

ETSI TS 103 672 V1.1.1 (2020-12)



**Rail Telecommunications (RT);
Global System for Mobile communications (GSM);
Usage of Session Initiation Protocol
with ISUP encapsulation (SIP-I) and other IP based protocols
for interconnection of GSM-R networks**

12th SRAVAP REVIEW
https://standards.iteh.ai/catalog/standards/si/60b456cf-b438-40d5-acb6-78dec80d2e5/etsi-ts-103-672-v1-1-2020-12

Reference

DTS/RT-0054

Keywords

GSM-R, IP, railways, SIP

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Foreword

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

Modal verbs terminology

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Introduction

In most of the GSM-R system deployments available at the time of the creation of the present document, the GSM-R Networks are interconnected using TDM based interfaces.

The present document deals with the introduction of IP interconnection towards external networks using SIP-I as a call control protocol, which seems to be beneficial both for operators and for network element vendors. ISUP interconnection and the supporting hardware elements are getting old and less effective compared to the new IP based interconnection methods already used in public networks.

In addition, the present document deals with MTP3 and MTP2 interworking between IP based interfaces and TDM based interfaces.

SIP-I is a modern, IP-based call control protocol to be used between core networks. It is applicable in particular, if the ISDN service interworking is kept completely.

While a number of interoperability specifications for various interfaces at various layers of GSM-R systems exist, the IP interface between GSM-R networks has not yet been addressed by any interoperability specification activity.

The present document addresses the interoperability specification between any two GSM-R Core Networks, where at least one of the networks uses IP based transport (Internet Protocol (IP) IETF RFC 791 [2]) for the interconnection.

In addition to the table of contents, the following explanation will help you navigate through and understand the contents of the present document:

- Clauses 1 to 3 are predefined by ETSI.
- Clause 4 shows and explains the reference system architecture and identifies the interface(s) for the present document.
- Clause 5 holds the functional requirements for the interfaces subject to the present document.
- Clause 6 specifies in detail the signalling interfaces for all supported functions and services.
- Clause 7 specifies in detail the media interfaces.

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1 Scope

The present document defines the IP based signaling and media interfaces between any two GSM-R Core networks of a set of GSM-R Core networks that share a GIRA and that agree to interconnect via IP based technology.

Furthermore it defines the IP based signaling and media interface between any GSM-R Core network that wants to interconnect with other GSM-R Core networks via IP based technology - and a centralized hub during a distinct phase of migration.

The present document defines the IP Interconnect between 2 GSM-R Core networks - together with the interworking with BICC/ISUP at the edges of the networks - and the IP Interconnection between a GSM-R Core network and the current TDM hub - together with the interworking with ISUP at the current TDM hub and the interworking with BICC/ISUP at the edge of the GSM-R network.

Only the network layer (e.g. IP) and layers that build on the network layer are considered. The lower layers are denoted as L2 and L1 and are out of scope in the present document.

The present document will address all services (bearer services, tele services, supplementary services and railway services) that are defined by relevant EIRENE SRS [1].

The present document could address all domains of the GSM-R networks (e.g. CS domain, PS domain, IMS domain, etc.), however in a first step only the CS domain and the PS domain are covered.

The present document does not address any specific 3GPP Release or Architecture.

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 CODE 951(0.0.2): "UIC Project EIRENE System Requirements Specification (Version 16.0)".
- [2] IETF RFC 791 (1981): "Internet Protocol".
- [3] Recommendation ITU-T Q.1912.5 (2018/01): "Interworking between session initiation protocol (SIP) and bearer independent call control protocol or ISDN user part".
- [4] UIC REFERENCE O-8350 2.0: "FFFS for Voice and Data Services Interconnection & Roaming between GSM-R networks".
- [5] ETSI TS 129 002: " Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Mobile Application Part (MAP) specification (3GPP TS 29.002)".
- [6] IETF RFC 3550 (2003): "RTP: A Transport Protocol for Real-Time Applications".
- [7] IETF RFC 4733 (2006): "RTP Payload for DTMF Digits, Telephony Tones, and Telephony Signals".

- [8] ETSI TS 129 164 (V12.0.0): " Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Interworking between the 3GPP CS domain with BICC or ISUP as signalling protocol and external SIP-I networks (3GPP TS 29.164 version 12.0.0 Release 12)".
- [9] IETF RFC 3312 (2002): "Integration of Resource Management and Session Initiation Protocol (SIP)".
- [10] IETF RFC 4165 (2005): "Signaling System 7 (SS7) Message Transfer Part 2 (MTP2) - User Peer-to-Peer Adaptation Layer (M2PA)".
- [11] IETF RFC 3264 (2002): "An Offer/Answer Model with the Session Description Protocol (SDP)".
- [12] Recommendation ITU-T G.711: "Pulse Code Modulation (PCM) of voice frequencies".
- [13] IETF RFC 3551 (2003): "RTP Profile for Audio and Video Conferences with Minimal Control".
- [14] IETF RFC 4040 (2005): "RTP Payload Format for a 64 kbit/s Transparent Call".

2.2 Informative references

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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] ETSI TS 103 389 (V3.1.1): "Railway 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.2] IETF RFC 6086 (2011): "Session Initiation Protocol (SIP) INFO Method and Package Framework".
- [i.3] Recommendation ITU-T H.248.n: "Gateway Control Protocol, version 3".
- [i.4] ETSI TS 129 332: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); Media Gateway Control Function (MGCF) - IM Media Gateway; Mn interface (3GPP TS 29.332)".
- [i.5] ETSI TS 129 163: "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)".
- [i.6] IETF RFC 2663 (1999): "IP Network Address Translator (NAT) Terminology and Considerations".
- [i.7] IETF RFC 5226 (2008): "Guidelines for Writing an IANA Considerations Section in RFCs".
- [i.8] IETF RFC 5727 (2010): "Change Process for the Session Initiation Protocol (SIP) and the Real-time Applications and Infrastructure Area".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

downlink path: IP path from a hub to a GSM-R Core network, optionally traversing one or more transit networks

end-to-end path: IP path from one GSM-R Core network to another GSM-R Core network, optionally traversing one or more transit networks or even hubs

IP interconnect: all facilities that are necessary to transmit the PDUs of all IP based protocols for the signalling plane and for the media plane

NOTE: The IP Interconnect can take place between 2 GSM-R Core Networks or between a GSM-R Core Network and a hub.

Logical Link (LL): end-to-end connection at layer 2

NOTE: E.g. an LLC connection over Ethernet or a Frame Relay PVC.

network connection: generic term to address one of the following:

- a tuple of UDP transport addresses;
- a TCP connection;
- an SCTP association; or
- an RTP session

TDM interconnect: all facilities that are necessary to transmit ISUP, SCCP or MTP3 PDUs or bearer traffic

NOTE 1: The TDM Interconnect can take place between 2 GSM-R Core Networks or between a GSM-R Core Network and a hub.

NOTE 2: The TDM Interconnect is not specified in the present document, but its existence is a precondition as far as the interworking between IP Interconnect and TDM Interconnect is specified here.

uplink path: IP path from a GSM-R Core network to a hub, optionally traversing one or more transit networks

3.2 Symbols

Void.

3.3 Abbreviations

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

ACM	Address Complete Message
ANM	Answer message
AoCC	Advice of Charge (Charging)
AoCI	Advice of Charge (Information)
BAIC	Barring All Incoming Calls
BAOC	Barring All Outgoing Calls
BGP	Border Gateway Protocol
BICC	Bearer Independent Call Control
BOIC	Barring All Outgoing International Calls
CAMEL	Customized Application of Mobile Enhanced Logic
CAP	CAMEL Application Part
CCBS	Completion of Call to Busy Subscribers

CDN	Call Dial Number
CFB	Call Forwarding on Busy
CFNRc	Call Forwarding on not Reachable
CFNRy	Call Forwarding on no Reply
CFU	Call Forwarding Unconditionally
CGN	Code Group Number
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Presentation Restriction
CoLP	Connected Line Identification Presentation
CoLR	Connected Line Identification Presentation Restriction
CON	CONnect
CPG	Call ProGress
CS	Circuit Switched
CSD	Circuit Switched Data
CUG	Closed User Group
CW	Call Waiting
DL	Downlink
DNS	Directory Name Server
DTMF	Dual Tone Multiple Frequency
E2E	End-to-End
ECT	Explicit Call Transfer
EIRENE	European Integrated Radio Enhanced Network
eMLPP	Enhanced Multilevel Precedence and Preemption
ETCS	European Train Control System
FAC	Facility message
FQDN	Full Qualified Domain Name
FTS	Fixed Terminal Subsystem
GGSN	Gateway GPRS Support Node
GIRA	GSM-R Interconnection and Roaming Agreement

NOTE: Defined at FFFS I&R [4].

GN	Group Number
GNS	GPRS domain Name System
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GSM-R	GSM for Railways
GTP-C	GPRS Tunneling Protocol - Control plane
GTP-U	GPRS Tunneling Protocol - User plane
GW	Gateway
HLR	Home Location Register
IAM	Initial Address message
IANA	Internet Assigned Number Association
IMS	IP Multimedia Subsystem
INTL	International
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
IWU	Inter Working Unit
L1	Layer 1 (Bit Transmission)
L2	Layer 2 (Link)
LL	Logical Link
LLC	Logical Link Control
M2PA	MTP2 Peer-to-Peer Adaptation
M3UA	MTP3 User Adaptation
MAP	Mobile Application Part
MGW	Media Gateway
MLPP	Multi Level Precedence and Pre-emption
MPTY	Multi Party
MSC	Mobile Switching Center
MSC-S	Mobile Switching Center - Server
MTP	Message Transfer Part

NAPT	Network Address and Port Translation
NAT	Network Address Translation
NOA	Nature Of Address
NPI	Number Plan Identification
NSS	Network and Switching Subsystem
PCM	Pulse Code Modulation
PLMN	Public Landbased Mobile Network
PS	Packet Switched
PVC	Permanent Virtual Connection
REC	Railway Emergency Call
RTCP	Real-time Control Protocol
RTP	Real-time Transport Protocol
SCCP	Signaling Connection Control Part
SCTP	Stream Control Transmission Protocol
SDP	Session Description Protocol
SGSN	Serving GPRS Support Node
SIP	Session Initiation Protocol
SIP-I	SIP with embedded ISUP
SIP-R	Service Independent Protocol for Railways
SMS MO	Short Message Service, Mobile Originated
SMS MT	Short Message Service, Mobile Terminated
SMS	Short Message Service
SRS	System Requirement Specification
STP	Signaling Transfer Point
TCAP	Transaction Capabilities Part
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing
TMR	Transmission Medium Requirement
UDP	User Datagram Protocol
UIC	International Union of Railways
UL	Uplink
URI	Unified Resource Identifier
USSD	Unstructured Supplementary Service Data
UUS	User to User Signalling
VBS	Voice Broadcast Service
VGCS	Voice Group Call Service
VLR	Visitor Location Register
VNF	Virtual Network Function

4 Reference system architecture

The reference system architecture describes a layered network, which can be used to display the different use cases of a GIRA, in case that at least one of both GSM-R Core networks connects to the other via IP based transport.

Use Case I: Both networks use IP based transport to connect to each other (IP Interconnect).

Use Case II: One of both networks (here GSM-R Core B) still uses TDM based transport (TDM Interconnect).