	A	N/A	Based on latest decisions in ETSI-RT, there will be no interaction of talker control between the systems. As a consequence, only two related requirements on unmute/mute remain on the IWF
[R-6.4.11-005]	When the Railway Emergency Call in the GSM-R system is terminated, the linked railway emergency alert and the railway emergency voice communication in the FRMCS System shall also be terminated.	A	22.179	Covered in 6.18.4.2
[R-6.4.11-006]	When the railway emergency voice communication in the FRMCS System is terminated and there is a linked Railway Emergency Call in the GSM-R system, the Railway Emergency Call in the GSM-R system shall also be terminated.	A	22.179	Covered in 6.18.4.2

[R-6.4.11-007]	When the railway emergency alert in the FRMCS System is terminated and there is a Railway Emergency Call in the GSM-R system linked, the Railway Emergency Call in the GSM-R system shall not be terminated.	A	N/A	No I/W between FRMCS emergency alert and GSM-R voice communication. Therefore, requirement becomes obsolete.
[R-6.4.11-008]	When the Railway Emergency Call in the GSM-R system is terminated, the railway emergency alert and the railway emergency voice communication in the FRMCS System shall be terminated.	A	N/A	Voice communications gets terminated. No I/W between FRMCS emergency alert and GSM-R voice communication. Therefore, that part becomes obsolete
[R-6.4.11-009]	The information from the Role management and presence application of the FRMCS System shall be used to identify and address GSM-R users to be included in the railway emergency alert /railway emergency voice communication.	A	N/A	Approach has changed now, linked calls are used instead.
[R-6.4.11-010]	The identity of the initiator of a Railway Emergency Call in the GSM-R system shall be presented to the FRMCS Users involved in that railway emergency voice communication.	A	TS 22.179	Covered for on-network: [R-6.18.4.2-003]
[R-6.4.11-011]	For a Railway Emergency Call, when the GSM-R system becomes unavailable, e.g. due to coverage problems, the FRMCS Equipment, if capable of making use of the FRMCS System shall be able to reconnect to the railway emergency alert and, if applicable, the railway emergency voice communication on the FRMCS System. An interruption of voice communication is acceptable. Note 1: This use case only applies when a FRMCS Equipment and a GSM-R UE are linked together. It is further assumed the FRMCS Application on the FRMCS Equipment to have some control of the GSM-R UE.	A	22.280	Communication aspect covered by 6.6.4.1.2 and 6.6.5.2

[R-6.4.11-012]	<p>For railway emergency alert / railway emergency voice communication, when the FRMCS System becomes unavailable, e.g. due to coverage problems, the end user device, if capable of making use of legacy GSM-R shall be able to reconnect to the railway emergency voice communication via GSM-R. An interruption of voice communication is acceptable.</p> <p>Note 2: This use case only applies when a FRMCS Equipment and a GSM-R UE are linked together. It is further assumed the FRMCS Application on the FRMCS Equipment to have some control of the GSM-R UE.</p>	A		Covered by GSM-R late entry
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## 6.4.12 Use case: Interface to train borne recorder

### 6.4.12.1 Description

The FRMCS Equipment shall provide information about railway emergency communication to the train borne recorder or other equipment via a dedicated interface.

### 6.4.12.2 Pre-conditions

The FRMCS Equipment is switched on.

### 6.4.12.3 Service flows

The following events on the FRMCS Equipment related to the railway emergency communication is provided to the train borne recorder:

- Initiation of the railway emergency alert
- Reception of the railway emergency alert
- Leaving of the railway emergency alert
- Termination of the railway emergency alert
- Initiation of railway emergency voice communication
- Termination of railway emergency voice communication

### 6.4.12.4 Post-conditions

User actions related to the railway emergency communication have been provided to the train borne recorder.

### 6.4.12.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.4.12-001]	FRMCS Equipment shall provide a dedicated interface for train borne recording purposes	A	N/A	Interface for train borne recorder is outside scope of 3GPP.
[R-6.4.12-002]	FRMCS Equipment shall provide following information to the train borne recorder: <ul style="list-style-type: none"> <li>Initiation of the railway emergency alert</li> <li>Reception of the railway emergency alert</li> <li>Leaving of the railway emergency alert</li> <li>Termination of the railway emergency alert</li> <li>Initiation of railway emergency voice communication</li> <li>Termination of railway emergency voice communication</li> </ul>	A	TS 22.280	Covered for on-network: [R-6.15.4-004] [R-6.15.4-007] [R-6.15.4-008] Not applicable to off-network (see table C-1).

## 6.5 Use case: Automatic Train Protection (ATP) support by the FRMCS System

### 6.5.1 Description

For Automatic Train Protection (ATP) the train transmits its information (such as current location, current speed, etc.) to a radio block centre (RBC). As soon as a connection has been established between a train, a radio block centre and a train centre, the train sends its position and speed information periodically. The RBC uses the received information to decide movement authority of the train.

### 6.5.2 Pre-conditions

It is assumed the current position of the train and its speed is provided by the Location Service as defined in 9.4.

It is assumed that there is a bearer of suitable QoS established between the train the radio block centre and the train control centre.

### 6.5.3 Service flows

Via the bearer of suitable QoS the train provides its related information, e.g. train number, location, to the RBC. Via this bearer the train can request movement authority from the RBC and the RBC can grant this to the train.

### 6.5.4 Post-conditions

A train Driver controls the speed of the train according to movement authority.

## 6.5.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.5-001]	The FRMCS System shall be able to provide the necessary QoS for a data bearer to be used for the Automatic Train Protection (ATP) used for e.g. movement authority messages or emergency brake messages.	A/T	TS 22.282 (MCData)	Sub-clause 5.5

## 6.6 Trackside Maintenance Warning System communication related use cases

### 6.6.1 Introduction

Generally, trackside maintenance occur during daily train operation. For safety reasons trackside maintenance staff need to be informed about approaching trains entering the area of maintenance. Thus, the intention of a trackside warning system is to inform trackside staff about the approaching train.

Trackside warning system consists of several specific sensors and warning entities. The sensors are responsible to detect the approaching train and warning entities indicate trackside workers about the approaching train. A warning entity provides this indication in form of visual signal e.g. flashing light and an audio signal e.g. tone. In addition, the local maintenance staff will receive the train approaching indication on its FRMCS Equipment. When the train has left the track section, the warning system withdraws the indication.

Sensors and warning entities constitute the warning system that requires continuous communication between the sensors and the warning entities. In addition, it encompasses the communication among the warning system and the FRMCS Equipment of the local maintenance staff.

Due to the fact that such a warning system deployment is temporary and not always fixed network communication facilities are available at the track, FRMCS System provides necessary mobile communication services for the trackside warning system.

Hence this chapter describes the use cases related to Trackside Maintenance Warning System communication. The following use cases are identified:

- Initiation of a Trackside Maintenance Warning System communication
- Termination of a Trackside Maintenance Warning System communication

### 6.6.2 Use case: Initiation of a trackside maintenance warning system communication

#### 6.6.2.1 Description

The FRMCS User (sensors of the warning system entity) shall be able to initiate data communication to the FRMCS Equipment of trackside maintenance staff and/or trackside warning indication entities (FRMCS User) in the applicable area/track.

When a train approaches that FRMCS User (FRMCS Equipment of the trackside maintenance staff) and/or the warning indication entities of the warning system get notified.



### 6.6.2.2 Pre-conditions

The FRMCS Users as part of the warning system and the FRMCS Users as part of the maintenance crew are authorised to initiate the trackside maintenance warning system communication.

### 6.6.2.3 Service flows

The FRMCS Users (trackside maintenance warning system) and FRMCS User (trackside workers in the applicable area) initiate the trackside maintenance warning system communication to the receiving side.

A secure data communication application is used for the trackside maintenance warning system communication. The communication requests the QoS class which matches the application category of CRITICAL DATA (see QoS section 12.10) within the FRMCS System.

The arbitration is managed by the arbitration application.

The communication is recorded by the Data recording application.

### 6.6.2.4 Post-conditions

The FRMCS Users are part of the (warning system) communication are able to exchange data.

### 6.6.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.6.2-001]	The FRMCS System shall be able to initiate data communication for Trackside Maintenance Warning System to FRMCS Users upon a request from a functional identity entitled to raise such communication.	A	22.282	Covered by R-5.2.2-XXX, 5.3.2-XXX, , R-5.4.2-XXX, 5.5.2-XXX
[R-6.6.2-002]	For Trackside Maintenance Warning System the FRMCS System shall provide QoS, priority and communication setup time as defined in [Reference to QoS section 12.10].	A	N/A	See section 12.10 below
[R-6.6.2-003]	The FRMCS System shall be able to select FRMCS users to deliver the Trackside Maintenance Warning to base on their functional identity and their location.	A	22.280	Covered by [R-6.6.4.2-002a], [R-6.6.5.2-007] ]

## 6.6.3 Use case: Termination of a trackside maintenance warning system communication

### 6.6.3.1 Description

FRMCS Users are able to terminate data communication.

### 6.6.3.2 Pre-conditions

The data (trackside maintenance warning system) communication is ongoing.

### 6.6.3.3 Service flows

The FRMCS User terminates the trackside maintenance warning system communication with the receiving trackside worker applications.

### 6.6.3.4 Post-conditions

The data communication has been released disconnected.

### 6.6.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.6.3-001]	The FRMCS System shall be able to terminate the Trackside Maintenance Warning System data communication upon a request received from the functional identity that initiated the Trackside Maintenance Warning System data communication.	A	22.282	Covered by [R-6.2.3-001], [R-6.2.3-013]

## 6.7 Pushed Real Time Video streaming

### 6.7.1 Introduction

In this chapter the use cases related to real time video streaming are described, the following use cases are identified

- Initiation of a real time video streaming
- Termination of a real time video streaming

### 6.7.2 Description

The video image quality depends on the application needs, e.g. lip reading, pattern detection.

Video based supervision for rail operational purposes requires also the support of Real time video capabilities from the FRMCS System. Multiple recipients are able to use the real time video for different purposes.

The FRMCS Users in this case are applications both onboard of the train and on the ground, for example FRMCS Users in a train control center.

For real time video streaming, both video and audio information are combined.

### 6.7.3 Use case: Initiation of a real time video streaming

#### 6.7.3.1 Description

Video is streamed between FRMCS Users or FRMCS Equipment.

#### 6.7.3.2 Pre-conditions

The streaming FRMCS User or FRMCS Equipment has registered to a functional identity that is authorised to initiate a real time video stream.

Note: Successful registration of a functional identity authorised to stream video implies the FRMCS Equipment is able to support streaming video (e.g. camera available)

The receiving FRMCS User or FRMCS Equipment has registered to a functional identity that is authorised to receive a real time video stream.

Note: Successful registration of a functional identity authorised to receive streaming video implies the FRMCS Equipment is able to support streaming video (e.g. monitor or recording device available)

### 6.7.3.3 Service flows

The initiating FRMCS User requests a real time video streaming to another FRMCS User.

The video streaming requests the QoS class which matches to the application category of VIDEO or CRITICAL VIDEO within the FRMCS System, depending on the application needs.

The video quality requested to the FRMCS System by the FRMCS User is checked by the FRMCS Application.

If the requested quality can be reached, the FRMCS System establishes the real time video data communication with a setup time specified as NORMAL (see 12.12).

If the requested quality cannot be reached, the FRMCS Application or the FRMCS User can decide to stop the request or to continue the setup of video streaming with a lower video quality, depending on the application needs.

During the real time video streaming the FRMCS Application constantly monitors the quality. If the delivered quality of the real time video data communication changes, the FRMCS Application or the FRMCS User is informed about the change. The FRMCS Application or the FRMCS User may decide to change the quality of the real time video streaming, depending on the applications needs.

If authorized, the real time video communication is recorded by the data recording and access to recorded data application.

The arbitration is managed by the arbitration application.

### 6.7.3.4 Post-conditions

Depending on the QoS offered, the FRMCS Application or a FRMCS User decide if video streaming is set up.

### 6.7.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.7.3-001]	Depending on the information associated with the functional identity used by the initiator, the FRMCS System shall setup the real time video streaming to one or more FRMCS User(s) identified by functional identities that are able and authorised to receive streaming video.	A	TS 22.281 (MCVideo)	Functional identities covered under User identities in 4.7
[R-6.7.3-002]	Real time video streaming requests shall be set up by the FRMCS System with a QoS, priority and setup time as defined in [Reference to QoS section 12.10].	A	TS 22.281 (MCVideo)	Priority covered under Imminent Peril and Emergency cases. Corresponds to Critical Video

### 6.7.4 Use case: Termination of a real time video communication

#### 6.7.4.1 Description

The FRMCS User is able to terminate a real time video communication.

#### 6.7.4.2 Pre-conditions

There is an ongoing real time video data communication.

#### 6.7.4.3 Service flows

The FRMCS Applications or FRMCS Users involved terminate the real time video data communication.

#### 6.7.4.4 Post-conditions

The real time video data communication is terminated. The FRMCS Application or the FRMCS User is informed about the termination.

### 6.7.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.7.4-001]	Upon request from the streaming or receiving FRMCS User, the FRMCS System shall be able to terminate the real time video streaming.	A	TS 22.281 (MCVideo)	This is covered in requirement R-5.2.8-001 clause 5.2.8.

## 6.8 Public emergency call related use cases

### 6.8.1 Introduction

FRMCS Users have to indicate events that endanger public safety or emergency that requires the public safety involvement. For this reason, the FRMCS System is able to route the emergency call based on the current position of the initiating FRMCS User. The initiation of an emergency call has no dependency on the registration status of the FRMCS User.

Depending on the national rules, the operator of the FRMCS System may decide if the routing of the public emergency numbers is supported.

Following use cases related to public emergency call handling has been identified.

- Initiation of a public emergency call
- Termination of a public emergency call
- Call back the public emergency call initiator

## 6.8.2 Use case: Initiation of a public emergency call

### 6.8.2.1 Description

If enabled by the FRMCS System, an FRMCS User is able to report an emergency to an officer of the Public Safety Answering Point (PSAP) that will be responsible of bringing assistance or organizing response. The second scenario addresses the call back of a PSAP officer to the originator of the public emergency call which is a FRMCS User.

### 6.8.2.2 Pre-conditions

The underlying transport of the FRMCS System supports emergency calls and the FRMCS System allows FRMCS Users to make use of emergency calls.

### 6.8.2.3 Service flows

The FRMCS User or a public user initiates the public emergency call voice communication by dialling a public emergency call number.

The voice communication is recorded by the voice recording and access application.

The arbitration is managed by the arbitration application.

### 6.8.2.4 Post-conditions

The PSAP officer has received the public emergency call.

### 6.8.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.8.2-001]	The FRMCS System shall be able to allow or inhibit the processing of public emergency numbers.	A	TS 22.280	TS 22.280 sub-clause 6.16 Requirement [R-6.16-001]
[R-6.8.2-002]	In case public emergency call setup is allowed, the 3GPP defined handling of public emergency calls shall be applied.	A	TS 22.280	TS 22.280 sub-clause 6.16 Requirement [R-6.16-001]

## 6.8.3 Use case: Termination of a public emergency call

### 6.8.3.1 Description

Both the initiating user, FRMCS User or a public user, and the PSAP officer shall be able to terminate the public emergency call voice communication.

The PSAP officer shall be able to put on hold the public emergency communication.

### 6.8.3.2 Pre-conditions

The public emergency call is ongoing.

### 6.8.3.3 Service flows

#### PSAP officer on hold

A PSAP officer shall be able to put the public emergency call on hold.

After the PSAP officer has put the voice communication on hold, the communication remains in the FRMCS System, and the PSAP officer is able to be part of the communication again.

#### Termination

The FRMCS User or a public user, and/or the PSAP officer shall be able to terminate the public emergency call.

The FRMCS System terminates the voice communication. All involved users are informed.

### 6.8.3.4 Post-conditions

The public emergency call voice communication is terminated.

### 6.8.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
	No requirements.  Note: Procedures for normal emergency call behaviour applies if a call is allowed to be established.			

## 6.8.4 Use case: Call back the public emergency call initiator

### 6.8.4.1 Description

The PSAP officer shall be able to establish the communication towards the FRMCS user or a public user, who previously initiated the public emergency call (e.g. in the case the initial call was dropped).

### 6.8.4.2 Pre-conditions

The public emergency call initiator is reachable via FRMCS System or a public network.

The FRMCS System is connected to the Public Safety Answering Point.

### 6.8.4.3 Service flows

The PSAP officer initiates the voice communication by using the subscriber identity or the device identity of the previous calling user, FRMCS User or a public user, of a public emergency call. The QoS class of the communication is managed by the QoS class application. The voice communication requests the QoS class which matches the application category of CRITICAL VOICE (see [QoS]) within the FRMCS System.

The FRMCS System establishes the voice communication to the public emergency initiator within a setup time specified as IMMEDIATE (see [QoS]).

The arbitration is managed by the arbitration application.

The voice communication is recorded by the voice recording and access application.

#### 6.8.4.4 Post-conditions

The call-back of the public emergency call is ongoing.

#### 6.8.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
	No requirements.  Normal emergency call service behaviour applies if a call is allowed to be established.			

## 6.9 Data communication for possession management related use cases

### 6.9.1 Introduction

In this chapter the use cases related to possession management data communication are described, the following use cases are identified:

- Initiation of a possession management data communication
- Termination of a possession management data communication
- Service interworking and service continuation with GSM-R

### 6.9.2 Use case: Initiation of a possession management data communication

#### 6.9.2.1 Description

The application supports the processes involved in taking possession of an area of railway infrastructure for engineering purposes (for example for track maintenance). This application is intended to allow track side workers to remotely take control of infrastructure elements to perform safe engineering works on those elements. The application provides the communication bearer in a safe and secure way. The possession management application is able to initiate, release data communication for possession related data of a certain track section.

#### 6.9.2.2 Pre-conditions

The initiator (Controller(s), trackside maintenance personnel, ground system) is authorised to initiate the possession management data communication.

#### 6.9.2.3 Service flows

The FRMCS Equipment initiates the possession management data communication towards the track possession management system.

#### 6.9.2.4 Post-conditions

The communication for possession management has been established.

Application messages can be exchanged between the possession management application and the possession management system.

### 6.9.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.9.2-001]	The FRMCS System shall be able to support the transfer of messages to/from an authorised FRMCS Equipment identity, FRMCS User identity or functional identity with a QoS, priority and setup time as defined in clause 12.10 to/from an external system.	A	22.280	<p>[R-5.9a-020] The MCX Service shall provide a mechanism for an MCX Service Administrator to configure for a particular functional alias, a set of functional aliases under the same authority to which a Private Communication (without Floor control) can be made by an MCX User registered to this particular functional alias.</p> <p>[R-5.9a-021] The MCX Service shall provide a mechanism for an MCX Service Administrator to configure for a particular functional alias, a set of functional aliases under the same authority from which Private Communication (without Floor control) is allowed to an MCX User registered to this particular functional alias.</p> <p>[R-5.9a-022] For private calls to functional aliases the authorizations in clause 5.9a.2 shall replace the authorizations defined in clause 6.7.3.</p> <p>[R-5.9a-023] The MCX Service system shall be capable of handling private calls to functional aliases that are allowed to be simultaneously active for multiple MCX Users by using group call mechanisms and by using first-to-answer private call mechanisms.</p> <p>[R-5.9a-024] The MCX Service system shall enable an MCX Service Administrator to select the mechanism to be used for handling of private calls to functional aliases that are allowed to be</p>



				simultaneously active for multiple MCX Users.
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## 6.10 Recording of communication

### 6.10.1 Introduction

In this chapter the use cases related to recording and access are described, the following use cases are identified

- Recording

### 6.10.2 Use case: Recording

#### 6.10.2.1 Description

The FRMCS System is able to provide means to record communication and communication related information for voice, video and data services. The means of recording include FRMCS User identities, functional identities and location information of all involved users.

Which communication is applicable for recording is configurable. Criteria for recording can be based on different attributes or a combination of those e.g. communication application, functional identity, type of communication, location, certain context.

#### 6.10.2.2 Pre-conditions

A communication is configured to be recorded.

#### 6.10.2.3 Service flows

Recording of the communication starts when the particular communication becomes initiated.

The recording stops when the communication is terminated.

#### 6.10.2.4 Post-conditions

The recorded communication is stored and ready for post-analysis

#### 6.10.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.10.2-001]	The FRMCS System shall provide the means to record communication and communication related information to an external system. That encompasses voice, video and data services.	A	22.280	On-Network: 6.15.4-001 - 010  Off-Network: covered by [R-7.14-001]: Only metadata are logged, no recording of transmissions of group/private communications as provided in on-network ([R-6.15.4-003]).

[R-6.10.2-002]	<p>The FRMCS System shall be able to select the communication to be provided to the external system based on the following criteria:</p> <ul style="list-style-type: none"> <li>• Communication application / use case</li> <li>• FRMCS User identities</li> <li>• functional identities</li> <li>• location information of all involved users</li> </ul>	A	22.280	<p>On-Network: 6.15.4-001 - 010</p> <p>Off-Network: not applicable. No selection mechanism are supported. All communication and non-communication activity metadata from an MCX UE are collected.</p>
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## 6.11 Remote control of engines communication related use cases

### 6.11.1 Introduction

In this chapter the use cases related to remote control of engines communication are described, the following use cases are identified

- Initiation of a remote control of engines communication
- Termination of a remote control of engines communication

### 6.11.2 Use case: Initiation/termination of a remote control of engines communication

#### 6.11.2.1 Description

Remote control requires secure data communication between the FRMCS Equipment as part of on-board control system and the FRMCS User as part of a remote-control device, either via Off-network or On-network communication.

#### 6.11.2.2 Pre-conditions

The FRMCS User are authorised to initiate engine remote control communication.

#### 6.11.2.3 Service flows

The FRMCS User at the ground initiates the engine remote control communication to the FRMCS Equipment in the locomotive.

The communication requests the QoS which matches to the application category as defined by the operator within the FRMCS System.

The FRMCS User at the ground terminates the engine remote control communication to the FRMCS Equipment in the locomotive.

### 6.11.2.4 Post-conditions

Remote control communication for the engine is established.

### 6.11.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.11.2-001]	Upon a request received from an authorised FRMCS User, the FRMCS System shall establish or terminate communication for remote control of engines communication.	A	Covered 22.280	Covered by [R-5.21.1.2-001] The MCX Service shall provide a mechanism for an authorized MCX User (e.g. dispatch operator) to remotely initiate an MCX Service Private Communication or MCX Service Group Communication from another user's MCX UE. [R-5.21.2.1-001] The MCX Service shall provide a mechanism for an authorized MCX User (e.g. dispatch operator) to remotely terminate an MCX Service Private Communication or MCX Service Group Communication from another user's MCX UE.
[R-6.11.2-002]	The FRMCS System shall support engine remote control communication in both On-network and off-network communication mode.	A	Covered by 22.280	As the whole section 5 is applicable for both on-network and off-network. i.e., "MCX Service requirements common for on the network and off the network"  So the requirements (" [R-5.21.1.2-001] and[R-5.21.2.0-001]) are naturally supported by on/off – network communication.

## 6.12 Automatic Train Operation data communication

### 6.12.1 Introduction

In this chapter the use cases related Automatic Train Operation (ATO) communication are described, the following use cases are identified

- Initiation of an Automatic Train Operation data communication
- Termination of an Automatic Train Operation data communication

Note: A plain 3GPP bearer is requested below, as additional layers such as MCDATA are adding additional hurdles in achieving certification by railway regulatory authorities.

### 6.12.2 Description

Automatic Train Operation (ATO) is the application which performs some or all the functions of automatic speed regulation, accurate stopping, door opening and closing, performance level regulation, and other functions assigned to a train driver or train attendant.

Some ATO systems require radio communication to interchange performance and/or safety relevant data between a train and the corresponding trackside control center.

The (FRMCS) users in this case are the ATO application both on-board of the train and in the control center at the trackside (ground system).

ATO systems may require communication between on-board applications of different trains (on-network).

Some modes of ATO operation require real time video between a train and the corresponding trackside control center. Please refer to the Real Time Video streaming use cases.

### 6.12.3 Use case: Initiation of an Automatic Train Operation data communication

#### 6.12.3.1 Description

The FRMCS Application is able to initiate data communication.

#### 6.12.3.2 Pre-conditions

The initiating functional identity is authorised to initiate the automatic train operation data communication to the trackside control centre.

#### 6.12.3.3 Service flows

The initiating FRMCS Application (e.g. on-board of the train) initiates the Automatic Train Operation data communication to the receiving side (e.g. control centre at the trackside).

#### 6.12.3.4 Post-conditions

ATO communication is established.

Data can be exchanged between the Automatic Train Operation applications.

#### 6.12.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.12.3-001]	Upon request received from a functional identity entitled to set up ATO communication the FRMCS System shall be able to setup and terminate a data bearer for ATO operation of a QoS, priority and setup time as defined in clause 12.10.	A	TS 22.282 (data bearer) N/A (QoS)	TS 22.282 sub-clause 5.5.2  See section 12.10 below

## 6.13 Monitoring and control of critical infrastructure related use cases

### 6.13.1 Introduction

In this chapter the use cases related to monitoring and control of critical infrastructure communication are described. The following use cases are identified

- Initiation of Monitoring and control of critical infrastructure communication

- Termination of a Monitoring and control of critical infrastructure

## 6.13.2 Use case: Initiation of a Monitoring and control of critical infrastructure communication

### 6.13.2.1 Description

This use case enables FRMCS to setup data communication between infrastructure systems and a ground based or train based system in order to monitor or control critical infrastructure such as train detection, signals and indicators, movable infrastructure, level crossing elements, including barrier controls vehicle sensors, lighting controls and alarms.

### 6.13.2.2 Pre-conditions

The initiating application is authorised to initiate Monitoring and control of critical infrastructure communication.

The receiving application is authorised to use the Monitoring and control of critical infrastructure communication.

### 6.13.2.3 Service flows

The initiating application initiates the monitoring and control of critical infrastructure communication to the receiving side.

### 6.13.2.4 Post-conditions

Monitoring and control of critical infrastructure data is made available to the application.

### 6.13.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.13.2-001]	Upon request from an authorised FRMCS Application the FRMCS System shall be able to establish data communication between a FRMCS Equipment and a central monitoring infrastructure system for monitoring and controlling critical infrastructures.	A	Covered by 22.282	<p>[R-6.1.2.1.2-001] The MCDData Service shall enable the control of robots.</p> <p>1) A FRMCS Equipment can be seen as a certain kind of robots.</p> <p>[R-6.1.3.2-001] The MCDData Service shall provide a means to share in real-time operational status information between members of a selected group.</p> <p>2) Sharing the operational status information can be seen as monitoring.</p>
[R-6.13.2-002]	The FRMCS System shall setup the monitoring of critical infrastructure communication with an operator defined QoS and priority and setup time as defined in clause 12.10.	A	TS 22.282 (data bearer) N/A (QoS)	<p>Mission critical is already supported by 3GPP QoS (QCI or 5QI)</p> <p>[R-5.1.7-002] The MCX Service shall provide a mechanism to prioritize MCX Service Group Communications based on the priorities associated with elements of the communication (e.g., service type, requesting identity, and target identity).</p> <p>See section 12.10 below.</p>

## 6.13.3 Use case: Termination of a Monitoring and control of critical infrastructure communication

### 6.13.3.1 Description

Terminate data communication between infrastructure systems and a ground based or train-based system used to monitor or control critical infrastructure.

### 6.13.3.2 Pre-conditions

The Monitoring and control of critical infrastructure applications have an ongoing data communication.

### 6.13.3.3 Service flows

One of the communication entities terminates the monitoring and control of critical infrastructure communication.

### 6.13.3.4 Post-conditions

The terminating Monitoring and control of critical infrastructure application entity is disconnected from the receiving application entity.

### 6.13.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.13.3-001]	The FRMCS System shall be able to terminate data communication between the infrastructure systems and a central monitoring infrastructure system upon request by either communication partner.	A	Covered by 22.280, 22.282,	TS 22.280 [R-6.7.6-002] The MCX Service shall provide a means by which an MCX User ends a Private Communication (without Floor control) in which the MCX User is a Participant. TS 22.282  [R-5.4.2-008] The MCDData data streaming capability shall allow an authorised user to terminate streaming of data being sent and cancel streaming of data remaining buffered in the system waiting to be streamed.

## 6.14 Use case: Data transmission in real time

### 6.14.1 Description

This use case allows the authorized FRMCS Users to exchange data in real time from each other, for example, health and status of train are transferred between intelligent on-train systems and train maintenance.

### 6.14.2 Pre-conditions

The user A is authorized FRMCS User (e.g., administrator who has authorization to the data).

User B is an equipment for monitoring the train.

User C is a normal FRMCS User (e.g., user without authorization to the data)

### 6.14.3 Service flows

User A requests User B to transmit the data (e.g., health, status of train, etc.) in real time.

User B receives the request from User A and accepts the request.

User B starts to transmit the requested data in real time to User A.

User C requests User B to transmit the data (e.g., health, status of train, etc.) in real time.

User B receives the request from C and rejects the request (e.g., without authorization to the data).

User C receives a notification that the request was rejected by User B.

### 6.14.4 Post-conditions

The data of User B is sent to User A in real time.

The data of User B is not sent to User C in real time.

## 6.14.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.14.5-001]	The FRMCS System shall enable an authorized FRMCS User to request another FRMCS User to establish real time data transmission.	A	TS 22.282	Covered by 22.282 [R-5.5.2-003]: remote initiation of MCDData Point-to-point IP connectivity between two MCDData Users
[R-6.14.5-002]	The FRMCS System shall provide a list of identities for the requesting authorized FRMCS User to select from. The list may contain functional identities, FRMCS User identities, or FRMCS Equipment Identities	A	TS 22.280	Covered by functional alias requirements.
[R-6.14.5-003]	The real time data request shall either be based on the functional identity, FRMCS User Identity, or FRMCS Equipment Identity.	A	TS 22.280	[R-5.9a-002] If the MCX Service system supports functional aliases, the MCX User shall be reachable by its functional alias(es).  Functional Alias is specified by merging functional identity, user identity, and equipment identity.
[R-6.14.5-004]	The FRMCS User shall be able to accept a real time data transmission request.	A	TS 22.282	Only an authorised person can enable authorisation of IP connectivity to a specific destination.
[R-6.14.5-005]	The FRMCS User shall be able to reject a data in real time transmission request.	A	TS 22.282	Only an authorised person can revoke authorisation of IP connectivity to a specific destination.
[R-6.14.5-006]	The requesting FRMCS User shall be notified if the request is rejected or ignored.	A	TS 22.282	Implicit requirement.

## 6.15 On-train incoming voice or video communication from the Controller(s) of the train towards the drivers

### 6.15.1 Introduction

This use case is based on the International Union of Railways User Requirements Specification on FRMCS [15].

It is considered as a necessary scenario in China railway market that an authorised controller shall be able to set up a voice communication to a driver. As stated in URS 2.0, this application allows an authorised controller to establish voice communication with the driver of a specific train for operational purposes, for example to support the transfer of orders, to advise of delays, reporting of a disturbance, assault or staff security support.

The controller shall be able to call the drivers located in the area managed by the controller.

The controller can initiate the voice or video call to the drivers using the function alias.

The following use cases related to the function of On-train incoming voice or video communication from the Controller(s) of the train towards the drivers are defined.



- Initiation of On-train incoming voice or video communication from the Controller(s) of the train towards the drivers
- Termination of On-train incoming voice or video communication from the Controller(s) of the train towards the drivers

## 6.15.2 Use case: Initiation of On-train incoming voice or video communication from the Controller(s) of the train towards the drivers

### 6.15.2.1 Description

An authorised Controller shall be able to set up a voice or video communication to the drivers within a configured area.

### 6.15.2.2 Pre-conditions

The authorisation application authorises the Controller to call the drivers.

### 6.15.2.3 Service Flows

#### **Controller(s) to Drivers**

The Controller initiates the voice or video communication to the drivers. The priority of the communication is managed by the prioritisation application.

The FRMCS System determines the drivers, based on:

- Location information of the train provided by the locations services application, and/or
- Functional identity provided by the Role management and presence application.
- System configuration (To identify which Controller is responsible for which part of the track/station/etc.)

The FRMCS System establishes the voice or video communication to the drivers within a setup time specified as NORMAL (see 12.10). The information from the Role management and presence application is used to present the identities for both Drivers and Controller. Also, the location of the Drivers is presented to the Controller which is retrieved from the location services application.

If the controller is connected to more than one train, the multiuser talker control application is used.

The voice or video communication is recorded by the Voice or video recording and access application.

### 6.15.2.4 Post-conditions

The controller is connected to the requested drivers.

### 6.15.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.15.2-001]	For Controller to drivers voice or video communication, the FRMCS System shall be able to determine the responsible driver(s), based on the location of the train and/or the function alias and/or the System configuration on the Controller who is responsible for which part of the track/station/etc.	A	22.280	6.6.4.2

### 6.15.3 Use case: Termination of On-train incoming voice or video communication from the Controller(s) of the train towards the drivers

#### 6.15.3.1 Description

Only the controller can terminate the On-train incoming voice or video communication from the Controller(s) of the train towards the drivers.

#### 6.15.3.2 Pre-conditions

The controller is connected to the requested drivers.

#### 6.15.3.3 Service Flows

Only the controller is able to terminate the voice or video communication.

#### 6.15.3.4 Post-conditions

The controller terminates the voice or video communication.

### 6.15.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.15.3-001]	For Controller to Driver communication, only the controller shall be able to terminate the On-train incoming voice or video communication.	A	22.280	R-5.9a-012a R-5.9a-012b

## 6.16 Use cases on data communication for Train Operation System Communication

### 6.16.1 Introduction

In this chapter the use cases related to data communication for Train Operation System are described. The following use cases are identified:

- Train dispatch order data communication between driver and controller
- LOCOTROL information transmission between leading engine and subordinate engine on a multi-headed locomotive
- Data communication for Security use cases between two approaching trains

### 6.16.2 Use case: Train dispatch order data communication between controller and driver

#### 6.16.2.1 Description

In this use case, the FRMCS system transmits the train dispatch order between Controller and Driver, including train orders, station receiving route, running tokens, etc.

It is needed that the information are received in due time by the driver to avoid any collision with any other train standing in another lines.

#### 6.16.2.2 Pre-conditions

User A and User B are authorized FRMCS User.

User A is a Driver entering in the train station.

User B is Controller of the train responsible for the train's current area.

#### 6.16.2.3 Service flows

User B initiates a data communication to User A in order to send station route within short time.

#### 6.16.2.4 Post-conditions

User A receives the station line to follow when entering in the train station.

#### 6.16.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
6.16.2-001	The FRMCS system shall support data communication between Controller and Driver with a QoS, priority and setup time as defined in clause 12.10.	A	TS 22.282 (data bearer) N/A (QoS)	TS 22.282 sub-clause 6.1.2  See section 12.10 below

## 6.16.3 Use case: LOCOTROL information transmission between leading engine and subordinate engine on a multi-headed locomotive

### 6.16.3.1 Description

The multi-headed locomotive has several engines, all the engines act synchronized as the LOCOTROL information will be sent between engines through FRMCS system.

It is quite important to ensure this LOCOTROL information is sent to the corresponding locomotives safely and in an integrated way so that synchronized actions can be taken.

### 6.16.3.2 Pre-conditions

User A and User B are authorized FRMCS User.

User A is a leading locomotive.

User B is a subordinate locomotive.

### 6.16.3.3 Service flows

User A initiates a data communication to send the LOCOTROL information to transport information regarding synchronization with the User B in safely and timely method, e.g., with a QoS and priority.

### 6.16.3.4 Post-conditions

User B receives the LOCOTROL information, so User B can be kept synchronized with User A.

### 6.16.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
6.16.3-001	The FRMCS system shall provide a mean to exchange messages between different FRMCS Equipment with a QoS, priority and setup time as defined in clause 12.10.	A	TS 22.282 (data bearer)  N/A (QoS)	TS 22.282 sub-clause 6.1.2  See section 12.10 below

## 6.16.4 Use case: data communication for security between two approaching trains

### 6.16.4.1 Description

This use case describes data communication between FRMCS Users in order to avoid train accident, for example, two trains exchange warning data to each other when one train is approaching to another train.

And it is also used for the case that different devices in different carriages send detection data to head device in the train, so that the Driver can take appropriate actions.

This data information needs to be transported in a safe and timely manner so that the train can operate in a safe way.

### 6.16.4.2 Pre-conditions

User A, User B, User C and User D are authorized FRMCS Users.

User A is a Driver of train A.

User B is FRMCS Equipment used for detection of the environment (sensor).

User C is a Driver of train B.

Train A is approaching to train B.

### 6.16.4.3 Service flows

Train driver User A initiates a data communication to the other train driver User C to indicate the approaching event to train B.

The sensor User B initiates a data communication to train driver User A, to report what User B detected if some threshold is reached.

These two communications are transported in safely and timely method

### 6.16.4.4 Post-conditions

Train driver User C receives the approaching event and takes appropriate action.

Train driver User A receives the message from sensor User B.

### 6.16.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
6.16.4-001	The FRMCS system shall support data communication between FRMCS Users with a QoS, priority and setup time as defined in clause 12.10	A	TS 22.282 (data bearer)  N/A (QoS)	TS 22.282 sub-clause 6.1.2  See section 12.10 below

## 6.17 On-train safety device to ground communication

### 6.17.1 Introduction

Based on a critical situation in the train (for example, triggered by a Driver Safety Device (DSD) or Dead Man Switch, a voice and/or data communication is automatically set up towards a ground user (controller or ground system).

In this chapter the use cases related to On-train safety device to ground communication are defined. The following use case describes:

- Initiation, termination of the On-train safety device data communication
- Voice communication between driver/train staff and controller/train control system

### 6.17.2 Use case: Initiation of safety device to ground data communication

#### 6.17.2.1 Description

- 1.) Based on a train safety issue, the Driver Safety Device will automatically establish a data communication to FRMCS User(s) at the ground (controller or train management system). The functional identity of the DSD and other FRMCS User(s) at the train are indicated to the FRMCS User(s) at the ground.
- 2.) On demand a voice communication can be established by the train staff (FRMCS User) or the FRMCS User at the ground.

### 6.17.2.2 Pre-conditions

The FRMCS User at the train is authorised to initiate Driver Safety Device data communication.

The FRMCS User at the ground (controller or train management system) is authorised to receive Driver Safety Device data communication.

### 6.17.2.3 Service flows

If the driver is not reacting to the DSD, the Driver Safety Device (FRMCS User) may initiate a data communication to the FRMCS User at the ground to notify the controller or train management system about the safety issue of a running train.

After reception of this train safety issue, other trains in the same area get notified by an emergency alert to lower the instantaneous velocity of the train or stops completely.

The FRMCS User at the ground (controller or train management system) acknowledges the reception of DSD emergency notification. The DSD emergency notification remains active and is continuously transmitted until the train safety has been recovered.

In addition, the entitled train staff or entitled ground staff establishes a voice communication to commence further steps, to recover train safety again.

### 6.17.2.4 Post-conditions

The emergency didn't cause a safety issue at other trains as well as the people in those trains.

## 6.17.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.17.2-001]	The FRMCS Equipment shall be able to integrate the Driver Safety Device (DSD).	A/T	N/A	Outside scope of 3GPP
[R-6.17.2-002]	Triggering the Driver Safety Device (DSD) the FRMCS User related to the DSD shall be able to establish a non-pre-emptible data communication that matches with QoS category CRITICAL DATA (see QoS section), to FRMCS Users in the same area i.e. trains, controller and/or a train management system.	A	22.280 22.282	Covered by 22.282-5.2.2-XXX, 5.3.2-XXX, R-5.4.2-XXX, 5.5.2-XXX, 22.280 [R-5.1.7-002], [R-6.6.4.2-002a], [R-6.6.5.2-007]
[R-6.17.2-003]	The FRMCS System shall be able to forward the Driver Safety Device trigger to the Controller or external systems e.g. train operation management.	A	22.280	[R-5.1.7-002], [R-6.6.4.2-002a], [R-6.6.5.2-007]
[R-6.17.2-004]	Upon request by an authorised FRMCS user at the ground or the train, the FRMCS System shall be able to establish a non-pre-emptible voice communication.	A	22.280	Covered by [R-5.1.7-002], [R-5.6.2.2.1-006], [R-6.8.1-002], [R-6.8.1-003]
[R-6.17.2-005]	The FRMCS system shall determine the responsible FRMCS Users (e.g. trains, controllers or train management system) based on. <ul style="list-style-type: none"> <li>• location information, instantaneous velocity and direction of the concerned train (DSD trigger active)</li> <li>• functional identity associated with the Driver Safety Device</li> <li>• responsible controller</li> </ul>	A	22.280	[R-5.1.7-002], [R-6.6.4.2-002a], [R-6.6.5.2-007]



[R-6.17.2-006]	Upon request by the Driver Safety Device (DSD), authorised FRMCS Users or authorised external systems, the FRMCS System shall terminate the data communication related to the DSD.	A	22.282	Covered by [R-6.2.3-001], [R-6.2.3-013]
[R-6.17.2-007]	For On-train safety device to ground communication, the communication shall be recorded by the recording and access to recorded data application.	A	22.280	[R-6.15.4-XXX]

## 6.18 Train Integrity monitoring data communication

### 6.18.1 Introduction

Train integrity encompasses the continuous verification of the train completeness, i.e. trains integrity status, for the time of mission. The safety system on-board the train and/or at the ground will apply the foreseen safety reaction when the train integrity status becomes undefined or is unknown.

Due to its safety relevance, train integrity information exchange requires a very high reliable communication as well as very low packet data latency.

### 6.18.2 Use case: Data communication for train integrity information exchange

#### 6.18.2.1 Description

The FRMCS System will be used to exchange such train integrity information. Every train regardless the type of composition requires this kind of data communication in a fully automated train operation scenario.

The FRMCS Users in this case are the train integrity entities on-board of the train and the ground system. There several options to determine train integrity:

- 1.) Train integrity information will be only determined by the applicable entities at the train. For this approach train integrity entities are located at the front and the end of the train as well as on demand partially between the front and the end. The front entity supplies the train's integrity status to the safety entity on-board the train responsible for Control Command Signalling. This scenario requires Off-network communication bearer services for multi-user communication.
- 2.) Train integrity information will be determined by the applicable entities at the train and the ground. Train integrity entities are distributed equally over the total length of a train. The ground (train) integrity entity will collect the reported train integrity information and compute the train integrity status of a particular train. This scenario requires On-network communication bearer services.

#### 6.18.2.2 Pre-conditions

The FRMCS Users (train integrity entities) are authorised to initiate a train integrity data communication.

The FRMCS Users (train integrity entities) are authorised to use the train integrity application.

### 6.18.2.3 Service flows

#### **Off-network communication**

On demand by the FRMCS Users (train integrity entities), the FRMCS System establishes a communication between the authorised FRMCS Users at the train. The data communication for train integrity requires the QoS class which matches the application category of CRITICAL DATA (see chapter 12.10) within the FRMCS system. The FRMCS system establishes the bearer service required for the data communication within a setup time specified as NORMAL (see 12.10).

The FRMCS System verifies if the FRMCS Users are authorised to use the train integrity application.

The FRMCS Users are exchanging continuously information about the train integrity until the end of the mission.

The entire train integrity communication will be recorded.

#### **On-network communication**

On demand by the FRMCS Users (train integrity entities), the FRMCS System establishes a communication between the authorised FRMCS Users at the train and the ground. The data communication for train integrity requires the QoS class which matches the application category of CRITICAL DATA (see 12.10) within the FRMCS system. The FRMCS system establishes the bearer service required for the data communication within a setup time specified as NORMAL (see 12.10).

The FRMCS System verifies if the FRMCS Users are authorised to use the train integrity application.

The FRMCS Users are exchanging continuously information about the train integrity until the end of the mission.

The entire train integrity communication will be recorded.

### 6.18.2.4 Post-conditions

Train integrity information can be exchanged continuously between the involved FRMCS Users

The train approaches its final destination without any delay.

### 6.18.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.18.2-001]	The FRMCS System shall allow authorised FRMCS Users to establish/terminate train integrity communication.	A	TS 22.282	Sub-clause 5.5 The whole section 5 is applicable for both on-network and off-network.
[R-6.18.2-002]	The FRMCS System shall allow authorised FRMCS Users to use train integrity monitoring.	A	TS 22.280	TS 22.280 sub-clauses 5.1.x The whole section 5 is applicable for both on-network and off-network.
[R-6.18.2-003]	The FRMCS System shall provide the necessary communication means to support train integrity monitoring.	T	TS 22.282	TS 22.282 sub-clause 5.5 (IP connectivity)  The whole section 5 is applicable for both on-network and off-network.
[R-6.18.2-004]	The FRMCS System shall support train integrity monitoring in Off-network, On-network and a combination of On-network/Off-network mode.	T	TS 22.282 TS 22.280	TS 22.282: IP connectivity sub-clause 5.5. The whole section 5 is applicable for both on-network and off-network. TS 22.280: On network is covered by sub-clause 6. Off network covered (see all R-6.18.2-XXX requirements).
[R-6.18.2-005]	The FRMCS System shall provide the QoS class as defined for CRITICAL DATA (see 12.10) within the FRMCS System.	A/T	N/A	See section 12.10 below
[R-6.18.2-006]	The FRMCS System shall setup train integrity monitoring within the time specified as NORMAL (see 12.10).	A/T	N/A	See section 12.10 below
[R-6.18.2-007]	The FRMCS System shall allow arbitration for Train Integrity communication.	A	TS 22.280	TS 22.280 sub-clause 5.4.2 The whole section 5 is applicable for both on-network and off-network.

## 6.19 Use case: Broadcast of public emergency warning information

### 6.19.1 Introduction

A Public Safety Authority is able to broadcast a public emergency warning to a subset of the civil population based on their location. The subset can include FRMCS Users because off the location or functional identity of the FRMCS User.

### 6.19.2 Description

The Public Safety Authority (PSA) is able to broadcast textual messages, pictures, audio and video content to a subset of FRMCS Users.

## 6.19.2a Pre-conditions

The FRMCS User is active (logged in) in the FRMCS system.

The FRMCS System provides interworking with a Public Safety Authority.

## 6.19.3 Service flows

The FRMCS System is receiving broadcasting information from the PSA.

The FRMCS System determines the set of FRMCS Users based on:

- The location provided by the PSA broadcast system and/or;
- The functional addressing information of the concerned FRMCS Users provided by PSA and/or;
- The system configuration (e.g. a fixed routing or other conditions).

The FRMCS System establishes a data bearer services for PSA data communication which matches to the application category of CRITICAL DATA (see [QoS]).

The FRMCS System establishes the data bearer service(s) within the timeframe specified as IMMEDIATE (see [QoS]).

The data communication is recorded by the data recording and access application.

## 6.19.4 Post-conditions

The concerned FRMCS Users are informed about the public emergency information provided by the PSA.

## 6.19.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.19.5-001]	The FRMCS System shall provide the interworking to the Public Safety Authority broadcast information system to convey public emergency warning information to authorised FRMCS Users.	A/T	22.268	This can be (partly) solved with existing PWS system [TS 22.268] or can be handled at application level.
[R-6.19.5-002]	The FRMCS System shall be able to locate FRMCS User for PSA broadcast information based on the location information provided by the PSA broadcast system and/or the functional identities of the authorised FRMCS Users.	A	22.268	This can be (partly) solved with existing PWS system [TS 22.268] or can be handled at application level.
[R-6.19.5-003]	The FRMCS System shall be able to address PSA broadcast information to FRMCS User functional identities by using a "broadcast" functional identity.	A	22.268	This can be (partly) solved with existing PWS system [TS 22.268] or can be handled at application level.

## 6.20 Safety related critical advisory messaging

### 6.20.1 Introduction

Critical advisory information are exchanged among railway users in order to, for example, provide safety related instructions/information from a controller to a driver (e.g. written order, to inform about traffic disturbances, a change in the maximum authorized speed), provide information on how to proceed during an emergency, confirm to the controller the readiness of the train to start, exchange information between control centres on the traffic situation, etc.

Messages can be exchanged on user-to-user or on multi-user level and the exchange is applicable in On-network, Off-network as well as a combination of On-network and Off-network mode.

### 6.20.2 Use case: Initiation/Termination of safety device to ground data communication

#### 6.20.2.1 Description

In this chapter the use cases related to Critical advisory messaging services – safety related- communication are described; the following use cases are identified:

- The communication mode e.g. group communication required for Critical advisory messaging services
- Service interworking with GSM-R

#### 6.20.2.2 Pre-conditions

The FRMCS Users are authorised to initiate and terminate safety related - Critical advisory messaging service communication.

#### 6.20.2.3 Service flows

The authorised FRMCS User at the train/ground establishes safety related – Critical advisory messaging session that corresponds to the category CRITICAL DATA (see QoS chapter).

The FRMCS system establishes the bearer service required for the messaging-based communication within a setup time specified as IMMEDIATE (see QoS chapter).

The FRMCS System assigns a certain priority of the safety related – Critical advisory messaging within arbitration management.

The FRMCS Users provide their functional identity associated with the safety related – Critical advisory messaging communication.

The FRMCS Users are reachable by their functional identity associated with the safety related – Critical advisory messaging communication.

The FRMCS System records the communication of the involved FRMCS Users.

An authorised FRMCS User is able to terminate the safety related – Critical advisory messaging communication.

#### 6.20.2.4 Post-conditions

Safety related – Critical advisory messages can be exchanged among FRMCS Users.

On demand by an authorised FRMCS User, the safety related – Critical advisory messaging communication is terminated.

The FRMCS System was able to record the communication among the FRMCS Users.

### 6.20.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.20.2-001]	The FRMCS System shall allow authorised FRMCS Users to establish/terminate Critical advisory messaging.	A	TS 22.280	TS 22.280 sub-clauses 5.1.x
[R-6.20.2-002]	The FRMCS System shall allow authorised FRMCS Users to use Critical advisory messaging.	A	TS 22.280	TS 22.280 sub-clauses 5.1.x
[R-6.20.2-003]	The FRMCS System shall be able to support Critical advisory messaging in Off-network mode, On-network mode as well as a combination of On-network and Off-network mode.	A	TS 22.280 TS 22.282	.On network covered by TS 22.280 sub-clause 6. .Partly covered by TS 22.282 sub-clause 5.2 SDS one-to-one and group but no predefined messages (not a 3GPP topic). .Off-network is FFS.
[R-6.20.2-004]	The FRMCS System shall be able to provide for Critical advisory messaging the QoS class of CRITICAL DATA (see QoS chapter).	A	N/A	See section 12.10 below
[R-6.20.2-005]	The FRMCS System shall be able to manage Critical advisory messaging communication in the arbitration management.	A	TS 22.280	TS 22.280 sub-clause 5.4.2
[R-6.20.2-006]	The FRMCS Users shall be reachable by their functional identity/ies.	A	TS 22.280	[R-5.9a-002]

## 6.20.3 Use case: Service interworking with GSM-R

### 6.20.3.1 Description

Service interworking of safety related - Critical advisory messaging service communication with GSM-R is not required.

6.20.3.2 Void

6.20.3.3 Void

6.20.3.4 Void

6.20.3.5 Void

## 6.21 Automatic Train Protection data communication

### 6.21.1 Introduction

In this chapter the use cases related Automatic Train Protection (ATP) data communication are described, the following use cases are identified:

- Initiation of an Automatic Train Protection data communication
- Termination of an Automatic Train Protection data communication
- Service interworking with GSM-R

## 6.21.2 Description

Automatic Train Protection (ATP) is the application which performs some or all the functions that ensures the safe movement of a train. ATP supervises the train ensuring that speed and movement limits are kept and the train proceeds only when it is allowed to do so.

Some ATP systems require radio communication to interchange safety relevant data between a train and the corresponding control center.

The FRMCS Users in this case are the Automatic Train Protection applications both on-board of the train and in the control center at the trackside (ground system).

Depending on the implementations, ATP systems require communication between on-board applications of different trains using On-network communication mode.

ATP is considered to be user-to-user communication. Due to safety relevance of Automatic Train Protection (ATP), data communication requires a non-delay tolerant bearer service.

## 6.21.3 Use case: Initiation of an Automatic Train Protection data communication

### 6.21.3.1 Description

The FRMCS Application is able to initiate data communication for communication having continuous characteristics between the on-board applications and ground system and/or the on-board applications of other trains.

### 6.21.3.2 Pre-conditions

The FRMCS User at the train and at the FRMCS User at ground are authorised to initiate the Automatic Train Protection data communication.

The receiving application is authorised to use the Automatic Train Protection data communication.

### 6.21.3.3 Service flows

The FRMCS User (i.e. on-board of the train or the control center at the track side) initiates the Automatic Train Protection data communication (i.e. control center at the trackside or on-board the train).

For the operation of ATP, a non-delay tolerant bearer service is required that corresponds to application category CRITICAL DATA/VERY CRITICAL DATA according to QoS definition in chapter 12.10.

The FRMCS system takes into account the appropriate access criterion to establish the data bearer service within a setup time specified as IMMEDIATE (see QoS).

The arbitration among ATP and other applications applies. The communication is recorded by the data recording application.

### 6.21.3.4 Post-conditions

ATP related data can be exchanged between the Automatic Train Protection communication entities.

### 6.21.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.21.3-001]	Upon request of an authorised FRMCS User, the FRMCS System shall be able to provide a non-delay tolerant data bearer for ATP data communication that matches to the application category of CRITICAL DATA/ VERY CRITICAL DATA (see QoS).	A/T	TS 22.282 (data bearer)  N/A (QoS)	TS 22.282 sub-clause 5.5.2  See section 12.10 below
[R-6.21.3-002]	For ATP, the FRMCS System shall take into account the appropriate access criterion to establish the bearer service required for ATP communication within a setup time specified as IMMEDIATE (see 12.10).	A/T	N/A	See section 12.10 below
[R-6.21.3-003]	The FRMCS System shall apply arbitration to ATP data communication.	A	TS 22.280	Arbitration: [R-5.4.2-004] [R-5.4.2-004A] [R-5.4.2-004B]
[R-6.21.3-004]	The ATP data communication shall be recorded.	A	TS 22.280	[R-6.15.4-003] for on-network Not applicable to off-network (see table C-1).

## 6.21.4 Use case: Termination of an Automatic Train Protection data communication

### 6.21.4.1 Description

The FRMCS User is able to terminate data communication.

### 6.21.4.2 Pre-conditions

The Automatic Train Protection related data communication is ongoing.

### 6.21.4.3 Service flows

The FRMCS User (i.e. on-board of the train or the control centre at the track side) terminates the Automatic Train Protection data communication.

The FRMCS System terminates the bearer service required for ATP related data communication.

### 6.21.4.4 Post-conditions

The Automatic Train Protection data communication has been released.



### 6.21.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.21.4-001]	The FRMCS User shall be able to terminate the Automatic Train Protection data communication. The FRMCS System shall terminate the bearer service.	A	TS 22.280	TS 22.280 Requirements [R-6.4.9-001] on termination conditions. [R-6.7.6-002] 7.4: specific termination conditions for off-net.

## 6.22 Voice communication transfer related use cases

### 6.22.1 Introduction

In this chapter the use cases related to the transfer of incoming or ongoing voice communication are defined. The following use cases are defined:

- Transfer of an incoming voice communication
- Transfer of an ongoing voice communication
- Service interworking and service continuation with GSM-R

To provide some background, a description of one use case based on operational rules is described: a railway station could temporarily be closed for any operational reasons. In that case, railway staff could not be joined anymore. A mechanism of transferring calls to railway staff located in another railway stations shall be provided.

The use cases are applicable for user-to-user voice communications.

### 6.22.2 Use case: Transfer of an incoming voice communication

#### 6.22.2.1 Description

When FRMCS User receives a notification of an incoming voice communication, and the FRMCS Equipment does not automatically accept the communication, the FRMCS User, if authorised, shall be able to transfer the communication to another FRMCS User.

#### 6.22.2.2 Pre-conditions

FRMCS User is registered to a single or multiple FRMCS Equipment.

FRMCS User is or is not part of an ongoing communication.

#### 6.22.2.3 Service flows

The FRMCS System provides and activates a mechanism to transfer communications.

FRMCS User is authorised to use the mechanism to transfer communications.

When the notification of an incoming voice communication is received by the FRMCS equipment, a notification is presented to appropriate FRMCS User allowing the transfer of the incoming voice communication to another FRMCS User.

FRMCS User selects the new FRMCS User out of a list (e.g. telephone book) or entered manually based on either FRMCS User Identity, FRMCS Functional Identity or MSISDN.

The arbitration is managed by the arbitration application.

## 6.22.2.4 Post-conditions

The incoming voice communication is transferred to the new FRMCS User by the FRMCS System.

## 6.22.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.22.2-001]	The FRMCS System shall enable FRMCS User to transfer incoming voice communications based on different criteria	A/T	22.179	Limited to private calls because group communication already provides other mechanisms [R-5.6.3-015], [R-6.7.4-016]
[R-6.22.2-002]	The FRMCS System shall support the transfer of incoming voice communications based on following criteria: <ul style="list-style-type: none"> <li>• Unconditional;</li> <li>• When not reachable;</li> <li>• Busy;</li> <li>• Not answering;</li> </ul>	A/T	22.179 22.280	Partly covered (Busy excluded). Limited to private calls because group communication already provides other mechanisms [R-5.6.3-015], [R-6.7.4-016]. Busy concept no more applicable to MCX: an MCX UE/client can be simultaneously engaged in multiple private calls, or even mixed in private and group calls (see 22.179 5.5 & 22.280 5.4 & 6.14).
[R-6.22.2-003]	The FRMCS System shall be able to support configurable time when the FRMCS User is busy and shall be able to support configurable time when the FRMCS User is not answering	A/T	22.179 22.280	Partly covered (Busy excluded). Limited to private calls because group communication already provides other mechanisms [R-5.6.3-015], [R-6.7.4-016]. Busy concept no more applicable to MCX: an MCX UE/client can be simultaneously engaged in multiple private calls, or even mixed in private and group calls (see 22.179 5.5 & 22.280 5.4 & 6.14).
[R-6.22.2-004]	The FRMCS System shall support the transfer of incoming voice communications for user-to-user.	A/T	22.179	Indicated by sub-clause 5.6.3 Private Call (with Floor control) commencement requirements 6.7.4 Private Call (without Floor control) commencement requirements
[R-6.22.2-005]	The FRMCS System shall be aware of the busy condition of the targeted FRMCS user to forward the incoming voice communication to another FRMCS User.	A/T	22.179	Partly covered (Busy excluded). Limited to private calls because group communication already provides other mechanisms [R-5.6.3-015], [R-6.7.4-016]. Busy concept no more applicable to MCX: an MCX UE/client can be simultaneously engaged in multiple private calls, or even mixed in private and group calls (see 22.179 5.5 & 22.280 5.4 & 6.14).

## 6.22.3 Use case: Transfer of an ongoing voice communication

### 6.22.3.1 Description

When FRMCS User is part of an ongoing voice communication, FRMCS User, if authorised, shall be able to transfer the communication to another FRMCS User.

### 6.22.3.2 Pre-conditions

FRMCS User is registered to a single or multiple FRMCS Equipment.

FRMCS User is part of an ongoing voice communication.

The FRMCS System provides and activates a mechanism to transfer communications.

FRMCS User is authorised to use the mechanism to transfer communications.

### 6.22.3.3 Service flows

Whilst in an ongoing voice communication, the FRMCS Equipment provides an option to the FRMCS User allowing the transfer of the current communication to another FRMCS User.

FRMCS User selects the new FRMCS User out of a list (e.g. telephone book) or entered manually based on either FRMCS User Identity, FRMCS Functional Identity or MSISDN.

### 6.22.3.4 Post-conditions

The ongoing voice communication is transferred to the new FRMCS User by the FRMCS System.

### 6.22.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.22.3-001]	The FRMCS System shall enable FRMCS User to transfer ongoing voice communications.	A/T	22.179	Limited to private calls because group communication already provides other mechanisms [R-5.6.3-014], [R-6.7.4-015]

## 6.22.4 Use case: Service interworking with GSM-R

### 6.22.4.1 Description

For coexistence between FRMCS System and the legacy GSM-R communication system, service interworking among the systems is required.

Transfer of incoming voice communication to a GSM-R User shall be provided by the FRMCS System.

Transfer of ongoing communication to a GSM-R User shall be provided by the FRMCS System.

Service interworking for the automatic transfer function is not required.

### 6.22.4.2 Pre-conditions

FRMCS User is attached to the FRMCS System.

GSM-R User is attached to GSM-R System.

The transfer procedure (either transfer of incoming voice communication or transfer of ongoing communication) has been initiated by the FRMCS User.

#### 6.22.4.3 Service flows

FRMCS User selects the new GSM-R User out of a list (e.g. telephone book) or entered manually based on the functional address of the GSM-R User or E.164 numbering plan.

#### 6.22.4.4 Post-conditions

The incoming voice communication or the ongoing voice communication is transferred to the new GSM-R User by the FRMCS System.

#### 6.22.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-6.22.4-001]	The FRMCS System shall allow FRMCS User to forward of incoming voice communications and transfer of ongoing communication to GSM-R User using the applicable the addressing scheme.	A/T	22.280	[R-5.19.2-006]

## 7 Performance communication applications related use cases

### 7.1 Use cases related to transmission of real time video

#### 7.1.1 Introduction

In this clause, the use cases related to the function of transmitting video in real time are defined.

- An FRMCS User requesting another FRMCS User to transmit real time video
- An FRMCS User receiving a request to transmit real time video
- An FRMCS User accepting a request to transmit real time video
- An FRMCS User rejecting a request to transmit real time video
- An FRMCS User ignoring a request to transmit real time video

#### 7.1.2 Use Case: An FRMCS User requesting another FRMCS User to transmit real time video

##### 7.1.2.1 Description

An FRMCS User can request another FRMCS User to transmit real time video.

##### 7.1.2.2 Pre-conditions

The FRMCS User has a functional Role entitled to request other FRMCS Users to transmit real time video.

The requested FRMCS User can be addressed by the assigned functional identity(ies), FRMCS User Identity, or FRMCS Equipment Identity.

The FRMCS Equipment of the requested user is capable of providing video

### 7.1.2.3 Service flows

#### Requesting FRMCS User

From a list of FRMCS Users provided by the FRMCS System, or by entering an unlisted identity, the requesting FRMCS User selects another FRMCS User to be invited. The list may contain functional identities, FRMCS User identities, FRMCS Equipment Identities, or phone numbers.

### 7.1.2.4 Post-conditions

The FRMCS User has been requested transmission of real time video.

### 7.1.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-7.1.2-001]	The FRMCS System shall enable an entitled FRMCS User to request another FRMCS User to transmit video in real time.	A	22.281	5.1.2.2.2-xxx
[R-7.1.2-002]	The FRMCS System shall provide a list of identities for the requesting FRMCS User to select from. The list may contain functional identities, FRMCS User identities, FRMCS Equipment Identities or E.164 numbers.	A	22.281	5.1.3.2.2-xxx
[R-7.1.2-003]	The real time video request shall either be based on the functional identity, FRMCS User Identity, FRMCS Equipment Identity or E.164 number.	A	22.280	This requirement is covered by MCCore for rail esp. 5.9a

## 7.1.3 Use Case: An FRMCS User receiving a real time video request to transmit real time video

### 7.1.3.1 Description

An FRMCS User will receive a real time video request originated by the requesting FRMCS User.

### 7.1.3.2 Pre-conditions

The FRMCS User has a functional Role that is entitled to receive real time video request from other FRMCS Users.

The FRMCS User's equipment has a capability to capture real time video.

NOTE: Examples of Role management, like functional Roles, functional identities, FRMCS Equipment Identities, etc. in the railway environment are covered by Annex A.

The FRMCS User may or may not be transmitting real time video to an FRMCS User different from the requesting FRMCS User.

### 7.1.3.3 Service flows

#### Requested FRMCS User

The real time video request is indicated to the FRMCS User by audible and visual notification. If the FRMCS User is not managed by a human, the audible and visual notification is not necessary.

### 7.1.3.4 Post-conditions

The FRMCS User has received the real time video request.

Ongoing real time video transmission of the requested FRMCS User continues unaffected.

### 7.1.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-7.1.3-001]	The FRMCS System shall be able to deliver requests for real time video to a FRMCS User entitled to provide real time video independent of the FRMCS User being involved in another ongoing real time video transmission without excessively using radio resources.	A	22.281	5.1.3.2.2-xxx

## 7.1.4 Use case: An FRMCS User accepting a request to transmit real time video

### 7.1.4.1 Description

An FRMCS User can accept the invitation sent by the requesting FRMCS User.

### 7.1.4.2 Pre-conditions

The FRMCS User has received a request to transmit real time video.

### 7.1.4.3 Service flows

#### Requested FRMCS User

The FRMCS User accepts the request to transmit real time video.

#### Requesting FRMCS User

The FRMCS User receives a notification that the requested FRMCS User accepted the request.

### 7.1.4.4 Post-conditions

The requested FRMCS User captures and transmits video in real time to the requesting FRMCS User.

In case the FRMCS User receives multiple requests to stream the video, the FRMCS System will handle this in a resource efficient way i.e. by streaming the video from the FRMCS User to the FRMCS System via the radio only once and distributing it from there to the different FRMCS Users.

### 7.1.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-7.1.4-001]	The FRMCS User shall be able to accept to accept a real time video transmission request.	A	22.281	5.1.3.2.2-xxx esp. 5.1.3.2.2-003 5.2.6.2.1-xxx
[R-7.1.4-002]	If entitled to, a FRMCS User shall be able to provide real time video captured by itself to the FRMCS User requesting the video.	A	22.281	5.1.3.2.2-xxx esp. 5.1.3.2.2-003 5.2.6.2.1-xxx
[R-7.1.4-003]	In case of multiple requests to stream the same video to several FRMCS Users the FRMCS System shall handle this in a resource efficient manner.	A	22.281	5.2.6.2.4-001

## 7.1.5 Use case: An FRMCS User rejecting a request to transmit real time video

### 7.1.5.1 Description

An FRMCS User can reject the invitation sent by the requesting FRMCS User.

### 7.1.5.2 Pre-conditions

The FRMCS User has received a request to transmit real time video.

### 7.1.5.3 Service flows

#### Requested FRMCS User

The FRMCS User rejects the request to transmit real time video.

#### Requesting FRMCS User

The FRMCS User receives a notification that the requested FRMCS User rejected the request.

### 7.1.5.4 Post-conditions

The requested FRMCS User does not transmit video to the requesting FRMCS User.

### 7.1.5.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-7.1.5-001]	The FRMCS User shall be able to reject a real time video transmission request.	A	22.281	5.2.6.2.4-xxx
[R-7.1.5-002]	The FRMCS System shall automatically reject requests to FRMCS Users not entitled to provide video or not capable of providing video (e.g. no camera in the FRMCS Equipment).	A	22.281	5.2.6.2.4-001 5.1.3.1.2-001
[R-7.1.5-003]	The requesting FRMCS User shall be notified of the reason for rejection.	A	22.280	This is an implicit functionality of group communication setup 6.2.1-xxx

## 7.1.6 Use case: An FRMCS User ignoring a request to transmit real time video

### 7.1.6.1 Description

An FRMCS User can ignore the invitation sent by the requesting FRMCS User.

### 7.1.6.2 Pre-conditions

The FRMCS User has received a request to transmit real time video.

### 7.1.6.3 Service flows

The requested FRMCS User does not respond.

The timeout expires.

The requesting FRMCS User receives a notification that the invitation was rejected due to a timeout.

### 7.1.6.4 Post-conditions

The requested FRMCS User does not transmit video to the requesting FRMCS User.

### 7.1.6.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
	FRMCS User			
[R-7.1.6-001]	If the receiving FRMCS User has not reacted on the invitation within a certain period of time [t1] the FRMCS System shall notify the inviting FRMCS User accordingly and stop the invitation request.		22.280	This is an implicit functionality of group communication setup 6.2.1-xxx

## 7.2 Transfer of CCTV archives related use cases

### 7.2.1 Introduction

In this chapter, the use cases related to CCTV and the use of FRMCS are defined.



- Transfer of CCTV archives from Train to Ground
- Massive Inter-carriage data transfer

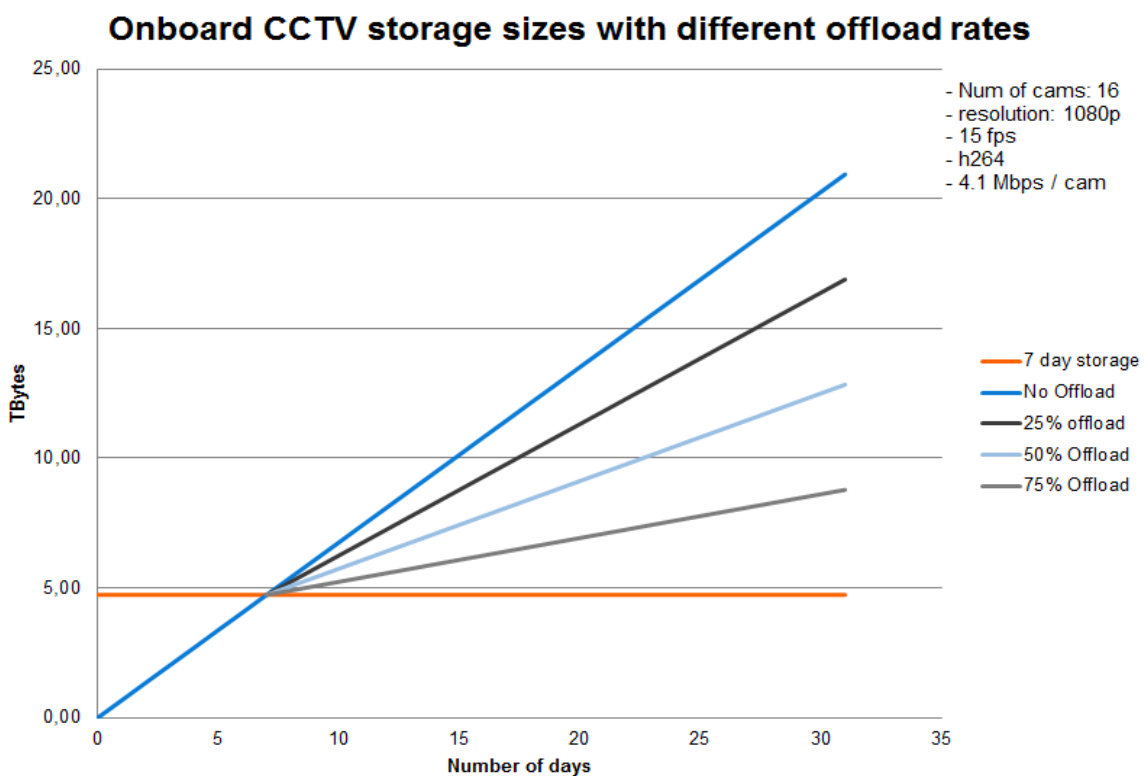
## 7.2.2 Use Case: Bulk Transfer of CCTV archives from Train to Ground

### 7.2.2.1 Description

This use case describes the bulk transfer of CCTV archives from the on-board system to the ground system. This use case assumes the following:

- The retention time for the recordings in the on-board system is seven days.
- The minimum retention time for the CCTV recordings in the ground system is 31 days.
- Bulk transfer of CCTV archives is performed only when train approaches stations in order to stop and at the depot.

An example calculation of the CCTV storage need during 31 days period is provided in Figure.7.2.2.1-1.



**Figure.7.2.2.1-1. Onboard CCTV storage sizes with different offload rates.**

Next, an example estimation is provided to illustrate the offload performance with different uplink speeds, when the train is commuting from Helsinki to Kemijärvi. The parameters for the calculation are provided in Table 1, whereas the offload results for uplink speeds of 400 Mbps, 750 Mbps and 1000 Mbps are provided respectively in Figure 7.2.2.1-2, Figure 7.2.2.1-3 and in Figure 7.2.2.1-4.

Station	Arrives	Departs	Stop time	Time between stations
HELSINKI		18:52		
PASILA	18:57	19:00	0:03	0:08
TIKKURILA	19:41	19:44	0:03	0:44
RIIHIMÄKI	20:19	20:22	0:03	0:38
HÄMEENLINNA	20:46	20:48	0:02	0:26
TAMPERE	21:38	22:11	0:33	1:23
PARKANO	23:03	23:06	0:03	0:55
SEINÄJOKI	0:08	0:10	0:02	1:04
KOKKOLA	1:37	1:39	0:02	1:29
YLIVIESKA	3:10	3:12	0:02	1:33
OULU	4:42	5:00	0:18	1:48
KEMI	6:08	6:12	0:04	1:12
ROVANIEMI	7:47	7:55	0:08	1:43
MISI	8:31	8:32	0:01	0:37
KEMIJÄRVI	9:00	9:05	0:05	0:33

**Table 7.2.2.1-1. The parameters for the offload calculation for the train route between Helsinki and Kemijärvi.**

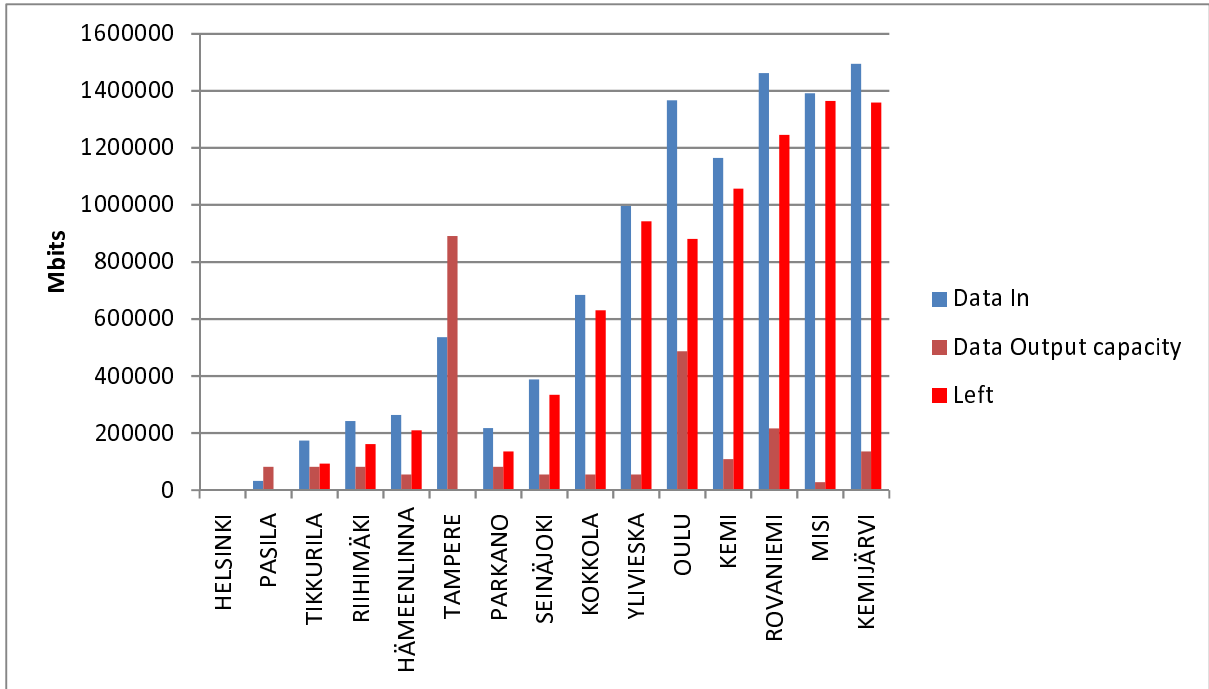


Figure 7.2.2.1-2. The offload results with uplink speed of 450 Mbps.

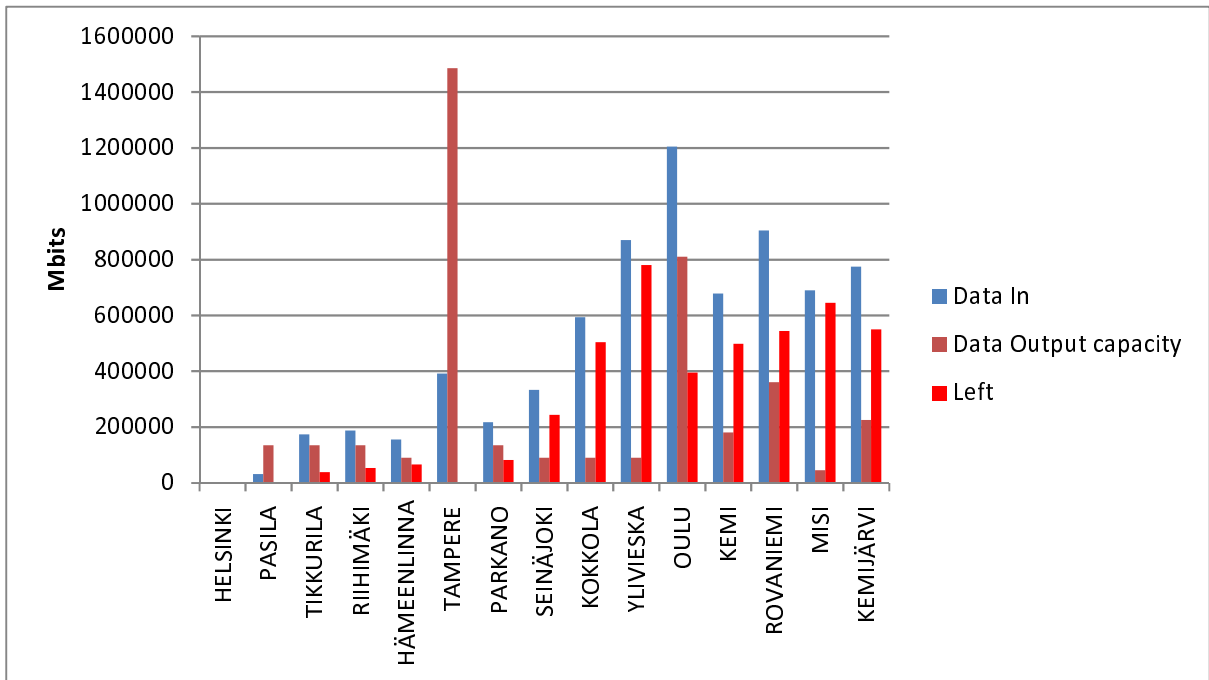


Figure 7.2.2.1-3. The offload results with uplink speed of 750 Mbps.

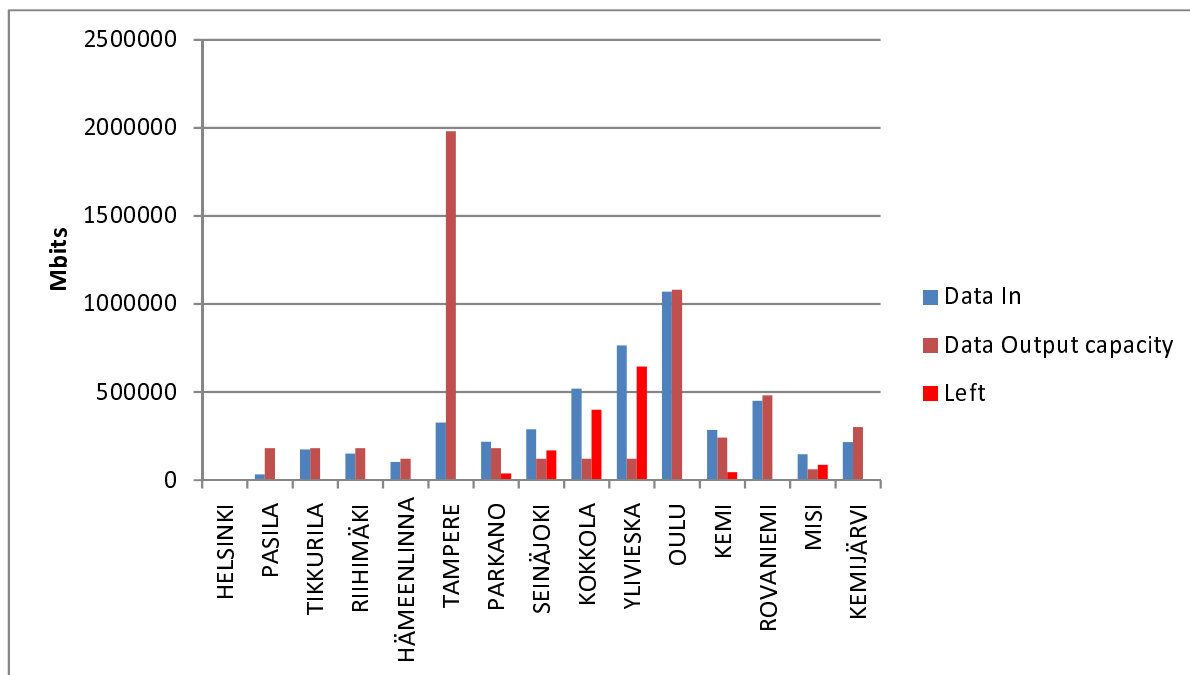


Figure 7.2.2.1-4. The offload results with uplink speed of 1000 Mbps.

### 7.2.2.2 Pre-conditions

- Bulk transfer of CCTV archives is performed only when the train stops at the stations.
- Mobile communication infrastructure between train and ground system enables transfer of CCTV archives from train to the ground system while the train stops at the stations.
- The ground system supports sufficient archiving system for the transferred recordings.

### 7.2.2.3 Service flows

1. The train approaches the station.
2. Mobile communication system in train establishes connection dedicated for the transfer of CCTV archives with the ground system at a priority level allowing critical communication to continue in parallel
3. The transfer of CCTV archives is started upon successful connection with the ground system.
4. The transfer of CCTV archives is stopped when the connection is no longer available.

### 7.2.2.4 Post-conditions

- The on-board CCTV system may re-write over the seven days and older recordings that have been transferred.
- The on-board mobile communication system remains monitoring the next approach of station.

### 7.2.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-7.2.2-001]	The FRMCS System shall be able to support that CCTV archives can be transferred into the ground system in a time and resource efficient way with a minimum of 1 Gbps in dedicated places such as stations or train depots.	A/T	TS 22.289	See: <a href="http://www.3gpp.org/technologies/keywords-acronyms/97-lte-advanced">http://www.3gpp.org/technologies/keywords-acronyms/97-lte-advanced</a> TS 22.289 [R4.1.2-1] [R4.1.2-2] [R4.1.2-3] [R4.1.2-4]
[R-7.2.2-002]	Transferring CCTV archives shall not affect mission critical communication. NOTE: Transferring CCTV archives is not considered to be a mission critical service.	A/T	TS 22.289	TS 22.289 [R4.1.2-1] [R4.1.2-2] [R4.1.2-3] [R4.1.2-4]

## 7.3 Use Case: Massive Inter-carriage data transfer

### 7.3.1 Description

This use case describes the transfer of CCTV archives inside the train from different storages and through Inter-carriage links into the FRMCS node providing the uplink connection with the ground system.

### 7.3.2 Pre-conditions

- Mobile communication infrastructure between train and ground system enables transfer of CCTV archives from train to the ground system while the train stops at the stations.
- The ground system supports sufficient archiving system for the transferred recordings.
- The Inter-carriage links support the same throughput speed as the FRMCS node providing the uplink.

### 7.3.3 Service flows

Mobile communication system in train establishes connection between carriages of the train dedicated for the transfer of CCTV archives to a central node in the train from which the uplink to the ground system will take place.

### 7.3.4 Post-conditions

Recording capacity is freed up in the carriages.

### 7.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-7.3-001]	The FRMCS System shall facilitate the onboard CCTV communication between carriages of a train, to collect CCTV content at one place on the train for transfer to the ground system.	A/T	22.289	CR 22.289 R4.3.1-001-003
[R-7.3-002]	The onboard CCTV communication between carriages of a train shall not impact mission critical communication NOTE: Transferring CCTV archives is not considered to be a mission critical service.	A/T	22.289	CR 22.289 R4.3.1-001-003

## 7.4 Void

## 7.5 On-train outgoing voice communication from train staff towards a ground user related use cases

### 7.5.1 Introduction

In this chapter the use cases related to on-train outgoing voice communication from train staff towards a ground user e.g. controller are defined. The following use cases are defined:

- Initiation of on-train outgoing voice communication by the train staff
- Termination of on-train outgoing voice communication by the train staff
- Service interworking with GSM-R

### 7.5.2 Use case: Initiation of on-train outgoing voice communication from train staff

#### 7.5.2.1 Description

FRMCS User at the train shall be able to initiate a voice communication to any FRMCS User (s) at the ground.

#### 7.5.2.2 Pre-conditions

The FRMCS User, member of the train staff, is authorised to initiate the voice communication.

The FRMCS System is able to retrieve location information of the FRMCS User at the train to address the appropriate FRMCS Users at the ground.

#### 7.5.2.3 Service flows

The FRMCS User at the train (member of the train staff) initiates the voice communication to an FRMCS User at the ground (one or multiple). This kind of voice communication requires the QoS category of NON-CRITICAL VOICE (see [QoS]) within the FRMCS system.

The FRMCS System establishes the voice communication among the FRMCS user(s) within a setup time specified as NORMAL (see [QoS]).

The activated identities to the FRMCS User(s) are presented to all FRMCS Users during the entire voice communication.

This kind of communication can become part of the communication arbitration management.

On demand this voice communication can be recorded for post processing purposes.

If two or more than two FRMCS Users are part of the voice communication, multi talker control applies.

#### 7.5.2.4 Post-conditions

The FRMCS User at the train is able to communicate to the FRMCS Users at the ground.

### 7.5.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-7.5.2-001]	The FRMCS System shall setup a voice communication between one FRMCS User at the train and one/multiple FRMCS Users on the ground based. The NON-CRITICAL VOICE QoS class shall apply for this kind of communication.	A	22.179 22.280	TS 22.179 Floor Control clause 6.2.3.2 Req #1, TS 22.280 clause 5.1 req # 2
[R-7.5.2-002]	The location information of the FRMCS User at the train shall be used to locate and address the responsible FRMCS Users on the ground.	A	22.280	R-5.6.2.1.2-002 R-5.6.2.4.1-004 R-6.8.8.4.1-006 (Using User regroup, not 5.6.2.4.1-005) R-6.6.4.2-002b R-6.6.4.1-XXX User regroup
[R-7.5.2-003]	The FRMCS System shall verify if the FRMCS User at the train as well as the FRMCS Users on the ground are authorised to establish the communication.	A	22.280	5.1.x
[R-7.5.2-004]	The FRMCS System shall establish the voice communication between the FRMCS User at the train and the FRMCS Users on the ground within a setup time specified as NORMAL (see [QoS]).	A	N/A	See section 12.10 below
[R-7.5.2-005]	The FRMCS System shall provide for on-train to one/multiple ground FRMCS User: <ul style="list-style-type: none"> <li>- arbitration information to the FRMCS User</li> <li>- communication recording</li> <li>- Multi-Talker Control.</li> </ul>	A	22.280	Arbitration: [R-5.4.2-004] [R-5.4.2-004A] [R-5.4.2-004B] Multiuser talker control, recording: See relevant section

### 7.5.3 Use case: Termination of on-train outgoing voice communication from train staff

#### 7.5.3.1 Description

The FRMCS User that is member of train staff shall be able to terminate the voice communication towards the FRMCS Users on the ground.

The FRMCS User on the ground shall be able to put on hold, leave or terminate the on-train voice communication.



### 7.5.3.2 Pre-conditions

The on-train outgoing voice communication is ongoing.

### 7.5.3.3 Service flows

#### **Member of train staff termination**

The FRMCS User that is member of the train staff terminates the voice communication.

The FRMCS system releases the voice communication.

#### **Communication on hold**

A FRMCS User on the ground put the voice communication on hold.

The communication remains active in the FRMCS system and the FRMCS User on the ground user is able to re-join the communication.

#### **Leaving the communication**

The FRMCS User at the ground user is able to leave the voice communication if more than one FRMCS User at the ground is part of the voice communication.

#### **Communication Termination by the ground FRMCS User**

Any FRMCS User on the ground is able to terminate the voice communication between train staff and the ground user.

The FRMCS system releases the voice communication. All involved FRMCS Users are informed about.

### 7.5.3.4 Post-conditions

The on-train outgoing voice communication is terminated.

## 7.5.3.5 Potential requirements and gap analysis

Reference Number	Requirement test	Application / Transport	SA1 spec covering	Comments
[R-7.5.3-001]	The FRMCS System shall allow an authorised FRMCS User at the train that is part of the On-train outgoing voice communication, to terminate the voice communication.	A	22.280	6.4.4 002; 6.4.5 001; 5.1.5 003-008 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is sufficient to mimic the desired behavior"
[R-7.5.3-002]	Based on the On-train outgoing voice communication termination request, the FRMCS System shall release the voice communication.	A	22.280	6.4.4 002; 6.4.5 001; 5.1.5 003-008 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is sufficient to mimic the desired behavior"
[R-7.5.3-003]	If authorised, a FRMCS User on the ground shall be able to put the train staff to ground user voice communication on hold if more than one ground FRMCS Users are part of the voice communication.	A	22.280	6.4.4 002; 6.4.5 001; 5.1.5 003-008 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is sufficient to mimic the desired behavior"
[R-7.5.3-004]	After the FRMCS User has put the voice communication on hold, the communication shall remain active and the FRMCS User on the ground shall be able to re-join the communication.	A	22.280	6.4.4 002; 6.4.5 001; 5.1.5 003-008 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is sufficient to mimic the desired behavior"
[R-7.5.3-005]	If more than one FRMCS Users on the ground participate to an On-train outgoing voice communication from train staff towards a ground user, the FRMCS User on the ground user shall be able to withdraw from the communication with ability to re-join. The remaining FRMCS Users shall be informed about the withdrawn FRMCS User.	A	22.280	6.4.4 002; 6.4.5 001; 5.1.5 003-008 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is sufficient to mimic the desired behavior"
[R-7.5.3-006]	If authorised, the FRMCS User at the train or the FRMCS Users on the ground shall be able to terminate the train staff to ground user voice communication. The FRMCS system shall inform the involved FRMCS Users about the release of the communication.	A	22.280	6.4.4 002; 6.4.5 001; 5.1.5 003-008 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is sufficient to mimic the desired behavior"

## 7.5.4 Use case: Service interworking with GSM-R

### 7.5.4.1 Description

For coexistence between FRMCS System and the legacy GSM-R communication system, service interworking among the systems is required.

Depending on the scenario a ground FRMCS User can be attached to the FRMCS system, to the GSM-R system or both. The FRMCS User at the train can be attached either to the GSM-R system or to the FRMCS system.

This use case only applies to an FRMCS Equipment that supports FRMCS System and GSM-R.

### 7.5.4.2 Pre-conditions

The FRMCS User is either attached to the FRMCS System or to GSM-R.

### 7.5.4.3 Service flows

#### **FRMCS User (Train staff) attached to GSM-R**

When the FRMCS User (member of the train staff) is attached to the GSM-R system and is initiating voice communication to FRMCS Users on the ground, the GSM-R system will route the voice communication to the FRMCS User on the ground accordingly.

If the FRMCS User on the ground is registered to the FRMCS System, the GSM-R system establishes the communication considering the appropriate addressing scheme.

#### **FRMCS User (Train staff) attached to FRMCS System**

When the FRMCS User (member of train staff) is active in the FRMCS system and is initiating voice communication to FRMCS Users on the ground, the FRMCS system will establish the communication considering the appropriate addressing schemes applicable for FRMCS System as well as to GSM-R accordingly.

#### **FRMCS User (Train staff) relocates between GSM-R and FRMCS System/FRMCS System and GSM-R**

When the FRMCS User (train staff) relocates between GSM-R - FRMCS System or vice versa the communication service requires continuation. An interruption of the applicable bearer service is acceptable.

### 7.5.4.4 Post-conditions

The communication continues if the FRMCS User at the train relocates between GSM-R and FRMCS System or vice versa.

### 7.5.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-7.5.4-001]	The FRMCS System shall provide the necessary means to allow FRMCS Users to be reachable from the legacy GSM-R system.	A	22.179	Covered in 6.18.4.2
[R-7.5.4-002]	The FRMCS System shall provide the necessary means to FRMCS Users to set up On-train outgoing voice communication including users registered to the GSM-R system.	A	22.179	Covered in 6.18.4.2
[R-7.5.4-003]	When the FRMCS User has to relocate between FRMCS System and GSM-R or vice versa, the voice communication service shall continue. The interruption of the bearer service associated with the relocating FRMCS User is acceptable.  Note : This requirement applies to FRMCS Equipment that contains FRMCS UE and GSM-R UE capabilities.	A	N/A	Call has to be re-established by UE. This is UE function outside scope of 3GPP

## 7.6 Real-time video communication (video conferencing) related use cases

### 7.6.1 Introduction

A real-time video communication (video conferencing) can be used to support railway operations, such as maintenance staff when investigating infrastructure or vehicles components where help is needed from other staff or during testing of infrastructure or vehicles.

Real-time video communication (video conferencing) is supported by the FRMCS System. That encompasses user-to-user as well as multiuser video communication, including audio, and is applicable to On-network only.

In this chapter the use cases related to real-time video communication (video conferencing) are described. The following use cases are identified:

- An FRMCS User initiates a video conference
- An FRMCS User leaves and re-joins a video conference
- An FRMCS User terminates a video conference
- An FRMCS User changes from a video conference to a voice-only conference
- An FRMCS User changes from a voice-only conference to a video conference
- An FRMCS User joins an ongoing video conference

## 7.6.2 Use case: Initiation of video conference

### 7.6.2.1 Description

An FRMCS User is able to set up a video conference to other FRMCS User(s). This encompasses transmission of synchronized video and audio information under conditions.

### 7.6.2.2 Pre-conditions

The initiating FRMCS User is authorised to initiate a video conference.

The receiving FRMCS User(s) is(are) authorised to use video conference.

### 7.6.2.3 Service flows

An authorised FRMCS User initiates a video conference that corresponds to the application category VIDEO (see QoS chapter).

The FRMCS System determines the FRMCS User(s) to be included in the communication, based on:

- Selection by the initiating FRMCS User, or
- Location of all FRMCS Users, and/or
- Functional identity of all FRMCS Users, and/or
- System configuration.

The FRMCS system establishes the bearer service(s) required for the video conference within a setup time applicable to application category VIDEO (see QoS chapter). FRMCS User(s) are using their registered functional identities and provide furthermore their location.

The FRMCS System assigns a certain priority of the video conference.

The receiving FRMCS User(s) is able to accept, reject, or ignore the incoming video conference.

The involved FRMCS Users are able to select which video content is to be presented (at both sender and receiver sides).

The FRMCS System records the communication of the initiating and receiving FRMCS Users.

### 7.6.2.4 Post-conditions

Real-time video (synchronized video and audio information) can be transmitted and received among authorised FRMCS Users involved in the ongoing video conference.

### 7.6.2.5 Potential requirements and gap analysis

This use case is not in the scope of current normative work.

A decision has to be taken to consider a fully OTT solution, or if MCVideo current group communications functionality are sufficient, or if MMTel conference could be used, or if we need a new technical study on MCVideo conferencing.

It is recommended that MCVideo Service (MCVideo group communications as stated in TS 22.281) or MCDData Service using IP connectivity (MCDData group communications as stated in TS 22.282) and Functional Alias to reach MCX Users as 3GPP building blocks to support Real-time video communication (video conferencing) related use cases.

## 7.6.3 Use case: Leave and re-join a video conference

### 7.6.3.1 Description

An FRMCS User is able to leave and re-join an ongoing video conference under conditions.

### 7.6.3.2 Pre-conditions

The video conference is ongoing.

The FRMCS User is authorised to leave and re-join an ongoing video conference.

### 7.6.3.3 Service flows

The authorised FRMCS User is able to leave the video conference while receiving a new incoming communication or initiating another outgoing communication. The other involved FRMCS User(s) are informed and can continue the ongoing video conference if the number of remaining participants is sufficient.

The authorised FRMCS Users is then able to re-join the video conference.

The ongoing video conference is terminated if the number of remaining participants is not sufficient.

### 7.6.3.4 Post-conditions

The authorised FRMCS User has left the ongoing video conference.

### 7.6.3.5 Potential requirements and gap analysis

This use case is not in the scope of current normative work.

A decision has to be taken to consider a fully OTT solution, or if MCVideo current group communications functionality are sufficient, or if MMTel conference could be used, or if we need a new technical study on MCVideo conferencing.

It is recommended that MCVideo Service (MCVideo group communications as stated in TS 22.281) or MCDData Service using IP connectivity (MCDData group communications as stated in TS 22.282) and Functional Alias to reach MCX Users as 3GPP building blocks to support Real-time video communication (video conferencing) related use cases.

## 7.6.4 Void

## 7.6.5 Use case: Termination of a video conference

### 7.6.5.1 Description

Any authorised FRMCS User is able to terminate an ongoing video conference.

### 7.6.5.2 Pre-conditions

The video conference is ongoing.

The FRMCS User is authorised to terminate an ongoing video conference.

### 7.6.5.3 Service flows

The authorised FRMCS User is able to terminate the video conference. The involved FRMCS User(s) are informed and the video conference is terminated.

### 7.6.5.4 Post-conditions

The authorised FRMCS User has terminated the ongoing video conference.

### 7.6.5.5 Potential requirements and gap analysis

This use case is not in the scope of current normative work.

A decision has to be taken to consider a fully OTT solution, or if MCVideo current group communications functionality are sufficient, or if MMTel conference could be used, or if we need a new technical study on MCVideo conferencing.

It is recommended that MCVideo Service (MCVideo group communications as stated in TS 22.281) or MCDATA Service using IP connectivity (MCDATA group communications as stated in TS 22.282) and Functional Alias to reach MCX Users as 3GPP building blocks to support Real-time video communication (video conferencing) related use cases.

## 7.6.6 Use case: Changes from a video conference to a voice-only conference

### 7.6.6.1 Description

Any authorised FRMCS User is able to change from a video conference to a voice-only conference only.

### 7.6.6.2 Pre-conditions

There is an ongoing video conference.

The initiating FRMCS User is authorised to change from a video conference to a voice-only conference.

The initiating FRMCS User is authorised to initiate voice-only conference.

### 7.6.6.3 Service flows

An authorised FRMCS User initiates the change from a video conference to a voice-only conference.

The FRMCS System determines if the change can be proceeded, based on:

- Authorisation from initiating FRMCS User, and/or
- Authorisation from receiving FRMCS User(s), and/or
- System configuration.

The FRMCS system establishes the bearer service required for the voice-only conference within a setup time applicable to application category CRITICAL VOICE or VOICE (see QoS chapter). FRMCS User(s) are using their registered functional identities and provide furthermore their location.

The FRMCS System assigns a certain priority of the voice-only conference.

The receiving FRMCS User(s) shall be able to accept, reject or ignore the change to a voice-only conference.

The bearer service required for the video conference is maintained under conditions (e.g. timer) to allow FRMCS Users to return to the video conference.

The receiving FRMCS User(s) are notified that a change from video conference to voice-only conference has been initiated by the authorised FRMCS User.

The FRMCS System records the communication of the initiating and receiving FRMCS Users.

### 7.6.6.4 Post-conditions

After the change from video conference to voice-only conference, the FRMCS Users are not able to transmit and receive video anymore.

### 7.6.6.5 Potential requirements and gap analysis

This use case is not in the scope of current normative work.

A decision has to be taken to consider a fully OTT solution, or if MCVideo current group communications functionality are sufficient, or if MMTel conference could be used, or if we need a new technical study on MCVideo conferencing.

It is recommended that MCVideo Service (MCVideo group communications as stated in TS 22.281) or MCDData Service using IP connectivity (MCDData group communications as stated in TS 22.282) and Functional Alias to reach MCX Users as 3GPP building blocks to support Real-time video communication (video conferencing) related use cases.

## 7.6.7 Use case: Change from a voice-only conference to a video conference

### 7.6.7.1 Description

Any authorised FRMCS User is able to change from a voice-only conference to a video conference.

### 7.6.7.2 Pre-conditions

There is an ongoing voice-only conference.

The initiating FRMCS User is authorised to change from a voice-only conference to a video conference.

The initiating FRMCS User is authorised to initiate a video conference.

### 7.6.7.3 Service flows

An authorised FRMCS User initiates the change from a voice-only conference to a video conference.

The FRMCS System determines if the change can be proceeded, based on:

- Authorisation from initiating FRMCS User, and/or
- Authorisation from receiving FRMCS User(s), and/or
- System configuration.

The FRMCS system establishes the bearer service required for the video conference within a setup time applicable to application category VIDEO (see QoS chapter). FRMCS User(s) are using their registered functional identities and provide furthermore their location.

The FRMCS System assigns a certain priority of the video conference.

The receiving FRMCS User(s) is able to accept, reject or ignore the change to a video conference.

The bearer service required for the voice-only conference is maintained under conditions (e.g. timer) to allow FRMCS Users to return to the voice-only conference.

The receiving FRMCS User(s) are notified that a change has been initiated by the authorised FRMCS User.

The FRMCS System records the communication of the initiating and receiving FRMCS Users.

### 7.6.7.4 Post-conditions

After the change from voice-only conference to video conference, the FRMCS Users are able to transmit and receive video and audio.

### 7.6.7.5 Potential requirements and gap analysis

This use case is not in the scope of current normative work.

A decision has to be taken to consider a fully OTT solution, or if MCVideo current group communications functionality are sufficient, or if MMTel conference could be used, or if we need a new technical study on MCVideo conferencing.

It is recommended that MCVideo Service (MCVideo group communications as stated in TS 22.281) or MCDData Service using IP connectivity (MCDData group communications as stated in TS 22.282) and Functional Alias to reach MCX Users as 3GPP building blocks to support Real-time video communication (video conferencing) related use cases.



## 7.6.8 Use case: Join an ongoing video conference

### 7.6.8.1 Description

Any authorised FRMCS User is able to join an ongoing video conference under conditions.

### 7.6.8.2 Pre-conditions

There is an ongoing video conference.

An FRMCS User is authorised to join an ongoing video conference.

### 7.6.8.3 Service flows

The FRMCS System determines if the authorised FRMCS User can join an ongoing video conference, based on:

- Selection/Invitation by the initiating FRMCS User of the ongoing video conference, or
- Location of all FRMCS Users, and/or
- Functional identity of all FRMCS Users, and/or
- System configuration.

The authorised FRMCS User joins an ongoing video conference.

The involved FRMCS User(s) are notified that an FRMCS User has joined the ongoing video conference. FRMCS User(s) are using their registered functional identities and provide furthermore their location.

### 7.6.8.4 Post-conditions

The authorised FRMCS Users has joined the ongoing video conference. All involved FRMCS Users of the ongoing video conference are able to transmit and receive video and audio.

### 7.6.8.5 Potential requirements and gap analysis

This use case is not in the scope of current normative work.

A decision has to be taken to consider a fully OTT solution, or if MCVideo current group communications functionality are sufficient, or if MMTel conference could be used, or if we need a new technical study on MCVideo conferencing.

It is recommended that MCVideo Service (MCVideo group communications as stated in TS 22.281) or MCDATA Service using IP connectivity (MCDATA group communications as stated in TS 22.282) and Functional Alias to reach MCX Users as 3GPP building blocks to support Real-time video communication (video conferencing) related use cases.

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## 8 Business communication applications related use cases

### 8.1 Multimedia applications related use cases

#### 8.1.1 Introduction

In this chapter, the following use cases related to Multimedia applications are defined:

- Live streaming of multimedia
- Bulk transfer of multimedia data bases from ground to train

## 8.2 Use Case: Live streaming of multimedia

### 8.2.1 Description

This use case describes the live streaming of multimedia content from ground to train.

### 8.2.2 Pre-conditions

- FRMCS User equipment is registered into the FRMCS System.
- Passengers can access live streaming services through the FRMCS System in the train.

### 8.2.3 Service flows

1. FRMCS System provides data communication for the live streaming services.
2. FRMCS User equipment requests data communication for the live streaming services from the FRMCS System.
3. FRMCS System allocates requested data communication for the FRMCS User equipment.
4. FRMCS User equipment allocates the communication to the passengers.

### 8.2.4 Post-conditions

FRMCS User equipment deregisters from the FRMCS System upon the reception of live streaming is ceased.

### 8.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-8.2.5-001]	The FRMCS System SHALL enable bandwidth for the live streaming inside the train through the FRMCS System.		22.261	Live streaming service covered by 22.261 Table 7.1-1.
[R-8.2.5-002]	The FRMCS User equipment SHALL be able to balance the bandwidth between the passengers.		22.261	Live streaming service covered by 22.261 Table 7.1-1.

NOTE: Live streaming of multimedia from ground to train is not considered to be a mission critical service.

## 8.3 Use Case: Bulk transfer of multimedia from ground to train

### 8.3.1 Description

This use case describes the transfer of multimedia databases from ground to train. The multimedia may contain movies, TV shows, cached webpages etc.

Figure 1 illustrates an example calculation of upload time of movies with different bitrates, when 1-100 movies are uploaded, and the upload speed is 1 Gbps.

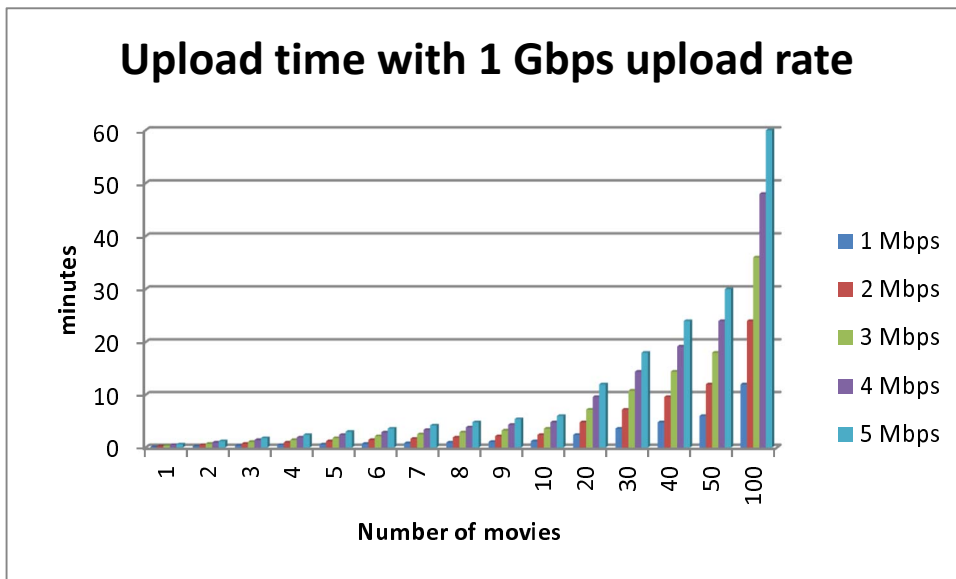


Figure 8.3.1-1. An example calculation of upload time of movies with different bitrates and 1 Gbps upload speed.

### 8.3.2 Pre-conditions

FRMCS System enables transfer of multimedia databases from ground to train while the train stops at the stations or is at the depot.

### 8.3.3 Service flows

1. Train has stopped at the station or at the depot and
2. FRMCS User equipment responsible for the bandwidth allocation for the transfer of on-board multimedia database is registered into the FRMCS System
3. FRMCS User equipment asks from FRMCS System to allocate needed bandwidth for the transfer of the multimedia database upon request by the content server.

### 8.3.4 Post-conditions

FRMCS User equipment responsible for the bandwidth allocation for the transfer of on-board multimedia database de-registers from the FRMCS System.

### 8.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-8.3.5-001]	For the sufficient transfer of large sized multimedia databases, the FRMCS System SHALL support throughput speed minimum of 1 Gbps.		22.289 22.261	TS 22.289 [R4.2.2-2] s

NOTE: Bulk transfer of multimedia from ground to train is not considered to be a mission critical service.

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## 9 Critical support applications related use cases

### 9.1 Overview

Critical applications are essential for train movements, safety, shunting, presence, trackside maintenance, legal aspects such as emergency communications, etc.

### 9.2 Assured voice communication (AVC)

#### 9.2.1 Introduction

In this chapter the use cases related to the function of assured voice communication are defined. Assured Voice Communication (AVC) shall provide an indication to FRMCS Users as soon as a voice communication link is interrupted. It is invoked on an existing voice communication between two or more FRMCS Users.

The following use cases are defined:

- Invocation of AVC
- Stopping AVC
- Degradation of a communication link (e.g. bad quality of the signal quality or interruption of a communication link)
- Extension of AVC

#### 9.2.2 Use case: Invocation of Assured Voice Communication

##### 9.2.2.1 Description

This use case describes the invocation of Assured Voice Communication.

##### 9.2.2.2 Pre-conditions

A FRMCS User is part of a voice communication with one or more FRMCS Users for which Assured Voice Communication can be invoked either automatically or manually.

##### 9.2.2.3 Service flows

###### **Automatic Invocation**

Upon establishment of a voice communication for which automatic AVC is activated, AVC will be invoked by the FRMCS System.

The involved FRMCS Users are informed about the successful activation of AVC.

###### **Manual Invocation**

The user invokes AVC in the FRMCS System.

The involved FRMCS Users are informed about the successful activation of AVC.

##### 9.2.2.4 Post-conditions

The voice communication links of all FRMCS Users involved in the communication are supervised.

### 9.2.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.2.2-001]	Upon establishment of a voice communication for which automatic AVC is activated, AVC shall be invoked by the FRMCS System.	A	22.280	R-6.2.1-001 But the AVC remains as OTT application while 3GPP building block provides the enabling framework."
[R-9.2.2-002]	If entitled, a FRMCS User shall be able to invoke AVC manually.	A	22.280	MCX Services take the approach that all communication are acknowledged and the MCPTT User is given the choice to proceed without acknowledgement 22.280 R-6.2.1-010

## 9.2.3 Use case: Stopping Assured Voice Communication

### 9.2.3.1 Description

This use case describes the deactivation of the communication link supervision.

### 9.2.3.2 Pre-conditions

A FRMCS User is part of a voice communication with one or more FRMCS Users for which Assured Voice Communication was invoked.

### 9.2.3.3 Service flows

#### Automatic stopping

If the ongoing voice communication is terminated by one of the involved users, the Assured Voice Communication is stopped.

The involved FRMCS Users are informed about the successful stop of AVC.

#### Manual stopping

The FRMCS User who has previously manually invoked AVC may stop AVC.

The involved FRMCS Users are informed about the successful stop of AVC.

### 9.2.3.4 Post-conditions

#### Automatic stopping

The FRMCS User is no longer part of a voice communication with one or more FRMCS Users.

#### Manual stopping

The FRMCS User is still part of a voice communication with one or more FRMCS Users.

### 9.2.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.2.3-001]	If the voice communication is terminated stopping of AVC shall be done by the FRMCS System automatically.	A	N/A	Implicit as done on burst basis
[R-9.2.3-002]	Only the FRMCS User who requested the end-to-end supervision shall be able to stop AVC.	A	22.280	Communication is acknowledged on a per talk burst basis so stopping that ack processing can be done by R-6.2.1-008 R-6.2.1-010"

## 9.2.4 Use case: Degradation of a communication link

### 9.2.4.1 Description

Alternative 1: The FRMCS System provides a so called negative notification to the FRMCS Users as soon as voice communication link is interrupted.

Alternative 2: A positive notification will be given by the FRMCS System as long as the voice communication link is unaffected.

### 9.2.4.2 Pre-conditions

A FRMCS User is part of a voice communication with one or more FRMCS Users.

AVC is invoked on all links of the voice communication.

### 9.2.4.3 Service flows

#### Positive Notification

The FRMCS System continuously checks whether the voice communication links are unaffected (e.g. bad quality of the signal quality or interruption of a communication link).

The FRMCS System indicates to all FRMCS Users involved in the voice communication service is working properly e.g. by a periodic audio signal.

If an interruption of at least one of the communication links is detected, the positive notification is immediately stopped.

If AVC itself fails, the positive notification shall be stopped immediately.

Active speech transmission shall suppress the positive notification to all FRMCS Users involved.

Optionally all FRMCS Users have to confirm their availability periodically (e.g. by pressing a button or by talking). If this confirmation is not received, AVC shall be stopped immediately.

A FRMCS User terminating his participation in the voice communication shall immediately stop AVC.

When AVC is stopped the ongoing voice communication is continued. Assured Voice Communication may be reinvoked for the remaining FRMCS Users of the ongoing voice communication.

#### Negative Notification

The FRMCS System continuously checks whether the voice communication links are unaffected (e.g. bad quality of the signal quality or interruption of a communication link).

If a degradation of a voice communication link is detected the FRMCS System warns all involved FRMCS Users, e.g. by generating a warning audio signal. If possible, the FRMCS User with the interrupted communication link shall also be warned.

If AVC itself fails, the negative notification shall be given immediately e.g. by a warning tone.

A FRMCS User terminating his participation in the voice communication shall stop AVC and a negative notification shall be given immediately e.g. by a warning tone.

Optionally all FRMCS Users have to confirm their availability periodically (e.g. by pressing a button or by talking). If this confirmation is not received, AVC shall be stopped and a negative notification shall be given immediately e.g. by a warning tone.

When AVC is stopped the ongoing voice communication is continued. Assured Voice Communication may be reinvoked for the remaining FRMCS Users of the ongoing voice communication.

#### 9.2.4.4 Post-conditions

The voice communication between the remaining FRMCS Users continues.

#### 9.2.4.5 Potential requirements and gap analysis



Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.2.4-001]	The FRMCS System shall be able to continuously supervise the voice communication links to all involved FRMCS Users.	A	22.280 22.179	Result of this supervision is provided by 22.179 6.2.1-001-010 22.280 5.20.2-001
[R-9.2.4-001a]	The FRMCS System shall be able to provide indications to AVC on the signal quality of the link/connection to take decision to maintain a reliable communication path.	T	22.261	Covered by QoS monitoring.
[R-9.2.4-002]	If a degradation of a voice communication link is detected, the remaining FRMCS Users shall be informed. The ongoing voice communication among the remaining FRMCS Users shall continue. A FRMCS User quitting the communication shall cause the AVC to stop.	A	22.280 22.179	Done by 22.179 6.2.1-001-010 22.280 5.20.2-001 Supervision is done on a per talk burst basis, if user drops out or de-affiliates during the burst 22.280 5.20.2-001 takes effect, if user drop out between the bursts this will be noticed during the ack process as described in 22.179 6.2.1-001-010
[R-9.2.4-003]	The FRMCS System shall be able to inform the FRMCS Users of an interrupted voice communication link by either positive or negative notification.	A	22.179	R-6.2.1-008 R-6.2.1-009
[R-9.2.4-004]	In case of positive notification all FRMCS Users shall receive a periodic audio signal while no voice communication is ongoing. Active speech transmission shall suppress the positive notification.	A	22.280 22.179"	Information conveyed to UE by 22.179 6.2.1-001-010 22.280 5.20.2-001R-6.2.1-002 how this information is presented to the user is user I/F design, due to the talk burst nature of the communication it does not make sense while not talking to have that indication It rather should be notified at the set-up that certain users did not acknowledge see 22.179 6.2.1-010
[R-9.2.4-005]	In case of negative notification all FRMCS Users shall receive an audio signal when an interrupted voice communication link is detected, the AVC has failed or a FRMCS terminated his participation in the voice communication.	A	22.280 22.179"	Information conveyed to UE by 22.179 6.2.1-001-010 22.280 5.20.2-001R-6.2.1-002 how this information is presented to the user is user I/F design, due to the talk burst nature of the communication it does not make sense while not talking to have that indication It rather should be notified at the set-up that certain users did not acknowledge see 22.179 6.2.1-010a

[R-9.2.4-006]	Negative notification shall be stopped after acknowledgement by all remaining FRMCS Users in the voice communication.	A	22.280 22.179"	Information conveyed to UE by 22.179 6.2.1-001-010 22.280 5.20.2-001R-6.2.1-002 how this information is presented to the user is user I/F design, due to the talk burst nature of the communication it does not make sense while not talking to have that indication It rather should be notified at the set-up that certain users did not acknowledge see 22.179 6.2.1-010a
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## 9.2.5 Use case: Extension of Assured Voice Communication

### 9.2.5.1 Description

The assured voice communication application shall provide the ability to extend an assured voice communication to a user who has joined an ongoing communication.

### 9.2.5.2 Pre-conditions

The use of Assured Voice Communication is activated for the ongoing voice communication.

### 9.2.5.3 Service flows

If a user joins an ongoing assured voice communication, the initiator of the assured voice communication is informed. The joining user is not supervised yet but is part of the communication.

The initiator shall have the option to extend the assured voice communication to this new user.

### 9.2.5.4 Post-conditions

If the assured voice communication is extended, the new user is supervised by the assured voice communication.

If the assured voice communication is not extended to the new user, the new user is not supervised by the assured voice communication but remains part of the existing ongoing communication.

### 9.2.5.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.2.5-001]	The initiator shall be able to extend the AVC to a new FRMCS User in the communication.	A	22.280	This is done automatically due to the talk burst nature and the Automatic user regrouping in 22.280 6.6.4.2. Question is whether this always makes sense if the group membership changes frequently from talk burst to talk burst For this reason, a requirement is added allowing to exclude such automatic user regrouping groups from the ack mechanism in general.

## 9.3 Functional identities and role management

### 9.3.1 Introduction

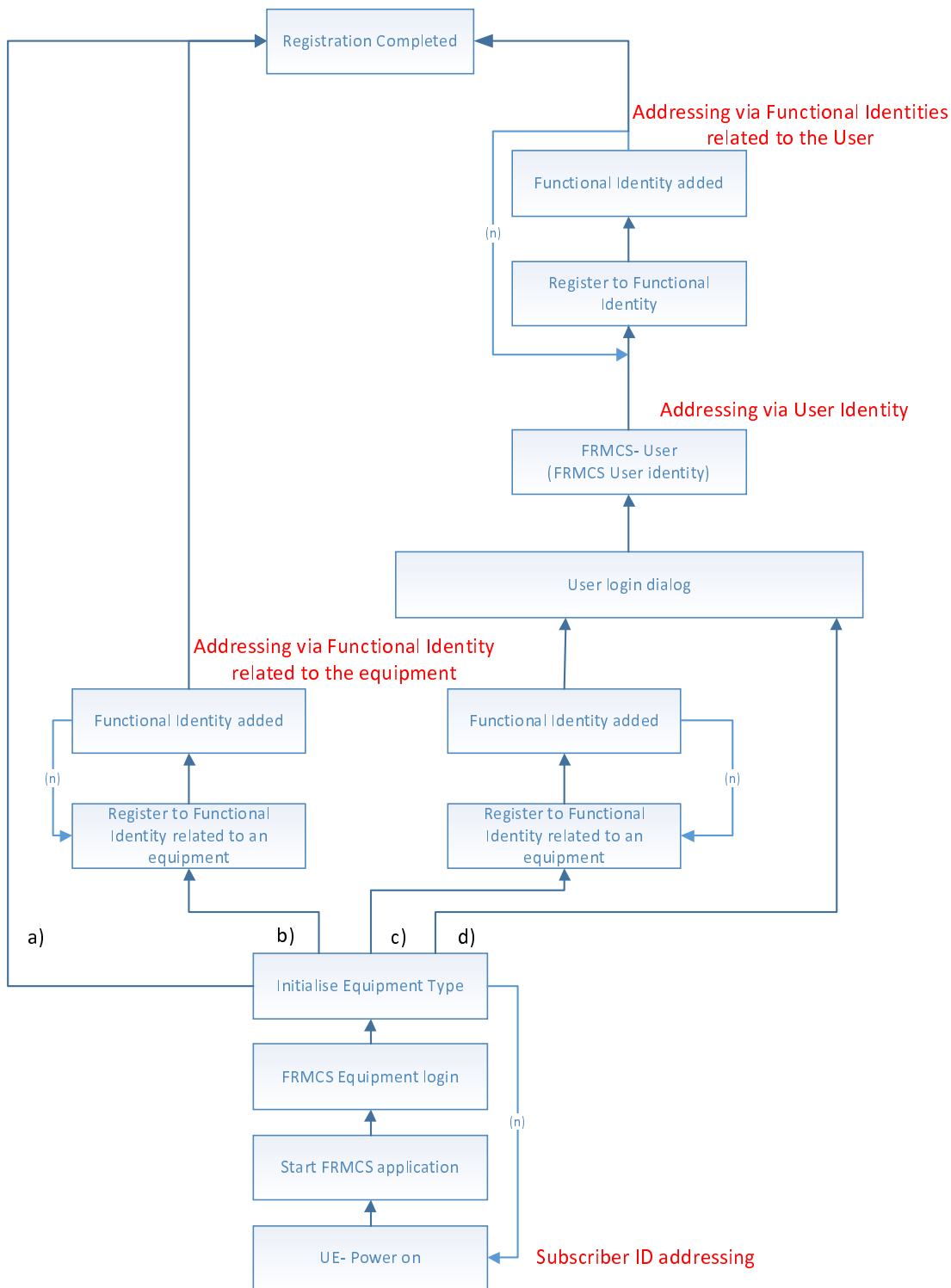
In this chapter the use cases related to functional identities and role management are defined:

- Registration to a functional identity
- Deregistration of a functional identity
- FRMCS User changing functional identity
- User log-in to the system
- User log-out from the system
- Presentation of identities
- Interrogation of identities within a certain context

Examples of Role management, like functional identities, FRMCS Equipment Identities, etc. in the railway environment are covered by annex A.

### 9.3.2 General pre-conditions

In order to fully understand the uses cases in this chapter, Figure 9.3.2-1 illustrates the different steps required to complete the registration process.



**Figure 9.3.2-1: Example of Role management**

In this definition, it is needed to make a distinction between different types of FRMCS Equipment. The following are, as a principle, defined:

- a) FRMCS Equipment without MMI, without the possibility to be addressed via a functional identity related to the equipment (e.g. sensor in the track or simple modem operation)
- b) FRMCS Equipment that can be registered to a functional identity related to the equipment (e.g. maintenance log collecting device connected to a power station) but without other FRMCS User login
- c) FRMCS Equipment that can be registered to a functional identity and that allows a FRMCS User to login and register to functional identities related to the user (e.g. cab radio)

- d) FRMCS Equipment that cannot register to a functional identity, but that allows a FRMS User to login and to register to functional identities related to the user (e.g. a generic handheld device)

Steps:

1. UE-Power on: The UE has started up and is attached to the FRMCS network on telecoms level. The UE is reachable via its subscriber identity address.
2. Start FRMCS Application: On the UE the FRMCS Application start up and is ready for use.
3. FRMCS Equipment login: The FRMCS Application is logging in into the FRMCS System and the FRMCS Equipment becomes known to the FRMCS System.
4. Initialise FRMCS Equipment type: the type of FRMCS Equipment used is identified.

At this stage of the user flow four different routes can be followed, based on the determined FRMCS Equipment type of the FRMCS Equipment.

Type a) “sensor”:

- No action required. The FRMCS Equipment is now reachable via its subscriber identity address.

After this step the process of registration is completed.

Type b) “Announcement System”:

- Register to a functional identity: the FRMCS Equipment will request for a registration on a functional number. This functional number is related to the equipment and identifies the device, like a PA system on a train.
- Functional identity added: the request for a functional identity is granted by the FRMCS System. The end user device is now reachable via its functional identity.

After this step the process of registration is completed.

Type c) “cab radio”:

- Register to a functional identity: the FRMCS Equipment will request for a registration on a functional identity. This functional identity is related to the FRMCS Equipment and identifies the environment where the equipment is used, like a cab radio in a cabin of a train.
- Functional identity added: The FRMCS User is now only reachable via all of its functional identities related to the FRMCS Equipment.

Type d) “Handheld”:

Next, for both the types c) and d) the following steps apply:

- User login dialog: the user is presented with a log-in MMI action. The user can now login into the FRMCS System. By successfully logging into the FRMCS System the user becomes a FRMCS User.
- FRMCS User: The FRMCS User is now reachable via its FRMCS User Identity (and in case c) the functional identity registered by the FRMCS Equipment).
- Register to a functional identity: the FRMCS User may request for a registration on a functional identity. This functional identity relates to the FRMCS User and identifies the role of the FRMCS User e.g. driver, controller etc. and the environment e.g. train number.
- Functional identity added: The FRMCS User is now reachable via all the functional identities registered to the user (Further, the FRMCS Equipment is reachable via its registered functional identity(ies)).

After this step the process of registration is completed.

Note: Use cases related to power up the UE until complete initialisation of the equipment type are covered in chapter 5.

### 9.3.2.1 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.3.2-001]	The FRMCS System shall be able to make use of the underlying transport system's subscriber identities.	A	22.280	This requirement can be supported by existing MCCore requirements.
[R-9.3.2-002]	The FRMCS System shall support a FRMCS User identity per FRMCS User.	A	22.280	This requirement can be supported by existing MCCore requirements.
[R-9.3.2-003]	The FRMCS System shall support functional identities.	A	22.280	This requirement is partly covered by MCCore, new and additional types of identities need to be supported.
[R-9.3.2-004]	The UE shall be reachable by its subscriber identity.	A	22.280	This requirement can be supported by existing 3GPP requirements.
[R-9.3.2-004a]	The FRMCS system shall be able to inhibit the use of the underlying transport system's subscriber identities for communication	A	22.280	Implicit. [R-5.12-002] The MCX Service supports MCX Service User ID + functional alias, independent of subscriber identity assigned by 3GPP operator to UE.
[R-9.3.2-005]	The FRMCS User shall be reachable by its FRMCS User identity.	A	22.280	This requirement can be supported by existing MCCore requirements.
[R-9.3.2-006]	The FRMCS User shall be reachable by its functional identity/ies.	A	22.280	This requirement is partly covered by MCCore, new and additional types of identities need to be supported.
[R-9.3.2-007]	At the time of initialisation the FRMCS-system shall be able to determine the FRMCS Equipment Type.	A	N/A	Outside scope of 3GPP standardization.

## 9.3.3 Use case: Registration to a functional identity

### 9.3.3.1 Description

A FRMCS User or the FRMCS Equipment shall be able to register to one or multiple functional identities. A functional identity can therefore be equipment related or user related.

### 9.3.3.2 Pre-conditions

The equipment type is identified.

Functional registration of the user, the user is logged in into the FRMCS System.

### 9.3.3.3 Service flows

#### Requested functional identity is not in use

The FRMCS User or the FRMCS-equipment selects the functional identity. The identity can be selected from a list based on the location of the FRMCS User, operational schedules, etc. or the functional identity can be entered manually.

The FRMCS User or the FRMCS-equipment requests the FRMCS System to register the new functional identity.

The FRMCS System informs the FRMCS User or the FRMCS-equipment about the outcome of the registration request.

#### Requested functional identity that is in use

The FRMCS User or the FRMCS-equipment selects the functional identity. The identity can be selected from a list based on the location of the FRMCS User, operational schedules, etc. or the functional identity can be entered manually.

The FRMCS User or the FRMCS-equipment requests the FRMCS System to register the new functional identity.

The FRMCS User or the FRMCS-equipment is informed of the functional identity already in use.

The FRMCS User or the FRMCS-equipment shall be able to select from the following options:

- Cancel the registration
- If the selected functional identity allows take over the functional identity.
- If the selected functional identity allows register as an additional FRMCS User to this functional identity.

The FRMCS System informs the FRMCS User about the outcome of the registration request.

In the case of taking over a functional identity, the FRMCS System deregisters the other FRMCS User or FRMCS-equipment from this particular functional identity. The deregistered FRMCS User or the FRMCS-equipment gets informed about the deregistration by the FRMCS System.

### **Registration by the Railway Subsystem of the FRMCS System**

Based on the user identification, operational conditions, like schedules when entering the train, location, time, recent activity etc., the Railway Subsystem shall be able automatically register a FRMCS User or an FRMCS Equipment to a functional identity.

The FRMCS User gets informed about the registration by the FRMCS System.

#### **9.3.3.4 Post-conditions**

In case of successful registration, the FRMCS User or the FRMCS-equipment can be reached based on the functional identity. The FRMCS User or the FRMCS-equipment can be registered to different functional identities. The FRMCS User or the FRMCS-equipment are also reachable by using the FRMCS Equipment Identity, the FRMCS User Identity (if logged in) and its subscriber identity.

In case of successful registration and based on system configuration, the FRMCS System shall be able to notify a specific group of FRMCS User(s) registered to functional identity(ies) with similarities in the structure of the successfully registered functional identity.

If the FRMCS System has not accepted the registration, the FRMCS User or the FRMCS-equipment cannot be reached on a particular functional identity.

## 9.3.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.3.3-001]	The FRMCS User or the FRMCS-equipment shall be able to register to a functional identity.	A	TS 22.280	5.9a2
[R-9.3.3-002]	To select from, the FRMCS System shall provide the FRMCS User or the FRMCS-equipment a list of functional identities. The list contains functional identities based on a certain context, like location of the user, operational schedule, etc. The FRMCS User or the FRMCS-equipment shall also be able to perform a registration of an unlisted functional identity.	A	TS 22.280	.Predefined list of functional identities based on criteria: [R-5.9a-004] .Unlisted functional identity: [R-5.9a-010]
[R-9.3.3-003]	The FRMCS System shall inform the FRMCS User or the FRMCS-equipment of the outcome of the registration request.	A	TS 22.280	[R-5.9a-025]
[R-9.3.3-004]	In the case the functional identity is already in use, the FRMCS System shall advise the FRMCS User or the FRMCS-equipment about options to <ul style="list-style-type: none"> <li>• cancel the registration,</li> <li>• take over the functional identity</li> <li>• register as an additional identity.</li> </ul>	A	TS 22.280	Covered. [R-5.9a-007]: sharing FA first (no user selection), then [R-5.9a-008]: take over (with user selection). If take over not selected, registration considered canceled.
[R-9.3.3-005]	The FRMCS System shall be able to register a FRMCS-user or the Railway Subsystem without human intervention. For example, automatic registration can be initiated by: <ul style="list-style-type: none"> <li>• user identification</li> <li>• operational conditions, like schedules when entering the train (for example by using Near Field Communication, Smart Card etc.)</li> <li>• location</li> <li>• time</li> <li>• recent activity</li> <li>• Smart cards or RFID tokens in the vicinity of the UE</li> <li>• FRMCS Equipment Type</li> <li>• etc.</li> </ul>	A	TS 22.280	[R-5.9a-015] [R-5.9a-018]
[R-9.3.3-006]	The FRMCS System shall support multiple functional identities per FRMCS User or FRMCS Equipment.	A	TS 22.280	[R-5.9a-001]
[R-9.3.3-007]	The FRMCS System shall be able to notify a specific group of FRMCS User(s) registered to functional identity(ies) with similarities in the structure of the successfully registered functional identity.	A	TS 22.280	Covered in on-network with affiliation mechanism + automatic information when affiliation information changes in a group ([R-6.4.5-003a]).



## 9.3.4 Use case: Deregistration of a functional identity

### 9.3.4.1 Description

A FRMCS User or the FRMCS-equipment shall be able to deregister from one or multiple functional identities.

### 9.3.4.2 Pre-conditions

The FRMCS User or the FRMCS-equipment has at least one functional identity.

### 9.3.4.3 Service flows

#### **Deregistration functional identity initiated by the FRMCS User**

The FRMCS User or the FRMCS-equipment chooses the functional identities to be deregistered among the list of currently registered functional identities by:

- electing a set of functional identities (the application may select the appropriate set of functional identities automatically)
- selecting one functional identity

The FRMCS System informs the FRMCS User or the FRMCS-equipment about the outcome of the registration request.

#### **Deregistration by the Railway Subsystem**

Based on certain criteria the FRMCS System deregisters a FRMCS User or the FRMCS-equipment from one or multiple functional identities and informs the FRMCS User or the FRMCS-equipment about the deregistration.

For example, possible criteria are timer, location, operational schedules, another FRMCS User taking over the functional identity.

### 9.3.4.4 Post-conditions

If the FRMCS System has deregistered the functional identity, the previously registered FRMCS User (s) or FRMCS-equipment are not any longer reachable on this particular functional identity.

If the FRMCS System has deregistered the functional identity and based on system configuration, the FRMCS System shall be able to notify a specific group of FRMCS User(s) registered to functional identity(ies) with similarities in the structure of the successfully deregistered functional identity.

If the FRMCS System was unable to deregister the functional identity, the actually registered FRMCS User or FRMCS-equipment remains active and can be reached on this functional identity.

In addition, the FRMCS User is reachable using the FRMCS Equipment Identity, its user identity (if logged in) and its subscriber identity.

### 9.3.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.3.4-001]	The FRMCS User or the FRMCS-equipment shall be able to deregister from a functional identity.	A	TS 22.280	5.9a2
[R-9.3.4-002]	During the deregistration process, the FRMCS System shall provide a list of functional identities to the FRMCS User or the FRMCS-equipment, to select for deregistration.	A	TS 22.280	[R-5.9a-004]
[R-9.3.4-003]	The FRMCS User or the FRMCS-equipment shall also be able to perform a deregistration of a functional identity that might not be part of the list provided by the FRMCS System. Then a manual input is required by the FRMCS User.	A	TS 22.280	[R-5.9a-010]
[R-9.3.4-004]	The FRMCS System shall inform the FRMCS User or the FRMCS-equipment about the outcome of a deregistration request.	A	TS 22.280	[R-5.9a-025]
[R-9.3.4-005]	At any time, the Railway Subsystem of the FRMCS System shall be able to deregister any functional identity. An automatic deregistration request can be based on: <ul style="list-style-type: none"> <li>• user identification</li> <li>• operational conditions, like schedules when entering the train (for example by using Near Field Communication, Smart Card etc.)</li> <li>• location</li> <li>• time</li> <li>• recent activity</li> <li>• Smart cards or RFID tokens in the vicinity of the UE</li> <li>• FRMCS Equipment Type</li> <li>• etc.</li> </ul>	A	TS 22.280	[R-5.9a-015] [R-5.9a-018]
[R-9.3.4-006]	The FRMCS System shall be able to notify a specific group of FRMCS User(s) registered to functional identity(ies) with similarities in the structure of the successfully deregistered functional identity.	A	TS 22.280	Covered in on-network with affiliation mechanism + automatic information when affiliation information changes in a group ([R-6.4.5-003a]).

### 9.3.5 Use case: User log-in to the FRMCS System

#### 9.3.5.1 Description

The user is identified by the FRMCS System.

#### 9.3.5.2 Pre-conditions

The equipment type is initialized.

The FRMCS Equipment provides suitable means to the user to log in.

### 9.3.5.3 Service flows

The user performs the log-in procedure.

#### Successful identification

The user is informed about the successful log-in into the FRMCS System. The user has now become a FRMCS User identified by a FRMCS User identity.

#### Unsuccessful identification

The user is informed about the unsuccessful log-in to the FRMCS System. The user is redirected to the log-in procedure.

### 9.3.5.4 Post-conditions

The FRMCS User is identified in the FRMCS System and can register a functional identity.

The FRMCS User is reachable by the FRMCS User identity.

### 9.3.5.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.3.5-001]	The FRMCS System shall allow a user to log into the FRMCS System using its FRMCS User Identity to make use of the services provided by the FRMCS System	A	TS 22.280 TS 22.179	3GPP building blocks = user authentication, service authorization and group affiliation. Sign-in/sign-off and 3GPP building blocks: 22.280 [R-5.1.1-001] 22.179 section 4.5.
[R-9.3.5-002]	The FRMCS System shall provide service only to FRMCS Users logged in into the FRMCS System.	A	TS 22.280 TS 22.179	3GPP building blocks = user authentication, service authorization and group affiliation. Sign-in/sign-off and 3GPP building blocks: 22.280 [R-5.1.1-001] 22.179 section 4.5

## 9.3.6 Use case: User log-out from FRMCS System

### 9.3.6.1 Description

The FRMCS User is logged out of the FRMCS System.

### 9.3.6.2 Pre-conditions

The FRMCS User is logged-in the FRMCS System.

### 9.3.6.3 Service flows

The FRMCS User performs the log-out procedure.

#### Successful log-out

The FRMCS System deregisters all functional identities of the FRMCS User.

The FRMCS System logs out the FRMCS User.

The FRMCS User is informed about the successful log-out from the FRMCS System.

#### Unsuccessful log-out

The FRMCS User is informed about the unsuccessful log-out to the FRMCS System.

#### 9.3.6.4 Post-conditions

The FRMCS User is logged out of the FRMCS System. The FRMCS Equipment is still registered to the FRMCS System.

The FRMCS Equipment is reachable by the subscriber identity.

#### 9.3.6.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.3.6-001]	The FRMCS System shall provide a notification to the FRMCS User when the FRMCS User is logged-out of the FRMCS System	A	Partly covered by TS 22.280 & 22.179. Remaining functionality are outside scope of 3GPP.	No specific login/logout procedure in TS 22.280. so no notification. 3GPP building blocks = user authentication, service authorization and group affiliation. Sign-in/sign-off and 3GPP building blocks: 22.280 [R-5.1.1-001] 22.179 section 4.5.
[R-9.3.6-002]	The FRMCS System shall provide the FRMCS User the necessary means to log out of the FRMCS System.	A	Partly covered by TS 22.280 & 22.179. Remaining functionality are outside scope of 3GPP.	No specific login/logout procedure in TS 22.280. 3GPP building blocks = user authentication, service authorization and group affiliation. Sign-in/sign-off and 3GPP building blocks: 22.280 [R-5.1.1-001] 22.179 section 4.5.
[R-9.3.6-003]	By logging out all functional identities of a FRMCS User are deregistered from the FRMCS User.	A	Partly covered by TS 22.280 & 22.179. Remaining functionality are outside scope of 3GPP.	Partly covered by [R-5.9a-018] but login/logoff from the MCX Service system not defined. 3GPP building blocks = user authentication, service authorization and group affiliation. Sign-in/sign-off and 3GPP building blocks: 22.280 [R-5.1.1-001] 22.179 section 4.5.
[R-9.3.6-004]	After logging out the FRMCS User, the FRMCS Equipment shall be reachable via the subscriber identity.	A	Covered	This requirement can be supported by existing MCCore requirements in TS: 22.280, 22.278, 22.261.

#### 9.3.7 Use case: Presentation of identities

##### 9.3.7.1 Description

A FRMCS User or the FRMCS-equipment shall be able to be identified by the functional identity (ies) to other FRMCS Users

### 9.3.7.2 Pre-conditions

The FRMCS User or the FRMCS-equipment is registered to at least one functional identity.

### 9.3.7.3 Service flows

#### **During call initiation**

The identities of the initiating entity (functional identity of a user, functional identity of equipment, user identity and subscriber identity) are to be passed and presented to the other FRMCS Users during communication.

The FRMCS System passes the appropriate functional identity(ies) based on a certain context (like location, destination, time, local configuration, selection from the initiating entity, etc.).

If multiple functional identities are used by the FRMCS User, the presentation is based on certain context (e.g. a call to a train Controller shows the running number, a call to a maintenance Controller shows the engine number).

If the functional identity is not available, the FRMCS User identity is to be presented.

If the functional identity and the FRMCS User identity are not available, the subscriber identity is to be presented.

#### **During a call**

The identities of the connected FRMCS User (s) (functional identity of a user, functional identity of equipment, user identity and subscriber identity) are forwarded to the FRMCS Users participating to the call.

The FRMCS System passes the appropriate functional identity(ies) based on a certain context (like location, destination, time, local configuration, etc.).

If multiple functional identities are used by the FRMCS User, the presentation is based on certain context (e.g. a call to a train Controller shows the running number, a call to a maintenance Controller shows the engine number).

If the functional identity is not available, the FRMCS User identity is to be presented.

If the functional identity and the FRMCS User identity are not available, the subscriber identity is to be presented.

The functional identity(ies) of the talking FRMCS User is/are to be indicated to the listening FRMCS User (s).

If the functional identity is not available, the FRMCS User identity is to be presented.

If the functional identity and the FRMCS User identity are not available, the subscriber identity is to be presented.

### 9.3.7.4 Post-conditions

The FRMCS Users are informed about the FRMCS User initiating the communication initiator.

The FRMCS User is informed about who are the participants of the call.

The FRMCS User has at least one functional identity.

### 9.3.7.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.3.7-001]	During communication initiation, the identities of the initiating entity (functional identity of a user, functional identity of equipment, user identity and subscriber identity) shall be passed to the FRMCS User (s) of the receiver(s) of the call.	A	TS 22.280	This requirement is partly covered by MCCore, new and additional types of identities need to be supported.] [R-6.4.3-001]: only identification of the transmitting participant is sent to all other affiliated members. TS 22.280 [R-5.9a-002] [R-5.9a-020] [R-5.9a-022] [R-5.9a-023]
[R-9.3.7-002]	During a communication, the identities of the connected FRMCS User (s) (functional identity of a user, functional identity of equipment, user identity and subscriber identity) shall be sent to the FRMCS User (s) participants of the call.	A	TS 22.280	This requirement is partly covered by MCCore, new and additional types of identities need to be supported. TS 22.280 [R-5.9a-002] [R-5.9a-020] [R-5.9a-022] [R-5.9a-023] [R-6.9-004]
[R-9.3.7-003]	The FRMCS User (s) shall be presented with the appropriate functional identity(ies) based on a certain context (like location, destination, time, local configuration, etc.).	A	TS 22.280	Partly covered: functional identity based on context are provide to the FRMCS User on demand for activation. Only activated functional alias(ses) are presented. TS 22.280 [R-5.9a-002] [R-5.9a-020] [R-5.9a-022] [R-5.9a-023]
[R-9.3.7-004]	If a functional identity is not available, the FRMCS System shall present the FRMCS User identity.	A	TS 22.280	Partly covered: [R-6.4.3-001] Only the MCX Service User ID of the transmitting participant is sent to all other affiliated members.
[R-9.3.7-005]	If both the functional identity and the FRMCS User identity are not available, the FRMCS System shall present the subscriber identity.	A	TS 22.280 TS 22.278 TS 22.261	This requirement can be supported by existing MCCore requirements.

## 9.3.8 Use case: Interrogation of identities within a certain context

### 9.3.8.1 Description

A FRMCS User or the FRMCS-equipment is able to recognize which other functional identities are present within a certain context (for example train, region, communication group, Railway Emergency Communication, all Drivers on a station, etc.).

### 9.3.8.2 Pre-conditions

The FRMCS-equipment is initialised.

### 9.3.8.3 Service flows

#### Interrogation of functional identities

The FRMCS User or the FRMCS-equipment can interrogate the FRMCS System to recognize the own functional identity(ies) or the functional identity of other FRMCS Users or FRMCS-equipment based on a FRMCS User identity or a subscriber identity.

The FRMCS System returns the functional identity(ies) of the particular FRMCS User or FRMCS-equipment.

#### **Interrogation of FRMCS User identities**

The FRMCS User or the FRMCS-equipment can interrogate the FRMCS System to recognize the own or other FRMCS User identity of FRMCS User (s) based on a functional identity or a subscriber identity.

The FRMCS System returns the FRMCS User identity of the particular FRMCS User (s).

#### **Interrogation of a subscriber identity**

The FRMCS User or the FRMCS-equipment can interrogate the FRMCS System to recognize the own or other FRMCS Equipment Identity based on a functional identity or a FRMCS User identity.

The FRMCS System returns the particular subscriber identity.

#### **Interrogation of functional identity(ies) in a certain context**

The FRMCS User or the FRMCS-equipment can interrogate the FRMCS System to recognize the functional identities of own or other FRMCS Users within a certain context.

The FRMCS System returns to the FRMCS User or the FRMCS-equipment a set of functional identities (own or other) within the certain context.

#### **9.3.8.4 Post-conditions**

The requesting FRMCS User or FRMCS-equipment is informed about the own or other FRMCS Users / FRMCS-equipment with a functional identity within a certain context, for example train, region, communication group, Railway Emergency Communication, all Drivers on a station, etc.

### 9.3.8.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.3.8-001]	The FRMCS User or the FRMCS-equipment shall be able to interrogate the FRMCS System to provide the functional identity(ies) registered to a certain FRMCS User identity. The FRMCS System shall return the functional identity(ies) of the FRMCS User.	A	TS 22.280	TS 22.280 R-5.9a-011 R-5.9a-012
[R-9.3.8-002]	The FRMCS User or the FRMCS-equipment shall be able to interrogate the FRMCS System to provide the functional identity(ies) based on a subscriber identity. The FRMCS System shall return the functional identity(ies) of a subscriber identity.	A	TS 22.280	TS 22.280 R-5.9a-011 R-5.9a-012
[R-9.3.8-003]	The FRMCS User or the FRMCS-equipment, shall be able to interrogate the FRMCS System to provide the FRMCS User identity registered to a functional identity. The FRMCS System shall return the FRMCS User identity/identities.	A	TS 22.280	TS 22.280 R-5.9a-011 R-5.9a-012
[R-9.3.8-004]	The FRMCS User or the FRMCS-equipment, shall be able to interrogate the FRMCS System to provide the FRMCS User identity based on a subscriber identity. The FRMCS System shall return the FRMCS User identity/identities.	A	TS 22.280	TS 22.280 R-5.9a-011 R-5.9a-012
[R-9.3.8-005]	The FRMCS User or the FRMCS-equipment, shall be able to interrogate the FRMCS System to provide the subscriber identity based on a functional identity The FRMCS System shall return the subscriber identity(ies).	A	TS 22.280	[R-5.9a-011]

## 9.3.9 Use case: Service interworking with GSM-R

### 9.3.9.1 Description

Service interworking with legacy communication systems is of importance for the time period both systems have to coexist. In this section service interworking between the GSM-R System and the FRMCS System for functional identities and its associated roles will be addressed.

#### Functional Address

On top of the E.164 numbering plan alternative addressing scheme called functional addressing is used in the context with GSM-R. Functional addressing scheme allows the establishment of communication without knowing each E.164 number associated with a particular train. A functional address consists of:



## IC+CT+UN

- IC International code is used to route calls to the appropriate GSM-R network
- CT Call Type prefix defines how to interpret the User Number (UN) as train function number, engine function number, group calls etc.
- UN User Number is of variable length and depends on the information i.e. train function number etc. Within the UN a Functional Code (FC) is associated and provides the information of the person or equipment on a particular train, or a particular team within a given area. Therefore, the UN consists of User Identification Number (UIN) i.e. train number etc. and the Functional Code (FC) resulting into: UN= UIN+FC

A functional address only consists of numeric characters.

### 9.3.9.2 Pre-conditions

Following user addressing scenarios applies between FRMCS System and GSM-R system when using alternative addressing schemes in FRMCS:

A GSM-R user is able to obtain communication services from the GSM-R system. E.164 numbering plan and functional addressing scheme applies.

A FRMCS User is able to obtain communication services from the FRMCS System or from the GSM-R system. If the FRMCS User, in this sense the FRMCS Equipment is registered to the FRMCS System, user addressing of the FRMCS system applies comprising the use of functional identity addressing scheme. If the FRMCS Equipment is registered to the GSM-R system, E.164 numbering plan and functional addressing i.e. IC+CT+UIN+FC scheme applies.

For a train route which encompasses both GSM-R and FRMCS coverage areas the functional identity registration for users and equipment travelling this route shall be made in two parallel entries in the respective GSM-R functional addressing and FRMCS Functional Aliasing databases.

Any subsequent modification of functional addressing or functional aliasing while the user or equipment is registered shall be done in parallel on both systems

The deregistration of the functional aliasing or functional addressing for the user or equipment with parallel registration shall be deregistered in parallel.

### 9.3.9.3 Service flows

#### **FRMCS User relocates from GSM-R system to the FRMCS System**

When the FRMCS Equipment relocates from GSM-R system to the FRMCS System, the applicable functional address(es) associated with the FRMCS User require(s) a conversion to the functional identity format applicable within the FRMCS System. The functional address remains active until the corresponding functional identity becomes deactivated.

#### **FRMCS User relocates from FRMCS System to the GSM-R system**

When the FRMCS Equipment relocates from RMCS System to the GSM-R system, the applicable functional identity or identities associated with FRMCS user require(s) a conversion to the functional address format applicable within the GSM-R system. The functional identity or identities remains active until the corresponding functional address becomes deactivated.

#### **Bilateral communication addressing between FRMCS System and GSM-R**

A FRMCS User establishes a communication using the functional identity of another FRMCS User whose FRMCS Equipment is registered to GSM-R.

A FRMCS User establishes a communication using the functional address of a GSM-R user whose GSM-R equipment is registered to GSM-R.

A GSM-R user establishes a communication using the functional identity of a FRMCS User.

#### 9.3.9.4 Post-conditions

After successful relocation following is applicable:

- From GSM-R point of view, the FRMCS User is reachable for communication by its functional address.
- From FRMCS System point of view, the FRMCS User is reachable for communication by its functional identity.

### 9.3.9.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.3.9-001]	The FRMCS System shall support the conversion between functional identity encompassing the associated role and functional addressing as part of the GSM-R system.	A	22.179 22.280	22.179 [R-6.18.4.2-002], [R-6.18.4.2-002a], [R-6.18.4.2-002b] and 22.280 [R-6.17.3.1-003], [R-6.17.3.1-004], [R-6.17.3.1-005]
[R-9.3.9-002]	<p>The FRMCS System shall support functional addressing format consisting of:</p> <p>IC+CT+UN</p> <p>IC International code is used to route calls to the appropriate GSM-R network</p> <p>CT Call Type prefix defines how to interpret the User Number (UN) as train function number, engine function number, group calls etc.</p> <p>UN User Number is of variable length and depends on the information i.e. train function number etc. Within the UN a Functional Code (FC) is associated and provides the information of the person or equipment on a particular train, or a particular team within a given area. Therefore, the UN consists of User Identification Number (UIN) i.e. train number etc. and the Functional Code (FC) resulting into: UN= UIN+FC</p> <p>A functional address only consists of numeric characters.</p>	A	22.280	[ [R-5.9a-014]
[R-9.3.9-003]	A FRMCS User shall be reachable by its FRMCS Functional Identity if the FRMCS Equipment is registered to the GSM-R system	A	22.179 22.280	22.179 [R-6.18.4.2-002], [R-6.18.4.2-002a], [R-6.18.4.2-002b] and 22.280 [R-6.17.3.1-003], [R-6.17.3.1-004], [R-6.17.3.1-005]

[R-9.3.9-004]	A GSM-R User shall be reachable if a FRMCS User is registered to the FRMCS System using the functional address of the particular GSM-R user.	A	22.179 22.280	22.179 [R-6.18.4.2-002], [R-6.18.4.2-002a], [R-6.18.4.2-002b] and 22.280 [R-6.17.3.1-003], [R-6.17.3.1-004], [R-6.17.3.1-005]
[R-9.3.9-005]	A FRMCS User shall be reachable if a GSM-R user uses the functional identity of the particular FRMCS User.	A	22.179 22.280	[ 22.179 [R-6.18.4.2-002], [R-6.18.4.2-002a], [R-6.18.4.2-002b] and 22.280 [R-6.17.3.1-003], [R-6.17.3.1-004], [R-6.17.3.1-005]

## 9.4 Location services related use cases

### 9.4.1 Introduction

In this chapter the use cases related to location services are defined. The following use cases are defined:

- Provide location information
- Request for location information
- Request for identities based on location

The location information of an FRMCS Equipment consists of the following elements:

- Geographic Location,
- Velocity (the combination of speed and direction),
- Infra Location (additional information specifying railway infra elements; for example: signal 123, switch 456, track section 789A, etcetera), and
- Quality of Service information (horizontal and vertical accuracy, response time, QoS class, accuracy of Infra Location).

### 9.4.2 Use Case: Provide location information

#### 9.4.2.1 Description

The FRMCS Equipment provides its location information to the FRMCS System for further processing e.g. for automatic train operation. External systems can be supported in providing additional location information with or without functional identity reference to the FRMCS System for further processing.

The location information may be shared directly with other applications on the same FRMCS Equipment without the involvement of the FRMCS System.

#### 9.4.2.2 Pre-conditions

The FRMCS Equipment supports some mechanisms to obtain its location.

#### 9.4.2.3 Service flows

The FRMCS Equipment determines its current location in a periodic or an event-triggered manner. The frequency of the location reporting may change according to the application requirements.

The FRMCS Equipment reports location information that may include its applicable FRMCS Equipment Identity. At any time, upon request, the FRMCS Equipment shall be able to report its location information.

External systems can provide additional information to the FRMCS System in order to improve location accuracy of an FRMCS Equipment.

The received location information is stored by FRMCS System.

In case of periodic location reporting, the FRMCS System supervises the continuous supply of the location information. If the supply of periodic location information by the FRMCS Equipment stops, the FRMCS System initiates the re-establishment of the periodic location information data flow. The FRMCS System can correlate other identities from the FRMCS Equipment Identity.

#### 9.4.2.4 Post-conditions

The location information of the FRMCS Equipment is available in the FRMCS System.

#### 9.4.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.4.2-001]	The FRMCS Equipment shall be able to provide its location to the FRMCS System.	A	22.280	This requirement can be supported by existing 3GPP requirements
[R-9.4.2-001a]	The location information of an FRMCS Equipment shall consist of: <ul style="list-style-type: none"> <li>• The geographic location,</li> <li>• The velocity,</li> <li>• The infra location, and</li> <li>• The Quality of service information.</li> </ul>	A	22.071	Partly covered by TS 22.071. Location Information of a UE consists of Geographic Location, Velocity, <b>Civic Location</b> and Quality of Service information. Civic location (also called Dispatchable Location) is only applicable to emergency services based on regional regulatory requirements (wireless 911 calls).
[R-9.4.2-002]	The FRMCS System shall be able to request the FRMCS Equipment to provide its location.	A	22.280	This requirement can be supported by existing 3GPP requirements
[R-9.4.2-003]	The FRMCS System shall be able to request the FRMCS Equipment to provide its location periodically.	A	22.280	This requirement can be supported by existing 3GPP requirements
[R-9.4.2-004]	The FRMCS System shall be able to request the FRMCS Equipment to stop providing its location periodically.	A	22.280	This requirement can be supported by existing 3GPP requirements
[R-9.4.2-005]	The FRMCS System shall be able to handle additional location information from other external sources.	A	22.280	

### 9.4.3 Use Case: Request for location information

#### 9.4.3.1 Description

A FRMCS User, an application or an External System can request the location information of a functional identity, FRMCS User identity or FRMCS Equipment Identity from the FRMCS System.

#### 9.4.3.2 Pre-conditions

The FRMCS User, an application or an External System, is entitled to request location information from the FRMCS System.

### 9.4.3.3 Service flows

A FRMCS User, an application or an External System requests location information to the FRMCS System based on a functional identity, FRMCS User identity or FRMCS Equipment Identity.

The location requesting entity can request for a single location information or a periodical update of the location information.

The location requesting entity can send a request to the FRMCS System to stop the periodical update of location information.

#### *Positive outcome*

The FRMCS System provides the location information as requested, either once or periodically.

#### *Negative outcome*

The location information is not available, or the identity is not known in the FRMCS System.

The FRMCS System sends a response back to the requesting FRMCS User, application or External System if the location information is not available.

### 9.4.3.4 Post-conditions

The location information is provided, if available.

### 9.4.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.4.3-001]	Upon request from FRMCS Users, applications or External Systems the FRMCS System shall be able to provide the location information of a functional identity, FRMCS User identity or FRMCS Equipment Identity.	A	Partly covered by TS 22.280. Remaining functionality are outside scope of 3GPP.	This requirement is partly covered by TS 22.280 [R-5.9a-027] and TS 22.280 [R-6.12-006].
[R-9.4.3-002]	Upon request from FRMCS Users, applications or External Systems the FRMCS System shall be able to periodically provide the location information of a functional identity, FRMCS User identity or FRMCS Equipment Identity.	A	Partly covered by TS 22.280. Remaining functionality are outside scope of 3GPP.	This requirement is partly covered by TS 22.280 [R-6.12-006].
[R-9.4.3-003]	The FRMCS System shall only allow the FRMCS User, the application or the External System initially requesting periodic location reporting to stop the periodic location reporting.	A	Partly covered by TS 22.280. Remaining functionality are outside scope of 3GPP.	This requirement is partly covered by TS 22.280 [R-5.11-005] and TS 22.280 [R-6.12-007].

## 9.4.4 Use Case: Request for identities in a certain area

### 9.4.4.1 Description

A FRMCS User, an application or an External System can request identities based on location information from the FRMCS System.

### 9.4.4.2 Pre-conditions

The FRMCS User, an application or an External System, is entitled to request location information from the FRMCS System.

### 9.4.4.3 Service flows

The FRMCS User, an application or an External System requests the FRMCS System to provide a list of functional identities, FRMCS User identities or FRMCS Equipment Identities at a certain point, area, station, track section, etc.

The FRMCS User, an application or an External System can request the list of identities to be given once or periodically by the FRMCS System.

Only the FRMCS User, the application or the External System initially requesting periodic reporting can stop the periodic reporting by the FRMCS System.

### 9.4.4.4 Post-conditions

The FRMCS System provides the list of identities as requested.

### 9.4.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.4.4-001]	The FRMCS System shall allow a FRMCS User, an application or an External System to request a list of functional identities, FRMCS User identities or FRMCS Equipment Identities in a certain area either periodically or as a onetime request.	A	Covered by TS 22.280. Serving an external system is outside the scope of 3GPP.	This requirement is covered by existing 3GPP Location Services and MCCore requirements. [R-5.9a-031]
[R-9.4.4-002]	The FRMCS System shall be able to provide the list of identities and their location to the requesting FRMCS User, application or External System either periodically or as a onetime report.	A	Covered by TS 22.280. Serving an external system is outside the scope of 3GPP.	This requirement is covered by existing 3GPP Location Services and MCCore requirements. [R-5.9a-031]
[R-9.4.4-003]	The FRMCS System shall allow only the requesting FRMCS User, application or External System to stop the periodic reporting.	A	Covered by TS 22.280. Serving an external system is outside the scope of 3GPP.	This requirement is covered by existing 3GPP Location Services and MCCore requirements. [R-5.9a-031]

## 9.5 FRMCS User communication handling related use cases

### 9.5.1 Introduction

In this chapter the use cases related to the function of inviting a FRMCS User to a communication are defined.

- Invite-a-FRMCS User to a FRMCS communication
- FRMCS User receiving an invitation to a FRMCS communication
- FRMCS User accepting an invitation to a FRMCS communication



- FRMCS User rejecting an invitation to a FRMCS communication
- FRMCS User ignoring an invitation to a FRMCS communication
- Service interworking with GSM-R

## 9.5.2 Use Case: Inviting-FRMCS User(s) to a voice communication

### 9.5.2.1 Description

An authorized FRMCS User can invite other(s) FRMCS User(s) to join an ongoing voice communication.

### 9.5.2.2 Pre-conditions

The inviting FRMCS User is part of an already established FRMCS voice communication of two or more FRMCS Users.

### 9.5.2.3 Service flows

#### **Inviting user**

From a list of FRMCS Users provided by the FRMCS System or by entering an unlisted identity, the inviting FRMCS User selects another FRMCS User, or a pre-defined group of users, to be invited.

### 9.5.2.4 Post-conditions

The FRMCS User (s) have been invited.

The inviting FRMCS User remains connected to the FRMCS voice communication involving two or more FRMCS Users.

### 9.5.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.5.2-001]	If authorized to, a FRMCS User shall be able to invite other(s) FRMCS User(s) to join an ongoing voice communication.	A	22.280	Partially covered by 6.4.6.2 "Negotiated change" provides the basic functionality (limited to ongoing group communications).
[R-9.5.2-002]	The FRMCS System shall provide a list of identities for the inviting FRMCS User to select from.	A	N/A	Implementation option: 22.280 6.4.6.2 "Negotiated change" does not make any assumption on the way and means an authorised user gets the identities to be included - i.e. this happens on application layer
[R-9.5.2-003]	The invitation request shall either be based on the functional identity, FRMCS User Identity, FRMCS Equipment Identity.	A	N/A	Implementation option: Keep it on application layer as otherwise, considering the sheer number of users, we would have to give an indication on how to filter that list.

## 9.5.3 Use Case: FRMCS User receiving an invitation to a voice communication

### 9.5.3.1 Description

A FRMCS User will receive the invitation originated by the inviting FRMCS User.

### 9.5.3.2 Pre-conditions

The FRMCS User may or may not be involved in voice communication.

### 9.5.3.3 Service flows

The invitation is indicated to the FRMCS User by audible and visual notification.

### 9.5.3.4 Post-conditions

The FRMCS User has received the invitation.

Voice communication of the invited FRMCS User continues unaffected.

### 9.5.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.5.3-001]	If entitled to, a FRMCS User shall be able to receive invitations to voice communication(s), independent of being involved in communication.	A	22.280	Implicitly provided by the normal function of MCX Communication

## 9.5.4 Use case: FRMCS User accepting an invitation to a voice communication

### 9.5.4.1 Description

A FRMCS User can accept the invitation sent by the inviting FRMCS User.

### 9.5.4.2 Pre-conditions

The FRMCS User has received an invitation to a voice communication which is not yet expired.

### 9.5.4.3 Service flows

#### **Invited FRMCS User not involved in a voice communication**

The FRMCS User accepts the invitation of the voice communication.

The FRMCS User joins the ongoing voice communication. If the ongoing voice communication involves two users (user-to-user), the ongoing voice communication is translated into a multi-users voice communication.

Other FRMCS Users involved in the voice communication receive a notification that the FRMCS User has joined the communication by which the joining FRMCS User is identified to the other FRMCS Users.

#### **Invited FRMCS User is involved in a voice communication**

The FRMCS User accepts the invitation of the voice communication.

The FRMCS System prompts the invited FRMCS User about the treatment of the existing voice communication.

The FRMCS User may have the choice between some or all of these options:

- **Terminate:** The FRMCS User terminates the current voice communication.
- **Leave** the existing voice communication. If the communication consisted only of two participants, a participant leaving the communication will cause the communication to be terminated.
- **Merge:** The FRMCS System merges the two voice communications into one single voice communication.

The FRMCS User joins the ongoing voice communication. If the ongoing voice communication involves two users (user-to-user), the ongoing voice communication is translated into a multi-users voice communication.

Other FRMCS Users involved in the voice communication(s) are notified that the invited user has joined the communication or the communication has been merged.

### 9.5.4.4 Post-conditions

The invited FRMCS User is participating in the voice communication he was invited to.

The invited FRMCS User is indicated as connected to the voice communication to all FRMCS Users in the communication.

The presence status of the invited user is updated with the appropriate attributes.

### 9.5.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.5.4-001]	The FRMCS User shall be able to accept an invitation to join a voice communication.	A	22.280	R-6.4.6.2-005
[R-9.5.4-002]	When accepting a communication invitation, in case the FRMCS User has a voice communication, the FRMCS User shall be able to leave, terminate or merge the voice communication. If the FRMCS User decides to merge the communications both voice communications shall be merged.	A	22.280	5.4.1, 5.4.2, 5.1.5 R-6.4.4-003, R-6.4.4-004 The affiliation mechanism is sufficient to mimic the desired behavior of leave and terminate Merging can be done by 22.280 6.6.1 Group regrouping"
[R-9.5.4-003]	When accepting a communication invitation (i.e. the FRMCS User joins the ongoing voice communication), If the ongoing voice communication involves two users (user-to-user), the ongoing voice communication is translated into a multi-users voice communication.	A	Not covered	TS 22.280 6.4.6.2 Negotiated change is limited to group communications.
[R-9.5.4-004]	When accepting a communication invitation, other FRMCS Users involved in the voice communication(s) are notified that the invited user has joined the communication, or the communication has been merged.	A	22.280	Covered by the affiliation mechanism.

## 9.5.5 Use case: FRMCS User rejecting an invitation to a voice communication

### 9.5.5.1 Description

A FRMCS User can reject the invitation sent by the inviting FRMCS User.

### 9.5.5.2 Pre-conditions

The FRMCS User has received an invitation to a voice communication which is not expired yet.

### 9.5.5.3 Service flows

The FRMCS User rejects the invitation.

The inviting FRMCS User receives a notification that the invitation was rejected by the invited FRMCS User.

### 9.5.5.4 Post-conditions

The invited FRMCS User is not participating in the voice communication related to the received invitation.

### 9.5.5.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.5.5-001]	The FRMCS User shall be able to reject the invitation to join a voice communication.	A	22.280	R-6.4.6.2-005
[R-9.5.5-002]	The inviting FRMCS User sending the invitation shall be informed. The inviting FRMCS User shall be notified.	A	22.280	R-6.4.6.2-005

## 9.5.6 Use case: FRMCS User ignoring an invitation to a voice communication

### 9.5.6.1 Description

A FRMCS User can ignore the invitation sent by the inviting FRMCS User.

### 9.5.6.2 Pre-conditions

The FRMCS User has received an invitation which is not yet expired.

### 9.5.6.3 Service flows

The invited FRMCS User does not respond to the received invitation within a certain period of time

The inviting FRMCS User receives a notification that the invitation was rejected as it was not accepted within a certain period of time.

### 9.5.6.4 Post-conditions

The invited FRMCS User does not participate in the voice communication.

### 9.5.6.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.5.6-002]	If the receiving FRMCS User has not reacted on the invitation within a certain period of time [t1] the FRMCS System shall notify the inviting FRMCS User accordingly and stop the invitation request.	A	N/A	This is left to the app layer design to decide what happens if a MCX User does not react in due time.

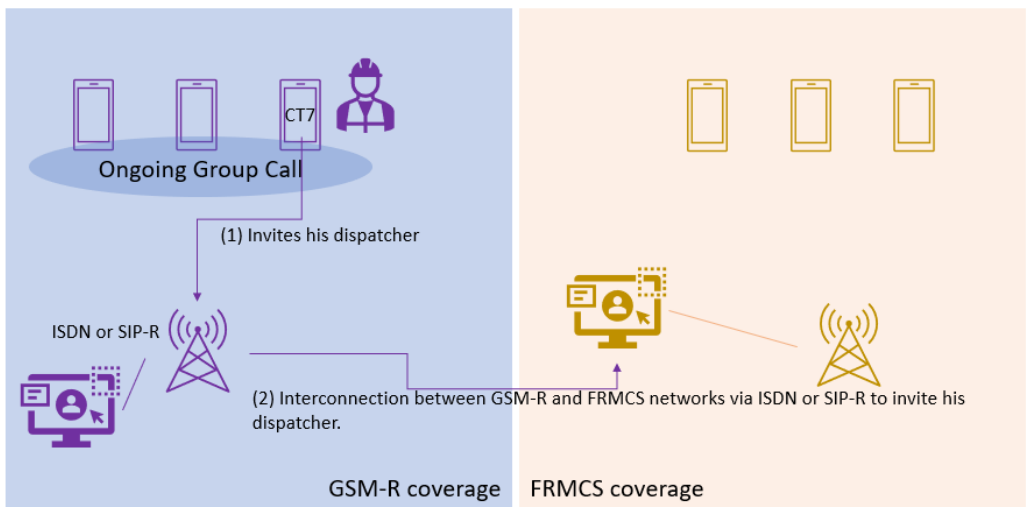
## 9.5.7 Service interworking with GSM-R

### 9.5.7.1 Description

For migration purposes, the service interworking between the GSM-R system and FRMCS system for inviting a user needs to be defined.

The following interworking use cases are needed for alerting a controller functionality: the case that there is a group call in GSM-R and a user would like to invite a controller who is in FRMCS:

Inviting-a-FRMCS User to a GSM-R voice group communication:  
operational scenarios to support service interworking between GSM-R and FRMCS

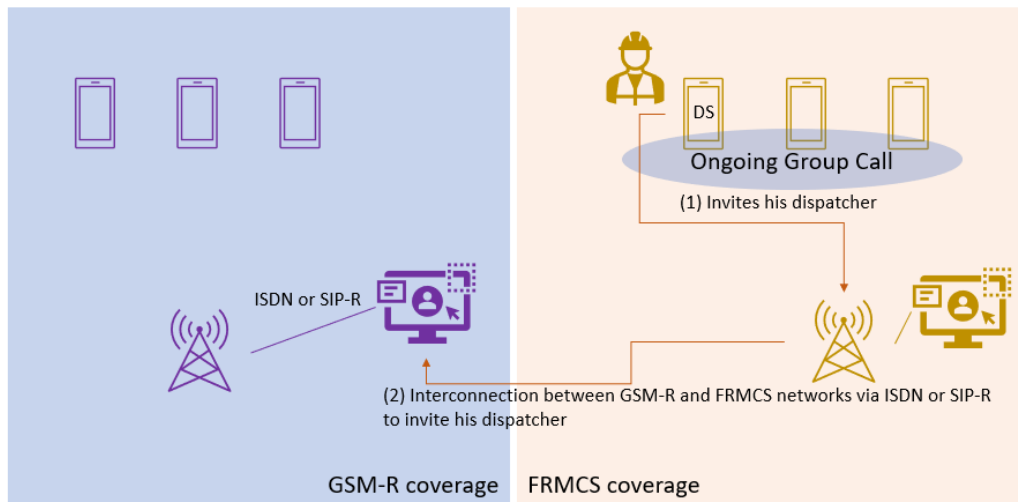


Note: Group calls may be used by shunting or trackside workers when their dispatcher has already migrated to FRMCS

Figure 9.5.7.1-1. Inviting-a-user from GSM-R to FRMCS

The case that there is a group communication in FRMCS, and a user would like to invite a controller who is in GSM-R also applies:

Inviting-a-GSM-R User to a FRMCS voice group communication:  
operational scenarios to support service interworking between GSM-R and FRMCS



Note: Group calls may be used by shunting or trackside workers when their dispatcher has not migrated to FRMCS yet

Figure 9.5.7.1-2. Inviting-a-user from FRMCS to GSM-R

The above use cases only apply if the controller system is connected to only one system. If the controller system is connected to both FRMCS and GSM-R systems, there is no need.

This use case only applies to end user devices supporting both FRMCS and GSM-R systems.

### 9.5.7.2 Pre-condition

#### **Group call in GSM-R and controller in FRMCS**

A voice group call has been established in GSM-R System.

The controller in charge of the area is attached to FRMCS System only. This controller is not part of the voice group call.

#### **Group call in FRMCS and controller in GSM-R**

A voice group call has been established in FRMCS System.

The controller in charge of the area is attached to GSM-R System only. This controller is not part of the voice group call.

### 9.5.7.3 Service flow

#### **Group call in GSM-R and controller in FRMCS**

When there is an ongoing voice group call in GSM-R system and when a GSM-R User part of this group call is initiating an *alerting-a-controller* to invite a controller to join this group call, the request to join this group call shall be routed to the relevant Controller(s) attached to FRMCS System.

#### **Group call in FRMCS and controller in GSM-R**

When there is an ongoing voice group call in FRMCS system and when a FRMCS User part of this group call is initiating an *Inviting-FRMCS User(s) to a voice communication* to invite a controller to join this group call, the request to join this group call shall be routed to the relevant Controller(s) attached to GSM-R System.

### 9.5.7.4 Post-condition

#### **Group call in GSM-R and controller in FRMCS**

The relevant Controller(s) attached to FRMCS System are invited to join the ongoing voice group call in GSM-R system.

#### **Group call in FRMCS and controller in GSM-R**

The relevant Controller(s) attached to GSM-R System are invited to join the ongoing voice group call in FRMCS system.

### 9.5.7.5 Potential requirements

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[9.5.7-001]	The FRMCS System shall provide service interworking between the alerting a controller functionality in the GSM-R system and in the FRMCS System.	A	22.280	Covered by [R-6.17.3.1-002] to [R-6.17.3.1-005].

## 9.6 Void

## 9.7 Multiuser talker control related use cases

### 9.7.1 General Description and potential requirements

#### 9.7.1.1 General Description

In this chapter the use cases related to multiuser talker control for voice communication are defined. The following use cases are defined:

- Set the number of simultaneous talkers
- Set initial talker permissions and priorities
- Request permission to talk
- Grant permission to talk
- Revoke permission to talk

Note: For examples of Role management, like functional identities, FRMCS Equipment Identities, etc. in the railway environment, see annex A.

#### 9.7.1.2 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.7.1-001]	Multiuser talker control shall be available for both on-net and off-net communication.	A	22.179	Covered for On-net only

### 9.7.2 Use case: Set the number of simultaneous talkers

#### 9.7.2.1 Description

For multiuser communication, i.e. when several users are involved in the same communication, the number of users that are granted the right to talk at the same time can be limited to either one, a limited number or unrestricted number.

The communication application (e.g. shunting team communication) will set the number of simultaneous talkers and/or the identities of involved FRMCS Users and if required other application specific criteria.

#### 9.7.2.2 Pre-conditions

An active communication application capable to use the multiuser talker control.



### 9.7.2.3 Service flows

The communication application sends the number of simultaneous talker(s) information to the multiuser talker control.

This information is used by multiuser talker control when setting up the communication.

If there is a need to change the number of simultaneous talkers, it is the communication application which sends this information to the multiuser talker control.

The multiuser talker control then uses this updated information for controlling the number of simultaneous talkers in the communication.

### 9.7.2.4 Post-conditions

The multiuser talker control is aware about the number of simultaneous FRMCS Users and uses this information during communication.

### 9.7.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.7.2-001]	The FRMCS System shall be able to limit the number of simultaneous talkers in a multiuser communication.	A	22.179	R-6.2.3.7.2-005
[R-9.7.2-002]	The maximum number of simultaneous talkers in a multiuser communication shall be provided by the communication application. The number of simultaneous talkers can be either one, a limited number or an unrestricted number and shall be changeable during the communication.	A	22.179	R-6.2.3.7.2-006

## 9.7.3 Use case: Set initial talker permissions and priorities

### 9.7.3.1 Description

There are different requirements for talker permissions and to prioritise talkers in different communication applications.

The FRMCS Users are identified by their functional identities.

The communication application defines the talker permissions and priorities based on the functional identities and the type of communication application, e.g., railway emergency call, shunting, multi train.

One or multiple FRMCS Users can be granted with the permission to perform as talker in a certain communication. These FRMCS Users are able to request permission to talk during communication.

Certain FRMCS User (s) that have requested the permission to talk at the same time or while another user is talking can be granted with an initial talker permission i.e., they will be given the permission first before requests of others are served independent of whether they were the first requesting the permission to talk or not. This initial talker permission granted for certain FRMCS User(s) is limited in time by system configuration.

Different FRMCS Users can be granted with a different talker priority. In case of parallel requests for permission to talk, the permission is granted to the FRMCS User (s) with highest talker priority. The requests with identical talker priorities will be queued based on the time of request.

### 9.7.3.2 Pre-conditions

An active communication application capable to use the multiuser talker control.

### 9.7.3.3 Service flows

The communication application sends information about talker permissions and talker priorities to the multiuser talker control application.

This information is used in multiuser talker control when setting up the communication.

If there is a need to change the information about talker permissions and talker priorities, it is the communication application that sends this information to multiuser talker control.

The multiuser control then uses this updated information for controlling the talker permissions and talker priorities in the communication.

### 9.7.3.4 Post-conditions

The multiuser control is aware of the talker permissions and talker priorities and uses this information for communication control/setup.

### 9.7.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.7.3-001]	The FRMCS System shall be able to handle talker permissions and priorities as provided by the communication application, e.g., railway emergency call, shunting, multi train	A	22.179	R-6.2.3.7.4.1-002 R-6.2.3.7.4.1-004
[R-9.7.3-002]	The FRMCS System shall allow to grant several FRMCS Users with the permission to perform as talker in a certain communication.	A	22.179	R-6.2.3.7.4.1-002 R-6.2.3.7.4.1-003
[R-9.7.3-003]	FRMCS Users shall be able to request permission to talk during communication.	A	22.179	R-6.2.3.7.3-004
[R-9.7.3-004]	The FRMCS System shall be able to grant FRMCS Users an initial talker permission (i.e., be the first speaker in the communication) ensuring that the entitled FRMCS User (s) are able to talk first, once the communication is established.	A	22.179	R-6.2.3.7.4.1-003
[R-9.7.3-004a]	This initial talker permission granted for certain FRMCS User(s) is limited in time by system configuration.	A	22.179	Partly covered by floor priority, override mechanism and dynamic change of maximum number of simultaneous talkers (section 6.2.3.7). How to identify that certain user(s) can be granted (e.g., train driver initiating the call) is not in the scope of 3GPP. No timer in current specification to limit time for initial talker permission.
[R-9.7.3-005]	The FRMCS System shall be able to grant the permission to talk based on a FRMCS User talker priority. In case of pending requests for permission to talk, the permission shall be granted to the FRMCS User with highest talker priority. Requests of identical talker priority shall be handled based on the time of request.	A	22.179	R-6.2.3.7.4.1-004 R-6.2.3.7.4.1-004

## 9.7.4 Use case: Request permission to talk

### 9.7.4.1 Description

There are occasions in the railway environment where it is needed to mitigate the risk of miscommunication. Use cases include, for example:

- Emergency communication
- Shunting communication
- Trackside worker communication

The system shall therefore be able to limit the number of simultaneous talkers in a voice communication.

An entitled FRMCS User shall be able to select and de-select FRMCS User (s) being able to talk in a voice communication.

The FRMCS User shall be able to request the permission to talk (raise the hand).

#### 9.7.4.2 Pre-conditions

The FRMCS User is involved in an active voice communication. The number of simultaneous talkers is limited in this communication.

#### 9.7.4.3 Service flows

The FRMCS User requests permission to talk on the MMI of the communication application (e.g. by pressing a Push-to-talk button)

The communication application sends the request to the multiuser talker control in the FRMCS System.

The communication application indicates on the MMI that talker permission has been requested.

#### 9.7.4.4 Post-conditions

Permission to talk has been requested and a response from the multiuser talker control in the FRMCS System expected.

#### 9.7.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.7.4-001]	An entitled FRMCS User shall be able to select and de-select FRMCS User (s) being able to talk in a voice communication.	A	22.179	[R-6.2.3.7.2-002]
[R-9.7.4-002]	The FRMCS User shall be able to request permission to talk of the FRMCS UE (e.g. by pressing a Push-to-talk button). The FRMCS UE shall indicate the talker permission has been requested.	A	22.179	[R-6.2.3.7.3-001]

### 9.7.5 Use case: Grant permission to talk

#### 9.7.5.1 Description

There are occasions in the railway environment where it is needed to mitigate the risk of miscommunication. Use cases include, for example:

- Emergency communication
- Shunting communication
- Trackside worker communication

The system shall be able to limit the number of simultaneous talkers in a voice communication.

The list of FRMCS Users with permission to talk and those who have requested it, shall be available to the Multiuser Talker Control application.

#### 9.7.5.2 Pre-conditions

The FRMCS User is an active voice communication.

Multiuser Talker Control is configured by the communication application to limit the number of simultaneous talkers.

By default, the Multiuser Control uses a set of criteria, like priorities, identities, etc. to manage the requests automatically

In addition, an entitled FRMCS User (i.e. based on functional identity) who is monitoring the progress of the communication can select and de-select simultaneous talkers.

### 9.7.5.3 Service flows

#### **Automatic management of requests**

The Multiuser Talker Control in the FRMCS System receives a request to talk from a FRMCS User.

The Multiuser Talker Control in the FRMCS System verifies the number of FRMCS Users who already have permission to talk.

If the number of FRMCS Users with permission to talk does not exceed the maximum number of simultaneous talkers, the Multiuser Talker Control grants automatically the permission to the requester.

If the number of FRMCS Users with permission to talk exceeds the maximum number of simultaneous talkers, the Multiuser Talker Control decides based on certain criteria, like priorities, functional identity, etc. who will keep the right to speak and who will be granted the permission to talk the Multiuser Talker Control configures the system accordingly.

If the number of talker permissions are reduced and the reduction results in having more active talkers than permitted, the active talkers lose their permission to talk as soon as they stop talking (i.e. release PTT) until the new maximum allowed number of talkers is met.

The Multiuser Talker Control service sends an indication to the FRMCS Users whose permission to talk has been changed due to that.

#### **Management of requests by an entitled FRMCS User**

The Multiuser Talker Control in the FRMCS System receives a request to talk from a FRMCS User.

The Multiuser Talker Control service in the FRMCS System verifies the number of FRMCS Users who already have permission to talk.

If the number of FRMCS Users with permission to talk does not exceed the maximum number of simultaneous talkers, the Multiuser Talker Control service grants automatically the permission to the requester.

If the number of FRMCS Users with permission to talk exceeds the maximum number of simultaneous talkers, the Multiuser Talker Control service alerts the entitled FRMCS User that is monitoring the communication, who is presented with the list of simultaneous talkers and the list of pending requests and decides who will keep the right to speak and who will be granted the permission to talk by selecting and de-selecting the corresponding FRMCS User.

The Multiuser Talker Control service configures the system accordingly.

The Multiuser Talker Control service sends an indication to the FRMCS Users whose permission to talk has been changed due to that.

### 9.7.5.4 Post-conditions

Permission to talk is granted to the selected FRMCS Users.

### 9.7.5.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.7.5-001]	Multiuser Talker Control shall keep track of FRMCS Users with permission to talk and FRMCS Users requesting to talk.	A	22.179	[R-6.2.3.7.3-004] [R-6.2.3.7.4.1-002]
[R-9.7.5-002]	Multiuser Control shall use a set of criteria provided by the communication application, like priorities, identities, etc. to manage the requests automatically.	A	22.179	[R-6.2.3.7.4.1-003]
[R-9.7.5-003]	Based on its functional identity an entitled FRMCS User shall be able to select and de-select simultaneous talkers.	A	22.179	Partly covered by participant type [R-6.2.3.7.4.1-002] [R-6.2.3.7.4.1-006] override mechanism by authorized participant.
[R-9.7.5-004]	If the number of FRMCS Users with permission to talk does not exceed the maximum number of simultaneous talkers, the Multiuser Talker Control service shall grant automatically the permission to additional requestors.	A	22.179	[R-6.2.3.7.4.1-001] [R-6.2.3.7.4.1-004]
[R-9.7.5-005]	If the number of FRMCS Users with permission to talk exceeds the maximum number of simultaneous talkers: the Multiuser Talker Control shall decide based on certain criteria, like priorities, functional identity, etc. who will keep the right to talk and who will be granted the permission to talk. Affected FRMCS Users shall be informed of their changed permission to talk.	A	22.179	[R-6.2.3.7.4.1-001] [R-6.2.3.7.4.1-004]
[R-9.7.5-006]	If the number of FRMCS Users with permission to talk exceeds the maximum number of simultaneous talkers: the Multiuser Talker Control service shall present an entitled FRMCS User is monitoring the communication, with the list of simultaneous talkers and the list of pending requests to decides who will keep the right to speak, who will be granted the permission to talk. Affected FRMCS Users shall be informed of their changed permission to talk.	A	22.179	[R-6.2.3.7.4.1-005] [R-6.2.3.7.4.1-006]

### 9.7.6 Use case: Revoke permission to talk

#### 9.7.6.1 Description

There are occasions in the railway environment where it is needed to mitigate the risk of miscommunication. Use cases include, for example:

- Emergency communication
- Shunting communication
- Trackside worker communication

The system shall be able to limit the number of simultaneous talkers in a voice communication.

The list of FRMCS Users with permission to talk shall be available to the Multiuser Talker Control service.

An entitled FRMCS User who monitors the progress of the communication shall be able at any point to revoke the permission to talk of any of the FRMCS Users with permission to talk. Automatic revocation of talkers in case the maximum number of simultaneous talkers has been reached and a request to talk is received, is included in the use case above.

#### 9.7.6.2 Pre-conditions

A number of FRMCS Users are in an active voice communication for which Multiuser Talker Control is enabled and have been granted permission to talk.

An entitled FRMCS User is monitoring the progress of the communication and shall be able at any point to revoke the permission to talk of any of the FRMCS Users currently with permission to talk.

#### 9.7.6.3 Service flows

The Multiuser Talker Control service presents a list of simultaneous talkers to an entitled FRMCS User, who decides who will not keep the right to speak by de-selecting the corresponding FRMCS User.

The Multiuser Talker Control service configures the system accordingly.

The Multiuser Talker Control service sends an indication to the FRMCS Users who have modified their situation with respects to the permission to talk.

The FRMCS User is no longer able to talk after the entitled FRMCS User has changed the permission.

#### 9.7.6.4 Post-conditions

Permission to talk is revoked for the de-selected FRMCS Users.

### 9.7.6.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.7.6-001]	An entitled FRMCS User who monitors the progress of the communication shall be able at any point to revoke the permission to talk of any of the FRMCS Users currently with permission to talk.	A	22.179	[R-6.2.3.7.4.1-008]
[R-9.7.6-002]	The FRMCS User who's permission to talk has been revoked, shall no longer be able to talk after the entitled FRMCS User has revoked the permission.	A	22.179	[R-6.2.3.7.4.1-004]

## 9.8 Authorisation of communication

### 9.8.1 Introduction

In this chapter the use cases related to authorisation of communication are described, the following use cases are identified:

- Permit / deny communication

### 9.8.2 Use case: Permit / deny communication

#### 9.8.2.1 Description

The purpose of the authorisation function is to allow the network operator to control and regulate communications in order to avoid disruption/distraction to the users (for example Drivers during voice communication) and preventing unauthorised communication and to minimise network load.

The FRMCS System may therefore restrict communication based on a configurable access matrix related to the FRMCS subscriber identity, the FRMCS Functional Identity of the equipment, the FRMCS User Identity, the FRMCS Functional Identity of the FRMCS Users considering the source and destination address.

Decision to permit or deny communication is based on full or subparts of the FRMCS Functional Identity of the FRMCS Users. An example of a full FRMCS Functional Identity of an FRMCS User is a specific driver on a specific train. An example of a subpart of an FRMCS Functional Identity of an FRMCS User is all train drivers.

#### 9.8.2.2 Pre-conditions

An FRMCS User attempts to establish a communication.

#### 9.8.2.3 Service flows

Upon an attempt to establish a communication, the FRMCS System checks if the source FRMCS User address is allowed to invite the destination FRMCS User address. The FRMCS System shall consider for the verification process the source and destination FRMCS User address.

If multiple identities are simultaneously active to a FRMCS User, the following order shall be applied to determine the authorisation of the communication establishment:

- Functional identities or subparts of functional identities related to the FRMCS User
- FRMCS User Identity
- FRMCS functional identities related to the equipment



- FRMCS subscriber identity

If the FRMCS User is allowed to establish the communication, the FRMCS System proceeds the communication setup.

If the FRMCS User is not allowed establish the communication, the FRMCS System shall reject the attempt including the reason of the rejection.

#### 9.8.2.4 Post-conditions

Either the communication has been established or the FRMCS User has been informed about the denial of the call attempt.

#### 9.8.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.8.2-001]	The FRMCS System shall be able to control and restrict the establishment of communication in order to avoid disruption/distraction of the FRMCS Users (for example Drivers).	A	TS 22.280	TS 22.280 sub-clause 6.7.3 Requirement [R-6.7.3-007a]
[R-9.8.2-002]	The FRMCS System shall be able to restrict communication based on related to the FRMCS subscriber identity, the FRMCS Equipment Identity, the FRMCS Functional Identity of the equipment, the FRMCS User Identity, the FRMCS Functional Identity or subparts of the FRMCS Functional Identity of the FRMCS Users considering the source and destination address.	A	TS 22.280	TS 22.280 Requirements [R-5.17-001] for group calls and [R-6.7.2-002] for private calls. Covered by [R-5.9a-020] and [R-5.9a-021] for functional identities. Not covered for subparts of functional identities.
[R-9.8.2-003]	The FRMCS System shall inform the FRMCS User in case the FRMCS User is not allowed to establish a communication.	A	TS 22.280	Implicit in many requirements.

## 9.9 Authorisation of application

### 9.9.1 Introduction

In this chapter the use cases related to authorisation of application are described, the following use case is identified

- Enabling/Disabling applications
- Robust mission critical group communication services
- Enabling/Disabling communication privileges per FRMCS User based on identities/talker status

## 9.9.2 Use case: Enabling/Disabling applications

### 9.9.2.1 Description

The FRMCS System shall allow the network operators to control the use of FRMCS Applications in order to avoid disruption/distraction to the FRMCS Users (for example Drivers), preventing unauthorised usage according to his Role.

The FRMCS System shall therefore be able to enable / disable FRMCS Applications for a FRMCS User depending on subscriber identity, the functional identity of the FRMCS Equipment, the FRMCS User Identity or the functional identity/ies of the FRMCS User. Also, context based criteria like location and other conditions are to be taken into account.

### 9.9.2.2 Pre-conditions

The FRMCS User equipment is powered on and the FRMCS Application on the FRMCS User equipment has started.

### 9.9.2.3 Service flows

#### **Power-on**

After powering on the FRMCS Equipment and start of the FRMCS Application on the FRMCS Equipment, the FRMCS System enables the FRMCS Application(s) on the FRMCS Equipment according to the Role related to the FRMCS subscriber identity.

#### **Change of registration status**

Upon a change in registration status by registration / deregistration to / from a functional identity, change of a functional identity, user login /logout to / from the FRMCS System, the FRMCS System enables / disables applications.

If multiple identities are active, the following order is used to determine the correct state:

- FRMCS functional identities related to the FRMCS User
- FRMCS User identity
- FRMCS functional Identities related to the FRMCS Equipment
- FRMCS subscriber identity

If a FRMCS User has registered to multiple functional identities, the FRMCS User is authorised to use all applicable FRMCS Applications related to the different FRMCS functional identities.

If an FRMCS Application is relying on other FRMCS Applications, enabling of all required FRMCS Applications is managed by the FRMCS System.

Only authorised FRMCS Applications shall be presented to the FRMCS User.

#### **Change of location**

If the FRMCS User enters a certain area, the FRMCS System may prevent the use of FRMCS Application(s) which had been authorised previously.

If the FRMCS User enters a certain area, the FRMCS System may enable the use of FRMCS Application(s) which had not been authorised previously.

If a FRMCS Application is relying on other FRMCS Applications, enabling of all required FRMCS Applications is managed by the FRMCS System.

Only authorised FRMCS Applications shall be presented to the FRMCS User.

### 9.9.2.4 Post-conditions

The FRMCS User has access to all authorised FRMCS Applications.

### 9.9.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.9.2-001]	The FRMCS System shall allow the network operator to control the use of FRMCS Applications in order to avoid disruption/distraction to the FRMCS Users (for example Drivers), preventing unauthorised usage according to his Role.	A	TS 22.280, requirement [R-6.6.4.2-002] [R-6.7.3-007] [R-6.7.3-007a]	Covered for both group and private communications with CR 0053 to TS 22.280
[R-9.9.2-002]	The FRMCS System shall be able to enable / disable FRMCS Applications for a FRMCS User depending on subscriber identity, the functional identity of the FRMCS Equipment, the FRMCS User Identity or the functional identity/ies of the FRMCS User. The FRMCS System shall also be able to take context-based criteria like location, speed, direction of travel and other conditions be taken into account.	A	TS 22.280, requirement [R-6.6.4.2-002]	Covered for group communication with CR 0053 to TS 22.280
[R-9.9.2-003]	After powering on the FRMCS Equipment and start of the FRMCS Application on the FRMCS Equipment, the FRMCS System shall enable the FRMCS Application(s) on the FRMCS Equipment according to the Role related to the FRMCS subscriber identity.	A	Not applicable	This is related to implementation and is outside 3GPP scope.
[R-9.9.2-004]	Upon a change in registration status by registration / deregistration to / from a functional identity, a change of a functional identity, user login /logout to / from the FRMCS System, the FRMCS System shall be able to enable / disable applications.	A	[TS 22.280, requirement [R-5.9a-001]	
[R-9.9.2-005]	The FRMCS System shall allow the operator to configure the order in which the FRMCS functional Identities related to the FRMCS User identity FRMCS functional Identities related to the FRMCS Equipment FRMCS subscriber identity are evaluated to determine with the set of application authorised for use	A	Not covered	TS 22.280: only authorisation based on MCX Service User ID is supported.

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.9.2-006]	If a FRMCS User has registered to multiple functional identities, the FRMCS User shall be authorised to use all applicable FRMCS Applications related to the different FRMCS functional identities.	A	Implicitly covered	This requirement is implicitly covered. Chapter 5.9a.1 in TS 22.280 states that "The activation of the functional alias(es) will take place after the user has signed in to the MCX Service using the MCX User ID." So the user is already authorized to use the services when functional ID is activated.
[R-9.9.2-007]	If the FRMCS User enters a certain area, the FRMCS System shall prevent the use of FRMCS Application(s) which had been authorised previously.	A	Covered by [R-5.9a-015] in TS 22.280	
[R-9.9.2-008]	If the FRMCS User enters a certain area, the FRMCS System shall enable the use of FRMCS Application(s) which had not been authorised previously.	A	Covered by [R-5.9a-015] in TS 22.280	
[R-9.9.2-009]	If a FRMCS Application is relying on other FRMCS Applications, enabling of all required FRMCS Applications shall be managed by the FRMCS System.	A	Not applicable	This requirement should be covered in implementation.

### 9.9.3 Use case: Robust mission critical group communication services

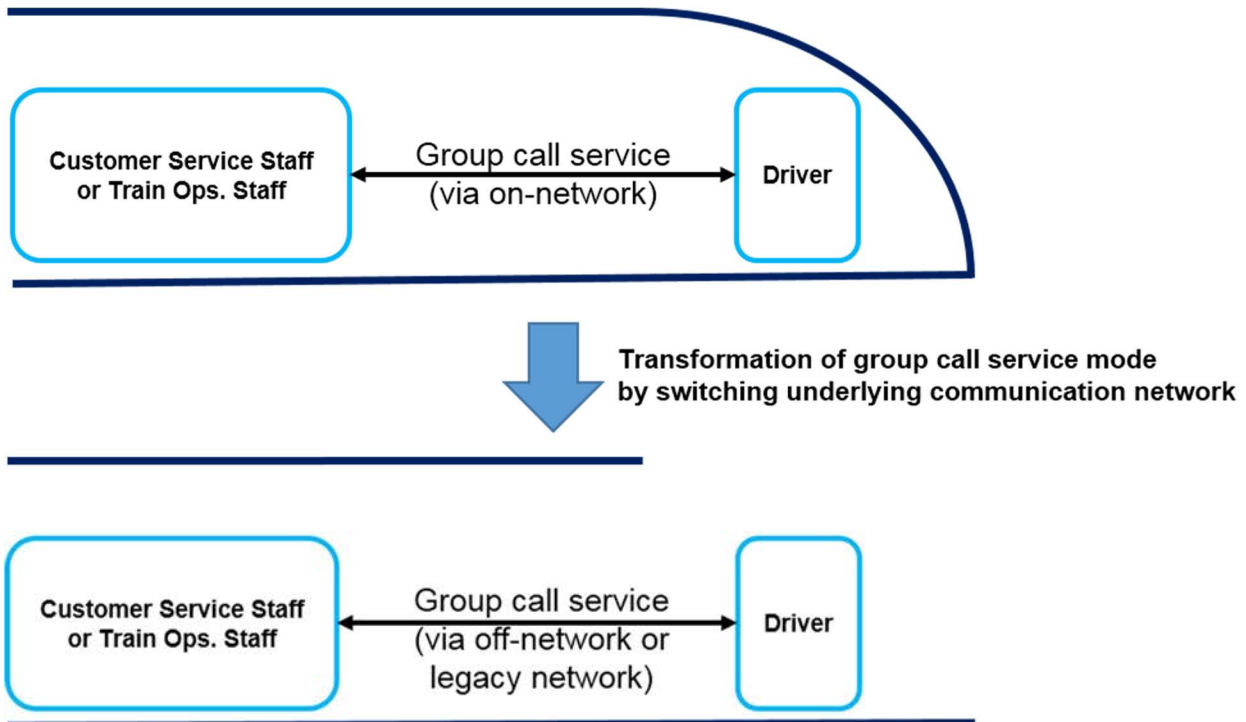
#### 9.9.3.1 Description

For reliable railway services, conventional way is to use dualization methodology. Most of railway services are based on on-network communication, which is supported by base station and core networks under 3GPP standard. However, when disaster happens so that the communication infrastructure is not feasible, railway service based on the communication infrastructure cannot be maintained any more. From 3GPP Rel. 12, device-to-device communications has been considered to be supported not only in the transport layer but also in the application layer. In addition, interworking of FRMCS System with legacy systems including GSM-R and TRS is expected to be supported in Rel. 15. As a consequence, off-network and legacy systems will become feasible for group communication services in 3GPP technology. Therefore, by considering not only off-network but also legacy systems, reliability of mission critical group communication service in the on-network can be enhanced. Figure 9.9-1 depicts a required transformation of group communication service mode.

#### 9.9.3.2 Pre-conditions

FRMCS Equipment for train driver, customer service staff, and train operations staff support device to device communications in the perspective of transport layer.

FRMCS Equipment for train driver, customer service staff, and train operations staff support on-network, off-network group communication services in the perspective of applications layer.



**Figure 9.9.3.2-1. Transformation of group communication service mode**

### 9.9.3.3 Service Flows

1. After initial disaster happens, emergency message (including voice or data) delivery service based on on-network group communication among train driver, customer service staff, or train operations staff have been preceded without any problem.
2. Disaster becomes worse, and associated communication infrastructure is destroyed and is not usable anymore.
3. Transformation of on-network group communication service into off-network or legacy network-based group communication service is accomplished among group members for maintaining the group communication services even in the worse disaster.

### 9.9.1.4 Post-conditions

Off-network or legacy network-based group communication among train driver, customer service staff, or train operations staff is activated and group communication service is maintained normally.

### 9.9.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.9.3-001]	FRMCS Equipment shall support on-network based group communications.	A/T	TS 22.179 V.14.2.0	Support
[R-9.9.3-002]	FRMCS Equipment shall support off-network based group communications.	A/T	TS 22.179 V.14.2.0	Support
[R-9.9.3-003]	FRMCS Equipment should support legacy network- based group communications optionally.	A/T	N/A	Implementation option.
[R-9.9.3-004]	FRMCS System shall provide a mechanism in the application layer to transform on-network based group communication into off-network based group communication.	A	TS 22.280	Automatic and manual switching from on-network service to off-network service are supported. [R-7.13-004] On-going MCX service communication interruption are minimized when switching from on-network to -off-network services.
[R-9.9.3-005]	FRMCS System shall provide a mechanism in the application layer to transform on-network based group communication into legacy networkbased group communication.	A	22.179 22.280	TS 22.179 Project 25: subclause 6.18.3.2. TETRA: subclause 6.18.3.3. TIA-603 systems: subcla use 6.18.3.4. GSM-R: 6.18.4. TS 22.280 GSM-R: subclause 6.17.3.1.

### 9.9.3a Use case: Enabling/Disabling communication privileges per FRMCS User based on identities/talker status

#### 9.9.3a.1 Description

In addition to enable the control of use of of FRMCS Applications, the FRMCS System shall allow the network operators and/or the FRMCS Users to control the use of FRMCS Applications with communication privileges per FRMCS User.

FRMCS User authorization shall be based on the FRMCS User Identity and/or the functional identity/ies of the FRMCS User, the functional identity of the FRMCS Equipment, and/or the talker status for ongoing communications.

Regarding this last parameter (i.e., communication privileges based on talker status), as an example, if an FRMCS User A who is involved as a listener in a voice communication, and FRMCS User B is talking in this voice communication, FRMCS User A is allowed or not to put on hold/leave/terminate the call, and/or to kick out FRMCS User B based on talker status of both FRMCS Users A and B.

#### 9.9.3a.2 Pre-conditions

The FRMCS User equipment is powered on and the FRMCS Application on the FRMCS User equipment has started.

#### 9.9.3a.3 Service flows

##### Change of FRMCS User authentication and authorisation status

Upon a change in FRMCS User authentication and authorisation status, the FRMCS System triggers a change of communication privileges (e.g., FRMCS User profiles) for that particular FRMCS User.

The following use cases are concerned:

- An FRMCS User is authorised or not to initiate a private or group voice, video or data communication;
- An FRMCS User is authorised or not to put a group voice communication on hold;
- An FRMCS User is authorised or not to leave a group voice communication;
- An FRMCS User is authorised or not to terminate a private or group voice communication;
- An FRMCS User is authorised or not to merge Railway Emergency Alerts;
- An FRMCS User is authorised or not to kick out another FRMCS User from a group voice communication;
- An FRMCS User is authorised or not to invite another FRMCS User to a group voice communication.

#### **Change of FRMCS User registration status**

Upon a change in registration status by registration / deregistration to / from a functional identity, the FRMCS System triggers a change of communication privileges (e.g., FRMCS User profiles) for that particular FRMCS User.

The following use cases are concerned:

- An FRMCS User is authorised or not to initiate a private or group voice, video or data communication;
- An FRMCS User is authorised or not to put a group voice communication on hold;
- An FRMCS User is authorised or not to leave a group voice communication;
- An FRMCS User is authorised or not to terminate a private or group voice communication;
- An FRMCS User is authorised or not to merge Railway Emergency Alerts;
- An FRMCS User is authorised or not to kick out another FRMCS User from a group voice communication;
- An FRMCS User is authorised or not to invite another FRMCS User to a group voice communication.

#### **Change of FRMCS User's talker status during ongoing group voice communication**

Upon a change of talker status when an FRMCS User is involved in an ongoing group voice communication (i.e., the current talker becomes listener and vice-versa), the FRMCS System may be able to trigger a change of communication privileges (e.g., FRMCS User profiles) for all FRMCS Users affiliated to that group.

The following use cases are concerned:

- An FRMCS User is authorised or not to put an ongoing group voice communication on hold;
- An FRMCS User is authorised or not to leave an ongoing group voice communication;
- An FRMCS User is authorised or not to terminate an ongoing group voice communication;
- An FRMCS User is authorised or not to merge Railway Emergency Alerts;
- An FRMCS User is authorised or not to kick out another FRMCS User from an ongoing group voice communication;
- An FRMCS User is authorised or not to invite another FRMCS User to an ongoing group voice communication.

#### **9.9.3a.4 Post-conditions**

The FRMCS User is authorized or not to use FRMCS Applications.



### 9.9.3a.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.9.2-001]	When an FRMCS User performs MCX authentication and authorisation, the FRMCS System shall be able to trigger a change of communication privileges for that particular FRMCS User.	A	Partly covered (refer to communication privileges below)	<p>Identification of the targeted user of the communication privilege status change: partly covered by MCX authentication and authorisation mechanism (MC ID only, no FA).</p> <p>Change of user profiles on MCX authentication and authorisation: covered →MCX User Service Authorization is the function that validates whether or not a MCX user has the authority to access certain MCX services.</p>
[R-9.9.2-002]	When an FRMCS User activates or deactivates Functional Alias(es), the FRMCS System shall be able to trigger a change of communication privileges for that particular FRMCS User.	A	Partly covered (refer to communication privileges below)	<p>Identification of the targeted user of the communication privilege status change: covered by FA mechanism (MC ID + list of FA(s)).</p> <p>Change of user profiles on FA activation or creation of new profiles for FA: not covered. <b>Editor's note: CR is needed</b></p>
[R-9.9.2-003]	When the floor is granted or released for a particular FRMCS User (including multi-talker floor control), the FRMCS System shall be able to trigger a change of communication privileges for all FRMCS Users <u>affiliated to that group</u> .	A	Partly covered	<p>Identification of the targeted users of the communication privilege status change: Partly covered. Only MCPTT ID(s) and list of FA(s) of the requester(s) (floor control request &amp; multi-talker) are known by the system. <b>Editor's note: CR is needed</b></p> <p>Change of user profiles when floor granted/released: not covered. <b>Editor's note: CR is needed</b></p>
[R-9.9.2-004]	The FRMCS System shall support Communication privilege as (1) authorisation to put a group voice communication on hold.	A	Covered	<p>Put a group voice communication on hold: covered by the affiliation mechanism which is considered sufficient to mimic the desired behaviour.</p> <p>Authorisation mechanism: authorization of changing affiliation based on registration status by registration / deregistration to / from a functional identity or by talker status: not covered. <b>Editor's note: CR is needed</b></p>

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.9.2-005]	The FRMCS System shall support Communication privilege as (2) authorisation to leave a group voice communication.	A	Covered	<p>Leave a group voice communication: covered by the affiliation mechanism which is considered sufficient to mimic the desired behaviour.</p> <p>Authorisation mechanism: authorization of changing affiliation based on registration status by registration / deregistration to / from a functional identity or by talker status: not covered. <b>Editor's note: CR is needed</b></p>
[R-9.9.2-006]	The FRMCS System shall support Communication privilege as (3) authorisation to terminate a group voice communication.	A	Not covered	<p>Terminate a group voice communication: strictly performed by the system.</p> <p>Authorisation mechanism: not covered. <b>Editor's note: CR is needed</b></p>
[R-9.9.2-007]	The FRMCS System shall support Communication privilege as (4) authorisation to merge Railway Emergency Alerts.	A	[Need analysis]	[Need analysis – finalize potential requirements for Merging of Railway Emergency Alerts first]
[R-9.9.2-008]	The FRMCS System shall support Communication privilege as (5) authorisation to kick out another FRMCS User from a group voice communication.	A	Covered by 22.280	<p>Kick out another user: covered by remote change of affiliation (mandatory mode) 22.280 6.4.6.1.</p> <p>Authorisation mechanism: authorization of changing affiliation based on registration status by registration / deregistration to / from a functional identity or by talker status: not covered. <b>Editor's note: CR is needed</b></p>
[R-9.9.2-009]	The FRMCS System shall support Communication privilege as (6) authorisation to invite another FRMCS User to a group voice communication.	A	Covered by 22.280	<p>Invite a user to join: covered by remote change of affiliation (negotiated mode) 22.280 6.4.6.2.</p> <p>Authorisation mechanism: authorization of changing affiliation based on registration status by registration / deregistration to / from a functional identity or by talker status: not covered. <b>Editor's note: CR is needed</b></p>
[R-9.9.2-010]	The FRMCS System shall support Communication privilege as (7) authorisation to initiate private voice, video or data communication.	A	Covered by 22.280	<p>Initiate private voice, video or data communication: covered by MC private call request mechanism.</p> <p>Authorisation mechanism: covered by authorisation check based on user profile.</p>

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.9.2-011]	The FRMCS System shall support Communication privilege as (8) authorisation to initiate group voice, video or data communication.	A	Covered by 22.280	Initiate group voice, video or data communication: covered by group call request mechanism.  Authorisation mechanism: covered by authorisation check based on user profile.

## 9.10 Sharing FRMCS Equipment by FRMCS Users

### 9.10.1 Description

Commonly, FRMCS Users may share FRMCS Equipment, e.g. a trainborne UE. To use the shared equipment securely, it is needed to identify the user for the equipment.

### 9.10.2 Pre-conditions

A train driver is in a train.

The train driver has an identification card.

### 9.10.3 Service Flows

The train driver wants to use a trainborne UE to make communication to train control centre.

The train driver puts his/her identification card in the trainborne UE to identify himself/herself. In this case, the identification card is an example. It can be a type of ID number, finger-print, etc. instead.

The trainborne UE reads the identification information from the card and requests authentication to FRMCS security server.

FRMCS security server confirms the information and replies the authentication information to the trainborne UE.

FRMCS registers the train driver as the user of the trainborne UE to relay a call for the train driver to the trainborne UE.

The trainborne UE indicates readiness to use for the train driver.

### 9.10.4 Post-conditions

The train driver makes a call to the train control centre.

The train driver receives a call using the trainborne UE that is relayed by FRMCS.

## 9.10.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.10-001]	The FRMCS System shall be able to provide a mean to identify a FRMCS User (for example, the train driver).	A	TS 22.280	TS 22.280 sub-clause 5.9a and covered by many requirements in MCX
[R-9.10-002]	The FRMCS System shall be able to provide a mapping between the FRMCS User identification information and FRMCS Equipment in order to route communication.	A	TS 22.280	Covered by many requirements in MCX
[R-9.10-003]	The FRMCS System shall be able to provide communication routing based on the mapping information.	A	TS 22.280	Covered by many requirements in MCX
[R-9.10-004]	The FRMCS System should provide functions for the shared FRMCS Equipment to get identification information from the FRMCS User who wants to use the equipment.	A	TS 22.280	Covered by many requirements in MCX

## 9.11 FRMCS naming authority

### 9.11.1 Description

The FRMCS Naming Authority (NA) is a registry service provided by FRMCS System to facilitate the handling of various namespaces, number spaces or other information sets needed to support FRMCS services.

For example, FRMCS User identification requires a registry to manage the identification information which shall not be duplicated during its registration process.

### 9.11.2 Pre-conditions

A new train driver is registered as a new user of FRMCS.

A new trainborne UE is installed in a train.

### 9.11.3 Service Flows

The new train driver wants to use FRMCS System.

The train driver makes a request to register the user identification information in FRMCS with his/her finger-print as an identification method.

The FRMCS checks the duplication of the user identification under the guidance of FRMCS NA and registers the user identification information in its registry.

The train driver installs a new trainborne UE in the train. During the installation process, the trainborne UE is registered as a new FRMCS UE in FRMCS registry under the guidance of FRMCS NA to avoid duplication of FRMCS UE address.

### 9.11.4 Post-conditions

The train driver is registered as a new user in FRMCS System without duplication of user identification information.

The trainborne UE is installed in the train and is registered as a new FRMCS UE in FRMCS System without duplication of UE address.

### 9.11.5 Potential requirements and gap analysis

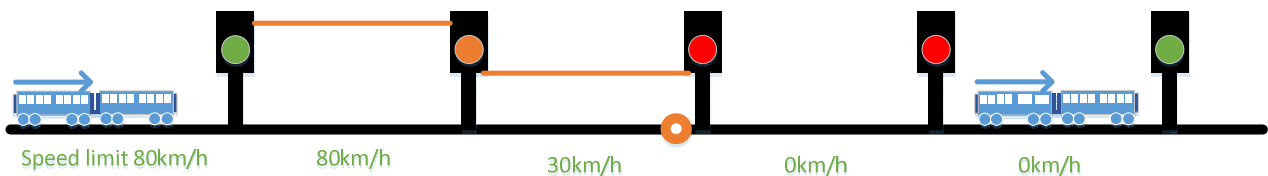
Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.11-001]	The FRMCS System shall be able to avoid duplication of identities.	A	22.280	covered by 22.280 [R-6.9-002]

## 9.12 Wayside-Centric Automatic Train Control

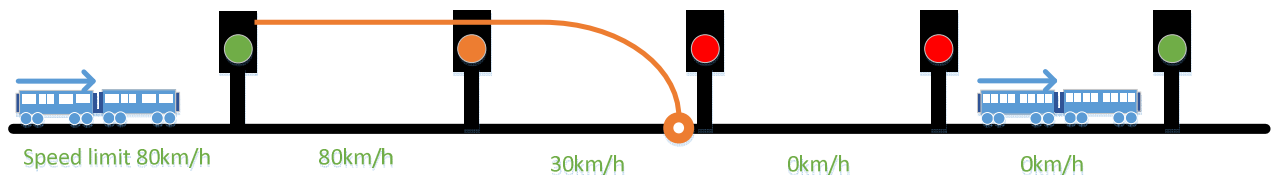
### 9.12.1 Description

Signalling block system, which is a fundamental factor in the perspective of train control, enables the safe and efficient operation of railways to avoid collisions between trains. The signalling block system basically keeps a train away from entering the block occupied by the other train. It is commonly known that moving block system compared to fixed block system. As shown in Figure 9.12-1, the train in moving block system can approach the leading train more closely.

#### Fixed Block System (Signal)



#### Fixed Block System (On-board ATP)



#### Communication Based Moving Block System (WATP - OATP)



**Figure 9.12-1 Examples of various railways block systems**

One way to realize the moving block system is that a centralized server communicates with trains and manages the moving block based on the positions of the trains. The On-board Automatic Train Protection (OATP), which is on the train, report the position of the train to the Wayside Automatic Train Protection (WATP), and the WATP decides and provide the movement authority of the train to the OATP. The train controls itself based on the movement authority, and trigger brake when it approaches the border of its authorized moving area.

### 9.12.2 Pre-conditions

1. The user equipment dedicated to train control gets power-on, and registers to the train control system.

2. WATPs are located in the Packet Data Network (PDN), and each train knows the nearby WATP which can offer a movement authority and make it move.

3. The user equipment establishes a connection through the 3GPP network for transporting periodical data between WATP and OATP.

### 9.12.3 Service flows

1. The OATP periodically report its position to the serving WATP.

2. The WATP periodically provide movement authority to the OATP

3. The train accelerates, or triggers brake based on the last received movement authority. It moves till the position that it is authorized to move, and stops if it reaches to the border of the authorized area.

### 9.12.4 Post-conditions

The train triggers emergency brake and stops immediately if the connection is lost and data is not received for a certain time from WATP.

### 9.12.5 Potential requirements and gap analysis

Requirement Reference Number	Requirement text	Application/ Transport	SA1 spec covering	Comments
[9.12-001]	The FRMCS System shall provide a mechanism for a train to autonomously discover an assigned application server which can offer movement authority.	A/T	22.280	This requirement is covered by the combination of functional alias, affiliation mechanism, and IP connectivity.
[9.12-002]	Train control data shall be able to be transported with the highest priority.	T	22.280	Covered by 22.280 [R-6.8.7.2-001], [R-6.8.7.2-010] and [R-5.1.7-002].

## 9.13 Autonomous Train Control and Operation

### 9.13.1 Description

In legacy train control systems, trains typically decide its movement by interacting with trackside devices (e.g. track circuits, balise, radio block system) or communicating with a trackside server. If a train can autonomously figure out the positions of the nearby trains and decide its movement authority, the transport capacity of the railway will be enhanced. In the autonomous train control system whose service concept is aligned to the eV2X service, trains share its position by exchanging the information without any centralized server, and each train decides how far it can be authorized to move based on the position information. It is expected that main application area will be mass transportation such as subway.

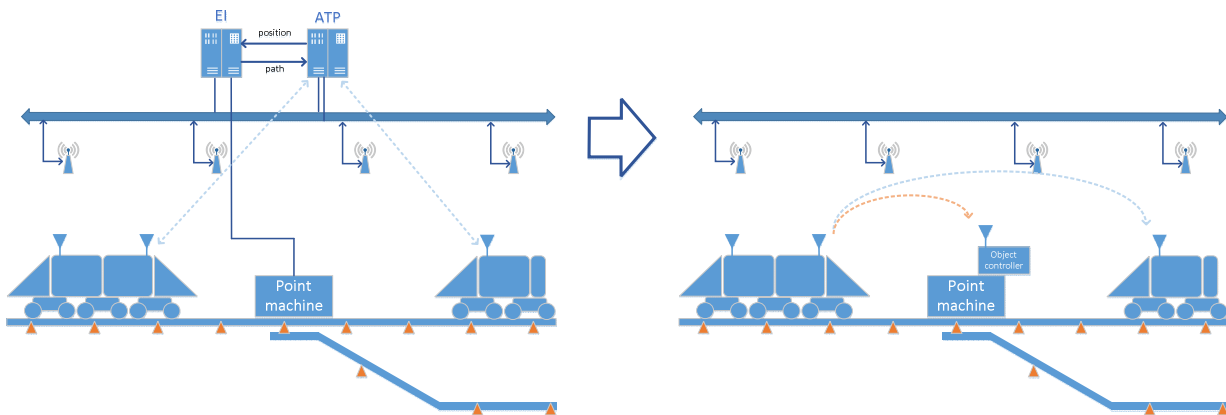


Figure 9.13.-1 An example of autonomous train control scenario

### 9.13.2 Pre-conditions

1. Trains know the overall schedule, and the user equipment of each train is connected to the user equipment of the other trains operating at the same time.
2. A user equipment of each train is able to establish a connection with the object Controller for the nearby point machine.

### 9.13.3 Service Flows

1. A train gets started and try registration to the currently operating trains. The registration message includes the position of the train.
2. The train gets the responses of the registration from the other trains and estimates the positions of the trains.
3. The train decides its movement authority based on the position information and starts moving.
4. The train positions in the corresponding areas are shared through multicasting.
5. Based on the periodically updated information, each train updates its movement authority and conduct train control based on it.
6. If needed, the train connects to the nearby point machine and sends switch command.

### 9.13.4 Post-conditions

The autonomous train control is achieved by activating movement authority for each train or activating object Controller for nearby point machine.



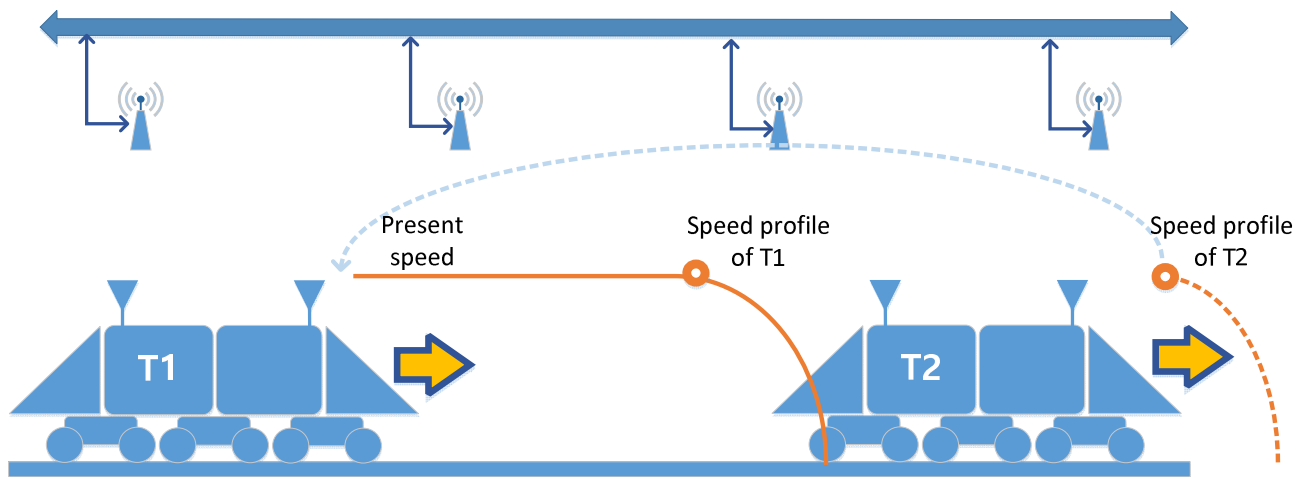
## 9.13.5 Potential requirements and gap analysis

Requirement Reference Number	Requirement text	Application/Transport	SA1 spec covering	Comments
[9.13-001]	The 3GPP network shall provide a mechanism using on-network communications to establish a bearer from a user equipment to the other user equipment	A	22.280	The requirement of [R-5.9a-002] "The MC User shall be reached by its functional alias(es) from within the MCX Service system where the functional alias was activated." Includes point to point MCDATA transport service.
[9.13-002]	The 3GPP network shall provide an efficient way to disseminate data to multiple FRMCS UEs for train control.	A/T	22.282 22.280	The requirements of [R-6.2.2.1-002a] and [R-6.2.2.1-002b] of 22.282 include a dissemination of data to multiple receiving users. The efficient way of the dissemination is covered by functional alias in 5.9a requirements of 22.280.
[9.13-003]	The 3GPP network shall be able to multicast train control data originated from one FRMCS UE to the other FRMCS UE.	A/T	22.282	The requirements of [R-6.2.2.1-002a] and [R-6.2.2.1-002b] include a multicast of data to chosen receiving users.
[9.13-004]	The FRMCS System shall provide a mechanism to discover feasible objects for point machine.	A	22.280	Covered by [R-5.9a-002] "The MCX User shall be reachable by its functional alias(es) from within the MCX Service system where the functional alias was activated."

## 9.14 Virtual Coupling

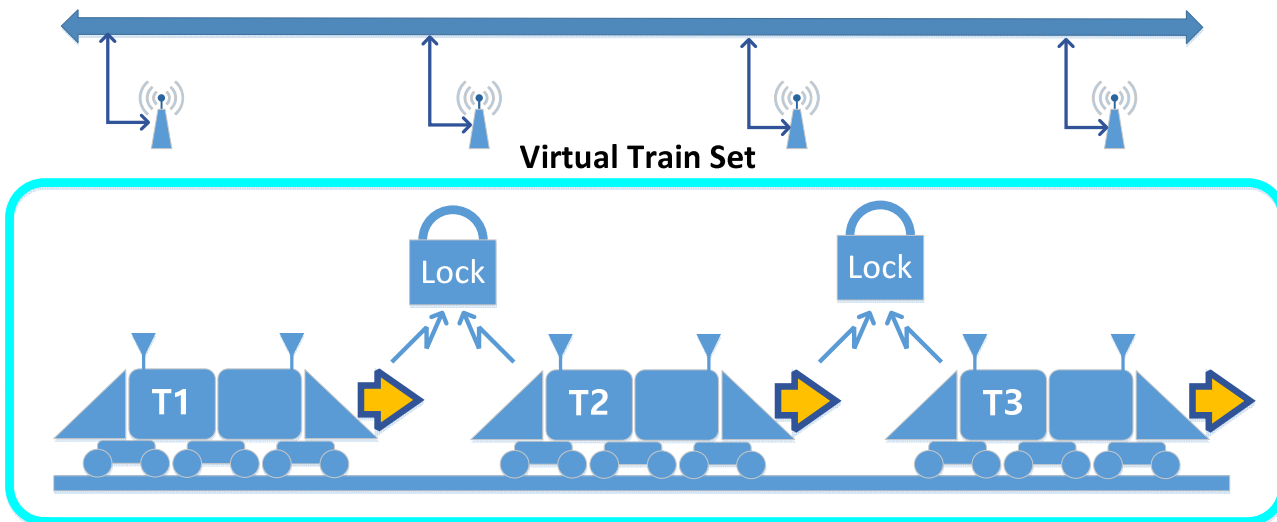
### 9.14.1 Description

One of the important missions that the future railway service should achieve is to increase its transport capacity. A straight-forward solution is to minimize the distance between successive trains so that train interval is reduced. It is difficult to do so in a legacy train control system, because the successive trains need to have distance as much as a safety margin, which should be larger than the full braking distance.



**Figure 9.14-1 Sharing acceleration and braking control information to shorten safety margin**

This safety margin can be further shortened if the successive trains share control information (acceleration and braking) and apply it to its own train control. As shown in Figure 9.14.1, the safety margin can be shortened if the following train immediately knows that the leading train starts braking and also triggers braking. This is the fundamental principle and the main purpose of virtual coupling. Figure 9.14.2 shows the basic concept of the virtual coupling scenario. Multiple trains which are in close distance move together *as they are physically coupled*. As the distance between two trains gets smaller, the control information of a train should be delivered to the other in shorter time.



**Figure 9.14-2 The concept of virtual coupling scenario**

### 9.14.2. Pre-conditions

1. The leading and following trains in operation recognize each other and have just got configured to be coupled virtually.
2. The user equipment for train control support device to device communications in the perspective of transport layer.

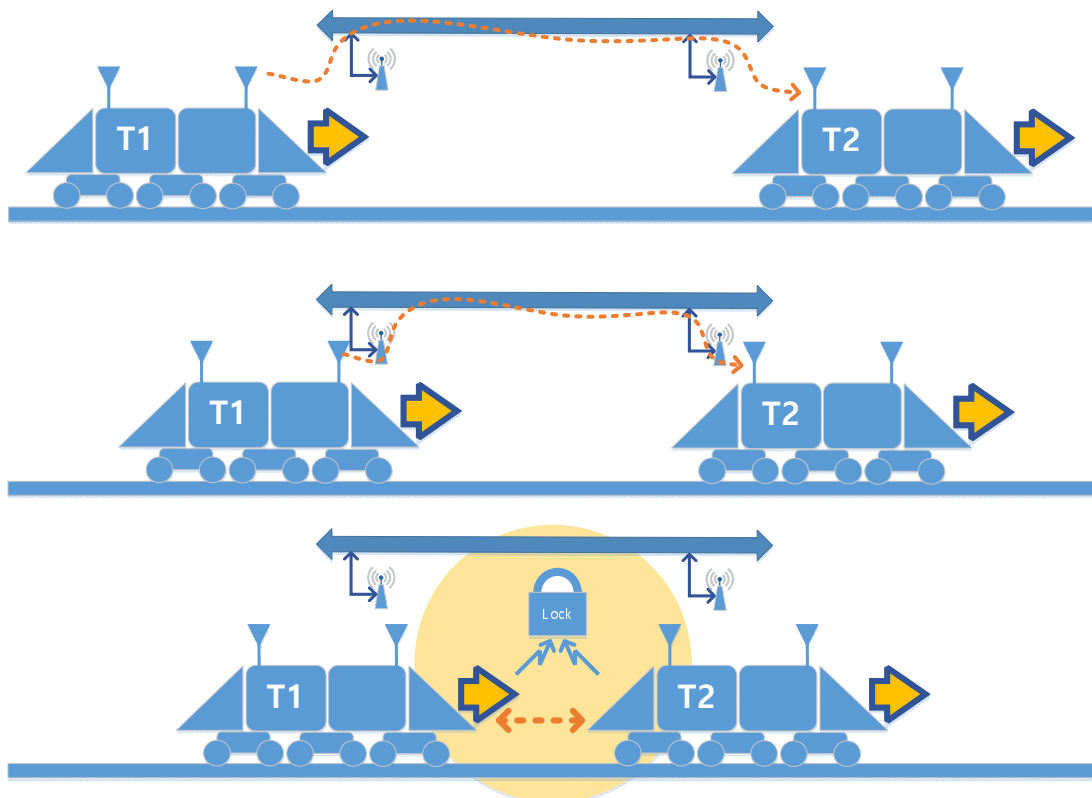


Figure 9.14-3 Overall procedure of virtual coupling

### 9.14.3 Service Flows

1. The following train begins to approach to the leading train by exchanging the information about their position. The two trains, which are far enough to allow a certain amount of end-to-end latency, are initially connected through the 3GPP network.
2. As the following train approaches to the leading train, they start exchanging the information about movement control and each train then controls itself while considering the control of the other train. The two trains, which are still far enough to allow a certain amount of end-to-end latency, keep the connection through the 3GPP network.
3. As the following train further approaches to the leading train, the safe braking distance gets shorter and they are required to have a connection of which end-to-end latency is very short for delicate train control. At this moment, they seamlessly switch the connection from the 3GPP network to PC5 interface

### 9.14.4 Post-conditions

For safety train operation, integrity needs to be checked for train control information delivery in the perspective of application or transport layer. Any error on integrity check shall be immediately reported to the train control application.

## 9.14.5 Potential requirements and gap analysis

Requirement Reference Number	Requirement text	Application/T ransport	SA1 spec covering	Comments
[9.14-001]	An On-board FRMCS UE for automatic train control shall be able to communicate through off-network up to 3km in the line of sight channel environment.	T	22.289	This requirement is covered by section 5.2.2 of TS22.289
[9.14-002]	Integrity protection shall be provided for each data transfer between FRMCS UEs for train control	A/T	22.280	Covered by [R-5.12-001]" The MCX Service shall provide a means to support the confidentiality and integrity of all user traffic and signalling at the application layer."
[9.14-003]	The 3GPP system shall support service continuity between on-network based connection and off-network based connection.	A/T	22.280	[R-7.11-001] An MCX UE shall be capable of utilizing off-network MCX Service communications and on-network MCX Service communications at the same time. [R-7.13-004] On-going MCX service communication interruption are minimized when switching from on-network to -off-network services.
[9.14-004]	FRMCS UEs for train control shall communicate through off-network, where the FRMCS UEs' relative speed is less than 40km/h.	T	22.289	This requirement is covered by section 5.2.2 of TS22.289

## 9.15 Composite-based train operation

### 9.15.1 Description

This use case considers the composition and decomposition of trains or tractions. One is the case, where two autonomous trains / traction (train A and train B) are conducted as one composition (Train C). The other case describes the decomposition of a train set (Train C) into autonomous train A and train B. For these scenarios, specific FRMCS Equipment Identity management need to be provided by the FRMCS System.

### 9.15.2 Pre-conditions

Train A and Train B share information for train operation such as position and velocity profile.

### 9.15.3 Service Flows

#### Train composition

1. Train/traction A and Train/traction B are autonomous trains and moving on different tracks.
2. Train/traction A and the train/traction B are put together into one train composition using the same railway.
3. Consequently, the different FRMCS UE identities of train/traction A and train/traction B are changed into common FRMCS UE identity composite train C/traction C.

**Train decomposition**

1. Train/traction C which is the composition of train/traction A and train/traction B is moving along the railway.
2. Based on the train routing i.e. different destination of train/traction A and train/traction B of train/traction A and train/traction B uses two different railways.

Consequently, the FRMCS UE identity of train/traction C is decomposed again into FRCMS UE identities of train/traction A and train/traction B.

**9.15.4 Post-conditions**

1. Train/traction C arrives at the destination consisting of train/traction A&B
2. Train A and Train B arrive at the planned destination.

**9.15.5 Potential requirements and gap analysis**

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[9.15-001]	The FRMCS System shall be able to assign and withdraw an FRMCS Equipment Identity common to several FRMCS Equipment, e.g. for trains being coupled together in order to be reachable under the same FRMCS Equipment Identity.	A	22.280	Covered by [R-5.9a-015] The MCX Service system shall allow an MCX Service Administrator to make use of information (e.g. operational schedules, locations, velocity or direction) from external sources to create or delete a functional alias.and [R-5.9a-18] The MCX Service shall support automatic activation and de-activation of a functional alias based on the operational criteria (e.g. MCX User ID, login/logoff from the MCX Service system, specific external information supplied by external systems).

**9.16 Arbitration related use cases**

**9.16.1 Introduction**

In this chapter the use cases related to arbitration are defined. The following use cases are defined:

- Arbitration
- Arbitration for communication auto-connection

## 9.16.2 Use case: Arbitration

### 9.16.2.1 Description

The FRMCS System shall be able to perform arbitration, based on the context of the communication. Arbitration in this context means that the FRMCS System is able to determine the behaviour of the end user device in case of multiple competing communications. Additionally, the FRMCS System may ask the FRMCS User which communication to accept.

### 9.16.2.2 Pre-conditions

The FRMCS System is authorised to perform arbitration on communication on the end user device.

### 9.16.2.3 Service flows

#### Incoming communication

When the communication is received by the FRMCS User on any of its registered functional identities, the FRMCS System provides to the FRMCS User arbitration information.

FRMCS System is able to present arbitration options to the FRMCS User to select from.

Arbitration of communication determines automatically to accept, reject, put on hold or queue the incoming and/or the ongoing communication, based on both the incoming and the ongoing communication characteristics.

#### Outgoing communication

The FRMCS User is initiating a new communication. Arbitration information is available from the FRMCS application.

The arbitration application has the possibility to present arbitration options to the end user to select from.

The arbitration application decides to accept, reject, and put on hold or queue, the ongoing and/or the new communication, based on both the incoming and the ongoing communication characteristics.

### 9.16.2.4 Post-conditions

The communication is established to the FRMCS Equipment the FRMCS User has selected.

### 9.16.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.16.2-001]	The FRMCS System shall be able to provide communication to the FRMCS User based on the arbitration information associated with the communication.	A	TS 22.280 section 6.19.1	
[R-9.16.2-002]	The FRMCS System shall be able to accept, reject, hold, queue or prompt the user for his choice on the incoming communication.	A	TS 22.280	Automatic arbitration in on-network mode: <b>covered</b> by requirements in section 6.19.1: MCX request to transmit are granted, rejected or queued (put on hold and queue are considered as similar mechanism).

				Automatic arbitration in off-network mode: <b>covered</b> by requirements in section 7.3.2.  Manual arbitration (user selection) in on-network mode: accept and reject are covered by section 6.7.6. Mechanism to queue is <b>not covered</b> .  Manual arbitration (user selection) in off-network mode is <b>not covered</b> .
[R-9.16.2-003]	When the FRMCS User is using multiple FRMCS Equipment simultaneously, the FRMCS System shall be able to establish the communication to the appropriate FRMCS Equipment, based on FRMCS User selected option.	A	TS 22.280	[R-6.7.2-005]

### 9.16.3 Use case: Arbitration for communication auto-connection

#### 9.16.3.1 Description

The FRMCS System shall be able to automatically accept incoming communications without asking the FRMCS User, based on configuration (i.e., configured arbitration rules).

#### 9.16.3.2 Pre-conditions

The FRMCS System is authorised to perform arbitration on communication on the FRMCS Equipment (i.e., end user device).

#### 9.16.3.3 Service flows

##### **FRMCS User is using a single FRMCS Equipment**

When the communication is received by the FRMCS User on any of its identities (including registered functional identities), the FRMCS System automatically accepts the incoming private or group communication if arbitration rules are configured to do so.

##### **FRMCS User is using multiple FRMCS Equipment simultaneously**

If arbitration rules allow configuration for automatic answering and if an FRMCS User is logged in multiple FRMCS Equipment simultaneously, the FRMCS System automatically accepts the incoming private or group communication to the FRMCS User's default FRMCS Equipment when the communication is received by the FRMCS User on any of its registered functional identities.

The FRMCS User's default FRMCS Equipment is set up by either the FRMCS User or by the FRMCS System Administrator.

If the FRMCS System fails to automatically accept the incoming private or group communication to the FRMCS User's default FRMCS Equipment, the FRMCS System automatically accepts the incoming private or group communication to another FRMCS Equipment the FRMCS User is logged in.

##### **Arbitration rules**

Arbitration rules allows configuration for automatic answering based on:

- The FRMCS User identities;
- The FRMCS User registered functional identities;
- The FRMCS Application identities;
- The FRMCS User's default FRMCS Equipment.

#### 9.16.3.4 Post-conditions

The incoming communication is automatically accepted to the relevant FRMCS Equipment the FRMCS User is logged in.



## 9.16.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.16.3-001]	When an incoming private communication is received by the FRMCS User, the FRMCS System shall be able to automatically accept the communication if arbitration rules are configured to do so (based on FRMCS User identities, registered functional identities or FRMCS Application types).	A	22.280	Partly covered by private call setup in automatic commencement mode (request for automatic commencement mode – automatic answering – is triggered by the calling party, not by the System). In addition, configuration for automatic commencement mode is based on MC User ID only. Arbitration rules based on FRMCS Application types (i.e., MCPTT, MCData or MCVideo) is supported but not on Functional Alias(es). <b>Editor's note: CR is needed.</b>
[R-9.16.3-002]	When an incoming group communication is received by the FRMCS User, the FRMCS System shall be able to automatically accept the communication if arbitration rules are configured to do so (based on FRMCS User identities, registered functional identities or FRMCS Application types).	A	22.280	Covered by affiliation and functional alias mechanisms.
[R-9.16.3-003]	When the FRMCS User is using multiple FRMCS Equipment simultaneously, the FRMCS System shall be able to automatically accept an incoming private communication to the default FRMCS Equipment.	A	22.280	Covered by 5.10 Support for multiple devices (i.e., multiple MCX UEs) and [R-6.7.2-005] default device designated by the receiving user. <b>Editor's note on multiple devices support: default UE covered by stages 2&amp;3? (didn't find it)</b>
[R-9.16.3-004]	The default FRMCS Equipment is configured by either the FRMCS User or by the FRMCS System Administrator.	A	22.280	Partly covered by 5.10 Support for multiple devices (i.e., multiple MCX UEs) and [R-6.7.2-005]: only the receiving user can designate the default device.
[R-9.16.3-005]	When the FRMCS User is using multiple FRMCS Equipment simultaneously, the FRMCS System shall be able to automatically accept an incoming private communication to other FRMCS Equipment if communication to the default FRMCS Equipment fails to be established.	A	22.280	Not covered by [R-6.7.2-005]: it is up to the receiving user to detect that something is wrong with default UE and then to select another UE to receive incoming call. <b>Editor's note on multiple devices support: selection of default UE "on the fly" supported or only during MC Registration?</b>

## 9.17 Data communication to exchange key information for train safety application use cases

### 9.17.1 Introduction

In this chapter the use cases related to Key management communication are defined. The following use cases are defined:

- Initiation of a Key Management data communication
- Termination of a Key Management data communication
- Service interworking and service continuation with GSM-R

### 9.17.2 Use case: Initiation of a Key Management data communication

#### 9.17.2.1 Description

Key Management communication is the application which performs the functions that ensure the exchange of credentials/keys required by other applications (such as ATO, ATP) to ensure the correct authentication of the end users of each application and the integrity of the messages exchanged.

Some Key Management systems require radio communication to interchange the relevant data between a train and its corresponding key distribution centre (Key Management Center). This key distribution centre may be located in the same network or in an external network.

The users in this case are the Key Management applications both on-board of the train and in the key distribution centre at the trackside (ground system).

Key Management communication is considered to be user-to-user data communication.

The communication of keys may be requested each time that an ATP or ATO communication session is established or at any other time, depending on the specific configuration of the Key Management application.

#### 9.17.2.2 Pre-conditions

The initiating application on the FRMCS equipment is authorised to initiate the Key Management data communication. This is managed by the authorisation of communication application.

The receiving application on the FRMCS equipment is authorised to use the Key Management data communication. This is managed by the authorisation of communication application.

#### 9.17.2.3 Service flows

The initiating application on the FRMCS equipment (e.g. on-board of the train or the key distribution centre at the track side) initiates the Key Management data communication to the receiving side on the FRMCS equipment (e.g. key distribution centre at the trackside or on-board of the train). The QoS profile of the communication is managed by the QoS Profile application. The data communication requests the QoS profile which matches the application category of CRITICAL DATA (see [QoS]) within the FRMCS system, depending on the application needs.

The FRMCS system establishes the bearer service required for the data communication within a setup time specified as IMMEDIATE (see [QoS]).

The arbitration is managed by the arbitration application on the FRMCS equipment.

The communication is recorded by the Data recording and access to recorded data application.

#### 9.17.2.4 Post-conditions

The initiating application on the FRMCS equipment is connected to the receiving application.

Data can be exchanged between the Key Management applications.

### 9.17.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.17.2.5-001]	For Key management communication, the communication shall be considered to be user-to-user data communication.	A	TS 22.282	TS 22.282 Sub-clause: 5.5  Note: Application Layer Key Management is transparent to the transport and communications services. Reference transport.
[R-9.17.2.5-002]	For Key management communication, the initiating and the receiving application on the FRMCS equipment shall be able to be authorised to initiate the Key management communication. This shall be managed by the authorisation of data communication application.	A	TS 22.280	TS 22.280 Sub-clause: 5.5, and 5.12.  Note: Application Layer Key Management is transparent to the transport and communications services.
[R-9.17.2.5.2-003]	For Key management communication, the initiating application on the FRMCS equipment (e.g. on-board of the train or the key distribution centre at the track side) shall be able to initiate the Key Management data communication to the receiving side on the FRMCS equipment (e.g. key distribution centre at the trackside or on-board of the train). The QoS profile of the communication shall be managed by the QoS Profile application. The data communication shall be able to request the QoS profile which matches the application category of CRITICAL DATA (see [QoS]) within the FRMCS system, depending on the application needs.	A	N/A	See sub-clause 12.10.
[R-9.17.2.5-004]	For Key management communication, the FRMCS system shall be able to establish the bearer service required for the data communication within a setup time specified as IMMEDIATE (see [QoS]).	A	N/A	See sub-clause 12.10.
[R-9.17.2.5-005]	For Key management communication, the arbitration shall be managed by the arbitration application on the FRMCS equipment.	A	TS 22.280	TS 22.280 Sub-clause: 6.4.7

[R-9.17.2.5-006]	For Key management communication, the communication shall be recorded by the recording and access to recorded data application.	A	TS 22.280	TS 22.280 sub-clause 6.15.4
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## 9.17.3 Use case: Termination of a Key Management data communication

### 9.17.3.1 Description

The initiating or the receiving application can terminate de Key Management data communication.

### 9.17.3.2 Pre-conditions

The Key Management applications on-board and trackside have a data communication initiated.

### 9.17.3.3 Service flows

The terminating application on the FRMCS equipment (e.g. on-board of the train or the key distribution centre at the track side) terminates the Key Management data communication with the receiving side application on the FRMCS equipment (e.g. key distribution centre at the trackside or on-board of the train).

The FRMCS system terminates the bearer service required for the data communication.

### 9.17.3.4 Post-conditions

The terminating Key Management data application is disconnected from the receiving application.

### 9.17.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-9.17.3.5-001]	For Key management communication, the terminating application on the FRMCS equipment (e.g. on-board of the train or the key distribution centre at the track side) shall be able to terminate the Key Management data communication with the receiving side application on the FRMCS equipment (e.g. key distribution centre at the trackside or on-board of the train).	A	TS 22.280	TS 22.280 Sub-clause: 5.5, and 5.12.  Note: Application Layer Key Management is transparent to the transport and communications services.
[R-9.17.3.5-002]	For Key management communication, the FRMCS system shall be able to terminate the bearer service required for the data communication.	A	TS 22.282	TS 22.282 Sub-clause: 5.5  Note: Application Layer Key Management is transparent to the transport and communications services. Reference transport.

## 9.17.4 Use case: service interworking and service continuation with GSM-R

### 9.17.4.1 Description

For migration purposes the service interworking and service continuation between the GSM-R system and FRMCS system for Key Management data communication needs to be clear.

Depending on the migration scenario a key distribution centre can be attached to the FRMCS system, to the GSM-R system or both. The on-board Key Management application can be attached either in the GSM-R system or in the FRMCS system. Functional identities are applicable in one system only.

This use case only applies to end user devices supporting both FRMCS and GSM-R systems.

Online Key Management data exchange is supported only with a packet switched (PS) bearer in the GSM-R system. Therefore, for service interworking and service continuation only the PS bearer is required.

### 9.17.4.2 Pre-conditions

The initiating application on the FRMCS equipment is authorised to initiate the Key Management data communication. This is managed by the authorisation of communication application.

The receiving application on the FRMCS equipment is authorised to use the Key Management data communication. This is managed by the authorisation of communication application.

### 9.17.4.3 Service flows

#### **Initiating Key Management application attached to GSM-R**

When the initiating Key Management application on the FRMCS equipment is attached to the GSM-R system and is initiating data communication to another Key Management application, the GSM-R system will route the data communication accordingly.

If the other Key Management application on the FRMCS equipment is attached to the FRMCS system, the GSM-R system can only route the data communication if the destination can be reached by an address or identity understood by

the GSM-R system. The role management in FRMCS provides the appropriate address or identity e.g. by providing a mapping of GSM-R identities and FRMCS identities.

The information from the role management and presence application is used to route the communication and to present the identities.

#### **Initiating Key Management application attached to FRMCS**

When the initiating Key Management application on the FRMCS equipment is attached to the FRMCS system and is initiating data communication to another Key Management application, the FRMCS system will route the communication accordingly.

If the other Key Management application on the FRMCS equipment is attached to the GSM-R system, the FRMCS system can only route the data communication if the destination can be reached by an address or identity understood by the FRMCS system. The role management in FRMCS provides the appropriate address or identity e.g. by providing a mapping of GSM-R identities and FRMCS identities.

The information from the role management and presence application is used to route the communication and to present the identities.

#### **Key Management application moving from GSM-R to FRMCS**

When the Key Management application on the FRMCS equipment is detached from the GSM-R system the FRMCS end user device shall provide service continuation by setting up the communication via the FRMCS system. An interruption of data communication is acceptable.

#### **Key Management application moving from FRMCS to GSM-R**

When the Key Management application on the FRMCS equipment is detached from the FRMCS system, the FRMCS end user device shall provide service continuation by setting up the communication via the GSM-R system. An interruption of data communication is acceptable.

#### 9.17.4.4 Post-conditions

None.

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## 10 Performance support applications related use cases

*Editor's Note: Text to be provided.*

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## 11 Business support applications related use cases

### 11.1 Charging and Billing information related use cases

#### 11.1.1 Introduction

In this chapter the use cases related to charging and billing are defined. The following use cases are defined:

- Obtaining charging and billing information



## 11.1.2 Use case: Obtaining charging and billing information

### 11.1.2.1 Description

The Railway operators may have the obligation or the desire to charge FRMCS Users of their FRMCS Networks, or to use billing information for statistical reasons.

An entitled FRMCS User shall be able to obtain information for any type of FRMCS communications from the FRMCS system, to be able to generate bills.

### 11.1.2.2 Pre-conditions

An entitled FRMCS User is logged on to the FRMCS system.

### 11.1.2.3 Service flows

The entitled FRMCS User requests billing information for a single FRMCS User or a group of FRMCS Users.

The entitled FRMCS User selects defined criterias (e.g. timeframe, incoming communications, outgoing communications, numbers and/or any kind of FRMCS Identity) to get more detailed results.

The entitled FRMCS User configures the FRMCS system to generate the billing information once or periodically.

### 11.1.2.4 Post-conditions

The requested billing information is generated from the FRMCS System.

### 11.1.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-11.1.2-001]	The FRMS System shall be able to generate charging records for one or multiple FRMCS Users based on defined criterias (e.g. timeframe, incoming communications, outgoing communications, numbers and/or any kind of FRMCS Identity).	A/T	Partly covered (only CDR covered by 3GPP – billing system outside the 3GPP domain).	6.15.4
[R-11.1.2-002]	The FRMCS System shall allow to charge separately for each type of FRMCS Application and/or each type of application category.	A/T	TS 22.261 section 9.2	Support collection of charging information based on resource usage (e.g. QoS, applications).
[R-11.1.2-003]	The FRMCS System shall allow to charge for different Service Attributes.	A/T	TS 22.261 section 9.2	Support collection of charging information based on resource usage (e.g. QoS, applications).

## 12 FRMCS System principles related use cases

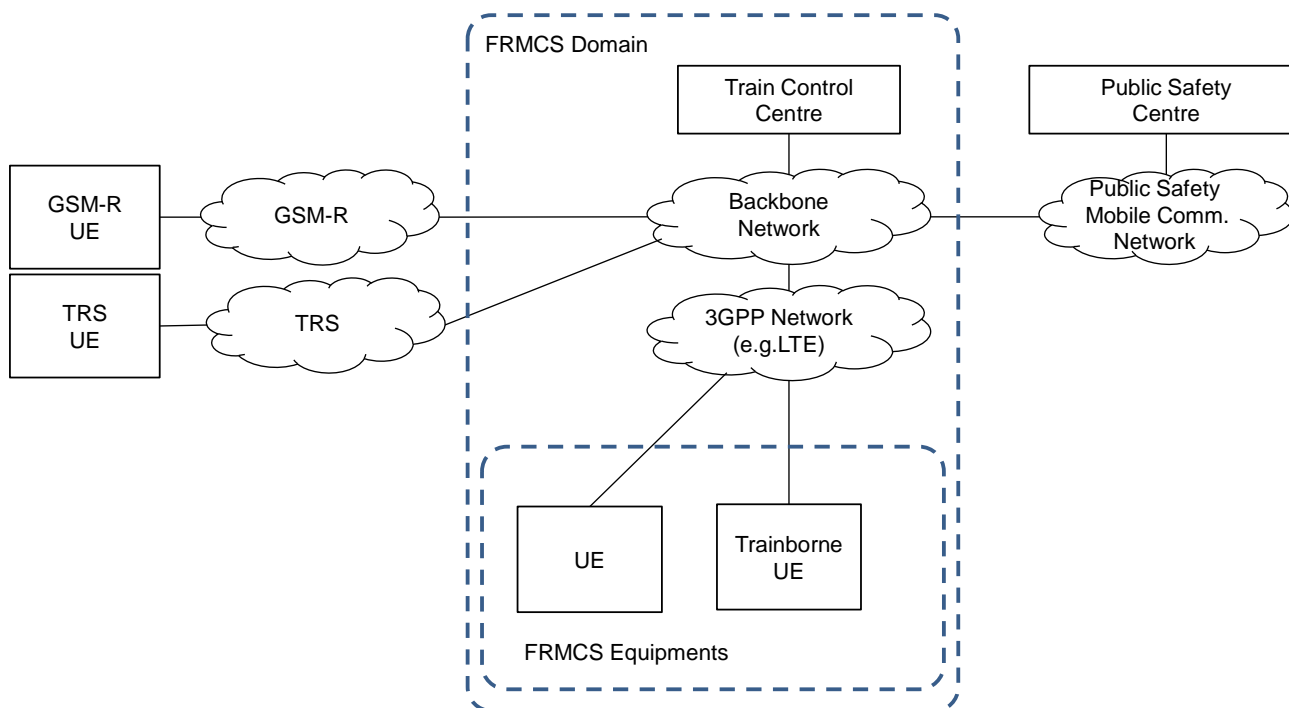
### 12.1 FRMCS System principles overview

In this chapter, FRMCS System related use cases are described which are complying with principles such as:

- Provide broadband and/or mission critical services with seamless connectivity

- Offer high-quality control functions and real-time performance monitoring
- Interworking with legacy systems including GSM-R and LMR
- Build stable positioning framework for FRMCS services and devices including trainborne (in-train) and handheld (in-train, and in/out-door) UEs
- Bearer flexibility
- QoS in a railway environment
- FRMCS System security framework

To describe the use cases, an example system is assumed by adapting LTE for railway communication [4] as follows:



**Figure 12.1-1. An example system for FRMCS System principle use cases**

The example system is consisted of the train control centre, 3GPP network such as LTE with UE and the trainborne UE. The backbone network connects the train control centre, 3GPP network and legacy systems. FRMCS System is interworking with the legacy systems such as GSM-R and TRS.

## 12.2 Area Broadcast Group Communication interworking between GSM-R and FRMCS Users

### 12.2.1 Description

This use case describes an area broadcast group communication between FRMCS User(s) and GSM-R User(s), and vice versa.

### 12.2.2 Pre-condition

FRMCS User A and GSM-R User B and User C are authorized Users to perform group communication together by the FRMCS System.

User A and User B and User C are in the same group communication area defined by the FRMCS System.

### 12.2.3 Service flow

#### FRMCS System to GSM-R

FRMCS User A initiates a new area broadcast group communication (based on location etc., of GSM-R User B and C).

FRMCS User A broadcasts group communication invitations to all Users in the same area.

GSM-R User B and User C receive the group communication invitations.

GSM-R User B and User C accept the invitation and join the group communication. Or GSM-R User B and User C automatically join this group communication.

#### GSM-R to FRMCS

GSM-R User B initiates a new group call (based on location etc., of FRMCS User A and GSM-R User C).

GSM-R User B broadcasts group call invitations to all Users in the same area.

FRMCS User A and GSM-R User C receive the group call invitations.

FRMCS User A and GSM-R User C accept the invitation and join the group call. Or FRMCS User A and GSM-R User C automatically join this group call.

### 12.2.4 Post-condition

FRMCS User A, GSM-R User B and User C can communicate among each other in a group call.

### 12.2.5 Potential requirements

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[12.2-001]	FRMCS System shall provide a means to initiate group communication between FRMCS Users and GSM-R Users.	A	22.179	R-6.18.3.5-003
[12.2-002]	FRMCS System shall provide means to FRMCS Users to join the group calls of GSM-R	A	22.179	R-6.18.3.5-003

## 12.3 Location Service interworking between GSM-R and FRMCS Users

### 12.3.1 Description

This use case allows FRMCS System and GSM-R system to obtain and share the location information of their users.

### 12.3.2 Pre-condition

User A is an authorized FRMCS User.

User B is an authorized GSM-R User.

User A and User B are affiliated to a group that consists of FRMCS User(s) and GSM-R User(s).

### 12.3.3 Service flow

#### *FRMCS System to GSM-R*

FRMCS User A sends a location request to the specific GSM-R User B.

GSM-R User B accepts and return his location information as requested.

#### *GSM-R to FRMCS System*

GSM-R User B sends a location request to the specific FRMCS User A.

FRMCS User A accepts and returns his location information as requested.

### 12.3.4 Post-condition

FRMCS User A's location information is sent to GSM-R User B.

GSM-R User B's location information is sent to FRMCS User A.

### 12.3.5 Potential requirements

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[12.3-001]	FRMCS System shall provide a means to obtain and share with FRMCS User the location information of GSM-R User(s).	A	22.280	R-6.17.3.1-001
[12.3-002]	FRMCS System shall provide means to provide location information of FRMCS User to GSM-R.	A	22.280	R-6.17.3.1-001

## 12.4 Presence interworking between GSM-R and FRMCS Users

### 12.4.1 Description

Service interworking of user's presence between GSM-R and FRMCS Systems is not required.

### 12.4.2 Pre-condition

Void.

### 12.4.3 Service flow

Void.

### 12.4.4 Post-condition

Void.

### 12.4.5 Potential requirements

Void.

## 12.5 Point to Point communication between GSM-R and FRMCS Users

### 12.5.1 Description

This use case allows a FRMCS User to communicate with a GSM-R User, vice versa.

### 12.5.2 Pre-condition

User A is an authorized FRMCS User.

User B is an authorized GSM-R Users.

### 12.5.3 Service flow

#### FRMCS System to GSM-R

FRMCS User A initiates a point to point communication to GSM-R User B.

GSM-R User B accepts the communication and joins the communication.

#### GSM-R to FRMCS System

GSM-R User B initiates a point to point call to FRMCS User A.

FRMCS User A accepts the call and joins the call.

### 12.5.4 Post-condition

GSM-R User B and FRMCS User A are communicating with each other.

### 12.5.5 Potential requirements

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[12.5-001]	FRMCS System shall provide a means for point to point communication between an authorized FRMCS User and a GSM-R User,	A	22.179	R-6.18.3.5-004

FRMCS System

## 12.6 Interworking with legacy systems including LMR

### 12.6.1 Description

This use case describes the way of interworking with legacy systems including LMR.

### 12.6.2 Pre-conditions

The train driver uses the trainborne UE.

Train crews have a LMR UE for each.

The operator at the train control centre has a 3GPP UE.

The train control centre is connected to the public safety centre via 3GPP network.

### 12.6.3 Service flows

The train driver calls the train control centre to report an emergency of the train and wants to share the report with train crews in the train.

The FRMCS System initiates a 3GPP call to the operator at train control centre.

The FRMCS System initiates a LMR call to all of train crews.

The train driver reports the situation. The FRMCS System transmits the report to the train control centre via 3GPP network and to train crews in the train via LMR.

The train control centre received the report and forward the call via 3GPP network to report the situation to the public safety centre.

The train control centre activates the switching device on the railway track to pass other trains via the signal control network.

The train control centre orders the train crews to do a counter-action on the situation.

Train crews are shared with the report and order, and deal with the situation properly.

### 12.6.4 Post-conditions

The situation has been handled.

The train control centre has the information on the situation, the counter-action and its result.

The public safety centre gets the report on the situation in real-time.

### 12.6.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[12.6-001]	The FRMCS System shall provide interworking related functionality between the 3GPP network and the legacy network of LMR, e.g. TETRA and P25.	A/T	22.179	The requirement is covered by 6.18.3 Interworking with non-3GPP PTT systems of 22.179
[12.6-002]	The FRMCS System should provide interworking with the signal control network.	A	22.280	This requirement is covered by the combination of functional alias, affiliation mechanism, and IP connectivity.

## 12.7 Use case: Builds stable positioning framework for FRMCS services and devices including trainborne and handheld devices

### 12.7.1 Description

This use case considers stable positioning framework for FRMCS services and devices are placed in indoor and/or outdoor. The use case focuses covering "GPS shadow area" with ad-hoc positioning technology such as LTE location service.

## 12.7.2 Pre-conditions

The trainborne UE has GNSS function.

The trainborne UE has 3GPP Communication Module.

The train control centre monitors the train traffics.

## 12.7.3 Service flows

The operator at the train control centre requests location information from a train.

The train is running through a very long tunnel, therefore the GNSS in the trainborne UE does not work.

The operator at the train control centre connects the location service in the 3GPP system as an alternative way and obtains the train's location which is actually the location of the trainborne UE.

The operator at the train control centre determines the train path and controls railway tracks by signalling the track circuit device.

## 12.7.4 Post-conditions

The train control centre obtains the location of the train.

The track circuit for the train is reorganized.

## 12.7.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[12.7-001]	The FRMCS System shall provide the alternative means than GNSS to obtain the position of the FRMCS Equipment.	A	TS 22.280	The interfacing method and format of the location information from the LTE system is covered by 3GPP specification such as UE positioning in E-UTRAN[5]. Covered by [R-5.11-002a] of TS 22.280 which is "The MCX Service shall be able to provide a mechanism for obtaining high accuracy Location information by integrating position information from multiple external sources (e.g. magnetometers, orientation sensors, GNSS)".
[12.7-002]	The positioning information shall provide an accuracy of [TBD] whilst the UE is travelling at a maximum of 500 km/h.	A/T	TS 22.261	TS 22.261 sub-clause 6.27.2 TS 22.261 sub-clause 7.3.2 – refer to positioning service level 3 (only one speed limit supported – up to 500 km/h – with horizontal accuracy of 1m) See [R-12.14.2-001] of clause 12.14.2.5.

## 12.8 Interworking between GSM-R and FRMCS

### 12.8.1 Introduction

GSM-R is the widely used wireless communication system of the railways. It provides the bearer service for current critical and supportive railway applications. The deployment of FRMCS and the migration to FRMCS is expected to

encompass a large timeframe estimated currently at 10 years. During this period, coexistence and interworking of both communication systems is required. Interworking between the FRMCS System and GSM-R system shall be provided.

Interworking on functional level e.g. numbering plan alignment is not part of this use case.

Note 1: Interworking is the functionality of two networks to talk to each other enabling services to be delivered across the two networks (source: GSMA Document IR.65 "IMS Roaming, Interconnection and Interworking Guidelines").

Note 2: 3GPP MCX specifications have different understandings of Interworking and Interconnection than GSMA and the Railways.

## 12.8.2 Circuit Switched interworking between GSM-R and FRMCS

### 12.8.2.1 Description

#### **Background:**

Circuit switched bearer services are used in GSM-R for voice and data communication. That encompasses user-to-user as well as multiuser voice communication.

#### **Description:**

FRMCS and the GSM-R will coexist for a period estimated currently at 10 years that demands interworking for circuit switched bearer services to cover voice. It requires the necessary circuit switched transport adaptation, the necessary conversion of the signalling and the user data coding among the systems.

### 12.8.2.2 Pre-conditions

GSM-R user is attached to the GSM-R system.

FRMCS Users is attached to the FRMCS System.

### 12.8.2.3 Service flows

GSM-R user establishes a user-to-user voice communication to a FRMCS User.

GSM-R user establishes a multiuser communication including FRMCS Users.

FRMCS User establishes a user-to-user voice communication to a GSM-R user.

FRMCS User establishes a multiuser voice communication including GSM-R users.

### 12.8.2.4 Post-conditions

User-to-user voice communication between GSM-R user and FRMCS User are established.

Multiuser voice communication between GSM-R user and FRMCS Users are established.



### 12.8.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.8.2-001]	FRMCS-system to GSM-R circuit switched signalling and bearer service interworking shall be supported for user-to-user and multiuser voice communication.	A/T	22.179	[R-6.18.4.2-003], [R-6.18.4.2-004]
[R-12.8.2-002]	FRMCS System shall support the current voice codecs used by GSM-R.	A/T	22.179	[R-6.18.4.2-005]
[R-12.8.2-003]	The FRMCS System shall be able to support interworking of GSM-R MLPP based call priorities to the priority mechanisms of the FRMCS System.	A	22.179	[R-6.18.4.2-003]
[R-12.8.2-004]	The FRMCS System shall be able to support interworking between the arbitration scheme used in GSM-R and the arbitration scheme used in the FRMCS System.	A	22.179	[R-6.18.4.2-003]]

## 12.8.3 Packet Switched interworking between GSM-R and FRMCS

### 12.8.3.1 Description

Packet switched bearer services i.e. GPRS/EGPRS are used in GSM-R for data communication e.g. ATP. FRMCS and the GSM-R will coexist for a period estimated currently at 10 years that demands an interconnection for packet switched based communication. It requires the necessary packet switched transport adaptation to FRMCS, the conversion of the signalling and the user data coding among the systems.

### 12.8.3.2 Pre-conditions

GSM-R user is attached to the GSM-R system.

FRMCS Users are attached to the FRMCS System.

### 12.8.3.3 Service flows

GSM-R user establishes a user-to-user packet switched communication to a FRMCS User.

FRMCS User establishes a user-to-user packet switched communication to a GSM-R user.

### 12.8.3.4 Post-conditions

Packet Switched communication among GSM-R user and FRMCS User are established.

### 12.8.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.8.3-001]	FRMCS-system to GSM-R packet switched interworking shall be supported.	A/T	N/A	According to latest decision from UIC (see FRMCS project activities status report in ERIG#70 (July 2018), the requirement is not required. No use case has been identified by UIC ((E )GPRS EVC could not be connected to any FRMCS RBC).

## 12.8.4 SMS/SDS interworking between GSM-R and FRMCS

### 12.8.4.1 Description

SMS has been widely used in GSM-R.

FRMCS and GSM-R will coexist for some period. So, interworking between the FRMCS System and Short Message Service in GSM-R is needed.

A possible scenario is that a GSM-R user sends a short message to a FRMCS User to transfer some information.

### 12.8.4.2 Pre-conditions

GSM-R user is attached to the GSM-R system.

FRMCS User is attached to the FRMCS system.

### 12.8.4.3 Service Flows

A GSM-R user sends a short message to a FRMCS User to transfer some information.

### 12.8.4.4 Post-conditions

The FRMCS User can communicate with the GSM-R user.

### 12.8.4.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.8.4-001]	The FRMCS System shall be able to interwork with the Short Message Service in GSM-R.	A	22.282	[R-7.2-001]

## 12.9 Use case: Bearer flexibility

### 12.9.1 Description

FRMCS envisages bearer flexibility to allow a certain level of independence between Railway Applications and the underlying transport system. FRMCS includes wireless and wireline access. It comprises multiple access systems and shall support various voice and data applications.

The rationale behind these requirements is that the lifecycle of railway applications is in general much longer than the lifecycle of telecommunication access/transport systems. Moreover, bearer flexibility aims at improving service availability and performance.

The characteristics of bearer flexibility are:

1. A Railway Application may use one or several access systems as appropriate.
2. Connection of FRMCS Equipment to different access systems is dynamic (i.e. the most appropriate 3GPP or non-3GPP access technologies are selected automatically, potentially using multiple access technologies for one or more Railway Applications).
3. The set of access systems chosen meets the defined QoS and the service requirements e.g. FRMCS User mobility and connectivity which are necessary to guarantee the functionality.
4. The introduction of a new access system should not negatively impact existing Railway Applications.

The approach taken within FRMCS allows the integration of 3GPP and non-3GPP radio access evolution.

IP is used as a generic interface towards Railway Applications, facilitating connectivity, quality of service control, security and the separation of transport system and applications. NOTE: Non-3GPP access can consist of non-terrestrial e.g. Satellite as well as of terrestrial access systems.

## 12.9.2 Pre-conditions

The Railway Adaptation Sub-System as part of the FRMCS System is embedded between the Railway Applications and the Multi Access Core Network (MACN) and enables the access system independence towards those applications. This Sub-System adapts application characteristics to the access systems. It manages e.g. QoS, address conversion, functional roles and train location information.

The MACN has the ability to manage and interwork with wireless access systems (i.e. 3GPP and non-3GPP) as well as with wireline access systems. It encompasses for example the management of FRMCS User mobility, FRMCS User session/communication handling and control of end-to-end communication prioritisation. The MACN interworks with legacy communication systems and other FRMCS Systems.

The Access Control & Management function of the FRMCS Equipment is able to manage the different access systems as well as access via GSM-R (for roaming and simultaneous operation).

## 12.9.3 Service flows

### Case 1 (data communication)

As an example the Automatic Train Protection (ATP) application of a train establishes a data communication session with the applicable ground communication entity which is connected via the fixed network service. For ATP message exchange, the on-board system can encompass a railway operated private 3GPP 4G access system and a public 3GPP 5G access system (e.g. a VPN service) as part of the FRMCS System. ATP periodically reports train position information and receives Control Command instructions from the ground communication entity. The FRMCS Equipment is registered to both access systems and uses these simultaneously if applicable. Simultaneous use of radio access systems may improve communication resilience, availability, and QoS and increases bandwidth.

The concept as described here can generally be extended to other data communication applications and (non-)3GPP access systems.

### Case 2 (railway emergency voice communication)

The on-board FRMCS Users are registered to the FRMCS System. An on-board FRMCS User establishes a Railway Emergency Communication (REC) from a specific location in the FRMCS network. This particular communication request takes into account the most appropriate radio access system, for example the railway-operated private 3GPP network. The FRMCS System notifies the applicable users determined by the location of the initiator of the communication by using all available access system(s) e.g. 3GPP (public and private), WLAN or wireline. The applicable Controller is notified via the wireline access system. The intended recipients of the call may be using different access systems.

The concept as described here can in general be extended to other voice group communication applications and point to point communication services.

#### **Case 3 (telemetry operation at a railway depot)**

A train is located in a railway depot where only WLAN coverage (non-3GPP access) as part of the FRMCS System is provided. FRMCS Users of this train are attached to the FRMCS System. An FRMCS User starts a data session towards the applicable vehicle diagnostic entity. At that point in time WLAN provides the radio access system for this telemetry communication. Once the train leaves the depot and enters into a 3GPP coverage area, the FRMCS Equipment adapts the transmission of the telemetry data session to the most QoS effective radio access system (3GPP access). The telemetry session continues uninterrupted when the train changes its location.

The concept as described here can in general be extended to other voice and data applications where other combinations of access systems at specific locations are possible.

#### **Case 4 (Backup operation/resilience)**

In a certain area with dedicated 3GPP access, coverage fails. Despite unavailability of the dedicated railway 3GPP access, FRMCS Users have the capability to continue communications by using public 3GPP access using an access system which may support the required or some degraded form of QoS and which is provided in the area and which serves as a backup or complementary system. Communication applications on trains continue to operate, service continuity is preserved. When the functionality of the dedicated 3GPP access system is restored, the FRMCS Equipment resumes operation on that system.

The concept as described here can generally be extended to any combination of access systems, e.g. WLAN and private 3GPP access.

#### **Case 5 (Notification of radio bearer availability)**

In general, there is only little radio spectrum resources allocated to railways in most regions. These should be preferably used for operational rail communication purposes. In parallel, there are communications that require broadband wireless communication services. The availability of broadband wireless access can be limited e.g. to railway stations. Thus, the FRMCS System is able to take into account radio bearer availability at the FRMCS User's position allowing to start communication such as a file download/upload not harming operational rail communication.

#### **Case 6 (Use of Satellite Communication)**

In some regions, trains are circulating in rural areas, on low traffic lines. For such situation, deploying dedicated rail terrestrial radio access is not economically viable and public mobile operator's service is very limited due to low population density rate. Satellite access is foreseen as an alternative to terrestrial radio access that reduces investment in access infrastructure. In this first approach, satellite access is considered as an enabler to extend communication service of rail lines with FRMCS.

Some rail applications require service continuity for railways operation. In some situation, rail traffic is stopped when communication services are not available. To overcome situations of temporary outage or total destruction of terrestrial access, use of non-terrestrial access systems by the FRMCS system could be envisaged to deliver a highly resilient transport service. In this second approach, satellite access is foreseen as a backup from terrestrial radio access.

It is envisaged that the FRMCS application could be configured with preconditions that trigger an alternate mode of operation.

## 12.9.4 Post-conditions

#### **Case 1 (data communication)**

The train protected by ATP arrives on time without service interruptions of the communication.

#### **Case 2 (railway emergency voice communication)**

Railway emergency voice communication is established to all FRMCS Users in the designated area independent of the used access network.

#### **Case 3 (telemetry operation at a railway depot)**

Telemetry communication continued while relocating the train/vehicle.

#### **Case 4 (Backup operation/resilience)**

Communication continued when the private 3GPP access is unavailable in an area.

**Case 5 (Notification of radio bearer availability)**

none

**Case 6 (Use of Satellite Communication)**

Communication continued when the 3GPP terrestrial radio access coverage is physically not provided in an area.

Communication continued when the 3GPP terrestrial radio access is temporarily not available in an area.

## 12.9.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.9-001]	The FRMCS System shall be able to manage 3GPP access systems and non-3GPP access systems (terrestrial and non-terrestrial) simultaneously.	A/T	TS 22.278 TS 22.261	TS 22.278 sub-clause 5.0 TS 22.261 sub-clause 6.3.2.1
[R-12.9-002]	If provided by the FRMCS Equipment, the FRMCS Application on the FRMCS Equipment shall be able to make use of 3GPP and non-3GPP access systems simultaneously.	A	TS 22.278 TS 22.261	TS 22.278 sub-clause 6.2 TS 22.261 sub-clause 6.3.2.1
[R-12.9-003]	The FRMCS User shall not experience service interruptions in the usage of applications due to a change of an access system.	A	TS 22.278 TS 22.261	TS 22.278 sub-clause 5.0 TS 22.261 sub-clause 6.2.3 broader functional spectrum
[R-12.9-004]	The FRMCS transport system including 3GPP and non-3GPP access shall be agnostic to Railway Applications.	T	TS 22.278 TS 22.261	TS 22.278 sub-clause 5.0 TS 22.261 sub-clause 6.2.1/6.2.3 broader functional spectrum
[R-12.9-005]	New access technology shall not require changes for the pre-existing application layer to be able to make use of this new access technology. Note: Changes are required if the application layer wants to make use of the new capabilities of a new access technology.	A/T	TS 22.261	TS 22.278 only partially compliant because of missing satellite access support
[R-12.9-006]	The transport layer shall allow using IP as a generic interface.	T	TS 22.278 TS 22.261	TS 22.278 sub-clause 7.2 TS 22.261 sub-clause 5.1.2.3
[R-12.9-007]	For recording purposes, the FRMCS System shall be able to provide communication content as well as the associated communication related information.	A	TS 22.280 TS 22.278 TS 22.261	TS 22.280 sub-clause 6.15.4 TS 22.278 sub-clause 9.2 TS 22.261 sub-clause 8.6

[R-12.9-008]	The FRMCS System shall be able to make use of one or more of the followings: 3GPP radio access (i.e. 4G and/or 5G) through railway-dedicated licensed spectrum 3GPP radio access (i.e. 4G and/or 5G) provided by public providers 3GPP radio access (e.g. LTE-U) through unlicensed spectrum Non-3GPP radio access (e.g. IEEE 802.11 based and/or satellite based) Wireline access Note 1: GSM-R, TETRA, and P25 are not considered as a radio access technology of FRMCS. Note 2: Not all of the radio access technologies may support all of the FRMCS requirements.	T	TS 22.261	TS 22.278 reduced capabilities; partially encompasses only 4G access
[R-12.9-009]	The FRMCS System shall consider the availability of radio bearer services at the position of the FRMCS User to allow communication.	A	TS 22.261	6.3.2.1: The 5GS shall be able to dynamically offload part of the traffic (e.g. from 3GPP RAT to non-3GPP access technology), taking into account traffic load and traffic type.
[R-12.9-010]	The FRMCS System shall select appropriate radio bearer service with consideration of the FRMCS applications configurable preconditions (e.g. ranking of the available bearer services).	T	TS 22.261	TS 22.261 sub-clause 6.3.2.1  TS 22.278 reduced capabilities; partially encompasses only 4G access TS 22.278 sub-clause 7.1.6
[R-12.9-011]	The FRMCS System shall provide indication to FRMCS application on which bearer service is being used.	T	N/A	Implementation requirement
[R-12.9-012]	Session continuity between 3GPP access and non-3GPP access shall not require FRMCS Users intervention.	T	TS 22.261	6.2.3: service continuity 6.3.2.1: The 5GS shall be able to support mobility between the supported access networks

## 12.10 Use Case: QoS in a railway environment

### 12.10.1 Introduction

This system principle use case provides the framework for Quality of Service within the FRMCS System including the railway applications. The main purpose is to specify the list of attributes applicable to the FRMCS bearer service.

Railway applications exhibit different characteristics, e.g., in terms of latency or reliability. On the other hand, the FRMCS System offers bearer services with different properties.

In this context, two types of applications can be distinguished:

1. Applications that are aware of their transport service requirements and that are able to request those from the FRMCS System.



2. Applications that are not aware of their transport service requirements and that are therefore not able to request those.

Railway applications require a QoS classification ranging from high to low as low is “best effort”. The most important QoS parameters that determine the quality of the transport system are latency of the user data and reliability of the communication. In addition, guaranteed bandwidth assures the continuation of critical communication.

QoS impacts train punctuality and the entire utilisation of the track system. Therefore, the FRMCS System has to consider the various QoS requirements.

Apart from high train speed operation, which goes up to 500kmh<sup>-1</sup>, other fundamental factors affect wireless communication. Railways are facing various radio signal propagation conditions such as in free space and in tunnels. Free space encompasses various structural and constructional scenarios. Railway corridors in hilly terrain or forest aisle are some examples.

Radio propagation in large railway stations and shunting yards is different from the one of the main lines. Moving trains in stations or moving cargo wagons in shunting yards cause different propagation conditions.

Radio tower site-to-site distance requires special attention. This distance varies depending on the type of area (rural or urban) and is determined by the boundary conditions of the RF signal (e.g. frequency band and power budget). Railways clearly require to deploy FRMCS while keeping the same distance between the radio towers in order to reuse the infrastructure deployed for GSM-R.

Voice communication is commonly used during rail operation to give instructions to a driver of a locomotive in shunting operation, track maintenance etc. Rail environmental conditions like slowdown or movement of a train can impact the understandability of the voice.

Radio propagation conditions in a rail environment are quite specific. For example train speed up to 500km/h or the insertion loss of the radio signal into a train. Staff has to work in the train, beside a train or under the train etc. while voice communication is ongoing. Such conditions shall not lower the intelligibility of the voice.

Radio spectrum constraints in some regions require high efficiency in terms of radio bandwidth utilisation where voice communication coexists with other communication types simultaneously. The resulting voice codec has to consider these specific conditions.

## 12.10.2 Use case: Quality of Service and railway environment

### 12.10.2.1 Description

The basis for this use case is the UIC FRMCS URS wherein communication attributes define the QoS to be achieved for the various kinds of railway applications. These attributes are not part of the functional use case description but relevant for the FRMCS System and therefore subject of this use case.

Regarding the URS communication attributes, not all attributes are covered in the QoS use case. The following items are considered:

- Type of communication
- Latency, the delay between action and reaction
- Session Reliability
- Setup of communication, the time to establish a voice or data communication session
- Talker assignment time in group communication
- Audio (Voice) Quality

For further details, refer to the corresponding use cases in chapters 5 – 9. In these chapters the QoS requirements are specified on functional level. A reference is used which refers to real values’ in this QoS use case.

### 12.10.2.2 Pre-conditions

The pre-conditions of the functional use cases out of chapter 5 – 9 are applicable.

### 12.10.2.3 Service flows

The service flows of the functional use cases out chapter 5 – 9 are applicable.

#### Application categories

Application categories describe the data transfer characteristic to be achieved by a bearer service. The FRMCS System shall consider the following user plane application categories:

**Voice** for user to user or multiuser communication; Voice follows the typical conversational pattern and requires low delay inside the transport system;

**Critical Voice** follows the voice conversational pattern but requires immediate session setup;

**Video** used for general observations purposes, e.g. maintenance;

**Critical Video** with indirect impact on train operation, e.g. passenger surveillance;

**Very Critical Video** with direct impact on safety- related critical train control and operation, e.g. used in driverless ( e.g. GoA3/GoA4) operation for automated detection of objects (no human in the loop) or video-based remote control (human in the loop).

**Very critical data** for future rail applications;

**Critical data** follows the response pattern and requires high reliable transport. This category comprises future and legacy applications e.g. ETCS;

**Non-Critical data** used for the exchange of railway system or communication relevant information; requires high reliable transmission and preservation of the response pattern;

**Messaging** for the exchange of non-critical short information messages, recorded voice (for example voicemail), data, pictures, video; requires reliable transmission;

#### Priority Level

In order to reach the QoS applicable for each application category, transport priority levels are required to differentiate among the communication urgency. Priority handling of communication service encompasses the assignment of a priority to a communication and involves the seizing of resources, which are in use by a communication having a lower ranking in the absence of idle resources. Priority handling includes as well discontinuation of an ongoing communication having a lower priority to allow an incoming communication of higher priority. Priority handling needs to be provided to a FRMCS User for all communications.

Priorities are treated by the FRMCS User/Equipment in the FRMCS System based on the following conditions:

- The priority level depends on the FRMCS User initiating the communication.
- The communication can have the priority level selected by the FRMCS User at setup or the priority level is predefined at registration. The treatment of priority level also applies when the FRMCS User is registered to a visited FRMCS network.
- The definition of the priority level which may cause pre-emption of another ongoing communication needs to be stored and can be changed by the FRMCS User.
- The FRMCS System is able to allocate setup classes i.e. communication setup time requirements and resource pre-emption capabilities to each priority level.
- In case of resource pre-emption, the pre-empted FRMCS user needs to be provided with a suitable indication.
- The priority level can be selected by the FRMCS User on a per communication basis.

The FRMCS User may select any priority level up to the authorised priority level. The maximum priority level needs to be stored on the UICC. At communication setup, the FRMCS Equipment and the FRMCS System verify the priority level at setup against the maximum authorised priority level. If the FRMCS User has not selected a priority level at setup, the FRMCS System applies a FRMCS User specific default priority level. If the FRMCS User has selected at setup a priority level higher than the maximum authorised priority level, the maximum authorised priority level is applied for the communication.

## Service Attributes

From FRMCS User point of view there are two main service attributes latency and communication reliability.

For the **Latency** two classifications are applicable:

**Low** User data delay harms the functioning of the application.

**Normal** User data delay does not harm the sequence and progress of the application.

From FRMCS System point of view, latency quantifies the end-to-end user data transport delay between the involved communication entities.

**Reliability** (in accordance to TS 22.261): in the context of network layer packet transmissions, percentage value of the amount of sent network layer packets successfully delivered to a given system entity within the time constraint required by the targeted service, divided by the total number of sent network layer packets.

Two levels are to be taken into account:

**High** The packet loss at transport level is exceptional rare.

**Normal** The packet loss at transport level is seldom.

The FRMCS System is able to assign multiple individual FRMCS User communications having individual QoS profile to a single IP address.

To meet the different application characteristics e.g. conversational pattern, real-time or critical data further itemisation is necessary. The mapping of the service attributes latency and reliability among functional requirements and FRMCS System as well as their target values are summarised in Table 12.10-1.

Service Attribute	FRMCS - Functional Requirement	FRMCS – System Requirement	Service Attribute value
Latency	Low	Ultra-Low	≤10ms
		Low	≤100ms
	Normal	Normal	≤500ms
		Best Effort	>500ms
Reliability	High	Ultra-High	99.9999%
		High	99.9%
	Normal	Normal	99%

**Table 12.10-1 - Service attribute mapping**

Some application categories are time stringent e.g. critical voice or critical data.

The range of latency and reliability requirements have a certain dependency on the speed of the trains. In general, the requirement is that the service attributes can be guaranteed up to 500kmh<sup>-1</sup>. Certain combinations of latency and reliability apply only to **Low Speed** (≤ 40kmh<sup>-1</sup>).

The applications are considered as real-time when the FRMCS functional requirement for the latency is specified as “Low” and “Ultra Low”, according to table 12.10 1.

## Session handling

**Setup time** of a communication session is essential because of their safety related character. Communication session setup encompasses the value of the elapsed time between the communication establishment request and the indication of successful communication session establishment. The FRMCS User requires two classes:

**Immediate** The FRMCS User requires immediate setup of the communication session. The duration of the immediate communication session establishment shall not exceed 1 second.

**Normal** Normal communication session setup time range does not harm the use of the application. The time duration of the normal communication session establishment shall not exceed 3 seconds.

**Talker assignment time** comprises the timeframe between talker request and the permission to talk applicable to group communication. This timeframe shall be lower than 300ms. Talker assignment time assumes that a group communication has been set up.

**Session Loss Rate (SLR)** indicates the number of sessions released unintentionally per accumulated session time. SLR shall be  $<10^{-2}/h$ .

### Communication and QoS assignment

In order to provide the required level of communication quality, the FRMCS System will request the applicable resources as required for the communication service from the underlying 3GPP transport system and if appropriate also from non-3GPP transport systems. The transport resources are characterised by latency, reliability, guaranteed bitrate/non-guaranteed bitrate and communication service priority.

If no specific service attributes are required for a certain communication service, the FRMCS System is able to apply a predefined default.

Each communication service resource characteristic can be requested independently of the others.

As result of the request to the underlying transport system, the FRMCS System may offer different values than the ones requested but which fit to the categories summarised in Table 12.10-1.

The available radio spectrum in certain regions, for example in Europe is rather limited, therefore the FRMCS System might apply different resources for the same communication service in different regions to achieve a radio resource efficient use of the available bandwidth.

### Audio quality

Voice intelligibility strongly depends on the audio bandwidth. FRMCS System has to consider for voice communication following minimum requirements:

- Encoding of speech encompass in minimum the range of 200–7000 Hz;
- The codec meets the local radio channel and capacity requirements of the FRMCS system;
- The coding of speech signals is robust to radio impairments sacrificing voice clarity;

#### 12.10.2.4 Post-conditions

The post conditions of the functional use cases out of chapter 5 – 9 are applicable.

#### 12.10.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.10.2-001]	The FRMCS System shall be capable of providing different levels of QoS.	(A)T	TS 22.261	sub-clause 6.7.2 paragraph 1
[R-12.10.2-002]	The FRMCS-system service attributes shall be allocated unambiguously per application and/or per session and/or per FRMCS User.	(A)T	TS 22.261	sub-clause 6.7.2 paragraph 1 sub-clause 6.8 paragraph 3, 4
[R-12.10.2-003]	The FRMCS System shall support the efficient use of the radio resources.	(A)T	TS 22.261	sub-clause 6.7.2 paragraph 3 sub-clause 6.23.2

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.10.2-004]	The FRMCS System shall provide service attribute control on a peer to peer basis.	(A)T	TS 22.261	sub-clause 6.7.2 paragraph 6 sub-clause 6.8 paragraph 3
[R-12.10.2-005]	The FRMCS System shall provide a mapping between application characteristics and the bearer service attributes.	(A)T	TS 22.261	sub-clause 6.7.2 paragraph 1
[R-12.10.2-006]	The FRMCS System shall be able to support different QoS for uplink and downlink of asymmetric bearers.	(A)T	TS 22.261	sub-clause 6.7.2 paragraph 2
[R-12.10.2-007]	The FRMCS System shall be able to modify service attributes during an active communication session.	A/T	TS 22.261 TS 22.280	TS 22.261 sub-clause 6.8 paragraph 1 TS 22.280 sub-clause 6.8
[R-12.10.2-008]	The FRMCS System shall detect and process the various user data traffic characteristics, latency and session reliability requirements. These requirements are summarised in Table 12.10-2.	(A)T	TS 22.261	sub-clause 6.8 paragraph 6
[R-12.10.2-009]	The FRMCS System shall support the applicable QoS requirements up to a train speed of 500kmh <sup>-1</sup> at all locations along the track unless restrictions are indicated which are:  Low speed $\leq 40\text{kmh}^{-1}$ .	T	22.289	sub-clause 5.2.2
[R-12.10.2-010]	To prioritize among the application categories and their related QoS, the FRMCS System shall support 15 priority levels.	T	22.280	[R-6.8.7.2-005]
[R-12.10.2-011]	The FRMCS System shall be able to request service attributes (latency, reliability, guaranteed bitrate/ non-guaranteed bitrate and priority) from the underlying 3GPP transport system and if appropriate also from non-3GPP transport systems.	T	TS 22.261	sub-clause 6.7.2 paragraph 5, 8
[R-12.10.2-012]	The FRMCS System shall be able to apply predefined default service attributes.	T	TS 22.261	sub-clause 6.8 paragraph 4-6

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.10.2-013]	The FRMCS System shall be able to request each communication service attributes independently of the others.	T	TS 22.261	sub-clause 6.7.2 paragraph 1, 2, 6
[R-12.10.2-014]	The FRMCS System shall be able to assess whether the communication service attributes received from the transport system are sufficient to support the communication service fully or in a restricted way and report this information to the FRMCS application.	T	TS 22.261	sub-clause 6.7.2 paragraph 3
[R-12.10.2-015]	The FRMCS System shall be able to keep the communication priority independent from the QoS parameters latency, reliability, guaranteed/non-guaranteed bitrate.	T	TS 22.261	sub-clause 6.7.2 paragraph 4
[R-12.10.2-016]	The FRMCS System shall provide a radio resource efficient allocation of the communication bandwidth.	T	TS 22.261	sub-clause 6.7.2 paragraph 3 sub-clause 6.23.2
[R-12.10.2-017]	Talker assignment time, the timeframe between talker request and the permission to talk in a multi-user voice communication, shall be lower than 300ms.	A/T	22.179	[R-6.15.3.2-012] The MCPTT Service shall provide an MCPTT Access time (KPI 1) less than 300 ms for 95% of all MCPTT Request.  [R-6.15.3.2-013] For MCPTT Emergency Group Calls and Imminent Peril Calls the MCPTT Service shall provide an MCPTT Access time (KPI 1) less than 300 ms for 99% of all MCPTT Requests.
[R-12.10.2-018]	FRMCS system shall support at least encoding of speech signals between 200–7000 Hz.	A/T	22.280 26.441	TS 22.280 sub-clause 5.13 TS 26.441 entire document
[R-12.10.2-019]	The FRMCS voice codec shall be robust to meet different radio channel impairments caused by the different working conditions in the train, beside or under the train.	A/T	22.280 26.445	clause 5 s0504-s0506

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.10.2-020]	The encoding of speech signals in the FRMCS system shall be efficient to meet limited radio resource availability.	A/T	22.280 26.445	clause 5 s0504-s0506
[R-12.10.2-021]	Priority handling of communication service in the FRMCS System shall encompass the assignment of a priority to a communication and involves the seizing of resources, which are in use by a communication having a lower ranking in the absence of idle resources.	A/T	22.280	[R-6.8.7.2-001]
[R-12.10.2-022]	Priority handling of the FRMCS System shall support discontinuation of an ongoing communication having a lower priority to allow an incoming communication of higher priority.	A/T	22.280	[R-6.8.7.2-004]
[R-12.10.2-023]	The FRMCS System shall always consider the priority of the FRMCS User initiating the communication.	A	22.280	[R-6.8.7.2-002]
[R-12.10.2-024]	The FRMCS System shall consider for a communication the priority level selected by the FRMCS User at setup or the priority level predefined at registration.	A	22.280	[R-6.8.7.2-004]
[R-12.10.2-025]	The FRMCS System shall treat the communication priority levels when the FRMCS User is registered to a FRMCS network.	A	22.280	[R-6.8.7.2-001]
[R-12.10.2-026]	The definition of the priority level which may cause pre-emption of another ongoing communication shall be stored and can be changed by the FRMCS User.	A	22.280	[R-6.8.7.2-004]
[R-12.10.2-027]	The FRMCS System shall be able to allocate setup classes i.e. communication setup time requirements and resource pre-emption capabilities to each priority level.	A/T	22.280	[R-6.8.7.2-003]

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.10.2-028]	In case of resource pre-emption, the pre-empted FRMCS user shall be provided with a suitable indication.	A	N/A	It is an implementation choice
[R-12.10.2-029]	The priority level shall be selected by the FRMCS User on a per communication basis.	A/T	22.280	[R-6.8.7.2-001]
[R-12.10.2-030]	The FRMCS User shall be able to select any priority level up to the authorised priority level. The maximum priority level shall be stored on the UICC.	A	22.280	[R-6.8.7.2-006] [R-6.8.7.2-007]
[R-12.10.2-031]	At communication setup, the FRMCS Equipment/UE and the FRMCS System shall verify the priority level at setup against the maximum authorised priority level.	A	22.280	[R-6.8.7.2-008]
[R-12.10.2-032]	If the FRMCS User has not selected a priority level at setup, the FRMCS System shall apply a FRMCS User specific default priority level.	A	22.280	[R-6.8.7.2-009]
[R-12.10.2-033]	If the FRMCS User has selected at setup a priority level higher than the maximum authorised priority level, the maximum authorised priority level shall be applied by the FRMCS System for the communication.	A	22.280	[R-6.8.7.2-010]
[R-12.10.2-034]	The FRMCS System shall take into account the service attributes to allow selection of the available bearer services.	T	TS 22.261	sub-clause 6.7.2 paragraph 5, 8
[R-12.10.2-035]	The FRMCS System shall be able to assign multiple individual FRMCS User communications having individual QoS profile to a single IP address.	A/T	TS 22.261 TS 22.280	TS 22.261 sub-clause 6.8 paragraph 3 TS 22.280 sub-clause 5.15



Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.10.2-036]	The FRMCS System shall provide a mechanism to derive the communication characteristics of an application and map those on a data flow with a predefined QoS profile.	A/T	TS 22.261 TS 22.280	TS 22.261 sub-clause 6.8 paragraph 3 TS 22.280 sub-clause 5.15

Application categories and their related service attributes are grouped into specific QoS class. Table 12.10-2 summarises the QoS classes and their applicable service attributes.

Application Category	Service Attribute (according to Table 12.10-1)		Session establishment	Session Loss Rate
	Latency peer to peer	Reliability		
Voice	Low	Normal	Normal	NA
Critical Voice	Low	High	Immediate	NA
Video	Normal	High	Normal	NA
Critical Video	Low	High	Immediate	NA
Very Critical Video	Ultra Low or Low Note 1	High	Normal	NA
Critical Data (future applications)	Low	Ultra-High	Immediate	NA
Very Critical Data	Ultra-Low or Low (Note 1)	Ultra- High	Immediate	NA
Critical Data (legacy applications)	Normal	High	Normal	<10 <sup>-2</sup> /h
Non-Critical data	Normal	High	Normal	NA
Messaging	Best Effort	High	Normal	NA
Note 1: The latency "Ultra low" is restricted to low speed ≤40 kmh <sup>-1</sup> .				

**Table 12.10-2 - Service and Service Attribute requirements**

### Railway specific conditions

1.) Following propagation conditions are to be considered:

- Free space in general
- Railway corridors in general and especially in hilly terrain
- Forest Aisle
- Underground / tunnel environment
- Moving trains or objects in a railway station and shunting yards

2.) FRMCS System should be able to reuse the existing GSM-R sites. A non-exhaustive example list provides the typical site-to-site deployment scenarios:

Rural environment: between 5 - 7km.

Urban environment: <5km.

## 12.11 Use case: Provide broadband and mission critical services with seamless connectivity

### 12.11.1 Description

The FRMCS shall provide the broadband and mission critical services with seamless connectivity.

### 12.11.2 Pre-conditions

The operator at the train control centre has a Railway Emergency Call to a train which is in operation with 500km/h speed via 3GPP network.

Using a trainborne UE, the train driver is discussing an issue on operation of the train with train crews by a video call via a proximity-based services such as ProSe.

### 12.11.3 Service flows

The operator at the train control centre calls the train driver to give an emergency information including broadband video via the 3GPP network of FRMCS System.

The FRMCS System indicates the train driver is currently having a video call which has a normal priority with train crews.

The FRMCS System compares the priority of the Railway Emergency Call and the ongoing call.

Due to the higher priority of the Railway Emergency Call, the FRMCS System puts the ongoing call on hold and the participants receive a notification.

Within 300ms, the train driver is connected to the railway emergency call.

During the Railway Emergency Call, the train driver watches the broadband video as a supplement material to understand the emergency easier.

The train driver recognizes the emergency and does some proper works.

### 12.11.4 Post-conditions

After the Railway Emergency Call is ended, the hold call is resumed.

## 12.11.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.11.5-001]	The FRMCS System shall be able to define the priority level of Railway Emergency Call.	A	22.280	This requirement is covered by 22.280 [R-5.16.2-002]
[R-12.11.5-002]	The FRMCS System shall be able to handle the priority level of Railway Emergency Call.	A	22.280	This requirement is covered by 22.280 [R-5.16.2-002]
[R-12.11.5-003]	The FRMCS System shall support switching between on-network service and off-network service.	A	22.280	[This requirement is covered by 22.280 [R-6.18-001] to [R-6.18-006].]
[R-12.11.5-004]	The FRCMS system shall handle a priority call less than 300ms of call setup time in the environment of train speed up to 500km/h.	A	22.289	This requirement is covered by section 5.2.2 of 22.289.
[R-12.11.5-005]	The FRMCS System shall be able to present a video included in the Railway Emergency Call.	A	22.281	This requirement is covered by 22.281 [R-5.1.9.2.2-001] to [R-5.1.9.2.2-003].

## 12.12 Use case: Offer railway services high-quality control functions with real-time train status monitoring

### 12.12.1 Description

The FRMCS System offers high-quality control functions for railway services with real-time train status monitoring.

The train runs on railway by 500km/h of speed. The operator at the train control centre makes request to get the status of the train.

### 12.12.2 Pre-conditions

The train runs on railway by 500km/h of speed.

In the train, there is a trainborne UE and it is connected via 3GPP network.

### 12.12.3 Service flows

The operator at the train control centre makes request to get the status of a train which runs on railway by 500km/h of speed.

The request is made with the train number, rather than the trainborne UE equipment identity.

The request goes through the backbone network and 3GPP network, reaches a trainborne UE.

The trainborne UE gets the train status such as speed and location and records the video monitoring data of the train.

The train status data are encrypted in the security reason by the trainborne UE and is responded back to the train control centre via the 3GPP network.

The trainborne UE requests the moving authority data to the train control system in the train control centre. The moving authority is a permission for a train to move to a specific location with supervision of speed.

The train control system responds the moving authority data to the trainborne UE within a time which is defined in FRMCS QoS.

## 12.12.4 Post-conditions

The train control centre de-encrypts the train status data and is able to see the status of the train including the streaming video of monitoring.

The train receives the moving authority data and references the data.

## 12.12.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.12-001]	The FRMCS System shall provide a mapping between FRMCS Equipment Identity and the train number.	A	22.280	This requirement is covered by [R-5.9a-018] of 22.280
[R-12.12-002]	The FRMCS System shall be able to maintain a secure data channel for the train status monitoring communication.	A	22.280	This requirement is covered by [R-5.12-001] and [R-5.12-009] of 22.280
[R-12.12-003]	The FRMCS should be able to define a minimum bandwidth of video monitoring.	A	22.289	This requirement is covered by section 5.2.2 of 22.289
[R-12.12-004]	The FRMCS should be able to define a minimum delay time of communicating the train status monitoring.	A	22.289	This requirement is covered by section 5.2.2 of 22.289
[R-12.12-005]	The FRMCS should be able to define a minimum delay time of communicating the moving authority data.	A	22.289	This requirement is covered by section 5.2.2 of 22.289.

## 12.13 Use case: Provide call priority during interworking with LMR

### 12.13.1 Description

There are Mission Critical Services such as Railway, use many kinds of communication technology, e.g. TRS and LTE. To make interworking between the networks to during provide FRMCS communication, it needs to manage call priority between calls which are made between the networks.

During the interworking between FRMCS and LMR systems including TETRA and P25, FRMCS provides call priority based on factors such as the situation, group priority, level of user, etc. For example, a Railway Emergency Call could be categorized as a public announcement on emergency (low-level priority) or an operation emergency call (high-level priority).

Examples on the priority of calls in FRMCS are provided in the following table:

**Table 12.13-1: Priority of calls in FRMCS**

Call Type	Priority	Related Action
Operation Emergency Call	0 (the highest)	Stop all the calls have priority lower than or equal to Control Safety Announcement
Control Safety Announcement (between Operation Users)	1	Stop all the calls have priority lower than or equal to Public Announcement on Emergency
Public Announcement on Emergency	2	Stop all the calls have priority lower than or equal to Operation Call

Operation Call (not emergency case)	3	Stop all the calls have priority lower than or equal to Service Information Announcement
Service Information Announcement	4	-

The examples in the table 12.13-1 are made by modifying of the call priority of the railway communication system as a mission critical service [4].

If an operation emergency call is invoked by a user (maybe a train driver), it should have higher level of priority than the public announcement on emergency call of other user. In this case, all the lower priority calls may need to be pre-empted or queued to allow the operation emergency call.

In order to provide the call priority, the interworking needs to be able to maintain the information on the priority of each call and each user who invoked a call or a group call. When a call is invoked, FRMCS should compare the priority between the current call and the new call and decide which one is allowed to go through.

## 12.13.2 Pre-conditions

The operator at the train control centre has a Railway Emergency Call to a train which is in operation with 500km/h speed via 3GPP network.

Using a trainborne UE, the train driver has an announcement of control safety to the train crews via LMR such as TRS.

## 12.13.3 Service flows

The operator at the train control centre calls the train driver and the train crews to give an emergency notice via the 3GPP network of FRMCS System.

The FRMCS System indicates the train driver and the train crews are currently having a group call which has a lower priority than the emergency notice call.

The FRMCS System queues the ongoing TRS call and connects the train control centre and the trainborne UE.

The emergency notice call from the train control centre via the 3GPP network, is relayed to TRS to make announce to the train driver and the train crews.

The train driver and the train crews recognize the emergency and do some proper works.

## 12.13.4 Post-conditions

After the emergency notice call is ended, the queued TRS call is resumed.

## 12.13.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.13-001]	FRMCS should be able to handle call priority when interworking with LMR communication systems.	A	22.179 22.280	<p>This requirement is covered by 22.179 [R-6.18.3.2-006] to [R-6.18.3.2-009] and 22.179 [R-6.18.3.3-006] to [R-6.18.3.3-007].</p> <p>The high level requirements of handling call priority are covered by many sections of 22.280, e.g. section 5.1.7 and 5.6.</p> <p>TETRA and P25 may need considerations as follows:</p> <ul style="list-style-type: none"> <li>a. TETRA may provide some customizable features to maintain the call priority such as Call ownership and Call priority.</li> <li>b. P25 has no features to support the call priority.</li> <li>c. FRMCS has many basic information to handle the call priority such as 'Priority of the user for initiating/receiving calls' in the user profile data and 'Priority of the group' in the group configuration data.]</li> </ul>
[R-12.13-002]	The FRMCS System should be able to define a maximum call setup time for a call between 3GPP system and LMR system.	A	22.289	This requirement is covered by section 5.2.3 of 22.289
[R-12.13-003]	FRMCS should provide the call priority supporting features to interworking with LMR.	A	22.179 22.280	<p>This requirement is covered by 22.179 [R-6.18.3.2-006] to [R-6.18.3.2-009] and 22.179 [R-6.18.3.3-006] to [R-6.18.3.3-007].</p> <p>The high level requirements of handling call priority are covered by many sections of 22.280, e.g. section 5.1.7 and 5.6.</p>
[R-12.13-004]	FRMCS should provide interworking between FRMCS System and LMR system.	A	22.179	covered by 22.179 [R-6.18.3.2-001] and [R-6.18.3.3-001]

## 12.14 Use Case: FRMCS Positioning Accuracy

### 12.14.1 Introduction

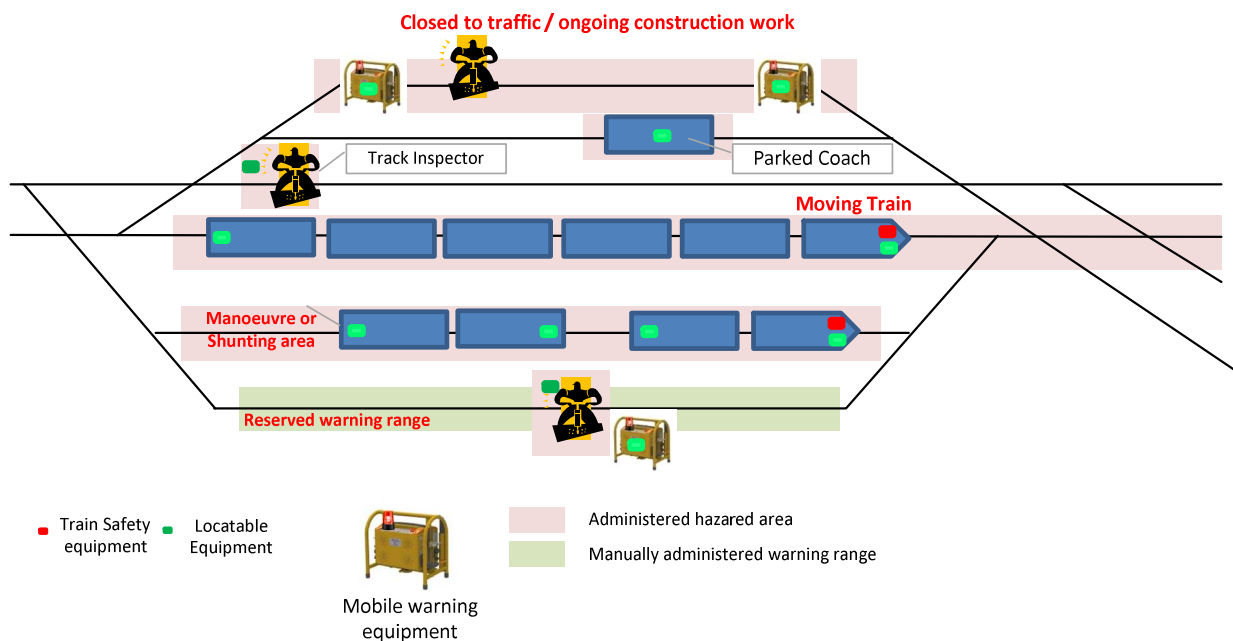
This system principle use case describes the positioning accuracy requirements to position a train, track side worker as well as other stationary and non-stationary object inside the track system. In general, positioning accuracy will become a major building block to increase the automation level of train operation. The main purpose is to specify the accuracy parameter values.

## 12.14.2 Use case: FRMCS Positioning Accuracy

### 12.14.2.1 Description

Today fixed mounted balise are used to derive the train position inside the track-system. This kind of train positioning is precise enough when the train is moving. Static conditions like in stations, push-pull train operation or the frequent change between static and dynamic conditions during shunting operation require hundreds of fixed mounted balise. Thus, a balise without stationary reference shall overcome this circumstance.

According to Figure 12.14-1, individual coaches, trains, track side worker get equipped which such devices that report continuously the process status towards the applicable control centre enriched with the actual position information.

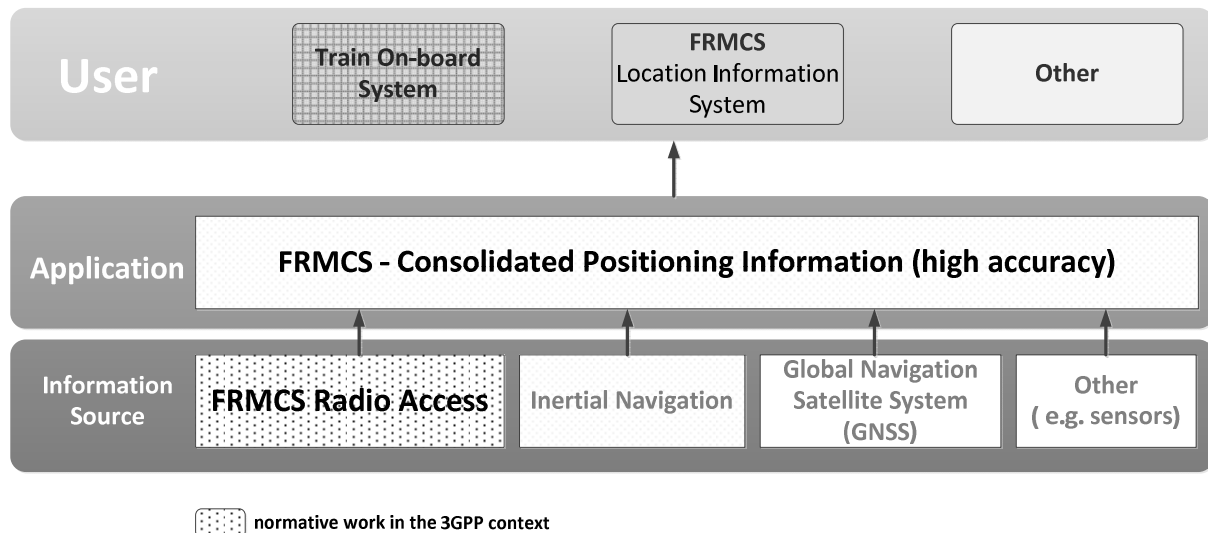


**Figure 12.14-1 Positioning application areas**

Tracks/lines or shunting areas are subdivided into autonomous hazard areas (red blocks see Figure 12.14-1). The continuous processing of positioning information allows the control centre to detect when hazard areas start to overlap. Based on the computed risk integral, the control centre is able to instruct the vehicles or trains in the concerned area to lower the speed up to a full stop.

To guarantee fail-safe operation in deriving the position of the vehicle, track-side worker etc., and independent positioning sources need to be provided. Beside inertial navigation, GNSS and others, the FRMCS System is required to be part of the positioning data acquisition process. This results from rather low predictable availability of satellite systems especially in mountain regions, multilevel railway station as well as in tunnels. In the worst case, “rough” positioning information only derived from the FRMCS – Land Mobile Network is present.

The combination of 3GPP radio access network and the train on-board system is able to support mechanisms that can be used to locate an entire train, stationary as well as non-stationary objects. Together with the positioning information of other sources (see Figure 12.14-2) e.g. inertial navigation and GNSS, consolidated positioning information of the train/object will be computed that is able to fulfil higher accuracy of the positioning information. Train Onboard system as well as FRMCS location information system will receive the consolidated location positioning information for further processing by the train safety applications and/or FRMCS location information system.



**Figure 12.14-2 Consolidation of positioning source information**

The subject described is applicable to other FRMCS functional use cases. The resulting positioning requirements in this use case are relevant for the FRMCS System.

### 12.14.2.2 Pre-conditions

Railway line consist of station A, B and C. Station B is between station A and C.

FRMCS User 1 is used by an InterRegio train that stops in station A, B and C.

FRMCS User 2 is used by a high speed train that stops in station A and station C.

FRMCS User 3 is used on a parked train in station B.

FRMCS User 4 is used by mobile warning equipment located in station B.

Ground FRMCS User processes the received positioning information of the different train FRMCS Users for safety purposes.

FRMCS Users on the train (safety application) established the communication to the ground FRMCS User (safety application) that is responsible for train safety purposes on the line between the stations A and C including station B.

Base stations are covering the line between station A and station C. The structure of the base station along the line is linear. In some cases dual base stations per site can be used. The distance between adjacent base stations various between 1 and 10km.

Train speed profile ranges between 0 - 500km/h.

The base stations covering the line between station A and C are enhanced cellular base stations that are able to form a carrier grade positioning network.

### 12.14.2.3 Service flows

Train FRMCS User 1 (safety application) as part of the InterRegio train approaches station B coming from station A.

Train FRMCS User 2 (safety application) as part of a high speed train passes station B coming from station C.

Train FRMCS User 3 (safety application) as part of the parked train in station B that continuous later.

Train FRMCS User as part of a mobile warning system protects a line section that is under construction.

All train FRMCS Users (safety application) periodically report their current position to the ground FRMCS User (safety application).



### 12.14.2.4 Post-conditions

Every train approached his final destination.

No harm to the ongoing construction work in station B.

### 12.14.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.14.2-001]	The consolidated positioning information i.e. the location information resulting from the combination of all positioning sources available to the FRMCS System shall support following absolute positioning accuracy based on the train speed at >= 90% of the occasions: 0 - 40km/h Longitudinal: ≤1 m lateral: 1 - 3 m Up to 120km/h Longitudinal: ≤34m lateral: 1 - 3 m Up to 160km/h Longitudinal: ≤45m lateral: 1 - 3 m Up to 320km/h Longitudinal: ≤89m lateral: 1 - 3 m Up to 500km/h Longitudinal: ≤200m lateral: 1 - 3 m See [9]	A/T	TS 22.261	TS 22.261 sub-clause 6.27.2 TS 22.261 sub-clause 7.3.2 – refer to positioning service level 3 (only one speed limit supported – up to 500 km/h – with horizontal accuracy of 1m)  TS 22.278 does not consider this requirement.
[R-12.14.2-002]	FRMCS System shall be able to support an initial positioning fix time of ≤5s.	A/T	TS 22.261	TS 22.261 sub-clause 7.3.2  TS 22.278 does not consider this requirement.
[R-12.14.2-003]	To avoid large offsets between adjacent hazard areas due to limited track space in a railway station, FRMCS System shall be able to support a sampling interval between two positioning cycles of <1s.	A/T	Not covered	TS 22.261 TS 22.261 sub-clause 7.3.2 (Positioning service latency = 1 s)  TS 22.278 does not consider this requirement.
[R-12.14.2-004]	FRMCS Equipment power consumption due to the use of positioning capabilities shall be minimised.	A/T	TS 22.261	TS 22.261 sub-clause 6.27.2 and 7.3.2.3 (location power saving mode with restriction in update rate)  TS 22.278 does not consider this requirement.

## 12.15 Use Case: FRMCS System security framework

### 12.15.1 Introduction

The security framework protects the FRMCS System against attacks and threats, like misuse, Denial of Service (DoS), unauthorized access to services, interception, man-in-the-middle attacks, replay attacks and intended data modification. It encompasses the protection of security attributes confidentiality, privacy, integrity, availability and non-reputation.

## 12.15.2 Use case: FRMCS System security framework

### 12.15.2.1 Description

The security framework protects:

- Services provided by the FRMCS System;
- Bearer flexible access including 3GPP as well as non-3GPP access;
  
- Direct interaction between FRMCS Equipment;
- Interaction between the FRMCS end user devices and FRMCS network;
- Interaction between FRMCS network functions;
- Stored data within the FRMCS System;
- Interworking between a FRMCS System and another FRMCS System;
- Interworking between a FRMCS System and a legacy system.

### 12.15.2.2 Pre-conditions

FRMCS System is in use.

### 12.15.2.3 Service flows

FRMCS System security framework related service flows cover the following aspects:

- identity management;
- authentication;
- authorization;
- key management;
- data protection (regarding integrity, confidentiality, privacy, non-reputation);
- prevention of attacks;
- detection of attacks;
- reaction on detected attacks.

### 12.15.2.4 Post-conditions

The FRMCS System is protected.

## 12.15.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.15.2-001]	The FRMCS System security framework shall enable the use of unique identities.	A	TS 22.228 TS 22.280	A- TS 22.228 sub-clause 7.5.1 A- TS 22.280 [R-5.12-002]
[R-12.15.2-002]	The FRMCS System security framework shall allow the grouping of identities.	A	TS 22.228 TS 22.280	A- TS 22.228 sub-clause 7.5.1 A- TS 22.280 sub-clause 5.1.3, 5.12
[R-12.15.2-003]	The FRMCS System security framework shall provide mechanisms to authenticate a unique identity.	A/T	TS 22.278 TS 22.261 TS 22.228 TS 22.280	T- TS 22.278 sub-clause 9.2 T- TS 22.261 sub-clause 8.3 A- TS 22.228 sub-clause 11.2, H 2.3, H 3.3, H 4.3 A- TS 22.280 sub-clause 5.12
[R-12.15.2-004]	The FRMCS System security framework shall provide authentication mechanisms required for the secured interaction between FRMCS network functions.	A/T	N/A	Implementation requirement
[R-12.15.2-005]	The FRMCS System security framework shall provide mechanisms to authorise communications and the use of applications.	A	TS 22.280 TS 22.228	sub-clauses:5.9a2, 5.12, 5.16, 5.19, 6.4.2, 6.4.5, 6.4.6, 6.6, 6.7, 6.8, 6.13, 6.19.1 TS 22.228: sub-clause 5
[R-12.15.2-006]	The FRMCS System security framework shall provide a management of identities, passwords and keys required for the protection of FRMCS User communication, the interaction between FRMCS network functions as well as subscribers and service related data.	A/T	TS 22.261 TS 22.280	TS 22.261: Identity management (see section 8.5) TS 22.280: Key management, profile management (see section 5.12) Password management is an implementation requirement.
[R-12.15.2-007]	The FRMCS System security framework shall be able to block the use of any FRMCS Equipment when it is detected as being stolen or lost.	A/T	TS 22.261 TS 22.280	T TS 22.261 sub-clause 8.7 A TS 22.280 sub-clause 6.13.4
[R-12.15.2-008]	The FRMCS System security framework shall be able to unblock the use any recovered stolen or lost FRMCS Equipment.	A/T	TS 22.278 TS 22.261 TS 22.280	T TS 22.261 sub-clause 8.7 A TS 22.280 sub-clause 6.13.4
[R-12.15.2-009]	The FRMCS System security framework shall protect the services provided by the FRMCS System; bearer flexible access including 3GPP as well as non-3GPP access; interaction between the FRMCS end user devices and FRMCS network; interaction between FRMCS network functions; stored data within the FRMCS System; interworking between a FRMCS System and another FRMCS System; Interworking between a FRMCS System and a legacy system.	A/T	TS 22.261 TS 22.280	TS 22.261 sub-clause 8.2 TS 22.280: [R-6.13.6-001]

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.15.2-010]	The FRMCS System security framework shall prevent software based attacks which have an impact on any of the following security attributes: data confidentiality; information privacy; data integrity; non-repudiation of data; FRMCS System availability.	T	N/A	Implementation requirement
[R-12.15.2-011]	The FRMCS System security framework shall be able to detect software based attacks which have an impact on any of the following security attributes: data confidentiality; information privacy; data integrity; non-repudiation of data transfer; FRMCS System availability.	T	N/A	Implementation requirement
[R-12.15.2-012]	The FRMCS System security framework shall be able to react on detected software based attacks: which have an impact on any of the following security attributes: data confidentiality; information privacy; data integrity; non-repudiation of data transfer; FRMCS System availability.	T	N/A	Implementation requirement
[R-12.15.2-013]	The FRMCS System security framework shall provide procedures and mechanisms for management of FRMCS System security.	T	N/A	Implementation requirement
[R-12.15.2-014]	The FRMCS System security framework shall be able to track users' actions such as usage of communication services, management operations, configuration changes etc.	A	TS 22.280	TS 22.280 sub-clause 6.15.4
[R-12.15.2-015]	The FRMCS System security framework shall be able to store security related data for post-analysis, e.g. forensic.	A	TS 22.280	TS 22.280 sub-clause 6.15.4

## 12.16 Use Case: Interworking to external networks

### 12.16.1 Introduction

This section describes the general interworking between FRMCS System, based on 3GPP transport and external communication/data networks.

## 12.16.2 Use case: FRMCS System external network interworking

### 12.16.2.1 Description

Apart from the communication facilities within one FRMCS network, FRMCS User(s) require as well communication facilities to and from other external networks. Thus an FRMCS System has to provide various communication facilities between FRMCS User(s) and external network user(s).

The term “user” is hereby meant as either an individual or an application.

The necessary interworking to external networks is able to provide incoming and outgoing voice- and data bearer services.

The following are considered as external networks:

- Public Switched Telephone Network (PSTN)
- Private Telephone Network
- Private Mobile Radio (PMR) or Land Mobile Radio (LMR): refer to section 12.6 for additional use cases to interworking between FRMCS and LMR.
- Public Land Mobile network (PLMN)
- Other GSM-R networks: refer to section 12.8 for additional use cases to interworking between FMCS and GSM-R.
- Other FRMCS networks
- Other Wireless Access
- Other packet data networks, e.g. Internet.

### 12.16.2.2 Pre-conditions

The FRMCS User is attached to the FRMCS System.

The external network user is attached to the external network.

Authentication and authorization of the FRMCS User(s) and communications initiated by the FRMCS Users are managed within the FRMCS System.

The required Quality of Service is managed by the FRMCS System.

### 12.16.2.3 Service flows

#### **Case 1 (Communication is to be established from FRMCS system towards an external network)**

An entitled FRMCS User enters a destination address for establishment of a communication session. The destination address can be of the following formats:

- E.164 address
- Uniform Resource Identifier (URI) (e.g. SIP address, URL, e-mail address...)
- EIRENE functional number
- FRMCS Functional Identity
- FRMCS User Identity
- FRMCS subscriber identity

Based on the destination address, the FRMCS System performs the following:

- Detects the correct bearer type including characteristics

- Translates the destination address to a routable format
- Analyses if the destination is external to FRMCS System
- Selects an available interconnection for the bearer type. (Interconnection selection can be either a direct or indirect connection, e.g. gateway)
- Attempts to setup the communication session

#### **Case2 (Communication is to be established from an external network towards FRMCS system)**

An external network user tries to establish a communication session towards an FRMCS User. The destination address can be of the following formats, depending of the capabilities of the external network:

- E.164 address
- Uniform Resource Identifier (URI) (e.g. SIP address, URL, e-mail address...)
- FRMCS Functional Identity (other FRMCS networks)
- FRMCS User Identity (other FRMCS networks)
- FRMCS subscriber identity (other FRMCS networks)

Based on the destination address, the FRMCS System does the following:

- Locates user(s) within the FRMCS System to detect possible roaming case
- Translates the destination address into a routable format
- Detects the correct bearer characteristics
- Establishes the communication session.

### 12.16.2.4 Post-conditions

#### **Case1**

An FRMCS User is able to establish voice and/or data communication with intended user(s) in an external network.

#### **Case2**

An external network user is able to establish voice and/or data communication with intended user(s) managed by the FRMCS System.

## 12.16.2.5 Potential requirements and gap analysis



Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.16.2-001]	The FRMCS System shall provide means of regulated interworking (s) for telephony services to/from external public networks e.g. system administrator has the ability to restrict access telephony services to/from external networks.	T	Covered by TS 22.179 TS 22.280	For GSM-R, covered in 22.179 [R-6.18.4.2-001-5]. For other MCX systems, covered in 22.280 [R-6.17.2-001-7] For LMR/PMR (e.g. TETRA, P25 and TIA-603-D refer to section 12.6. For PLMN and PSTN, covered by 22.280 [R.6.17.3.2-002]
[R-12.16.2-002]	The FRMCS System shall provide Packet switched (PS) interworking (s) to/from external networks.	T	Partly covered by TS 22.280	For GSM-R and according to latest decision from UIC (see FRMCS project activities status report in ERIG#70 (July 2018), the requirement is not required. No use case has been identified by UIC ((E)GPRS EVC could not be connected to any FRMCS RBC). For other MCX systems, covered in 22.280 [R-6.17.2-001-7]. For LMR/PMR (e.g. TETRA, P25 and TIA-603-D refer to section 12.6. For PLMN and PSTN, interworking is not covered.
[R-12.16.2-003]	The FRMCS System shall provide the necessary signalling and voice codec adaptation in the context of interworking with external networks.	T	Partly covered by TS 22.179	For GSM-R covered in 22.179 [R-6.18.4.2-005] For other MCX systems, not required.  For LMR/PMR (e.g. TETRA, P25 and TIA-603-D refer to section 12.6. For PLMN and PSTN, interworking is not covered
[R-12.16.2-004]	The FRMCS System shall provide interworking for supplementary services related to the external network.	A	Not covered.	For other MCX systems, not applicable (other mechanisms are provided). For LMR/PMR (e.g. TETRA, P25 and TIA-603-D refer to section 12.6. For other external systems, not covered.
[R-12.16.2-005]	The FRMCS System shall provide interworking communication with external networks in a secured way.	A/T	Partly covered by TS 22.280	For other MCX systems covered in 22.280 [R-6.17.2-001], [R-6.17.2-002], [R-6.17.2-007]. For LMR/PMR (e.g. TETRA, P25 and TIA-603-D refer to section 12.6. For PLMN and PSTN, interworking is not covered. For other external systems, not covered.

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.16.2-006]	The FRMCS System shall provide interworking communication with external networks with the required Quality of Service.	T	Partly covered by TS 22.280	For other MCX systems, not covered. For GSM-R, covered by [R-6.17.3.1-002]. For LMR/PMR (e.g. TETRA, P25 and TIA-603-D refer to section 12.6. For PLMN and PSTN, interworking is not covered.
[R-12.16.2-007]	The FRMCS System shall be able to select interconnection based on multiple interconnections of the same type (i.e. redundancy of physical/logical paths and transmission links for both control and user planes including load aggregation and/or warm stand-by techniques).	A/T	N/A (physical paths) TS 22.280	Implementation requirement for redundant physical paths. Partly covered by clause 6.17.3.1 for GSM-R. Load aggregation and/or warm stand-by techniques to be supported by the Interworking Function (IWF).
[R-12.16.2-008]	The FRMCS System shall select the bearer characteristics based on exchanged signalling information (i.e. dynamic and automatic configuration of interconnections parameters).	T	TS 22.280	Partly covered by clause 6.17.3.1 for GSM-R. Dynamic and automatic configuration of interconnections parameters to be supported by the Interworking Function (IWF).
[R-12.16.2-009]	The FRMCS System shall select the appropriate interconnection type, e.g. CS or PS based on the destination address of the target user.	T	N/A	For GSM-R, PS interworking is not required (see above).

## 12.17 Use Case: FRMCS On-network/Off-network communication

### 12.17.1 Introduction

Typical communication will involve the transport capabilities of the FRMCS network but some of the FRMCS communication scenarios require the use of Off-network bearer services. Also a combination of On-network and Off-network bearer services can increase the entire availability of the entire FRMCS transport system which is essential for railways especially in Automated Train Operation.

This results into three global FRMCS communications modes:

- On-network only communication
- Off-network only communication
- Combined On-network and Off-network communication.

Note: The different types of communication use cases related to On-network and/or Off-network are summarised in Annex C.

## 12.17.2 Use case: On-network/Off-network communication

### 12.17.2.1 Description

**On-network** only communication mode uses the bearer services that are provided by the FRMCS land mobile network. It relies on the flexible use of 3GPP and non 3GPP bearer services and allows user to user as well as multi-user communication.

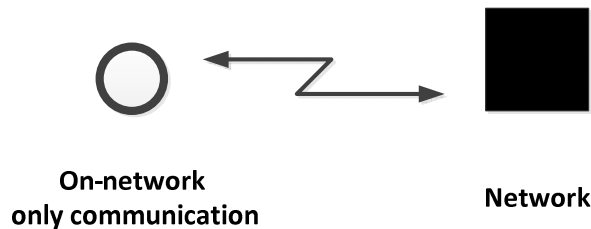


Figure 12.17-1 FRMCS On-network communication mode

On-network communication is used for Mobile FRMCS User (onboard) to Ground FRMCS User (controller) communication.

**Off-network** only communication mode uses a dedicated radio bearer service for proximity communication which is supported by FRMCS Equipment. It relies on an appropriate 3GPP bearer service that allows user to user as well as multi-user communication without direct involvement of FRMCS land mobile network. A relay function in Off-network communication mode can extend the range of the communication facilities. FRMCS Equipment may bridge a distance for proximity communications of up to 3km.

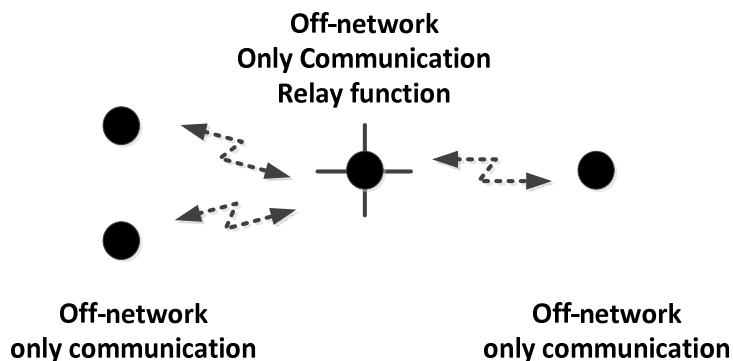


Figure 12.17-2: FRMCS Off-network communication mode

Off-network communication can be used for e.g. shunting or banking communication where not always a ground FRMCS User i.e. controller is necessary. Off-network communication provides also the backup if On-network communication is unavailable.

**Combined On-and Off-network** communication mode encompasses the parallel use of the FRMCS land mobile network and the radio bearer service for proximity communication. There are various sub-categories for this communication mode:

**Relay mode 1:** A FRMCS Equipment uses On-network and Off-network communication and constitutes an On-and Off-network relay function to other FRMCS Equipment's that are in Off-network only communication mode.

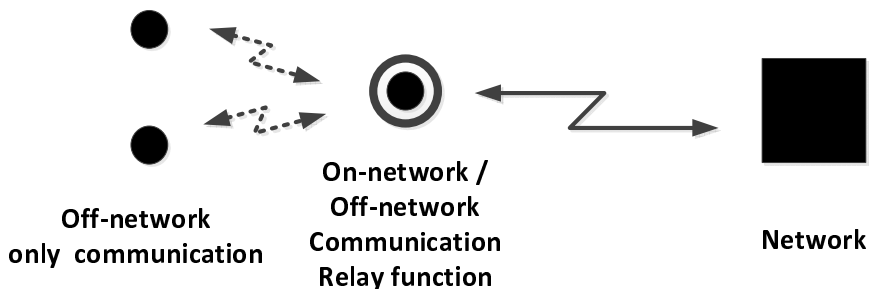


Figure 12.17-3: FRMCS On-network and Off-network communication mode - Relay mode 1

On-network and off network communication mode relay mode 1 bridge over the coupling loss for FRMCS Users in a train that do not have access to the roof antenna. Hence, relay mode 1 helps to overcome radio link issues in a train.

**Relay mode 2:** FRMCS equipment encompasses On-network and Off-network communication that enables Off-network bearer service for an Off-network only communication relay function.

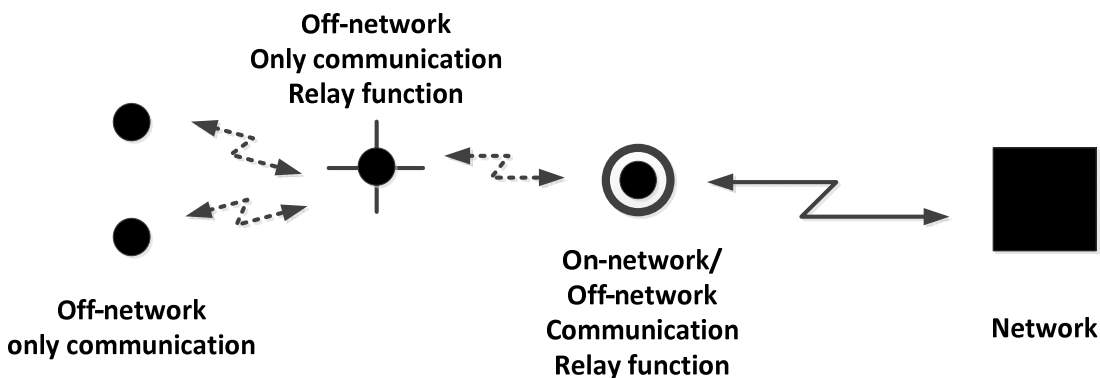
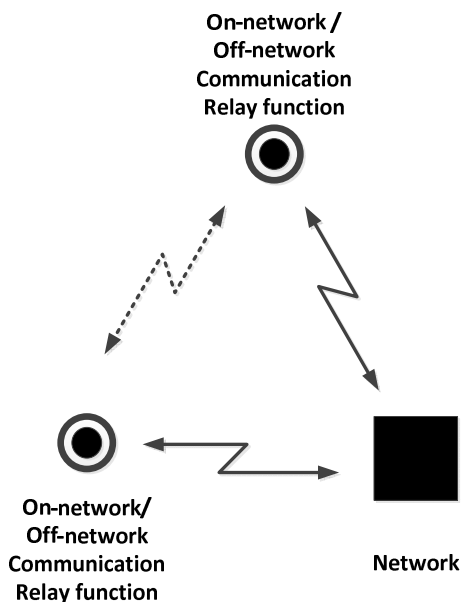


Figure 12.17- 4: FRMCS On-network/Off-network communication mode - Relay mode 2

Relay mode 2 is an extension of relay mode 1 that allows e.g. the concatenation of maintenance teams during tunnel maintenance activities.

**Relay mode 3:** FRMCS Equipment encompasses On-network and Off-network communication. Each FRMCS Equipment is able to constitute an On-network and Off-network relay function. Interworking between one and several of such relay functions allows the use of multipath transport facilities for communication purposes.



**Figure 12.17-5: FRMCS On-network-and Off-network communication mode - Relay mode 3**

Relay mode 3 allows multipath transport facilities for FRMCS Applications that require extreme high communication reliability e.g. control command signaling applications like ATP.

**12.17.2.2 Pre-conditions****On-network only communication**

FRMCS Equipment is authorised to use On-network communication mode.

FRMCS Users are attached to the FRMCS System and is authorised to establish user to user and/or multi-user communication.

**Off-network only communication**

FRMCS Equipment is authorised to use Off-network only communication mode. Some of the FRMCS Equipment's are authorised to establish an Off-network communication relay function.

The FRMCS Users are authorised to establish user to user and/or multi-user communication.

**Combined On-network-and Off-network communication**

The FRMCS Users are authorised to establish user to user and/or multi-user communication.

**Relay Mode 1**

The FRMCS Equipment that supports in On-network/Off-network relay communication mode is authorised to establish Off-network communication to other FRMCS Equipment's which are in Off-network only communication mode.

**Relay Mode 2**

FRMCS Equipment that supports Off-network relay communication mode is authorised to establish a communication to other FRMCS Equipment's that are in Off-network communication mode. FRMCS Equipment that is in Off-network relay communication mode is authorised to establish an Off-network communication to an On-network and Off-network relay communication mode FRMCS Equipment.

**Relay Mode 3**

FRMCS Equipment's in On-network and Off-network communication mode are authorised to establish On- and Off-network communications.

**12.17.2.3 Service flows**

FRMCS Users are involved in the different types of communication modes establishes user to user and/or multi-user communications.

**On-network only communication**

The FRMCS equipment establishes On-network only communication.

**Off-network only communication**

The FRMCS Equipment in Off-network relay communication mode and the FRMCS Equipment's in Off-network communication mode establish the Off-network communication.

**Combined On-network-and Off-network communication****Relay Mode 1**

The FRMCS Equipment in On-network/Off-network communication mode establishes:

- an On-network communication

- Off-network communication to FRMCS Equipment's in Off-network only communication mode

### **Relay Mode 2**

The FRMCS Equipment in On-network and Off-network communication mode establishes:

- an On-network communication
- Off-network communication to a FRMCS Equipment in Off-network relay communication mode

The FRMCS equipment in Off-network relay communication mode establishes Off-network communication to FRMCS equipment's in Off-network only communication mode.

### **Relay Mode 3**

The FRMCS equipment's in On-network and Off-network communication mode establishes:

- an On-network communication
- Off-network communication to a FRMCS Equipment in On-network-and Off-network relay communication mode.

## 12.17.2.4 Post-conditions

### **On-network only communication**

User-to-user and/or multi-user communication is established.

### **Off-network only communication**

User-to-user and/or multi-user communication is established.

### **Combined On-network/Off-network communication**

User-to-user and/or multi-user communication is established that encompasses both communication modes.

## 12.17.2.5 Potential requirements and gap analysis

Reference Number		Application / Transport	SA1 spec covering	Comments
[R-12.17.2-001]	FRMCS security requirements according to chapter 12.15 shall apply to On-network and Off-network communication.	A/T	TS 22.278 TS 22.261 TS 22.228 TS 22.280	Covered for on-network (refer to section 12.15).
[R-12.17.2-002]	FRMCS QoS requirements (reference QoS section 12.10) shall apply to On-network and Off-network communication.	A/T	TS 22.261 TS 22.280 TS 22.289	Covered for on-network (refer to section 12.10).
[R-12.17.2-003]	FRMCS positioning accuracy requirements according to chapter 12.14 shall apply to On-network and Off-network communication.	A/T	TS 22.261	Partly covered for on-network (refer to section 12.14).
[R-12.17.2-004]	The FRMCS System requirements applicable for communication recording as specified in the recording and access application use cases shall apply to On-network and Off-network communication.	A/T	TS 22.280	See gap analysis of sub-clause 6.10.
[R-12.17.2-005]	FRMCS On-network communication shall support the flexible use of different radio bearers (see Bearer Flexibility).	A/T	TS 22.278 TS 22.261 TS 22.280	TS 22.280 See sub-clauses in chapter 5 and 6
[R-12.17.2-006]	FRMCS Equipment shall support On-network only as well as On-and Off-network relay communication.	T	TS 22.278 TS 22.261 TS 22.280	22.278 – sub-clause 7A: Mode 1 covered by ProSe UE-to-Network relay (single-hop relay with UE-to-Network relay UE between remote UE and gNb) Mode 2 not covered by ProSe UE-to-UE Relay (multi-hop relays not covered) Mode 3 not covered (multi-hop relays not covered). 22.261: UE-to-Network Relay not covered in 5GS. 22.280 [R-7.11-001]: use of off-net and on-net MCX Services simultaneously
[R-12.17.2-007]	FRMCS shall be able to support Off-network communication that tide over a distance between FRMCS UE's of up to 3km.	T	TS 22.289	Covered by table 5.2.2-2 (relevant for Off-Network MCDATA Service only)
[R-12.17.2-008]	FRMCS Equipment shall support Off-network only as well as Off-network relay communication.	T	TS 22.278 TS 22.261 TS 22.280	22.278 – sub-clause 7A: Mode 1 covered by ProSe UE-to-Network relay (single-hop relay with UE-to-Network relay UE between remote UE and gNb) Mode 2 not covered by ProSe UE-to-UE Relay (multi-hop relays not covered) Mode 3 not covered (multi-hop relays not covered). 22.261: UE-to-Network Relay not covered in 5GS. 22.280 [R-7.11-001]: use of off-net and on-net MCX Services simultaneously

## 12.18 Call restriction service

### 12.18.1 Description

Call restriction based on location information and/or user identity is widely used in China railway market. It is proposed that FRMCS supports this service. This service restricts calls outside specific area according to the location information and/or user identity.

### 12.18.2 Pre-conditions

FRMCS user is attached to the FRMCS system.

### 12.18.3 Service Flows

Scenario 1: The dispatcher calls the driver; the call shall be allowed in the area managed by the dispatcher according to the location information (i.e. calls outside area managed by dispatcher are restricted)

Scenario 2: The user calls the dispatcher, whether the call is allowed or restricted depends on the user identity.

### 12.18.4 Post-conditions

If the driver is located within the area managed by the dispatcher, the call is allowed.

If the driver is outside the area managed by the dispatcher, the call is restricted.

Only an authorised user (e.g. the driver) is able to initiate the call to dispatcher, calls from other users to dispatcher will be restricted.

### 12.18.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.18-001]	The FRMCS System shall be able to support the call restriction service taking into account the user identity and/or location information.	A	22.280	Covered by R-5.9a-020, R-5.9a-021, R-5.11-0XX, in particular R-5.11-007 and R-5.11-009

## 12.19 Allocation and isolation of FRMCS communication resources

### 12.19.1 Introduction

Rail communication distinguishes between critical, performance and business applications. It is an essential task of the FRMCS System to support segregation of data transmission, in this context the isolation of railway application data utilizing the same available transport resources. The principle of segregation of data transmission applies to:

- FRMCS communication infrastructure may be shared by multiple railway undertakings;
- Different railway applications of one railway undertaking require isolated and customized communication resources (transport resources and functionalities) for each application.

In general, it is anticipated that isolated transport services can be provided with a predictable and guaranteed QoS.



## 12.19.2 Use case: Isolation of FRMCS communication resources

### 12.19.2.1 Description

#### **Scenario 1: Isolation for individual railway undertakings**

An FRMCS System infrastructure manager may have to host different railway undertakings. Due to isolation reasons, these railway undertakings require segregation of their communication and a predictable and guaranteed QoS.

#### **Scenario 2: Isolation among categories of applications belonging to one railway undertaking**

Railway community has classified their application to different categories, i.e. critical, performance and business. Due to isolation reasons, the related communications require segregation of data transmission having a predictable and guaranteed QoS for the different categories of applications.

### 12.19.2.2 Pre-conditions

#### **General**

Segregation of data transmission is supported by the FRMCS system.

#### **Scenario 1: Isolation reasons for individual railway undertakings**

Railway undertakings need their own segregated transport resources and network functionalities needed for their communications.

#### **Scenario 2: Isolation among categories of applications belonging to one railway undertaking**

Railway undertaking assigns each application category to their own segregated transport resources and network functionalities needed for their communications.

### 12.19.2.3 Service flows

#### **Scenario 1: Isolation reasons for individual railway undertakings**

Each railway undertaking in a country utilises dedicated and isolated transport resources and network functionalities.

#### **Scenario 2: Isolation among categories of applications belonging to one railway undertaking**

Each application category of one railway undertaking utilises dedicated and isolated transport resources and network functionalities.

### 12.19.2.4 Post-conditions

#### **Scenario1**

Each railway undertaking in a country obtains dedicated and segregated transport resources and network functionalities.

#### **Scenario2**

Each application category of one railway undertaking obtains dedicated and segregated transport resources and network functionalities.

### 12.19.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.19.2.5-001]	The FRMCS System shall be able to support the segregation of transport data for different application categories.	A/T	22.261, clause 4	“Flexible network operations are the mainstay of the 5G system. The capabilities to provide this flexibility include network slicing, network capability exposure, scalability, and diverse mobility. Other network operations requirements address the necessary control and data plane resource efficiencies, as well as network configurations that optimize service delivery by minimizing routing between end users and application servers.”
[R-12.19.2.5-002]	The FRMCS System shall support dedicated QoS handling for segregation of transport data.	T	22.261 clause 6.1.1	“Network slicing allows the operator to provide customised networks. For example, there can be different requirements on functionality (e.g., priority, charging, policy control, security, and mobility), differences in performance requirements (e.g., latency, mobility, availability, reliability and data rates), or they can serve only specific users (e.g., MPS users, Public Safety users, corporate customers, roamers, or hosting an MVNO).”

## 12.20 FRMCS Equipment capabilities for multiple FRMCS Users

### 12.20.1 Introduction

For communication, rail vehicles today have a dedicated terminal approach. For each type of application, voice or data (e.g. ATP), one (1:1) or several mobile terminals (1: n) are used. Multiple Mobile Terminals for one application are required for operational or availability reasons.

With the introduction of the FRMCS System, the number of applications will multiply. More recent train compositions already have a large number of sensors whose information is exchanged for control or diagnosis between the vehicle and the ground control centre.

With the continuation of the 1:1 principle (application equals mobile terminal) this would correspond to a multiplication of the mobile terminals. In addition, the space required for mobile terminals and roof antennas would significantly increase.

## 12.20.2 Description

In the case of vehicle/train composition, FRMCS Users can take full advantage of the transport facilities of the 3GPP system while ensuring priority, latency and reliability for each communication. FRMCS User and the associated communication applications need to be decoupled from the FRMCS Equipment.

## 12.20.3 Pre-conditions

At least one FRMCS Equipment is installed at the vehicle/train that provides transport capabilities between vehicle/train to ground or vice versa.

## 12.20.4 Service flows

Multiple FRMCS Users starts communication, for example:

- ATP;
- ATO;
- Sensor information exchange.

## 12.20.5 Post-conditions

FRMCS Users on the vehicle/train are able to communicate to FRMCS Users on the ground or to other vehicles/trains.

## 12.20.6 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.20.6-001]	Multiple FRMCS Users in the vehicle/train shall be able to use one FRMCS Equipment simultaneously.	A/T	TS 22.280	TS 22.280 sub-clause 5.15 5.15-001
[R-12.20.6-002]	The service capabilities of an FRMCS Equipment shall be attributable individually to multiple FRMCS Users.	A/T	TS 22.280	TS 22.280 [R-5.15-002] & [R-5.15-003]
[R-12.20.6-003]	When an FRMCS Equipment is simultaneously used by multiple FRMCS Users, the communication for each of the FRMCS Users shall receive its required priority and QoS (latency and reliability) within the FRMCS System.	T	TS 22.280	TS 22.280 [R-5.15-003] [
[R-12.20.6-004]	When an FRMCS Equipment is simultaneously used by multiple FRMCS Users, each of the FRMCS Users shall be individually addressable.	A	TS 22.280	TS 22.280 [R-5.15-002]

## 12.21 FRMCS System/FRMCS User roaming capabilities

### 12.21.1 Introduction

FRMCS Roaming use cases address the ability for an FRMCS User to make use of FRMCS Applications when he is provided service by a network different from his Home FRMCS Network. A specific use case applies for FRMCS Functional Identities (see 12.21.3 use case).

It is essential for the operation of international trains, transporting passenger or freight across borders, that FRMCS Users are using the capabilities and services of other FRMCS networks.

The situations envisaged also encompass situations where trains are moving to an area where a dedicated FRMCS network has been deployed for an urban area, for a region, for a rail track operated by a different company in a tunnel, in a large industrial area.

Other cases are pertinent for rail operation such as trains running in countries or regions where communications services provided by the local responsible Rail Infrastructure Manager are different from the one where they have subscription or where service can only be provided by a Public Mobile Network Operator.

FRMCS Roaming capabilities are necessary to ensure that Railways Undertaking will be able to use a single FRMCS Equipment for their FRMCS Users while roaming.

## 12.21.2 Use case: FRMCS User is relocating towards a Visited (FRMCS) Network

### 12.21.2.1 Description

This use case addresses the situation where an FRMCS User is moving beyond the coverage of its Home FRMCS Network and where communications services can be provided by another Visited (FRMCS) Network. Following scenarios for an FRMCS User are:

- Relocation from Home FRMCS Network to a Visited (FRMCS) Network and vice versa;
- Relocation from a Visited (FRMCS) Network to another Visited (FRMCS) Network.

### 12.21.2.2 Pre-conditions

The Visited (FRMCS) Network is capable to retrieve FRMCS Users information from applicable Home FRMCS network.

### 12.21.2.3 Service flows

FRMCS User is relocating from Home FRMCS Network to Visited (FRMCS) Network, or from a Visited (FRMCS) Network to another Visited (FRMCS) Network.

FRMCS User makes use of FRMCS Applications that are applicable in the Home FRMCS Network and the FRMCS Application that are applicable in the Visited (FRMCS) Network.

### 12.21.2.4 Post-conditions

FRMCS User is able to use FRMCS Applications after relocating to a Visited (FRMCS) Network.

FRMCS User has not experienced service interruption of FRMCS Application while relocating.

### 12.21.2.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.21.2-001]	The FRMCS System shall provide the technical means to allow communication services between FRMCS Users that are belonging to different administrative realms of the FRMCS System i.e. Home FRMCS Network and Visited (FRMCS) Network.	A/T	T TS 22.261 A TS 22.280	T sub-clause 5.1.2.1 T sub-clause 5.1.2.2 A sub-clause 6.17.2
[R-12.21.2-002]	The FRMCS System shall provide communication services to FRMCS Users visiting another administrative realm i.e. Visited (FRMCS) Network.	A/T	T TS 22.261 A TS 22.280	T sub-clause 5.1.2.1 T sub-clause 5.1.2.2 A sub-clause 6.17.2
[R-12.21.2-003]	The FRMCS System shall support a mechanism for an administrator to determine if a FRMCS User is able to use communication services in the Visited (FRMCS) Network.	A/T	T TS 22.261 A TS 22.280	T sub-clause 5.1.2.1 A sub-clause 6.17.2
[R-12.21.2-004]	The FRMCS System shall be able to provide service continuity when relocating between FRMCS Network without the FRMCS User noticing the change.	A/T	T TS 22.261 A TS 22.280	T sub-clause 6.18.2 A sub-clause 6.17.2
[R-12.21.2-005]	The FRMCS system shall be able to provide the same Quality of Service for the use of FRMCS Applications regardless of whether the FRMCS User is using the Home FRMCS Network or Visited (FRMCS) Network.	A/T	T TS 22.261 A TS 22.280	T sub-clause 5.1.2.1 A sub-clause 6.17.2

## 12.21.3 Use case: Functional Identities in FRMCS Roaming situations

### 12.21.3.1 Description

This use case addresses the situation where an FRMCS User or FRMCS Equipment is moving beyond the coverage of its Home FRMCS Network and where communications services can be provided by another Visited (FRMCS) Network.

An FRMCS User or FRMCS Equipment in FRMCS Roaming situations (referring to 12.21.2 use case) shall be able to make use of FRMCS Functional Identities, from its Home FRMCS Network and, when applicable, from Visited (FRMCS) Networks. For instance, an FRMCS User or FRMCS Equipment in a train can be registered to a permanent FRMCS Functional Identity with its Home FRMCS Network (associated with the engine), and an FRMCS Functional Identity registered with a Visited (FRMCS) Network. For train cross border operations (e.g. FRMCS Roaming situations), some registered FRMCS Functional Identities shall remain valid for the duration of the train international run, the same FRMCS Functional Identity keeping the same association to FRMCS Equipment while border crossing.

Each FRMCS Network shall maintain its own FRMCS Functional Identity addressing scheme. For the purpose of FRMCS roaming, an international FRMCS Functional Identity scheme will be used and national scheme will align on it. If a train (e.g. an FRMCS User) is involved in cross border operation, the FRMCS System shall detect automatically if an activated FRMCS Functional Identity requires a re-association to the local applicable addressing domain. The responsible local functional addressing entity in the Visiting (FRMCS) Network aligns the Home FRMCS Network functional addressing entity about FRMCS Functional Identity re-association. The activation status of the re-associated

FRMCS Functional Identity will be aligned accordingly. The responsible entity of the functional address is keeping the status (active/inactive).

### 12.21.3.2 Pre-conditions

FRMCS User is registered to at least one FRMCS Functional Identity F1 with its Home FRMCS Network.

FRMCS Equipment is associated with a permanent Functional Identity administrated by the Home FRMCS Network.

The Visited (FRMCS) Network is capable to retrieve FRMCS Users information from applicable Home FRMCS network.

### 12.21.3.3 Service flows

FRMCS User is relocating from Home FRMCS Network to Visited (FRMCS) Network, or from a Visited (FRMCS) Network to another Visited (FRMCS) Network.

FRMCS Users and FRMCS Equipment register to at least one FRMCS Functional Identity F2 with the Visited (FRMCS) Network.

FRMCS User makes use of FRMCS Functional Identities associated with the Home FRMCS Network, at least F1, and the FRMCS Functional Identities associated with the Visited (FRMCS) Network, at least F2.

### 12.21.3.4 Post-conditions

An FRMCS User and FRMCS Equipment in FRMCS Roaming situations are able to use FRMCS Functional Identities associated with both Home FRMCS Network and Visited (FRMCS) Networks.

### 12.21.3.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.21.3-001]	The FRMCS System shall be able to establish communication services based on FRMCS Functional Identity(ies) between FRMCS Users or FRMCS Equipment associated with different FRMCS Networks.	A/T	TS 22.280	For communication TS 22.280, subclause 6.17.2 requirements [R-6.17.2-004] , [R-6.17.2-005], [R-6.17.2-006] Functional alias: TS 22.280 subclause 5.9a, requirements [R-5.9a-001] up to [R-5.9a-002a]
[R-12.21.3-002]	The FRMCS System shall be able to establish a communication services based on FRMCS Functional Identity(ies) associated with different FRMCS Networks.	A/T	TS 22.280	For communication TS 22.280, subclause 6.17.2 requirements [R-6.17.2-004] , [R-6.17.2-005], [R-6.17.2-006] Functional alias: TS 22.280 subclause 5.9a, requirements [R-5.9a-001] up to [R-5.9a-002a]
[R-12.21.3-003]	The FRMCS System shall provide the necessary means for a FRMCS User or FRMCS Equipment to register and deregister FRMCS Functional Identity(ies) with the Home FRMCS Network and/or with the Visited (FRMCS) network.	A/T	TS 22.280	For communication TS 22.280, subclause 6.17.2 requirements [R-6.17.2-004] , [R-6.17.2-005], [R-6.17.2-006] Functional alias: TS 22.280 subclause 5.9a, requirements [R-5.9a-001] up to [R-5.9a-002a]
[R-12.21.3-004]	When the FRMCS User or FRMCS Equipment is relocating between networks, the FRMCS System shall provide a mechanism to perform necessary registration/deregistration of one or multiple FRMCS Functional Identity(ies) with the Visited (FRMCS) Network operator and inform the Home FRMCS Network.	A/T	TS 22.280	For communication TS 22.280, subclause 6.17.2 requirements [R-6.17.2-004] , [R-6.17.2-005], [R-6.17.2-006] Functional alias: TS 22.280 subclause 5.9a, requirements [R-5.9a-001] up to [R-5.9a-002a]

## 12.22 Use case: Availability – increasing measures

### 12.22.1 Description

In some regions railways are a major constituent for the economy. Disturbance in the complex railway system can have a significant impact for example in the manufacturing process if components cannot be delivered in-time. There are significant improvements in train punctuality and track utilisation by using Automatic Train Protection (ATP) systems. Unavailability of the FRMCS System, FRMCS sub-systems or simple components can cause a significant impact to railway operation.

ATP provides different levels of operation. The moving block mode is the most demanding one that requires multiple times more information in one second, e.g., position reports from the train towards the ground controlling entity which computes continuously the risk that consecutive trains can collide.

In order to minimise the risk of FRMCS System unavailability, Single Point of Failures (SPOF) need to be eliminated. There are different strategies such as duplication of components, subsystems or the entire system. The mode of system redundancy ranges from hot-standby, warm-standby to cold-standby. Hot-standby is the most demanding mode and requires an instantaneous continuation of the end-to-end service. Also the use of only one spectrum block represents a SPOF. In case one spectrum block become unavailable due to wideband jamming or similar, the FRMCS System needs to be able to make flexible use of spectrum to minimize the risk of radio path unavailability.

FRMCS System or sub-system maintenance may cause outages of some minutes or hours. Today, a high utilisation of rail tracks already reduces the number of maintenance windows. A redundant deployment of the radio access sub-system allows continuation of rail operation while one part of radio access sub-system is under maintenance.

## 12.22.2 Pre-conditions

The basis for setting up the FRMCS System takes into account the elimination of Single Point Of Failure which encompasses:

- Usage of multiple independent spectrum blocks;
- Duplication of system functionalities/entities of the FRMCS System.

## 12.22.3 Service flows

### Case 1:

During train control operation, some portion of the used spectrum block is disturbed, e.g., through interference from an external source.

### Case 2:

During train control operation a FRMCS sub-system fails or has been put under maintenance.

## 12.22.4 Post-conditions

The communication service continues without interruption.

Train operation efficiency is not affected in any way despite the disturbances caused by:

- Interference (intentional or unintentional);
- Unavailability of FRMCS sub-systems due to planned (maintenance) or unplanned (outage) reasons.

## 12.22.5 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.22-001]	The FRMCS System shall be able to provide a mechanism to allow redundancy of transmission paths making use of multiple spectrum blocks.	T	Covered in TS 22.261 chapter 7.2 by referring to TS 22.289	The reliability figures for rail is included in 22.289 (KPI for rail) and referenced in 22.261 sub-clause 7.2 on low latency and high reliability.
[R-12.22-002]	The FRMCS System shall provide a mechanism that minimizes the risk of single point of failure.	A/T	Covered in TS 22.261 chapter 7.2 by referring to TS 22.289	The reliability figures for rail is included in 22.289 (KPI for rail) and referenced in 22.261 sub-clause 7.2 on low latency and high reliability.

## 12.23 Use case: Flexible use of available contiguous spectrum blocks(s) and related bandwidth(s)

### 12.23.1 Introduction

Globally, different contiguous spectrum block(s) with related bandwidth(s) may be available for rail communication in different areas. An FRMCS Equipment may also support different contiguous spectrum block(s) with related bandwidth(s) than the infrastructure deployed in the area. The use case addresses the general requirements related to the ability of the FRMCS System to flexibly use the maximum extent of rail spectrum available in an area, also considering the capabilities of the FRMCS Equipment that is served.



## 12.23.2 Description

It is essential that the FRMCS system can flexibly utilize the available bandwidth of the contiguous spectrum block(s), for both On-network and Off-network communication, also considering the contiguous spectrum block(s) and related bandwidth(s) supported by served FRMCS Equipment.

## 12.23.3 Pre-conditions

In certain areas, specific contiguous spectrum block(s) and related bandwidth(s) are available for rail communication. An FRMCS Equipment served in the area supports (possibly different) specific contiguous spectrum block(s) and their related bandwidth(s).

## 12.23.4 Service flows

The FRMCS System obtains information about the specific contiguous spectrum block(s) and their related bandwidth(s) supported by the FRMCS Equipment.

The FRMCS System allocates the locally available contiguous spectrum block(s) and their related bandwidth(s), and serves FRMCS Equipment according to its supported contiguous spectrum block(s) and their related bandwidth(s).

## 12.23.5 Post-conditions

The FRMCS System is able to flexibly use the maximum extent of rail spectrum available in a given area, also considering the capabilities of the FRMCS Equipment that is served.

## 12.23.6 Potential requirements and gap analysis

Reference Number	Requirement text	Application / Transport	SA1 spec covering	Comments
[R-12.23-001]	The FRMCS System shall be able to support for individual contiguous spectrum blocks, bandwidths less than 5 MHz (e.g. 1.4 MHz or 3 MHz).	T	N/A	Covered by RAN specifications: <ul style="list-style-type: none"> <li>• Covered by E-UTRA,</li> <li>• Not covered by NR.</li> </ul>

# 13 Potential New Requirements

This chapter lists the potential new requirements that have been considered for introduction in Rel-15 normative specifications. Only parts of “9.3 Role management and presence” and “9.7 Multiuser talker control related use cases” were introduced. All other requirements identified in the TR above but not listed below are not covered in Rel-15.

The third column “SA1 spec covering” identifies the specification and the requirement number within that specification where the 22.889 requirement with the number as specified in the first column of the table is covered. The fourth column provide additional explanation if needed.

# 14 Conclusion and Recommendations

This TR provides use cases and potential requirements for Railway Communication. It is proposed to start normative work based on these potential requirements.

Where applicable, it is proposed to include the requirements identified by this work into the set of existing stage 1 missing critical and other specifications.

Requirements not fitting to any existing specification are proposed to go into a new TS.

## Annex A: Examples of Role management

This annex gives some examples on how Role management is used in the railway environment. This is to better understand the use.

### **Functional identity**

Every operational railway function e.g. train driver, a shunter or Controller is identified by their functions. A non-exhaustive list is provided in the table underneath.

<b>Functional identities</b>
Leading train driver
Driver 2
Driver 3
Shunting leader
Shunting member
Track side maintenance leader
Track side maintenance member
Primary train controller
Secondary train controller
Power controller
Shunting controller
Trackside maintenance controller
Platform inspector
Public announcement
Chief conductor
Second conductor
Third conductor
Catering staff chief
Diagnostics

In order to make a function of a user known to other users, the user has to register itself to a specific functional identity.

For example, user can be authorised by the railway undertaking to be a train driver (functional Role) of a train. When the Driver starts the scheduled train ride, from A to B at time x, the train running schedule assigns a specific train running number for this train. In principle the train keeps this number for the complete journey. The train driver uses his communication equipment to register himself, as the leading train driver (functional Role), of train number 123 (functional identity). After registration the train driver is now registered to the FRMCS System as the leading train driver of train 123. In some cases there can be multiple Drivers on one train, so the individual Drivers can register themselves accordingly.

### **FRMCS Equipment Type**

The equipment used in the railway environment can be very specific. The FRMCS Equipment is constituted of an UE and the FRMCS Application on this UE. This depends on the location and situation the equipment is used. The following different equipment types can be used, as an example:

Equipment type	Equipment Capabilities (Examples)
Cabin radio	Emergency button, external loudspeaker
Shunting radio	Loudspeaker, hands free
Trackside maintenance radio	
Security staff radio	Emergency button, public emergency call button
Catering staff radio	
Train controller device	Emergency button, call to maintenance staff button, call to power controllers button
Shunting controller device	
Sensor	No HMI

These different types of FRMCS Equipment are relevant for the registration process of functional identities. For example a train driver cannot register to a functional identity using a FRMCS Equipment which is not fit for the train driver to perform his Role. So a train driver cannot perform a registration as train driver of train 123 if he uses a catering staff FRMCS Equipment (where there is no train emergency button available, no loudspeaker and handset, etc.). The registration request will be rejected by the FRMCS System.

The FRMCS Equipment shall also be reachable based on the identity of the FRMCS Equipment. For example the cabin radio of a specific train can be reached by their FRMCS Equipment Identity.

#### **FRMCS User identity**

The railway employee (a specific person) is also reachable even if no functional identity has been assigned. This is done by using a unique FRMCS User identity. This can be an E.164 number, any other number according to a specific railways numbering plan or by fully qualified domain names (FQDN). Such a number or FQDN is dedicated/ assigned to a specific railway employee. After the employee has performed the log-in procedure to the FRMCS System, he is reachable via his individual FRMCS User identity.

## Annex B: Minimum functional and performance requirements for FRMCS from a perspective of Korea LTE-based railway services

In this annex, minimum functional and performance requirements [5]-[6] are introduced for FRMCS from a perspective of Korea's LTE-based railway services. Here, the term 'minimum' is used from the fact that the requirements are expected to be satisfied even with previous Rel. version of 3GPP LTE. Specifically, all the functionalities and performance requirements except for the high speed (500km/h) listed in the above have been shown to be fully supported by LTE Rel. 9, which have been validated in a commercial railway with a length of 54.2km [7]. Also, train control service named as Korea Radio-Based Train Control System (KRTCS) has been shown to be feasible by handling priorities among multiple data, where the level of KRTCS is equivalent to European Train Control System (ETCS) level 3 in a train control perspective. All the specific test scenarios regarding functional and performance requirements including KRTCS have been validated in a commercial railway [8]. For promising FRMCS supporting LTE Rel. 15, more enhanced and sophisticated requirements should be provided. In that sense, these requirements can be considered as basic functional and performance requirements for FRMCS.

### Minimum functional requirements

In a communication perspective, the followings can be minimum functional requirements for LTE based railway communication systems. The contents of each function and each digital radio equipment are described in detail in [5]-[6].

Service	Detailed service	Description	Mandatory/Optional
<b>Voice service</b>	<b>Individual voice call</b>	<b>The system shall support voice calling between two callers.</b>	<b>M</b>
	<b>Public emergency call</b>	<b>The system shall allow the user to make a public emergency call.</b>	<b>M</b>
	<b>Broadcasting voice call</b>	<b>The system shall support a broadcasting call.</b>	<b>M</b>
	<b>Group voice call</b>	<b>The system shall support a group call.</b>	<b>M</b>
	<b>Multi-party voice call</b>	<b>The system shall support a multi-party call between at least 3 different parties.</b>	<b>M</b>
<b>Data service</b>	<b>Multimedia message service</b>	<b>The network shall support point-to-point and point-to-multi-point message transmission from the ground to mobile radio equipment users.</b>	<b>M</b>
	<b>General data service</b>	<b>The system shall support broadband data communication between ground and mobile radio equipment users.</b>	<b>M</b>
	<b>Train control service</b>	<b>The system shall support seamless data communication for stable train control.</b>	<b>M</b>

Service	Detailed service	Description	Mandatory/Optional
Video service	Individual video call	The system shall support video calling between two callers.	M
	Group video call	The system shall support group video calling.	M
	Video information transmission	The system shall support the video information transmission function related to safe train operation.	M
Call related service	Receiver /Caller ID display	The equipment shall display the receiver or caller ID in the form of a standard telephone number.	M
	Receiver /caller ID display restriction	The system shall allow the ID of a specific user to be prevented from being displayed on the mobile radio equipment.	O
	Priority and preemptive right	A function in which a call is allocated to the member who has top priority among the members who have different priority levels shall be provided.	M
	Closed user group	The user group who can access the Korean railway integrated radio network from outside shall be restricted.	M
	Call transfer	The incoming call or data message for one user shall be transferred to other devices in the network.	M
	Call holding	The network shall allow the user to hold a call temporarily from an existing call.	M
	Call waiting	The network shall be able to notify the user of the existing call that another user is attempting to access.	M
	Charging information	When there is a network service charge, the network shall be able to provide the information on call charge and ongoing call charges.	O
	Call restriction	The system shall be able to restrict a call using the network management or maintenance facility.	M
	Automatic answering service	A call shall be answered automatically according to the priority of an incoming call.	M
	All voice/ Video call recording	A call shall be answered automatically according to the priority of an incoming call.	M

Service	Detailed service	Description	Mandatory/Optional
<b>Railway specialized service</b>	<b>Functional addressing</b>	<b>The system shall provide the addressing system in which the Controller can set communication with the train driver using train number</b>	<b>M</b>
	<b>Location-dependent addressing</b>	<b>The system shall provide the location-dependent addressing system in order to identify the destination number, which varies depending on the location of users</b>	<b>M</b>
	<b>Railway emergency call</b>	<b>The network shall provide the system to handle a voice call with high priority for a railway emergency call</b>	<b>M</b>
	<b>Shunting mode</b>	<b>The network shall provide the system to regulate and control the user's access to the function and features of mobile radio equipment being used for shunting mode communication</b>	<b>M</b>
	<b>Direct communication</b>	<b>The system shall support direct communication between terminals in the event that an LTE-based railway communication service is not normally available due to a failure in eNb.</b>	<b>O</b>

### Minimum performance requirements

In the following table, specific performance requirements are listed as a base line of performance requirements for real FRMCS. The detailed performance of a railway communications system and the contents of the interface for each equipment are described in detail in [5]-[6].

Items	Description	Remarks
<b>Coverage and performance</b>	<p>Coverage shall be continuous from a time and space perspective, and the temporal and spatial range to guarantee stability shall be more than 98% based on the vehicle being equipped with an external antenna.</p> <p>The network shall be able to accommodate the mobile terminal for railway communication.</p> <p>The system shall be able to provide communication when moving at track speed limit or 500 km/h, whichever is lower.</p>	
<b>Call setting time</b>	<p>Railway emergency call &lt; 1s (90%), &lt; 2s (99% or more)</p> <p>Broadcasting or group call &lt; 1s (90%), &lt; 2.5s (99% or more)</p>	<p>*</p> <p>External PSTN connection not considered</p>
<b>Handover</b>	<p>The network shall be able to have seamless data transmission, and the handover success rate shall be 99%</p>	
<b>Call access success</b>	<p>The call access success rate shall be 99% or more.</p>	
<b>Connection drop rate</b>	<p>The system shall be able to guarantee a call disconnection rate less than 0.01 times per hour during a lengthy call</p>	
<b>Train control data transmission</b>	<p>The network shall guarantee more than 99% data reliability to transmit data for train control.</p> <p>Train control data shall have top priority.</p>	
<b>Network redundancy</b>	<p>The network including eNb equipment, core equipment and server shall be designed to be redundant for stability and availability.</p>	<p>However, the application scope of redundancy is determined by the operator.</p>
<b>Broadcasting and group call area</b>	<p>Radio equipment in a restricted area can participate in broadcasting and group call, and the radio equipment out of broadcasting and group call area during call shall be excluded from call.</p>	

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## Annex C: Applicability to On-network/Off-network communication

The different types of communication and support applications related to On-Network and Off-Network are covered by the table below:



Section	Use case	Applicability to On-Network	Applicability to Off-Network
5.3	Power on the UE	Yes	Not applicable
5.4	Access to the FRMCS System to activate the FRMCS Equipment	Yes	Not applicable
5.5	Controlled power down of UE	Yes	Not applicable
5.6	Uncontrolled power down UE	Yes	Not applicable
6.2	Multi-train voice communication for Drivers and Ground FRMCS User(s)	Yes	Yes
6.3	On-train outgoing voice communication from the Driver towards the Controller(s) of the train	Yes	No
6.4	Railway emergency communication	Yes	No
6.5	Automatic Train Protection (ATP) support by the FRMCS System	Yes	No
6.6	Trackside Maintenance Warning System communication		
	6.6.2	Yes	Yes
	6.6.3	Yes	Yes
6.7	Pushed Real Time Video streaming	Yes	No
6.8	Public emergency call	Yes	No
6.9	Data communication for possession management	Yes	No
6.10	Recording of communication		
	6.10.2	Yes	Yes
6.11	Remote control of engines communication		
	6.11.2	Yes	Yes
6.12	Automatic Train Operation data communication		
	6.12.3	Yes	Yes
6.13	Monitoring and control of critical infrastructure	Yes	No
6.14	Data transmission in real time	Yes	No
6.15	On-train incoming voice or video communication from the Controller(s) of the train towards the drivers	Yes	No
6.16	Data communication for Train Operation System Communication		
	6.16.2	Yes	No
	6.16.3	Yes	Yes
	6.16.4	Yes	Yes
6.17	On-train safety device to ground communication	Yes	No
6.18	Train Integrity monitoring data communication		
	6.18.2	Yes	Yes
6.19	Broadcast of public emergency warning information	Yes	No

6.20	Safety related Critical advisory messaging		
	6.20.2	Yes	Yes
	6.20.3	Yes	No
6.21	Automatic Train Protection data communication	Yes	No
6.22	Voice communication transfer	Yes	No
7.1	Transmission of real time video	Yes	No
7.2	Transfer of CCTV archives	Yes	No
7.3	Massive Inter-carriage data transfer	Yes	Yes
7.5	On-train outgoing voice communication from train staff towards a ground user	Yes	No
8.2	Live streaming of multimedia	Yes	Yes
8.3	Bulk transfer of multimedia from ground to train	Yes	Yes
9.2	Assured voice communication (AVC)		
	9.2.2	Yes	Yes
	9.2.3	Yes	Yes
	9.2.4	Yes	Yes
	9.2.5	Yes	Yes
9.3	Functional identities and role management		
	9.3.3	Yes	Yes
	9.3.4	Yes	Yes
	9.3.5	Yes	Yes
	9.3.6	Yes	Yes
	9.3.7	Yes	Yes
	9.3.8	Yes	Yes
	9.3.9	Yes	No

9.4	Location services		
	9.4.2	Yes	Yes
	9.4.3	Yes	Yes
	9.4.4	Yes	Yes
9.5	FRMCS-user communication handling		
	9.5.2	Yes	Yes
	9.5.3	Yes	Yes
	9.5.4	Yes	Yes
	9.5.5	Yes	Yes
	9.5.6	Yes	Yes
9.7	Multiuser talker control		
	9.7.2	Yes	Yes
	9.7.3	Yes	Yes
	9.7.4	Yes	Yes
	9.7.5	Yes	Yes
	9.7.6	Yes	Yes
9.8.1	Robust mission critical group communications	Yes	Yes
9.8	Authorisation of communication		
	9.8.2	Yes	Yes
9.9	Authorisation of application		
	9.9.2	Yes	Yes <sup>1</sup>
	9.9.1	Yes	Yes
9.10	Sharing FRMCS Equipment by FRMCS Users	Yes	Yes
9.11	FRMCS naming authority	Yes	No
9.12	Wayside-Centric Automatic Train Control	Yes	No
9.13	Autonomous Train Control and Operation	Yes	Yes
9.14	Virtual Coupling	Yes	Yes
9.15	Composite-based train operation	Yes	Yes

9.16	Arbitration 9.16.2	Yes	Yes
9.17	Data communication to exchange key information for train safety application	Yes	No
11.1	Charging and Billing information	Yes	No

**Table C-1. Applicability to On-network/Off-network to use cases.**

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<sup>1</sup> A default profile shall be considered.

## Annex D: Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2020-09	SA#89	-	-	-	-	Created from TR 22.889, same technical content as TR 22.889 v.17.3.0	18.0.0
2021-03	SA#91e	SP-210200	0001	1	D	Align TR with SA1 drafting rules on Inclusive Language	18.1.0
2021-03	SA#91e	SP-210223	0002	1	C	Changes to Critical Support Applications "Inviting-a-FRMCS User to a voice communication" use case	18.1.0
2021-03	SA#91e	SP-210223	0003	1	C	Merging of Railway Emergency Communications	18.1.0
2021-09	SA#93e	SP-211049	0004	1	C	Changes to Critical Support Applications Inviting-a-FRMCS User to a voice communication use case to support Interworking with GSM-R	18.2.0
2021-09	SA#93e	SP-211049	0006	1	C	Changes to Critical Support Applications Multiuser talker control use case to support configurable initial talker permission	18.2.0
2021-12	SP-94	SP-211489	0008	2	C	Triggering a change of communication privileges for a particular FRMCS User based on identities and/or talker status	18.3.0
2021-12	SP-94	SP-211489	0009		C	Arbitration: automatic answer	18.3.0
2021-12	SP-94	SP-211489	0010	2	C	Alignment between Changing conditions of Railway Emergency Alert and Merging Railway Emergency Alert	18.3.0
2021-12	SP-94	SP-211489	0011		C	Service interworking between FRMCS and GSM-R of presence is no more required	18.3.0
2022-03	SP#95e	SP-220079	0012	1	B	Adding MCX Service Ad hoc Group Communication as alternative capability to support Railway Emergency Communication	18.4.0
2022-06	SA#96	SP-220430	15	1	F	Call restriction based on subparts of functional identities	18.5.0

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# History

<b>Document history</b>		
V18.5.0	May 2024	Publication