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SERIES Q: SWITCHING AND SIGNALLING, AND ASSOCIATED MEASUREMENTS AND TESTS

Signalling requirements and protocols for the NGN – VoLTE/ViLTE network signalling

Framework of interconnection of VoLTE/ViLTE-based networks

Recommendation ITU-T Q.3640

International Telecommunication Union

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Recommendation ITU-T Q.3640

Framework of interconnection of VoLTE/ViLTE-based networks

Summary

Recommendation ITU-T Q.3640 specifies the high-level framework of interconnection of long-term evolution (LTE)-based networks for providing interoperable voice and video services.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.3640	2018-01-13	11	11.1002/1000/13482

Keywords

Framework, interconnection, networks, LTE, ViLTE, VoLTE.

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Framework of interconnection of VoLTE/ViLTE-based networks

1 Scope

This Recommendation describes the framework and procedures that should be implemented by operators for establishing an interconnection between voice over long-term evolution / video over long-term evolution (VoLTE/ViLTE)-based networks to achieve worldwide interoperability.

This Recommendation identifies additional scenarios and requirements for VoLTE/ViLTE interconnection which have not been defined in existing 3GPP standards and GSMA guidelines, as follows:

– possible E2E scenarios in terms of interconnection and roaming;

– description of the EPC functions which should be supported;

– EPC configuration requirements;

– device and U/ISIM requirements;

– comparison of VoLTE roaming architecture;

– list of mandatory and optional services which should be supported by operators for interconnection and roaming scenarios;

– protocol implementation statement (PICS) needed for the service level agreement (SLA).

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Q.1912.5] Recommendation ITU-T Q.1912.5 (2018), *Interworking between session initiation protocol (SIP) and bearer independent call control protocol or ISDN user part*.

[ITU-T Q.3403] Recommendation ITU-T Q.3403 v.1 (2016), *IP multimedia call control protocol based on the session initiation protocol and the session description protocol – Basic call: Requirements for the user side and the network side*.

[ITU-T Q.3617] Recommendation ITU-T Q.3617 v.1 (2015), *Terminating identification presentation and terminating identification restriction using IP multimedia core network subsystem. Protocol specification*.

[ITU-T Q.3618] Recommendation ITU-T Q.3618 v.1 (2016), *Originating identification presentation and originating identification restriction using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3619] Recommendation ITU-T Q.3619 v1 (2016), *Communication HOLD using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3620] Recommendation ITU-T Q.3620 v.1 (2016), *Communication diversion using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3621] Recommendation ITU-T Q.3621 v.1 (2016), *CONF using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3622] Recommendation ITU-T Q.3622 v.1 (2016), *Communication waiting using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3623] Recommendation ITU-T Q.3623 v.1 (2016), *Explicit communication transfer using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3624] Recommendation ITU-T Q.3624 v.1 (2016), *Malicious communication identification using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3625] ITU-T Q.3625 v.1 (2016), *Completion of communications to busy subscriber and completion of communications by no reply using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3626] Recommendation ITU-T Q.3626 v.1 (2016), *Message waiting indication using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3627] Recommendation ITU-T Q.3627 v.1 (2016), *Closed user group using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3628] Recommendation ITU-T Q.3628 v.1 (2016), *Anonymous communication rejection and communication barring using IP multimedia core network subsystem – Protocol specification*.

[ITU-T Q.3630] Recommendation ITU-T Q.3630 v1 (2017), *Inter-IMS network to network interface – Protocol specification*.

[ITU-T T.38] Recommendation ITU-T T.38 (2015), *Procedures for real-time Group 3 facsimile communication over IP networks*.

[ITU-T V.152] Recommendation ITU-T V.152 (2010), *Procedures for supporting voice-band data over IP networks*.

[ETSI TS 124 229] ETSI TS 124 229 (2016-01), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3 (3GPP TS 24.229 Release 10).*

[ETSI TS 124 604] ETSI TS 124 604 V10.11.0 (2015-10), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Communication Diversion (CDIV) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol specification (3GPP TS24.604 version 10.11.0 Release 10).*

[ETSI TS 124 605] ETSI TS 124 605 V10.1.0 (2013-01), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Conference (CONF) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol specification (3GPP TS 24.605 Release 10).*

[ETSI TS 124 606] ETSI TS 124 606 V10.2.0 (2012-07), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Message Waiting Indication (MWI) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol specification (3GPP TS 24.606 Release 10).*

[ETSI TS 124 607] ETSI TS 124 607 V10.1.0 (2014-03), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Originating Identification Presentation (OIP) and Originating Identification Restriction (OIR) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol specification (3GPP TS 24.607 Release 10)*.

[ETSI TS 124 608] ETSI TS 124 608 V10.1.0 (2013-07), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Terminating Identification Presentation (TIP) and Terminating Identification Restriction (TIR) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol specification (3GPP TS 24.608 Release 10)*.

[ETSI TS 124 610] ETSI TS 124 610 V10.2.0 (2013-10), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Communication HOLD (HOLD) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol specification (3GPP TS 24.610 Release 10).*

[ETSI TS 124 611] ETSI TS 124 611 V10.2.0 (2012-01), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Anonymous Communication Rejection (ACR) and Communication Barring (CB) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol specification (3GPP TS 24.611 Release 10)*.

[ETSI TS 124 615] ETSI TS 124 615 V10.6.0 (2015-07), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Communication Waiting (CW) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol Specification (3GPP TS 24.615 Release 10)*.

[ETSI TS 124 616] ETSI TS 124 616 V10.0.0 (2011-03*), Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Malicious Communication Identification (MCID) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol specification (3GPP TS 24.616 Release 10).*

[ETSI TS 124 629] ETSI TS 124 629 V10.2.0 (2013-04), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Explicit Communication Transfer (ECT) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol specification (3GPPTS 24.629 Release 10)*.

[ETSI TS 124 642] ETSI TS 124 642 V10.7.0 (2013-07), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Completion of Communications to Busy Subscriber (CCBS) and Completion of Communications by No Reply (CCNR) using IP Multimedia (IM) Core Network (CN) subsystem; Protocol Specification (3GPP TS 24.642 Release 10).*

[ETSI TS 124 654] ETSI TS 124 654 V10.3.0 (2013-04), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Closed User Group (CUG) using IP Multimedia (IM) Core Network (CN) subsystem, Protocol Specification (3GPP TS 24.654 Release 10)*.

3 Definitions

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ENUM telephone Number Mapping

GRX/IPX GPRS Roaming exchange / IP exchange

HPMN Home Public Mobile Network

IBCF Interconnection Border Control Functions

II-IMS Inter-IMS

II-NNI Inter-IMS Network to Network Interface

IMS IP Multimedia Subsystem

LBO Local Breakout

LI Lawful Interception

LTE Long-Term Evolution

NNI Network Network Interface

OTT Over The Top

PS Packet Switched

R-NNI Roaming Network to Network Interface

SAE System Architecture Evolution

SIP Session Initiation Protocol

SLA Service Level Agreement

ViLTE Video over LTE

VoLTE Voice over LTE

VoPS IMS voice over PS Session

VPMN Visited Public Mobile Network

5 Conventions

None.

6 Rationale

The LTE is a popular wireless technology used for providing customers access to IP core networks. By using broadband wireless technology such as LTE, telecommunication operators have finally reached the concept of "all over IP networks" and may provide with a wireless interface any telecommunication service using an all IP environment.

Among others, LTE may have been used for providing the most popular services such as real-time voice and video (e.g., telephony). However, the implementation of VoLTE/ViLTE poses some challenges to the operators, which aim to establish end-to-end connections between calling parties, because there is only a packet-switched (PS) network and the service control is provided by an IP multimedia subsystem (IMS).

Different VoLTE/ViLTE solutions are available for operators. However these solutions are not always interoperable and VoLTE/ViLTE roaming procedures are not agreed and therefore may not be implemented.

This Recommendation aims to specify common requirements to the interconnection of VoLTE/ViLTE-based networks.

7 Key issues of interconnection

There are the following key issues of interconnection among VoLTE/ViLTE-based networks:

– different options for signalling protocols used for Inter-IMS interconnection, which can support all existing services (basic call and supplementary services);

– different options for roaming scenarios (there are no strict requirements for operators and no default option);

– charging (e.g., roaming charges, calls using interconnection networks);

– numbering/addressing (e.g., ENUM resolution, ITU-T E.164 → SIP-URI conversion);

– floating delay (problem of providing legacy services and applications, e.g., Fax/Modem over IP);

– lawful interception;

– data retention;

– emergency services (e.g., emergency call 112).

8 General principles of interconnection of VoLTE-based networks

The voice over LTE (VoLTE) and video over LTE (ViLTE) services are the services that aim to deliver voice and video communication over packet-based networks which include LTE technology, on the access stratum. It means that VoLTE/ViLTE services might be provided by either traditional fixed or mobile telecommunication operators who implemented LTE technology as access technology to its core IP network.

Also, VoLTE/ViLTE services are so-called "managed" voice and video services which are based on standardized SIP/IMS signalling and provided by telecommunication operators, while over-the-top (OTT) applications are services which are basically provided in public Internet by independent third parties, without standardized signalling protocols, traffic prioritization and guaranteed quality of services.

An IMS platform is used as a service control stratum which is used for managing VoLTE/ViLTE sessions. The reference architecture of IMS is shown in Figure 8-1.

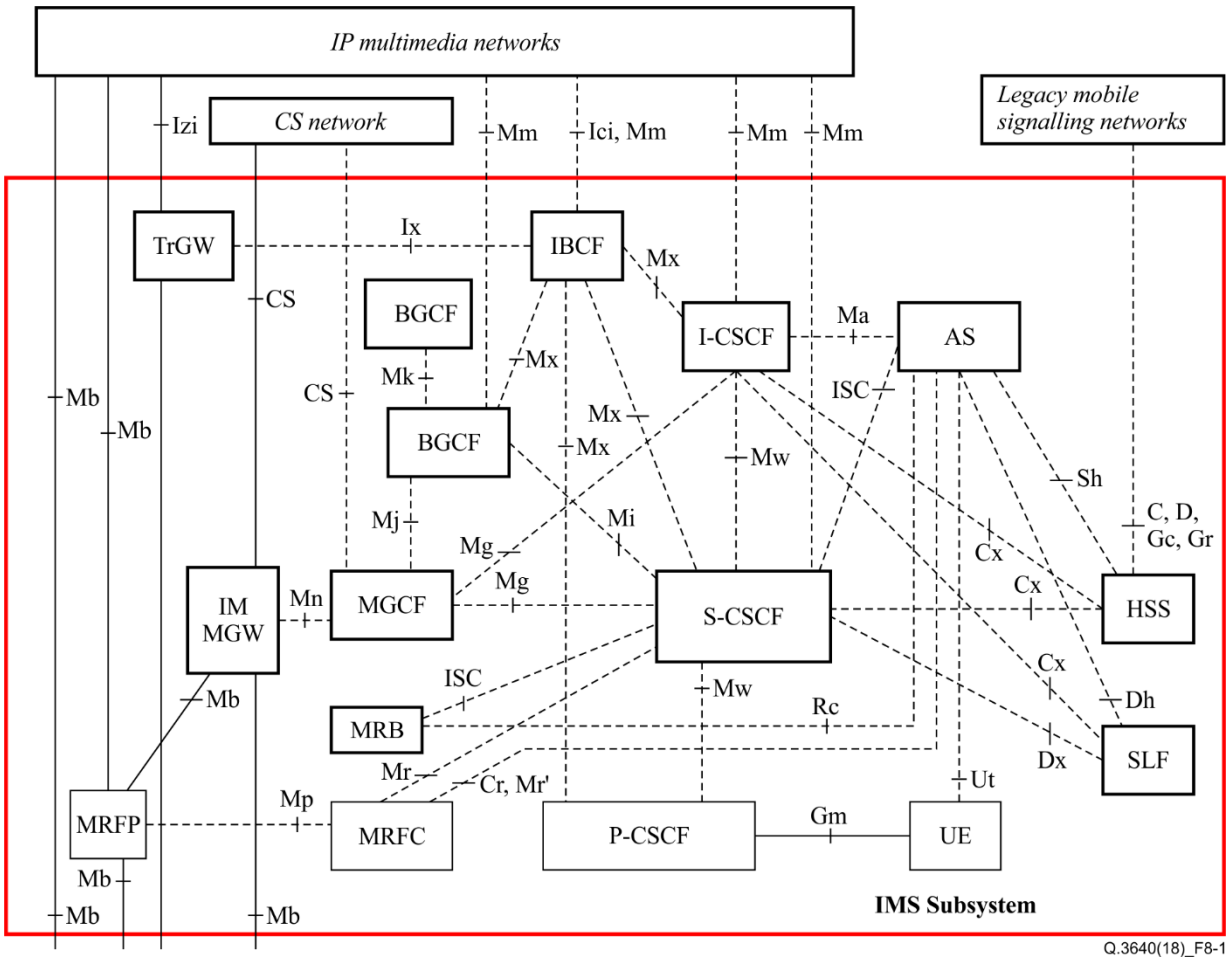

Figure 8-1 – Reference architecture of the IP multimedia core network subsystem [b-ETSI TS 123 002]

VoLTE/ViLTE interconnection implies interconnection of IMS platforms for providing VoLTE/ViLTE and legacy e2e sessions.

There are the following types of interconnection between IMS-based telecommunication operators:

– interconnection for delivering sessions among users of different operators (hereafter interworking scenarios);

– interconnection for providing roaming of users of the home networks in visited networks (hereafter roaming scenarios).

There are also options for interconnection between the VoLTE/ViLTE and IMS-based networks with existing legacy networks (e.g., PSTN, PLMN).

The ENUM/DNS translation mechanism as specified in [b-IETF RFC 3761] can be used by all IMS nodes that require ITU-T E.164 address to SIP URI resolution. Subsequently, the GSMA published [b-GSMA PRD IR.67] and [b-GSMA PRD NG.105].

9 E2E scenarios in terms of interconnection and roaming

9.1 E2E scenarios in terms of interconnection and roaming

According to general principles there are the following key e2e scenarios:

Interworking scenarios (established connection):

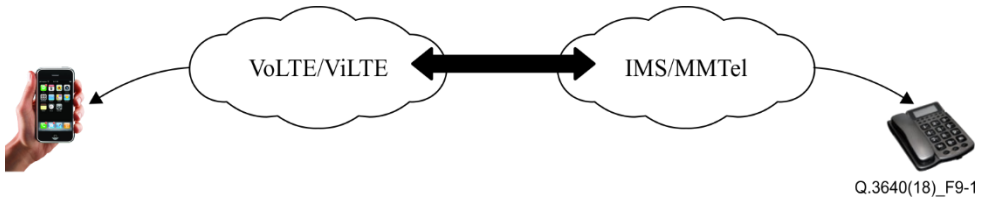

Figure 9-1 – VoLTE – IMS/MMTel interconnection scenarios

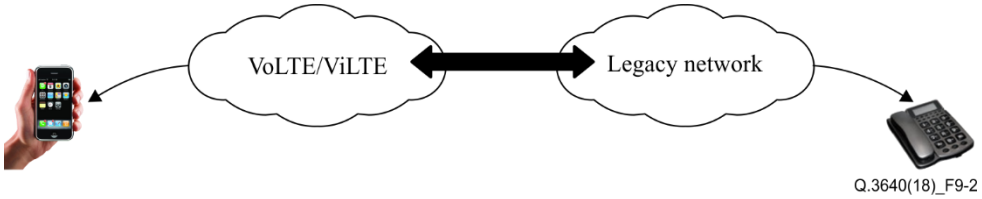

Figure 9-2 – VoLTE – Legacy network interconnection scenarios

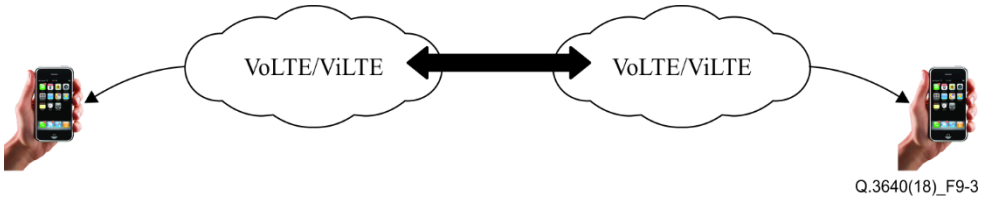

Figure 9-3 – VoLTE/ViLTE – VoLTE/ViLTE interconnection scenarios

Table 9-1 – E2E scenarios in terms of interconnection and roaming

No.	Scenario	Description	Roaming options
VoLTE – IMS interworking scenarios			
1	Scenario 1	User UE1 (a) is in the IMS network A, UE2 (a) in HPMN (a)	
2	Scenario 1A	User UE 1 (a) is in the IMS network A, UE2 (a) in HPMN (a) with CSFB (circuit switched fallback) NOTE – Occurs only in the case if IMS voice over PS Session (VoPS) is not supported in the home public mobile network (HPMN)'s LTE networks	
3	Scenario 1B	User UE1 (a) is in the IMS network A, UE2 (a) in HPMN (a) is moving from 4G to 3G coverage with SRVCC	
4	Scenario 1C	User UE1 (a) is in the IMS network A, UE2 (a) roamed in VPMN (b)	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
5	Scenario 1D	User UE1 (a) is in the IMS network A, UE2 (a) roamed in VPMN (b) moving from 4G to 3G coverage with SRVCC	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
VoLTE – Legacy network scenarios			
6	Scenario 2	User UE1 (a) is in the legacy network A, UE2 (a) is in HPMN (a)	
7	Scenario 2A	User UE1 (a) is in the legacy network A, UE2 (a) is in HPMN (a), with CSFB (circuit switched fallback) NOTE – occurs only in the case if VoPS is not supported in the HMPMN's LTE N/W	
8	Scenario 2B	User UE1 (a) is in the legacy network A , UE2 (a) is in HPMN (a), roamed in VPMN (b) moving from 4G to 3G coverage with SRVCC	

Table 9-1 – E2E scenarios in terms of interconnection and roaming

No.	Scenario	Description	Roaming options
9	Scenario 3	User UE1(a) is in the legacy network A , UE2 (a) is in VPMN (b)	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
VoLTE – VoLTE and ViLTE – ViLTE interconnection scenarios			
10	Scenario 4	UE1 (a) is in HPMN (a), UE2 (b) is in HPMN (b)	
11	Scenario 4A	UE1 (a) is in HPMN (a), UE2 (b) is in HPMN (b) with CSFB (circuit switched fallback). NOTE – occurs only in the case if VoPS is not supported in HPMN.	
12	Scenario 4B	UE1 (a) is in HPMN (a), UE2 (b) is in HPMN (b) moving from 4G to 3G coverage with SRVCC	
13	Scenario 4C	UE1 (a) is in HPMN (a) with CSFB (circuit switched fallback). UE2 (b) is in HPMN (b).	
14	Scenario 4D	UE1 (a) is in HPMN (a) moving from 4G to 3G coverage with SRVCC, UE2 (b) is in HPMN (b).	
VoLTE – VoLTE and ViLTE – ViLTE roaming scenarios			
15	Scenario 5	UE1 (a) is in HPMN (a), UE3 (a) roamed in VPMN (b)	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
16	Scenario 5A	UE1 (a) is in HPMN (a), UE3 (a) roamed in VPMN (b) with CSFB (circuit switched fallback). NOTE – Occurs only in the case if VoPS is not supported in VPMN.	
17	Scenario 5B	UE1 (a) is in HPMN (a), UE3 (a) roamed in VPMN (b) moving from 4G to 3G coverage with SRVCC	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture

Table 9-1 – E2E scenarios in terms of interconnection and roaming

No.	Scenario	Description	Roaming options
18	Scenario 5C	UE1 (a) in HPMN (a) with CSFB (circuit switched fallback), UE3 (a) roamed in VPMN (b)	Roaming options: – Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
19	Scenario 5D	UE1 (a) is in HPMN (a) moving from 4G to 3G coverage with SRVCC, UE3 (a) roamed in VPMN (b)	Roaming options: – Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
20	Scenario 6	UE1 (a) calls UE3 (a), both roamed in VPMN (b)	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
21	Scenario 6A	UE1 (a) calls UE3 (a), both roamed in VPMN (b), UE1 (a) with CSFB (circuit switched fallback) NOTE – occurs only in the case if VoPS is not supported in VPMN of UE1.	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
22	Scenario 6B	UE1 (a) calls UE3 (a), both roamed in VPMN (b), UE1 (a) is moving from 4G to 3G coverage with SRVCC	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
23	Scenario 6C	UE1 (a) calls UE3 (a), both roamed in VPMN (b), UE2 (a) is moving from 4G to 3G coverage with SRVCC	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
24	Scenario 7	UE1 (a) roamed in VPMN (b), UE2 (b) roamed in VPMN (a)	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
25	Scenario 8A	UE1 (a) roamed in VPMN (b), UE2 (b) roamed in VPMN (a), UE1 (a) with CSFB (circuit switched fallback)	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture

Table 9-1 – E2E scenarios in terms of interconnection and roaming

No.	Scenario	Description	Roaming options
26	Scenario 7B	UE1 (a) roamed in VPMN (b), UE2 (b) roamed in VPMN (a) and UE2 (b) is moving from 4G to 3G coverage with SRVCC	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
27	Scenario 7C	UE1 (a) roamed in VPMN (b), UE2 (b) roamed in VPMN (a), and UE1 (a) is moving from 4G to 3G coverage with SRVCC	– Local breakout VPMN routing architecture (LBO-VR) – LBO home routing architecture (LBO-HR) – S8HR VoLTE roaming architecture
28	Scenario 8	The VoLTE subscriber UE1 (a) in the HPMN (a) is calling the 2G/3G user UE2 (b) in HPMn (b)	
29	Scenario 9	The VoLTE subscribers UE1 (a) and UE 2(a) are subscribed in the HPMN (a). Subscribers UE1 (a) is roaming in 2G/3G VPMN (b).	
30	Scenario 10	The VoLTE subscribers UE1 (a) and UE 2(a) are subscribed in the HPMN (a). Subscribers UE1 (a) and UE2 (a) are roaming in 2G/3G VPMN (b).	

9.2 VoLTE consideration

9.2.1 EPC consideration

An EPC network should support general VoLTE related functions, for example, basic voice and video call. These are:

– The visited network MME shall support VoLTE capability indication to UE, "IMS voice over PS" in order to select voice solution.

– The visited network MME may support the Sv interface and eSRVCC handover control function.

– SAE-GW should support the establishment of the dedicated bearer with QCI=8/9, QCI=1 and QCI=2.

– SAE-GW should support IPv6 PDN type.

– P-GW shall support the P-CSCF discovery function and allocate the P-CSCF IP address to the UE.

– PCRF shall guarantee end-to-end QoS by interworking with the IMS and AF via Rx interface.

9.2.2 EPC configuration requirements

MME

– The MME in the visit network shall configure the PLMN for the inbound roamer, so that the inbound roamer could attach to the network.

– The MME in the visit network shall configure "IMS voice over PS" for the inbound roamer.

– LBO VR: The MME in the visit network shall be able to resolve IMS APN to the PGW address in the visit network.

– S8 HR: The MME in the visit network should resolve IMS APN into the PGW address in the home network instead of the visit network. If the home network cannot resolve IMS APN to P-GW, manually configuring it to the MME in the visited network would be also acceptable for this trial.

9.3 Device and U/ISIM consideration

9.3.1 Multi-Mode and Multi-band Terminal

To meet the requirements for domestic frequency access and international roaming, five radio modes including LTE FDD, TD-LTE, TD-SCDMA, WCDMA, and GSM should be supported. The multi-mode and multi-band requirements are as follow.

– GSM: Band3, Band8 and Band2 are mandatory. Besides, Band5 is recommended.

– TD-SCDMA: Band34 and Band39 are mandatory.

– TD-LTE: Band39, Band40 and Band41 (at least supporting 2575-2635 MHz) are mandatory. If the terminals support Band41 without Band38, it must support the frequency mutual identification via mFBI.

– WCDMA: Band1, Band2 and Band5 are mandatory.

– LTE FDD: Band3 and Band7 are mandatory. Besides, Band1, Band17, Band4 and Band20 are recommended.

Additionally, compatible bands based on bilateral/multi-lateral discussions will be supported by the Device. Other multimode and multiband terminals could also be introduced in accordance with demand.

9.3.2 General requirements for VoLTE terminal

To achieve excellent user experience, VoLTE terminals shall have performance requirements that are comparable with mainstream commercial terminals in the following aspects: operation system, hardware, software, MTBF, standby time, communication duration.

Regarding the outbound roaming requirement, VoLTE handsets should support CSFB from LTE to WCDMA/GSM and support four kinds of functions for VoLTE.

9.3.2.1 RAN features

– Support SPS, TTI-Bundling, RoHC, Connected-DRX and its combinations; support interoperation from LTE to GSM via eSRVCC, aSRVCC, mid-call SRVCC; support SRVCC related measurement capability and capability report;
– support UE-based fast return to LTE after SRVCC CS call ends;
– support IPv4, IPv6 and IPv4v6 dual-stacks;
– support multi-PDN connections; delete IMS PDN when moving out of VoLTE coverage;
– support EPS bearer combinations for VoLTE service; support end-to-end QoS.

9.3.2.2 IMS function on control plane

– Support the standard SIP/IMS protocol in order to interwork with the global IMS networks;
– support derivation of IMS identifiers from USIM, if ISIM is not introduced;
– support IMS exceptions handling;
– support RTP/RTCP;
– support IMS authorization and authentication etc;
– support early media;
– support precondition;
– support upgrade and downgrade between voice and video call;
– support supplementary service configuration via Ut/XCAP.

9.3.2.3 IMS function on media plane

– Audio Codec: Entities in the IMS core network that terminate the user plane supporting speech communication and supporting TFO and/or TrFO shall support AMR speech codec modes 12.2, 7.4, 5.9 and 4.75. Entities in the IMS core network that terminate the user plane supporting wideband speech communication and supporting TFO and/or TrFO shall support AMR-WB speech codec modes 12.65, 8.85 and 6.60.
– Video Codec: H.264 640*480@30fps; 720P@30fps is recommended.
– Quality enhanced features: Noise Suppression, Echo Cancellation, jitter buffer, lip sync.

9.3.2.4 Services requirements

– Voice call
  • Support standard voice calls and HD voice calls;
  • support voice domain transition between VoLTE and CSFB; support voice continuity among different scenarios;
  • support SilentRedial.
– Message
  • Support SMS over IP, SMS over CS;
  • support MMS.
– Video call

- Support video call when UE within VoLTE coverage.

– Supplementary services
  - Supported enhanced conference calls;
  - support IMS supplementary services.

– IMS emergency services.

10 IMS roaming and interworking guidelines

According to [b-GSMA PRD IR.65] there are different possible options for IMS interconnection which should meet the following requirements:

1) The routing of media for voice and video over IMS when call originator is roaming should be at least as optimal as that of current circuit switched (CS) domains.
2) The charging model for roaming used in the CS domain shall be maintained in VoIMS.
3) Allow the HPMN to decide, based on service and commercial considerations and regulatory obligations, to enforce the routing of the originated traffic to itself (home routing).

The UE has obtained IP connectivity in the visited network and might have access to home network's IMS services via one of the following options:

Option 1 – Target IMS roaming solution, IMS is required in both VPLMN and HPLMN

The UE has obtained IP connectivity from the visited network and is connected to the P-CSCF in the visited network which establishes connections using the home IMS platform; traffic is routed directly by the visited network.

Option 2 – Data local breakout, but IMS home routed, IMS is not needed in VPLMN

The UE has obtained IP connectivity from the visited network and is connected to the P-CSCF in the visited network which itself is connected to the home IMS platform; traffic is routed via the home network.

Option 3 – The UE has obtained IP connectivity from the home network and is directly connected to the home IMS platform; traffic is routed via the home network. Data and IMS are both home routed, IMS is not needed in VPLMN.

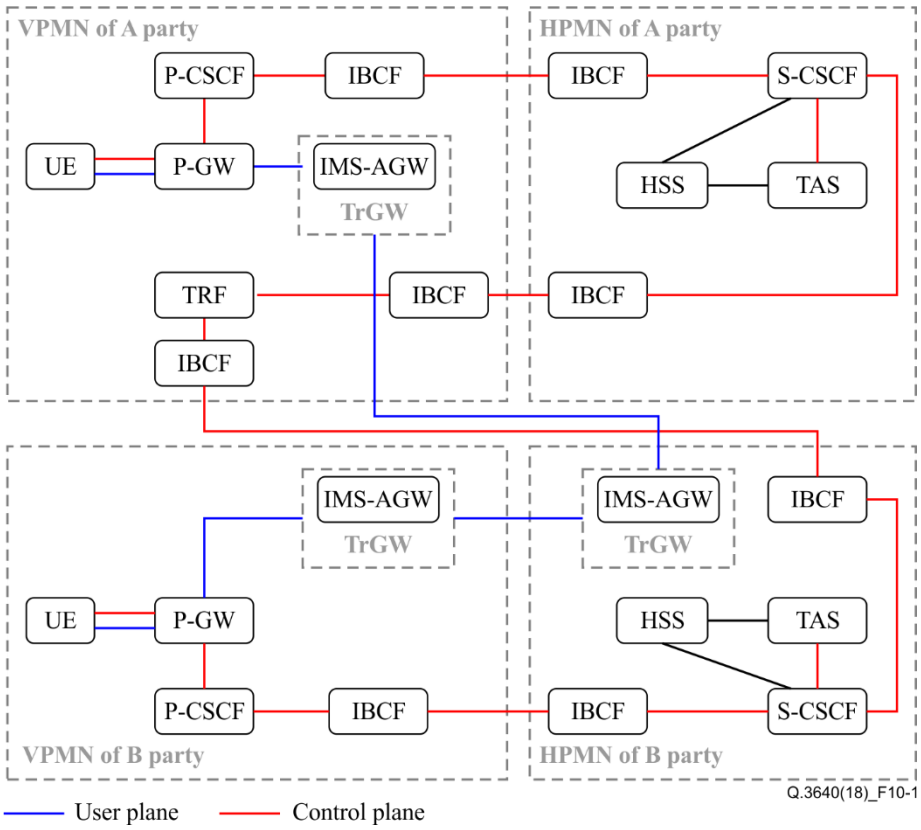

Figure 10-1 – Local breakout VPMN routing architecture (LBO-VR) [b-GSMA PRD IR.65]

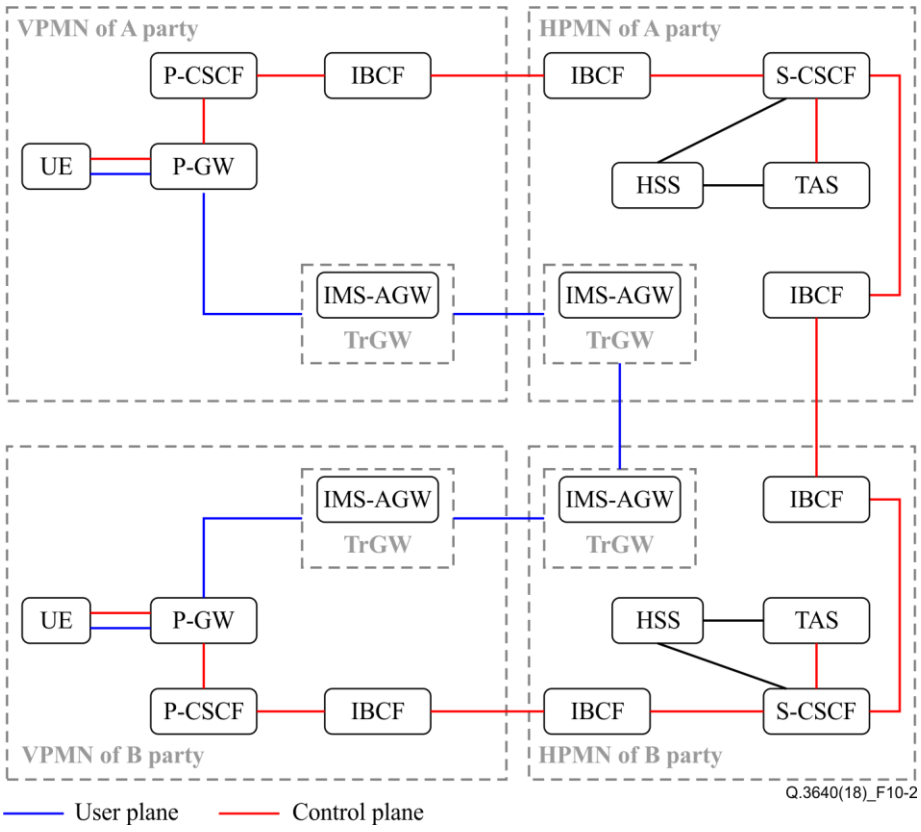

Figure 10-2 – LBO home routing architecture (LBO-HR) [b-GSMA PRD IR.65]

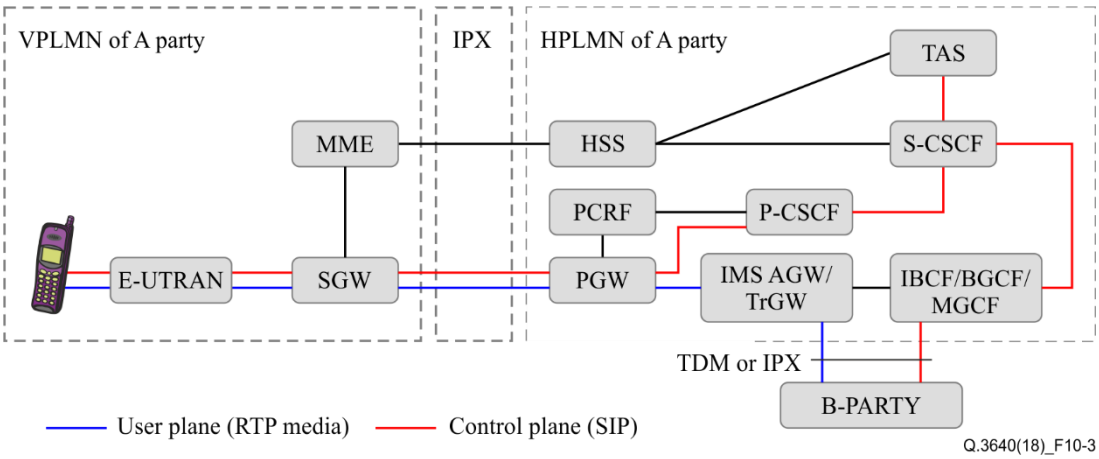

Figure 10-3 – S8HR VoLTE Roaming architecture [b-GSMA PRD IR.65]

For S8HR VoLTE roaming architecture, regulatory requirements (legal interception and emergency calling) have triggered additional specification work currently being performed in 3GPP. Deliverables are confirmed to be included in 3GPP Release 14.

Table 10-1 – Comparison of VoLTE roaming architecture

Item	Option 1 LBO-VR (target IMS roaming solution, IMS is required in both VPLMN and HPLMN)	Option 2, LBO-HR (data local breakout, but IMS home routed, IMS is not needed in VPLMN)	Option 3 S8HR Data and IMS are both home routed, IMS is not needed in VPLMN
HPLMN with VoLTE implementation	Required	Required	Required
VPLMN with VoLTE implementation	Required	Not required	Not required
IMS service over GRX	Not required	Required	Required
Charging depending on evolved packet core (EPC)	Optional (charge on IMS service layer)	Required	Required
Policy and charging control mode	HPLMN hPCRF can control the VPLMN vPCRF via S9 Interface (S9 interface is optional)	HPLMN hPCRF controls VPLMN vPCRF via S9 Interface or via roaming agreement and support of common QCIs	HPLMN hPCRF controls HPLMN PGW, 2/3G and 4G (e.g., web browsing) data roaming via S8
Single radio voice call continuity (SRVCC) support capability	Fully supported	Supported	Partially supported
VoLTE local emergency call	Supported	Supported	Not supported
VoLTE local LI	Supported	Supported	Not supported (LI will be possible at the S-GW (under development in Rel. 14 of 3GPP).
LBO with optimal media routing (OMR)	Supported	Not supported	Not supported

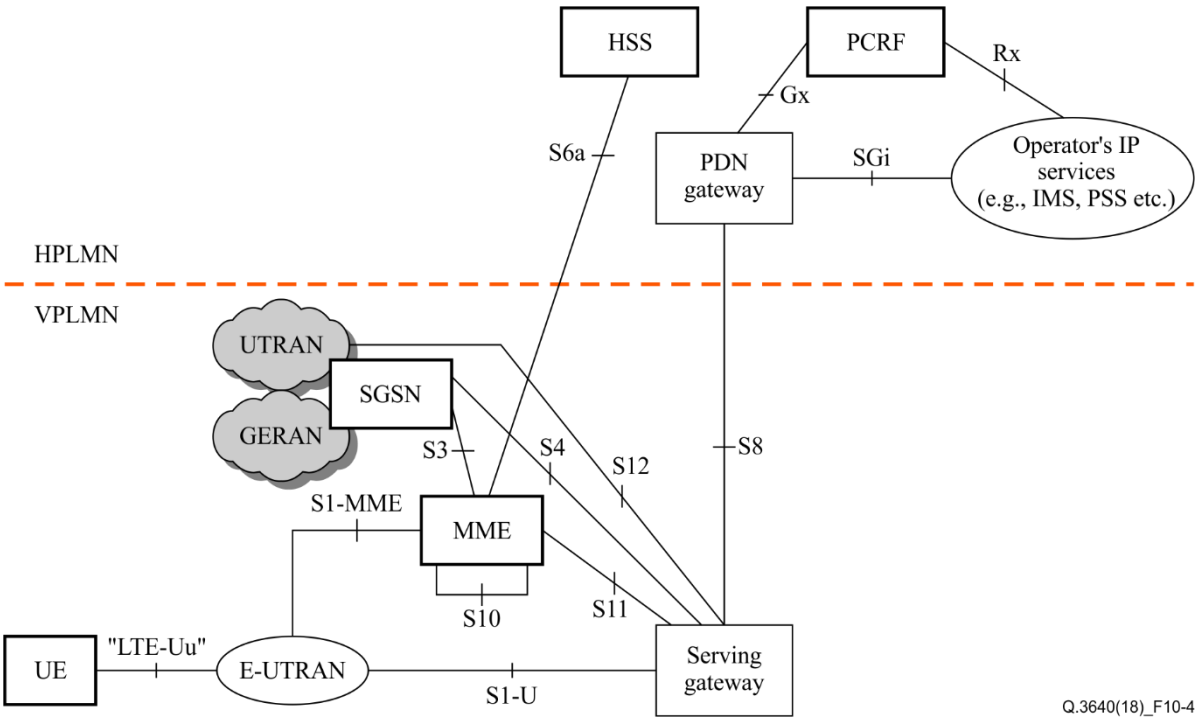

Figure 10-4 – Roaming architecture scenario with home routed traffic

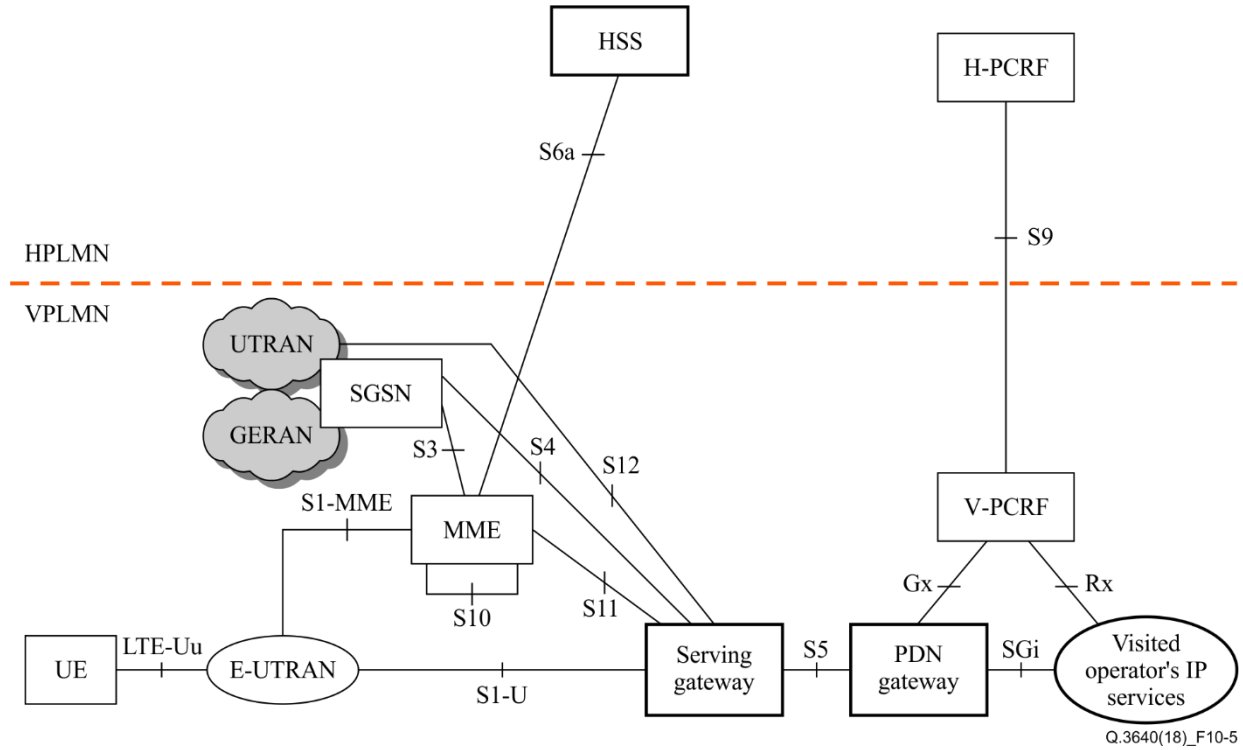

Figure 10-5 – Roaming architecture for local breakout, with home operator's application functions only

11 Services for e2e VoLTE/ViLTE interconnection scenarios

Among others there are some key services which have to be provided over the IMS-based networks for the e2e interconnection scenarios (see clause 9).

Table 11-1 specifies the list of mandatory and optional services which should be supported by operators for interconnection and roaming scenarios.

Table 11-1 – List of mandatory and optional services which should be supported by operators for interconnection and roaming scenarios

#	Service	ITU-T Recommendation	Relevant standard developed by other SDO	Status
1	Basic call (voice and video sessions)	Q.3403 v.1	ETSI TS 124.229	M
Supplementary services				
2	TIP/TIR	Q.3617 v.1	ETSI TS 124.608	O
3	OIP/OIR	Q.3618 v.1	ETSI TS 124.607	M
4	HOLD	Q.3619 v.1	ETSI TS 124.610	O
5	CDIV	Q.3620 v.1	ETSI TS 124.604	O
6	CONF	Q.3621 v.1	ETSI TS 124.605	O
7	CW	Q.3622 v.1	ETSI TS 124.615	O
8	ECT	Q.3623 v.1	ETSI TS 124.629	O
9	MCID	Q.3624 v.1	ETSI TS 124.616	O
10	CC	Q.3625 v.1	ETSI TS 124.642	O
11	MWI	Q.3626 v.1	ETSI TS 124.606	O
12	CUG	Q.3627 v.1	ETSI TS 124.654	M
13	ACR-CB	Q.3628 v.1	ETSI TS 124.611	O
NOTE – M: mandatory; O: optional.				

12 Interconnection for Inter-IMS scenario

12.1 Scenario 1

The Inter-IMS scenario is used for establishing service sessions between users of two IMS platforms (e.g., long distance call).

The reference configuration is depicted in Figure 12-1.

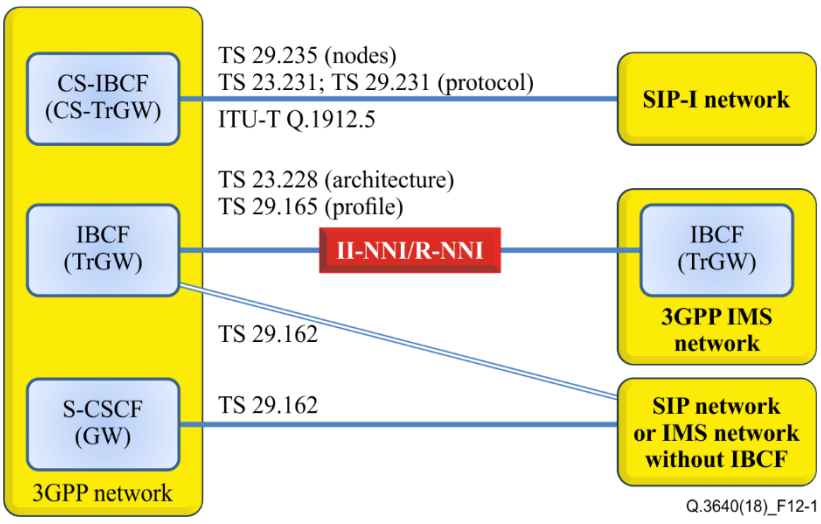

Figure 12-1 – Reference configuration for interconnection

The architecture of IMS interconnection for Inter-IMS scenario is shown in Figure 12-2.

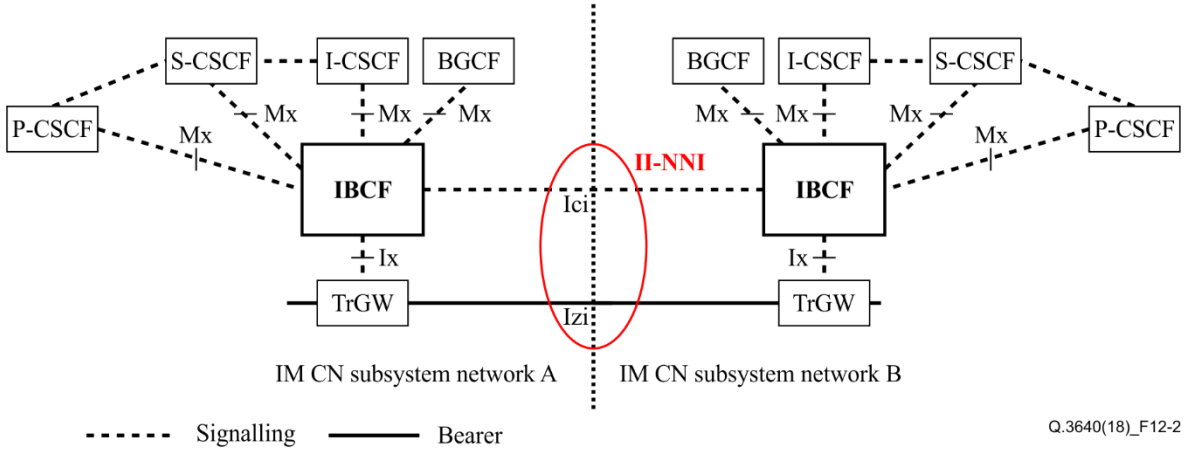

Figure 12-2 – Interconnection for inter-IMS scenario [b-ETSI TS 123.228]

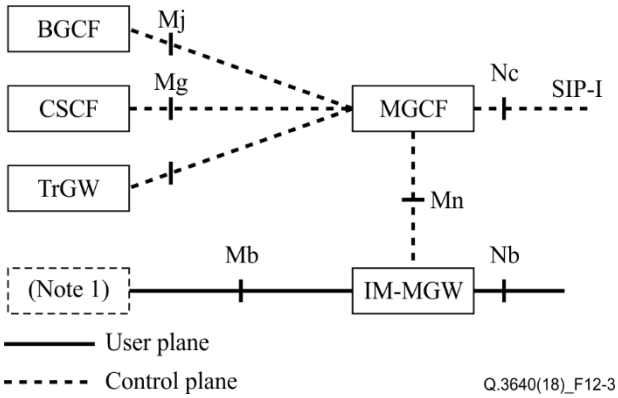

Figure 12-3 – IM CN subsystem to CS network logical interworking reference model [b-ETSI TS 129 235]

According to [b-ETSI TS 123.228] there are two reference points Ici and Izi which are used on II-NNI.

The Ici reference point allows IBCFs to communicate with each other in order to provide the communication and forwarding of SIP signalling messaging between IMS platforms, while the Izi reference point allows TrGWs to forward media streams between IMS-based networks. The reference point Ici is based on SIP signalling which has to be adapted to IMS features.

Table 12-1 provides a list of signalling protocols and relevant standards used on both interfaces.

Table 12-1 – Protocols used on II-NNI interfaces

Interface	Type of protocol	Standard
Nc/Ici	SIP, SIP-I	– SIP-I [ITU-T Q.1912.5] (NOTE – ITU-T is trying to update it issuing a revision) – II-NNI [ITU-T Q.3630]
Izi	RTP/RTCP	[b-IETF RFC 3550]

12.2 Protocol implementation statement (PICS)

The protocol implementation statement depicted in Table 12-2 describes the scope between network operator A and network operator B. The table shall be filled out with a yes/no.

Table 12-2 – Protocol implementation statement

Selection expression	Support	Support
	Network A	**Network B**
Network capabilities		
SE 1: The originating network (Network A) sends the P-Charging-Vector header?		
SE 2: The originating network (Network A) sends a subset of parameters in the P-Charging-Vector header?		
SE 3: The P-Early-Media header is supported?		
SE 4: Overlap procedure using multiple INVITE method is supported?		
SE 5: Overlap sending using in-dialog method is supported?		
SE 6: Network A supports the PSTN XML schema?		
SE 7: The resource reservation procedure is supported?		
SE 8: Does the network perform the "Fall back" procedure (PSTN or MGCF)?		
SE 9: The network is untrusted?		
SE 10: The originating network does not have a number portability data base, the number portability look up is done in the interconnected network?		
SE 11: The network supports the REFER method?		
SE 12: The network supports the 3 party call control procedure (REFER interworking)?		
SE 13: Number portability is supported?		
SE 14: Carrier selection is performed?		
SE 15: The network is a long distance carrier?		
SE 16: SIP support of charging is supported?		
SE 17: The interworking ISUP – SIP I is performed in the network?		
Supplementary services		
SE 18: The network supports the originating identification presentation (OIP)?		
SE 19: The network supports the "Special arrangement" procedure for the originating user?		
SE 20: The network supports the originating identification restriction (OIR)?		
SE 21: The network supports the terminating identification presentation (TIP)?		
SE 22: The network supports the "Special arrangement" procedure for the terminating user?		
SE 23: The network supports the terminating identification restriction (TIR)?		
SE 24: The network supports the session HOLD procedure?		
SE 25: The network supports communication forwarding unconditional (CFU)?		

Table 12-2 – Protocol implementation statement

Selection expression	Support	Support
	Network A	**Network B**
SE 26: The network supports communication forwarding busy (CFB)?		
SE 27: The network supports communication forwarding no reply (CFNR)?		
SE 28: The network supports communication forwarding not logged in (CFNL)?		
SE 29: The network supports communication deflection?		
SE 30: The network supports the CDIV notification procedure?		
SE 31: The network supports conference (CONF)?		
SE 32: The network supports the communication barring procedure (CB) – (black list for incoming calls)?		
SE 33: The network supports the anonymous communication rejection (ACR)?		
SE 34: The network supports the closed user group (CUG)?		
SE 35: The network supports the communication waiting (CW) service?		
SE 36: The network supports the $T_{AS\text{-}CW}$ timer?		
SE 37: The network supports explicit communication transfer (ECT)?		
SE 38: The network supports malicious communication identification (MCID)?		
SE 39: The network supports message waiting indication (MWI)?		
SE 40: The network supports completion of communications to busy subscriber (CCBS)?		
SE 41: The network supports completion of communications by no reply (CCNR)?		
Terminal capabilities		
SE 42: Void		
SE 43: The end device supports fax transmission via ITU-T G.711 codec?		
SE 44: The end device supports fax transmission via ITU-T V.152 codec?		
SE 45: The end device supports fax transmission via m-line ITU-T T.38 codec?		
SE 46: A SIP end device is used supporting an ISDN user equipment and the PSTN XML schema is used?		
SE 47: End device is located in the PSTN or PLMN?		
SE 48: The terminating UE supports the from-change tag procedure and sends a second user identity in an UPDATE request after the dialogue is confirmed?		
SE 49: The end device performs ECT using the 'Blind/assured transfer'?		
SE 50: The end device performs ECT using the 'Consultative transfer'?		
SE 51: The end device supports the Resource reservation procedure?		

Table 12-2 – Protocol implementation statement

Selection expression	Support	Support
	Network A	**Network B**
PSTN/PLMN supplementary services		
SE 52: CLIP/CLIR is supported in the PSTN/PLMN part of the network?		
SE 53: COLP/COLR is supported in the PSTN/PLMN part of the network?		
SE 54: HOLD is supported in the PSTN/PLMN part of the network?		
SE 55: CDIV is supported in the PSTN/PLMN part of the network?		
SE 56: CONF/3PTY is supported in the PSTN/PLMN part of the network?		
SE 57: ACR is supported in the PSTN/PLMN part of the network?		
SE 58: CUG is supported in the PSTN/PLMN part of the network?		
SE 59: CW is supported in the PSTN/PLMN part of the network?		
SE 60: ECT is supported in the PSTN/PLMN part of the network?		
SE 61: MCID is supported in the PSTN/PLMN part of the network?		
SE 61A: Call completion is supported in the PSTN/PLMN part of the network?		
SE 62: SUB is supported in the PSTN/PLMN part of the network?		
SE 63: UUS is supported in the PSTN/PLMN part of the network?		
SE 64: TP is supported in the PSTN/PLMN part of the network?		
DTMF transmission		
SE 65: The network supports DTMF transmission in the RTP stream?		
SE 65: The network supports DTMF transmission indicating in the SDP offer in the RTP stream?		
SE 67: The network supports DTMF transmission by the SIP INFO/NOTIFY method for DTMF tone generation?		

Appendix I

The current standards, guidelines and other documents related to VoLTE interconnection

(This appendix does not form an integral part of this Recommendation.)

Currently, the interconnection issue of VoLTE-based networks is an issue of interconnection/interworking of IMS platforms used for service sessions control. This topic is under study in different standardization organizations and alliances of operators. Among others there are the following key organizations involved to this activity: 3GPP, ETSI, ITU and GSMA.

For the time being there are some documents and standards which might be considered for understanding the current state of this issue.

I.1 GSMA

Nowadays GSMA as an alliance of mobile operators, which aims to provide recommendations on how to build in IMS interconnection, and is developing some guidelines and temporary documents.

One such document is [b-GSMA PRD IR.92] which defines a profile that identifies a minimum mandatory set of features which are defined in 3GPP specifications that a wireless device (the user equipment (UE)) and network are required to implement in order to guarantee an interoperable, high quality IMS-based telephony service and IMS-based and SGs-based short message service (SMS) over long-term evolution (LTE) radio access.

NOTE 1 – [b-GSMA PRD IR.92] defines a minimum set of basic call and supplementary services. It refers to relevant 3GPP standards and sometimes provides additional text selecting a given option in the 3GPP documents.

[b-GSMA PRD IR.65] gives common guidelines for IMS (IP multimedia subsystem as specified by 3GPP) inter-operator connections in order to prevent non-interoperable and/or inefficient IMS services and networks. Areas covered are IMS specific issues in roaming and interworking, addressing of users and network elements, routing of traffic, inter-operator related security issues, IP version usage and requirements for inter-PLMN backbone caused by IMS, and the document concentrates on the network level issues.

NOTE 2 – The common role of this document is to provide guideline for operators on how to establish inter-service provider connections using IMS platforms. It focuses on the requirements for the inter-service provider IP backbone network in terms of IMS interconnection. Also, it is mentioned that higher level issues like service interconnection, network (PSTN) as well as layer 3 (IP) connections between IMS network elements and terminals/applications are not within the scope of this document.

[b-GSMA PRD IR.88] aims to provide a standardized view on how long-term evolution (LTE) and evolved packet core (EPC) networks can interwork in order to provide "Next Generation Mobile Network" capabilities when users roam onto a network different from their HPMN. The document describes the interface S8 between the HPMN and VPMN. It is mentioned that the PMIP protocol will not be maintained for the S8 roaming interface, only the GTP protocol is used for this interface.

NOTE 3 – In general this document focuses on establishing scenarios for LTE and EPC roaming over 3GPP access. Roaming from non-3GPP access is not supported in this version of the document.

Also, GSMA started working on developing a dedicated IP exchange network (IPX) with its main objective to create a basic IP-based core network for establishing interconnection among IMS-based networks used for providing VoLTE/ViLTE services.

In this regard, GSMA is developing guidelines on the implementation of IPX and a relevant numbering system (ENUM) used for providing such VoLTE/ViLTE services. [b-GSMA PRD IR.67] describes a structure and delegation model of Carrier ENUM on the GRX/IPX network.

NOTE 4 – There are no agreements among operators on how to implement the ENUM infrastructure for VoLTE/ViLTE-based networks.

Another GSMA guideline, [b-GSMA PRD IR.34] focuses on the requirements for an IPX network which can be used for IMS interworking, according to [b-GSMA PRD IR.65] mentioned above.

NOTE 5 – There are no requirements for signalling protocols and interfaces used for roaming scenarios.

I.2 ITU

ITU-T has started working on SIP-IMS standardization due to the fact that IMS is also widely used on fixed networks. It was considered that the direct "IP-IP" interconnection of fixed network operators using the IP multimedia subsystem (IMS) through Inter-IMS network to network interface (NNI) is a complex issue due to differences in IMS implementations.

Addressing this challenge, fixed network operators have initiated a session initiation protocol – IMS (SIP-IMS) standardization plan in ITU-T Study Group 11 (Protocols and test specifications). The plan includes a set of ITU-T Recommendations and related test specifications to provide a unified international reference for the implementation of SIP-IMS on fixed networks.

More details about this activity is available on the relevant ITU web page.

NOTE – These services may also be used on VoLTE/ViLTE-based networks.

Bibliography

[b-GSMA PRD IR.34] GSMA PRD IR.34, *Guidelines for IPX Provider networks*.

[b-GSMA PRD IR.65] GSMA PRD IR.65, *IMS Roaming and Interworking Guidelines*.

[b-GSMA PRD IR.67] GSMA PRD IR.67, *DNS and ENUM guidelines for service providers and GRX and IPX providers*.

[b-GSMA PRD IR.88] GSMA PRD IR.88, *LTE and EPC Roaming Guidelines*.

[b-GSMA PRD IR.92] GSMA PRD IR.92, *IMS Profile for Voice and SMS*.

[b-GSMA PRD IR.94] GSMA PRD IR.94, *IMS Profile for Conversational Video Service*.

[b-GSMA PRD NG.105] GSMA PRD NG.105, *ENUM Guidelines for Service Providers and IPX Providers*.

[b-RFC 3550] RFC 3550 (2003), *RTP: A Transport Protocol for Real-Time Applications*.

[b-RFC 3761] RFC 3761 (2004), *The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM)*.

[b-ETSI TS 123 002] ETSI TS 123 002 V12.7.0 (07/2015), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunication System (UMTS); LTE; Network architecture (3GPP TS 23.0.002 version 12.7.0 Release 12)*.

[b-ETSI TS 123.228] ETSI TS 123.228 V10.9.0 (07/2015), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; IP Multimedia Subsystem (IMS); Stage 2 (3GPP TS 23.228 version 10.9.0 Release 10)*.

[b-ETSI TS 129.235] ETSI TS 129 235 V10.3.0 (2013-09), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Interworking between SIP-I based circuit-switched core network and other networks (3GPP TS 29.235 version 10.3.0 Release 10)*.

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