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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Railway Telecommunications (RT).

Modal verbs terminology

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Executive summary

Since the first studies on the successor to GSM-R have been launched by UIC in 2012, the rail community has been considering how to meet rail requirements with a future proof and flexible radio communication system.

The rail needs are defined in the User Requirements Specification (URS) [i.1] and the Telecom Onboard Architecture (TOBA) Requirements [i.2] delivered by the UIC Project Future Rail Mobile Communications System (FRMCS). From the UIC requirements, requirements relevant to 3GPP have been captured in 3GPP TS 22.889 [i.3]. Altogether, the stated requirements are the basis for the development of the GSM-R successor.

The present document is a study on FRMCS interworking with GSM-R, which initially analyse potential interworking scenarios and potential solutions applicable for GSM-R.

Introduction

GSM-R has been a great success not only in Europe, where more than 100 000 km of railway tracks are daily operated through GSM-R, but also worldwide, and this number will double within the next years due to the on-going installations of this technology all over the world.

As the needs of the railways are constantly evolving, in particular in the context of the digitalisation of rail operation that is pursued in many countries and considering the upcoming obsolescence of GSM-R technology, UIC launched in 2012 the first studies for a successor to GSM-R, pertinently named Future Rail Mobile Communication System (FRMCS). The UIC project then concretely delivered the new User Requirements Specifications (URS) [i.1] focusing mainly on rail communication needs - as a basis for the development of the GSM-R successor.

The present document is a study on the FRMCS interworking with GSM-R, which defines potential solutions and likely deployment scenarios, and which elaborates on possible technical realizations of the interworking.

1 Scope

The present document analyses the interworking scenario between FRMCS and GSM-R and the solution applicable to GSM-R. The focus is on GSM-R services equivalency such as voice, SMS, data and other services.

The present document presumes the existence of an interworking function IWF between FRMCS and GSM-R, however the IWF and the interface between IWF and GSM-R network are not specified.

ETSI TS 123 283 [i.13] specifies the stage 2 of interworking of MCX Systems with LMR Systems, where the requirements of interworking between FRMCS and GSM-R have not been considered completely.

NOTE: It is assumed that FRMCS is based on MCX Systems and interworking with GSM-R is to be defined on the same basis of the interworking with LMR systems.

The present document reviews this interworking from three viewpoints:

GSM-R	EIRENE specification of services
MCX System	ETSI TS 123 283 [i.13]
FRMCS	3GPP TS 22.889 [i.3]

This study focuses on the identification of key functions, key issues and solutions recommended for way forward resulting in end to end use cases for the IWF.

Prerequisites & Assumptions:

1) The interworking and interconnect is based on SIP interface.
2) The interworking is based on SIP protocol for signalling and RTP protocol for bearer (G.711 codec and AMR-WB as option).
3) The service continuity is not foreseen as per 3GPP TS 22.889 [i.3].
4) Cybersecurity is not part of this study.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative 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.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] UIC FRMCS URS v5.0: "User Requirements Specification".

[i.2] UIC FRMCS TOBA-7510 (V1.0.0) (April 2020): "FRMCS Telecom On-Board System - Functional Requirements Specification".

[i.3] 3GPP TS 22.889 (V17.2.0) (January 2020): "Study on Future Railway Mobile Communication System (FRMCS)".

[i.4] ETSI TS 123 040 (17.2.0): "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Technical realization of the Short Message Service (SMS) (3GPP TS 23.040 version 17.2.0 Release 17)".

[i.5] ETSI TS 129 163 (V17.3.0): "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Interworking between the IP Multimedia (IM) Core Network (CN) subsystem and Circuit Switched (CS) networks (3GPP TS 29.163 version 17.3.0 Release 17)".

[i.6] ETSI TS 103 389: "Rail Telecommunications (RT); Global System for Mobile communications (GSM); Usage of Session Initiation Protocol (SIP) on the Network Switching Subsystem (NSS) to Fixed Terminal Subsystem (FTS) interface for GSM Operation on Railways".

[i.7] ETSI TS 123 002 (V17.0.0): "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; Network architecture (3GPP TS 23.002 version 17.0.0 Release 17)".

[i.8] 3GPP TS 23.280 (V17.2.0) (March 2020): "Common functional architecture to support mission critical services; Stage 2".

[i.9] ETSI TS 123 228 (V16.4.0): "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; IP Multimedia Subsystem (IMS); Stage 2 (3GPP TS 23.228 version 16.4.0 Release 16)".

[i.10] ETSI TS 123 379 (V17.9.0): "LTE; Functional architecture and information flows to support Mission Critical Push To Talk (MCPTT); Stage 2 (3GPP TS 23.379 version 17.9.0 Release 17)".

[i.11] ETSI TS 123 282 (V17.9.0): "LTE; Functional architecture and information flows to support Mission Critical Data (MCData); Stage 2 (3GPP TS 23.282 version 17.9.0 Release 17)".

[i.12] ETSI TS 143 068 (V17.0.0): "Digital cellular telecommunications system (Phase 2+) (GSM); Voice Group Call Service (VGCS); Stage 2 (3GPP TS 43.068 version 17.0.0 Release 17)".

[i.13] ETSI TS 123 283 (V17.3.0): "LTE; Mission Critical Communication Interworking with Land Mobile Radio Systems (3GPP TS 23.283 version 17.3.0 Release 17)".

[i.14] ETSI TS 102 610 (V17.3.0): "Railways Telecommunications (RT); Global System for Mobile communications (GSM); Usage of the User-to-User Information Element for GSM Operation on Railways".

[i.15] ETSI GTS GSM 09.02 (V7.15.0) (March 2004): "Digital cellular telecommunications system (Phase 2+) (GSM); Mobile Application Part (MAP) specification (GSM 09.02)".

[i.16] ETSI TS 123 038 (V17.0.0): "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; Alphabets and language-specific information (3GPP TS 23.038 version 17.0.0 Release 17)".

[i.17] IETF RFC 4412: "Communications Resource Priority for the session Initiation Protocol (SIP)".

[i.18] IETF RFC 8101: "IANA Registration of New Session Initiation Protocol (SIP) Resource-Priority Namespace for Mission Critical Push To Talk Service".

[i.19] EIRENE System Requirements Specification, Version 15.1 (2010).

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

IMPU: IMS Public User Identity in the form of a SIP URI

NOTE 1: The domain part of the IMPU is equal to the domain of the IMS.

NOTE 2: An IMS subscription support one or more IMPUs.

MCX: all MC services standardized by 3GPP that are foreseen for interworking with GSM-R in the FRMCS

NOTE: Only MCX services related to Voice and Data are considered.

MCX IDs: users and groups of all MC services standardized by 3GPP

NOTE 1: MCX IDs include MCPTT ID, MCPTT group ID, MCData ID and MCData group ID.

NOTE 2: MCX IDs are always defined in the form of SIP URIs.

3.2 Symbols

Void.

3.3 Abbreviations

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

AMR	Adaptative Mobile Rate
AMR-WB	Adaptative MultiRate-Wide Band
AoCC	Advice of Charge Charging
AoCI	Advice of Charge Information
AS	Application Server
BAIC	Barring All Incoming Calls
BAOC	Barring All Outgoing Calls
BGCF	Breakout Gateway Control Function
BIC	Barring Incoming Call
BICC	Bearer-Independent Call Control
BOIC	Barring of Outgoing International Calls
CCBS	Call Control for Busy Subscriber
CFB	Call Forwarding Busy
CFNRc	Call Forwarding Not Reacheable
CFNRy	Call Forwarding No Reply
CFU	Call Forwarding Unconditional
CLIP	Calling Line Identity Presentation
CLIR	Calling Line Identification Restriction
CoLP	Connected Line Identification Presentation
CoRL	Connected Line Identification Restriction
CS	Circuit Switch
CSC	Control Signalling Code
CSCF	Circuit Switch Control Function
CT-7	Call Type 7
CUG	Closed User Group
CW	Call Waiting
DNS	Domain Name Server
ECT	Explicit Call Transfer
EiNUM	tElephone IP NUMber mapping
EIRENE	European Integrated Radio Enhanced NEtwork

eMLPP	Enhanced Multi-Level Precedence and Pre-emption
ENUM	tElephone NUMber mapping
eREC	enhanced Railway Emergency Call
EVS	Enhanced Voice Service
exHC	except Home Country
FA	Functional Address
FA/FN	Functional Address/Functional Number
FN	Functional Number
FRMCS	Future Railway Mobile Communications System
GC	Group Call
GCR	GSM Call Register
GPS	Global Positioning System
GSM	Global System for Mobile communications
GSM-R	Global System for Mobile communications - Railway
GW	GateWay
HLR	Home Location Register
I-CSCF	Interrogating-Call Session Control Function
ID/MC	Identifier/Mission Critical
IM-MGW	IMS MediaGateWay
IMPU	IMS Public User identity
IMS	IP Multimedia Subsystem
IoT	Internet of Things
IP	Internet Protocol
IP-SMS	Internet Protocol Short Message Service
ISC	International Switching Center
IWF	Interworking Function
LDA	Location Dependant Addressing
LMR	Land Mobile Radio
MAP	Mobile Application Protocol
MC	Mission Critical
MCDATA	Mission Critical Data
MCPTT	Mission Critical Push To Talk
MCX	Mission Critical Services
MCX-ID	Mission Critical Service Identifier
MGCF	Mobile Gateway Communication Function
MGW	Media GateWay
MLPP	Multi-Level Precedence and Pre-emption
MOC	Mobile Originated Call
MPTY	Multi ParTY service
MRFP	Media Resource Function Protocol
MS	Mobile Station
MSC	Mobile Switching Center
MSC-S	Mobile Switching Center-Serving
MSISDN	Mobile Station International ISDN Number
NG	Next Generation
OTDI	Originator to Dispatcher Information
P2P	Point 2 Point
PABX	Private Automatic Branch eXchange
PAI	P-Asserted Identity
P-CSCF	Proxy-Call Session Control Function
REC	Railway Emergency Call
RPH	Retention Priority Handling
RTP	Real-time Transport Protocol
SA1	Service Aspect 1
SCP	Service Control Point
S-CSCF	Serving-Call Session Control Function
SDP	Session Description Protocol
SDS	Short Data Service
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SM	Short Message
SME	Short Message Entity

SMPP	Short Message Peer-to-Peer protocol
SMS	Short Message Service
SMSC	Short Message Service Center
TCP/IP	Transmission Control Protocol/Internet Protocol
TE	Terminat Equipment
TOBA	Telecom On-Board Architecture
UIC	Union Internationale des Chemins de fer
URI	Uniform Resource Identifier
URS	User Requirements Specification
USSD	Unstructured Supplementary Service Data
UUI	User to User Information
UUIE	User to User Information Element
UUS	Unstructured Supplementary Service
UUS1	User-to-User Signalling type 1
VBS	Voice Broadcast Service
VGCS	Voice Group Call Service
XML	eXtensible Markup Language

4 FRMCS/GSM-R Interworking principle

4.1 General concept

The IWF is distributed over the SIP/IMS Core and the MCX AS.

An FRMCS/GSM-R specific SIP Profile (also known as SIPCORE) is to be defined for the Mg/Mj/Mb interface between IMS Domain and CS Domain to allow interworking of railway specific services between FRMCS and GSM-R:

- Based on ETSI TS 129 163 [i.5] (MGCF), enhanced by parts of ETSI TS 103 389 [i.6] (SIP-R), and potentially other enhancements.

The FRMCS UE is to be built on top of MCX UE.

The FRMCS AS is to be built on top of MCX AS.

4.2 FRMCS/GSM-R Interworking architectural principles

4.2.0 General Approach

The main objective of the present document is to identify the use cases to be considered for interworking. Then, for all the identified use cases, solutions suitable for interworking between mission critical systems and GSM-R systems are proposed.

The goal of the present document is to define the reference points that are between the IWF and the MC service servers and the reference points that are between the IWF and the GSM-R nodes. Additionally it defines the functionality of the IWF, which acts as an MC service server connecting with the MC service server utilizing the IWF-1 or IWF-2 reference points, including protocol translation, identity mapping, transcoding, routing and so on to be performed by the IWF between the reference points on the MC service side to the GSM-R side and vice versa.

The IWF provides centralised support for interworking between an MCPTT or MCData system and a GSM-R system. In MCPTT or MCData systems, the identity of a GSM-R user is provided as an MCPTT or MCData ID, and the identity of a GSM-R group is provided as a MCPTT or MCData group ID, which is to be used by the IWF to derive the corresponding identities used in the GSM-R system and vice versa.

The IWF performs the identity mapping between an MCPTT system or MCData system and a GSM-R system during exchange of signalling and media messages.

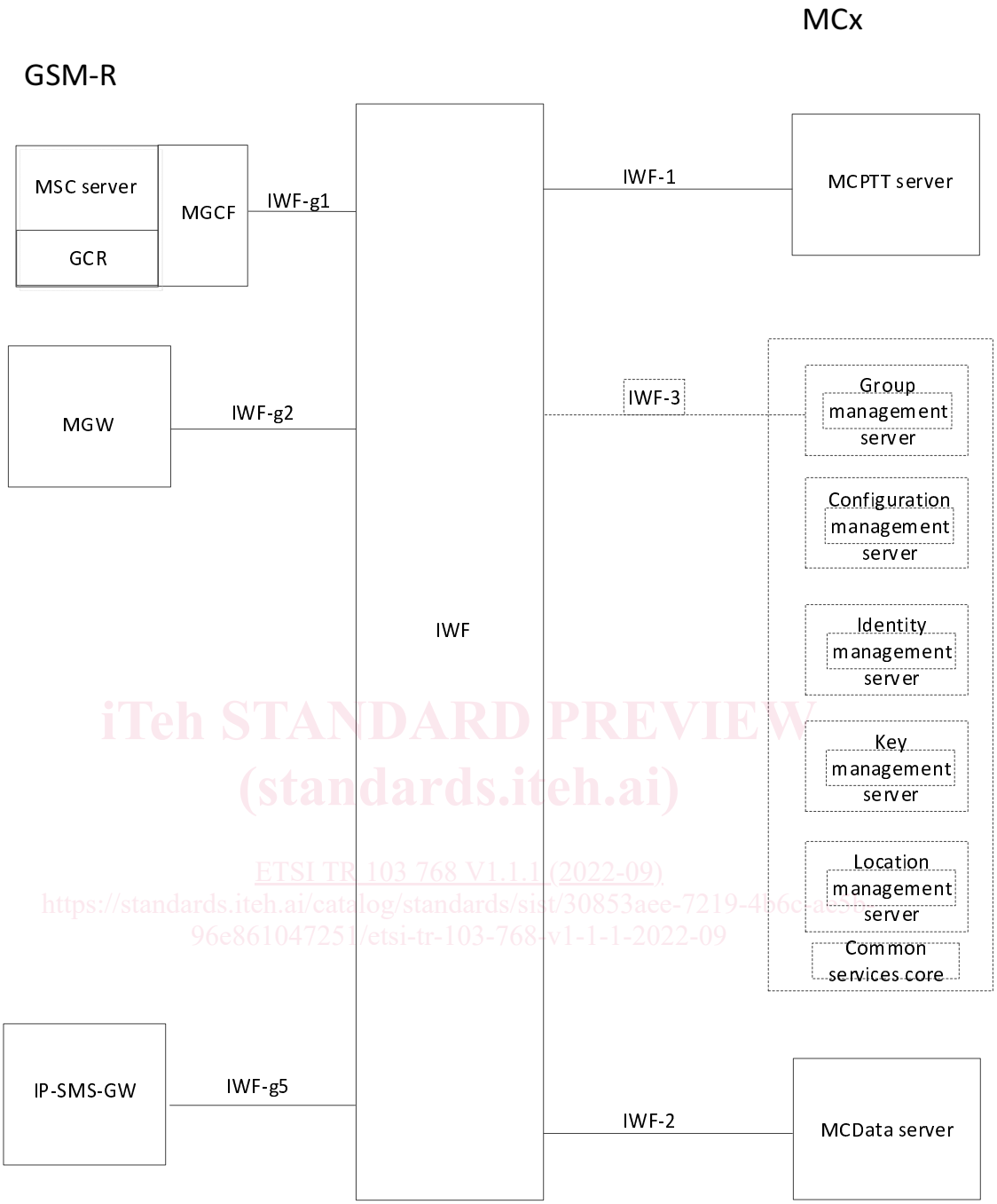

Figure 1: Functional model for application plane for interworking

Figure 1 illustrates the functional model for application plane for interworking between GSM-R and MCPTT and MCData. It is based on ETSI TS 123 283 [i.13]. The protocols on any reference point that is exposed for MCPTT service interoperability with other SIP core or other IMS entities in other systems is to be compatible with the protocols defined for the corresponding reference point defined in ETSI TS 123 002 [i.7].

From 3GPP TS 23.280 [i.8]:

"*The SIP core shall be either:*

1. *compliant with ETSI TS 123 228 [*i.9*], i.e. the SIP core is a 3GPP IP multimedia core network subsystem; or*
2. *a SIP core, which internally need not comply with the architecture of ETSI TS 123 228 [i.9], but with the reference points that are defined in subclause 7.5.3 (if exposed), compliant to the reference points defined in ETSI TS 123 002 [*i.7*]."*

4.2.1 Reference points

4.2.1.1 General

The SIP core as mentioned above does not need to be compliant to the IMS architecture, but the reference points is to be derived from IMS specific reference points as shown in Table 1.

Table 1: Proposed mapping of refence points on GSM-R side according to ETSI TS 129 163 [i.5]

Original IMS reference point	Derived IWF-gx reference point
Mg/Mj	IWF-g1
Mb	IWF-g2
ISC	IWF-g5

4.2.1.2 Reference point IWF-1 (between the IWF and the MCPTT server)

The IWF-1 reference point, which exists between the IWF and the MCPTT server, provides peer to peer interconnection between a GSM-R system and the MCPTT system. IWF-1 supports a subset of MCPTT-3 as defined in ETSI TS 123 379 [i.10], with some differences. The IWF-1 interface is supported by the same signalling plane protocol(s) as defined for MCPTT-3. Floor control signalling and media are also transferred using the IWF-1 reference point.

4.2.1.3 Reference point IWF-2 (between the IWF and the MCData server)

The IWF-2 reference point, which exists between the IWF and the MCData server, provides SDS interconnection between a GSM-R system and the MCData system. IWF-2 supports a subset of the functionality of MCData-SDS-1 and MCData-SDS-2, as defined in ETSI TS 123 282 [i.11] with some differences. The IWF-2 interface is supported by the same signalling plane protocol(s) as defined for MCData-3 except.

4.2.1.4 Reference point IWF-3 (between the IWF and the group management server)

The IWF-3 reference point, which exists between the IWF and the group management server, provides group management interconnection between an GSM-R system and the MC service system. IWF-3 is based upon CSC-16, as defined in 3GPP TS 23.280 [i.8] with some differences.

4.2.1.5 Reference point IWF-g1 (between the IWF and the MSC server/MGCF)

The IWF-g1 reference point, which exists between the IWF and the MSC server via MGCF, provides signalling plane for voice communication based on implementation of the reference point Mg/Mj as defined by ETSI TS 129 163 [i.5].

Additional information on GCR from ETSI TS 143 068 [i.12]:

"The general architecture of GSM is maintained. In addition, a network function is required which is used for registration of the group call attributes, the Group Call Register (GCR)".

The protocol for GCR is not specified, but the interface is standardized.

NOTE: The GCR implementation is not specified. It is to be realized e.g. as a new network node, in a PABX directly attached to an MSC, inside an MSC or as an HLR. The interface between the GCR function and other functions is not specified in the GSM technical specifications. As a consequence, the functional split between MSC and GCR as developed in the present document is only indicative.

The GCR data for a specific voice group call is set at the creation of the group call attributes, and is to be subsequently modified. No support for these functions is specified in the GSM technical specifications.

In a RANflex configuration with group call redundancy GCRs associated to MSCs belonging to the same redundancy pool need to communicate with each other by means of SYNC_GCR messages.