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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Railway Telecommunications (RT).

The present document is part 4 of a multi-part deliverable covering Building Blocks and Functions for the Future Railway Mobile Communication System (FRMCS), as identified below:

- Part 1: "Transport Stratum";
- Part 2: "Service Stratum";
- Part 3: "Train On-Board functions and interfaces";
- Part 4: "Trackside functions and interfaces";**
- Part 5: "User Equipment (UE) capabilities".

Modal verbs terminology

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1 Scope

The present document specifies non-3GPP network functions and interfaces applicable to the FRMCS Trackside Infrastructure.

The present document describes the trackside network architecture and proceeds with specifying the non-3GPP trackside network functional entities (such as the FRMCS Trackside Gateway), including functions, interfaces and procedures they need to comply to.

The present document does not consider message sequences within and between 3GPP and non-3GPP building blocks. These message sequences will be defined by related 3GPP specifications, ETSI FRMCS transport stratum definition and FRMCS service stratum definition documents or UIC FRMCS FIS [i.3] and UIC FRMCS FFFIS [1].

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

- [1] [UIC FFFIS-7950 \(V2.1.0\)](#): "FRMCS FFFIS Form Fit Functional Interface Specification".
- [2] [ETSI TS 103 765-2](#): "Rail Telecommunications (RT); Future Railway Mobile Communication System (FRMCS); Building blocks and functions; Part 2: Service Stratum".
- [3] [ETSI TS 103 765-1](#): "Rail Telecommunications (RT); Future Railway Mobile Communication System (FRMCS); Building blocks and functions; Part 1: Transport Stratum".
- [4] [ETSI TS 123 280 \(V18.12.0\)](#): "LTE; Common functional architecture to support mission critical services; Stage 2 (3GPP TS 23.280 version 18.12.0 Release 18)".
- [5] [ETSI TS 133 180 \(V18.1.0\)](#): "LTE; Security of the Mission Critical (MC) service (3GPP TS 33.180 version 18.1.0 Release 18)".
- [6] [ETSI TS 103 792](#): "Rail Telecommunications (RT); Future Railway Mobile Communication System (FRMCS); Interworking with GSM-R".
- [7] [ETSI TS 123 379 \(V18.12.0\)](#): "LTE; Functional architecture and information flows to support Mission Critical Push To Talk (MCPTT); Stage 2 (3GPP TS 23.379 version 18.12.0 Release 18)".
- [8] [ETSI TS 123 282 \(V18.10.0\)](#): "LTE; Functional architecture and information flows to support Mission Critical Data (MCData); Stage 2 (3GPP TS 23.282 version 18.10.0 Release 18)".
- [9] [ISO 8601 \(2019\)](#): "Date and time — Representations for information interchange".

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The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

- [i.1] ETSI TR 103 791: "Rail Telecommunications (RT); Future Railway Mobile Communication System (FRMCS); Terminology for FRMCS specifications".
- [i.2] UIC FW-AT 7800 (V2.1.0): "Future Railway Mobile Communication System - System Requirements Specification".
- [i.3] UIC FIS-7970 (V2.1.0): "Future Railway Mobile Communication System - Functional Interface Specification".
- [i.4] ETSI TS 124 229 (V18.7.0): "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3 (3GPP TS 24.229 version 18.7.0 Release 18)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI TR 103 791 [i.1] and the following apply:

Hosting Clients: MC Service Client located in FRMCS Trackside Gateway

NOTE: Hosting Client connects Loose-Coupled FRMCS applications to FRMCS system.

Reference point TAP TS: reference point represents the connection from FRMCS Trackside Gateway to transport core network(s) and to the FRMCS Service Server

TS_{APP} Application Context: context maintained by the FRMCS Trackside Gateway for an application instance (identified by the TS_{APP} application tuple), in between registration and de-registration

TS_{APP} application tuple (RegisterData): tuple of (appCategory, staticId, couplingMode) as specified in UIC FRMCS FFFIS-7950 [1], clause 10.8.1 and Annex B, clause A.3

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

DNS	Domain Name Server
FRMCS	Future Railway Mobile Communication System
H2H	Host-to-Host
H2N	Host-to-Network
HTTP	Hyper Text Transfer Protocol
IP	Internet Protocol

IWF	Interworking Function
JSON	JavaScript Object Notation
MC	Mission Critical
MCPTT	Mission Critical Push-To-Talk
MCX	Mission Critical Communications
NAT	Network Address Translation
SIP	Session Initiation Protocol
SSE	Server Sent Events
TAP TS	TAP Trackside
TAP	Transport Access Point
TS _{APP}	Trackside Application Reference Point
TS _{CTRL}	Reference point between VAS Controller Equipment and FRMCS System
VAS	Voice Application Subsystem

4 Trackside network architecture

FRMCS trackside architecture consists of at least one FRMCS Transport Domain (as described in ETSI TS 103 765-1 [3], clause 4.2) and zero or more non-FRMCS Transport Domains. The FRMCS Service Domain (as described in ETSI TS 103 765-2 [2], clause 5.1) enables communication as services between two or multiple FRMCS Users for voice and data applications. The Service Stratum is specified over the 3GPP Mission Critical Communications (MCX) Framework and decouples the application from the underlying transport networks.

The focus of clause 5 is the FRMCS Trackside Gateway, which provides access to communication and complementary services supported by the FRMCS System to and from trackside applications.

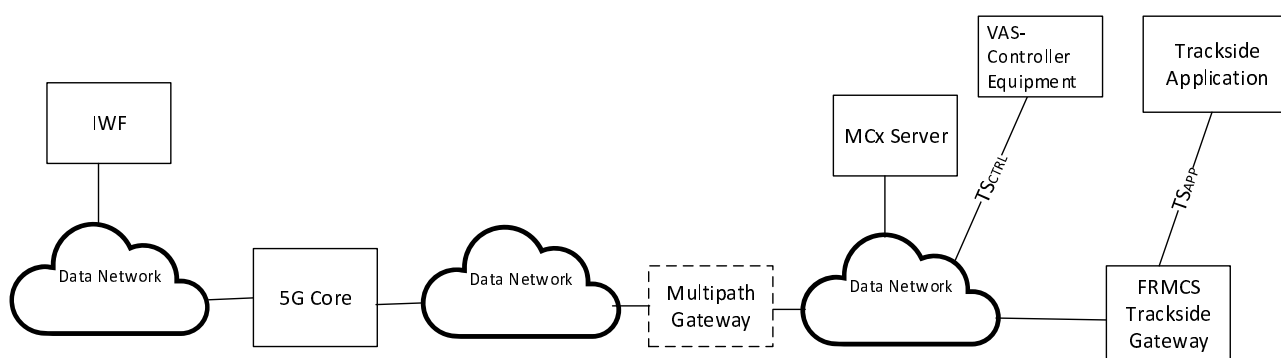
The IWF provides centralized support for interworking between an MCPTT or MCDATA system and a GSM-R system specified in ETSI TS 103 792 [6], clause 5.

Figure 4-1 shows the FRMCS trackside architecture.

The TS_{APP} reference point in Figure 4-1 is described in UIC FRMCS FFFIS-7950 [1] (Form Fit Functional Interface Specification).

The TS_{APP} reference point supports the coupling modes for FRMCS (outlined in UIC FRMCS SRS (FW-AT 7800) [i.2]) defined in ETSI TR 103 791 [i.1].

The TS_{CTRL} reference point is described in clause 7 of the present document.



NOTE: Multipath Gateway can be combined with the FRMCS Trackside Gateway. The selected deployment option is the choice of the FRMCS operator.

Figure 4-1: FRMCS trackside architecture

5 FRMCS Trackside Gateway

5.1 General

The FRMCS Trackside Gateway is a logical component which is used to host specific functions.

The FRMCS Trackside Gateway is the logical symmetrical component to the On-Board FRMCS. It is the link between the Transport Network and the Application at the infrastructure side (see UIC FRMCS SRS (FW-AT 7800) [i.2], Figure 6-4).

NOTE: Implementors have the choice of combining the FRMCS Trackside Gateway functionalities with the functionalities of the Multipath Gateway as specified in ETSI TS 103 765-1 [3], clause 5.3. In this case, the combined entity inherits the Reference points from both the FRMCS Trackside Gateway (TS_{APP} and TAP TS) and from the Multipath Gateway (TAP Service Agents and FS_{MPM}).

5.2 FRMCS Trackside Gateway architecture

The functional architecture of FRMCS Trackside Gateway is illustrated in Figure 5.2-1. The FRMCS Trackside Gateway links the trackside application.

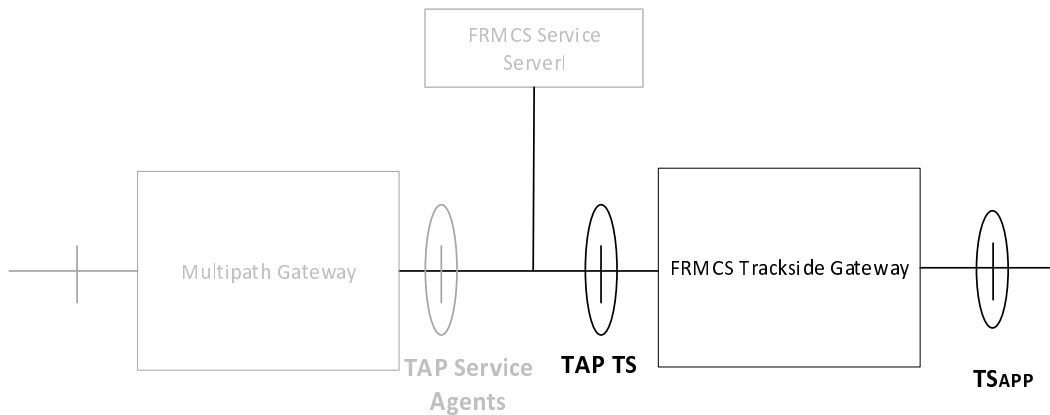


Figure 5.2-1: Functional architecture of FRMCS Trackside Gateway

The generic reference points of the FRMCS Trackside Gateway are shown in Figure 5.2-1:

- TS_{APP} .
- TAP TS (TAP Trackside).

Reference point TS_{APP} : This reference point represents the connection from the FRMCS Trackside Gateway to the Application(s). The TS_{APP} reference point is specified in UIC FRMCS FFFIS [1]. The behaviour expected from the FRMCS Trackside in relation with TS_{APP} is specified in clause 6.3.

Reference point TAP TS: This reference point represents the connection from FRMCS Trackside Gateway to transport core network(s) and to the FRMCS Service Server. It consists of a control plane and a user plane and is defined as per FRMCS Service Stratum based on MCX control plane (FRMCS Service Control Plane) and MCX user plane (FRMCS Service User Plane) client interfaces and information flows.

5.3 FRMCS Trackside Gateway functionalities

The FRMCS Trackside Gateway hosts the FRMCS Service Stratum functions when the FRMCS Trackside Gateway is configured to serve a Loose-Coupled Application (including H2H and H2N models). The detailed functional architecture of the FRMCS Trackside Gateway is depicted in Figure 5.3-1 (note that the figure does not resume a specific internal implementation variant of the different functions).

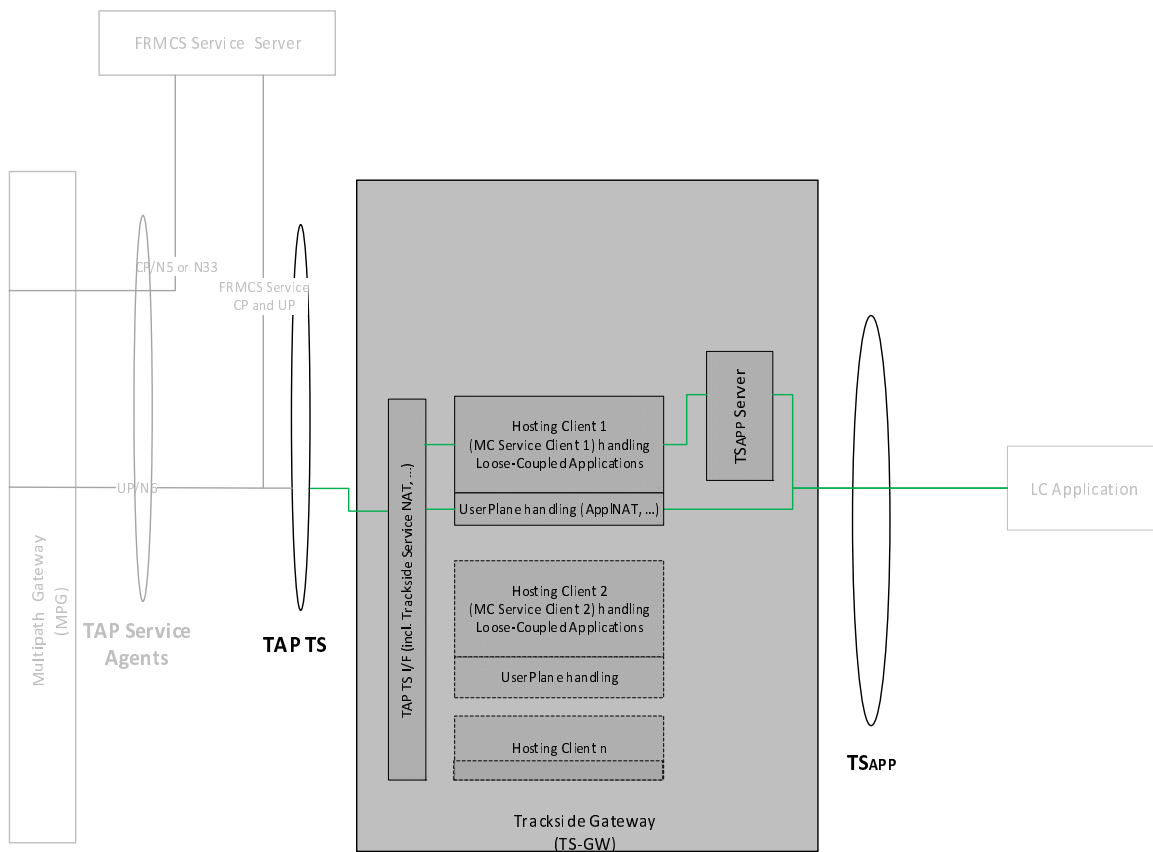


Figure 5.3-1: Functions of FRMCS Trackside Gateway

The following functions are provided by the FRMCS Trackside Gateway:

- **Hosting Clients:** For Loose-Coupled Applications the FRMCS Trackside Gateway provides MC service clients for integration into the MC service system.
- **TS_{APP} Server:** Server for handling communication via TS_{APP} reference point towards applications.

The FRMCS Trackside Gateway shall implement the functionalities associated with the Trackside Application Network NAT Function as specified in clause 5.4.1.

The FRMCS Trackside Gateway shall implement the functionalities associated with the Trackside Service NAT Function as specified in clause 5.4.2.

The FRMCS Trackside Gateway shall support the functionalities required for Host-to-Network provisioning as specified in clause 6.1.2.

5.4 FRMCS Trackside Gateway Functions

5.4.1 Trackside Application Network NAT Function

The FRMCS Trackside Gateway requires the implementation of NAT functionality when enabling communication with an On-Board FRMCS.

The Trackside Application Network NAT Function is responsible for NAT for the Application Plane communication between an on-Board Loose-Coupled application and a Trackside application.

When a MCDATA IPcon session of type Host-to-Host or Host-to-Network is established between an On-Board Loose-Coupled Application using IP address OBA1 on the Application Plane and a Trackside Loose-Coupled Application using IP address TSA1 on the Application Plane, the Trackside Application Network NAT Function shall maintain a mapping for the duration of the session between the tuple of IP addresses (OBA1, ViOB TSAx) and the tuple of IP addresses (ViTS OBA1, TSAx) where:

- ViOB TSAx is a virtual IP selected by the On-Board FRMCS to represent for this session TSAx within the On-Board FRMCS.
- ViTS OBA1 is a virtual IP selected by the FRMCS Trackside Gateway to represent for this session OBA1 within the FRMCS Trackside Gateway.

When a Host-to-Host or Host-to-Network session is terminated, the Trackside Application Network NAT Function shall delete the mapping between the two tuple of IP addresses it created at session establishment.

5.4.2 Trackside Service NAT Function

The FRMCS Trackside Gateway requires the implementation of NAT functionality when enabling communication with an On-Board FRMCS.

The Trackside Service NAT Function is responsible for NAT or the following particular aspects listed in the bullet points below:

- For the FRMCS Service Control Plane communication between a MC Service Client within the FRMCS Trackside Gateway towards the FRMCS Service Domain.
- For the FRMCS Service User Plane communication between a MC Service Client within the FRMCS Trackside Gateway and, for example, a MC Service Client within the On-Board FRMCS.

5.5 FRMCS Trackside Gateway interfaces

5.5.0 Introduction

As defined in clause 5.2, the FRMCS Trackside Gateway supports two interfaces:

- TS_{APP}.
- TAP TS.

5.5.1 TS_{APP}

The TS_{APP} interface is the interface between trackside applications and the FRMCS Trackside Gateway.

The FRMCS Trackside Gateway shall implement the procedures associated to the TS_{APP} interface specified in clause 6.3.

5.5.2 TAP TS

The TAP TS reference point connects the FRMCS Trackside Gateway and a FRMCS Domain. The FRMCS Trackside Gateway acts a MC Service Client over the TAP TS reference point. The TAP TS is composed of the MC Client reference points identified in ETSI TS 103 765-2 [2], clause 5.1.2.

6 FRMCS Trackside Gateway procedures

6.1 General procedures

6.1.1 General provisioning

The FRMCS Trackside Gateway needs to be provisioned as part of the FRMCS Railway Trackside Profile (defined in ETSI TR 103 791 [i.1]) with configuration data to enable the operation over the TS_{APP}. This includes in particular:

- Mapping rules to derive a MC User ID for a Loose-Coupled Application doing a Local Binding.
- Mapping rules to derive a destination MC Service User ID/Functional Alias for the recipient of a FRMCS-Trackside-Gateway-initiated session.
- MC credentials associated to MC User IDs.
- Scope (see ETSI TS 123 280 [4], clause B.4.2.2) associated to MC User IDs.
- IMS/SIP credentials associated to MC User IDs.
- Specific configuration related to Host-to-Network (see clause 6.1.2).

NOTE: The detailed contents of the FRMCS Railway Trackside Profile is not specified in the present document. It is planned to be formalized in a UIC document following the lessons learned from the industrial testing and validation programmes currently ongoing as of time of publication. Nevertheless, the present document indicates when information from the FRMCS Railway Trackside Profile is necessary to the execution of a procedure.

6.1.2 Host-to-Network provisioning

To enable the MCDATA IPcon session establishment procedures and the data transfer procedures specified in ETSI TS 103 765-2 [2], clauses 6.2.2.3 and 6.2.2.4 for Host-to-Network operation, the FRMCS Trackside Gateway relies on the provisioning of information associated to the network towards which it enables the connectivity.

For each IP network for which it enables Host-to-Network operation, the FRMCS Trackside Gateway shall:

- be configured with the MC Service User ID to use for that network;
- be configured with the required credentials to execute the MC user registration procedure as specified in ETSI TS 103 765-2 [2], clause 6.1;
- be configured with the IP address of the DNS server associated to that network;
- be configured with a route towards the gateway associated to that network;
- be configured in a way that the Trackside Application Network NAT Function can determine adequate NATing to enable routing of NATed IP addresses from and towards that network.

6.2 Procedures not associated to a reference point

6.2.1 MC Service Client IP assignment procedure

At setup of an MC Service Client inside the FRMCS Trackside Gateway an IP address shall be assigned for the Interface towards the TAP TS.

The IP address assignment may be set statically based on configuration inside the FRMCS Trackside Gateway or set dynamically via locally-defined dynamic IP address assignment methods when the MC Service Client can act as a standard IP-host in the IP network associated to the TAP TS reference point.

The IP address assignment procedure shall ensure IP connectivity of the MC Service Client to the FRMCS service control according to local IP network requirements.

6.2.2 MC Service Client readiness procedure

The following steps are undertaken:

- 1) The FRMCS Trackside Gateway shall retrieve from FRMCS Railway Trackside Profile the following information:
 - a) the mapping rule which allows to derive the MC User ID;
 - b) the password credentials for this MC User ID;
 - c) the scope associated to this MC User ID (as specified in ETSI TS 133 180 [5], clause B.4.2.2);
 - d) the IMS/SIP credentials associated to this MC User ID in the Home (and Foreign, if relevant) FRMCS Domain(s).

NOTE: The implementation of the storage of the FRMCS Railway Trackside Profile is out of scope of the present document.

- 2) The MC Service Client shall execute the MC User Registration procedure as specified in ETSI TS 103 765-2 [2], clause 6.1 using the retrieved parameters in step 1.
- 3) If the application is in the `Application_Locally_Bound` state, the FRMCS Trackside Gateway shall notify the application of the availability of the FRMCS Service Domain by sending a notification of type `fsdAvlNotif` on the notification event stream associated with the application as specified in clause 6.3.3.2 of the present specification. The JSON structure being passed is of type "fsdAvlNotif" (as specified in FRMCS FFFIS-7950 [1], clause 10.9.1.12) filled as follows:
 - a) The `fsdAVL` field shall be set to `TRUE`.
 - b) The `nwTransition` field shall be set to `FALSE`.

6.2.3 MC Service Client teardown procedure

The following steps are undertaken:

- 1) For each ongoing session associated with the application, the FRMCS Trackside Gateway shall notify the application of the termination of the session by sending a notification of type `sessionClosure` on the notification event stream associated with the application as specified in clause 6.3.3.2 of the present specification.
- 2) For each ongoing communication associated to the MC Client, the ongoing communication release shall be performed as specified in clause 6.2.5.
- 3) For each MC Service User associated with the application, the FRMCS Trackside Gateway shall execute the MC user deregistration procedure as specified in ETSI TS 103 765-2 [2], clause 6.3.
- 4) The FRMCS Trackside Gateway shall notify the application of the unavailability of the FRMCS Service Domain on the notification event stream associated with the application as specified in clause 6.3.3.2. The JSON structure being passed is of type "fsdAvlNotifData" (as specified in FRMCS FFFIS-7950 [5], clause 9.11.1.12) filled as follows:
 - a) The `fsdAVL` field shall be set to `FALSE`.
 - b) The `nwTransition` field shall be set to `TRUE` if the release is due to a network transition. Otherwise, it is set to `FALSE`.
- 5) After steps 3 and 4, the FRMCS Trackside Gateway shall notify the application of its deregistration from the FRMCS Trackside Gateway by sending a notification of type `upcomingDeregistration` on the notification event stream associated with the application as specified in clause 6.3.3.2 of the present document.

6.2.4 TS_{APP} Application Context clearance procedure

The following steps are undertaken:

- 1) For each ongoing session associated with the application, the FRMCS Trackside Gateway shall execute the MCDATA IPcon session release procedure as identified in ETSI TS 103 765-2 [2], clause 6.2.2.5.
- 2) The FRMCS Trackside Gateway shall clear the TS_{APP} application context associated with the TS_{APP} application tuple.

6.2.5 Ongoing communication release

The following steps are undertaken for releasing an ongoing communication associated to a Loose-Coupled Application:

- 1) The FRMCS Trackside Gateway shall execute the MCDATA IPcon session release procedure as identified in ETSI TS 103 765-2 [2], clause 6.2.2.5.
- 2) The FRMCS Trackside Gateway shall notify the application of the termination of the session by sending a notification of type sessionClosure on the notification event stream associated with the application as specified in clause 6.3.3.2 of the present specification.

6.2.6 Logging

For all procedures specified in clause 6.3, the FRMCS Trackside Gateway shall log the endpoint invocations which lead to a HTTP status code 400, 401, 403 or 404.

For all procedures specified in clause 6.3.2 (/sessions), the FRMCS Trackside Gateway shall log all endpoint invocations.

For each logged event, the FRMCS Trackside Gateway shall capture:

- Timestamp (ISO 8601 [9] as UTC).
- Source IP and TS_{APP} Application Tuple (appCategory, staticId).
- HTTP method + endpoint + status code.
- Specific parameters:
 - SessionId for session endpoints

The FRMCS Trackside Gateway shall not include sensitive information like credentials or passwords in logged events.

6.3 Procedures associated with TS_{APP} endpoints

6.3.0 Introduction

The present clause specifies the behaviour expected from the FRMCS Trackside Gateway in relation with the TS_{APP} reference point as specified in FRMCS FFFIS-7950 [1].

For all TS_{APP} endpoint procedures defined below, the FRMCS Trackside Gateway shall return HTTP error responses as specified in FRMCS FFFIS-7950 [5] when encountering the following conditions applicable to a given endpoint and HTTP verb:

- **400 Bad Request:** Malformed/invalid request syntax.
- **401 Unauthorized:** Unauthenticated application access attempt.
- **403 Forbidden:** Authorized user but operation not permitted per profile.

- **404 Not Found:** Resource (dynamicId/sessionId/channel) not found.

Additional specific behaviours are noted in individual procedures below.

6.3.1 /registrations endpoint procedures

6.3.1.1 Application registration procedure

Upon invocation of the "/registrations" endpoint with the HTTP POST verb, the FRMCS Trackside Gateway is expected to create an TS_{APP} Application Context for the application.

The following steps are undertaken:

- 1) If a TS_{APP} Application Context associated with a TS_{APP} Application Tuple already exists in the FRMCS Trackside Gateway, the FRMCS Trackside Gateway shall execute the TS_{APP} Application Context clearance procedure as specified in clause 6.2.4.
- 2) The FRMCS Trackside Gateway shall create a TS_{APP} Application Context for the TS_{APP} Application Tuple.
- 3) The FRMCS Trackside Gateway shall set the application state to Application_Registered.
- 4) The FRMCS Trackside Gateway shall respond with a 201 Created response code as specified in FRMCS FFFIS-7950 [5], clause 10.1.8.4. The JSON structure being passed is of type "RegisteredData" with a newly generated dynamicId as specified in FRMCS FFFIS-7950 [5], clause 10.1.8.5.

NOTE: For the Local Binding to be complete, the application is expected to open the notification event stream (clause 6.3.3.1).

6.3.1.2 Application-initiated deregistration procedure

Upon invocation of the "/registrations/{dynamicId}" endpoint with the HTTP DELETE verb, the FRMCS Trackside Gateway is expected to clean up any context associated to the application.

The following steps are undertaken:

- 1) For each ongoing MCDATA IPcon session associated with the application, the FRMCS Trackside Gateway shall execute the MCDATA IPcon session release procedure as identified in ETSI TS 103 765-2 [2], clause 6.2.2.5.
- 2) For each MC Service User associated with the application, the FRMCS Trackside Gateway shall execute the MC user deregistration procedure as specified in ETSI TS 103 765-2 [2], clause 6.3.
- 3) In parallel to steps 2 and 3, the FRMCS Trackside Gateway shall respond with a 204 (No Content) response code as specified in FRMCS FFFIS-7950 [5], clause 10.8.2.
- 4) The FRMCS Trackside Gateway shall clear the TS_{APP} Application Context associated to the TS_{APP} Application Tuple.

6.3.1.3 FRMCS-Trackside-Gateway-initiated deregistration procedure

The following steps are undertaken:

- 1) For each application in Locally Bound state:
 - a) the FRMCS Trackside Gateway shall notify the application of its upcoming deregistration from the FRMCS Trackside Gateway by sending a notification of type upcomingDeregistration on the notification event stream associated with the application as specified in clause 6.3.3.2 of the present specification; and
 - b) the FRMCS Trackside Gateway shall start a deregistration timer, T_DEREGISTRATION_TIMER, allowing the applications to take actions (e.g. for cleaning up their contexts).

- 2) At the expiry of the T_DEREGISTRATION_TIMER
 - a) For a Loose-Coupled Application:
 - i) The FRMCS Trackside Gateway shall perform for each ongoing session the ongoing communication release as specified in clause 6.2.5.
 - ii) The FRMCS Trackside Gateway shall execute the MC Client teardown procedure as specified in clause 6.2.3 of the present specification.
 - iii) The FRMCS Trackside Gateway shall perform the TS_{APP} Application Context clearance procedure as specified in clause 6.2.4.
 - b) For a Tight-Coupled Application, the FRMCS Trackside Gateway shall perform the TS_{APP} Application Context clearance procedure as specified in clause 6.2.4.

6.3.2 /sessions endpoint procedures

6.3.2.1 FRMCS-Trackside-Gateway-initiated session initiation procedure

Upon invocation of the "/sessions/{dynamicId}" endpoint with the HTTP POST verb, the FRMCS Trackside Gateway is expected to open a session towards a remote endpoint.

In the following, the parameters communicationCategory, localAppIPAddress, and recipient (containing remoteId) are those retrieved from the JSON payload of request.

The following steps are undertaken:

- 1) The FRMCS Trackside Gateway shall check in the FRMCS Railway Trackside Profile that the requesting application is authorized to initiate an FRMCS-Trackside-Gateway-initiated session. If the requesting application is not authorized, the FRMCS Trackside Gateway shall respond with a 403 Forbidden response code as specified in FRMCS FFFIS-7950 [1], clause 10.10.1.
- 2) The FRMCS Trackside Gateway shall respond with a 201 Created response code. The JSON structure being passed is of "TSSessionOpenedData" and includes a newly generated sessionId as specified in FRMCS FFFIS-7950 [1], clause 10.10.1.
- 3) If the MC Service Client readiness procedure has not been executed for the application, the FRMCS Trackside Gateway shall execute the MC Service Client readiness procedure as specified in clause 6.2.2 of the present document.
- 4) The FRMCS Trackside Gateway shall retrieve:
 - a) From the FRMCS Railway Trackside Profile:
 - i) the destination MC Service User ID/Functional Alias associated to remoteId field of the TS_{APP} request; and
 - ii) the Communication Session Category (ETSI TS 103 765-2 [2], clause 6.2.5) associated to communicationCategory field of the TS_{APP} request.
 - b) The IP address provided by the application in the localAppIPAddress field of the TS_{APP} request.
- 5) The FRMCS Trackside Gateway shall execute the MCDATA IPcon session establishment procedure as identified in ETSI TS 103 765-2 [2], clause 6.2.2.2.1 with the MC Service User ID/Functional Alias for the recipient(s) and the Communication Session Category determined at the previous step.
- 6) Upon success of the procedure in step 5, the FRMCS Trackside Gateway shall set up a route and an associated NAT for IP packets coming from the tunnel established at step 5 to the Local Application IP address provided in the JSON payload of the POST request. In addition, the FRMCS Trackside Gateway shall add the sessionId to the TS_{APP} Application Context.

- 7) The FRMCS Trackside Gateway shall notify the application with a final answer on the notification event stream associated to the application as specified in clause 6.3.3.2:
- a) The JSON structure being passed is of type "openSessionFinalAnswerNotif" (as specified in FRMCS FFFIS-7950 [1], clause 10.9.1) filled as follows:
 - i) Upon success of the procedure at step 5, the openSessionFinalAnswerNotif is of type "success" with the following structure:
 - 1) The sessionId field shall be set to the sessionId sent at step 2.
 - 2) The nextHopIPAddress field shall be set to the local FRMCS Trackside Gateway IP address to be used by the application for the session.
 - 3) In the case of a Host-to-Host addressing mode session, the destApplicationIPAddress field shall be set to the virtual IP address representing the On-Board Application within the FRMCS Trackside Gateway for this TS_{APP} session.
 - ii) Upon failure of the procedure at step 5, the openSessionFinalAnswerNotif is of type "failed" with the following structure:
 - 1) The sessionId field shall be set to the sessionId sent at step 2.
 - 2) The ErrorCause field shall be set as in Table 6.3.2.1-1 depending on the error code and warning text within MCDATA IPcon response:
 - 3) The ErrorDetail field can provide more details.
 - iii) Upon decline of the procedure at step 5, the openSessionFinalAnswerNotif is of type "declined" with the following structure:
 - 1) The sessionId field shall be set to the sessionId sent at step 2.
 - 2) The ErrorCause field shall be set to REMOTE_ENDPOINT_DECLINED.
 - 3) The ErrorDetail field can provide more details.

NOTE: In case 3 from Table 6.3.2.1-1, the FRMCS Trackside Gateway can perform a number of retrials of MCDATA IPcon establishment before sending openSessionFinalAnswerNotif to the application.

Table 6.3.2.1-1: ErrorCause in openSessionFinalAnswerNotif

Case	Error code (and warning text) in MCDATA IPcon response	ErrorCause in openSessionFinalAnswerNotif
1	480 ("FRMCS-terminating application is not locally bound")	TERMINATING_APPLICATION_ENDPOINT_NOT_REACHABLE
2	408 ("FRMCS-terminating application did not respond in time to session invitation")	TERMINATING_APPLICATION_ENDPOINT_NOT_REACHABLE
3	408 (without the warning text in case 2)	MCX_ENDPOINT_NOT_REACHABLE
4	403 ("FRMCS-terminating application is not allowed by profile to receive incoming session")	TERMINATING_APPLICATION_ENDPOINT_NOT_ALLOWED

6.3.2.2 FRMCS-Trackside-Gateway-initiated session termination procedure

Upon invocation of the "/sessions/{dynamicId}/{sessionId}" endpoint with the HTTP DELETE verb, the FRMCS Trackside Gateway is expected to terminate the referred session.

The following steps are undertaken:

- 1) The FRMCS Trackside Gateway shall execute the MCDATA IPcon session release procedure as identified in ETSI TS 103 765-2 [2], clause 6.2.2.5.
- 2) The FRMCS Trackside Gateway shall unset the route and an associated NAT for IP packets coming from the tunnel established for the station towards the Local Application IP address associated with the session.

If all the previous steps are successful, the FRMCS Trackside Gateway shall respond with a 204 No Notification response code and include a payload as specified in FRMCS FFFIS-7950 [1], clause 10.10.4.

6.3.2.3 FRMCS-Trackside-Gateway-terminated incoming session invite procedure

NOTE 1: The present document only specifies the handling of incoming MCDData IPcon session invites.

Upon receipt of a "SIP INVITE request for IP Connectivity session for terminating MCDData client" by the MC Service Client associated with a Loose-Coupled Application, the FRMCS Trackside Gateway is expected to notify the application.

The following steps shall be undertaken:

- 1) If the parameters fetched from the FRMCS Trackside Application Profile indicate that the application is not allowed to receive incoming sessions, the FRMCS Trackside Gateway shall send a 403 (Forbidden) response with the warning text equal to "FRMCS - terminating application is not allowed by profile to receive incoming session" as specified in ETSI TS 103 765-2 [2], clause 6.2.2.3.1 with warning text "FRMCS-Terminating application is not allowed to receive an incoming session" to reject the request.
- 2) The FRMCS Trackside Gateway shall notify the application of the incoming session request on the notification event stream associated to the application as specified in clause 6.3.3.2.
 - a) The JSON structure being passed is of type "incomingSessionNotif" (as specified in FRMCS FFFIS-7950 [1], clause 10.9.1) filled as follows:
 - i) The sessionId field shall be set to a new sessionId.
 - ii) The remoteID field shall be set to the originating application identity value within the <application-data> attribute of the SIP INVITE received by the terminating MCDData client.
 - iii) The communicationCategory field shall be set to the value mapped to the <user-requested-priority> retrieved from the SIP INVITE.
- 3) The FRMCS Trackside Gateway shall start a timer T_INCOMING_SESSION associated with the application and the session.
- 4) If the timer T_INCOMING_SESSION set at step 3 expires before being cleared, the FRMCS Trackside Gateway shall send a 408 (Request Timeout) response with the warning text equal to "FRMCS-Terminating application did not respond in time to session invitation" as specified in ETSI TS 103 765-2 [2], clause 6.2.2.3.1 to reject the request.

NOTE 2: If T_INCOMING_SESSION is longer than SIP Timer B (64* timer T1 or about 32 seconds), the standard behaviour according to ETSI TS 124 229 [i.4] is presumed. If T_INCOMING_SESSION is shorter than SIP Timer B, the normative statement of step 4 applies.

NOTE 3: The actual positive response to the SIP INVITE needs to be sent as part of the handling of the HTTP PUT verb on /sessions/{dynamicId}/{sessionId} in clause 6.3.2.4.

6.3.2.4 FRMCS-Trackside-Gateway-terminated incoming session response procedure

Upon invocation of the "/sessions/{dynamicId}/{sessionId}" endpoint with the HTTP PUT verb, the FRMCS Trackside Gateway is expected to provide a response to the "SIP INVITE request for IP Connectivity session for terminating MCDData client" received prior.

The following steps are undertaken:

- 1) The FRMCS Trackside Gateway shall clear the timer T_INCOMING_SESSION associated with the application and the session.

- 2) If the field `incomingSessionAppResponse` in the `IncomingSessionNotificationResponseData` JSON payload is set to "accepted":
 - a) The FRMCS Trackside Gateway shall provide the MC Service Client associated with the application with the IP address provided by the application in the field `localAppIPAddress`.
 - b) The MC Service Client associated with the application shall accept the SIP INVITE request as specified in ETSI TS 103 765-2 [2], clause 6.2.2.3.1 and include the IP address provided at step 2.a as part of the `<application-data>` element within the `AnyExt` extension field.
 - c) The FRMCS Trackside Gateway shall respond with a 201 Created response code as specified in FRMCS FFFIS-7950 [1], clause 10.10.5.
- 3) If the field `incomingSessionAppResponse` in the `IncomingSessionNotificationResponseData` JSON payload is set to "rejected":
 - a) The MC Service Client associated with the application shall send a 603 (Decline) response as specified in ETSI TS 103 765-2 [2], clause 6.2.2.3.1 to reject the SIP INVITE request.
 - b) The FRMCS Trackside Gateway shall respond with a 204 No Notification response code as specified in FRMCS FFFIS-7950 [1], clause 10.10.5.

6.3.2.5 FRMCS-Trackside-Gateway-terminated session termination procedure

Upon receipt of a "SIP BYE" request for releasing an MCDATA IPcon session by the terminating MC Client associated with a Loose-Coupled Application, if there is a `sessionId` in `TSAPP` Application context associated to the MCDATA IPcon session and if the `RELEASE_CAUSE` in the SIP Reason header field of SIP BYE is set to 1 ("user ends call"):

- 1) The FRMCS Trackside Gateway shall notify the application of the termination of the session by sending a notification of type `sessionClosure` on the notification event stream associated with the application as specified in clause 6.3.3.2.
- 2) The FRMCS Trackside Gateway shall unset the route for IP packets coming from the tunnel established for the session towards the Local Application IP address associated with the session.

6.3.2.6 Information query on ongoing sessions for an application

Upon invocation of the `/sessions/{dynamicId}` endpoint with the HTTP GET verb, the FRMCS Trackside Gateway is expected to provide information on the ongoing sessions associated to the application.

If the query is authorized, the FRMCS Trackside Gateway shall respond with a 200 OK response code as specified in FRMCS FFFIS-7950 [5], clause 10.10.3. The JSON structure being passed is of type "SessionsListData" (as specified in FRMCS FFFIS-7950 [5], clause 10.10.3.2).

6.3.2.7 Information query on a specific ongoing session for an application

Upon invocation of the `/sessions/{dynamicId}/{sessionId}` endpoint with the HTTP GET verb, the FRMCS Trackside Gateway is expected to provide information on the designated session.

If the query is authorized, the FRMCS Trackside Gateway shall respond with a 200 OK response code as specified in FRMCS FFFIS-7950 [5], clause 10.10.2. The JSON structure being passed is of type "SessionStatusData" (as specified in FRMCS FFFIS-7950 [5], clause 10.10.2.2).

6.3.3 /notifications endpoint procedures

6.3.3.1 Procedure for opening the notification event stream

Upon invocation of the `/notifications/{dynamicId}/events` endpoint with the HTTP GET verb, the FRMCS Trackside Gateway is expected to open an SSE notification stream towards the application.

The following steps are undertaken:

- 1) The FRMCS Trackside Gateway shall register the notification types identified in FRMCS FFFIS-7950 [5], clause 10.9.1.2 in the TS_{APP} Application Context.

NOTE: The notifications associated to a TS_{APP} session (i.e. OpenSessionFinalAnswerNotif, IncomingSessionNotif, and SessionClosureNotif) are only relevant to Loose-Coupled applications.

- 2) The FRMCS Trackside Gateway shall open an SSE event stream and respond with a 200 OK response code.
- 3) The FRMCS Trackside Gateway shall set the application state to Application_Locally_Bound.
- 4) If the application is a Loose-Coupled Application for which "Trackside-application-terminated sessions" are allowed in FRMCS Railway Trackside Profile and if the MC Service Client readiness procedure has not yet been executed for the application, the FRMCS Trackside Gateway shall execute the MC Service Client readiness procedure as specified in clause 6.2.2 of the present specification.
- 5) If the application is a Loose-Coupled Application and the MC Service Client readiness procedure has been successfully executed for the application, the FRMCS Trackside Gateway shall notify the application of the availability of the FRMCS Service Domain on the notification event stream associated to the application as specified in clause 6.3.3.2:
 - a) The JSON structure being passed is of type "fsdAvlNotifData" (as specified in FRMCS FFFIS-7950 [1], clause 10.9.1.12) filled as follows:
 - i) The fsdAVL field shall be set to TRUE.
 - ii) The nwTransition field shall be set to FALSE.

6.3.3.2 Procedure of notification to an application over a channel

The SSE *data* field shall be filled with the JSON data structure as passed to the procedure.

EXAMPLE: For a successful final answer notification, the JSON data structure would be:

```
{ "openSessionFinalAnswerNotif":
  "success": {
    "sessionId": <data>,
    "nextHopIpAddress": <data>,
    "destApplicationIpAddress": <data>
  }
}
```

The SSE *event* and the SSE *id* fields shall not be used.

6.3.4 /versions endpoint procedures

Upon invocation of the "/versions" endpoint with the HTTP GET verb, the FRMCS Trackside Gateway is expected to provide the list of versions it supports.

The following steps are undertaken:

- 1) The FRMCS Trackside Gateway shall prepare an API VersionsData data structure with the list of versions supported as specified in FRMCS FFFIS-7950 [1], clause 10.7.
- 2) The FRMCS Trackside Gateway shall respond with a 200 OK response code as specified in FRMCS FFFIS-7950 [1], clause 10.7.

6.3.5 /keepalive endpoint procedures

Upon invocation of the "/keepalive" endpoint with the HTTP GET verb, the FRMCS Trackside Gateway is expected to provide a HTTP-level response to indicate the TS_{APP} reference point is responsive.

The FRMCS Trackside Gateway shall respond with a 204 No Content response code as specified in FRMCS FFFIS-7950 [1], clause 10.11.

7 VAS-Controller Equipment connection

7.1 Functions

VAS Controller functions are not specified in the present document.

7.2 Interfaces

The reference point between VAS Controller Equipment and FRMCS System is TS_{CTRL}.

The VAS Controller Equipment (Dispatcher System) shall support the following ETSI reference points to access FRMCS service domain:

- CSC-1, CSC-2, CSC-4 and CSC-8 for the FRMCS Service User Plane as specified in ETSI TS 123 280 [4], clauses 7.5.2.2, 7.5.2.3, 7.5.2.5 and 7.5.2.8.
- MCPTT-1 and MCPTT-4 for the FRMCS Service Control Plane (Voice) as specified in ETSI TS 123 379 [7], clauses 7.5.2.2 and 7.5.2.5.
- MCPTT-7 for the FRMCS Service Media Plane (Voice) as specified in ETSI TS 123 379 [7], clause 7.5.2.8.
- MCDData-7 for the FRMCS Service User Plane as specified in ETSI TS 123 282 [8], clause 6.4.4.1.6.
- MCDData-SDS-1 for the FRMCS Service Control Plane (Data) as specified in ETSI TS 123 282 [8], clause 6.5.4.1.1.

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