

RCS VoLTE Interoperability Event 2012

Testing Scenarios

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Abstract:

This document describes a set of physical scenarios to test the interoperability between key components of the LTE/EPC architecture and IMS service layer as part of a RCS VoLTE interoperability event. The interfaces to be tested are specified (in terms of references to the appropriate 3GPP specifications) within this document such that additional implementation agreements for the individual interfaces need not be created. The tests cases are described at a high level, more detailed test plans will be created from these.

RCS VoLTE Interoperability Event 2012

1 Introduction

The RCS VoLTE architecture is based on GSMA's recommendations IR.65 "IMS Roaming & Interworking Guidelines", IR.88 "LTE Roaming Guidelines", IR.90 "RCS Interworking Guidelines" and IR.92 "IMS Profile for Voice and SMS", IR.94 "IMS Profile for Conversational Video Service", IR.58 "IMS Profile for Voice over HSPA".

Different versions of RCS Services and Client Specifications are valid to be tested with this architecture, i.e."RCS-e – Advanced Communications: Services and Client Specification: Version 1.2.1" and "Rich Communication Suite 5.0 Advanced Communications: Services and Client Specification".

The GSMA recommendations are based on the 3GPP defined architecture for Long Term Evolution (LTE), Evolved Packet Core network (EPC), and the IMS Core Network.

- **Radio Access Network**. The Evolved Universal Terrestrial Radio Access Network (E-UTRAN); this is often referred to as 3G Long Term Evolution (LTE).
- **Core Network.** The Evolved Packet Core (EPC), this is often referred to as the System Architecture Evolution (SAE).
- **IMS Core Network.** The IMS Core Network within the VoLTE architecture provides the service layer for providing Multimedia Telephony and RCS services.

The figure below shows the main components of the VoLTE/RCS architecture in the non-roaming configuration.

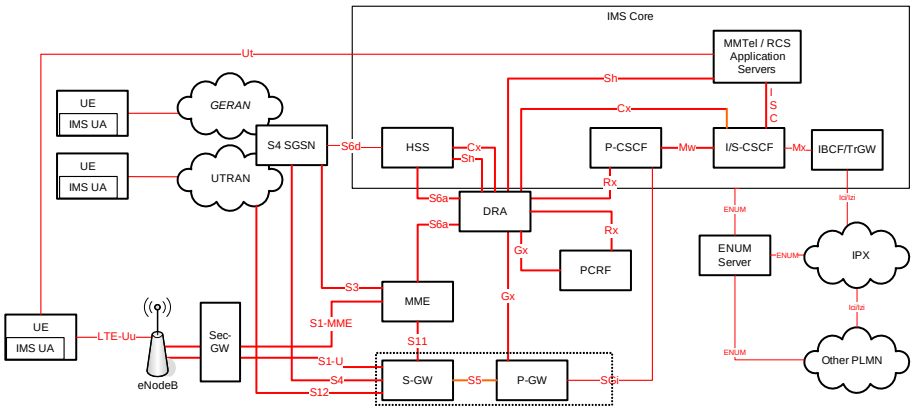

Figure 1 – RCS VoLTE Architecture

The main components of the Architecture are described below.

- **UE (User Equipment)**. The User Equipment that is used to connect to the EPS, in the figure above this is an LTE capable UE accessing EPS via the LTE-Uu radio interface.

- **eNodeB.** The evolved RAN (E-UTRAN) consists of a single node, the eNodeB that interfaces with the UE. The eNodeB hosts the Physical (PHY), Medium Access Control (MAC), Radio Link Control (RLC), and Packet Data Convergence Protocol (PDCP) layers that include the functionality of user-plane header-compression and encryption. It also offers Radio Resource Control (RRC) functionality corresponding to the control plane. It performs many functions including radio resource management, admission control, scheduling, enforcement of

negotiated UL QoS, cell information broadcast, ciphering/deciphering of user and control plane data, and compression/decompression of DL/UL user plane packed headers.

- **MME (Mobility Management Entity)**. The Mobility Management Entity (MME) is the key control-node for the LTE access-network. It is responsible for idle mode UE tracking and paging procedures including retransmissions. It is involved in the bearer activation / deactivation process and is also responsible for choosing the S-GW (see below) for the UE at the initial attach and at time of intra-LTE handover involving Core Network node relocation. It is responsible for authenticating the user (in conjunction with the HSS). The NAS (Non-Access Stratum) signalling terminates at the MME which is also responsible for the generation and allocation of temporary identities to the UEs. The MME validates the permission of the UE to camp on the service provider's PLMN (Public Land Mobile Network) and enforces UE roaming restrictions. The MME is the termination point in the network for ciphering/integrity protection for NAS signalling and handles security key management. Lawful interception of signalling is also a function provided by the MME. The MME provides the control plane function for mobility between LTE and 2G/3G access networks and interfaces with the home HSS for roaming UEs.

- **S-GW (Serving Gateway).** The S-GW routes and forwards user data packets, while also acting as the mobility anchor for the user plane during inter-eNodeB handovers and as the anchor for mobility between LTE and other 3GPP technologies (terminating S4 interface and relaying the traffic between 2G/3G systems and PDN GW). For idle state UE, the S-GW terminates the DL data path and triggers paging when the DL data arrives for the UE. It manages and stores UE contexts and performs replication of the user traffic in case of lawful interception. It is likely that the S-GW and P-GW functions would be realized as a single network element.

- **P-GW (Packet Data network GateWay).** The P-GW provides connectivity between the UE and external packet data networks, it provides the entry and exit point of traffic for the UE. A UE may have simultaneous connectivity with more than one P-GW for accessing multiple Packet Data Networks. The P-GW performs policy enforcement, packet filtering for each user, charging support, lawful interception and packet screening. The P-GW also acts as the anchor for mobility between 3GPP and non-3GPP technologies such as WiMAX or DSL. It is likely that the S-GW and P-GW functions would be realized as a single network element.

- **PCRF (Policy Charging and Rules Function).** The PCRF provides policy control decisions and flow based charging controls. The PCRF determines how a service data flow shall be treated in the enforcement function (P-GW in this case) and ensure that the user plane traffic mapping and treatment is in accordance with the user's profile.

- **HSS (Home Subscriber Server).** The HSS is a network database that holds both static and dynamic data elements related to subscribers. The HSS provides user profile information to the MME during user authentication.

- **S4-SGSN (Serving GPRS Support Node).** The SGSN supports the legacy access for UTRAN and GERAN. In the EPS architecture (3GPP release 8) the SGSN is enhanced to support the S4 and S3 interfaces (hence referred to as the S4 SGSN). The S4 interface provides control and mobility support between GPRS Core and the 3GPP Anchor function of the Serving GW. The S3 interface enables user and bearer information exchange for inter 3GPP access network mobility.

- **P-CSCF (Proxy Call Session Control Function).** The P-CSCF is the initial point of contact for session signaling for the IMS-enable VoLTE UE. The P-CSCF behaves as a SIP proxy by forwarding SIP messages the UE and the IMS Core Network, maintains the security associations between itself and the VoLTE UE, incorporates the Application Function aspect

of PCC to enable binding of the IMS session with the bearer for applying dynamic policy and receiving notifications of bearer level events.

- **I/S-CSCF (Interrogating/Serving Call Session Control Function).** The I-CSCF is the contact point within an operator's network for all connections destined to a user of that network. On IMS Registration, it interrogates the HSS to determine which suitable S-CSCF to route the request for registration. For Mobile Terminating calls, it interrogates the HSS to determine which S-CSCF the user is registered on.
  The S-CSCF provides session set-up, session tear-down, session control and routing functions. It generates records for billing purposes for all sessions under its control, and invokes applications using Application Servers. The S-CSCF acts as SIP registrar for VoLTE UE's that the HSS and I-CSCF assign to it. It queries the HSS for the applicable subscriber profiles and handles calls involving these end points once they have been registered. The S-CSCF uses subscription information to determine the appropriate onward routing for calls originating through it.

- **MMTel AS (Multimedia Telephony Application Server).** The MMTel AS is an IMS Application Server providing support for multimedia telephony services as defined by 3GPP e.g. supplementary service functionality.

- **IBCF/TrGW (Interconnection Border Control Function / Transition Gateway).** The IBCF/TrGW is responsible for the control/media plan at the network interconnect point to other PLMNs.

- **RCS ASs .** The RCS Application Servers provide support for RCS related services and comprise the following elements :-
  - Presence Server & XDM Server,
  - IM / Chat Server,
  - Video Share Application Server.

- **Sec-GW (Security Gateway).** The Sec-GW is used to originate and terminate secure associations between the eNodeB and the Evolved Packet Core network. IPsec tunnels are established with pre-shared security keys, which can take a number of different formats. IPsec tunnels enforce traffic encryption, for added protection, according to the parameters exchanged between the two parties during tunnel setup. This enables secure communications between the eNodeB and EPC across the S1-MME, S1-U and X2 interfaces.

- **DRA (Diameter Routing Agent).** The Diameter Routing Agent defined by 3GPP and GSMA, is a new network element that controls Diameter signalling, enabling the seamless communication and control of information between network elements within LTE or IMS networks and across LTE network borders. A DRA reduces the mesh of Diameter connections that negatively impacts network performance, capacity and management.

- **ENUM Server**. This element provides a database functionality to enable translation of E164 numbers to domain names to enable message routing of IMS sessions. In the above figure, a single ENUM Server is shown that is accessible from either PLMN as well as IPX.

- **IPX.** This is the IP-Exchange transit network providing an interconnect capability between PLMNs.

The main interfaces of the Architecture are described below.

- **LTE-Uu**. The radio interface between the eNodeB and the User Equipment. Interoperability of this interface is out of scope for the scenarios described in this document and is covered by the work of other organizations, principally LSTI (www.lstiforum.org).

- **S1-MME**. The control plane interface between EUTRAN and MME. The protocols used over this interface are the Non-access stratum protocols (NAS).

- **S1-U.** The interface between EUTRAN and the S-GW for per-bearer user plane tunnelling and inter-eNodeB path switching during handover. The transport protocol over this interface is GPRS Tunnelling Protocol-User plane (GTPv1-U).

- **S3**. The interface between the S4-SGSN and the MME enabling user and bearer information exchange for inter 3GPP access network mobility. The protocol used on the S3 interface is GPRS Tunnelling Protocol-Control plane (GTPv2-C).

- **S4.** The interface between the S4-SGSN and the S-GW providing user plane and related control and mobility support. The protocols used on the S4 interface are GPRS Tunnelling Protocol-Control plane (GTPv2-C) and is GPRS Tunnelling Protocol-User plane (GTPv1-U).

- **S5**. The interface provides user plane tunnelling and tunnel management between S-GW and P-GW. It is envisaged that the S-GW and P-GW may be realized as single network element in which case the S5 interface is not exposed. For the test scenarios described within this document. The protocol used on the S5 interface is GTPv1-U/GTPv2-C.

- **S6a**. The interface enables the transfer of subscription and authentication data for authenticating/authorizing user access. The protocol used on the S6a interface is Diameter.

- **S10**. The interface provides for MME – MME information transfer and is used to enable MME relocation. The protocol used on the S10 interface is GPRS Tunnelling Protocol-Control plane (GTPv2-C).

- **S11.** The interface between the MME and S-GW. The protocol used on the S11 interface is GPRS Tunnelling Protocol-Control plane (GTPv2-C).

- **S12**. The interface between the legacy UTRAN and the S-GW for user plane tunnelling when direct tunnel is established. The protocol used on the S12 interface is GPRS Tunnelling Protocol-User plane (GTPv1-U). Usage of the S12 interface is an operator configuration option.

- **Gx.** The interface between the PCRF and the P-GW, allowing the PCRF direct control over the policy enforcement functions of the P-GW. The protocol used on the Gx interface is Diameter.

- **Rx.** The interface between the appropriate Application Function (the P-CSCF in the case of IMS) and the PCRF allowing the Application Function to request the application of an appropriate policy for a session. The protocol used on the Rx interface is Diameter.

- **SGi.** The interface between the P-GW and the Packet Data Network which can be an operator external public or private packet data network or an intra operator packet data network (e.g. for provision of IMS services). In particular , the Gm reference point from the UE to P-CSCF is tunnelled within SGi.

- **Cx.** The interface between the I/S CSCF and HSS to enable IMS registration and passing of subscriber data to the S-CSCF. The protocol used on the Cx interface is Diameter.

- **Sh.** The interface between the IMS Application Server(s) and HSS to service related to be passed to the Application Server. The protocol used on the Sh interface is Diameter.

- Mx. Interface between CSCF and IBCF used for the interworking with another IMS network. The protocols used on the Mx interface are SIP and SDP.
- Mw. Interface between a CSCF and another CSCF. The protocols used on the Mw interface are SIP and SDP.
- ISC. Interface between S-CSCF and AS.the protocol used on the ISC interface is SIP.
- Ici Interface between an IBCF and another IBCF or I-CSCF belonging to a different IMS network. The protocols used on the Ici interface are SIP and SDP.
- Izi. Interface between a TrGW and another TrGW or media handling node belonging to a different IMS network. The protocols used on th Izi interface are RTP and MSRP.

1.1 Test Scenarios

This clause describes the scenarios that have been selected to test the interoperability of the key interfaces of the RCS VoLTE architecture. In all cases, it is intended (where possible) to limit multi-vendor interoperability testing to those interfaces that reflect real world deployment scenarios – i.e. it is intended to test configurations involving likely/typical single vendor blocks of network elements thereby limiting the interfaces to be tested to those between such single vendor blocks. Typical groupings would be :-

- UE,
- eNB
- EPC (MME, S-GW, P-GW),
- IMS core (P-CSCF, I/S-CSCF, HSS, Application Servers),
- Border Gateway elements (IBCF/TrGW and P-CSCF),

The scenarios are as follows :-

Home/Single Network. In this scenario a single instance of the RCS VoLTE architecture will be created using components from different vendors. Testing will include attachment and detachment from the network, Tracking Area Update, IPCAN session establishment, SIP registration (to IMS), SIP session establishment, interaction with IMS Multimedia Telephony, IMS Conversational Video Services and RCS services. This scenario focuses on testing interoperability of the functionality as profiled by GSMA PRDs IR.92, IR.94, IR.90, IR.67 and the RCS Services and Client Specification.

Roaming & Interconnect. In this scenario, the local breakout model with visited P-CSCF and home operator applications is tested. The test set will be the same as for the home/single network case, plus some roaming specific tests to demonstrate mapping of QCI values between the home/visited network where there is a misalignment.. This scenario focuses on testing interoperability of the functionality as profiled by GSMA PRDs IR.65, IR 88, IR.92, IR.94, IR.90, IR,67 and the RCS Services and Client Specification. In addition, an IPX provides the interconnect network between the 2 PLMNs.

Non-LTE Access. In this scenario, the 'legacy' 3GPP access types of UMTS (UTRAN) and GSM/EDGE (GERAN) are used to interface to the EPC. The test set will include attachment, IMS registration and IMS session establishment and teardown.

Handover. This scenario builds on the previous one and tests the a number of handover scenarios. This will include intra-LTE handover (between eNodeBs, MME/S-GW relocation) and handover between LTE and legacy 3GPP (UMTS, GSM/EDGE) access.

Inter-RAT Priority Call Handover. In this scenario the handover of priority voice calls between LTE and other RATs is tested. The scenario tests that voice calls originating as Multimedia Priority Service (MPS) VoLTE calls have relevant priority markings mapped properly when those calls are handed over to another Radio Access Technology (RAT) and the CS-domain and vice versa.

2 Testing Scenarios

2.1 Scenario 1 – RCS VoLTE in Home/Single Network

The architecture for this scenario is shown in the figure below. The interfaces for which interoperability will be tested are shown in red. In some circumstances it may be necessary to interoperate multiple of the interfaces together rather than in isolation.

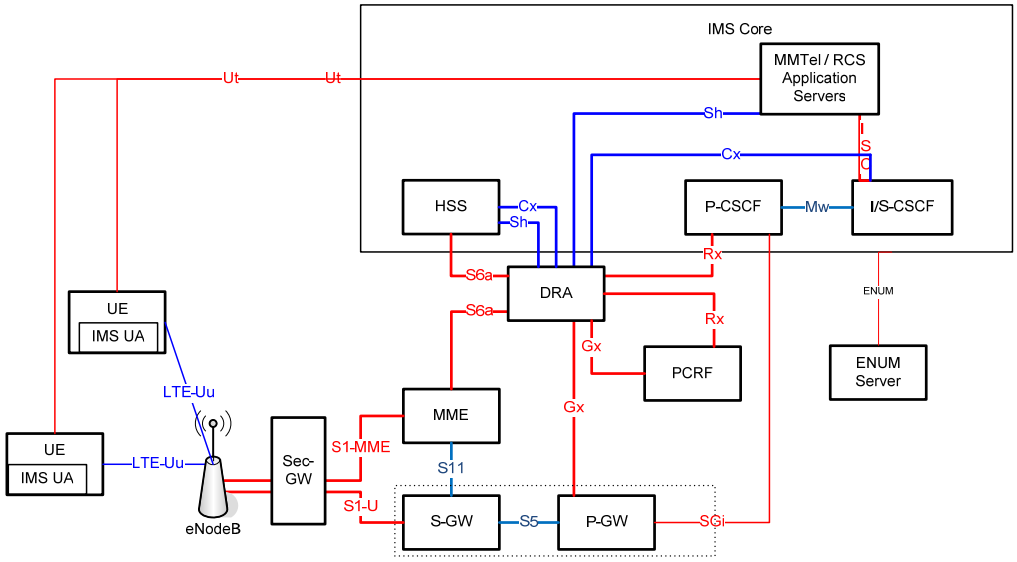

Figure 2 - Scenario 1 – Home/Single Network IMS/RCS Services

NOTE: The Gm interface (UE to P-CSCF) is a focus for testing although not shown in the above figure.

2.1.1 Network Components

2.1.1.1 Scenario 1

The following components are required for this scenario.

- Two LTE UE's with IMS User Agents
- One eNodeB
- One MME
- One S-GW
- One P-GW
- One PCRF
- One HSS
- One P-CSCF
- One I/S-CSCF
- One MMTel Application Server
- One Presence Server / XDM
- One IM/Chat Server
- One Video Share Application Server

- One Sec-GW
- One DRA

2.1.2 Protocols and Reference Points

The following reference points will be interoperated in this scenario.

Interface	Protocol	Sub Scenario
S1-MME	NAS	1a
S1-U	GTPv1-U	1a
S6a	Diameter	1a
Gx	Diameter	1
Rx	Diameter	1
Gm	IMS SIP	1
Mw	IMS SIP	1
ISC	IMS SIP	1
Ut	XCAP	1b, 1c
ENUM	ENUM	1

2.1.3 Test Cases

This scenario focuses on functionality profiled within GSMA PRDs IR.92, IR.94, IR.90 and the RCS Services and Client Specification. Furthermore, it has been decided to split the scenario into 4 sub-scenarios as described below to enable a more logical grouping of the required tests.

2.1.3.1 Scenario 1a

This sub-scenario focuses on attachment & IMS registration procedures that are common for VoLTE & RCS.

- LTE UE Attach (IP-CAN Session Establishment)
- Tracking Area Update
- LTE UE Detach (IP-CAN Session Tear Down)
- IMS UA Registration (via LTE UE)

2.1.3.2 Scenario 1b

This sub-scenario focuses on VoLTE services.

- IMS Voice Session Establishment (LTE UE to LTE UE)
- IMS Voice Session Termination
- MMTel Supplementary Service Interaction and Configuration

2.1.3.3 Scenario 1c

This sub-scenario focuses on RCS services, both standalone and with a parallel voice session

- Presence Management
- RCS Capabilities Exchange
- IM/Chat
- Picture / File Share
- Video Share
- Rich Call (RCS services during a voice call)
  - IM/Chat during a voice call,
  - Picture/File share during a voice call
  - Video share during a voice call.

2.1.3.4 Scenario 1d

This sub-scenario focuses on voice and video services

- IMS Voice/Video Session Establishment (LTE UE to LTE UE) with video stream set up in parallel to the voice stream.
- IMS Voice/Video Session Establishment (LTE UE to LTE UE) with video stream set up subsequent to an existing voice stream.
- IMS Voice/Video Session Termination

2.2 Scenario 2 – RCS VoLTE Roaming & Interconnect

This scenario covers roaming and interconnect scenarios for RCS/VoLTE. There are three configurations :-

i) where two subscribers, of the same home PLMN, perform an end to end call whilst one subscriber is in the HPLMN and the other is roaming in a VPLMN,

ii) the two subscribers have different home PLMNs attach via the same access network (one subscriber at home, one roaming) and perform an end to end call,

iii) Each subscriber belongs to a different PLMN and they both stay in their home PLMN from where they perform an end to end call (i.e. a pure interconnect scenario).

For the roaming cases, the roaming subscriber attaches in the visited network where local breakout is applied, via a Visited P-CSCF and home IMS/RCS services as depicted in Figures 3 & 4.

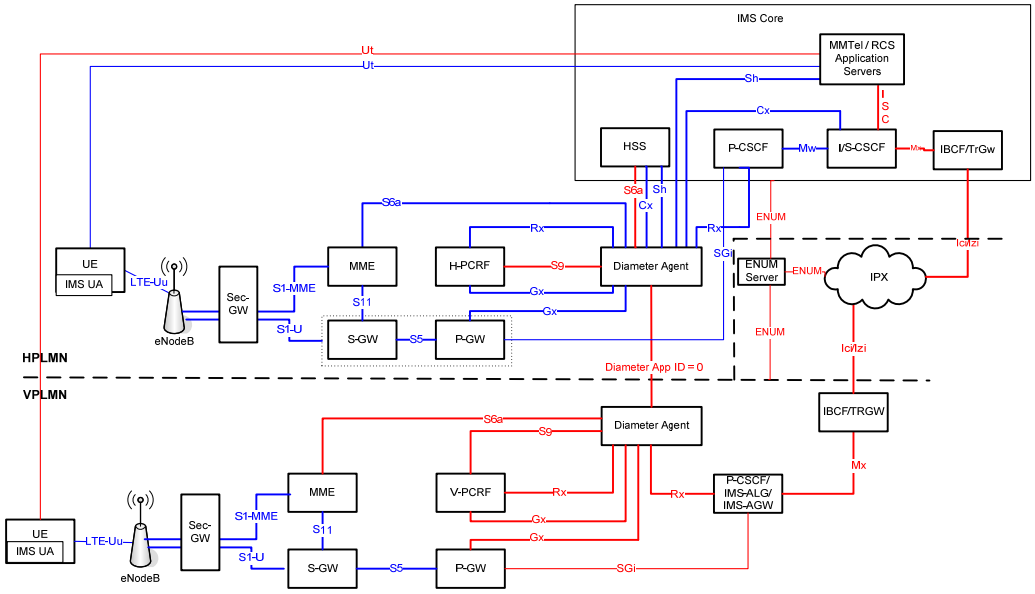

Figure 3 - Scenario 2 Config I - Roaming (same home PLMN)

NOTE: The Gm interface (UE to P-CSCF) is a focus for testing although not shown in the above figure.

NOTE: The IBCF/TrGW may be a single physical node, or two separate nodes utilising the Ix Interface. Although, Ix is not within scope of testing.

NOTE: The P-CSCF and IBCF/TrGw may be located in a single physical node.

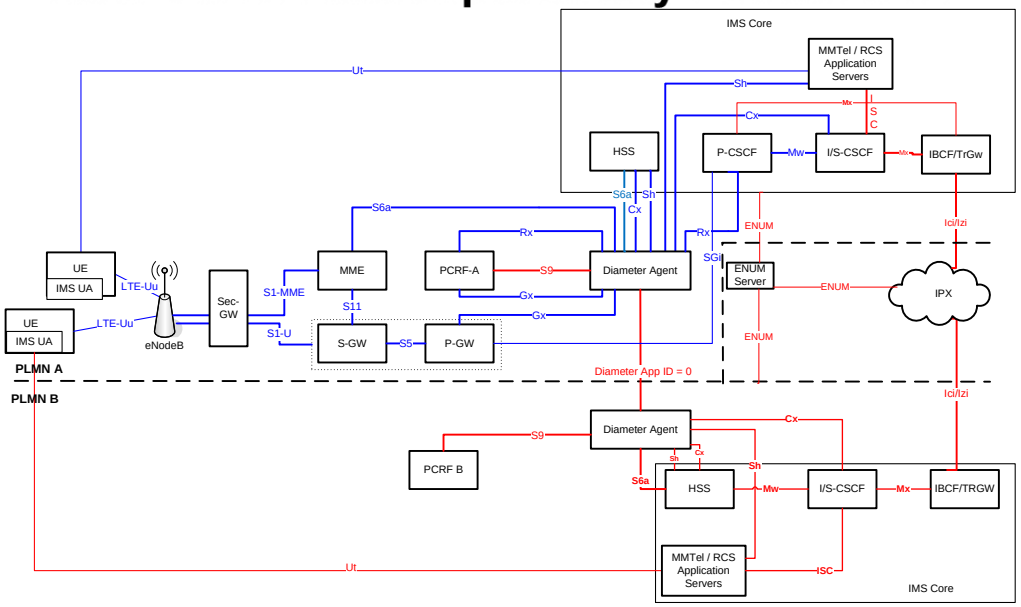

Figure 4 - Scenario 2 Config II - Roaming (Different home PLMNs)

NOTE: The Gm interface (UE to P-CSCF) is a focus for testing although not shown in the above figure.

NOTE: The IBCF/TrGW may be a single physical node, or two separate nodes utilising the Ix Interface. Although, Ix is not within scope of testing.

NOTE: The P-CSCF and IBCF/TrGw may be located in a single physical node.

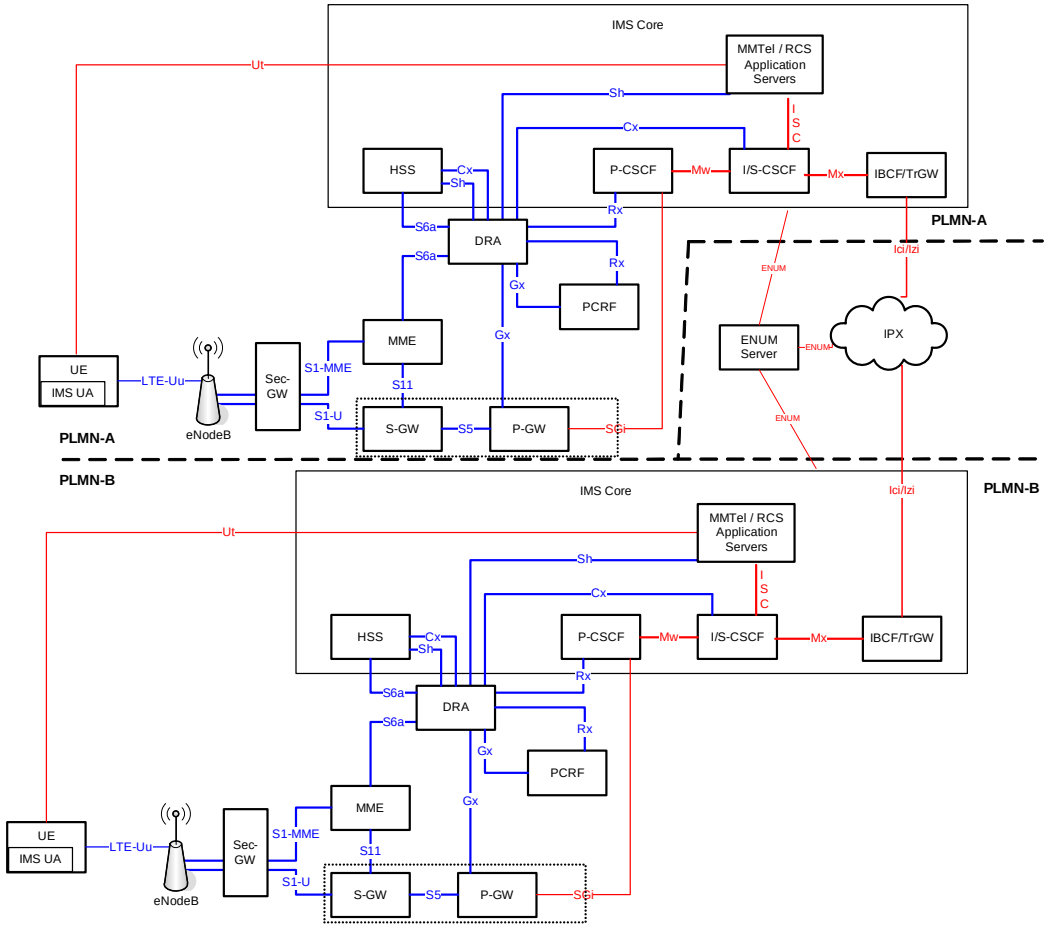

Figure 5 - Scenario 2 Config III - Interconnect between two subscribers in their Home PLMNs

NOTE: The Gm interface (UE to P-CSCF) is a focus for testing although not shown in the above figure.

NOTE: The IBCF/TrGW may be a single physical node, or two separate nodes utilising the Ix Interface. Although, Ix is not within scope of testing.

NOTE: The P-CSCF and IBCF/TrGw may be located in a single physical node.

2.2.1 Network Components

2.2.1.1 Scenario 2 Config I

In the Home Network (PLMN A)

- One LTE UE with IMS User Agent
- One eNodeB
- One MME
- One S-GW
- One P-GW
- One PCRF
- One DRA

- One HSS
- One P-CSCF
- One I/S-CSCF
- One IBCF/TrGW
- One MMTel Application Server
- One Presence Server / XDM
- One IM/Chat Server
- One Video Share Application Server
- One Sec-GW

In the Visited Network (PLMN B)

- One LTE UE with IMS User Agent
- One eNodeB
- One MME
- One S-GW
- One P-GW
- One PCRF
- One P-CSCF/IMS-ALG/IMS-AGW
- One IBCF/TrGW
- One DRA
- One Sec-GW

In the Interconnect Network

- One ENUM Server (logically partitioned to serve each IMS network)
- One IPX Provider

2.2.1.2 Scenario 2 Config II

In PLMN A

- Two LTE UEs with IMS User Agent (one roaming from PLMN B)
- One eNodeB
- One MME
- One S-GW
- One P-GW
- One PCRF
- One DRA
- One HSS
- One P-CSCF
- One I/S-CSCF
- One IBCF/TrGW
- One MMTel Application Server
- One Presence Server / XDM
- One IM/Chat Server
- One Video Share Application Server
- One Sec-GW

In PLMN B

- One PCRF
- One DRA
- One HSS
- One I/S-CSCF
- One IBCF/TrGW

- One MMTel Application Server
- One Presence Server / XDM
- One IM/Chat Server
- One Video Share Application Server

In the Interconnect Network

- One ENUM Server (logically partitioned to serve each IMS network)
- One IPX Provider

2.2.1.3 Scenario 2 Config III

In the PLMN-A

- One LTE UE with IMS User Agent
- One eNodeB
- One MME
- One S-GW
- One P-GW
- One PCRF
- One P-CSCF
- One HSS
- One I/S-CSCF
- One MMTel Application Server
- One Presence Server / XDM
- One IM/Chat Server
- One Video Share Application Server
- One IBCF/TrGW
- One Sec-GW
- One DRA

In the PLMN-B

- One LTE UE with IMS User Agent
- One eNodeB
- One MME
- One S-GW
- One P-GW
- One PCRF
- One P-CSCF
- One HSS
- One I/S-CSCF
- One MMTel Application Server
- One Presence Server / XDM
- One IM/Chat Server
- One Video Share Application Server
- One IBCF/TrGW
- One Sec-GW
- One DRA

In the Interconnect Network

- One IPX Service Provider
- One ENUM Server

2.2.2 Protocols and Reference Points

The following reference points will be interoperated in this scenario.

Interface	Protocol	Sub-Scenarios
S6a	Diameter	2
S9	Diameter	2
Rx	Diameter	2
Gx	Diameter	2
Gm	IMS SIP	2
Mw, Mw, Ici	IMS SIP	2
Izi	RTP, MSRP	2
ISC	IMS SIP	2
Ut	XCAP	2b, 2c
ENUM	ENUM	2

2.2.3 Test Cases

This scenario focuses on functionality profiled within GSMA PRDs IR.88, IR.92, IR.94, IR.90 and the RCS Services and Client Specification. Furthermore, as for scenario 1, it has been decided to split the scenario into 4 sub-scenarios as described below to enable a more logical grouping of the required tests.

2.2.3.1 Scenario 2a

This sub-scenario focuses on attachment & IMS registration procedures that are common for VoLTE & RCS. These tests are applicable to config I & II (roaming) only.

- LTE UE Attach in Visited Network (IP-CAN Session Establishment)
- LTE UE Detach in Visited Network (IP-CAN Session Tear Down)
- IMS UA Registration from Visited Network (via LTE UE)

2.2.3.2 Scenario 2b

This sub-scenario focuses on VoLTE services. Applicable to all configurations :-

- IMS Voice Session Establishment (between 2 LTE UEs)
- IMS Voice Session Termination
- MMTel Supplementary Service Interaction and Configuration for LTE UE in Visited Network

Applicable to roaming scenarios :-

- Mapping of QCI values between the home/visited networks (where there is misalignment)

2.2.3.3 Scenario 2c

This sub-scenario focuses on RCS services, both standalone and with a parallel voice session. Applicable to all configurations.

- Presence Management
- RCS Capabilities Exchange
- IM/Chat
- Picture / File Share
- Video Share
- Rich Call (RCS services during a voice call)
  - IM/Chat during a voice call,

- Picture/File share during a voice call
- Video share during a voice call.

2.2.3.4 Scenario 2d

This sub-scenario focuses on voice and video services. Applicable to all configurations.

- IMS Voice/Video Session Establishment (between 2 LTE UEs) with video stream set up in parallel to the voice stream.
- IMS Voice/Video Session Establishment (between 2 LTE UEs) with video stream set up subsequent to an existing voice stream.
- IMS Voice/Video Session Termination

2.3 Scenario 3 – Non-LTE Access to the EPC

This scenario covers access to the EPC via not-LTE 3GPP access.

The Non-LTE 3GPP Access test case can be realized in two different ways depending upon the compliance or otherwise of the SGSN. Both realizations are covered, as shown below.

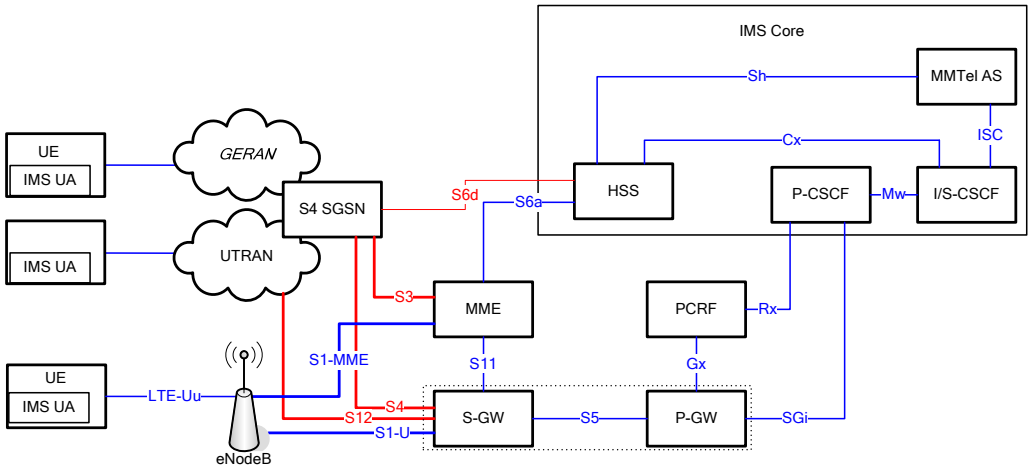

Figure 6 - Scenario 3a. Non LTE 3GPP Access with S4 SGSN

NOTE: Diameter Routing Agent and Security Gateway are not displayed in the figure but are applied to the architecture.

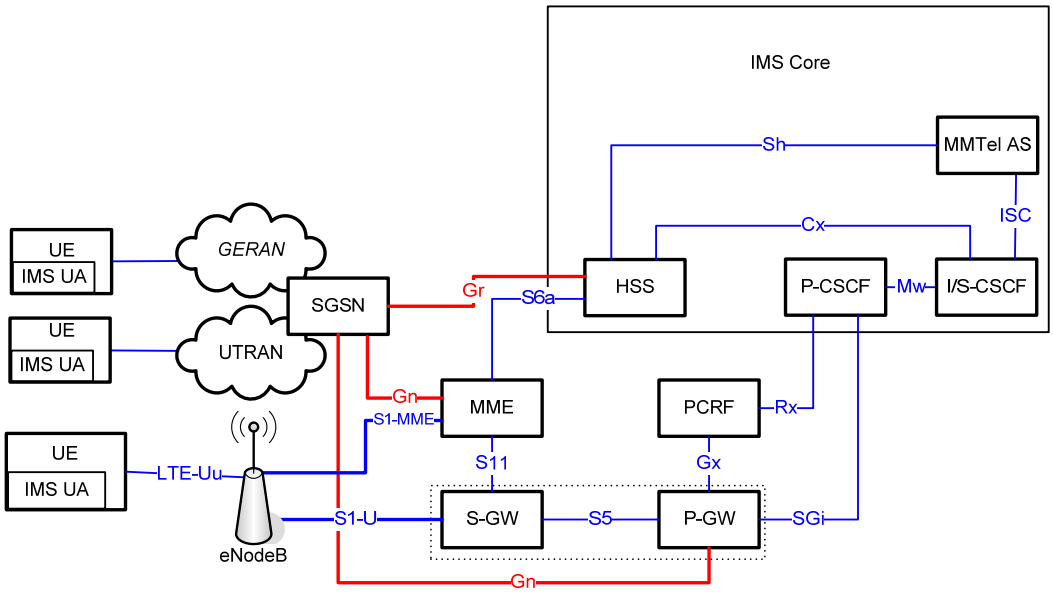

Figure 7- Scenario 3b. Non LTE 3GPP Access with legacy SGSN

NOTE: Diameter Routing Agent and Security Gateway are not displayed in the figure but are applied to the architecture.

2.3.1 Network Components

2.3.1.1 Scenario 3a

- One UTRAN with IMS UA
- One GERAN UE with IMS UA
- One LTE UE with IMS UA
- UTRAN access infrastructure
- GERAN Access Infrastructure
- One eNodeB
- One S4 SGSN
- One MME
- One S-GW
- One P-GW
- One PCRF
- One HSS
- One P-CSCF
- One I/S-CSCF
- One Sec-GW
- One DRA

2.3.1.2 Scenario 3b

- One UTRAN UE with IMS UA
- One GERAN UE with IMS UA
- One LTE UE with IMS UA
- UTRAN access infrastructure
- GERAN access infrastructure
- One eNodeB
- One Legacy SGSN
- One MME
- One S-GW
- One P-GW
- One PCRF
- One HSS
- One P-CSCF
- One I/S-CSCF
- One Sec-GW
- One DRA

2.3.2 Protocols and Reference Points

The following reference points will be interoperated in this scenario.

Interface	Protocol	Sub-Scenarios
S3	GTPv2-C	3a
S4	GTPv2-C (control plane) / GTPv1-U (user plane)	3a
S6d	Diameter	3a
S12	GTPv1-U	3a
Gr	MAP	3b
Gn	GTPv1	3b

2.3.3 Test Cases

The following tests will be executed for both scenarios in order to verify interoperability of the indicated interfaces between different vendors.

- UTRAN UE Attach (IP-CAN Session Establishment)
- GERAN UE Attach (IP-CAN Session Establishment)
- UTRAN UE Detach (IP-CAN Session Tear Down)
- GERAN UE Detach (IP-CAN Session Tear Down)
- IMS UA Registration (via UTRAN UE)
- IMS UA Registration (via GERAN UE)
- IMS Voice Session Establishment (combination of GERAN, UTRAN and LTE UE's)
- IMS Voice Session Termination (combination of GERAN, UTRAN and LTE UE's)

NOTE: For UE's attached to HSPA (High-Speed Packet Access) radio access, this scenario focuses on functionality profiled within GSMA PRDs IR.58.

2.4 Scenario 4 – Intra-LTE and LTE <-> 2G/3G Handovers

This scenario tests the different handover conditions both with registered terminals and with active sessions. There are three sub-test cases for this scenario, namely scenario 5a in which a Handover occurs intra-LTE, scenario 5b in which a Handover occurs to/from LTE to 2G/3G access using an S4-SGSN, and scenario 5c in which a Handover occurs to/from LTE to 2G/3G access using a legacy version of the SGSN. The architectures for these scenarios are shown in the figures below.

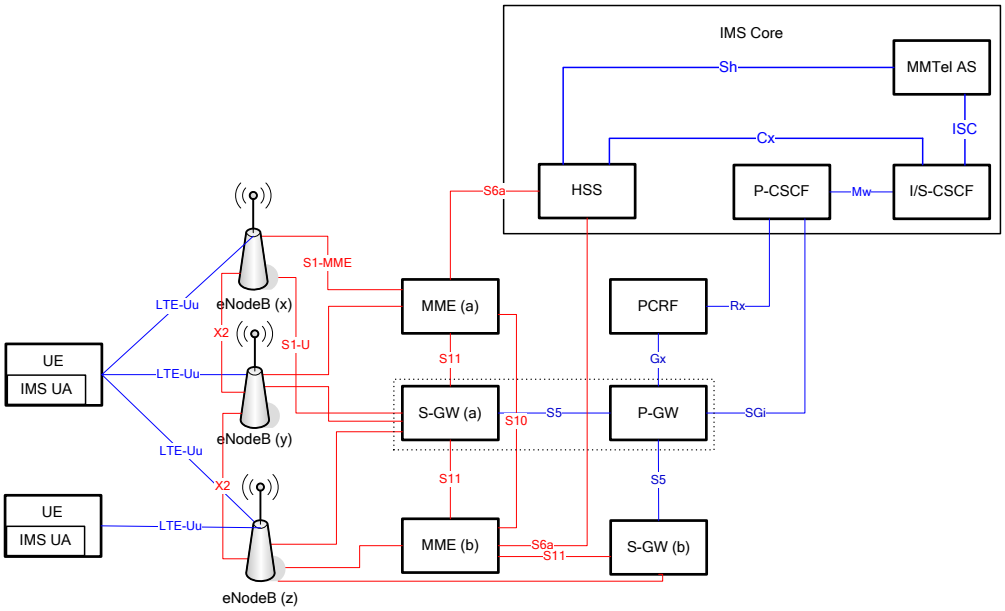

Figure 8 – Scenario 4a. Intra-LTE Handover

NOTE: Diameter Routing Agent and Security Gateway are not displayed in the figure but are applied to the architecture.

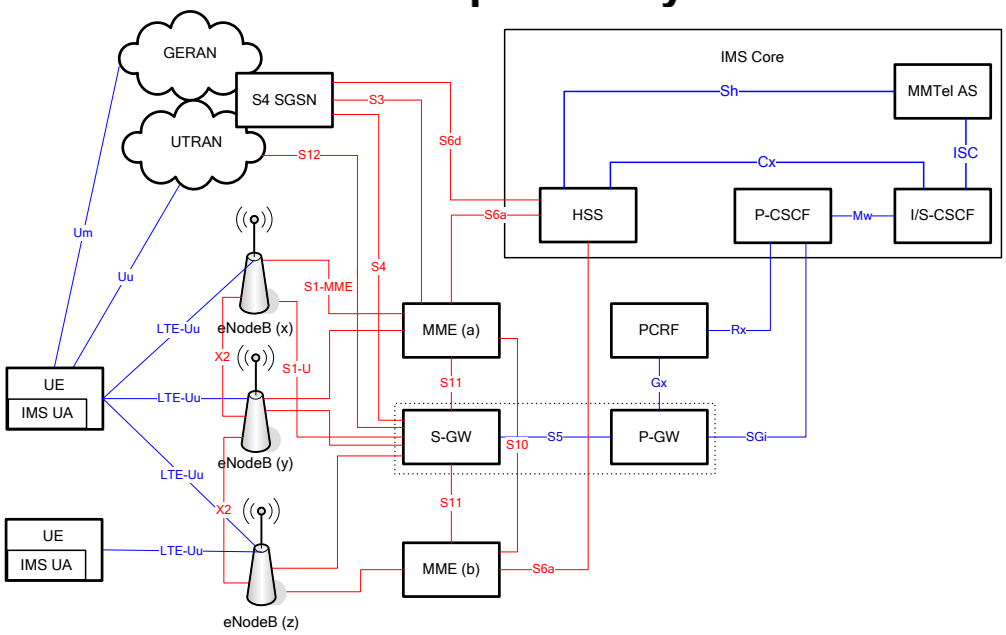

Figure 9 – Scenario 4b. Handovers to from LTE and 2G/3G with S4 SGSN

NOTE: Diameter Routing Agent and Security Gateway are not displayed in the figure but are applied to the architecture.

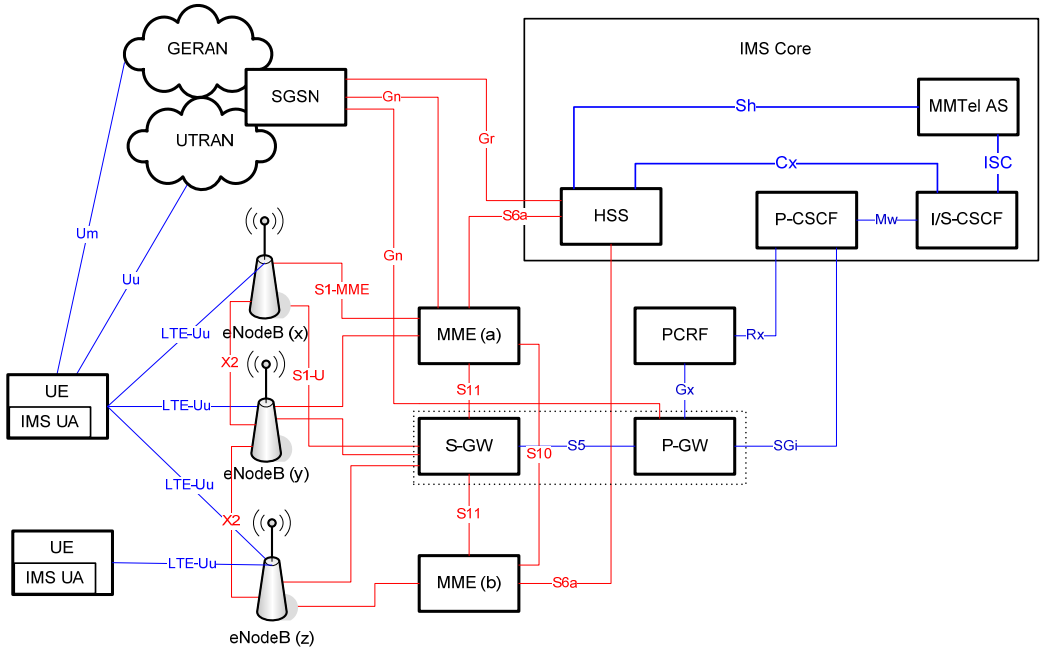

Figure 10 - Scenario 4c. Handovers to/from LTE and 2G/3G with legacy SGSN

NOTE: Diameter Routing Agent and Security Gateway are not displayed in the figure but are applied to the architecture.

2.4.1 Network Components

2.4.1.1 Scenario 4a

- Two LTE UE's with IMS User Agents
- Three eNodeB's
- Two MME
- One S-GW
- One P-GW
- One PCRF
- One HSS
- One P-CSCF
- One I/S-CSCF
- One Sec-GW
- One DRA

2.4.1.2 Scenario 4b

- One Multi-mode (LTE – UTRAN/GERAN) UE
- One IMS UA on the Multi-mode UE
- One LTE UE
- One IMS UA on the LTE UE
- Three eNodeB's
- Two MME
- One S-GW
- One S4 SGSN
- GERAN/UTRAN access infrastructure.
- One P-GW
- One PCRF
- One HSS
- One P-CSCF
- One I/S-CSCF
- One Sec-GW
- One DRA

2.4.1.3 Scenario 4c

- One Multi-mode (LTE – UTRAN/GERAN) UE
- One IMS UA on the Multi-mode UE
- One LTE UE
- One IMS UA on the LTE UE
- Three eNodeB's
- Two MME
- One S-GW
- One Legacy SGSN
- GERAN/UTRAN access infrastructure.
- One P-GW
- One PCRF
- One HSS
- One P-CSCF
- One I/S-CSCF

- One Sec-GW
- One DRA

2.4.2 Protocols and Reference Points

Interface	Protocol	Sub Scenarios
S1-MME	NAS	4a, 4b
S1-U	GTPv1-U	4a, 4b
X2	X2 AP (signalling) / GTPv1-U (user plane)	4a, 4b
S3	GTPv2-C	4a
S4	GTPv2-C (control plane) / GTPv1-U (user plane)	4a
S10	GTPv2-C	4a, 4b
S11	GTPv2-C	4a, 4b
S12	GTPv1-U	4a
S6a	Diameter	4a, 4b, 4c
S6d	Diameter	4b
Gn	GTPv1	4b, 4c
Gr	MAP	4b, 4c

2.4.3 Test Cases

The handover scenarios will be tested both for registered terminals and with established (IMS) sessions.

2.4.3.1 Scenario 4a

Basic Attachment.

- The Multimode UE attaches to eNB (y) and hands over to eNB(x), the Multimode UE remains attached.
- The Multimode UE attaches to eNB(y) and hands over to eNB(z), moving from MME(a) to MME(b), the Multimode UE remains attached.
- The Multimode UE attaches to eNB(y) and hands over to eNB(z), moving from S-GW(a) to S-GW(b), the Multimode UE remains attached.

IMS Registration.

- The Multimode UE attached to eNodeB (y) and the UA registers with the IMS Core. The Multimode UE hands over to eNodeB(x), the UA remains registered with the IMS Core.
- The Multimode UE attaches to eNodeB(y) and the UA registers with the IMS Core. The Multimode UE hands over to eNodeB(z), moving from MME(a) to MME(b), the UA remains registered with the IMS Core.
- The Multimode UE attaches to eNodeB(y) and the UA registers with the IMS Core. The Multimode UE hands over to eNodeB(z), moving from S-GW(a) to S-GW(b), the UA remains registered with the IMS Core.

IMS Session.

- The Multimode UE attaches to eNodeB (y) , the UA registers with the IMS Core and establishes an IMS voice session with the LTE UE that is also registered with the IMS. The Multimode UE hands over to eNodeB(x), the IMS voice session remains active.
- The Multimode UE attaches to eNodeB(y), the UA registers with the IMS Core and establishes an IMS voice session with the LTE UE that is also registered with the IMS. The Multimode UE hands over to eNodeB(z), moving from MME(a) to MME(b), the IMS voice session remains active.

- The Multimode UE attaches to eNodeB(y), the UA registers with the IMS Core and establishes an IMS voice session with the LTE UE that is also registered with the IMS. The Multimode UE hands over to eNodeB(z), moving from S-GW(a) to S-GW(b), the IMS session remains active.

2.4.3.2 Scenario 4b & 4c

Basic Attachment.

- The Multimode UE attaches to UTRAN/GERAN and hands over to eNB(x), the Multimode UE remains attached.

IMS Registration.

- The Multimode UE attaches to eNodeB (x) and the UA registers with the IMS Core. The Multimode UE hands over to UTRAN/GERAN, the UA remains registered with the IMS Core.
- The Multimode UE attaches to UTRAN/GERAN and the UA registers with the IMS Core. The Multimode UE hands over to eNodeB(x), the UA remains registered with the IMS Core.

IMS Session.

- The Multimode UE attaches to eNodeB (x), the UA registers with the IMS Core and establishes an IMS voice session with the LTE UE that is also registered with the IMS. The Multimode UE hands over to UTRAN/GERAN, the IMS session remains active over the PS connection.
- The Multimode UE attaches to UTRAN/GERAN, the UA registers with the IMS Core and establishes an IMS voice session over the PS connection with the LTE UE that is also registered with the IMS. The Multimode UE hands over to eNodeB(x), the IMS session remains active.

2.5 Scenario 5 – Inter-RAT Priority Call Handover

This scenario tests the handover of active priority call sessions between VoLTE and the CS-Domain for GERAN/UTRAN and CDMA 1xRTT. There are three sub-test cases for this scenario, namely priority call handover between LTE and UTRAN/GERAN (i.e. call originates on LTE as a Multimedia Priority Service (MPS) VoLTE call then is handed over to UMTS/GERAN as a priority CS call and vice versa) for both S4-SGSN/legacy SGSN and priority call handover between LTE and CDMA 1xRTT (i.e. call originates as on LTE as a MPS VoLTE call then is handed over to CDMA 1xRTT as a priority CS call and vice versa).

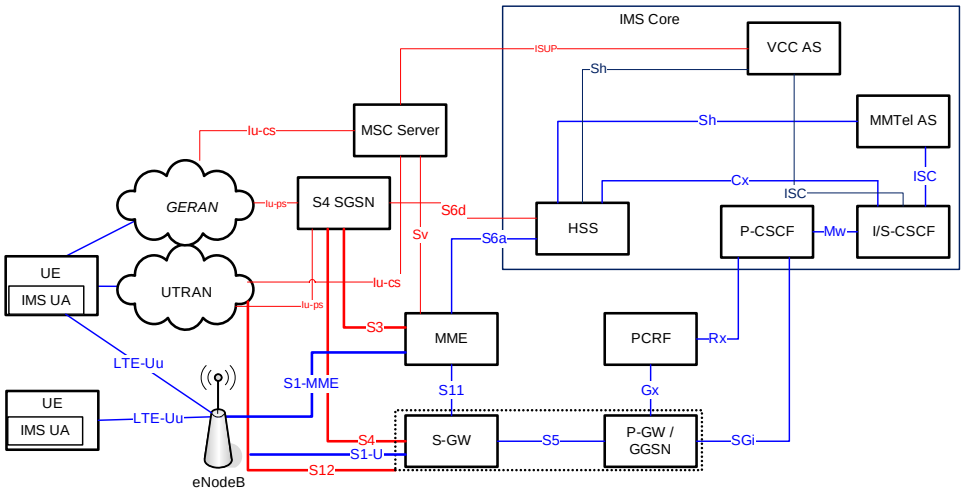

Figure 11 – Scenario 5a. Inter-RAT Handover (LTE-GERAN/UTRAN with S4-SGSN)

NOTE: Diameter Routing Agent and Security Gateway are not displayed in the figure but are applied to the architecture.

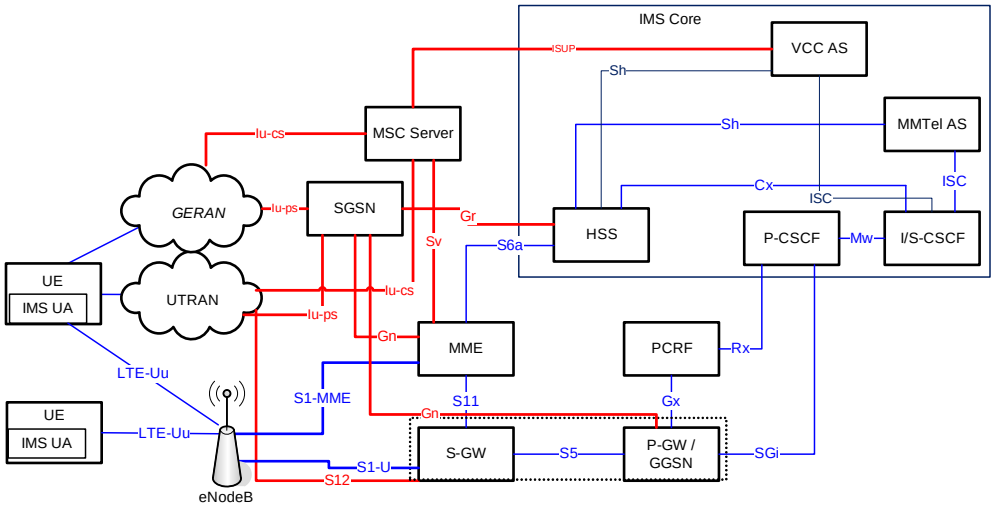

Figure 12 – Scenario 5b. Inter-RAT Handover (LTE-GERAN/UTRAN with legacy SGSN)

NOTE: Diameter Routing Agent and Security Gateway are not displayed in the figure but are applied to the architecture.

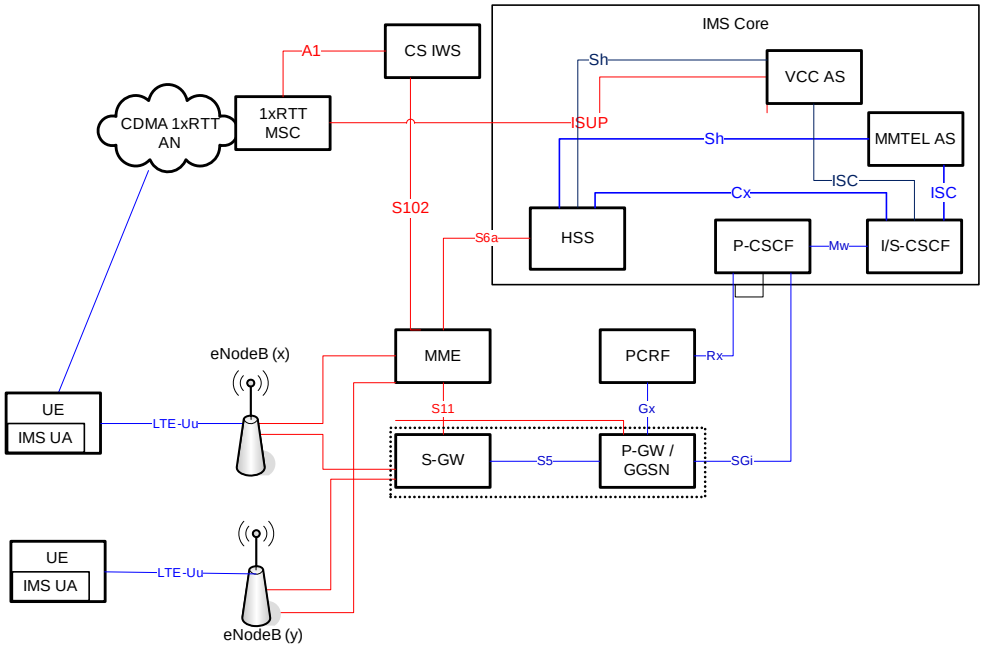

Figure 13 - Scenario 5c. Inter-RAT Handover (LTE-1xRTT CMDA)

NOTE: Diameter Routing Agent and Security Gateway are not displayed in the figure but are applied to the architecture.

2.5.1 Network Components

2.5.1.1 Scenario 5a

- One Multi-mode (LTE – UTRAN/GERAN) UE
- One IMS UA on the Multi-mode UE
- One LTE UE
- One IMS UA on the LTE UE
- Two eNodeBs
- One MME
- One S-GW
- One S4 SGSN
- GERAN/UTRAN access infrastructure.
- One P-GW / GGSN
- One PCRF
- One HSS
- One P-CSCF
- One I/S-CSCF
- One IMS VCC Application Server
- One MMTEL AS

- One MSC Server
- One Sec-GW
- One DRA

2.5.1.2 Scenario 5b

- One Multi-mode (LTE – UTRAN/GERAN) UE
- One IMS UA on the Multi-mode UE
- One LTE UE
- One IMS UA on the LTE UE
- Two eNodeBs
- One MME
- One S-GW
- One legacy SGSN
- GERAN/UTRAN access infrastructure.
- One P-GW / GGSN
- One PCRF
- One HSS
- One P-CSCF
- One I/S-CSCF
- One IMS VCC Application Server
- One IMS MMTEL AS
- One MSC Server
- One Sec-GW
- One DRA

2.5.1.3 Scenario 5c

- One Multi-mode (LTE – UTRAN/GERAN) UE
- One IMS UA on the Multi-mode UE
- One LTE UE
- One IMS UA on the LTE UE
- Two eNodeBs
- One MME
- One S-GW
- One Legacy SGSN
- CDMA 1xRTT access infrastructure.
- One P-GW / GGSN
- One PCRF
- One HSS
- One P-CSCF
- One I/S-CSCF
- One IMS VCC Application Server
- One IMS MMTEL AS
- One MSC Server
- One IWS Function
- One Sec-GW
- One DRA

2.5.2 Protocols and Reference Points

Interface	Protocol	Sub Scenarios

S1-MME	NAS	5
S1-U	GTPv1-U	5
S3	GTPv2-C	5a
S4	GTPv2-C (control plane) / GTPv1-U (user plane)	5a
S11	GTPv2-C	5
S12	GTPv1-U	5a, 5b
S6a	Diameter	5
S6d	Diameter	5b
Gn	GTPv1	5b
Gr	MAP	5b
S102	3GPP2 A21	5c

2.5.3 Test Cases

The following handover test cases will be executed in this scenario:-

2.5.3.1 Scenario 5a & 5b

LTE with Legacy 3GPP Interworking

- Call originates on LTE as a Multimedia Priority Service (MPS) VoLTE call then is handed over to UMTS as a priority CS call.
    - Verify UMTS CS call includes Enhanced Multi-Level Precedence and Pre-emption Service (eMLPP) mapped to the appropriate priority level
- Call originates on LTE as a MPS VoLTE call then is handed over to GSM as a priority CS call.
    - Verify GSM CS call includes eMLPP mapped to the appropriate priority level
- Call originates on UMTS as a priority CS call then is handed over to E-UTRAN as MPS VoLTE call.
    - Verify eMLPP value is mapped to appropriate ARP value
    - Verify eMLPP value is mapped to appropriate ARP value and appropriate QCI value(s)
- Call originates on GSM as a priority CS call then is handed over to E-UTRAN as MPS VoLTE call.
    - Verify eMLPP value is mapped to appropriate ARP value
    - Verify eMLPP value is mapped to appropriate ARP value and appropriate QCI value(s)

2.5.3.2 Scenario 5c

LTE with Non-3GPP Interworking

- Call originates as on LTE as a MPS VoLTE call then is handed over to CDMA 1xRTT as a priority CS call.
    - Verify CDMA call includes 3GPP2 WPSCallIndicator mapped to the appropriate priority level

- Call originates on CDMA 1xRTT as priority call then is handed over to E-UTRAN as MPS VoLTE call
    - Verify 3GPP2 WPSIndicator value is mapped to appropriate ARP value
    - Verify WPSIndicator value is mapped to appropriate ARP value and appropriate QCI value(s)

3 Interface Specifications

The following is a set of references for the interfaces tested in these scenarios.

3.1 LTE-Uu (UE – eNodeB)

3GPP TS 36.300 (E-UTRAN protocol)

3.2 S1-MME (UE – MME)

3GPP TS 24.301 (Non Access Stratum)

3.3 S1AP (eNodeB-MME)

3GPP TS 36.413 (S1 Application Protocol)

3.4 S1-U (eNodeB - S-GW)

3GPP TS 29.281 (GTPv1-U)

3.5 X2 (eNodeB – eNodeB)

Signaling 3GPP TS 36.423 (X2 Application Protocol).
User Plane 3GPP TS 29.281 (GTPv1-U)

3.6 S3 (S4 SGSN – MME)

3GPP TS 29.274 (GTPv2-C)

3.7 S4 (S4 SGSN – S-GW)

Control Plane 3GPP TS 29.274 (GTPv2-C).
User Plane 3GPP TS 29.281 (GTPv1-U).

3.8 S5 (S-GW - P-GW)

User Plane 3GPP TS 29.281 (GTPv1-U)
Control Plane 3GPP TS 29.274 (GTPv2-C)

3.9 S6a (HSS – MME)

3GPP TS 29.272 (Diameter)

3.10 S6b (P-GW – 3GPP AAA)

3GPP TS 29.273 (Diameter)

3.11 S6d (HSS – S4 SGSN)

3GPP TS 29.272 (Diameter)

3.12 S8 (S-GW – P-GW)

User Plane 3GPP TS 29.281 (GTPv1-U)
Control Plane 3GPP TS 29.274 (GTPv2-C)

3.13 S9 (PCRF – PCRF)

3GPP TS 29.215 (Diameter).

3.14 S10 (MME – MME)

3GPP TS 29.274 (GTPv2-C).

3.15 S11 (MME – S-GW)
3GPP TS 29.274 (GTPv2-C)

3.16 S12 (UTRAN – S-GW)
3GPP TS 29.281 (GTPv1-U, utilized for direct tunnel model).

3.17 Gx (PCRF – P-GW)
3GPP TS 29.212 (Diameter).

3.18 Rx (PCRF - IP Application [P-CSCF for IMS])
3GPP TS 29.214 (Diameter).

3.19 Gr (SGSN – HSS)
3GPP TS 29.002 (MAP)

3.20 Gn (SGSN – MME / SGSN – P-GW)
Control Plane 3GPP TS 29.060 (GTPv1-C)
User Plane 3GPP TS 29.281 (GTPv1-U)

3.21 Gm (UE – P-CSCF)
3GPP TS 24.229 (IMS SIP)

3.22 Mw (x-CSCF – x-CSCF)
3GPP TS 24.229 (IMS SIP)

3.23 Mx (x-CSCF – IBCF)
3GPP TS 24.229 (IMS SIP)

3.24 ISC (S-CSCF – AS)
3GPP TS 24.229 (IMS SIP)

3.25 Ut (UE – AS)
3GPP TS 24.623 (XCAP)

3.26 SGi (EPC based PLMN and another packet data network)
3GPP TS 29.061 (IP)

3.27 ENUM
IETF RFC 6116 (ENUM)

3.28 S102 (MME – 1xCS IWS)
3GPP 29.277 (3GPP2 A21)

3.29 Ici (IBCF-IBCF)
3GPP 29.165 (IMS SIP)

3.30 Izi (TrGW-TrGW)
3GPP 29.165 (RTP/MSRP)

4 GSMA Permanent Reference Documents (PRDs)

The following is a set of GSMA PRDs to be tested in these scenarios.

4.1 IR.65: IMS Roaming & Interworking Guidelines

4.2 IR.88: LTE Roaming Guidelines

4.3 IR.92: IMS Profile for Voice and SMS

4.4 IR.90: RCS Interworking Guidelines

4.5 IR.67: DNS/ENUM Guidelines for Service Providers & GRX/IPX

4.6 IR.58: IMS Profile for Voice over HSPA

4.7 IR.94: IMS profile for Conversation Video Service

4.8 RCS-e – Advanced Communications: Services and Client Specification: Version 1.2.1

4.9 Rich Communication Suite 5.0 Advanced Communications: Services and Client Specification