ERTMS

Interface Requirements Specification GSM-R for ETCS

Version 2.5

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Contents

1 Scope

1.1 Identification

This Interface Requirements Specification (IRS) contains a specification of the interfaces between the GSM-R network and ETCS/CSS in the Netherlands. The interfaces also include mobile and fixed GSM-R network interfaces and interfaces to ETCS related subsystems.
ETCS is specified in the documents Technical Reference Architecture of ERTMS [REFARCHERTMS], [SSS VRIJGEVEN INFRA] and [SSDD VRIJGEVEN INFRA].
Figure 1-1 shows a schematic overview of the position of the GSM-R specifications in the document specification structure of ETCS.

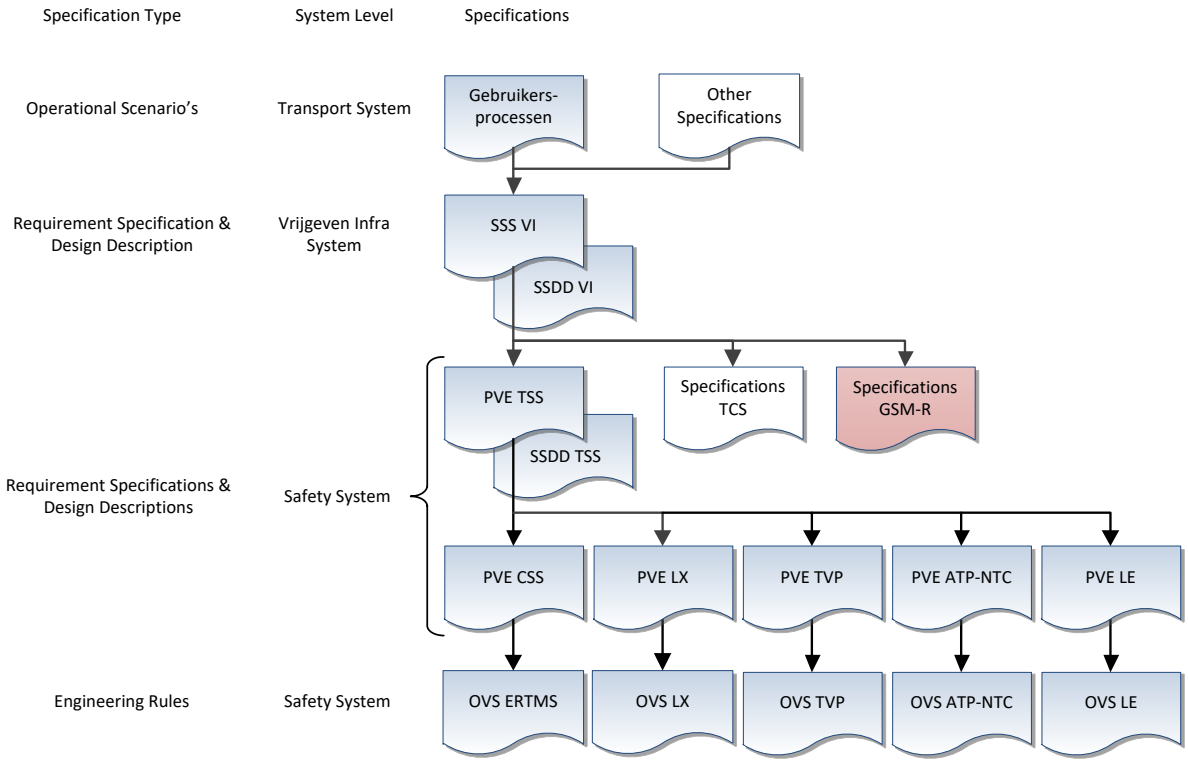

Figure 1-1 ETCS specification document structure

The GSM-R IRS forms part of the GSM-R specifications.

An overview of the interfaces between GSM-R and ETCS is shown in Figure 1-2.

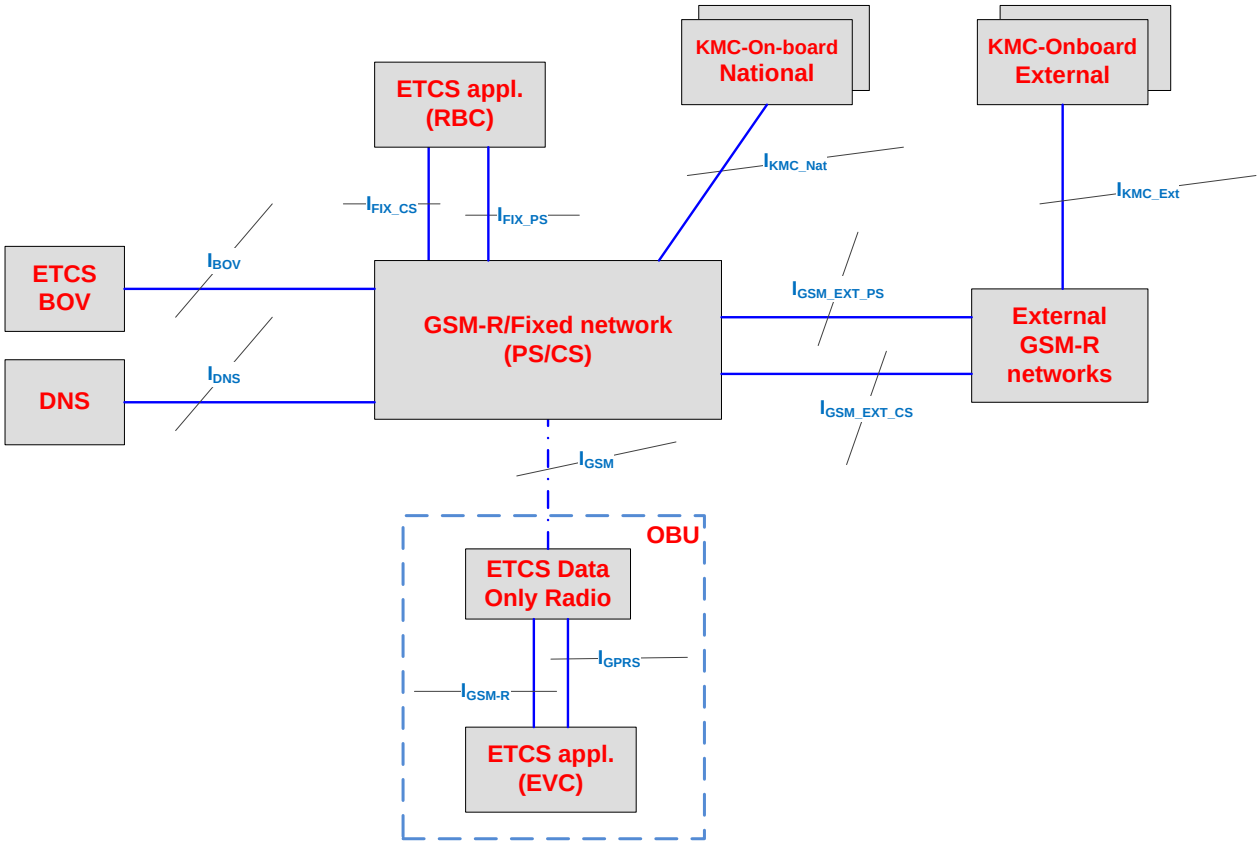

Figure 1-2 Interface identification GSM-R for ETCS

In Figure 1-2 all interfaces which are relevant for GSM-R in relation to ETCS are identified. These interfaces reside at the mobile side (train) or at the fixed network side. The interface naming convention used here follows that of the ETCS baseline specification. Some of these interfaces are equivalent with interfaces as defined in the document Technical Reference Architecture of ERTMS [REFARCHERTMS]. If that is the case, a mapping is provided.

1. I_{FIX_CS}
   This interface denotes the connection between an RBC and the GSM-R/ Fixed network for circuit switched services.
2. I_{FIX_PS}
   This interface denotes the connection between an RBC and the GSM-R/ Fixed network for packet switched services.
3. I_{GSM}
   This interface denotes the air interface between a GSM-R mobile (EDOR) and the GSM-R network.
4. $I_{GSM\text{-}R}$
   This interface denotes the connection between an EVC and the GSM-R mobile (EDOR) in a train for circuit switched services.
5. I_{GPRS}
   This interface denotes the connection between an EVC and the GSM-R mobile (EDOR) in a train for packet switched services.
6. $I_{GSM\_EXT\_PS}$
   This interface denotes the interconnection between the GSM-R network and an external network (foreign GSM-R network) for packet switched services.

7. $I_{GSM\_EXT\_CS}$
   This interface denotes the interconnection between the GSM-R network and an external network (foreign GSM-R network) for circuit switched services.
8. I_{BOV}
   This interface denotes the interface between the GSM-R network and the system for integral monitoring of the ETCS communication characteristics (BOV: Beheer, Onderhoud, Vernieuwing). This interface is identified as interface number 105 in the Technical Reference Architecture of ERTMS [REFARCHERTMS].
9. I_{KMC_Nat}
   This interface denotes the connection between the KMC (responsible for key management of trains) in the Netherlands and the GSM-R network.
   This interface is identified as interface number 30 in the Technical Reference Architecture of ERTMS [REFARCHERTMS].
10. I_{KMC_Ext}
    This interface denotes the connection between the KMC (responsible for key management of trains) and an external (mostly foreign) GSM-R network.
11. I_{DNS}
    This interface denotes the connection between a Domain Name Service (DNS) and the GSM-R network for packet switched services.

Note that there is also a KMC for key management of RBCs. An interface of GSM-R with this KMC is not required.

An additional two interfaces are defined end-to-end across the mobile and fixed network between I_{GSM-R} and I_{FIX_CS} (i.e. $I_{EURORADIO\_CS}$) and beween I_{GPRS} and I_{FIX_PS} (i.e. $I_{EURORADIO\_PS}$). These interfaces are provided by the EURORADIO layer over the GSM-R communication bearer as depicted in Figure 1-3.

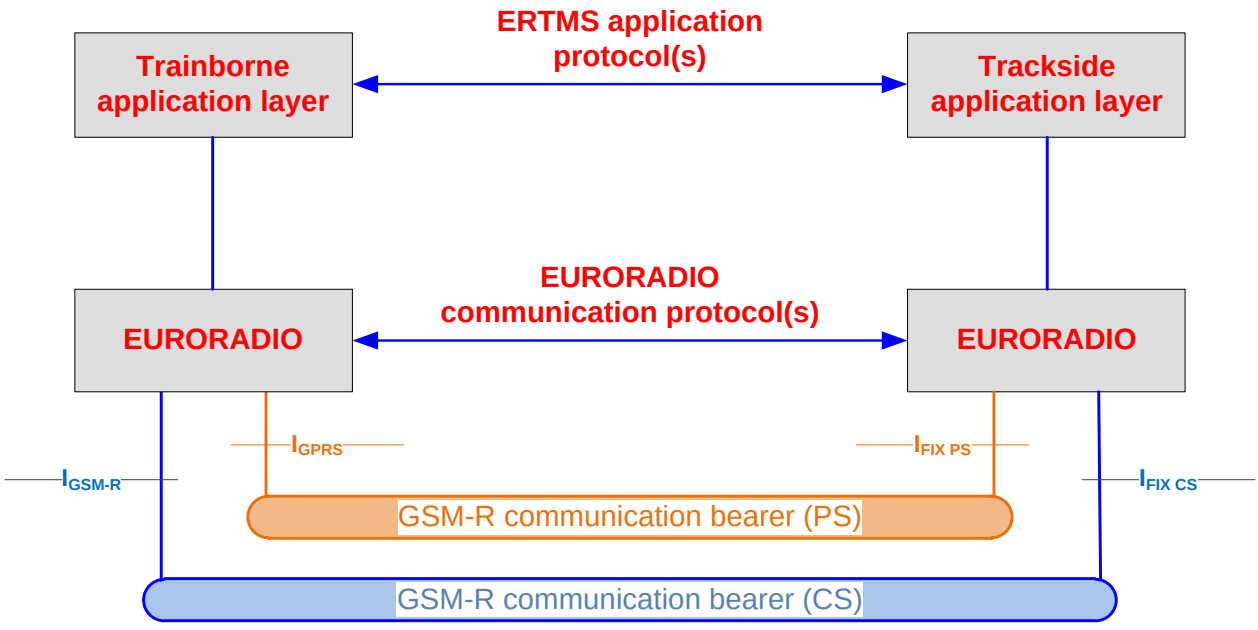

Figure 1-3 Interface identification GSM-R and ETCS (EURORADIO)

The EURORADIO interfaces over the GSM-R communication bearer are characterized by certain Key Performance Indicators (KPIs; latency, error rate, availability) as specified in section 3. The EURORADIO

interface is identified as interface 37 in the Technical Reference Architecture of ERTMS [REFARCHERTMS].

1.2 GSM-R system overview

A national GSM-R network in the Netherlands was deployed from 2000 onwards. The network is built conform the EIRENE GSM-R specifications. GSM-R coverage is provided on ERTMS tracks such as Betuweroute, HSL-Z, Hanzelijn and Amsterdam-Utrecht.
The scope and system boundaries of the GSM-R network with respect to ETCS are shown in Figure 1-4.

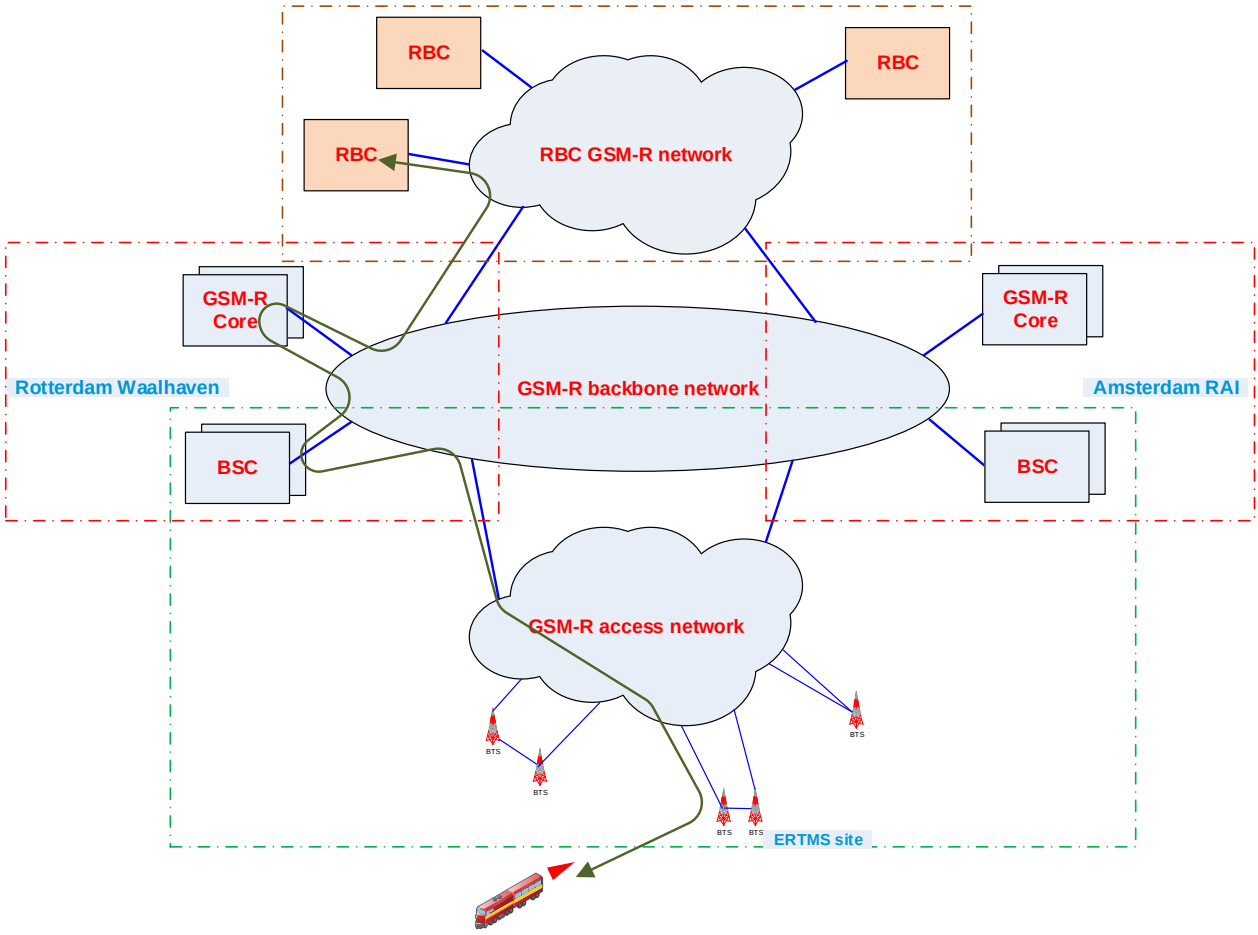

Figure 1-4 Scope and system boundaries of the GSM-R network

The GSM-R network consists of a GSM-R access network and two GSM-R core locations which are connected by a GSM-R backbone network. The scope of GSM-R, is in the context of ETCS, further extended with an RBC GSM-R network.
The GSM-R access network comprises BTSs at antenna sites. The BTSs are connected with BSCs at the GSM-R core locations via the GSM-R access and GSM-R backbone network. From a logical point of view BSCs, although residing at core locations, belong to the GSM-R access network.
GSM-R services for ETCS are monitored by a Performance and Capacity Management System which is an integral part of the GSM-R core.
GSM-R core subsystems are located in equipment rooms in Rotterdam and Amsterdam. The core systems are connected by the GSM-R backbone network. GSM-R provides data communication services for ETCS. The basic functionality of ETCS comprises two services: packet switching (PS) and circuit switched data (CS).

Several GSM-R core subsystems are involved in providing CS and PS services. The subsystems of PS differ significantly from those of CS. For CS the R4 subsystems MSG, MSS and CDS are used. For PS the GPRS subsystems SGSN and GGSN are used.
Subsystems which are shaded in blue are part of the scope of GSM-R for ETCS.
Connectivity of RBCs with GSM-R core is provided by the GSM-R backbone network and the RBC GSM-R network. RBCs do not belong to the GSM-R network. RBCs are the responsibility of the train safety department (Treinbeveiliging) and are shaded as orange. The 8ealization of the GSM-R network and the RBC GSM-R network is a responsibility of ProRail ICT.
GSM-R access network, GSM-R backbone network and RBC GSM-R network are using IP technology for providing connectivity between subsystems. A significant part of the IP connectivity is provided by an IP/MPLS network of ProRail (FIDES). FIDES provides for example transmission services for BTS-BSC connections, the RBC GSM-R network and connections for interfacing to KMCs.
The RBC GSM-R network is planned to be realized via FIDES. At locatons where realization of FIDES is not feasible or justified, public IP transmission services are deployed.
The communication route between EVC in a train and RBC is marked with a green arrow. The route is the same for PS and CS except for the part in the GSM-R core network.

1.3 Document overview

This document specifies the requirements for the interfaces between GSM-R and ETCS. The structure of the Interface Requirements Specification complies with DID number DI-IPSC-81434 (MILIRS) as part of the DoD standard MIL-STD-498 MIL-STD-498).

There are no security or privacy considerations associated with the use of this document.

Section 2 enumerates the referenced documents.

The requirements and design for the interfaces are described in chapter 3. The requirements are classified according to the verbal forms "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" which are to be interpreted as described below (see also [ETSI DRAFTING RULES]).

The verbal form **"shall"** is used to indicate mandatory requirements. These are strictly to be followed and deviation is not permitted.
The verbal form **"should"** shall be used to indicate that among several possibilities one is recommended.
The verbal form **"may"** is used to indicate a course of action permissible within the limits of the specification (optional). **"Can"** is used for statements to denote possibility or capability. **"Will"**shall be used to indicate behaviour of equipment or sub-systems outside the scope of the deliverable in which they appear.

EXAMPLE:
Extract from deliverable specifying behaviour of terminal equipment: "… On expiry of timer T3, the terminal shall send a TIMEOUT message to the network and start timer T4. The network will respond with a TIMOUT-ACKNOWLEDGE message. On receipt of a TIMEOUT-ACKNOWLEDGE message, the terminal shall stop timer T4 …"; thus is distinguished the strong future ("the terminal shall") used for requirements and the normal future ("the network will") used to indicate expected events.

A requirement can be followed by an explanation for clarification. This explanation may include examples or additional information about the reason it is included. The explanation will be shown in the same style as this paragraph.

The requirements of the interfaces are specified in section 3. Each requirement is assigned a unique identifier to support testing and traceability and is stated in such a way that an objective test can be defined for it.

Each requirement may be annotated with associated qualification method(s) for validation to ensure that

the requirement has been met (section 4). Traceability to system (or subsystem) requirements is provided in section 5. The degree of detail to be provided shall be guided by the characteristics of the interfacing entities that are conditions for their acceptance.

Section 6 provides provides general information that aids in understanding this document. This section includes assumptions, a listing of acronyms, abbreviations and terms, and their meanings as used in this document. The section also includes a colophon and an overview of the versions of this document.

2 Referenced documents

Reference	Author	Title	Date
[BlauwdrukGSMrArc]	J. Nooijen et al.	Blauwdruk GSM-R architectuur voor ERTMS	Versie 2.0
MilIRS	Mil, U.S. DoD	Military Standard Software Development, U.S. Department of Defense, Data Item Description IRS (DI-IPSC-81434)	
MIL-STD-498	Mil, U.S. DoD	Military Standard Software Development, U.S. Department of Defense, MIL-STD-498	December 5, 1994
[B3R2]	TSI Baseline 3, Release 2	Set of specifications # 3 (ETCS baseline 3 and GSM-R baseline 1) ERA Baseline 3 Release 2 specifications	5 July 2016
[EuroradioFFFIS]	UIC	A 11 T 6001 13.0.0 Radio Transmission FFFIS for EuroRadio	18 december 2015, versie 13.0.0
[TS 102 281]	ETSI	TS 102 281 Detailed requirements for GSM operation on railways	3.0.0
[EIRENE FRS]	UIC	EIRENE FRS GSM-R Functional requirements specification	8.0.0
[EIRENE SRS]	UIC	EIRENE SRS GSM-R System requirements specification	16.0.0
[SUBSET-037]	UNISIG	SUBSET-037 EuroRadio FIS	3.2.0
[SUBSET-093]	UIC	SUBSET-093, GSM-R interfaces, Bearer Service Requirements	Version tbd (July 2019)
[O-2475]	UIC	O-2475 ERTMS/GSM-R Quality of Service Test Specification	Version tbd (July 2019)
[ETSI TS 103 328]	ETSI	Railways Telecommunications (RT); GPRS/EGPRS requirements for ETCS	V1.1.1
[ETSI Drafting Rules]	ETSI	ETSI Drafting Rules	
[KaderstellingInfra]	Saskia Groot, Henri van Houten, Henk Tijssen en Pieter Smit	Kaderstelling infrastructuur (Onderdeel Systeemarchitectuur)	18 mei 2016, Versie: 1.0
[SSS Vrijgeven Infra]	M. Renkema, M. van Wilpe	System/Subsystem Specification (SSS) Vrijgeven Infra – ETCS – line	Versie 0.5, 13 oktober 2016
[SSDD Vrijgeven Infra]	M. Renkema, M. van Wilpe	System/Subsystem Design Description (SSDD) Vrijgeven Infra – ETCS – line	Versie 0.5, 13 oktober 2016
[IEEE 802.3]	IEEE	Ethernet specification	-
[GSM-R req. voor rolling stock]	Werkgroep ERTMS performance (Edwin Bottelier)	Materieeleisen GSM-R (ERTMS GSMR requirements for rolling stock)	OS/Ebo/0006.508.006/03-620946, version 2.0, 31 oktober 2016
[RefArchERTMS]	Niek Govers	ERTMS-Technische Referentie Architectuur Vervoersysteemcomponenten	Version 1.0, 28 September 2016, P1438110
[CR1146]	Jos Nooijen Adriaan Kroon	Additional explanation CR1146	EECT meeting, 5 April 2017
[IntTracMatr]	Erik Verweij	Interface Tracebility Matrix	Version 1.0, 26 November 2018

3 Requirements

The following paragraphs contain a specification of the requirements imposed on the systems or subsystems to achieve the interfaces among these entities. Each requirement or information statement is assigned a unique identifier to support testing and traceability. The format of the identity is [GSM-R IRS xyz], where xyz denotes a three-digit number. An interface traceability matrix is provided in [IntTracMatr]. The requirements are stated in such a way that an objective test can be defined for it.
Each requirement may be annotated with associated qualification method(s) and traceability to system (or subsystem) requirements (see section 4). The degree of detail that is provided is guided by the following rule: those characteristics of the interfacing entities that are conditions for their acceptance are included.

3.1 Interface identification and diagrams

1. A detailed technical overview of the interfaces is shown in Figure 3-1. [GSM-R IRS 001]

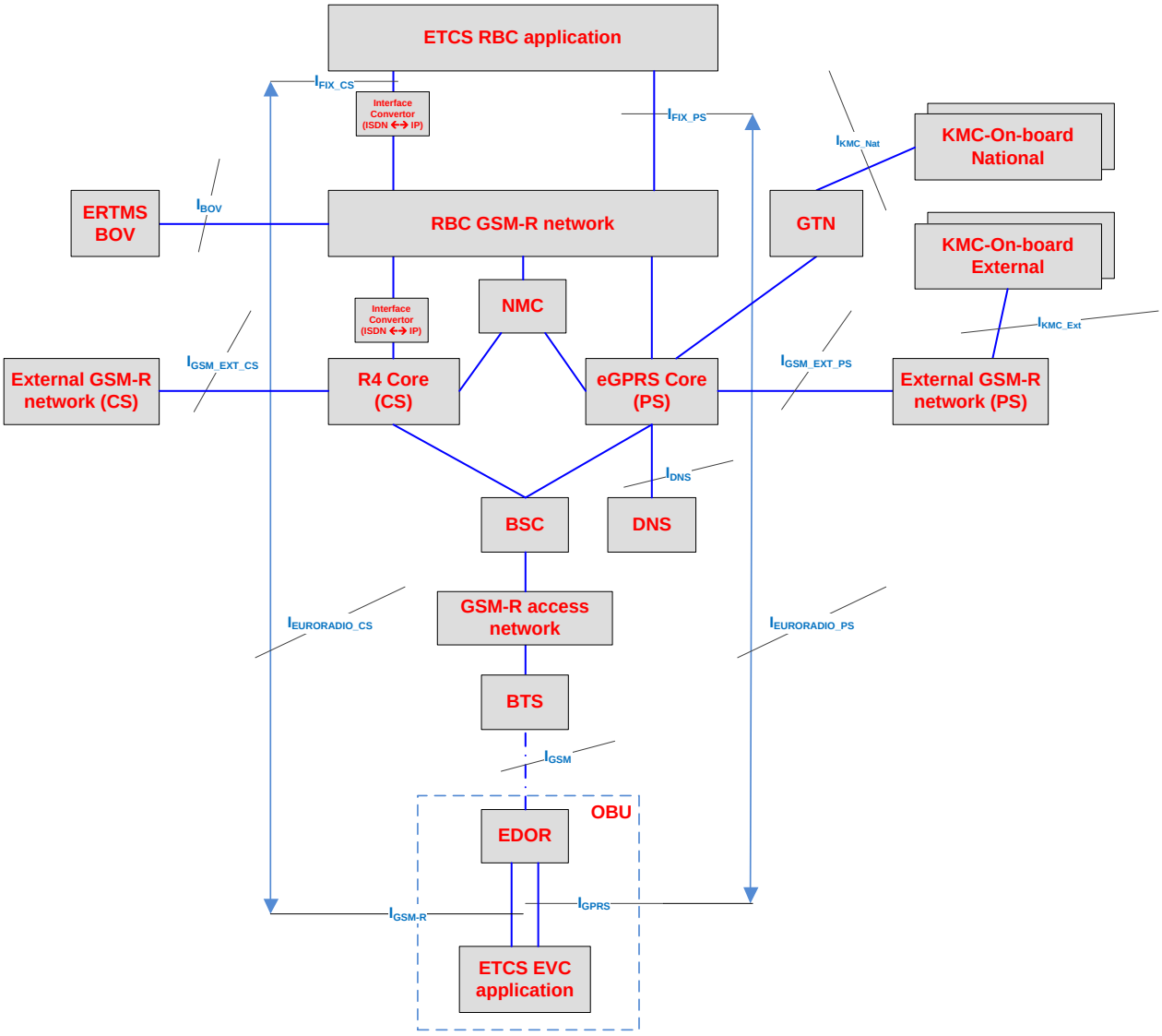

Figure 3-1 Overview of the interfaces between GSM-R and ETCS

3.2 Generic interface requirements

1. All interfaces shall comply with the requirements of ETCS TSI CCS baseline 3 maintenance release 2 (B3R2) as referenced in [BLAUWDRUKGSMRARC]. For an overview of these specifications refer to B3R2 specifications [B3R2][B3R2][B3R2][B3R2][B3R2]. [GSM-R IRS 002]
2. The dimensions of all interfaces shall comply with the results of the ERTMS traffic and capacity analysis. The results of the traffic and capacity analysis are provided in [BLAUWDRUKGSMRARC]. [GSM-R IRS 003]
3. All interfaces shall be compliant with the security policy and measures as specified in [BLAUWDRUKGSMRARC]. [GSM-R IRS 004]
4. The names of the interfaces are, when applicable, equivalent to the interface names of the Euroradio FFFIS specification ([EURORADIOFFFIS]). [GSM-R IRS 005]

5. The interfaces as described in this document are further detailed in [BLAUWDRUKGSMRARC] if required from a technical perspective. [GSM-R IRS 007]
6. Rolling stock or OBU requirements are specified here if required as starting points or assumptions for correct operation of the GSM-R infrastructure. [GSM-R IRS 128]

3.3 Interface I_{FIX_CS}

1. This interface denotes the connection between an RBC and the RBC GSM-R network for circuit switched services. [GSM-R IRS 008]
2. The interface shall comply with the Euroradio FFFIS specification ([EURORADIOFFFIS]). [GSM-R IRS 009]
3. The interface shall be provided as an ISDN PRI link (2 Mbps E1). [GSM-R IRS 010]
4. ISDN PRI link redundancy shall be supported. [GSM-R IRS 011]
5. ISDN PRI link load balancing shall be supported. [GSM-R IRS 012]
6. Link redundancy and load balancing shall be implemented by balancing traffic load on all E1 links to an RBC. Incoming calls from the OBU are evenly distributed on the 2 Mbps links following a round robin principle. At least one E1 link to an RBC is connected via GSM-R core location Rotterdam. A second E1 link is connected via GSM-R core location Amsterdam. [GSM-R IRS 013]
7. Every RBC is connected via two E1 links. [GSM-R IRS 014]
8. E1 link dimensioning in the GSM-R network is further detailed in [BLAUWDRUKGSMRARC]. Dimensioning depends on the number of trains simultaneously running and the number of RBCs. The number of RBCs is currently under investigation. [GSM-R IRS 015]
9. On physical level the interface complies with G.703 as depicted in Table 1. [GSM-R IRS 016]

2 Mbps Interface E1	
Bitrate:	2,048Mbit/s
Code:	HDB3
Frequency Tolerance	±50 ppm (Input)
Impedance	75 Ω unbalanced / 120 Ω balanced (Input and Output) (Input and Output) acc. To ITU-T G.703
Return Loss	Requirements acc. To Input acc. To ITU-T G.703 / Output acc. To ETS300-166
Input Cable Attenuation	0…6 dB (1024 kHz) acc. ITU-T G.703
Transmitting Pulse Shape	acc. To ITU-T G.703 / FIGURE15/G.703
Jitter	Requirements acc. To ITU-T G.783 / ITU-T G.823 / ETSI – Rec 300417.ets
Characteristics	Measurement arrangements acc. To ITU-T G.825
Connectors	Metrical high density
Overvoltage Protection	1kVpp 10µs / 700µs Acc. To. ETS 300 386-1

Table 1 ISDN PRI interface specification 2 Mbps

10. The interface shall support CRC4 which will be enabled for each ISDN PRI link. [GSM-R IRS 017]
11. The E1 link shall be provided by circuit emulation over IP (using the RBC GSM-R network). Protocol conversion from ISDN PRI/E1 to IP and vice versa is performed by interface convertors. [GSM-R IRS 018]
12. The MSISDN GSM-R numbering plan for RBCs shall comply with the requirements and clauses as specified in [BLAUWDRUKGSMRARC]. [GSM-R IRS 019]
13. Calls from OBU to RBC shall be screened by the GSM-R network using access control features as specified in [BLAUWDRUKGSMRARC]. [GSM-R IRS 020]

3.4 Interface I_{GSM}

1. This interface denotes the air interface of GSM-R as specified in [EIRENE SRS]. [GSM-R IRS 021]

2. The following radio frequency requirements are applicable on ERTMS tracks:
    a. The coverage level shall be >= -85 dBm/95% at the roof of a train (at a height of app. 4m) for every 100m section ot the track. [GSM-R IRS 123]
    b. The average C/I (Carrier to Interference Ratio) shall be >= 17 dB on average for every 100m section of the track. [GSM-R IRS 124]
3. The discontinuation of the data flow using GPRS/EGPRS bearer service ((e.g. during cell change) shall be less than:
    a. 1,5 s in 95% of cases [GSM-R IRS 135]
    b. 2 s in 99% of cases [GSM-R IRS 136]
4. The physical installation of the OBU in the train (e.g. antenna gain, quality of installation of the antenna, antenna cabling, feeders and patchpanels, grounding, obstacle free distance and antenna environment) shall comply with the requirements as specified in [GSM-R REQ. VOOR ROLLING STOCK]. [GSM-R IRS 022]
5. Each EDOR in a train shall be equipped with a separate antenna on the roof of a train to avoid splitter loss and to improve robustness of operation. [GSM-R IRS 023]
6. The area around an antenna on the roof of a train shall be free of obstacles within a radius of 1m. [GSM-R IRS 024]
7. The distance between two antennas shall be at least 2m (5λ – 7λ). [GSM-R IRS 025]
8. Antennas should, if required for quality of operation, be directly mounted on a conductive surface to create the required ground plane. [GSM-R IRS 026]
9. The antenna feeder and patch panel loss shall be less than 3 dB. [GSM-R IRS 028]

3.5 Interface I_{GSM-R}

1. This interface denotes the connection between an EVC and the GSM-R mobile (EDOR) in a train for circuit switched services. [GSM-R IRS 029]
2. The interface shall comply with the Euroradio FFFIS specification ([EURORADIOFFFIS]).This interface shall comply with the functional and performance requirements as outlined in [GSM-R REQ. VOOR ROLLING STOCK]. [GSM-R IRS 030]

3.6 Interface I_{FIX_PS}

1. This interface denotes the connection between an RBC and the RBC GSM-R network for packet switched services. [GSM-R IRS 031]
2. The interface shall comply with the Euroradio FFFIS specification ([EURORADIOFFFIS]). [GSM-R IRS 032]
3. Both Circuit Switched and Packet Switched connectivity of GSM-R towards RBCs is provided via a fixed IP network (i.e. the RBC GSM-R network). The connectivity path between train and RBC shall be redundant and disaster tolerant. The scope of the I_{FIX_PS} interface comprises the redundant connection between RBC and GSM-R core. [GSM-R IRS 137]
4. The interface shall be provided as an ethernet link (1 Gbps IEEE 802.3 ethernet as specified in [IEEE 802.3]). A speed of at least 100 Mbps (Fast Ethernet is mandatory.. [GSM-R IRS 033]
5. The CS part (ISDN30) is encapsulated into UDP/IP packets (SAToP) and transported via the IP connection. [GSM-R IRS 138]
6. A QoS profile is assigned to this packet flow. The exact QoS configuration is for further study. [GSM-R IRS 153]

7. An overview of the redundancy concept is shown in Figure 3-2. [GSM-R IRS 139]

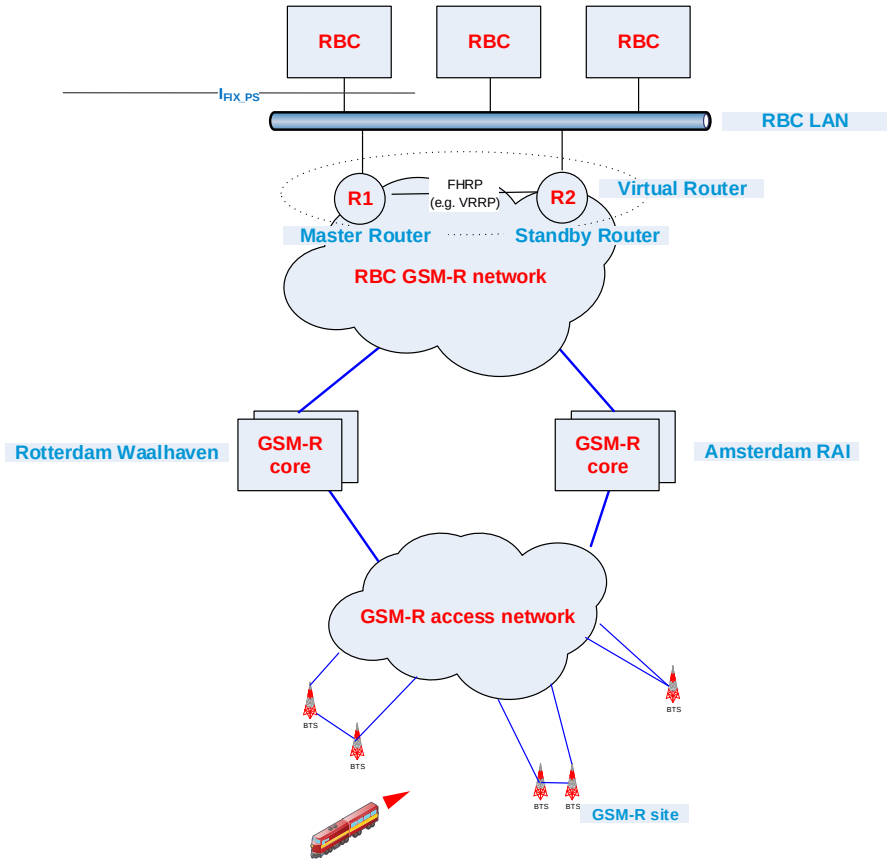

Figure 3-2 Overview of the interfaces between GSM-R and ETCS

8. From the perspective of an OBU, IP access redundancy of an RBC, KMC and/or a Domain Name Service shall be treated inside the GSM-R network or RBC GSM-R network by using logical IP address allocation. As part of the ETCS service initiation, this shall result into a single IP-address propagation of ETCS Domain Name Service during PDP context activation and RBC-Id to RBC IP address resolution. [GSM-R IRS 037]
9. An individual RBC (independent of its physical and geographical structure) is reachable through a single, unique, fixed IP address. [GSM-R IRS 140]
10. RBCs are either co-located at a single location or distributed among several locations and are connected to a local area environment which may comprise switches, routers, gateways and/or loadbalancers (RBC LAN). All RBC premises are interconnected with LAN connectivity. The exact configuration and setup of the RBC physical environment is supplier specific. [GSM-R IRS 141]
11. IP connectivity is provided to and from an RBC LAN. The LAN is connected to the RBC GSM-R network (IP WAN) by means of R1 and R2. There are two cases to consider when applying network redundancy. [GSM-R IRS 142]
    a. IP packet flow from train to RBC (uplink)
    b. IP packet flow from RBC to train (downlink)
12. For these packet flows R1 is configured as the master router, R2 is configured as standby. R1 and R2 must be part of the same subnet, the routers may or may not be co-located. [GSM-R IRS 143]
13. R1 and R2 are directly connected to the RBC GSM-R network, but shall be part of the RBC local area domain. Both the RBC GSM-R network and the RBC local network are beyond the scope of delivery of the ERTMS (RBC) supplier. [GSM-R IRS 144]

14. ProRail uses a First Hop Router Redundancy Protocol (e.g. VRRP or HSRP) that provides for automatic assignment of a single default gateway IP address to the RBCs. This increases the availability and reliability of routing paths via automatic default gateway availability on the RBC LAN. [GSM-R IRS 145]
15. The protocol achieves this by the creation of a virtual router, which is an abstract representation of multiple routers, i.e. master and backup routers, acting as a group (R1 and R2). The default gateway of an RBC is assigned to the virtual router instead of a physical router. If the physical router (R1) that is routing packets on behalf of the virtual router fails, another physical router (R2) is selected to automatically replace it. The physical router that is forwarding packets at any given time is called the master router. [GSM-R IRS 146]
16. In normal operation, IP packet flow from RBC to train is routed via R1 which serves as a master router. IP packet flow from train to RBC is routed by the routing protocol of the WAN via R1 (assuming that asymmetric routing is prevented by a suitable configuration if necessary). [GSM-R IRS 147]
17. In case of network failure (e.g. if R1 fails), R2 is assigned as the master. IP packet flow from RBC to OBU is then routed via R2. IP packet flow from train to RBC is routed by the routing protocol of the RBC GSM-R network (e.g. OSPF or BGP) via R2. [GSM-R IRS 148]
18. Failover time, after an outage occurs, depends upon the value of the advertisement timer. Ffailover time is three times as long as the advertisement timer. The value of the advertisement timer can be configured ranging from a subsecond to several seconds. [GSM-R IRS 149]
19. The IP GSM-R addressing plan for RBCs shall comply with the requirements and clauses as specified in [BLAUWDRUKGSMRARC]. [GSM-R IRS 039]

3.7 Interface I_{GPRS}

1. This interface denotes the connection between an EVC and the GSM-R mobile (EDOR) in a train for packet switched services. [GSM-R IRS 040]
2. The interface shall comply with the Euroradio FFFIS specification ([EURORADIOFFFIS]). [GSM-R IRS 152]
3. When the OBU is switched on, the OBU performs a GSM-R network registration followed by a GPRS attach and sets up a PDP Context. As part of the PDP context procedure, the OBU gets an IP source address and a default DNS server IP address (depending on the configuration of the DNS server, two DNS server addresses may be provided). [GSM-R IRS 041]
4. The APN associated with PDP context setup for communication with the RBC is etcs.mnc021.mcc204.gprs. [GSM-R IRS 051]
5. For setting up an IP connection with an RBC, the OBU uses a DNS name of the form: “id.ty.etcs” (e.g. “id031123. Ty01.etcs”). A DNS query of the OBU to the DNS server then returns the IP address of the RBC. [GSM-R IRS 052]
6. The DNS response message contains information in an option field (TXT field). The information is used by the OBU to determine its communication settings. The information consists of:
    a. The transmission mode txm=CS (if the RBC only supports CS). PS is the default mode of operation. The behavior of the OBU with respect to CS and PS is described in detail in [SUBSET-037]. See also section 3.10. [GSM-R IRS 054]
    b. TCP parameter settings. See section 3.9. [GSM-R IRS 055]
7. The OBU (i.e. on a single GSM-R modem) shall use two source IP addresses. One for RBC communication, the second one for KMC communication. [GSM-R IRS 053]
8. KMC communication setup is specified in par. 3.11 and par. 3.12. [GSM-R IRS 154]
9. The interface shall comply with the functional and performance requirements as outlined in [GSM-R REQ. VOOR ROLLING STOCK]. [GSM-R IRS 056]
10. The interface shall comply with the requirements for GPRS as further detailed in [BLAUWDRUKGSMRARC]. [GSM-R IRS 057]

3.8 Interface $I_{EURORADIO\_CS}$

1. This interface is defined end-to-end across the mobile and fixed network between I_{GSM-R} and I_{FIX_CS}. [GSM-R IRS 058]
2. This circuit switched interface is provided by the EURORADIO layer over the GSM-R communication bearer as depicted in Figure 1-3. [GSM-R IRS 059]
3. The interface shall comply with the requirements for availability as specified in [BLAUWDRUKGSMRARC]. [GSM-R IRS 060]
4. This interface shall comply with the functional and performance requirements as outlined in [GSM-R REQ. VOOR ROLLING STOCK]. [GSM-R IRS 061]
5. The interface shall comply with the requirements for performance as specified in [SUBSET-093]. Performance parameters for CS are shown in Table 2. [GSM-R IRS 062]

QoS parameter	Value
Connection establishment delay of mobile originated calls	< 8.5s (95%)
Connection establishment error ratio	$<10^{-2}$
Maximum end-to-end transfer delay (of 30 byte data block)	≤ 0.5s (99%)
Connection loss rate	≤ 10^{-2} /h
Transmission interference period	< 1s (99%)
Error-free period	>7s (99%) or, if one interference TTI < 1 sec occurs within the 7 seconds then the following condition applies: >11s (90%)
Network registration delay	≤35s (99%), ≤40s (99.999%)

Table 2 QoS requirements (CS)

6. The performance parameters for CS shall be verified and validated by specification O-2475 (refer to [O-2475]). [GSM-R IRS 063]
7. The interface shall comply with the parameter settings of HDLC as specified in [SUBSET-037]. [GSM-R IRS 064]
8. The HDLC parameter values shall be configured as specified in Table 3. The parameter settings as indicated in column “National value” shall be applied for ERTMS in the Netherlands. These values have been in use on current ERTMS tracks and are verified in practice. [GSM-R IRS 065]
9. The HDLC parameter values are applicable to fixed infrastructure (RBCs) and OBUs. [GSM-R IRS 125]
10. Note that the national values of N2 and T4 do not comply with the SUBSET-037 requirements. N2 is not in the range specified and recommendation T4 > N2 * T1 is not fulfilled. T4 is however much larger than T1 as required by the HDLC specifications. [GSM-R IRS 126]
11. The HDLC parameter values shall be validated and optimized (if necessary) in a measurement campaign (as part of an EoG pilot). [GSM-R IRS 066]
12. The HDLC parameters are under discussion and may be changed (refer to [CR1146]). [GSM-R IRS 129]

Parameter	Symbol	Recommended value (SUBSET-037)	National value
Window size	k	1 – 61	25
Acknowledge time	T1	0,8 – 2 s	1,3 s
Local processing delay time	T2	< 80 ms	< 80 ms
Out of service time	T3	T3 >> T4	4s
Inactivity time	T4	T4 > N2 * T1	2s
Maximum number of bits in an I frame	N1	240 < N1 < 1024	400
Maximum number of retransmission attempts	N2	3 – 6	2
Error detection and correction		FCS-16	FCS-16

Table 3 Layer 2 configuration parameters for CS mode

13. Further optimization, tuning and adjustment of parameters of the ETCS application layer, EURORADIO/HDLC and GSM-R network (CS services) may be required to enhance operational robustness and prevent connection losses and interruptions of the data communication flow. [GSM-R IRS 067]

3.9 Interface $I_{EURORADIO\_PS}$

1. This interface is defined end-to-end across the mobile and fixed network between I_{GPRS} and I_{FIX_PS} . [GSM-R IRS 068]
2. This packet switched interface is provided by the EURORADIO layer over the GSM-R communication bearer as depicted in Figure 1-3. [GSM-R IRS 069]
3. The interface shall comply with the requirements for availability as specified in [BLAUWDRUKGSMRARC]. [GSM-R IRS 070]
4. This interface shall comply with the functional and performance requirements as outlined in [GSM-R REQ. VOOR ROLLING STOCK]. [GSM-R IRS 131]
5. The interface shall comply with the requirements for performance as specified in [SUBSET-093]. [GSM-R IRS 071]
6. The performance requirements for PS are specified in Table 4. [GSM-R IRS 072]

QoS parameter	Value
PS mode Service setup Delay	≤ 40s (99%)
GPRS Attach Delay	≤ 5s (99%)
PDP Context Activation Delay	≤ 3s (99%)
RBC IP Resolution Delay	≤ 3s (99%).
Transaction Transfer Delay	
• **OBU originated 100 octet**	≤ 2.6s (99%)
• **RBC originated 320 octet**	≤ 3.0s (99%)
• **RBC originated 560 octet**	≤ 3.5s (99%)

Table 4 QoS requirements (PS)

7. The performance parameters for PS shall be verified and validated by specification O-2475 (refer to [O-2475]). [GSM-R IRS 073]
8. The interface shall comply with the parameter settings of TCP as specified in [SUBSET-037]. [GSM-R IRS 074]

Feature	RFC	Range	National value	Comments
Initial RTO	793 1122	>= TCP_RTO_MIN < TCP_RTO_MAX	TCP_RTO_MIN	Also known as “TCP_timeout_init” Note: not configurable per connection
Minimum Retransmission Time	793 1122	1 – 5s	4s	TCP_RTO_MIN: The RTO is not allowed to be lower than this value Note: not configurable per connection
Maximum Retransmission Timeout	793 1122	>= 5s	10s	TCP_RTO_MAX: Should be set to a value that defines the maximum allowed time before a forced re-transmission Note: not configurable per connection
Karn and Jacobson’s algorithm, with exponential back-off	1122	Used	Used	Standard TCP feature to compute RTO Note: not configurable per connection
TcpMaxConnectRetransmissions	793 1122	3	3	Number of SYN-packet retries; also known as “TCP_SYN_retries” Note: not configurable per connection
TcpMaxDataRetransmissions	793 1122	1 – 5	3	Also known as “TCP_retries2” Note: not configurable per connection
TcpKeepAliveTime	793 1122	10 – 20s	12s	The interval to wait before probing the idle connection Note: configurable per connection
TcpKeepAliveInterval	793 1122	2 – 5s	3s	The interval to wait before retrying the probe after an initial failure to respond: Note: configurable per connection
TcpKeepAliveProbes	793 1122	2 – 4	3	The maximum number of times to retry the probe Note: configurable per connection
TcpUserTimeout	5482	>= 10s	20s	The TCP user timeout controls how long transmitted data may remain unacknowledged before a connection is forcefully closed. It is checked during RTO update. Note: configurable per connection
TcpSack	2018 2883	enabled	enabled	Selective Acknowledgement Note: not configurable per connection
TcpTimestamps	1323	disabled	disabled	Note: not configurable per connection
TcpNoDelay	896	enabled	enabled	Disables Nagel’s algorithm which concatenates small messages before sending them

				Note: configurable per connection
TCP Push Bit	793	enabled	enabled	Force the processing of the receiver buffer Note: not configurable per connection
Max TCP segment size	793	<= 1416	1416	Maximum value is MTU – sizeof(max TCP Header) – sizeof(max IP Header) Where guaranteed MTU=1500 byte, sizeof(max TCP Header)=60 byte, sizeof(max IP Header) = 24 byte Note: configurable per connection

Table 5 Applicability conditions of TCP

9. The TCP parameter values shall be configured as specified in Table 5. The parameter settings as indicated in column “National value” shall be applied for ETCS in the Netherlands. [GSM-R IRS 075]
10. The TCP parameter values are applicable to fixed infrastructure (RBCs) and OBUs. [GSM-R IRS 127]
11. The TCP parameter values shall be validated and optimized (if necessary) in a measurement campaign (as part of an EoG pilot). [GSM-R IRS 076]
12. The parameter TCPUserTimeout is optional in SUBSET-037. The parameter is mandatory for national use. [GSM-R IRS 077]
13. TCP parameters which are denoted as “configurable per connection” can be set remotely (over the GSM-R network) via a text field in the DNS response message. This functionality shall be included in the DNS system. [GSM-R IRS 078]
14. The OBU shall support remote configuration of all TCP parameters denoted as “configurable per connection”. [GSM-R IRS 079]
15. Further optimization, tuning and adjustment of parameters of the ERTMS application layer, EURORADIO/TCP and GSM-R network (PS services) may be required to enhance operational robustness and prevent session losses and interruptions in the data communication flow. [GSM-R IRS 080]

3.10 Interface I_{DNS}

1. This interface denotes the connection between a Domain Name Service (DNS) and the GSM-R backbone network for packet switched services. [GSM-R IRS 081]
2. There are two DNS systems to meet different objectives. DNS_A is used to resolve APN IP addresses. DNS_B is used to resolve all other IP addresses as indicated below. [GSM-R IRS 150]
3. The DNS A system is part of the GSM-R core network. [GSM-R IRS 082]
4. The DNS B system may be part of the GSM-R core network or is part of a generic DNS service provided by ProRail ICT (TBD). [GSM-R IRS 156]
5. DNS B is connected behind the interface of GGSN and RBC GSM-R network (G_i). [GSM-R IRS 157]
6. The purpose of the DNS A system in the context of ETCS is to:
   a. Resolve the GGSN IP address of the APN of ETCS. [GSM-R IRS 083]
   b. Resolve the GGSN IP address of the APN of external (i.e. not national) networks belonging to external KMCs. [GSM-R IRS 084]
   c. Resolve the GGSN IP address of the APN of the GSM-R network in the Netherlands belonging to national KMCs. [GSM-R IRS 132]
7. The purpose of the DNS B system in the context of ETCS is to:
   a. Resolve IP addresses of RBCs. [GSM-R IRS 085]
   b. Resolve IP addresses of national KMCs. [GSM-R IRS 086]

c. Provide transmission mode capabilities (CS-mode or PS-mode) associated with an RBC DNS name resolution request/response (txt field option). [GSM-R IRS 087]

d. Provide adjustments in values of (some) TCP parameters (PS-mode) associated with an RBC DNS name resolution request/response (txt field option). [GSM-R IRS 088]

8. The interface shall comply with the Euroradio FFFIS specification ([EURORADIOFFFIS]). [GSM-R IRS 089]
9. The interface shall comply with the EIRENE SRS specification ([EIRENE SRS]). [GSM-R IRS 090]
10. The interface shall be provided as an ethernet link (1 Gbps IEEE 802.3 ethernet as specified in [IEEE 802.3]). A speed of at least 100 Mbps (Fast Ethernet is mandatory. [GSM-R IRS 091]
11. Ethernet link redundancy shall be supported. [GSM-R IRS 092]
12. Ethernet link traffic load balancing shall be supported. [GSM-R IRS 093]
13. Ethernet link redundancy and load balancing shall be implemented by balancing traffic load on all realized links to the DNS system. [GSM-R IRS 094]
14. The method of loadbalancing and redundancy is for further study and must be agreed across the interface of the DNS system and network. [GSM-R IRS 095]
15. DNS redundancy is provided by using logical IP-address allocation (the second IP address provided at PDP context activation may not be used by the OBU). DNS servers may be realized via a grid solution to provide geographical redundancy. The method is for further study. [GSM-R IRS 096]

3.11 Interface I_{KMC_Nat}

1. This interface denotes the connection between the KMC (responsible for key management of trains) in the Netherlands and the GSM-R network. [GSM-R IRS 097]
2. The term Nat(ional) in this context means that the KMC is associated with the GSM-R network in the Netherlands. [GSM-R IRS 098]
3. National KMCs are connected via the GTN (Generieke Toegangs Netwerk) of ProRail to the GSM-R core network. [GSM-R IRS 099]
4. Access to a national KMC shall be provided by IP/GPRS. [GSM-R IRS 100]
5. Train operators may share KMC functionality. If two or more KMCs will be in place, multiple equivalent interfaces will be defined. [GSM-R IRS 101]
6. An OBU of a train which belongs to a national KMC sets up a dedicated PDP context in order to select the GGSN for access to its KMC. The APN is of the form: “kms.mnc21.mcc204.gprs”. Mobile Network Code MNC=021 and Mobile Country Code MCC=204 uniquely identify the GSM-R network of ProRail. These attributes are used to route the PDP context request to the GGSN of ProRail. [GSM-R IRS 103]
7. The APN associated with PDP context setup for communication with the national KMC is kms.mnc021.mcc204.gprs. [GSM-R IRS 155]
8. The QoS setting of the APN for KMC is set to a lower priority than the APN for RBC communication. [GSM-R IRS 130]
9. The QoS setting of the APN for KMC is specified in [BLAUWDRUKGSMRARC]. [GSM-R IRS 133]
10. As part of the KMC PDP context setup the OBU receives a local IP address (i.e. an OBU IP source address of the GSM-R network of ProRail) and a DNS server address. [GSM-R IRS 104]
11. The DNS server address is used by the OBU to lookup the IP address of its KMC. The DNS name of the KMC has the form: “id<ETCS-ID>.ty<ETCS-ID Type>.etcs”, e.g. “id031123. Ty05.etcs”. [GSM-R IRS 105]
12. The interface shall comply with the requirements for KMC as further detailed in [SUBSET-037] and [BLAUWDRUKGSMRARC]. Routing cases for national and international trains will be provided there. [GSM-R IRS 106]

3.12 Interface I_{KMC_Ext}

1. This interface denotes the connection between the KMC (responsible for key management of trains) in an external GSM-R network and the GSM-R network in the Netherlands. [GSM-R IRS 107]
2. The term Ext(ernal) in this context means that the KMC is associated with the GSM-R network of a foreign country (i.e. reachable via an international link as described in paragraph 3.14). [GSM-R IRS 108]
3. Access to an external KMC shall be provided by IP/GPRS. The route to the external GGSN is set by the APN of key management (“kms.mnc<xxx>.mcc<yyy>.gprs”). The MNC (=xxx) and MCC (=yyy) uniquely identify the external GSM-R network. [GSM-R IRS 109]
4. The QoS setting of the APN for KMC is specified in [BLAUWDRUKGSMRARC]. [GSM-R IRS 134]
5. The DNS server address is used by the OBU to lookup the IP address of its KMC. The DNS name of the KMC has the form: “id<ETCS-ID>.ty<ETCS-ID Type>.etcs”, e.g. “id031123.ty05.etcs”. [GSM-R IRS 151].
6. The interface shall comply with the requirements for KMC as further detailed in [SUBSET-037] and [BLAUWDRUKGSMRARC]. [GSM-R IRS 110]
7. In general there are multiple external KMCs. For each KMC an equivalent interface will be defined. [GSM-R IRS 111]

3.13 Interface I_{BOV}

1. This interface denotes the connection between the ERTMS system for Beheer, Onderhoud en Vernieuwing (BOV) and the GSM-R Network Management Centre. [GSM-R IRS 112]
2. Maintenance, monitoring and performance management systems of the GSM-R network generate log files, KPI inidcators and other information which can be used by the ERTMS BOV, online KPI status reporting tools and end-to-end management systems of ERTMS stakeholders and railway associated parties for further processing and reporting. [GSM-R IRS 113]
3. This information shall be made available over the BOV interface in a consistent and uniform manner. [GSM-R IRS 114]
4. The interface shall use the Enterprise Service Bus (ESB). This is for further study. [GSM-R IRS 115]
5. The interface shall comply with the requirements for ESB as further detailed in [BLAUWDRUKGSMRARC]. [GSM-R IRS 116]

3.14 Interface $I_{GSM\_EXT\_PS}$

1. This interface denotes the interconnection between the GSM-R network and an external GSM-R network for packet switched services. [GSM-R IRS 117]
2. GPRS interconnection and roaming shall be provided by a GRX or IPX service which implements the GPRS Gp interface. The physical and functional interface and its configuration is subject to international standardization. This is for further study. [GSM-R IRS 118]
3. The interface shall comply with the requirements for packet switched interconnection and roaming as further detailed in [BLAUWDRUKGSMRARC]. [GSM-R IRS 119]

3.15 Interface $I_{GSM\_EXT\_CS}$

1. This interface denotes the interconnection between the GSM-R network and an external GSM-R network for circuit switched services. [GSM-R IRS 120]
2. The interface shall comply with the requirements for circuit switched interconnection and roaming as futher detailed in [BLAUWDRUKGSMRARC]. Interconnection with GSM-R Belgium and Germany does already exist. [GSM-R IRS 121]

3.16 Precedence and criticality of requirements

Precedence and criticality of requirements are not applicable. All requirements have equal weight. [GSM-R IRS 122]

4 Qualification provisions

Each requirement in section 3 may be annotated with associated qualification method(s) in order to be able to verify that the requirement will be met.
The qualification methods are provided in a separate document which is part of the integral verification & validation program as described and referenced in [BLAUWDRUKGSMRARC].

5 Requirements traceability

Traceability of each requirement imposed on the interfaces of section 3 is, when applicable, provided directly in that section as part of the requirement description. Most requirements can be traced back to the documents Technical Reference Architecture of ERTMS [REFARCHERTMS], [SSS VRIJGEVEN INFRA], [SSDD VRIJGEVEN INFRA] and Kaderstelling Infrastructuur [KADERSTELLINGINFRA]. Blauwdruk GSM-R architectuur [BLAUWDRUKGSMRARC] and international specifications (e.g. most notably [SUBSET-093] and [SUBSET-037]) contain further details of the interfaces.
Some requirements are not directly traceable to higher-level requirements since these are a further refinement of the system interfaces.
Traceablitiy of IRS requirements to specific interfaces is provided in document [IntTracMatr].

6 Notes

Glossary

Acronym/Abbreviation	Meaning	Explanation/description
APN	Access Point Name	-
AU	Amsterdam-Utrecht	-
BGP	Border Gateway Protocol	-
BOV	Beheer, Onderhoud en Vernvieuwing	-
B3R2	-	ERA Baseline 3 Release 2 specifications
BR	Betuweroute	-
BSC	Base Station Controller	System that controls a number of BTSs
BSS	Base Station Subsystem	A BSS comprises a BSC with multiple BTSs
BTS	Base Tranceiver System	GSM-R base station for transmitting and receiving radio signals
C/I	Carrier to Interference Ratio	Ratio between RF carrier and interference level. The interference level includes interference from internal (e.g. cochannel interference) and external sources (e.g. interference from public mobile networks)
CS	Circuit Switching	-
CDS	Circuit Switched Data Server	-
CRC4	Cyclic Redundancy Check 4	-
DID	Data Item Description.	-
DNS	Domain Name Service	-
DoD	Department of Defense	-
DI-IPSC-81434	Identification number of the DID that describes the IRS.	-
EDGE	Enhanced Data rates for Global Evolution	EDGE is an improved modulation technique in GSM which provides higher data rates on GSM channels (up to a factor of three)
EDOR	ETCS Data Only Radio	-
EGPRS	Enhanced GPRS	Enhanced GPRS uses EDGE and provides higher data rates than GPRS. EGPRS supports enhanced techniques for retransmission such as incremental redundancy for performance enhancement
ERA	European Railway Agency	-
ERTMS	European Railway Traffic Management System	-
ESB	Enterprise Service Bus	-
ETCS	European Train Control System	-
ETSI	European Telecommunications Standardisation Institute	-
EVC	European Vital Computer	-
FHRP	First Hop Routing Protocol	-
FIDES	-	ProRail transmission network (based on IP and MPLS)
GGSN	Gateway GPRS Support Node	-
GSM-R	GSM for Railways	-
GTN	Generieke Toegangs Netwerk	-
HSL-Z	Hogesnelheidslijn Zuid	-
HSRP	Hot Standby Router Protocol	-
IN	Intelligent Network	-
IPX	Internetwork Packet Exchange	
IRS	Interface Requirements Specification	-
ISDN PRI	ISDN Primary Rate Interface	-
IP	Internet Protocol	-

Acronym/Abbreviation	Meaning	Explanation/description
KMC	Key Management Centre	-
KPI	Key Performance Indicator	-
Loadsharing	Loadsharing	Load sharing is a method to distribute traffic load over multiple systems
MCC	Mobile Country Code	-
MGW	Media Gateway	-
MIL-STD	Military Standard.	-
MNC	Mobile Network Code	-
MPLS	Multiprotocol Label Switching	-
MSS	MSC Server	-
OBU	On-Board Unit	-
OSPF	Open Shortest Path First	-
PDP	Packet Data Protocol	-
PS	Packet Switching	-
R4	Release 4	Certain generation of GSM-R switch technology (IP based)
R4-R	Release 4 for Railways	R4-R consists oft R4 with additional railway specific features such as group and priority calls
RBC	Radio Block Centre	-
RF	Rado Frequency	-
RIC	Rail Infra Catalogus	-
RTO	Retransmission Time Out	-
Roaming	-	The use of a mobile on any communications network other than the user's home network
SAToP	Structure-Agnostic time-division multiplexing (TDM) over Packet	-
SGSN	Serving GPRS Support Node	-
TCP	Transmission Control Protocol	-
TSI	Technical Specifcation for Interoperability	-
CSS	Central Safety System	-
UDP	User Datagram Protocol	-
QoS	Quality of Service	-
VL	Verkeersleiding	-
VRRP	Virtual Router Redundancy Protocol	-

6.1 Colophon

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