IR.65 IMS Roaming & Interworking Guidelines

4.0

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Security Classification – NON-CONFIDENTIAL GSMA Material		

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1 GLOSSARY

Terms	Definitions
APN	Access Point Name
AS	Application Server
BGCF	Breakout Gateway Control Function
CDR	Charging Data Record
CSCF	Call Session Control Function
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
ENUM	E.164 number and DNS
HPLMN	Home Public Land Mobile Network
HSS	Home Subscriber Server
I-CSCF	Interrogating CSCF
IM-MGW	IP Multimedia – Media Gateway
IM-SSF	IP Multimedia – Service Switching Functionality
IMSI	International Mobile Subscriber Identity
IMS	IP Multimedia Subsystem
ISIM	IMS SIM
MGCF	Media Gateway Control Function
MGW	Media Gateway
MRF	Multimedia Resource Function
NAPTR	Naming Authority Pointer DNS Resource Record
NAT	Network Address Translation
NAT–PT	Network Address Translation – Protocol Translation
OAM	Operation, Administration and Maintenance
OSA	Open Service Access
P-CSCF	Proxy CSCF
PCF	Policy Control Function
PDP	Packet Data Protocol
PDP	Policy Decision Point
PDU	Protocol Data Unit
PoC	Push-to-talk over Cellular
QoS	Quality of Service
RAN	Radio Access Network
R-SGW	Roaming Signalling Gateway
S-CSCF	Serving CSCF
SGW	Signalling Gateway
SDP	Session Description Protocol
SIP	Session Initiation Protocol
SLF	Subscription Locator Function
SMTP	Simple Mail Transfer Protocol
THIG	Topology Hiding Inter-network Gateway

T-SGW	Transport Signalling Gateway
UE	User Equipment
URI	Uniform Resource Identifier
URL	Universal Resource Locator
VPLMN	Visited Public Land Mobile Network

2 SCOPE

The goal of this document is to ensure that crucial issues for operators such as interworking and roaming are handled correctly also with IMS (IP Multimedia Subsystem).

This document introduces guidelines for usage of inter-Service Provider connections in IMS environment and requirements IMS has for the Inter-Service Provider IP Backbone. Other issues discussed here are for example addressing and routing implications of IMS.

In order to get IMS services successfully started, roaming and interworking are seen as major issues. This document aims to increase the IMS interworking & roaming related knowledge level of operators and to prevent non-interoperable and/or inefficient IMS services and networks. This concerns especially roaming and interworking cases, since these issues could potentially significantly hinder the implementation of IMS if not handled properly.

Please note that the document does not aim to give an elementary level introduction to IMS, even though Chapter three (3) has a short introduction. (See 3GPP TS 22.228 [3] document for that purpose).

This Permanent Reference Document (PRD) concentrates on network level roaming and interworking, therefore higher level issues like service interconnection are not discussed in detail, see for example SE.35 [12] for service related documentation. Also issues such as radio interface, Quality of Service (QoS) details, General Packet Radio Service (GPRS) backbone, interworking with Public Switched Telephone Network (PSTN) as well as connections between IMS network elements and terminals/applications are not within the scope of this document. Connections to private networks such as corporate network are also out of scope. Charging and billing related issues regarding IMS roaming and interworking are handled by BARG; see for example PRD BA.27 [17].

Throughout this PRD, the term "GPRS" is used to denote both 2G GPRS and 3G Packet Switched (PS) service.

3 BACKGROUND

The 3rd Generation Partnership Project Release five (3GPP Rel 5) architecture introduces the addition of a new subsystem known as the IP Multimedia Subsystem (IMS) to the Packet-Switched (PS) domain. IMS supports new IP-based multimedia services as well as interoperability with traditional telephony services. IMS is not a service per se, but a framework for enabling advanced IP services and applications on top of packet bearer.

3GPP has chosen the Session Initiation Protocol (SIP) [2] for control plane signalling between the terminal and the IMS as well as between the components within the IMS. SIP is used to establish and tear down multimedia sessions in the IMS. SIP is text-based request-response application level protocol developed by the Internet Engineering Task Force (IETF). Although 3GPP has adopted SIP from IETF, many extensions have been made to core SIP protocol (for example new headers, see TS 24.229 [6]) for management, security and billing reasons, for instance. Therefore SIP servers and proxies are more complex in 3GPP system (that is, in IMS) than they normally are in Internet. However, all 3GPP extensions were specified by the IETF, as a result of collaboration between the IETF and 3GPP, so the SIP protocol as used in the IMS is completely interoperable with the SIP protocol as used on the Internet or any other network based on IETF specs.

4 ROAMING

It is very important to notice and understand the difference between IMS roaming and interworking. This chapter handles roaming issues; for interworking please see the following chapter.

The roaming capability makes it possible to use IMS services even though the user is not geographically located in the service area of the home service provider network. 3GPP architecture enables three different deployment configurations. These configurations are shown in Figures 1, 2 and 3. A short introduction is given here, for more detailed explanation please see 3GPP TS 23.221 [20].

Figure 1 depicts a model where the User Equipment (UE) has obtained IP connectivity from the Visited Service Provider's network and the Visited Service Provider's Proxy-Call Session Control Function (P-CSCF) is used to connect the UE to the home IMS.

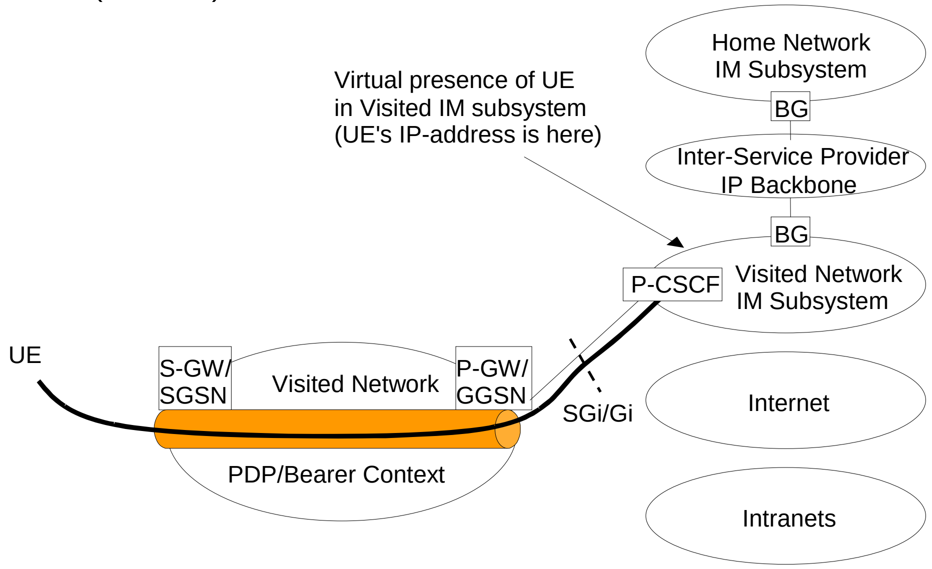

Figure 1: UE Accessing IM Subsystem Services with P-GW/GGSN in the Visited network via Visited Network IM subsystem

Figure 2 depicts a model where the UE has obtained IP connectivity from the Visited Service Provider's network and the Home Service Provider provides the IMS functionality.

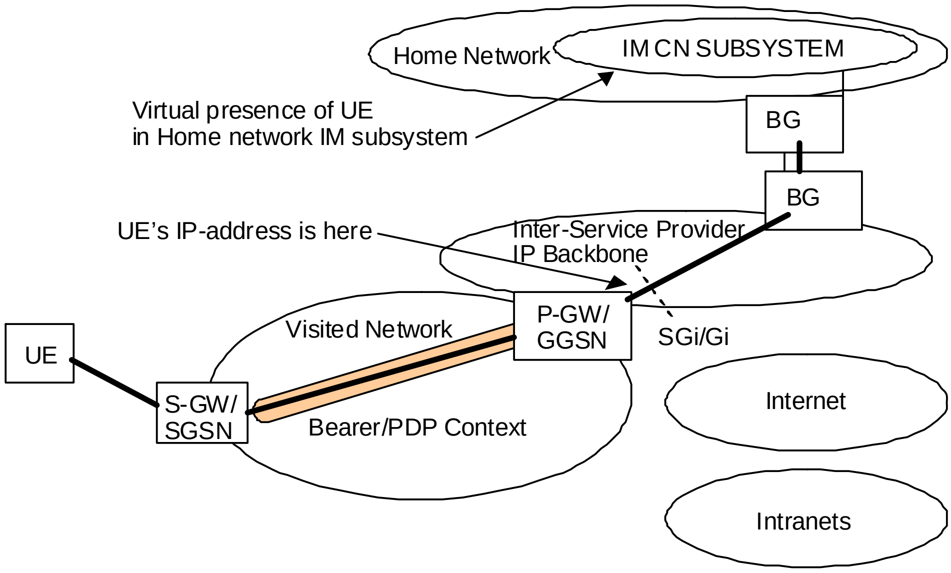

Figure 2: Accessing IM Subsystem Services with P-GW/GGSN in the Visited network

Figure 3 depicts a model where the UE has obtained IP connectivity from the Home Service Provider's network and the Home Service Provider provides the IMS functionality.

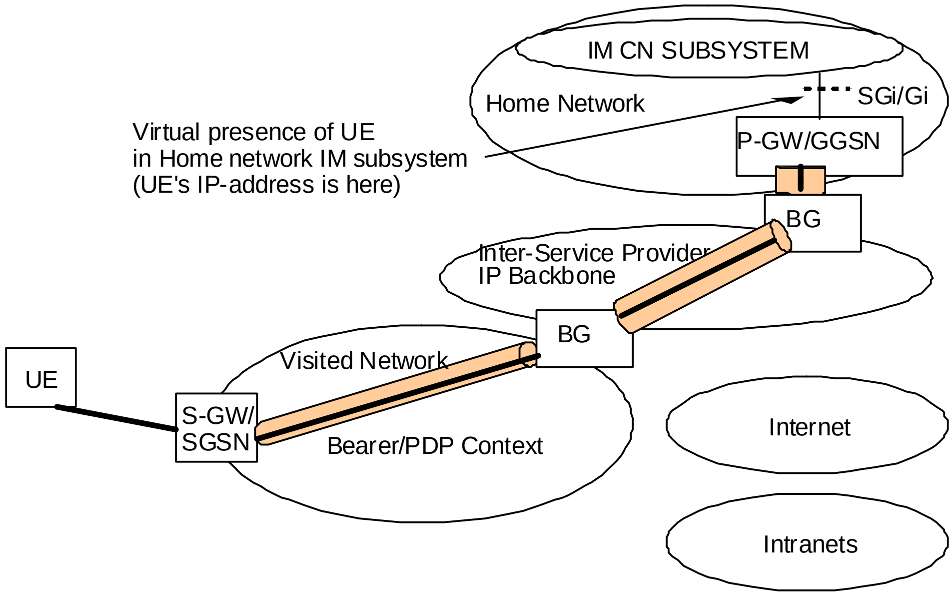

Figure 3: UE Accessing IM CN subsystem Services with P-GW/GGSN in the Home network

Figures 2 and 3 show configuration options that do not require IMS interworking between the Visited and Home IMS networks as the Visited Service Provider's IMS is not used.

When roaming is provided utilizing architecture shown in the Figure 1 the service providers need to deploy IMS interworking between the Visited and Home IMS Networks as defined in Chapter 5.

For the details of IMS roaming when using a LTE access, see IR.88 [26].

5 INTERWORKING

5.1 Introduction

Interworking between two different IMSs shall be guaranteed in order to support end-to-end service interoperability. For this purpose, IMS- Network to Network Interface (NNI) between two IMS networks is adopted. The general interworking model is shown in Figure 4.

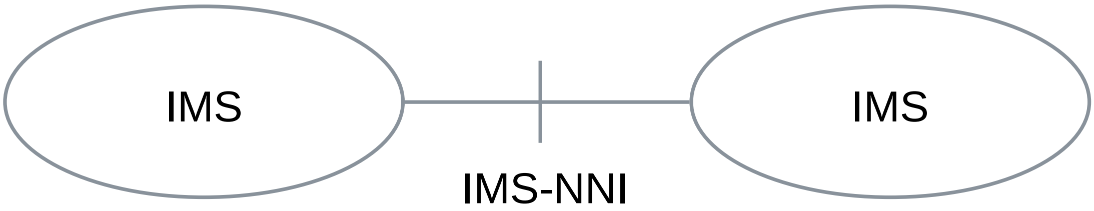

Figure 4: High-level view of the interworking model for IMS

There are two architectural variants of how the IMS-NNI can be deployed. These are depicted in Clauses 5.2, where an Interconnection Border Control Function (IBCF) is used at the border of each Service Provider, and Clause 5.3, where no IBCF is used at the border of each Service Provider. It is also possible that an IBCF is only used at the border of one Service Provider. However, the SIP profile applicable at the IMS-NNI is independent of these architectural variants.

5.2 Ici/Izi Interfaces

3GPP Release 8 introduces new border nodes and interfaces specifically for the purpose of IMS NNI in 29.165 [19]. Ici interface is used to transport SIP signalling, while Izi interface handles media traffic.

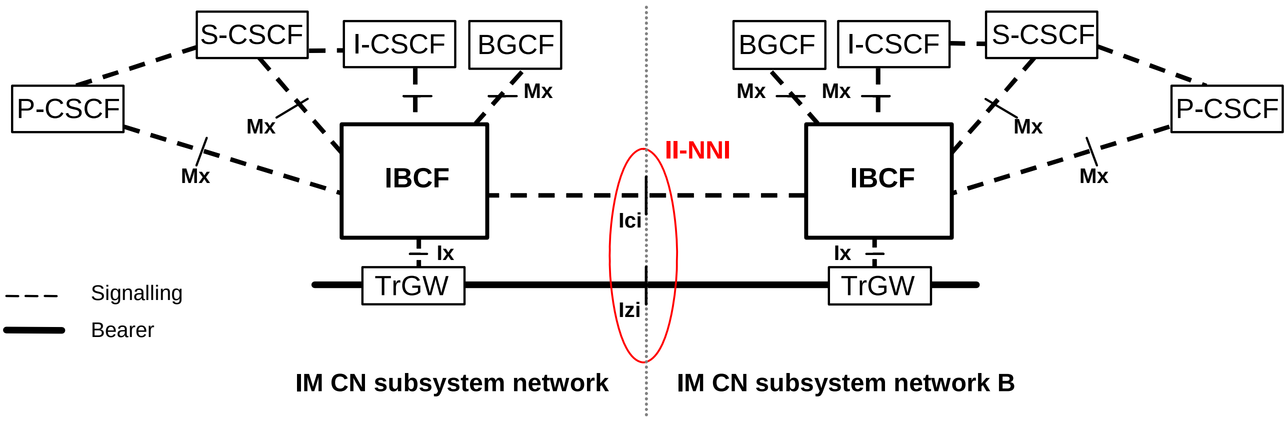

Figure 5: IMS interworking using Ici & Izi Interfaces (from 3GPP TS 23.228)

Figure 5 shows this model where IBCF (Interconnection Border Control Function) is a node handling control plane for the purpose of for example Topology Hiding Inter-network Gateway (THIG), Application Layer Gateway (ALG), screening of SIP signalling information and generation of Charging Data Records (CDRs). TrGW (Transition Gateway) is controlled by IBCF and provides functions such as Network Address Translation – Protocol Translation (NAT-PT) and IPv4/6 conversion for the user plane.

5.3 Mw/Gi/Sgi Interfaces

Figure 6 presents IMS interworking between originated and terminated network as specified in 3GPP Release 5 IMS NNI. SIP signalling is delivered via Mw interface and user plane is transported via Gi/Sgi interface. The actual IMS user traffic (such as Video Share stream) is encapsulated using Generic Routing Encapsulation (GRE) tunnel within the Inter-Service Provider IP Backbone (as illustrated in IR.34 [1]), SIP signalling always flows via IMS core networks

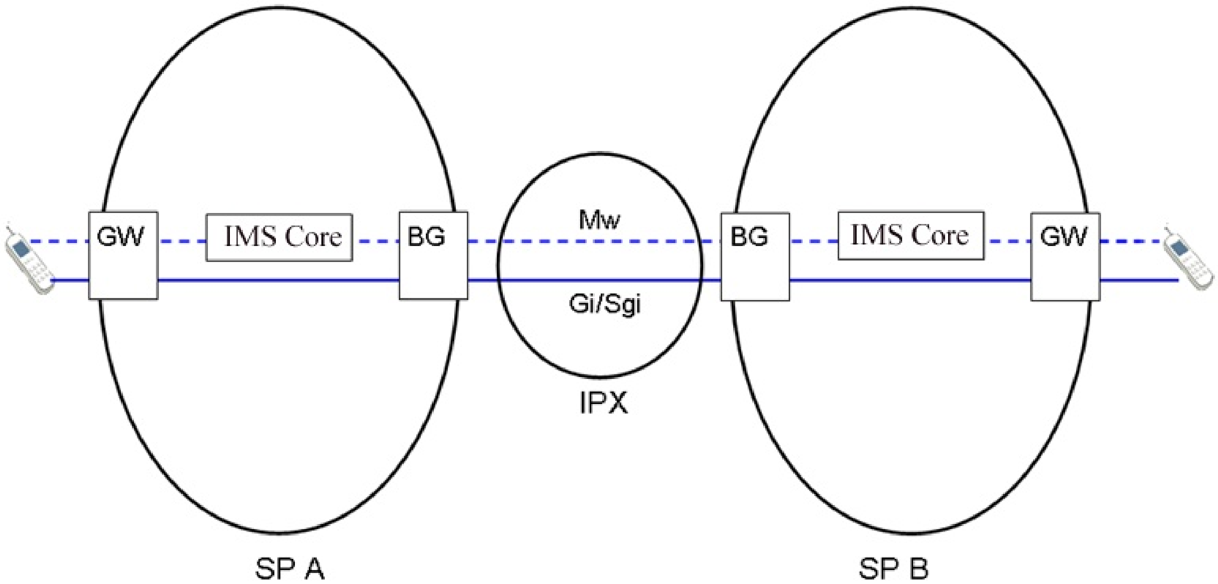

Figure 6: IMS interworking using Mw & Gi/Sgi Interfaces (simplified example not showing e.g. FW nodes)

Border Gateway (BG) shown in the figure above is a non-SIP aware element taking care of controlling incoming traffic from the Inter-Service Provider IP Backbone into the operator core system for example by performing filtering on IP layer. In addition to the BG there can be other nodes relevant for the IMS NNI, such as a SIP aware Firewall (FW) located between BG and Serving/ Interrogating (S/I)-CSCF. I-CSCF itself natively takes care of the being the point of contact to IMS.

5.4 Overview

Whilst 29.165 illustrates NNI using IBCF and Transition Gateway (TrGW) nodes, it actually only shows the interface profile between two operators. In other words it doesn't place any requirements as such on how the operator core network is implemented as long as the behavior over Ici and Izi interfaces is as expected.

One related issue is that IBCF and TrGW do not solve all the issues related to IP based inter-operator related cases in general since they handle only SIP based traffic and associated user plane traffic. So for example traffic filtering at the border of operator core network concerning PS roaming using GPRS Tunneling Protocol (GTP) must be taken care by some other node, somehow.

Therefore, it should be noted that both the option of using Mw/Gi/Sgi interfaces as well as the option of using Ici/Izi interfaces are possible in IMS interworking. In other words, individual operators can select the most optimal solution suitable.

The Inter-Service Provider IP Backbone must provide reliable transmission as in case of IMS roaming. Usage of Domain Name System (DNS) has special importance in interworking scenarios, further details are described in Chapter 8.

Interworking with Internet and corporate intranets is not handled in detail, although Chapter 7 considers some issues that are valid also when connecting to these networks.

Interworking with CS networks (CS-domain and PSTN) is needed for call routing between IMS operator and non-IMS operator. 3GPP specification TS 29.163 [7] covers interfaces and signalling in these cases.

6 REQUIREMENTS FOR THE INTER-SERVICE PROVIDER IP BACKBONE

6.1 General Issues

General requirements for the Inter-Service Provider IP Backbone shall be applied from the Chapter 6 of IR.34 [1].

From a technical point of view the required IP network between different operators might befor example public Internet (with Virtual Private Network (VPN)) or direct leased line such as Frame relay or Asynchronous Transfer Mode (ATM). Another solution, which in many cases could be considered to be the advisable one, is to utilize an existing, proven and reliable Inter-Service Provider IP Backbone, in other words GPRS eXchange/IP eXchange (GRX/IPX), as specified in IR.34 [1].

Using IPX networks to carry IMS traffic is less onerous than building direct connections between each and every IMS network in the world. Operators should evaluate the physical connect for IMS roaming and Interworking (IW) and choose the most appropriate. One suggestion would be to use IPX as the default routing choice but where traffic is high (typically between national carriers) a leased line or IP-VPN may be more cost effective. As the IP routing is separate from the physical topology, multiple physical connections may co-exist. In practice operators may have several physical interconnection links: leased line for national traffic, IP-VPN for medium volume or non-Service Provider and IPX for all others. The DNS system will resolve the destination domain to an IP address that will be routed over the appropriate link.

There is no need to build any kind of separate “IMS Roaming & Interworking Exchange network” only for IMS traffic. Issues such as QoS, security, control of interworking networks, overall reliability and issuing of new network features such as support for E.164 number and DNS (ENUM) are easier handled inside IPX than when using public internet to relay IMS traffic between operators. This is due to the fact that IPX can be considered to be a closed operator controlled network unlike public Internet, which is totally open for everyone.

Consequently, preferred Inter-Service Provider IP Backbone also in IMS case is IPX, as it is already preferred network in for example. GPRS roaming, Multimedia Messaging Service (MMS) interworking and Wireless LAN (WLAN) roaming. Existing networks can be reused as much as possible instead of building separate networks for each and every new service. There is no need for new separate VPNs inside IPX for IMS traffic, since IMS traffic can co-exist with current IPX protocols, such as GTP and Simple Mail Transfer Protocol (SMTP).

6.2 IP Version Issues

As documented in 3GPP TS 29.165 [19], the network elements interworking by means of the IMS NNI may support IPv4 only, IPv6 only or both. The support of one or both of the IP versions is a Service Provider specific implementation issue. See also IR.34 [1] and IR.40 [23] for more information on general recommendations relating to IPv4 and IPv6.

6.3 Security Issues

In order to maintain proper level of security within the Inter-Service Provider IP Backbone certain requirements for the Service Providers and Inter-Service Provider IP Backbone providers should be taken into account. Same security aspects shall be applied as described in IR.34 and IR.77.

6.4 Proxy

Optionally the Inter-Service Provider IP Backbone may deploy an additional element for IMS interworking routing. This separate intermediate Proxy functionality allows operator to make just a single connection from its own IMS core system to the Proxy in the Inter-Service Provider IP Backbone regardless of the number of IMS interworking partners. The Proxy is responsible for routing traffic towards correct recipient network.

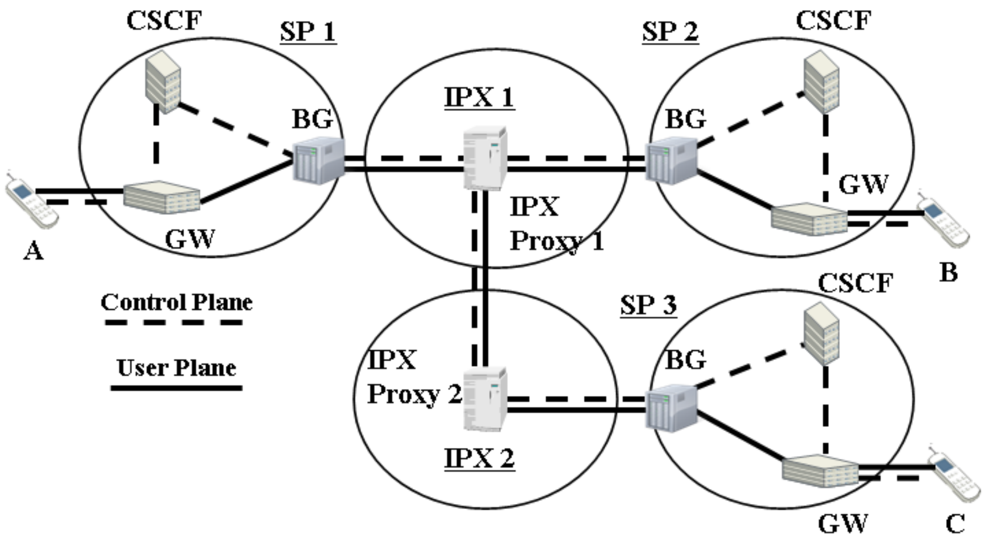

Figure 7: Overall Architecture of IMS Interworking using the Proxy Model

In IPX this Proxy functionality is offered in the Bilateral Service Transit and Multilateral Service Hub connectivity options, as illustrated in the AA.80 [22].

For further detailed information about this kind of additional Proxy functionality offered by the Inter-Service Provider IP Backbone, please see Annex B of IR.34 [1].

7 SERVICE RELATED ISSUES

7.1. Introduction

Different end-user services used in IMS have different requirements. As IMS allows basically any kind of IP based service to be used, issues regarding those have to taken into account when thinking about inter-Service Provider IMS connections. For example routing the Push to Talk over Cellular (PoC) user plane and control plane between two Service Provider PoC servers has quite different requirements than routing traffic between two users playing a peer-to-peer IMS game.

Generally speaking the roaming and interworking environment should be built in a way that it supports multiple different types of IMS based service & applications. Thus, NNI cannot be become the limiting factor when Service Providers are launching new services, including also the deployment of connectivity between the Service Providers.

The actual IMS based services and their requirements are listed in other documents, see e.g. SE.35 [12]. This document handles only the specific inter-Service Provider aspects of these different services. The following chapters illustrate the NNI details of some important IMS services.

It should be noted that according to the GSMA Interconnect Working Group (IWG), only the originator of a multiparty session can add further participants to on ongoing session such as multiparty chat or conference call. This general limitation applies to all IMS services in order to limit the possibilities for fraud.

7.2. IMS Telephony

7.2.1. Overview

Generally speaking "IMS Telephony" means IP based basic communication utilizing IMS as the enabling platform which can be used for example to replace the CS (Circuit Switched) based voice service with PS (Packet Switched) based voice. Figure 8 below gives a high-level illustration of the architecture where two clients using PS voice UNI are connected together via PS voice NNI, transporting IP based voice end-to-end enabled by the IMS core systems of each Service Provider.

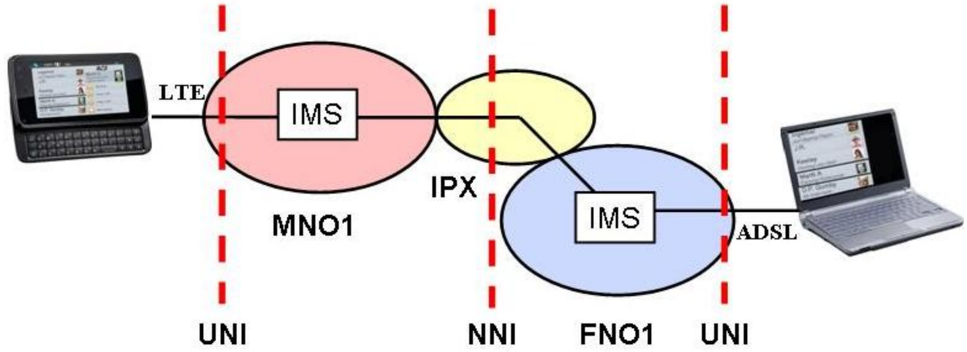

Figure 8: High-Level Example of IMS Telephony Connection

Technical solution for IMS Telephony NNI is the VoLTE (Voice over LTE) service as specified in IR.92 [28], based on the IMS MMTel (Multimedia Telephony) standard defined by 3GPP. Generally the technical details of voice UNI are applicable also for the purpose of voice NNI, for example the Supplementary Services supported over the interworking interface follow the set defined in IR.92.

7.2.2. Multiple Voice NNIs

It is very likely that Service Providers will have to handle more than one voice NNI at the same time for the same service. For example Service Provider A could have updated its voice interworking agreement and connection to use IP with Service Provider B, but still have the old TDM based voice interworking in place with Service Provider C. So Service Provider A must have some mechanism how to deal with both PS and CS based voice interworking interfaces. In addition there may be more than one voice NNI option within the PS category, for example SIP and SIP-I.

Generally speaking the originating Service Provider has some kind of preference list for the outgoing IMS Telephony calls, for example:

1. The first preference is likely direct IMS-to-IMS call since this requires no use of conversions or fall-back mechanisms, offering the best possible quality. Signalling uses SIP and media RTP/RTCP. Other IMS based services, such as RCS, also use the same IP based interface (see [IR.90])
2. Fall-back to MSC-S and MGW nodes, call originating from the IMS core system gets converted into a CS call. The voice NNI can be:
    a. IP based: SIP-I Signalling and RTP/RTCP media (see [IR.83])
    b. IP based: BICC Signalling and RTP/RTCP media with Nb UP Framing (see [29.163])
    c. ATM based: BICC Signalling and media with Nb UP Framing (see [29.163])

3. Fall-back to MSC, call originating from the IMS core system gets converted into a CS call and routed to the receiving Service Provider via CS based voice NNI. Normal ISUP Signalling and TDM mechanisms apply in this scenario (see [29.163])

The originating Service Provider is responsible to determine which voice NNI to use for any particular call/session according to its local policy such as the requirements the originator needs to fulfil to its subscribers, IMS Telephony NNI knowledge, technical capabilities available to it and cost. It is assumed that

- the originator will find a way to deliver traffic and,
- in the case of an IMS to IMS session the preferred solution is to deliver the traffic as IP end to end utilizing IMS Telephony NNI as described in Chapter 7.2.3

IMS NNI knowledge can be obtained through look up services. GSMA Recommends the use of Carrier ENUM for this purpose as defined in [IR.67]. Carrier ENUM provides information on a per international public telecommunications number basis and can indicate that routing via the IMS Telephony NNI is possible. IMS routing is possible when Carrier ENUM translation request provides a globally routeable SIP URI. If this translation attempt fails at the originating S-CSCF the call can be delivered via PS/CS interworking. PS/CS interworking technical capabilities available to the originator may include:

- Local ability to convert PS traffic into CS traffic
- Local ability to issue traffic using SIP-I

If the originator does not have or is not willing to provide PS/CS interworking technical capabilities it can make agreements with different carriers to perform PS/CS interworking as depicted in the Figure 8.

Note that even if Carrier ENUM does not provide a globally routable SIP URI, the originating Operator may obtain knowledge of the terminating operator by other means, and if an IMS Telephony NNI exists to that operator, the originating operator may still decide to route the call over the IMS Telephony NNI.

The capabilities that the originator arranges are influenced by cost. Investment in PS/CS conversion technology is normally a capex decision, while agreements with others to perform conversions are opex decisions. Where the originator has access to more than one option for any particular call, again, cost may influence the mechanism or voice NNI chosen.

Policy differs between Service Providers. The result is that the IMS NNI ecosystem will include Service Providers with a wide variety of combinations of the above capabilities and agreements to call on.

It should be noted that in the case where neither IMS Telephony NNI nor PS/CS interworking is supported the session will fail.

If Service Providers wish to enable the IPX to perform PS/CS conversions they have to make subscriber voice NNI information available to the IPX. One method of doing this is to allow Carrier ENUM access to the IPX.

Today it is possible for calls/sessions to undergo multiple conversions between CS and PS, even in the case of a CS to CS call. For IMS telephony it is recommended that PS to PS calls undergo no conversions. For PS to CS scenarios it is recommended that the conversion takes place only once

7.2.3. IMS Voice NNI

Full end-to-end IP based interworking for example between two Service Providers offering VoLTE based voice service to their LTE customers, connected to each other via IP based voice NNI transporting SIP signalling and RTP media between IMS core systems including IMS Telephony AS. No conversion or transcoding mechanisms ideally needed.

IPX is being used as an example of the inter-Service Provider IP Backbone in the following figures. For the avoidance of doubt, this does not exclude usage of other alternatives, such as bilateral leased line, for IMS Telephony NNI purposes when seen fit by the participating Service Providers.

It is recommended that a Carrier ENUM lookup is used during session setup to translate the international public telecommunications number into a globally routeable SIP URI.

Chapter 5 depicts two models for generic IMS NNI. Those models are fully applicable for the IMS Telephony NNI as well. A generic term “IMS Core” in the figures below is used to show that both architecture alternatives are equally applicable for the native IMS-to-IMS Telephony NNI.

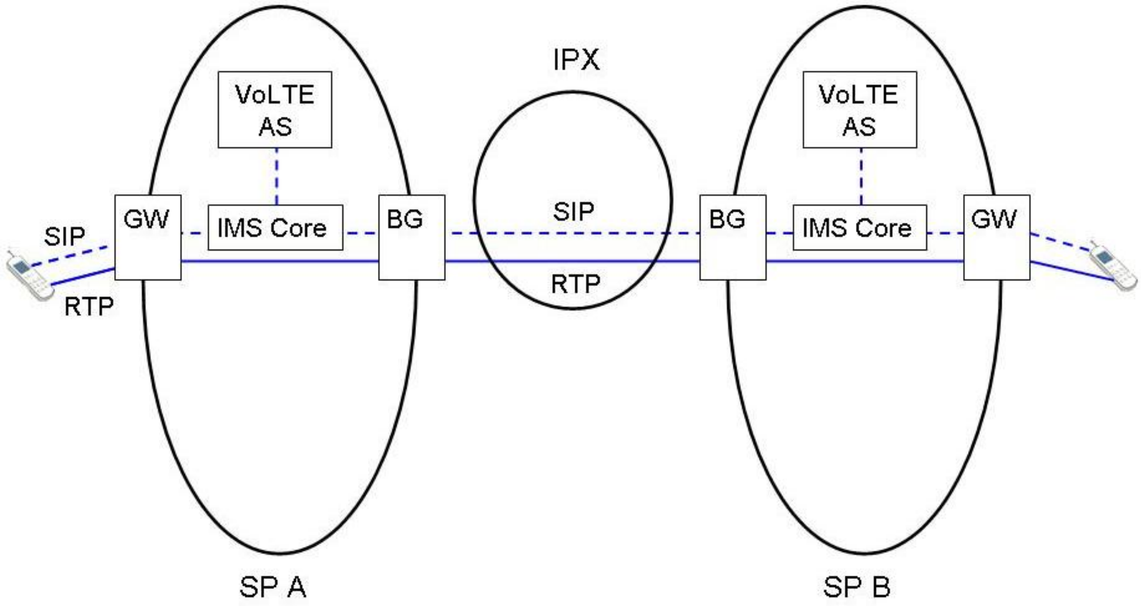

Figure 9: IMS-to-IMS Voice NNI

Figure 9 above shows the native IMS Telephony NNI, using IPX in the bilateral Transport Only connectivity option.

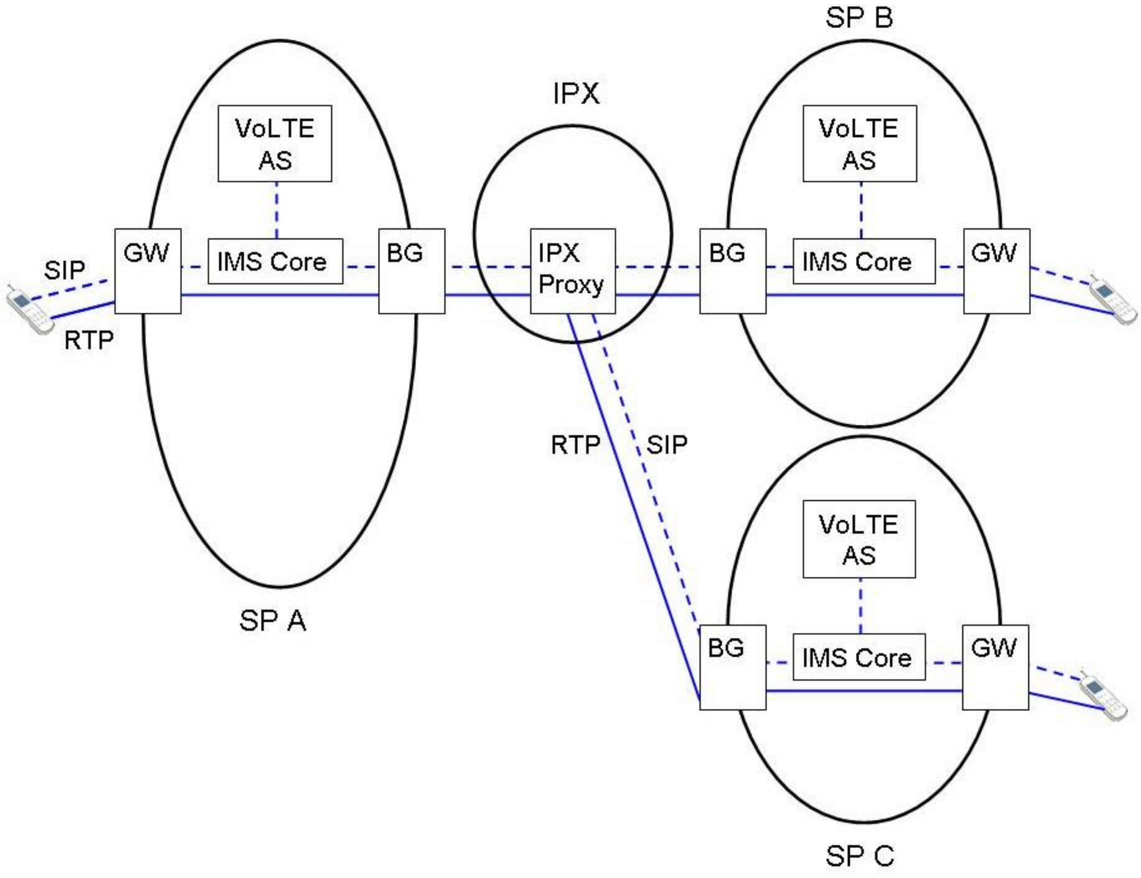

Figure 10: IMS-to-IMS Voice NNI (Hubbing Model)

Figure 10 above shows the native IMS Telephony NNI, using IPX in the multilateral Service Hub connectivity option. IPX Proxy is used to forward SIP signalling and RTP media between Service Provider A and Service Providers B and C. Annex B of [IR.34] illustrates further details of IPX Proxy.

7.2.4. PS/CS Interworking

When the native IMS voice NNI (as illustrated in the Chapter 7.2.3) cannot be used the originating IMS network may utilize the capabilities specified in [IR.83] (SIP-I based interworking) and [29.163] (BICC/ISUP based interworking). This is are briefly described below but further details are out of scope for the present document.

A Carrier ENUM lookup may be used during session setup to identify that the terminating user is an IMS subscriber as defined in [IR.67]. Call breakout to CS occurs when the session cannot be routed further via the IMS Telephony NNI. CS breakout can be done either in the originating network, IPX or terminating network, depending on the agreement between Service Providers. In the CS breakout scenario, the BGCF selects the terminating network according to the defined rules. A session is forwarded either to local MGCF (via Mj interface) or to BGCF of terminating network (via Mk interface). MGCF routes call establishment towards terminating network and handles the needed protocol interworking between 3GPP SIP, BICC/SIP-I and ISUP for controlling. IMS-MGW handles the user plane transporting between IP (Mb interface) and PSTN interface.

CS originated calls routed towards IMS are handled as any other CS call. If the CS call is to be terminated in IMS, the signalling is terminated in MGCF, which forwards the session to CSCF via Mg interface (3GPP SIP).

Further information on PS/CS interworking (different scenarios including figures) can be found in Annex A.

7.2.5. General Issues

As documented in Chapter 5, there are two alternative models for IMS interworking. Both of them are valid also for the IMS Telephony NNI purposes. A Service Provider may independently deploy either option defined above mutually exclusive of what an interconnected Service Provider chooses to deploy. For example. Ici/Izi and Mw/Gi/Sgi can interoperate without Service Provider configuration or a dependency on an interworking function.

General QoS related guidance on IPX as documented in [IR.34] Chapter 8 is fully applicable also for the purpose of IMS Telephony NNI.

As illustrated in Chapter 7.1., only the originator of a conference call can add further participants to on ongoing conference call. This is aligned with the similar restrictions placed towards other IMS based multiparty services, for example IMS based Chat service in IR.90 [27].

The addition of new media streams to an ongoing IMS telephony session (in other words the modification of the session through re-INVITE) is out of the current scope of this specification.

The Accept-Contact of an initial SIP INVITE request may, besides the MMTel (ICSI) feature tag, optionally also contain the 'audio' feature tag and the 'require' parameter. Said optional parts are set by RCS Broadband Access clients.

7.3. PoC

PoC (Push-to-talk over Cellular) is an example of IMS based service using server-to-server connection between the Service Providers. Since PoC has a dedicated server-to-server interface, routing of interworking traffic over the Inter-Service Provider interface is simpler than in services that lack this kind of interface. This is due to the fact a server can have an address that belongs to IPX address block (in other words is routable within IPX), while a terminal likely can not have this kind of address.

For the Inter-Service Provider PoC connection there are two interfaces: user plane (media + talk burst control, that is Real-time Transport Protocol (RTP) + Real-Time Transport Control Protocol (RTCP)) is routed via POC-4 interface between PoC servers, while control plane (SIP signalling) is routed via IP-1 interface between IMS core networks. Both of these interfaces are IP based. It is envisioned that both POC-4 and IP-1 will be routed over the Inter-Service Provider IP Backbone, as any other IMS interworking traffic. Anyway also the PoC user traffic needs to be protected from outsiders, either by using IPX network or by using VPN tunnels.

Deploying two separate network connections between Service Providers needs somewhat more consideration than just a single connection, for example regarding the dual configuration of firewalls/border gateways towards the Inter-Service Provider IP Backbone. However, the IP-1 interface between IMS core networks is the same as for any other IMS based service, in other words normal Mw or Ici interface is utilized. Thus deploying PoC interworking means that only the PoC server-to-PoC server interface (POC-4) will have to be implemented in the network layer, if these Service Providers already have general IMS interworking in place.

7.4. Peer-to-Peer Services

The main difference between P2P (Peer-to-Peer) service and client-to-server service is that P2P does not need any kind of application related support from the network, while client-to-server requires some kind of server, such as Multimedia Messaging Service Centre (MMSC) or PoC server. Typical P2P services envisioned for IMS are different multi-player games (such as chess, battleship or Reversi), media sharing, imaging and multimedia streaming.

Even if the media can go directly from one terminal to another terminal without any intermediate server or proxy, these services require IMS to support setting up that service, in other words signalling always goes via the Service Provider IMS core.

When P2P service is used user plane is routed directly between terminals implying that terminal IP addresses are utilized in user plane. However, as discussed above typically terminal IP addresses are not routable in the Inter-Service Provider IP Backbone, thus user plane needs to be put inside a tunnel in order to be routed over the Inter-Service Provider IP Backbone, such as IPX. GRE tunnels are used for this purpose as documented in IR.34 [1] Chapter 6.5.6.

Routing of P2P traffic between Service Providers is handled via using normal Mw/Ici control plane interface to set-up the service and then routing the user plane over the Inter-Service Provider IP Backbone between participating Service Providers. Roaming scenario does not pose any additional requirements for this kind of service, since IMS user is always connected to home network.

7.5. RCS

RCS (Rich Communication Suite) represents an IMS based service which combines a number existing stand-alone applications into an interoperable package, allowing end-users to for example see the capabilities of other users within the client address book before setting up a call/chat/message session with them.

From IMS point of view RCS is a bundle of various standardized services, consisting of:

- Presence based on OMA SIMPLE Presence & XDM
- Chat based on OMA SIMPLE IM
- File Transfer based on OMA SIMPLE IM
- Video Share based on GSMA IR.74
- Image Share based on GSMA IR.79

Standard inter-Service Provider interfaces for these particular services are applicable both in the stand-alone case and when used as a part of RCS, thus there's no need to specify anything special for RCS as such.

For further details of the inter-operator aspects of RCS service, see IR.90 [27].

8 ADDRESSING AND ROUTING

8.1. Addressing

IMS user addressing is defined in 3GPP TS 23.228 [5] and 23.003 [10]. GSMA PRD IR.92 [28] further clarifies that UEs and IMS core network must support SIP-Uniform Resource Identifiers (URIs) (alphanumeric) and Mobile Subscriber ISDN Number (MSISDN) based IP Multimedia Public Identity (IMPU), which means a tel-URIs with an associated SIP-URI, for example

- Alphanumeric SIP-URI
  - SIP: voicemail@example.com
- MSISDN based IMPU
  - tel: :+491721234512
  - SIP:+491721234512@example.com; user=phone

The CSCF, Breakout Gateway Control Function (BGCF), IBCF and Media Gateway Control Function (MGCF) nodes are identifiable using a valid SIP URI (Host Domain Name or Network Address) on those interfaces supporting the SIP protocol. SIP URIs are used when identifying these nodes in header fields of SIP messages.

For Public User Identities assigned to a user for receiving inbound calls/sessions, it is recommended to assign at least one E.164 number (MSISDN) in order to enable CS interworking (both for break-in and break-out, as well as SR-VCC). A SIP URI may also be assigned as a Public User Identity for receiving inbound calls/sessions, however, it should be noted that domain names used therein need to be agreed between interconnecting Service Providers in order to guarantee uniqueness and routing.

NOTE: The 3GPP and other standards bodies are looking into a more structured approach for resolving this issue, particularly for multi-national corporate entities (who may have different Service Providers in different countries where they have presence) as part of their work on "Alphanumeric SIP URIs".

8.2. General Issues

Coexistence of separate networks means that there is a requirement for certain IMS core elements to be reachable and routable from a Service Provider's internal IP network as well as from the Inter-Service Provider IP Backbone, since they are used both in internal connections and external connections. Thus, those IMS elements should be multi-homed or otherwise be capable of supporting two or more network addresses.

Also, the IMS core should be capable of distinguishing whether DNS queries need to be sent towards the Inter-Service Provider IP Backbone DNS or internal/public Internet DNS, due to the two Domain Names Systems being separate.

Chapter 7 of IR.34 [1] illustrates the general guidelines for Service Providers, including this issue of handling multiple IP networks from a single IMS core system.

8.3. Roaming Specific Issues

When utilizing IMS roaming where the P-CSCF is located in the visited service provider's network, the P-CSCF discovers the home network entry point of the home service provider by resolving the home network domain name (as given in the request URI of SIP REGISTER request). If the home network domain name is derived from IMSI as defined in 3GPP TS 23.003 then it is recommended to use only domain names specified in GSMA PRD IR.67 [REF] Chapter 2.3.3.

8.4. Interworking Specific Issues

Routing of SIP signalling over IMS NNI requires use of SIP URIs.

- Session requests based upon E.164 format Public User Identities (for example tel: :+491721234512) require conversion into a routable SIP URI format. This conversion can be done using ENUM (see GSMA PRD IR.67 [24] Chapter 5 for more information)
- Session request based upon SIP URI requires that domain names used therein need to be agreed between interconnecting Service Providers in order to guarantee uniqueness and routing

For IMS interworking, the IMS of the originating Service Provider discovers the IMS point of contact (I-CSCF/IBCF) of the terminating Service Provider based on the recipient domain as documented in the Chapter 4.5.2 of IR.67 [24]

9 REFERENCES

1. GSMA PRD IR.34 Inter-Service Provider IP Backbone Guidelines
2. IETF RFC 3261 Session Initiation Protocol (SIP)
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4. 3GPP TS 23.002 UMTS Release 5 Network Architecture
5. 3GPP TS 23.228 IP Multimedia Subsystem, Stage 2
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8. 3GPP TS 29.162 Interworking between the IMS and IP networks
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10. 3GPP TS 23.003 Numbering, addressing and identification
11. GSMA PRD IR.61 WLAN Roaming Guidelines
12. GSMA PRD SE.35 IMS Services and Applications
13. GSMA PRD SE.36 PoC Roaming and Inter-working Service Requirements
14. OMA Push to talk over Cellular (PoC) - Architecture
15. 3GPP TR 23.979 3GPP enablers for OMA PoC Services
16. 3GPP TS 23.141 Presence Service, Architecture and functional description
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19. 3GPP TS 29.165 Inter-IMS Network to Network Interface (NNI)
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22. GSMA PRD AA.80 Agreement for IP Packet eXchange (IPX) Services
23. GSMA PRD IR.40 Guidelines for IPv4 Addressing and AS Numbering for GPRS Network Infrastructure and Mobile Terminals
24. GSMA PRD IR.67 DNS/ENUM Guidelines for Service Providers & GRX/IPX Providers
25. GSMA PRD IR.77 Inter-Operator IP Backbone Security Requirements For Service Providers and Inter-operator IP backbone Providers
26. GSMA PRD IR.88 LTE Roaming Guidelines
27. GSMA PRD IR.90 RCS Interworking Guidelines
28. GSMA PRD IR.92 IMS Profile for Voice and SMS

ANNEX A: PS/CS VOICE INTERWORKING

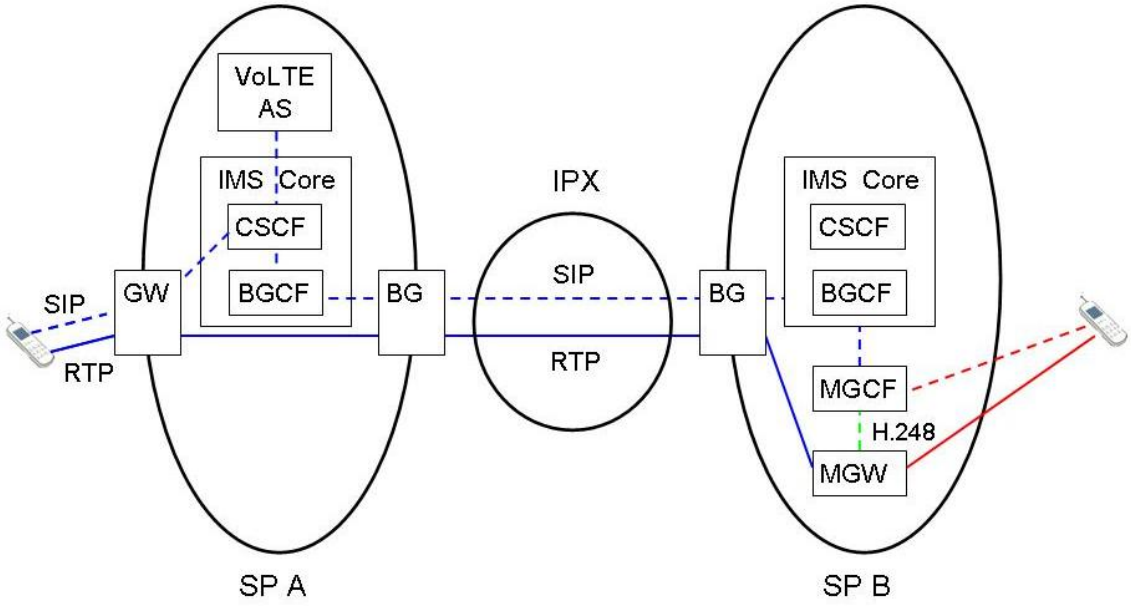

Figure 11: IMS-to-IMS Voice NNI with receiver using CS UNI

Figure 11 above shows an illustrative example of Client A using IP based UNI connecting with Client B using CS based UNI. The necessary CS/PS conversion takes place in Service Provider B premises in this example (as decided by the Service Provider A BGCF),that is the voice NNI is IP based.

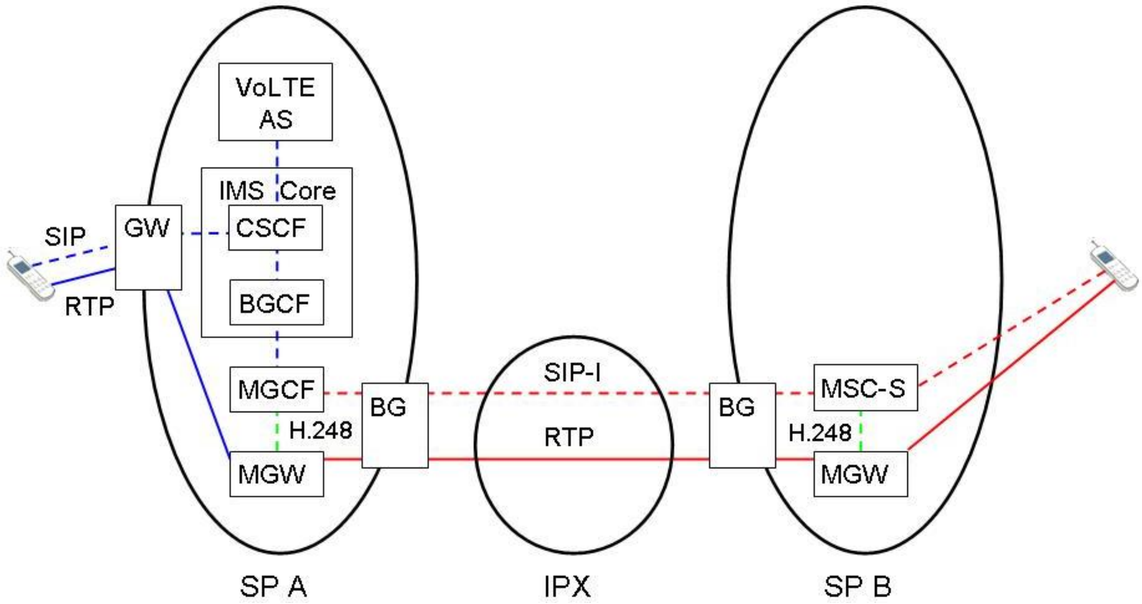

Figure 12: IMS-to-MSC-S Voice NNI

Figure 12 above shows an illustrative example of Client A using IP based UNI connecting with Client B using CS based UNI. The voice NNI in this scenario is IP based, using SIP-I between MGCF of Service Provider A and MSC-S of Service Provider B.

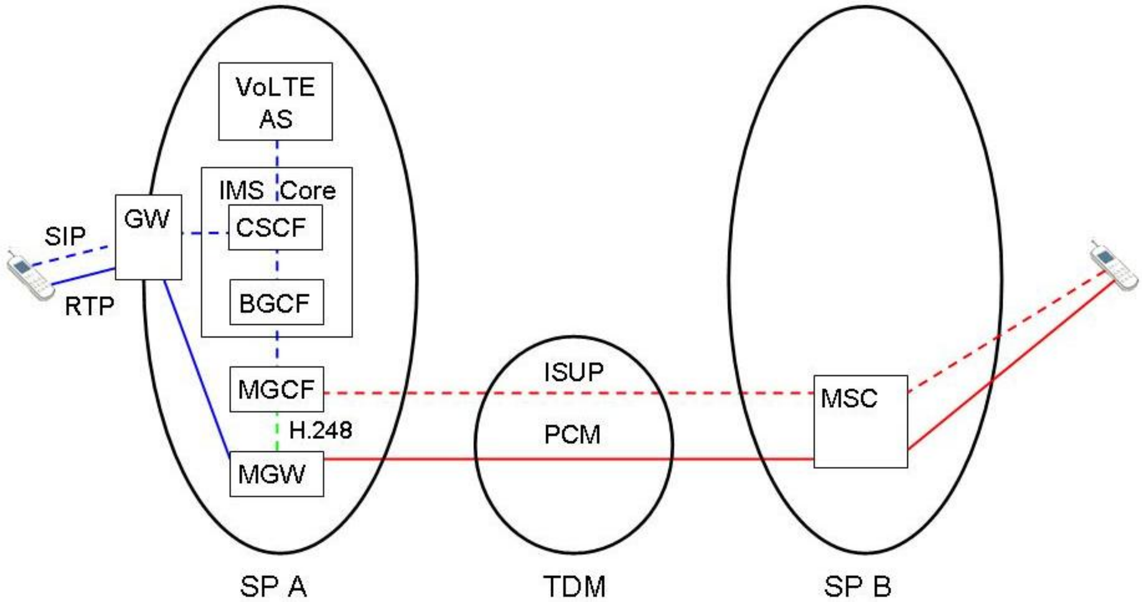

Figure 13: IMS-to-MSC Voice NNI

Figure 13 above shows an illustrative example of Client A using IP based UNI connecting with Client B using CS based UNI for the exchange of voice traffic. The necessary CS/PS conversion takes place in Service Provider A premises in this example, that is the voice NNI is CS based.

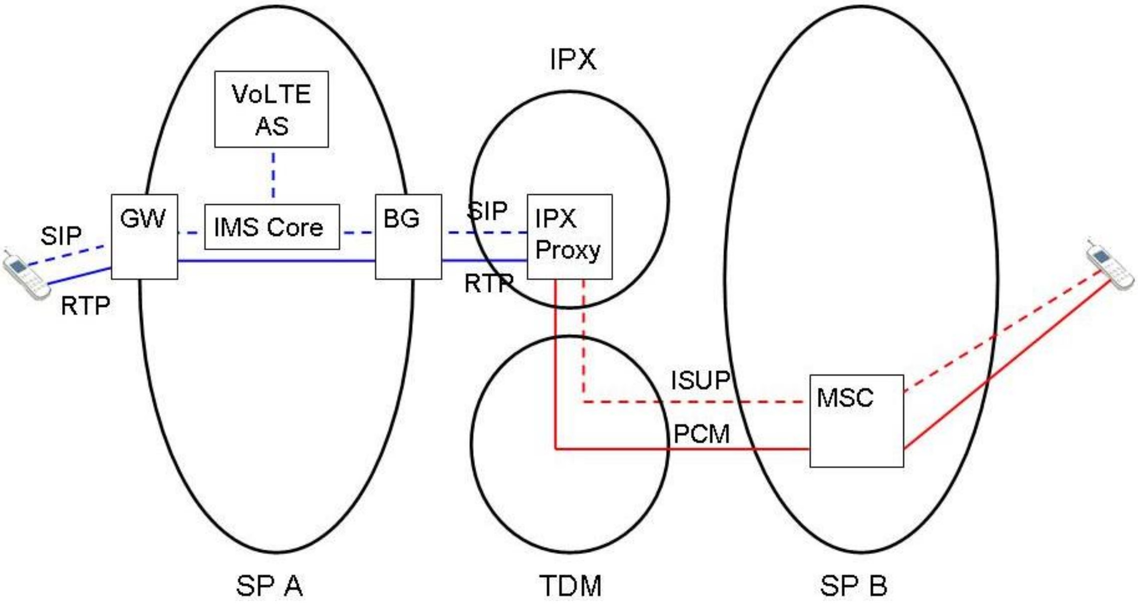

Figure 14: IMS-to-MSC Voice NNI with IPX performing the TDM breakout

Figure 14 above shows an illustrative example of Client A using IP based UNI connecting with Client B using CS based UNI for the exchange of voice traffic. The necessary CS/PS conversion is performed by the IPX Proxy in this example, that is the voice NNI gets converted from PS to CS.

DOCUMENT MANAGEMENT

Document History

Version	Date	Brief Description of Change	Approval Authority	Editor / Company
0.0.1	August 5th, 2003	Input paper IREG Doc 104/03 "IMS Roaming & Interworking Guidelines Proposal" for IREG Portland meeting	IREG	Tero Jalkanen / TeliaSonera
0.0.2	October 28th, 2003	First draft of PRD for IREG Packet WP London meeting		
0.0.3	January 28th, 2004	Second draft of PRD for IREG IMS Ad Hoc		
0.0.4	February 18th, 2004	Third draft of PRD for IREG Amsterdam meeting		
0.0.5	April 23rd, 2004	Forth draft of PRD for IREG IMS Ad Hoc		
0.0.6	May 18th, 2004	Fifth draft of PRD for IREG Packet WP Madrid meeting		
3.0.0	July 30th, 2004	First approved version		
3.0.1	December 23rd, 2004	Incorporated IREG Doc 48_025 (NSCR 001 to IR.65 3.0.0)		
3.3	November 7th, 2005	Incorporated Minor CRs 003 and 004		
3.4	February 7th, 2006	Incorporated Minor CR 005		
3.5	August 14th, 2006	Incorporated Minor CR 006		
3.6	November 21st, 2006	Incorporated Minor CRs 007 and 008		
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Other Information

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