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FFFS for Voice and Data Services Interconnection & Roaming between GSM-R networks

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EVOLUTION SHEET

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1.0.10	01/06/16	OG	Review of english wording

1.0.11	06/10/16	TIG/OG	Ad Hoc Group Review following TIG comments
2.0	20/10/16	UIC	Final version approved by OG and IG based on 1.0.11

TABLE OF CONTENTS

1. REFERENCES

1.1 Documentation

[EIRENE FRS]	EIRENE, System Requirement Specification, version 16.0.0
[EIRENE SRS]	EIRENE, Functional Requirements Specification, version 8.0.0
[CDD]	ENIR-08020-v1.6_CDD, Common Design Document ENIR v1.6
[RFC 1034]	Domain Concepts and Facilities
[RFC 1035]	Domain Names – Implementation and Specification
[RFC 4271]	A Border Gateway Protocol 4 (BGP-4)
[3GPP TS 23.002]	Network architecture
[3GPP TS 23.003]	Numbering, addressing and identification
[3GPP TS 23.060]	General Packet Radio Service (GPRS); Service description
[3GPP TS 29.060]	General Packet Radio Service (GPRS); GPRS Tunnelling Protocol (GTP) across the Gn and Gp interface

1.2 Abbreviation / Acronyms

APN	Access Point Name
AS	Autonomeous System
ASN	Autonomeous System Number
BC	Break out Code
BG	Border Gateway
BGP	Border Gateway Protocol
CC	Country Code
CDD	Common Design Document
CCS7	Common Channel Signaling #7
CPN	Called Party Number
CS	Circuit Switched
CT	Call Type
DNS	Domain Name Service
DPC	Destination Point Code
ENIR	UIC - European Network Integration for Railways group
FQDN	Fully Qualified Domain Name
GGSN	Gateway GPRS Support Node
GID	Group call Identifier
GMSC	Gateway MSC
GNS	GPRS Name Service
GIRA	GSM-R Interconnection and Roaming Agreement
GNS	GPRS Name Service
GPRS	General Packet Radio Service
GRX	GPRS Roaming eXchange
GTP	GPRS Tunneling Protocol
GTP-C	GTP- Control Plane
GTP-U	GTP- User Plane
GSM-R	Global System for Mobile communications – Railway
GT	Global Title

GTT	Global Title Translation
H-GGSN	Home GGSN
HLR	Home Location Register
IC	International Code
IM	Infrastructure Manager
IP	Internet Protocol
IPv4	IP version 4
IPv6	IP version 6
IPR	International Public routing
IPX	IP packet eXchange
ISPC	International Signalling Point Code
ISUP	ISDN User Part
I&R	Interconnection & Roaming
MAP	Mobile Application Part
MCC/mcc	Mobile Country Code
MNC/mnc	Mobile Network Code
MSC	Mobile Switching Center
MSISDN	Mobile Station International ISDN Number
MTP	Message Transfer Part
NDC	National Destination Code
NI (CS-mode)	Network Indicator
NI (PS-mode)	Network Identifier
NMG	UIC – Network Management Group
NUC	Nailed Up Connection
O&M	Operation & Maintenance
OI	Operator Identifier
PLMN	Public Lands Mobile Network
POI	Point Of Interconnection
PS	Packet Switched
QoS	Quality of Service
RDS	Routing Data Set
SCCP	Signalling Connection Control Part
SDC	Short Dialling Code
SGSN	Serving GPRS Support Node
SOA	Start of Authority
STP	Signalling Transfer Point
TLD	Top Level Domain
TRA	Transit Routing Agreement
TS	Technical Specification
UDP	User Datagram Protocol
UE	User Equipment
UN	User Number
V-GGSN	Visited GGSN

2. GENERAL

2.1 This document specifies technical conditions and functionalities to be fulfilled for Interconnection and Roaming of GSM-R networks in order to enable interoperable international train traffic. (I)

2.2 The statements made in the specification are assigned to one of four categories: (I)

- **Mandatory for Interoperability** (indicated by '(MI)' at the end of the paragraph). These are the requirements, **with respect to the authorisation in the EU according to the TSI,** that are considered in the European Directives to be relevant for interoperability as **fulfilling the essential requirements for the Control-Command and Signalling subsystem** related to safety and technical compatibility which must be met by the rail system, the subsystems, and the interoperability constituents, including interfaces according to the corresponding conditions set out in Annex III of the Directive 2008/57/EC. It is mandatory that each railway subsystem in the EU meets these requirements on lines under the scope of the Directive to ensure technical compatibility between Member States and safe integration between train and track.
- **Mandatory for the System** (indicated by '(M)' at the end of the paragraph). These requirements must be complied with together with the "Mandatory for Interoperability (MI)" requirements in order to deliver an EIRENE compliant system. The M requirements ensure additional level of system technical integration and compliance to existing standards; they allow that the technical characteristics of the network and fixed terminal system are compatible with each other and with those on board the trains to be used on the rail system.
- **Optional** (indicated by '(O)' at the end of the paragraph). These requirements allow the selection (or non-selection) of a set of requirements on a national basis and shall not be used as a precondition for the acceptance of roaming mobile equipment on GSM-R networks. When an option is selected, the method defined in the SRS and FRS by which such features are implemented becomes mandatory (M), both to provide a consistent service and to present a recognised and agreed standard to manufacturers in order to obtain economies of scale in development and manufacture.

  In addition:

- **Information** (indicated by '(I)' at the end of the paragraph). These are statements intended to provide explanatory notes.

2.3 The EIRENE requirements are described in documents [EIRENE FRS] and [EIRENE SRS]. (I)

3. ORGANIZATION

3.1 The UIC - Network Management Group (NMG) coordinates and facilitates the GSM-R services for interconnection and roaming for IMs that have a need to ensure cross border operations. The NMG reports to the European Rail Implementers Group (ERIG) and interacts with Operators Group (OG) as well as Functional Group (FG). (I)

3.2 The NMG provides a platform for IMs to: (I)

- Exchange relevant information among IMs;
- Provide templates (e.g. roaming agreements, O&M agreements);
- Provide testing guidelines;
- Agree on roadmaps and planning issues among IMs (e.g. new I&Rs);
- Coordinate usage of national allocated numbers (e.g. GIDs, SDCs).

3.3 The UIC - European Network Integration for Railways group (ENIR) ensures the technical definition, implementation and monitoring of the GSM-R European wide overlay network offering a high Quality of Service. The ENIR group reports to the NMG group. (I). The tasks of ENIR are: (I)

- Overall design of the GSM-R interworking network for CS-mode (overlay network) and PS-mode (railway IP-hub);
- Develop and maintain the configuration of the GSM-R CS-mode overlay network with so called Routing Data Sets (RDS);
- Maintain the configuration of the PS-mode interworking network in terms of route propagation and Domain Name Service (DNS);
- Coordinate changes in the CS-mode and PS-mode interworking network;
- Provide traffic measurement and traffic prediction in order to ensure sufficient resources;
- Maintain process descriptions and detailed implementation procedures for new IMs to get connected to the GSM-R CS-mode overlay network (see [CDD]);
- Propose changes and provide recommendation for national packet core networks (see [CDD]);
- Provide test plan guidelines.

3.4 The GSM-R Interconnection and Roaming Agreement (GIRA) is a bilateral agreement between two GSM-R IMs who have a need for interconnection and roaming. The GIRA and its appendixes describe the tele-, bearer and supplementary services used during roaming, the details of the communication relations and specify if public roaming is supported. (I)

3.5 The GSM-R International Transit Routing Agreement (TRA) is a multi-party agreement between all GSM-R IMs who have a need to connect to the GSM-R overlay network. It is needed to enable communication relations between different non-adjacent GSM-R networks by using hub functionality via so called nailled-up connections for transit services. The network configuration is specified and agreed on multilateral bases. (I)

4. REQUIREMENTS FOR INTERCONNECTION & ROAMING

4.1 The requirements that are classified as MI in [EIRENE FRS] and [EIRENE SRS] shall be supported. (M)

4.2 The requirements that are classified as M in [EIRENE FRS] and [EIRENE SRS] shall be supported. (M)

4.3 Based on the bilateral decision of the IMs if the requirements that are classified as O in [EIRENE FRS] and [EIRENE SRS] should be supported. (I)

4.4 A high availability of the Interconnection & Roaming are needed for train operation. The availability requirement can be agreed upon on between IMs. (I)

4.5 The use and support of GSM-R PS-mode, in particular GPRS/EGPRS, is an optional feature (O) for Infrastructure Managers. (I)

4.6 Protection of the railway IP-hub against internal or external attacks is not part of this specification. These measures should be addressed at national level. (I)

5. OVERLAY NETWORK

5.1 CS-mode

5.1.1 The international GSM-R CS-mode overlay network consists of national GSM-R core networks within different countries. (I)

5.1.2 Basically only one GSM-R CS-mode core network per country exists. (I)

5.1.3 Physical interconnections and gateway nodes / Point of Interconnections (PoIs) of these GSM-R CS-mode core networks are forming the international GSM-R CS-mode overlay network, providing cross border interconnection and roaming services. (M)

5.1.4 A geo-redundant configuration of the GSM-R CS-mode core network is based on two gateway nodes in an active-active configuration. These two gateway nodes are connected to the GSM-R CS-mode overlay network instead of a single node configuration / connection. (I)

5.2 PS-mode

5.2.1 To enable the PS-mode network access, the responsible network entity has to retrieve subscriber profile information from the home subscriber data repository e.g. HLR. For this purpose PS-mode utilises existing CS-mode overlay network (signalling) capabilities. (I)

5.2.2 The PS-mode overlay network shall comprise of physical or logical interconnections between the IP-hub and the Border Gateway(s) as part of the packet core network at national level. (M)

5.2.3 The PS-mode logical interconnection(s) between the packet core networks shall be realized via an IP-hub by using the Border Gateway Protocol (BGP). (M)

5.2.4 The IP-hub shall comprise of routing path propagation, User/Control data routing and Domain Name Services (DNS) between the Gp reference points of the national GSM-R packet core networks according to [3GPP TS 23.002].(M)
5.2.5 The IP hub should be either operated by railway Infrastructure Managers or the service obtained from an Internet Protocol Packet eXchange network (IPX) [IR.34] which provides GPRS Roaming eXchange (GRX) services. (I)5.2.6 When the IP hub function is performed by an IPX, implementation of the routing path propagation and User/Control data routing shall be possible by establishing peering between the IPX environment and the railway operated IP hub environment. (M)

5.2.7 Geo-redundant access between the particular PS-mode core network and the IP-hub function(s) shall support a failover mechanism. (M)

6. NETWORK ARCHITECTURE

6.1 CS-Domain

6.1.1 In order to perform interconnection and roaming an CS-mode overlay network architecture is required. The architecture of the GSM-R CS-mode overlay network shall be designed as layered hierarchical structure approach. (M)

6.1.2 The upper layer of the GSM-R overlay network shall be based on centralised hub nodes. These centralised hub nodes shall provide the transit functionality to retrieve PS-mode subscription information, to exchange CS-mode control plane and CS-mode user plane information between all GSM-R networks. The centralised CS-mode hubs shall also act as origin and destination nodes. (M)

6.1.3 The locations of the centralised hubs are selected in such a way that a cost optimized network architecture is achieved, mainly related to the costs of transmission links. (I)

6.1.4 The access layer of the GSM-R overlay network shall be formed by the peripheral (non-hub) nodes. Peripheral nodes shall act as origin and destination entities for control and user plane. (M)

6.1.5 In the access layer of the GSM-R overlay network a transit function for other GSM-R networks shall not be provided except in a geo-redundant node configuration (active – active) for the 'partner node' within the same network / country. (M))

6.1.6 The GSM-R networks consist of either: (I)

- a combined node (embedded STP and user CS-mode traffic exchange); or
- a separate node configuration (stand-alone STP and stand-alone user CS-mode traffic exchange).

6.1.7 Three relations of CS-mode network interconnections exist: (I)

- Hub to hub;
- Hub to non-hub;
- Non-hub to non-hub.

6.1.8 In order to design the CS-mode GSM-R overlay network, a set of rules are needed. The rules must be clear on how a node will be connected (physical layer) and what routing rules will be used (logical layer). The rules in section 6.1.9 until 6.1.18 shall be applied for both the physical layer and the logical layer. (M)

Physical layer

6.1.9 To guarantee a high availability of the CS-mode hub function in the GSM-R overlay network at least two independent hub nodes in different countries shall be installed. (M)

6.1.10 Every country shall have at least two physical independent links to the CS-mode GSM-R overlay network. This can be realized with direct link(s) to a hub node and/or with direct link(s) to a non-hub node, depending on the general overall design developed. (M)

6.1.11 Nailed-up connections (NUCs) in CS-mode are used to provide physical connectivity (trunk groups and signalling link sets) to hub nodes. The number of hops should not be a limiting factor. (I)

6.1.12 The dimensioning of the physical links should be done on a case by case basis. As a minimum step one 2 Mbit/s (E1) link is used with 31 time slots available. As a guideline a minimum of one timeslot is needed for each signalling link set. For traffic trunk group dimensioning it is advised to base the dimensioning on the estimate usage and traffic analyses. (I)

6.1.13 Hub sites shall be fully meshed connected. (M)

Logical layer

6.1.14 Every country shall have a logical connection to at least two CS-mode hub nodes in different countries. (M)

6.1.15 Preferably each country should be connected to all CS-mode hubs (in the case that more then two hubs are used in the overlay network). (O)

6.1.16 If non-hub nodes in different countries have a direct physical link (e. g. to neigbouring country), these countries shall also have a direct logical link. (M)

6.1.17 This direct logical link connection is the preferred route (1st path) and the alternative paths will run over the hub nodes. (I)

6.1.18 The routing should provide bi-directionality for signalling only on the first path. This means that the return path is using the same route as the initial path (forward and backward path are equal). (O)

6.2 PS-Domain

6.2.1 In order to perform PS-mode roaming an IP overlay network architecture is required. (M)

6.2.2 The centralised PS-mode IP-hub structure (see Figure 6-1) shall constitute the uppermost part of the hierarchical network architecture and shall provide the transit functionality to exchange IP based control plane and user plane information. (M)

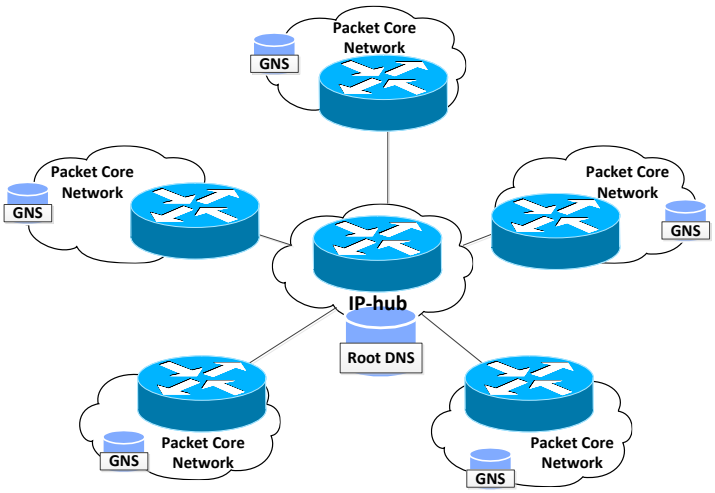


Figure 6-1 PS-mode Roaming - IP-hub

6.2.3 For the purpose of subscriber data retrieval during PS roaming, the concerned network entity i.e. SGSN shall use CS-mode roaming control plane facilities.(M)

6.2.4 The IP-hub can be operated at least by one of the railway Infrastructure Manager and/or can be obtained from IPX - GPRS Roaming eXchange (GRX) provider(s).(I)

6.2.5 If both IP-hub options (railway IP-hub and IPX) are used simultaneously, peering connection(s) between the railway IP-hub and the IPX network shall be established in order to align IP routing informations (see Figure 6-2).(M)

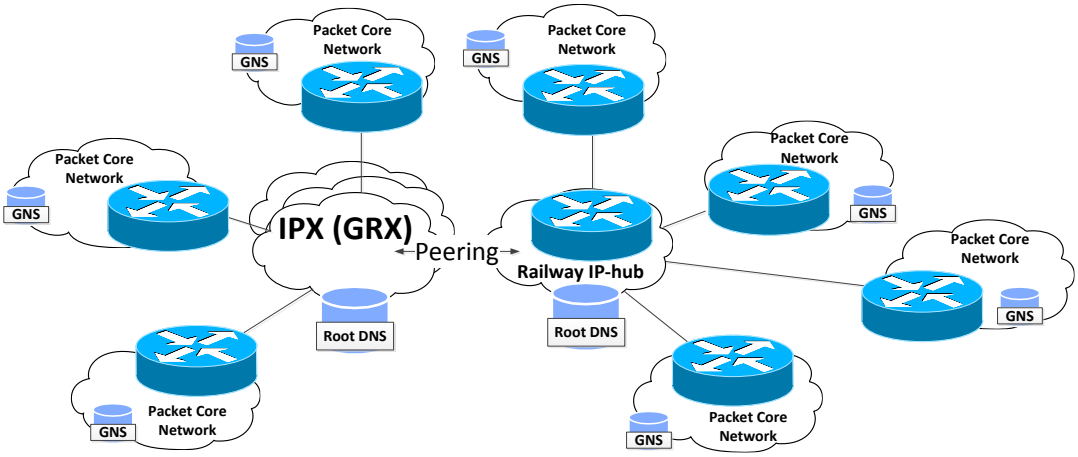


Figure 6-2 IP-hub - IPX peering schematic

6.2.6 The railway IP-hub shall consist of at least:

6.2.7 Two dedicated layer 3 IP routers (M)

6.2.8 Two dedicated root Domain Name Service entities (M)

6.2.9 The railway IP-hub shall be established and operated in a seamless failover configuration. (M)

6.2.10 The IPX availability should be defined in a Service Level Agreement between the Service and the IPX provider [IR.34]. (I)

6.2.11 Each GSM-R packet core network Infrastructure Manager shall provide at least one Border Gateway (BG) as point of interconnect between the local packet core network and the railway IP-hub. (M)

6.2.12 The use of Border Gateways is required according to [IR.34]. (I)

6.2.13 The interconnection between the GSM-R packet core network and the railway IP-hub/IPX provider shall be according to [IR.34]. (M)

6.2.14 The railway IP-hub shall be invisible and inaccessible from the public internet.(M)The railway IP-hub shall support IPv4 based addressing and routing. (M)

6.2.15 Peering between a railway IP-hub and an IPX shall support Border Gateway routing protocol. (M)

6.2.16 The change of routing information shall be advertised by using Border Gateway Protocol (BGP) according to [IR.34]. (M)

6.2.17 The DNS as part of the railway IP-hub/IPX provider environment shall provide ROOT Domain Name Services (see Figure 8-1) of the ".gprs" Top Level Domain (TLD). (M)

7. CS-DOMAIN INTERWORKING

7.1 Type of Interconnection

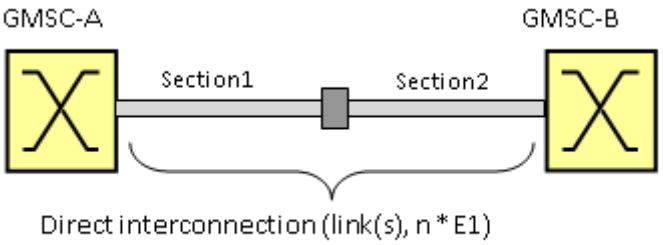
7.1.1 A logical interconnection shall be established between GSM-R networks to enable CS-mode roaming services. The logical interconnection is based on a physical connection, carried out via direct interconnection (tranmission link) or via nailed-up circuits (routed in existing physical interconnection links). (M)

7.1.2 The physical interconnection link between GSM-R networks for CS-mode purposes shall be used to exchange both control plane and user plane information. (M)

Direct physical interconnection

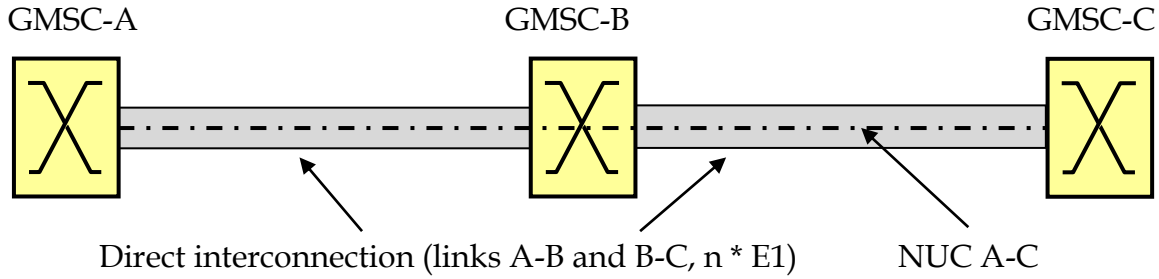
7.1.3 A direct interconnection link is a physical connection, defined by (at least) one 2 Mbit/s (E1) connection link between two Gateway MSCs directly connected to each other. This link consists of one or more sections provided by one or more carriers. (I)

7.1.4 One 2 Mbit/s (E1) carries up to 31 time slots of GSM-R user and/or signalling data. (I)



Physical nailed-up interconnection

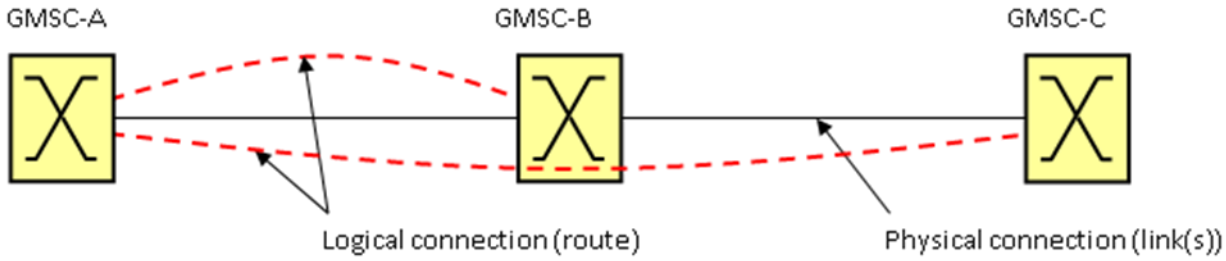
7.1.5 A nailed-up connection (NUC) is established via at least one other GSM-R network in-between. These GSM-R networks are connected via direct interconnection links. This kind of interconnection requires physical through connection of timeslots, so called nailed-up connections. Typically NUCs are used to connect non-Hubs to Hubs where no direct interconnection exists. (I)



Logical connection (route)

7.1.6 An End-to-End communication relationship (over a predefined way / path) is called "route". (I)

7.1.7 A logical connection can be established on a direct interconnection and/or via a NUC interconnection. (I)

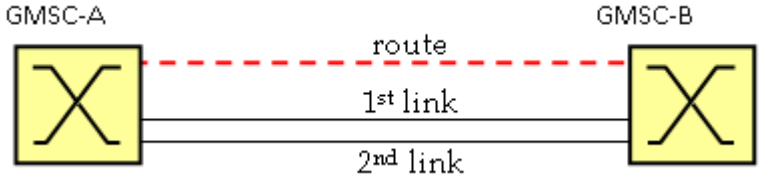


Availability

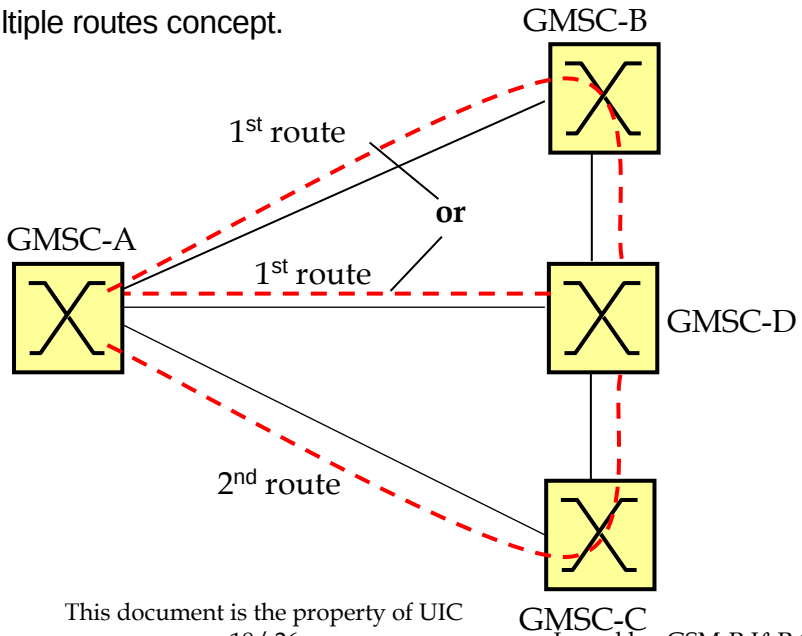
7.1.8 The availability of a single transmission link is a matter of the bilateral Service Level Agreement. The commonly used availablility is 98,5%. (I)

7.1.9 To increase the availability of the transmission connection there are two options: (I)

- Use redundant physical links for one route.



- Use a multiple routes concept.



7.2 Dimensioning

7.2.1 The physical transmission network dimensioning should be properly designed. The design and dimensioning of the physical transmission network is based on a set of rules defined by ENIR/NMG.(I)

7.2.2 The task of every IM is to monitor the traffic on the physical transmission network to ensure that the occupation rate does not exceed the predefined limit as set by ENIR/NMG. (I)

Routing principles

7.2.3 In order to reach the required End-to-End availability and to avoid circular routing of control plane and user plane information, a logical routing details are defined and documented in [CDD]. In this chapter the routing principles are given allowing IMs to enable interoperable train traffic. (I)

7.2.4 Based on the routing rules, the complex algorithms and the unpredictable migration/rollout of GSM-R networks, the calculation is done by a network planning tool, managed by UIC. (I)

7.2.5 All possible communication relations between the connected GSM-R networks are considered in the calculated routing paths (Full communication matrix). This includes the minimum number of hops and length of physical links for all alternative routes to a certain destination (I)

7.2.6 The calculated international routing paths for user plane and control plane information (CCS7) need to be considered when establishing an overlay network in a Routing Data Set (RDS). (M)

7.2.7 A RDS consists of the following items: (I)

- Physical and logical network maps;
- Detailed routing reports for physical NUC paths;
- Detailed routing reports / specifications for user plane and control plane information (CCS7);
- End-to-End routing plans for user plane and control plane information (CCS7), MTP and SCCP routing;
- Detailed numbering and ID table containing the different numbering schemas, IDs and labels for each country / GSM-R network.

7.2.8 This RDS shall to be applied by the relevant GSM-R network operators in the specified time. (M)

Signalling (control plane) routing strategy and rules

7.2.9 CCS7 routing targets for ISUP, SCCP and MAP messages is based on International Signalling Point Codes (ISPCs) used in the Message Transfer Part (MTP), Network Indicator (NI) = 00. (I)

7.2.10 The Destination Point Code (DPC) is the ISPC of a destination node. (I)

7.2.11 Global Title Translation (GTT) based routing strategy is used in non-hub nodes. Destination Point Code (DPC) of next hub / adjacent node is addressed except if geo-redundant configuration exists where the geo-redundant node is used as STP using the Message Transfer Part (MTP). (I)

7.2.12 DPC routing strategy based on the Message Transfer Part (MTP) is used in hub nodes. DPC of final destination node is addressed. (I)

7.2.13 Hub node priority level shall be defined (e. g.: CH(Zurich)=highest, D(Frankfurt)=second highest, CH(Basel)=lowest priority). (M)

7.2.14 In order to meet the requirements of the availability alternative routing via several routing paths shall be performed. (M)

7.2.15 The alternative routing paths are weighted excluding load sharing. The sequence is based on the existing physical connections to the destination network. (I)

- 1st priority: direct connection (if applicable);
- 2nd priority: direct connection via geo-redundant node in source or destination network (if applicable);
- 3rd priority: via hubs in the given hub priority.

User traffic (user plane) routing strategy

7.2.16 Bearer routing (speech and data) is controlled by ISUP CCS7 protocol. (I)

7.2.17 The destination GSM-R network is derived from the called party number (CPN). Supported are the numbering plans E.164 and EIRENE, in the international format.

- E.164: Country Code (CC) + National Destination Code (NDC) + first digits of the subscriber number, in case not a whole NDC-number block is assigned to the GSM-R network with NPI=E.164, NOA=International. (I)
- EIRENE: Break out Code (BC) + International Code (IC) + Call Type (CT) + User Number (UN) with NPI=E.164, NOA=Unknown. (I)

7.2.18 Hub node priority level shall be defined (e. g. CH(Zurich)=highest, D(Frankfurt)=second highest, CH(Basel)=lowest priority. (M)

7.2.19 In order to meet the requirements of the availability alternative routing via several routing paths shall be performed. (M)

7.2.20 The alternative routing paths are weighted. The sequence is based on the existing physical connections to the destination network. Load sharing will be performed to geo-redundant destinations only. (I)

- 1st priority: direct connection (if applicable);
- 2nd priority: direct connection via geo-redundant node in source or destination network (if applicable);
- 3rd priority: via hubs in the given hub priority.

7.2.21 Nodes with transit routing functionality shall support the feature origin depending traffic routing. (M)

8. PS-DOMAIN INTERWORKING

8.1 Architecture and GGSN Access

8.1.1 The interfaces and reference points that are necessary for IP interworking are described in Figure 8-1. (I)

8.1.2 To retrieve subscriber information from the concerned HLR, the Serving GPRS Support Node (SGSN) shall access the international CCS7 network. (M)

8.1.3 To get access to the Home-GGSN, the packet core network (see Figure 8-1) shall be interconnected via the Gp reference point to a railway IP-hub/IPX provider. (M)

8.1.4 Every local GPRS-DNS shall be owner of the zone "mncXXX.mccYYY.GPRS" derived from the Mobile Network Code (MNC) and Mobile Country Code (MCC) in use. (M)

8.1.5 To derive unknown zone responsible, the ROOT DNS shall be used according to [RFC 1034]. (M)

8.1.6 The Fully Qualified Domain Name (FQDN) of an Access Point Name consist of:

- <Network Identifier>.<Operator Identifier>.gprs. (I)

8.1.7 The Network Identifier (NI), as part of the Access Point Name (APN), grants access to particular Packet Data Networks attached to the GGSN. (I)

8.1.8 The Operator Identifier (OI) identifies whether the Visited-GGSN or Home-GGSN is used when abroad. (I)

8.1.9 The use of the V(P)LMN access flag i.e. VPLMN=N allows access restriction to the Visited-GGSN on a per APN basis. (I)

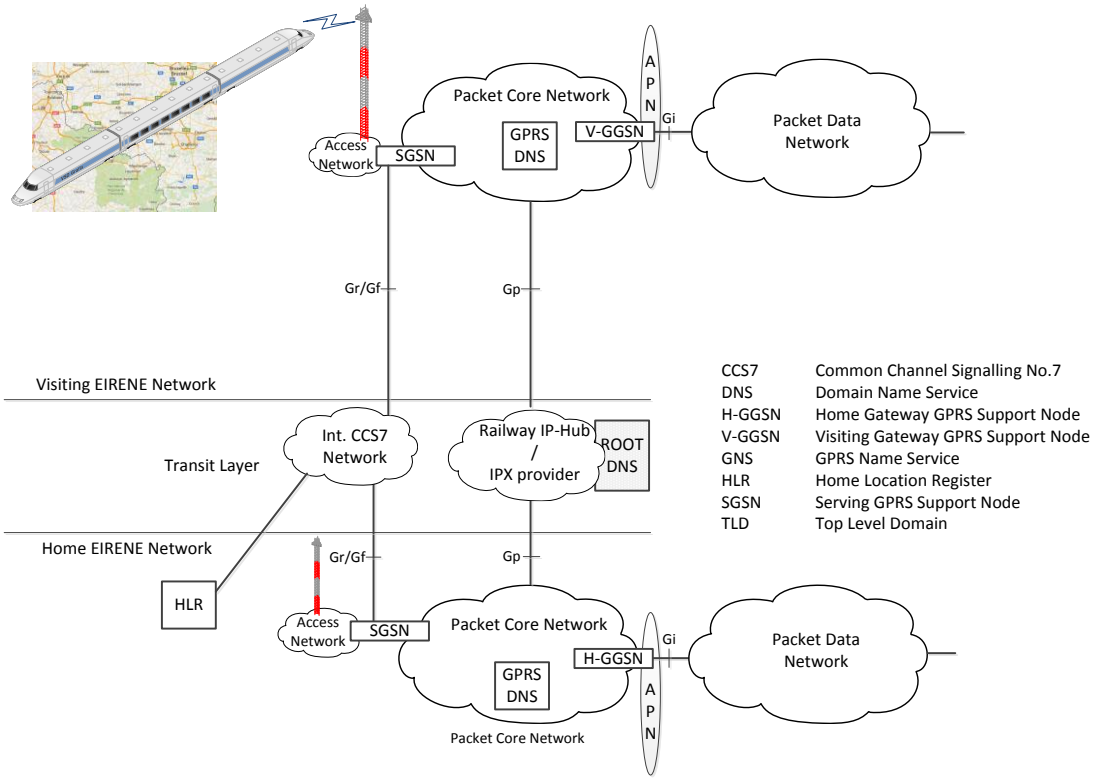


Figure 8-1 Network Architecture Interworking PS-mode roaming

8.2 Interconnections

8.2.1 The local packet core network and the railway IP-hub/IPX provider shall be interconnected by at least one link. (M)

8.2.2 For redundancy reasons, the local packet core network and the railway IP-hub /IPX provider should be interconnected by a second link. (O)

8.2.3 The Border Gateway shall constitute the point of interconnect between the local packet core network and the railway IP-hub/IPX provider (see Figure 8-22). (M)

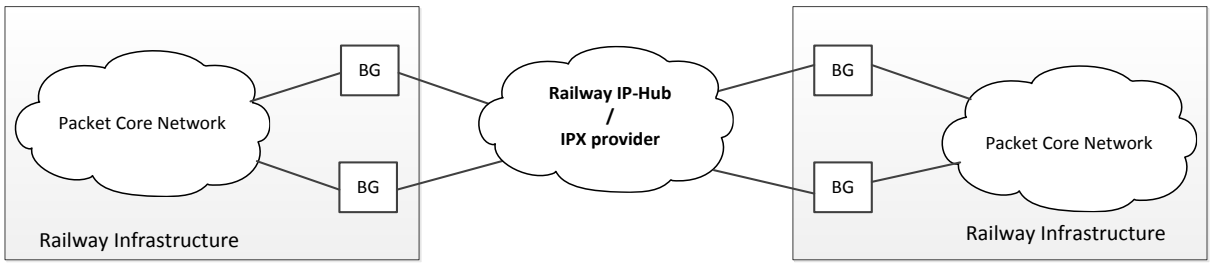


Figure 8-2 Point of Interconnection between IP-hub and the local Packet Core network

Addressing

8.2.4 Internal IP addressing of the local packet core network is a decision of the railway Infrastructure Manager. (I)

8.2.5 The local packet core network shall be invisible and inaccessible from the public internet. (M)

8.2.6 The local packet core network shall support IPv4 addressing and routing according to [3GPP TS 23.060]. (M)

8.2.7 The local packet core network should support IPv6 addressing and routing. (O)

8.2.8 If the local packet core network and the IP-hub or IPX support IPv6, it should be allowed to use IPv6 for addressing and routing. (O)

8.2.9 For peering between the local packet core network and the railway IP-hub/IPX provider, public IP addresses shall be used according to [IR.40]. (M)

8.2.10 IP address pool assignment to the User Equipment (UE)/MT is the responsibility of the infrastructure manager. (I)

8.2.11 This IP address pool assignment shall be according to [IR.40]. (M)

8.2.12 For the operation of ETCS, the IP version of the IP address pool shall be according to [EIRENE SRS]. (M)

8.3 Routing

8.3.1 The use of dynamic routing lowers the amount of management work when IP information changes as dynamic routing supports redundant and simultaneous connectivity to different railway IP-hub/IPX providers. (I)

8.3.2 Dynamic exchange of routing information between the involved networks shall use BGP-4 routing protocol according to [IR.34]. (M)

8.3.3 The Autonomous System Number (ASN) is required to run BGP routing protocol to peer the local packet core network with the IP-hub/IPX environment. The ASN has to be globally unique so that IP address blocks appear originated from a unique location. BGP uses this location to route to the destination. BGP uses Prefixes and Autonomous System Paths (AS Paths) to determine the shortest path to a destination where a prefix is located. (I)

8.3.4 The entire IP network of each local packet core network peered with an IP-hub/IPX is considered as an Autonomous System (AS). (I)

8.3.5 The way to obtain a private ASN is described in [IR.40]. In addition, GSMA assigns private ASNs to railway Infrastructure Manager. (I)

8.3.6 Railway Infrastructure Manager shall provide an Autonomous System Number (ASN) according to [RFC 4271] to enable BGP-4 routing protocol. (M)

8.3.7 If more than one peering link between the local packet core network is used, symmetrical routing of user and control plane information should be considered. (I)

8.4 Dimensioning

8.4.1 The dimensioning of the local packet core as well as the peering link(s) to the IP-hub/IPX is in the responsibility of the railway Infrastructure Manager. (I)

8.5 Protocols

8.5.1 To establish connectivity between SGSN and GGSN, GPRS Tunnelling Protocol version 1 (GTPv1) shall be used according to [3GPP TS 29.060]. (M)

8.5.2 To operate GTPv1, GTP-Control Plane (GTP-C) messages shall be exchanged using UDP port 2123 and GTP-User Plane (GTP-U) messages UDP port 2152 according to [3GPP TS 29.060]. (M)

8.5.3 The GPRS Domain Name System (GNS) shall be utilised to resolve an Access Point Name (APN) into a GGSN IP address taking into account UDP port 53 according to [RFC 1035]. (M)

8.5.4 The relevant APN(s) shall be part of the applicable “mncXXX.mccYYY.gprs” zone in a Start of Authority (SOA) record according to [RFC 1034]. (M)

8.5.5 The applicable APNs shall be configured as resource record type "A" record according to [RFC 1034]. (M)

8.5.6 If the local GPRS Domain Name Service is unable to resolve DNS APN request, the local DNS shall contact the ROOT DNS (operated by the IP-hub/IPX (M)) to derive the IP address(es) of the target DNS (see Figure 8-1). Then the local DNS shall contact the target DNS to resolve the APN into an GGSN IP address. (M)

8.6 Quality of Service

8.6.1 Requested QoS and QoS supported may vary from network to network. This may cause IP connectivity failures. (I)

8.6.2 The management of QoS parameter during PDP context activation ensures successful IP connectivity setup. (I)

8.6.3 To prevent IP connectivity failures, the QoS subscription profile parameters according to [EIRENE SRS] shall be used. (M)