GRQ Measurement Implementation
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1 Introduction

Global Roaming Quality (GRQ) provides a neutral, objective and proportionate framework for active testing, passive monitoring. Regular GRQ measurements assure end-to-end roaming services quality, thus enable GSMA members to get a global perspective on roaming quality.

By reducing roaming quality issues, reasonable quality levels can be assured and customer satisfaction improved. The costs associated with customer complaints and fault resolution will also reduce.

1.1 Overview

This document describes the implementation procedures for measuring the quality of SMS, voice, and data roaming services end-to-end both in the bilateral and in the roaming hubbing scenario. The document consists of four main sections.

The first section details common Quality of Service (QoS) monitoring methods for use with the GRQ monitoring framework.

The second section provides an overview of the quality parameters used with the GRQ monitoring framework. These parameters are defined with details of calculations in PRD IR.42 [1].

The third section contains the tables indicating which monitoring methods are appropriate for each monitoring parameter, and the necessary conditions for consistent monitoring results.

The fourth section provides detailed testing conditions for each parameter, method, and Visited Public Mobile Network/ Home Public Mobile Network (VPMN/HPMN) perspective.

The 5th section specifies the test trigger and measurement points for each test methods. As each section builds on the previous one, it is recommended to read all the sections in the given order.

1.1.1 Scope

This permanent reference document (PRD) provides the parameters, methods, and conditions necessary to perform end-to-end monitoring of roaming services according to the GRQ framework.

Other parameters may complement GRQ monitoring and other methods may be added in the future.

1.1.2 Purpose

This document is intended for mobile operators, roaming Hubbing Providers and vendors.

Operators will find information about the most important QoS parameters and common monitoring methods for end-to-end roaming QoS monitoring.

Roaming Hubbing Providers will find information about the most important QoS parameters and common monitoring methods that can be natively measured/performed by roaming Hubbing Providers themselves.

GRQ Framework

1.2

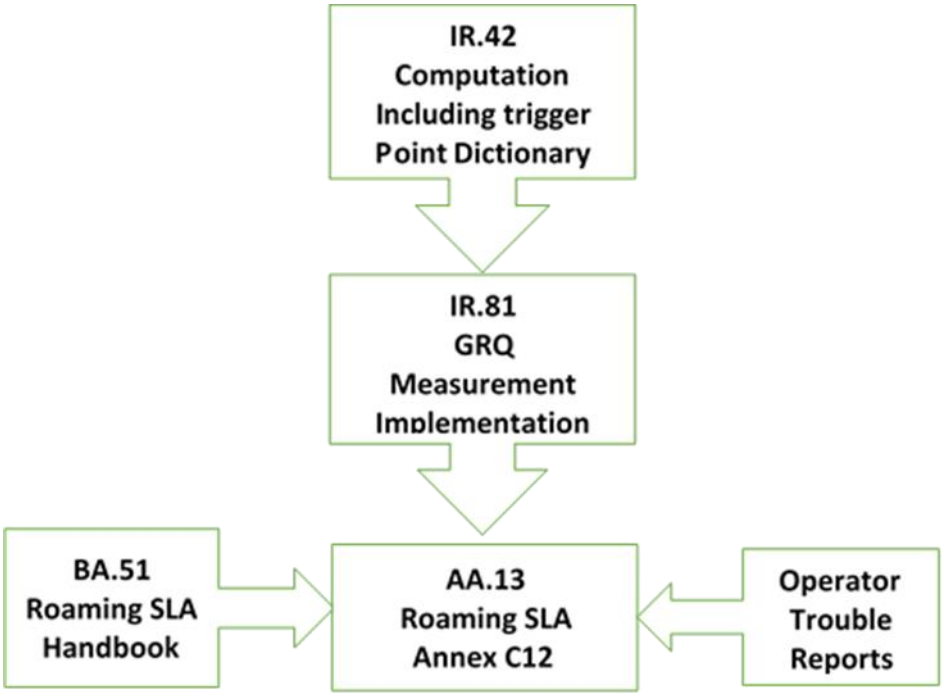

Figure 1: Relation of IR.81 to other PRDs in the GRQ Framework

Figure 1 depicts the GRQ framework and the relationship of IR.81 with the other relevant GSMA PRDs. The GSMA GRQ framework has been designed to standardize the parameters, measurement and implementation of roaming quality KPIs and to provide the guidelines and supporting information for operators to deploy those quality KPIs within end to end roaming SLAs.

The framework consists of four PRDs and a trouble report database.

- IR.42 contains the quality KPI definitions and calculations relevant for the global roaming
- IR.81 (the present PRD) specifies the roaming quality KPI test methods, test implementations and the KPI thresholds for roaming
- BA.51 provides the specific guidelines and advanced agreements to those operators wishing to establish an end-to-end Roaming Service Level Agreement (RSLA) either between themselves and/or through a Roaming Hub Provider.
- AA.13 Annex C12 provides the basis for establishing Roaming Service Level Agreement between operators.

1.3 Operator Trouble Report – operator report to communicate issues on their network to their roaming partners. May use the global NSIA (Network Service Interruption Advisory) reporting via the GSMA Infocentre when available.

Scope and Purpose

This permanent reference document (PRD) provides the parameters, methods, and conditions necessary to perform end-to-end monitoring of roaming services according to the GRQ framework.

This document is intended for mobile operators, roaming Hubbing Providers and vendors. Operators will find information about the most important QoS parameters and common monitoring methods for end-to-end roaming QoS monitoring. Roaming Hubbing Providers will find information about the most important QoS parameters and common monitoring methods that can be natively measured/performed by roaming Hubbing Providers themselves.

Vendors will find information about the most important QoS parameters and the necessary testing conditions providing for comparable monitoring results irrespective of the methods, vendors, and mobile operators involved.

1.4 Definition of Terms

Term	Description
ACD	Average Call Duration
ASR	Answer-Seize Ratio
CAMEL	Customized Applications for Mobile networks Enhanced Logic
CE	Coverage Enhancement
eDRX	Extended idle mode Discontinuous Reception
EN-DC	E-UTRA-NR Dual Connectivity
en-gNB	Enhanced gNB (a node providing NR user plane and control plane protocol terminations towards the UE and connected via the S1-U interface to the EPC and to the eNB via X2. Acts as the SN for EN-DC).
GTP	GPRS Tunnelling Protocol
HPMN	Home Public Mobile Network
IMSI	International Mobile Subscriber Identity
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
KPI	(QoS) Key Performance Indicator
LBO-HR	Local Breakout HPMN Routing (roaming architecture)
LBO-VR	Local Breakout VPMN Routing (roaming architecture)
LTE	Long Term Evolution
LTE-M	Long-Term Evolution Machine Type Communications
LwM2M	Lightweight Machine to Machine
MAP	Mobile Application Part
MCG	Master Cell Group
MIoT	Mobile Internet of Things
MN	Master Node
MOS	Mean Opinion Score
MQTT	Message Queuing Telemetry Transport
MQTT-SN	MQTT for Sensor Networks
MSC	Mobile Switching Centre
MTU	Maximum Transmission Unit
NB-IoT	Narrowband IoT
NSA	(5G) Non Stand-Alone
PDD	Post-Dial Delay
PSM	Power Save Mode
PTW	Paging Time Window
QoS	Quality of Service
RSRP	Reference Signal Received Power
SCG	Secondary Cell Group
SN	Secondary Node

SQI	Single Quality Indicator
SRVCC	Single Radio Voice Call Continuity
SS7	Signalling System 7
SSI	Single Service Indicator
S8HR	S8 Home-Routed (roaming architecture)
STP	Signalling Transfer Point
TAU	Tracking Area Update
ViLTE	(conversational) Video over LTE
VoLTE	Voice over LTE

1.5 Document Cross-References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document. References are non-specific, i.e. referred to the latest version.

No.	Document	Description
[1]	GMSA PRD IR.42	Definition of Quality of Service parameters and their computation
[2]	ETSI TS 102 250-4	"Speech Processing, Transmission and Quality Aspects (STQ); QoS aspects for popular services in GSM and 3G networks; Part 4: Requirements for Quality of Service measurement equipment ".
[3]	ETSI TR 103 114	"Speech Processing, Transmission and Quality Aspects (STQ); QoS parameters and measurement methodology for smartphone".
[4]	3GPP TS 23.272	"Circuit Switched Fallback in Evolved Packet System; Stage 2"
[5]	3GPP TS 23.401	"GPRS Enhancements for E-UTRAN Access"
[6]	3GPP TS 29.272	"MME and SGSN related interfaces based on Diameter protocol"
[7]	3GPP TS 29.274	"Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C); Stage 3"
[8]	3GPP TS 29.281	"General Packet Radio System (GPRS) Tunnelling Protocol User Plane (GTPv1-U)"
[9]	GMSA PRD IR.65	IMS roaming and interworking guidelines
[10]	GMSA PRD IR.88	LTE Roaming Guidelines
[11]	GMSA PRD IR.92	IMS Profile for Voice and SMS
[12]	GMSA PRD IR.94	IMS Profile for Conversational Video Service
[13]	3GPP TS 34.229-1	Internet Protocol (IP) multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); User Equipment (UE) conformance specification; Part 1: Protocol conformance specification
[14]	3GPP TS 36 508	Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Common Test Environments for User Equipment (UE) Conformance Testing

No.	Document	Description
[15]	3GPP TS 36 523-1	Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC); User Equipment (UE) conformance specification; Part 1: Protocol conformance specification
[16]	ITU-T P.863	Perceptual Objective Listening Quality Assessment (POLQA)
[17]	ITU-T G.107.1	Wideband E-Model
[18]	ITU-T J.247	Objective perceptual multimedia video quality measurement in the presence of a full reference
[19]	3GPP TS 37.340	Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity

2 Overview of roaming QoS monitoring methods

Monitoring is a continuous method to measure the QoS on an on-going basis. It provides a statistical representation of end-user experience based on a sample of the roaming services provided. This in contrast to ad-hoc tests, which are only giving a snap-shot of the QoS. Ad-hoc tests are typically more complicated, and are not standardized. These are used for troubleshooting.

There are two general approaches to monitoring roaming QoS end-to-end.

The first approach generates test calls in the visited network using test subscriber identity module (SIM) cards from stationery or a moving test rig. This is referred to as ‘active monitoring’.

The second approach monitors live roaming traffic signaling and IP traffic resulting from roaming subscriber activities in the visited network. This is referred to as ‘passive monitoring’, because this approach is non-intrusive. Roaming Hubbing Providers can natively perform some of these methods.

This document includes both approaches and contains details of the following common methods:

1. End-to-end Active Testing and Monitoring
2. Drive Testing and Monitoring
3. Passive Monitoring
4. CAMEL Monitoring
5. DIAMETER and GTP-C / –U Monitoring
6. Use smartphone

One or more methods can be combined to perform end-to-end GRQ monitoring. Other methods may be added in the future.

2.1 End-to-end Active Testing and Monitoring

The End-to-end Active Testing and Monitoring method deploys one or more stationary test rigs in the roaming destination. Each test rig contains one or more active Radio Frequency (RF) probes programmed to emulate subscriber behavior. Test calls are generated on the visited or on the home network using test SIM cards.

The active test probes typically support automated scheduled testing for on-going roaming service quality monitoring, as well as real-time testing for troubleshooting. An IP network is used to remotely control the probes and receive test results from the test rig. The test rigs often incorporate SIM multiplexing to centrally manage SIM resources and dynamically assign them to the active test probes.

2.2 Drive Testing and Monitoring

The Drive Testing and Monitoring method is similar to the End-to-end Active Testing and Monitoring method with the exception that the active probes are installed in vehicles (for example taxis or buses).

Given that monitoring is performed in different locations and potentially from a moving location, this method will give different results than stationary test rigs.

As Drive Testing and Monitoring was not included in the GRQ trial, no test conditions nor comparison factors could be included in this document. Once we have the framework ready and working for End-to-end active testing, we will further look into this mobile variant.

2.3 Passive Monitoring

Passive Monitoring method uses non-intrusive high-impedance Signaling System number 7 (SS7) signaling probes to record selected protocol messages for further analysis for example with an SS7 data analysis and reporting tool.

It is noted that some Signal Transfer Points (STP)s enable the replication of signaling messages. They can send the replicates towards a network monitoring application. Such approach is also considered as a “passive monitoring” method.

The SS7 data analysis provides a real-time view of the network and service performance experienced by the roamers.

It is important to note that only monitoring of basic and mandatory protocols for GSM/GPRS roaming services have been considered, that is Mobile Application Part (MAP), Integrated Services Digital Network User Part (ISUP).

Similarly, Passive Monitoring may be applied on the IP traffic for monitoring the GPRS Tunneling Protocol (GTP) flows, as required for evaluating the QoS of the PS-domain. The approach taken may consist of implementing high-impedance probes or to apply a port mirroring on a network switch. In the latter case, it forces the switch to send a copy of all network packets seen on one switch port (or an entire Virtual LAN (VLAN)) to a network monitoring connection on another switch port. This is commonly used for network appliances that require monitoring of network traffic.

CAMEL is the embodiment of the Intelligent Networks (IN) concept for mobile networks. CAMEL is bilaterally and specifically enabled across networks by roaming partners. It is supported by the CAP protocol.

In this document, CAMEL Monitoring refers to passive probes monitoring CAP signaling. This monitoring brings additional visibility on the activity of the roamer, so it is described separately from passive Monitoring, in a specific section – see below.

2.4 CAMEL Monitoring

The Customized Applications for Mobile Networks Enhanced Logic (CAMEL) Monitoring method uses a similar set up to SS7 Monitoring, whereby non-intrusive CAMEL signaling probes record selected protocol messages for further analysis and reporting.

Once a CAMEL relationship is established between a HPMN and a VPMN, an exchange of CAMEL Application Part (CAP) protocol messages takes places when customers are accessing different roaming services. This enables both the HPMN and the VPMN to monitor roaming QoS using passive signaling probes (subject to appropriate protocol stack library for decoding messages).
The CAMEL Phase enabled between the roaming partners will determine the scope of parameters available for GRQ monitoring:

- Phase 1: Applies to Mobile Originated (MO) and Mobile Terminated (MT) (at Gateway mobile switching center (GMSC)) calls related activities.
- Phase 2: Phase 1 plus Unstructured Supplementary Service Data (USSD) control, call duration, and so on.
- Phase 3: Phase 1 and Phase 2 plus control of dialed services (actual number dialed), mobility events, GPRS session and SMS-MO.
- Phase 4: All of the above plus IMS control and SMS-MT.

Most operators with CAMEL-enabled limit its support to CAMEL Phase 2.

The CAMEL Monitoring was not tested in the trial due to lack of CAMEL agreements between the participating operators and the CAMEL/CAP monitoring modules being inactive at the trial participants. However, due to widespread use of CAMEL for critical services (pre-paid roaming, VPN, and so on.), it was decided to include CAMEL Monitoring in this document. It is recommended that operators check the results from the calibration process if the CAMEL Monitoring method is to be used with GRQ.

2.5 Use smartphone for QoS test

Smartphones can be used either as a stand-alone test platform, or as a front-end of a host based active test system, for the execution of Quality of Service measurements [3].

Smartphone as a mobile device is based on an operating system which can be programmatically controlled via a programming interface, in combination with the possibility to run applications (Apps) at user level. The result is visible to the user.

The smartphones are capable of a parallel usage of different services. The multi-service testing describes a complex test scenario where at least two services are used in parallel. This situation has to be considered when QoS measurements and test result being closer to user experiences.

User agents acting as applications can be installed in the phone or on the SIM cards. These user agents are used to get a full End-to-End QoS view, from the user perspective.

This monitoring method can be used in both active and passive mode. In active mode the test is launched “on request” (mainly for troubleshooting); while in passive mode no

dedicated test is run, but the applications send on-usage statistics. This method would be mainly used for user experience monitoring and complaints troubleshooting.

Similar KPIs to the ones used in the scope of GRQ framework are applied by aggregating individual customer data at network level. The KPI values obtained can be very different from the ones using other test methods described in the present document and highly dependent on the number of customers monitored, static versus moving tests, radio coverage of the VPLMN, and so on. If the number of customers is high enough, so that the measured KPIs will give the most accurate view of roaming experience in real life scenarios. On the other hand, a good diagnostic/analyse process of the results is required as the KPIs measured by a single subscriber (for example, having a coverage issue) may influence very much the entire quality evaluation.

2.6 DIAMETER and GTP-C / -U Monitoring

A general description for DIAMETER and GTP monitoring to be added in this section

3 Overview of Roaming QoS Parameters

This section gives an overview of the basic parameters that enable monitoring of roaming quality of services end-to-end under the GRQ framework. These parameters were selected on the basis that they cover the five QoS aspects defined in PRD IR42, and represents the customer experience.

The five QoS aspects are:

1. **Network Accessibility**: Probability that the user performs a successful registration on the PLMN. The customer is registering to the network (either the circuit switched network for voice or the packet switched network for data). (For Global Roaming QoS monitoring, it is assumed that the network is available where the customer is located.). Some of these parameters can be natively monitored by a roaming Hubbing Provider
2. **Service Accessibility**: If a customer wants to use a service, the network operator will provide access to the service as quickly as possible. (The end-to-end bearer connection is provided to the customer. For voice services, the customer hears the ring tone; for data services, the end-to-end packet data protocol (PDP) context is activated; for SMS, the connection is established between the end-user terminal and the Short Message Service Centre (SMSC).)
3. **Connection Establishment**: For voice services, this describes the call setup end-to-end (even in case of call forward to voicemail). For data services, this describes the connection establishment for MultiMedia Service (MMS) or accesses to a Wireless Application Protocol (WAP) portal or web server and so on.
4. **Service Retain-ability**: Service Retain-ability describes the termination of services (in accordance with or against the will of the user), for example the customer terminates his voice call or data connection without cut-off.
5. **Connection Quality**: This describes the Quality of Service during service use. The connection is not impaired by quality problems, such as speech quality for voice or data rate for data services.

For Packet Switched services, there are two approaches measuring QoS.

1. Bearer level measures are included, as most data services are delivered using the HPMN's infrastructure and the VPMN's data bearer (that is 'bit pipe'). This approach has been used to measure GPRS / UMTS data QoS.
2. QoS measurement are performed at the specific services level (for example HTTP / HTTPS, as well as data capacity test). This approach can result more closely to the user experience, therefore, is mandatorily applied to the LTE data QoS measurement and can be optionally adopted for the GPRS / UMTS data QoS measurement.

The GRQ framework may further consider class-based QoS monitoring (cf. IP Exchange (IPX) QoS) in the future to reflect end-user applications more closely.

Voice QoS Parameters

3.1 CS voice QoS parameters

3.1.1

QoS Aspects	QoS Parameters
Network Accessibility (customer being able to register on the network)	1. Circuit Switched LU success ratio (*) 2. Circuit Switched LU delay (*)
Service accessibility (from customer hitting the send button until hearing a ring tone)	3. NER-MO or SAT-MO (success ratio) 4. NER-MT or SAT-MT (success ratio) 5. PDD-MO or STT-MO (duration) 6. PDD-MT or STT-MT (duration)
Connection establishment (from customer hitting the send button until a successful establishment of the call)	7. CSSR-MO (success ratio) 8. CSSR-MT (success ratio) 9. REL (ISUPv2) 10. OCN and RDN (ISUPv2)
Connection retain-ability (from a successful establishment of the call until service is terminated)	11. CCR (success ratio) 12. ALOC (duration)[1]
Connection quality	13a. CLI transparency (MO) 13b. CLI transparency (MT) 14a. Speech Quality (SpQ_received_R_side) 14b. Speech Quality (SpQ_received_H_side)

(*) Natively supported by roaming Hubbing Providers; other parameters may be supported through CAMEL.

3.1.2 Voice CSFB QoS parameters

CSFB denotes CS fallback. This session contains the KPIs for the voice CS fallback.

[1] Not relevant for a roaming QoS SLA.

QoS Aspects	QoS Parameters
LTE network accessibility	101. PS location update success ratio 102. PS location update delay 103a. CSFB return to LTE success ratio- MO 103b. CSFB return to LTE success ratio- MT 104a. CSFB return to LTE time – MO 104b. CSFB return to LTE time – MT
CS voice accessibility	3. NER-MO or SAT-MO (success ratio) 4. NER-MT or SAT-MT (success ratio) 115. CSFB PDD-MO or CSFB STT-MO (setup time) 116. CSFB PDD-MT or CSFB STT-MT (setup time) 7. CSSR-MO (success ratio) 8. CSSR-MT (success ratio)
Note 1: A combined EPS + IMSI attach is applied to QoS parameters 101 and 102. Note 2: CSFB QoS parameters 103 and 104 are (2G / 3G) technology-dependent. Note 3: After a successful CSFB, the CS voice QoS parameters are applied.	

3.1.3 VoLTE QoS parameters

QoS Aspects	QoS Parameters	
	GRQ Id	KPI description
VoLTE service Accessibility	201 202	IMS Registration success ratio IMS Registration time
VoLTE service integrity and retainability	203 204 205 206 207 208 211 212 213 210 214 215 216 217	Voice MO accessibility (NER-MO or SAT-MO success ratio) Voice MT accessibility (NER -MT or SAT-MT success ratio) Voice MO session setup time (PDD-MO or STT-MO duration) Voice MT session setup time (PDD-MT or STT-MT duration) Voice MO session setup ratio (CSSR-MO) Voice MT session setup ratio (CSSR-MT) Voice MO session duration Voice MT session duration OIP transparency MO (CLI transparency) OIP transparency MT (CLI transparency) Speech quality on call basis at R-party Speech quality on call basis at H-party Speech quality R-factor at R-party Speech quality R-factor at H-party
VoLTE service mobility	230 231 232	SRVCC MO success ratio SRVCC MT success ratio SRVCC MO time

	233	SRVCC MT time
LTE network quality for VoLTE service	240	Default EPS bearer context activation success ratio
	241	Default EPS bearer context activation time
	242	Default EPS bearer QCI
	243	Default EPS bearer UL AMBR
	244	Default EPS bearer DL AMBR
	245	Dedicated EPS bearer context activation success ratio (audio)
	246	Dedicated EPS bearer context activation time (audio)
	247	Dedicated EPS bearer QCI (audio)
	248	Dedicated EPS bearer UL GBR (audio)
	249	Dedicated EPS bearer DL GBR (audio)
	250	IP data volume received on QCI5 bearer at R-party
	251	IP data volume transmitted on QCI5 bearer at R-party
	252	IP data volume received on QCI5 bearer at H-party
	253	IP data volume transmitted on QCI5 bearer at H-party
	254	IP data volume received on QCI1 bearer at R-party
	255	IP data volume transmitted on QCI1 bearer at R-party
	256	IP data volume received on QCI1 bearer at H-party
	257	IP data volume transmitted on QCI1 bearer at H-party
Voice media transport quality for VoLTE service	260	RTP max packet delay variation R2H (A-B)
	261	RTP max packet delay variation H2R (B-A)
	262	RTP mean packet delay variation R2H (A-B)
	263	RTP mean packet delay variation H2R (B-A)
	264	RTP mean interarrival jitter of incoming streaming R2H (A-B)
	265	RTP mean interarrival jitter of incoming streaming H2R (B-A)
	266	RTP mean data rate transmitted R2H (A-B)
	267	RTP mean data rate received H2R (B-A)
	268	RTP mean data rate transmitted H2R (B-A)
	269	RTP mean data rate received R2H (A-B)
	270	RTP packets lost R2H (A-B)
	271	RTP packets lost H2R (B-A)
	272	RTP packet lost ratio R2H (A-B)
	273	RTP packet lost ratio H2R (B-A)
	274	RTP round-trip delay (RTD RHR A-B-A)
	275	RTP round-trip delay (RTD HRH B-A-B)
	276	RTP one-way delay (OWD R2H A-B)
	277	RTP one-way delay (OWD H2R B-A)

Table 1: VoLTE GRQ parameters

3.2 SMS QoS Parameters

3.2.1 SMS over GSM, UMTS and LTE

QoS Aspects	QoS Parameters
1. Network Accessibility (customer being able to register on the network)	No QoS Parameter (as not SMS specific) QoS parameters 101 and 102 are applied to SMSoSGs
2. Service accessibility (MO)	21. Service Accessibility for SMS-MO (*) 22. Service Accessibility for SMS-MT (*) 23. Access Delay for SMS-MO (*) 24. Access Delay for SMS-MT (*)
3. Connection establishment (from customer hitting the send button until a successful delivery of the SMS)	25. End-to-End Delivery Time for SMS-MO(*)[1] 26. End-to-End Delivery Time for SMS-MT(*)[1]
4. Connection retain-ability (from a successful establishment of the service until service is terminated)	No QoS Parameter (Store and Forward Mechanism)
5. Connection quality	No QoS Parameter (Store and Forward Mechanism)

(*) Natively supported by a roaming Hubbing Provider only in the case where the SMS traffic is controlled by the roaming HUB.

SMS over SGs applies the same QoS parameters for SMS.

3.2.2 SMS over IP

QoS Aspects	QoS Parameters	
	GRQ Id	KPI description
1. SMSoIP Accessibility	201 202	IMS Registration success ratio IMS Registration success time
2. Service accessibility	221 222 223 224	SMSoIP-MO accessibility SMSoIP-MT accessibility SMSoIP-MO access delay SMSoIP-MT access delay
3. Connection establishment	225 226	SMSoIP-MO e2e delay SMSoIP-MT e2e delay

Table 2: SMSoIP GRQ parameters

3.3 Data QoS Parameters

3.3.1 GPRS / UMTS data QoS parameters

GRQ monitoring involves testing of MMS, WAP and internet, all with their specific Access Point Name (APN)s.

QoS Aspects	QoS Parameters
Network Accessibility (customer being able to register on the network)	31. Packet Switched Location Update success ratio (*) 32. Packet Switched Location Update Delay (*)
Service accessibility (from customer hitting the send / connection button until accessing the data bearer)	33. PDP Context Activation success ratio 34. PDP Context Activation time
Connection retain ability (from a successful establishment of the service until service is terminated)	35. PDP Context Cut-Off Ratio 36. PDP Context Average Session Time[1].
Connection quality	37. Throughput (Kbit/sec) [2] 38. Goodput (Kbit/sec) 39. Roundtrip time (expressed in milliseconds) [3] 40. Packet loss[4]
HTTP / HTTPS WEB browsing service quality	142. HTTP / HTTPS IP service setup time 143. HTTP / HTTPS session success ratio 144. HTTP / HTTPS session time 145. HTTP / HTTPS mean data rate 146. HTTP / HTTPS data transfer success ratio

(*) Natively supported by a roaming Hubbing Provider; other parameters may be supported through CAMEL.

Various opinions exist[5] on how to measure throughput/goodput. It is acknowledged that the application used for measuring these parameters may even influence the measure itself. Therefore, it is recommended that the calibration process at the initial stage of the implementation of a GRQ framework between two operators scrutinizes these measures.

For the sake of clarity, it is noted that active probes may measure roundtrip and packet loss in different ways for example based on the PING application or based on analysis of TCP packet processing. It is also acknowledged that PING is not always trusted by IP experts for achieving accurate measure for the real customer experience. Indeed, PING is part of Internet Control Message Protocol (ICMP) while the data transfer is done in User Datagram

[2] Because a ‘bearer level’ approach is adopted for the data services QoS monitoring, these parameters have to be measured at the ‘bit pipe’ level.
[3] See ‘Delay’ in section 8 of GSMA PRD IR.34 ‘Inter-Service Provider IP Backbone Guidelines’.
[4] See ‘Packet Loss Ratio’ in section 8 of GSMA PRD IR.34 ‘Inter-Service Provider IP Backbone Guidelines’
[5] See RFC 5166 Metrics for the Evaluation of Congestion Control Mechanisms (http://tools.ietf.org/html/rfc5166)

Protocol (UDP) or Transmission Control Protocol (TCP). Therefore, it is recommended that both operators involved in the GRQ measurements agree on the chosen method and perform calibration tests.

A high-level definition of throughput is the ratio between the global data volume by unit of time; goodput is the ratio between the useful data volume by unit of time.

LTE data QoS parameters

QoS Aspects	QoS Parameters
LTE network accessibility	101. PS location update success ratio 102. PS location update delay
LTE data service accessibility	105. Default EPS bearer context activation success ratio 106. Default EPS bearer context activation time
LTE data service establishment	107. DNS host name resolution success ratio 108. DNS host name resolution time
LTE data service retainability	109. Default EPS bearer context cut-off ratio
FTP service quality	131. FTP {download | upload} IP service access success ratio 132. FTP {download | upload} IP service setup time 133. FTP {download | upload} session success ratio 134. FTP {download | upload} session time 135. FTP {download | upload} mean data rate 136. FTP {download | upload} data transfer success ratio 137. FTP {download | upload} data capacity
HTTP / HTTPS WEB browsing service quality	141. HTTP / HTTPS IP service access success ratio 142. HTTP / HTTPS IP service setup time 143. HTTP / HTTPS session success ratio 144. HTTP / HTTPS session time 145. HTTP / HTTPS mean data rate 146. HTTP / HTTPS data transfer success ratio 147. HTTP / HTTPS content compression ratio 148. HTTP / HTTPS {download | upload} data capacity
PING service quality	151. PING packet loss ratio 152. PING round trip time
Note 1: An EPS attach is applied to QoS parameters 101 and 102 Note 2: The KPI 107, 108, 131a-137b, 141-148, 151, 152 can also be applied as the GPRS / UMTS data QoS parameters to the data quality test. If it is the case, these KPI replace KPI 37 – 40.	

ViLTE QoS Parameters

QoS Aspects	QoS Parameters	
	GRQ Id	KPI description
ViLTE service Accessibility	301	IMS Registration success ratio
	302	IMS Registration time
ViLTE service integrity and retainability	303	ViLTE MO accessibility (NER-MO or SAT-MO success ratio)
	304	ViLTE MT accessibility (NER -MT or SAT-MT success ratio)
	305	ViLTE MO session setup time (PDD-MO or STT-MO duration)
	306	ViLTE MT session setup time (PDD-MT or STT-MT duration)
	307	ViLTE MO session setup ratio (CSSR-MO)
	308	ViLTE MT session setup ratio (CSSR-MT)
	311	ViLTE MO session duration
	312	ViLTE MT session duration
	313	OIP transparency MO (CLI transparency)
	310	OIP transparency MT (CLI transparency)
	314	Speech quality on sample basis at R-party
	315	Speech quality on sample basis at H-party
	216	Speech quality R-factor at R-party
	217	Speech quality R-factor at H-party
	318	Video quality on sample basis at R-party
	319	Video quality on sample basis at H-party
ViLTE service mobility	230	SRVCC MO success ratio
	231	SRVCC MT success ratio
	232	SRVCC MO time
	233	SRVCC MT time
LTE network quality for ViLTE service	240	Default EPS bearer context activation success ratio
	241	Default EPS bearer context activation time
	242	Default EPS bearer QCI
	243	Default EPS bearer UL AMBR
	244	Default EPS bearer DL AMBR
	247	Dedicated EPS bearer QCI (audio)
	248	Dedicated EPS bearer UL GBR (audio)
	249	Dedicated EPS bearer DL GBR (audio)
	345	Dedicated EPS bearer context activation success ratio (audio&video)
	346	Dedicated EPS bearer context activation time (audio&video)
	347	Dedicated EPS bearer QCI (video)
	348	Dedicated EPS bearer UL GBR (video)
	349	Dedicated EPS bearer DL GBR (video)
	343	Dedicated EPS bearer UL AMBR (video)
	344	Dedicated EPS bearer DL AMBR (video)
	250	IP data volume received on QCI5 bearer at R-party
	251	IP data volume transmitted on QCI5 bearer at R-party
	252	IP data volume received on QCI5 bearer at H-party

	253	IP data volume transmitted on QCI5 bearer at H-party
	254	IP data volume received on QCI1 bearer at R-party
	255	IP data volume transmitted on QCI1 bearer at R-party
	256	IP data volume received on QCI1 bearer at H-party
	257	IP data volume transmitted on QCI1 bearer at H-party
	354	IP data volume received on QCI2/8/9 bearer at R-party
	355	IP data volume transmitted on QCI2/8/9 bearer at R-party
	356	IP data volume received on QCI2/8/9 bearer at H-party
	357	IP data volume transmitted on QCI2/8/9 bearer at H-party
RTP transport quality for ViLTE service - audio	260	RTP max packet delay variation R2H (A-B)
	261	RTP max packet delay variation H2R (B-A)
	262	RTP mean packet delay variation R2H (A-B)
	263	RTP mean packet delay variation H2R (B-A)
	264	RTP mean interarrival jitter of incoming streaming R2H (A-B)
	265	RTP mean interarrival jitter of incoming streaming H2R (B-A)
	266	RTP mean data rate transmitted R2H (A-B)
	267	RTP mean data rate received H2R (B-A)
	268	RTP mean data rate transmitted H2R (B-A)
	269	RTP mean data rate received R2H (A-B)
	270	RTP packets lost R2H (A-B)
	271	RTP packets lost H2R (B-A)
	272	RTP packet lost ratio R2H (A-B)
	273	RTP packet lost ratio H2R (B-A)
	274	RTP round-trip delay (RTD RHR A-B-A)
	275	RTP round-trip delay (RTD HRH B-A-B)
	276	RTP one-way delay (OWD R2H A-B)
	277	RTP one-way delay (OWD H2R B-A)
RTP transport quality for ViLTE service - video	360	RTP max packet delay variation R2H (A-B)
	361	RTP max packet delay variation H2R (B-A)
	362	RTP mean packet delay variation R2H (A-B)
	363	RTP mean packet delay variation H2R (B-A)
	364	RTP mean interarrival jitter of incoming streaming R2H (A-B)
	365	RTP mean interarrival jitter of incoming streaming H2R (B-A)
	366	RTP mean data rate transmitted R2H (A-B)
	367	RTP mean data rate received H2R (B-A)
	368	RTP mean data rate transmitted H2R (B-A)
	369	RTP mean data rate received R2H (A-B)
	370	RTP packets lost R2H (A-B)
	371	RTP packets lost H2R (B-A)
	372	RTP packet lost ratio R2H (A-B)
	373	RTP packet lost ratio H2R (B-A)
	374	RTP round-trip delay (RTD RHR A-B-A)
	375	RTP round-trip delay (RTD HRH B-A-B)
	376	RTP one-way-delay (OWD R2H A-B)
	377	RTP one-way-delay (OWD H2R B-A)

Table 3: ViLTE GRQ parameters

3.5 MIoT QoS Parameters

QoS Aspects	MIoT QoS Parameters	
	GRQ Id	KPI description
MIoT service availability & network connectivity	101	PS location update success ratio
	102	PS location update delay
	105	Default EPS bearer context activation success ratio
	106	Default EPS bearer context activation time
	400	LPWA access type
	401	Attach type with additional update type
	402	Detach type
	403	Detach delay
	404	PDN type
	405	Serving PLMN rate control (NB-IoT)
	406	APN rate control (NB-IoT)
	407	APN rate control for exception data (NB-IoT)
	408	NAS signalling low priority (LTE-M)
	409	Non-IP link MTU size (NB-IoT)
	410	IPv4 link MTU size (NB-IoT)
	411	Half-duplex (FDD)
	412	RSRP
	413	CE Mode (LTE-M)
	414	CE Level (NB-IoT)
	150	PING Host
	151	PING packet loss ratio
	152	PING round trip time
	153	Number of packets received
	154	Number of packets sent
	155	PING interval
	156	PING packet payload size
	157	Sum of bytes received
	158	Sum of bytes sent
MIoT Power saving & eDRX	420	PSM enable / disable
	421	PSM status NW-accepted
	422	PSM TAU period UE-requested (T3412 extended)
	423	PSM TAU period NW-accepted (T3412 extended)
	424	PSM UE active timer UE-requested (T3324)
	425	PSM UE active timer NW-accepted (T3324)
	426	PSM Hibernate ratio NW-accepted
	427	PSM MT data transfer success ratio
	428	PSM SMS MT accessibility
	431	eDRX UE-config enable / disable
	432	eDRX status NW-accepted
	433	eDRX cycle UE- requested

	434	eDRX cycle NW-accepted
	435	eDRX PTW UE- requested
	436	eDRX PTW NW-accepted
	437	eDRX MT data transfer success ratio
	438	eDRX SMS MT accessibility
MIoT service integrity and retainability	109	Default EPS bearer context cut-off ratio
	440	MO TCP data transfer success ratio
	441	MO TCP data transfer payload size
	442	MO TCP data transfer throughput
	443	MO TCP data transfer duration
	444	MO TCP data RTT
	445	MO UDP data transfer success ratio
	446	MO UDP data transfer payload size
	447	MO UDP data transfer throughput
	448	MO UDP data transfer duration
	449	MO UDP data RTT
	450	MT TCP data transfer success ratio
	451	MT TCP data transfer payload size
	452	MT TCP data transfer throughput
	453	MT TCP data transfer duration
	454	MT UDP data transfer success ratio
	455	MT UDP data transfer payload size
	456	MT UDP data transfer throughput
	457	MT UDP data transfer duration
	460	MO Non-IP data transfer success ratio
	461	MO Non-IP data transfer payload size
	462	MO Non-IP data transfer throughput
	463	MO Non-IP data transfer duration
	464	MT Non-IP data transfer success ratio
	465	MT Non-IP data transfer payload size
	466	MT Non-IP data transfer throughput
	467	MT Non-IP data transfer duration
MIoT SMS	471	SMSinMME-MO accessibility
	472	SMSinMME-MO access delay
	473	SMSinMME-MT accessibility
	474	SMSinMME-MT access delay
Note 1: An EPS attach is applied to QoS parameters 101 and 102.		

5G NSA EN-DC QoS Parameters

EN-DC Categories	EN-DC Parameters
EN-DC NR accessibility & availability	500. 5G coverage indication 501. NR RSRP 502. Restrict DCNR
en-gNB resource availability	503. ENDC EPS bearer configuration 504. S1-U termination 505. Default EPS bearer QoS parameters
MBB data rate & latency	145. HTTP / HTTPS mean data rate 510. HTTP / HTTPS MBB data transfer success ratio 152. PING round trip time
Note 1: An EPS attach is a precondition for testing QoS parameters 501 – 505, 145 and 152.	

3.6

IPX QoS Monitoring

3.7 Roaming interconnection is an integral part of roaming services. A new interconnection framework for IP (PRD IR.34) also provides for network level QoS monitoring of IP traffic between mobile operators and interconnection providers. Where IPX interconnections replace GRX interconnections, it may be possible to utilise packet switched QoS parameters from the IPX QoS Monitoring scheme with the GRQ Framework in the future.

4 QoS Parameter-Method Grid

The following tables summarize the feasibility of each test method against each QoS parameter when measured by the HPMN or the VPMN.

The objective of the table is to identify whether a network acting as HPMN or as VPMN is able to measure a parameter. Parameters are measured independently (that is there is no coordination needed between the 2 roaming partners) and results are aggregated over the agreed monitoring period.

Drive Testing and Monitoring was not evaluated for this version.

Each GRQ test is referenced by a GRQ Test Code. For example, '*21BH'* refers to test parameter 21 (Service Accessibility SMS MO) measured by the HPMN using the SS7 Monitoring method.

Circuit Switched

Methods:		Monitoring by Roaming Hubbing Provider (R)			Monitoring by HPMN (H)			Monitoring by VPMN (V)		
		End-to-end Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring (CS11)	End-to-end Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring	End-to-end Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring
QoS Parameter	GRQ Test Code	A	B	C	A	B	C	A	B	C
Circuit Switched LU Success Ratio (CS LU – SR)	1	N Not applicable	Y (CS2)	N Not applicable	Y	Y (CS2)	N Not applicable	Y	Y	N. Not applicable
Circuit Switched Location Update Delay	2	N Not applicable	Y (CS3)	N Not applicable	Y (CS1)	Y (CS3)	N Not applicable	Y (CS1)	Y	N Not applicable
Service Accessibility Telephony – MO (SA-T-MO)	3	N Not applicable	N Not applicable	Y (CS10)	Y	N (CS4)	Y (CS10)	Y	Y	Y (CS11)
Service Accessibility Telephony – MT (SA-T-MT)	4	N Not applicable	N Not applicable	N	Y	Y	Y	Y	Y	Y (CS11)
Setup Time Telephony – MO (ST-T-MO)	5	N Not applicable	N Not applicable	Y (CS10)	Y	N (CS5)	Y (CS10)	Y	Y	Y (CS11)

Setup Time Telephony – MT (ST-T-MT)	6	N Not applicable	N Not applicable	N	Y	Y	Y (CS11)	Y	Y	Y (CS10)
Methods:		**Monitoring by Roaming Hubbing Provider (R)**			**Monitoring by HPMN (H)**			**Monitoring by VPMN (V)**		
		End-to-end Active Testing and Monitoring	**SS7 Monitoring**	**CAMEL Monitoring (CS11)**	**End-to-end Active Testing and Monitoring**	**SS7 Monitoring**	**CAMEL Monitoring**	**End-to-end Active Testing and Monitoring**	**SS7 Monitoring**	**CAMEL Monitoring**
Call Setup Success Ratio (CSSR – MO)	7	N Not applicable	N Not applicable	Y (CS10)	Y	N (CS5)	Y	Y	Y (CS6)	Y (CS11)
Call Setup Success Ratio (CSSR – MT)	8	N Not applicable	N Not applicable	N	Y	Y (CS6)	Y (CS11)	Y	Y	Y
ISUP signalling transparency (REL)	9	N Not applicable	N Not applicable	N	Y (CS20)	N (CS7)	Y (CS12)	Y (CS20)	N (CS15)	N (CS18,CS20)
ISUPv2 signalling transparency (OCN and RDN)	10	N Not applicable	N Not applicable	N	N	N (CS8)	Y.(CS10),(CS13)	N	N (CS16)	N (CS18, CS20)
Call Completion Rate Circuit Switched Telephony (CCR-CS-T)	11	N Not applicable	N Not applicable	Y (CS12)	Y	N (CS5)	Y	Y	Y	Y (CS11)

Average Length of a Call (ALOC)	12	N Not applicable	N Not applicable	Y (CS12, CS19)	N	N (CS4)	Y	N	Y	Y (CS19)
Methods:		**Monitoring by Roaming Hubbing Provider (R)**			**Monitoring by HPMN (H)**			**Monitoring by VPMN (V)**		
		End-to-end Active Testing and Monitoring	**SS7 Monitoring**	**CAMEL Monitoring (CS11)**	**End-to-end Active Testing and Monitoring**	**SS7 Monitoring**	**CAMEL Monitoring**	**End-to-end Active Testing and Monitoring**	**SS7 Monitoring**	**CAMEL Monitoring**
CLI Transparency	13a, 13b	N Not applicable	N Not applicable	N Not applicable	Y	N (CS4)	Y (CS10, CS13)	Y	N (CS17)	N (CS18)
Speech Quality (SpQ)	14a, 14b	N Not applicable	N Not applicable	N Not applicable	Y	N (CS9)	N (CS14)	Y	N (CS11)	N (CS18)

Table 4: Circuit Switched Test Parameters

Remarks:

- (CS1) The measurement might vary depending on the handset integrated in the active probe.
- (CS2) It is assumed that the Location Update (LU) success ratio is visible in the MAP signalling and can be monitored. In other words, it is assumed that the data-fill of the VLR is correct. The failures only happen at the HLR level and Steering of Roaming (SoR)-induced errors are filtered out.
- (CS3) Only for successful LU's and the measured duration is not the same as in VPMN
- (CS4) HPMN does not know when a call fails.
- (CS5) HPMN does not know when a call starts.
- (CS6) It is assumed that there is no cross talk.
- (CS7) HPMN cannot know which kind of release has been used.
- (CS8) HPMN cannot know which network was used for the call forwarding.

- (CS9) The method is non-intrusive.
- (CS10) It is assumed CAMEL works properly and the appropriate CAMEL capabilities are implemented/available.
- (CS11) Always in combination with a SS7 monitoring system
- (CS12) It is assumed the correct CAMEL parameters have been loaded for this call (that is BCSM Event Reports are in use).
- (CS13) Only in case of Home Routing.
- (CS14) CAMEL cannot measure voice quality.
- (CS15) The VPMN cannot know which release the B-party receives
- (CS16) The VPMN cannot know the OCN and RDN at the end of the call.
- (CS17) The VPMN cannot know the CLI of the B-Party
- (CS18) The SCP is at the HPMN side
- (CS19) Need to take into account the customer profile. Best to use only if HPMN customers are all CAMEL enabled.

SMS

4.2

	Methods:	Monitoring by Roaming Hubbing Provider (R)			Monitoring by HPMN (H)			Monitoring by VPMN (V)		
		End-to-end Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring	End-to-end Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring	End-to-end Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring
QoS Parameter	GRQ Test Code	A	B	C	A	B	C	A	B	C
Service Accessibility SMS MO (SA SMS MO)	21	N Not applicable	N(SM1)	N (SM1)	Y	N (SM1)	Y	Y	Y	Y (SM3)
Service Accessibility SMS MT (SA SMS MT)	22	N Not applicable	N (SM1)	N (SM1)	Y	Y	Y (SM3)	Y	N (SM1)	N (SM1)
Access Delay SMS MO (AD SMS-MO)	23	N Not applicable	N (SM2)	N	Y	N (SM2)	Y	Y	Y	Y (SM3)
Access Delay SMS MT (AD SMS-MT)	24	N Not applicable	N (SM1)	N (SM1)	Y	Y	Y (SM3)	Y	N (SM1)	N (SM1)
End-to-End Delivery Time for SMS-MO	25	N Not applicable	N (SM4)	N	Y (SM5)	Y (SM5)	Y (SM3)	Y	N (SM4)	N (SM4)
End-to-End Delivery Time for SMS-MT	26	N Not applicable	N (SM7)	N	Y (SM6)	Y (SM6)	Y (SM3)	Y	N (SM7)	N (SM7)

Table 5: SMS Test Parameters

Remarks:

- (SM1) Failed attempts will be missing
- (SM2) Actual Start time will be missing
- (SM3) Measurement may be based on standard SS7 procedure (MAP)
- (SM4) There is no knowledge beforehand to identify where the receiving side stands.
- (SM5) SM-MO from a roamer in a VPMN to a subscriber in the HPMN. Note a delivery time can only measure for complete and successful transactions.
- (SM6) SM-MT from a subscriber in the HPMN to a roamer in the VPMN
- (SM7) There is no knowledge to identify when the message is sent from the HPMN.

Packet Switched GPRS/UMTS

The HPMN decides which APNs are used for monitoring. For example, if there are 3 APN's for WEB, WAP and MMS, and they are specified in the IR.21, these may be used for measuring QoS for data. They may be specified in the "GPRS information - List of APN's available for testing and troubleshooting" section.

4.3

	Methods:	Monitoring by Roaming Hubbing Provider (R)			Monitoring by HPMN (H)			Monitoring by VPMN (V)		
		e2e Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring (PS13)	End-to-end Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring	End-to-end Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring
QoS Parameter	GRQ Test Code	A	B	C	A	B	C	A	B	C
Packet Switched LU Success Rate (PS LU – SR)	31	N/A	Y (PS2)	N/A	Y	Y (PS2)	N/A	Y	Y (PS2)	N/A
Packet Switched Location Update Delay (PS LU – D)	32	N/A	Y	N/A	Y (PS1)	Y	N/A	Y (PS1)	Y	N/A

Service accessibility for PSD (PDP-context activation success rate)	33	N/A	N/A	Y (PS8)	Y	Y (PS3)	Y (PS8)	Y	Y	Y (PS13)
Set-up Delay (ST PSD)	34	N/A	N/A	Y	Y	Y (PS4)	Y	Y	Y	Y (PS13)
PDP Context Cut-Off Ratio	35	N/A	N/A	Y	Y	N (PS5)	Y	Y	N (PS5)	Y (PS13)

Average PDP Context Session Time (per APN)	36	N/A	N/A	Y	N	Y	Y	N	Y	Y (PS13)
Throughput (Kbits/sec)	37	N/A	N/A	Y (PS9, PS15)	Y (PS6, PS14)	Y (PS15)	Y (PS9, PS15)	Y (PS14)	Y (PS15)	Y (PS9, PS15)
Goodput (Kbits/sec)	38	N/A	N/A	N (PS10)	Y (PS6, PS14)	Y (PS15)	N (PS10)	Y (PS14)	Y (PS15)	N (PS10)
Roundtrip time	39	N/A	N/A	N (PS11)	Y (PS6, PS14)	Y (PS7, PS15)	N (PS11)	Y (PS14)	Y (PS7, PS15)	N
Packet loss	40	N/A	N/A	N (PS12)	Y (PS6, PS14)	Y (PS7, PS15))	N (PS12)	Y (PS14)	Y (PS7, PS15)	N

Table 3: Packet Switched Test Parameters

Remarks:

- (PS1) The measurement might vary depending on the handset integrated in the active probe.
- (PS2) It is assumed that the LU success rate is visible in the MAP signalling and can be monitored. In other words, it is assumed that the data-fill of the VLR is correct. The failures only happen at the HLR level and SoR-induced errors are filtered out.
- (PS3) If successful activation or failed in the Gateway GPRS Support Node (GGSN) level
- (PS4) The time measurements will not be the same as in the VPMN.
- (PS5) No release cause provided in the MAP_DELETE_PDP_CONTEXT.
- (PS6) In order to limit the influence of the "internet" - not in control of the roaming partners - on the bearer-level measurements, it is recommended that the files/webpages accessed to measure the parameters are stored in a HPMN equipment.
- (PS7) Can be estimated at IP level (Gp interface).
- (PS8) Requires CAMEL ph3 GPRS-CSI.
- (PS9) Requires the CAMEL request (Charging Information).
- (PS10) Only the number of bytes sent and received are available – no distinction for retransmission.
- (PS11) Only the number of bytes sent and received are available and some timestamps. Not the roundtrip time.

- (PS12) The packets loss information is not transmitted in the CAMEL information. The CAMEL application may receive information about the volume transferred, but it does not know what the expected size of the transfer is. Therefore, it cannot estimate the lost packets.
- (PS13) In combination with SS7 methods.
- (PS14) To make it relevant and cost effective, the default value proposed for exchanged files in the case of active is 100KB.
- (PS15) Similarly, it proposed to track session for which minimum size is greater or equal to 100KB.

Voice CSFB

The CSFB feature is enabled in VPMN [4] [5] [6] [7].

		Monitoring by Roaming Hubbing provider (R)				Monitoring by HPMN (H)				Monitoring by VPMN (V)			
	Test method	e2e active test	Diameter monitoring	GTP-C monitoring	SS7 monitoring	e2e active test	Diameter monitoring	GTP-C monitoring	SS7 monitoring	e2e active test	Diameter monitoring	GTP-C monitoring	SS7 monitoring
KPI	GRQ test code	A	D	G	B	A	D	G	B	A	D	G	B
PS location update success ratio	101	N	Y	Y[6]	Y	Y	Y	Y	Y	Y	Y	Y	Y
PS location update delay	102	N	Y	Y[6]	Y	Y	Y	Y	Y	Y	Y	Y	Y
CSFB return to LTE success ratio – MO / MT	103a / 103b	N	N	N	N	Y	N	N	N	Y	N	N	N
CSFB return to LTE time – MO / MT	104a / 104b	N	N	N	N	Y	N	N	N	Y	N	N	N

		Monitoring by Roaming Hubbing Provider (R)			Monitoring by HPMN (H)			Monitoring by VPMN (V)		
	Test method	e2e active test	SS7 monitoring	CAMEL monitoring	e2e active test	SS7 monitoring	CAMEL monitoring	e2e active test	SS7 monitoring	CAMEL monitoring
KPI	GRQ test code	A	B	C	A	B	C	A	B	C
Service Accessibility Telephony – MO	3	N	N	Y	Y	N	Y	Y	Y	Y
Service Accessibility Telephony – MT	4	N	N	N	Y	Y	Y	Y	Y	Y
CSFB Setup Time Telephony – MO	115	N	N	Y	Y	N	Y	Y	Y	Y
CSFB Setup Time Telephony – MT	116	N	N	N	Y	Y	Y	Y	Y	Y
CSSR - MO	7	N	N	Y	Y	N	Y	Y	Y	Y
CSSR - MT	8	N	N	N	Y	Y	Y	Y	Y	Y

SMSoSGs

SMSoSGs allows to deliver SMS services over EPS NAS signalling without GERAN or UTRAN deployment [4] [5] [6] [7].

		Monitoring by Roaming Hubbing Provider (R)				Monitoring by HPMN (H)				Monitoring by VPMN (V)			
	Test method	e2e active test	Diameter monitoring	GTP-C monitoring	SS7 monitoring	e2e active test	Diameter monitoring	GTP-C monitoring	SS7 monitoring	e2e active test	Diameter monitoring	GTP-C monitoring	SS7 monitoring
KPI	GRQ test code	A	D	G	B	A	D	G	B	A	D	G	B
PS location update success ratio	101	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PS location update delay	102	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

		Monitoring by Roaming Hubbing Provider (R)			Monitoring by HPMN (H)			Monitoring by VPMN (V)		
	Test method	e2e active test	SS7 monitoring	CAMEL monitoring	e2e active test	SS7 monitoring	CAMEL monitoring	e2e active test	SS7 monitoring	CAMEL monitoring
KPI	GRQ test code	A	D	B	A	D	B	A	D	B
Service Accessibility SMS MO	21	N	N	N	Y	N	Y	Y	Y	Y
Service Accessibility SMS MT	22	N	N	N	Y	Y	Y	Y	N	N
Access Delay SMS MO	23	N	N	N	Y	N	Y	Y	Y	Y
Access Delay SMS MT	24	N	N	N	Y	Y	Y	Y	N	N
End-to-End Delivery Time for SMS-MO	25	N	N	N	Y	Y	Y	Y	N	N
End-to-End Delivery Time for SMS-MT	26	N	N	N	Y	Y	Y	Y	N	N

Packet Switched – LTE [5] [6] [7] [8]

		Monitoring by Roaming Hubbing Provider (R)			Monitoring by HPMN (H)			Monitoring by VPMN (V)		
	Test method	e2e active test	Diameter monitoring	GTP-C / U monitoring	e2e active test	Diameter monitoring	GTP-C / U monitoring	e2e active test	Diameter monitoring	GTP-C / U monitoring
KPI	GRQ test code	A	D	G	A	D	G	A	D	G
PS location update success ratio	101	N	Y	N	Y	Y	N	Y	Y	N
PS location update delay	102	N	Y	N	Y	Y	N	Y	Y	N
Default EPS bearer context activation success ratio	105	N	Y	Y[6]	Y	Y	Y	Y	Y	Y
Default EPS bearer context activation time	106	N	Y	Y[6]	Y	Y	Y	Y	Y	Y
DNS host name resolution success ratio	107	N	N		Y	N		Y	N	
DNS host name resolution time	108	N	N		Y	N		Y	N	
Default EPS bearer context cut-off ratio	109	N	N		Y	N		Y	N	
FTP {download | upload} IP service access success ratio	131a / 131b	N	N		Y	N		Y	N	
FTP {download | upload} IP service setup time	132a / 132b	N	N		Y	N		Y	N	
FTP {download | upload}	133a/ 133b	N	N		Y	N		Y	N	

session success ratio										
FTP {download | upload} session time	134a / 134b	N	N		Y	N		Y	N	
FTP {download | upload} mean data rate	135a/ 135b	N	N		Y	N		Y	N	
FTP {download | upload} data transfer success ratio	136a / 136b	N	N		Y	N		Y	N	
FTP {download | upload} data capacity	137a / 137b	N	N		Y	N		Y	N	
HTTP / HTTPS IP service access success ratio	141	N	N		Y	N		Y	N	
HTTP / HTTPS IP service setup time	142	N	N		Y	N		Y	N	
HTTP / HTTPS session success ratio	143	N	N		Y	N		Y	N	
HTTP / HTTPS session time	144	N	N		Y	N		Y	N	
HTTP / HTTPS mean data rate	145	N	N		Y	N		Y	N	
HTTP / HTTPS data transfer success ratio	146	N	N		Y	N		Y	N	
HTTP / HTTPS content compression ratio	147	N	N		Y	N		Y	N	
HTTP / HTTPS download data capacity	148	N	N		Y	N		Y	N	
PING packet loss ratio	151	N	N		Y	N		Y	N	
PING round trip time	152	N	N		Y	N		Y	N	

VoLTE, ViLTE and SMSoIP

VoLTE, ViLTE and SMSoIP quality KPIs are applicable to all VoLTE roaming architectures, S8HR, LBO-HR and LBO-VR (GSMA IR.65 [9]) when the end-to-end active test methodology is applied.

4.7 Test Methodology

This section details the methodology for each of the monitoring methods included in the GRQ Framework, and describes the general and specific conditions for all tests methods.

5

Each GRQ test is referenced by a GRQ Test Code. For example, '*21BH'* refers to test parameter 21 (Service Accessibility SMS MO) measured by the HPMN using the SS7 Monitoring method.

End-To-End Active Testing and Monitoring

5.1 General Information

5.1.1

When to measure:

5.1.1.1

Minimum six (6) tests per day.

Recommended: one (1) test every two (2) hours from 8am to 8pm, one (1) test every four (4) hours from 8pm to 8am.

5.1.1.2 Where to measure:

If Roaming Partner decides to publish its network topology, it is preferred that a limited number of test probes are spread across various representative VPMN MSC areas.

Radio level recommended: RX Level > -80dbm.

However, for some test cases, a RX Level > -70dbm is recommended in order to avoid any roaming issue reporting, while the service is only affected by only transient conditions (meteorological circumstances and so on)

5.1.1.3

Known Limitations

The testing is only performed at a limited number of locations. The measurement is limited in terms of number of geographic locations in the network that can be tested. This limitation has less influence when there are limited International Gateways used.

In case the PMN uses different core network vendors (MSC, Serving GPRS Support Node (SGSN), and so on) and decides to publish it, it would be ideal to test the QoS delivery for each network elements. It results it is recommended the active probe vendor to install one (1) probe per MSC, SGSN vendor region. However, this requirement might be difficult to achieve as the use of different vendors and the associated coverage is not public information to active probe vendors. Furthermore, it may lead to inefficient allocation of cost for installing probes. Example: in a country with three (3) operators, each having two (2) vendors, it might lead to the deployment up to four (4) probes in the worst case scenario.

GRQ Monitoring Pre-requisites

Steering of Roaming could influence some results: the cards used for testing will not be subject to steering (Blacklisting at the HPMN)

5.1.1.4 The receiving party is ready to receive SMS (no user errors like memory full, bad coverage, and so on)

For GPRS data transfer performance, the operator has to provide a file located in its GPRS network which can be transferred for the test. This file will be preferably on the GGSN in order to reduce the risk of packet loss independent of the roaming between the operators.

Requirements of active test equipment

ETSI TS 102 250-4 [2] defines the minimum requirements of QoS test equipment for mobile networks in the way that the values and trigger points needed to compute the QoS parameter as specified in IR.42 [1] can be measured. Test equipment fulfilling the specified minimum requirements will allow to perform the proposed measurements in a reliable and reproducible way.

5.1.1.1

GRQ test code

5.1.1.2 Based on the active test methodology, the terminology '*test probe'* is used overall in the section 5.1. The specifications of the test method for implementation contained in this section are also applied to a UE or a test UE which can provide observable test results at the GRQ test.

Each GRQ test is referenced by a GRQ Test Code which consists of a GRQ identifier (KPI number) and '*AH'* or '*AV'*. '*A*' denotes the end-to-end Active test methodology. '*H*' denotes the KPI for the outbound roaming quality to be tested at VPMN on behalf of HPMN or tested by HPMN itself. Similarly, '*V'* denotes the KPI for the inbound roaming quality to be tested at VPMN on behalf of VPMN or tested by VPMN itself. For example, '*203AV'* refers to the GRQ parameter 203 (Voice MO Accessibility) tested by a VPMN by using the active test methodology for the inbound roaming at the VPMN; '*203AH'* refers to the same GRQ parameter 203 tested by an HPMN by using the active test methodology for the outbound roaming at a VPMN.

5.1.2

GSM/GPRS and UMTS Test Specification

GRQ Test Code	Parameter	How to Measure	Test Specifics
CIRCUIT-SWITCHED			
1AH, 1AV	LU update success ratio	Force a location update via the modem, if there is steering the final result has to be the last location update of a maximum of five (5) attempts.	
2AH, 2AV	LU delay	Force a location update via the modem, if there is steering the delay of the last location update has to be taken into account. It is important that before starting, the simcards are	

GRQ Test Code	Parameter	How to Measure	Test Specifics
		registered on a different LAC in order to have a full location update.	
3AH, 3AV	NER-MO (Network Effectiveness Ratio on Mobile Originated calls in the visited network)	Generate a call from the probe located in the VPMN to a simcard of the probe located in the HPMN. The test is successful if the probe on the VPMN detects a ringing signal for the generated call.	
4AH, 4AV	NER-MT (Network Effectiveness Ratio on Mobile Terminated calls in the visited network)	Generate a call with a simcard from the probe located in the HPMN to a simcard on the probe located in the VPMN. The test is successful if the probe on the HPMN detects a ringing signal for the generated call.	
5AH, 5AV	PDD-MO (Post Dialling Delay)	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN. The delay is the time between the point where the call has been initiated and the ringing has been detected on the VPMN.	
6AH, 6AV	PDD-MT (Post Dialling Delay)	Generate a call with a simcard from the probe located in the HPMN to a simcard on the probe located in the VPMN. The delay is the time between the point where the call has been initiated and the ringing has been detected on the HPMN.	
7AH, 7AV	CSSR-MO (Call Setup Success Ratio on Mobile Originated calls in the visited network)	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN. The test is successful if the probe on the HPMN detects the ringing and picked up the call.	
8AH, 8AV	CSSR-MT (Call Setup Success Ratio on Mobile Terminated calls in the visited network)	Generate a call with a simcard from the probe located in the HPMN to a simcard on the probe located in the VPMN. The test is successful if the probe on the VPMN detects the ringing and picked up the call.	
9AH, 9AV	REL (ISUPv2 signalling transparency)	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN. At the end of the call, check if the release code is the same on both sides.	

GRQ Test Code	Parameter	How to Measure	Test Specifics
10AH, 10AV	OCN and RDN (ISUPv2 signalling transparency)	Generate a call with a simcard from the probe located in the HPMN to a simcard on the probe located in the VPMN. Forward this call to the HPMN and check if the OCN and RDN is correct.	
11AH, 11AV	CCR (Call Completion Rate Circuit)	Generate a call with a simcard on the probe located in the VPMN to a simcard from the probe located in the HPMN. Answer the call and after a time hang up the call again. If the call has not been interrupted, the call is successful. Recommended duration: 2 minutes.	Reasonable radio level required: RxLev > -70dbm.
12AH, 12AV	ALOC	N/A	
13AH, 13AV	CLI transparency	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN. Check at the HPMN if the CLI is in a dialable format to call back the A-party	
14AH, 14AV	SpQ (Speech Quality)	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN and answer the call. Uplink voice quality: play a standard file in the VPMN and record this file in the HPMN and calculate the voice quality. Downlink voice quality: play a standard file in the HPMN and record this file in the VPMN and calculate the voice quality. Recommended duration: 2 minutes. If the sample is played/analysed multiple times, the end-result of the test is the average of the individual voice quality assessments. If the sample is played/analysed multiple times, the end-result of the test is the average of the individual voice quality assessments.	Reasonable radio level required: RxLev > -70dbm.
SMS			
21AH, 21AV	Service Accessibility SMS MO (SA SMS MO)	Send and SMS from a subscriber from the HPMN located on the VPLMN to a subscriber from the HPMN located in the HPMN using the HPMN SMSC, if	

GRQ Test Code	Parameter	How to Measure	Test Specifics
		the positive acknowledgement of the SMSC is received the tests is OK.	
22AH, 22AV	Service Accessibility SMS MT (SA SMS MT)	Send and SMS from a subscriber from the HPMN located on the HPMN to a subscriber from the HPMN located in the VPLMN using the HPMN SMSC, if the SMS is received the test is OK.	Reasonable radio level required: RxLev > -70dbm.
23AH, 23AV	Access Delay SMS MO (AD SMS-MO)	Send and SMS from a subscriber from the HPMN located on the VPLMN to a subscriber from the HPMN located in the HPMN using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification from the SMSC that the message has been sent.	
24AH, 24AV	Access Delay SMS MT (AD SMS-MT)	Send an SMS from a subscriber from the HPMN located on the HPMN to a subscriber from the HPMN located in the VPLMN using the HPMN SMSC. Measure the time between the notification from the SMSC that the message has been sent and the notification on the B-party that the message has arrived.	Reasonable radio level required: RxLev > -70dbm.
25AH, 25AV	End-to-End Delivery Time for SMS-MO	Send an SMS from a subscriber from the HPMN located on the VPLMN to a subscriber from the HPMN located in the HPMN using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification on the B-party that the message has arrived.	Reasonable radio level required: RxLev > -70dbm.
26AH, 26AV	End-to-End Delivery Time for SMS-MT	Send an SMS from a subscriber from the HPMN located on the HPMN to a subscriber from the HPMN located in the VPLMN using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification on the B-party that the message has arrived.	Reasonable radio level required: RxLev > -70dbm.
PACKET-SWITCHED			
31AH, 31AV	Packet Switched LU Success Ratio (PS LU – SR)	Start manually a GPRS attach on the VPLMN, after the GSM location has been performed. If the GPRS attached is confirmed, the test is OK.	
32AH,	Packet Switched Location Update Delay (PS LU –	Start manually a GPRS attach on the VPLMN, after the GSM location has	

GRQ Test Code	Parameter	How to Measure	Test Specifics
32AV	D)	been performed. Measure the time between start and end of the GPRS attach.	
33AH, 33AV	Service accessibility for PSD (PDP-context activation success ratio)	Start the PDP context activation after the GPRS attach on the VPLMN. If the PDP context has been confirmed, the test is successful	
34AH, 34AV	Set-up Delay (ST PSD)	Start the PDP context activation after the GPRS attach on the VPLMN. Measure the time between the start and the acknowledgement of the PDP context activation.	
35AH, 35AV	PDP Context Cut-Off Ratio (session Stability measured at PDP context or PS level)	Start a PDP context, keep it open during a certain time and close it again. If the session is still open the test is OK.	Reasonable radio level required: RxLev > -70dbm.
36AH, 36AV	Average PDP Context Session Time (per APN)	N/A	
37AH, 37AV	Throughput (Kbits/sec)	Start downloading a reference file and measure the time from the start of the download till the end of file detection.	Reasonable radio level required: RxLev > -70dbm.
38AH, 38AV	Goodput (Kbits/sec)	Start downloading a reference file and measure the time from the start of the download till the end of file detection and count the used bytes	Reasonable radio level required: RxLev > -70dbm.
39AH, 39AV	Roundtrip time	Measure the time between sending a TCP packet and receiving the acknowledgement of the reception.	
40AH, 40AV	Packet loss	Count the TCP packets sent and count the TCP packets received for a file transfer.	Reasonable radio level required: RxLev > -70dbm.

Table 1: Test Procedures Table

5.1.3 LTE/EPC test specification

In order to ensure a reasonable test result, the radio power level from an LTE cell at the UE Rx antenna requires to fulfil: RxLev > -85 dbm / 15kHz.

5.1.3.1 Voice CSFB

The CSFB feature is enabled at VPMN.

If the VPMN has implemented the voice CS fallback to GSM and to UMTS, the relevant KPI for those radio technologies shall be separately measured.

H-party is a subscriber from the HPMN located in the HPMN.

R-party is a subscriber from the HPMN located in the VPMN and has the UE CSFB capable.

GRQ Test Code	Parameter	How to Measure	Test specifics
101AH, 101AV	PS location update success ratio	Configure the UE in CS/PS mode and initiate a combined location update (EPS/IMSI attach) in VPMN. Observe whether the network type indicator is LTE. If there is steering the end result shall be the last location update of maximum five (5) attempts.	
102AH, 102AV	PS location update delay	Configure the UE in CS/PS mode and trigger a combined location update (EPS/IMSI attach) in VPMN. In order to ensure a full location update, the USIM was registered on a different TAC and LAC before testing. Measure the time between the initiation of attach and LTE network type indicated. If there is steering the delay of the last location update is taken into account.	
103aAH, 103aAV	CSFB return to LTE success ratio – MO	Configure the UE in CS/PS mode and select LTE as preferable radio access technology. Make a successful CS MO phone call in VPMN and release the call. Observe whether the network type indicator on the UE display switches to LTE.	GSM or UMTS power level: RxLev > -70dbm.
103bAH, 103bAV	CSFB return to LTE success ratio - MT	Configure the UE in CS/PS mode and select LTE as preferable radio access technology. Make a successful CS MT phone call in VPMN and release the call. Observe whether the network type indicator on the UE display switches to LTE.	GSM or UMTS power level: RxLev > -70dbm.
104aAH, 104aAV	CSFB return to LTE time - MO	Configure the UE in CS/PS mode and select LTE as preferable radio access technology. Make a successful CS MO phone call in VPMN and release the call. Measure the time from the CS call release to the UE returning to LTE.	GSM or UMTS power level: RxLev > -70dbm.

104bAH, 104bAV	CSFB return to LTE time - MT	Configure the UE in CS/PS mode and select LTE as preferable radio access technology. Make a successful CS MT phone call in VPMN and release the call. Measure the time from the CS call release to the UE returning to LTE.	GSM or UMTS power level: RxLev > -70dbm.
3AH, 3AV	Service Accessibility Telephony – MO	UE registered in VPMN and the network type indicates LTE. R-party initiates a voice call to H-party. Observe whether ALERTING message is received at R-party and H-party rings.	GSM or UMTS power level: RxLev > -70dbm
4AH, 4AV	Service Accessibility Telephony – MT	UE registered in VPMN and the network type indicates LTE. H-party initiates a voice call to R-party. Observe whether the ALERTING message is received at H-party and R-party rings.	GSM or UMTS power level: RxLev > -70dbm
115AH, 115AV	CSFB Setup Time Telephony – MO (PDD-MO)	UE registered in VPMN and the network type indicates LTE. R-party initiates a voice call to H-party. Measure the time between the call initiation at R-party and ALERTING received at R-party.	GSM or UMTS power level: RxLev > -70dbm
116AH, 116AV	CSFB Setup Time Telephony – MT (PDD-MT)	UE registered in VPMN and the network type indicates LTE. H-party initiates a voice call to R-party. Measure the time between the call initiation at H-party and ALERTING sent at R-party.	GSM or UMTS power level: RxLev > -70dbm
7AH, 7AV	CSSR-MO (Call Setup Success Ratio on Mobile Originated calls in the visited network)	Generate a MO call with a SIM card from the probe located in the VPMN to a SIM card from the probe located in the HPMN. The test is successful if the probe on the HPMN detects the ringing and picks up the call.	GSM or UMTS power level: RxLev > -70dbm
8AH, 8AV	CSSR-MT (Call Setup Success Ratio on Mobile Terminated calls in the visited network)	Generate a MT call with a SIM card from the probe located in the HPMN to a SIM card from the probe located in the VPMN. The test is successful if the probe on the VPMN detects the ringing and picks up the call.	GSM or UMTS power level: RxLev > -70dbm

5.1.3.1

SMSoSGs

VPMN supports and enables SMSoSGs.

H-party is a subscriber from the HPMN located in the HPMN

R-party is a subscriber from the HPMN located in the VPMN

GRQ Test Code	Parameter	How to Measure	Test specifics
101AH, 101AV	PS location update success ratio	Configure the UE in CS/PS mode and initiate a combined location update (EPS/IMSI attach) in VPMN. Observe whether the network type	

		indicator is LTE. If there is steering the final result shall be the last location update of maximum five (5) attempts.	
102AH, 102AV	PS location update delay	Configure the UE in CS/PS mode and initiate a combined location update (EPS/IMSI attach) in VPMN. In order to ensure a full location update, the USIM was registered on a different TAC and LAC before testing. Measure the time between the initiation of attach and LTE network type indicated. If there is steering the delay of the last location update is taken into account.	
21AH, 21AV	Service Accessibility SMS MO (SA SMS MO)	Send an SMS from R-party to H-party, using the HPMN SMSC, Observe if the positive acknowledgement of the SMSC is received.	
22AH, 22AV	Service Accessibility SMS MT (SA SMS MT)	Send an SMS from H-party to R-party, using the HPMN SMSC. Observe if the positive acknowledgement of the SMSC is received.	.
23AH, 23AV	Access Delay SMS MO (AD SMS-MO)	Send an SMS from R-party to H-party, using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification from the SMSC that the message has been sent.	
24AH, 24AV	Access Delay SMS MT (AD SMS-MT)	Send an SMS from H-party to R-party, using the HPMN SMSC. Measure the time between the notification from the SMSC that the message has been sent and the notification at the R-party that indicates that the message has arrived.	
25AH, 25AV	End-to-End Delivery Time for SMS-MO	Send an SMS from R-party to H-party, using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification at the H-party that the message has arrived.	
26AH, 26AV	End-to-End Delivery Time for SMS-MT	Send an SMS from H-party to R-party, using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification on the R-party that the message has arrived.	

5.1.3.2

LTE Data

GRQ Test Code	Parameter	How to Measure	Test specifics
101AH, 101AV	PS location update success ratio	Configure the UE in PS mode and initiate a location update (EPS attach) in VPMN. Observe whether the network type indicator is LTE. If there is steering the final result shall be	

		the last location update of maximum five (5) attempts.	
102AH, 102AV	PS location update delay	Configure the UE in PS mode and initiate a combined location update (EPS attach) in VPMN. In order to ensure a full location update, the USIM was registered on a different TAC before testing. Measure the time between the initiation of attach and LTE network type indicated. If there is steering the delay of the last location update is taken into account.	
105AH, 105AV	Default EPS bearer context activation success ratio	Configure the UE in PS mode and initiate a location update (EPS attach) in VPMN. Observe whether ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message is received by the UE.	
106AH, 106AV	Default EPS bearer context activation time	Trigger an EPS attach at UE and measure the time between UE sending attach request and attach complete	
107AH, 107AV	DNS host name resolution success ratio	From VPMN request a DNS server to resolve a host name in HPMN and observe whether the host address is resolved successfully.	
108AH, 108AV	DNS host name resolution time	From VPMN request a DNS server to resolve a host name in HPMN and measure the time to perform the host name and address translation.	
109AH, 109AV	Default EPS bearer context cut-off ratio	Observe whether the UE in VPMN is detached by the network initiation after each LTE attach or after each LTE application usage (voice CSFB, HTTP/HTTPS, FTP or PING).	
131aAH, 131aAV	FTP download IP service access success ratio	Initiate in VPMN to download a FTP binary file from a FTP server. Observe whether the file contents downloading starts.	
131bAH, 131bAV	FTP upload IP service access success ratio	Initiate in VPMN to upload a FTP binary file to a FTP server. Observe whether the file content uploading starts.	
132aAH, 132aAV	FTP download IP service setup time	Initiate in VPMN to download a FTP binary file from a FTP server. Measure the time between the initiation and the start of the file contents downloading.	
132bAH, 132bAV	FTP upload IP service setup time	Initiate in VPMN to upload a FTP binary file to a FTP server. Measure the time between the initiation and the start of the file contents uploading.	
133aAH, 133aAV	FTP download session success ratio	Initiate in VPMN to download a FTP binary file from a FTP server. Observe whether the complete file is downloaded.	
133bAH, 133bAV	FTP upload session success ratio	Initiate in VPMN to upload a FTP binary file to a FTP server. Observe whether the complete	

		file is uploaded.	
134aAH, 134aAV	FTP download session time	Initiate in VPMN to download a FTP binary file from a FTP server. Measure the time between the initiation and the complete file content downloaded.	
134bAH, 134bAV	FTP upload session time	Initiate in VPMN to upload a FTP binary file to a FTP server. Measure the time between the initiation and the complete file content uploaded.	
135aAH, 135aAV	FTP download mean data rate	Initiate in VPMN to download a FTP binary file from a FTP server. Measure the time between the first data packet received containing the file contents and the last data packet received containing the file content.	
135bAH, 135bAV	FTP upload mean data rate	Initiate in VPMN to upload a FTP binary file to a FTP server. Measure the time between the first data packet sent containing the file contents and the last data packet sent containing the file content.	
136aAH, 136aAV	FTP download data transfer success ratio	Initiate in VPMN to download a FTP binary file from a FTP server. Observe whether all data packets containing the file content (from the first one to the last one) is successfully received.	
136bAH, 136bAV	FTP upload data transfer success ratio	Initiate in VPMN to upload a FTP binary file to a FTP server. Observe whether all data packets containing the file content (from the first one to the last one) is successfully sent.	
137aAH, 137aAV	FTP download data capacity	Initiate in VPMN multiple TCP/IP connections to download one or multiple FTP files from one or multiple FTP servers in parallel. Observe the max. capacity of the data pipe is reached.	
137bAH, 137bAV	FTP upload data capacity	Initiate in VPMN multiple TCP/IP connections to upload one or multiple FTP files to one or multiple FTP servers in parallel. Observe the max. capacity of the data pipe is reached.	
141AH, 141AV	HTTP / HTTPS IP service access success ratio	Initiate in VPMN to download an HTTP / HTTPS Web page. Observe whether downloading the Web page contents starts.	
142AH, 142AV	HTTP / HTTPS IP service setup time	Initiate in VPMN to download an HTTP / HTTPS Web page. Measure the time between the initiation and the start of downloading the Web page contents.	
143AH, 143AV	HTTP / HTTPS session success ratio	Initiate in VPMN to download an HTTP / HTTPS Web page. Observe whether the complete Web page contents are downloaded.	
144AH, 144AV	HTTP / HTTPS session time	Initiate in VPMN to download an HTTP / HTTPS Web page. Measure the time between	

		the initiation and the complete Web page contents downloaded.	
145AH, 145AV	HTTP / HTTPS mean data rate	Initiate in VPMN to download an HTTP / HTTPS Web page. Measure the time between the first data packet received containing the Web page content and the last data packet received containing the Web page content.	
146AH, 146AV	HTTP / HTTPS data transfer success ratio	Initiate in VPMN to download an HTTP / HTTPS Web page. Observe whether all data packets containing the Web page content (from the first one to the last one) is successfully received.	
147AH, 147AV	HTTP / HTTPS content compression ratio	Initiate in VPMN to download an HTTP / HTTPS Web page. Measure the entire size of the Web page contents received and compare with the original HTTP / HTTPS contents sent.	The size of the original Web page content sent is known.
148AH, 148AV	HTTP / HTTPS download data capacity	Initiate in VPMN multiple TCP/IP connections to download one or multiple Web pages from one or multiple HTTP / HTTPS servers in parallel. Observe the max. capacity of the data pipe is reached.	
151AH, 151AV	PING packet loss ratio	From VPMN send an ICMP echo request with a certain number of PING packets to be sent as parameter. Observe whether ICMP echo reply is received.	
152AH, 152AV	PING round trip time	From VPMN send an ICMP echo request with a certain number of PING packets to be sent as parameter. Measure the time between ICMP echo sent and ICMP echo reply received.	

5.1.4

VoLTE / ViLTE and SMSoIP GRQ test specification

When implementing the test methods in this section, the test message sequences and the default message contents are referred to 3GPP TS 34.229-1 [13] and 3GPP TS 36.508 [14].

Based on the active test methodology, the terminology '*test probe'* is used overall in this section. The descriptions of the test method for implementation containing in this section are also applied to a UE or a test UE which can provide observable test results at the GRQ test.

Each GRQ test is referenced by a GRQ Test Code which consists of a GRQ identifier (KPI number) and of '*AH'* or '*AV'*. '*A*' denotes the end-to-end Active test methodology. '*H*' denotes the KPI for the inbound roaming quality to be tested at HPMN. Similarly, '*V'* denotes the KPI for the outbound roaming quality to be tested at VPMN. For example, '*203AV'* refers to the GRQ parameter 203 (Voice MO Accessibility) tested at the VPMN by using the active test methodology for the outbound roaming; '*203AH'* refers to the same GRQ parameter 203 tested at the HPMN by using the active test methodology for the inbound roaming.

VoLTE

5.1.4.1

For the VoLTE GRQ test, the test probe shall be configured in accordance with GSMA IR.92 [11], annex C.3, with the exception of the parameter “Voice and/or Video over LTE allowed while roaming” that should be set to “voice allowed while roaming”. The test probe is attached to the LTE network.

The LTE network shall indicate at the (UE) EPS attach that the IMS voice over PS session in S1 mode is supported.

H-party is a subscriber from the HPMN located in the HPMN. R-party is a subscriber from the HPMN located in the VPMN.

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
201AH, 201AV	IMS Registration success ratio	Initiate an IMS registration in VPMN for IMS multimedia telephony service (VoLTE) at test probe. Observe whether the registration is successfully completed by receiving NOTIFY for registration event package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to TS 34.229-1, C.2 [13]). To ensure a full IMS registration, initiate an (UE) deregistration if it is already IMS registered.	
202AH, 202AV	IMS Registration time	Initiate an IMS registration in VPMN for IMS multimedia telephony service (VoLTE). Measure the time between the test probe sending the initial REGISTER request for IMS registration and receiving NOTIFY for registration event package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to 3GPP TS 34.229-1, C.2 [13]). To ensure a full IMS registration, initiate an (UE) deregistration if it is already IMS registered.	
203AH, 203AV	Voice MO accessibility	Initial a VoLTE MO call from a test probe at VPMN to HPMN. The call is successful if 180 Ringing is received at VPMN. The test probe at HPMN shall send 180 Ringing unreliably i.e. not containing "Require: 100rel”.	
204AH, 204AV	Voice MT accessibility	Initial a VoLTE MT call from HPMN to a test probe at VPMN. The call is successful if 180 Ringing is received at HPMN from the test probe at VPMN. The test probe at VPMN shall send 180 Ringing unreliably, i.e. not containing "Require: 100rel”.	
205AH, 205AV	Voice MO session setup time	Make a successful VoLTE MO call from a test probe at VPMN to HPMN. Measure the time between sending INVITE and receiving 200 OK (INVITE) (ref. to 3GPP TS 34.229-1, C.21 [13]). The time for the HPMN user accepting the incoming call is excluded in the calculation.	
206AH, 206AV	Voice MT session setup time	Make a successful VoLTE MT call from HPMN to a test probe at VPMN. Measure the time between receiving INVITE and receiving ACK for 200 OK	

		(INVITE) (ref. to 3GPP TS 34.229-1, C.11 [13]). The time for the VPMN user accepting the incoming call is excluded in the calculation.	
207AH, 207AV	Voice MO session setup ratio	Initial a VoLTE MO call from a test probe at VPMN to HPMN. The session is successfully established if 200 OK (INVITE) is received at VPMN.	
208AH, 208AV	Voice MT session setup ratio	Initial a VoLTE MT call from HPMN to a test probe at VPMN. The call is successfully established if ACK for 200 OK (INVITE) is received by the test probe at VPMN.	
211AH, 211AV	Voice MO session duration	Make a successful VoLTE MO call from a test probe at VPMN to HPMN. Measure the time at the test probe of VPMN between receiving 200 OK (INVITE) and receiving 200 OK (BYE) – using the MO call release in the test (ref. to 3GPP TS 34.229-1, C.21, C.32 [13]).	
212AH, 212AV	Voice MT session duration	Make a successful VoLTE MT call from HPMN to a test probe at VPMN. Measure the time at the test probe of HPMN between receiving ACK for 200 OK (INVITE) and receiving BYE – using the MT call release in the test (ref. to 3GPP TS 34.229-1, C.11, C.33 [13]).	
213AH, 213AV	OIP transparency MO	Make a successful VoLTE MO call from a test probe at VPMN to HPMN and check at the test probe of HPMN if the OIP results in a dial able format (ref. to GSMA IR.92, 2.3.12 [11]) to call back the call originator at VPMN.	
210AH, 210AV	OIP transparency MT	Make a successful VoLTE MT call from HPMN to a test probe at VPMN and check at the test probe of VPMN if the OIP results in a dial able format to call back the call originator at HPMN.	
214AH, 214AV	SpQ on call basis at R-party	Make a successful VoLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the test probe at HPMN and record this file in the test probe at VPMN and calculate the voice quality per POLQA as specified in ITU-T P.863 [16]. Recommended duration of the audio reference file: 8 - 32s. The sample is played/analysed. The end-result of the test is a pre-aggregation of the measured MOS-LQO values to *one value per call*.	
215AH, 215AV	SpQ on call basis at H-party	Make a successful VoLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the probe at VPMN and record this file in the probe at HPMN and calculate the voice quality per POLQA as specified in ITU-T P.863 [16]. Recommended duration of the audio reference file: 8 - 32s. The sample is played/analysed. The end-result of the test is a pre-aggregation of the measured MOS-LQO values to *one value per call*.	
216AH, 216AV	SpQ R-factor at R-party	Make a successful VoLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the test probe at HPMN and record this file in the test probe at VPMN and calculate the voice	

		quality. The sample is played/analysed. Recommended duration of the audio reference file: 8 - 32s. The end-result of the test is the R-factor LQ (Listening Quality) calculated per ITU-T G.107 [17].	
217AH, 217AV	SpQ R-factor at H-party	Make a successful VoLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the probe at VPMN and record this file in the probe at HPMN and calculate the voice quality. The sample is played/analysed. Recommended duration of the audio reference file: 8 - 32s. The end-result of the test is the R-factor LQ (Listening Quality) calculated per ITU-T G.107 [17].	
230AH, 230AV	SRVCC MO success ratio	Make a VoLTE MO call from a test probe at VPMN to a test probe at HPMN and trigger an SRVCC PS to CS event at VPMN. The test is successful if a TMSI REALLOCATION COMMAND message is received by the test probe in the target 2G/3G cell of VPMN, and - In case of SRVCC pre-alerting phase, CS call establishment is continued, CC_ALERTING and CONNECT are received (ref. to 3GPP TS 36.523-1, 13.4.3.7 [15]). - In case of SRVCC alerting phase, CS call establishment is continued, CONNECT is received (ref. to 3GPP TS 36.523-1, 13.4.3.21 [15]). The voice channel is through connected in the target 2G/3G cell of VPMN. - In case of SRVCC mid-call phase, the voice channel is through connected in the target 2G/3G cell of VPMN.	
231AH, 231AV	SRVCC MT success ratio	Make a VoLTE MT call from HPMN to a test probe at VPMN and trigger an SRVCC PS to CS event at VPMN. The test is successful if a TMSI REALLOCATION COMMAND message is received by the test probe in the target 2G/3G cell of VPMN, and - In case of SRVCC pre-alerting or alerting phase, CS call establishment is continued, CONNECT ACKNOWLEDGE is received (ref. to 3GPP TS 36.523-1, 13.4.3.10 [15]). The voice channel is through connected in the target 2G/3G cell of VPMN. - In case of SRVCC mid-call phase, the voice channel is through connected in the target 2G/3G cell of VPMN.	
232AH, 232AV	SRVCC MO success time	Make a VoLTE MO call from a test probe at VPMN to a test probe at HPMN and trigger an SRVCC PS to CS event at VPMN. - In case of SRVCC pre-alerting or alerting phase, measure the time between receiving MobilityFromEUTRACommand in the E-UTRAN cell and receiving CONNECT in the target 2G/3G cell (ref. to 3GPP TS 36.523-1, 13.4.3.7 [15]). - In case of SRVCC mid-call phase, two test	

		methods are applied. a) Measure the time at the test probe of VPMN between receiving MobilityFromEUTRACommand in the E-UTRAN cell and receiving TMSI REALLOCATION COMMAND in the target 2G/3G cell. b) An average of downlink voice interruption time at the two probes of VPMN and HPMN. The time for the HPMN user accepting the incoming call is excluded in the calculation.	
233AH, 233AV	SRVCC MT success time	Make a VoLTE MT call from a test probe HPMN to a test probe at VPMN and trigger an SRVCC PS to CS event at VPMN. - In case of SRVCC pre-alerting or alerting phase, measure the time between receiving MobilityFromEUTRACommand in the E-UTRAN cell and receiving CONNECT ACKNOWLEDGE in the target 2G/3G cell (ref. to TS 36.523-1, 13.4.3.10 [15]). - In case of SRVCC mid-call phase, two test methods are applied. a) Measure the time at the test probe of VPMN between receiving MobilityFromEUTRACommand in the E-UTRAN cell and receiving TMSI REALLOCATION COMMAND in the target 2G/3G cell. b) An average of downlink voice interruption time at the two probes of VPMN and HPMN. The time for the VPMN user accepting the incoming call is excluded in the calculation.	

Table 2: VoLTE service level GRQ test descriptions for active test methodology

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
Network quality parameters (ref. to 3GPP TS 36.508 [14])			
240AH, 240AV	Default EPS bearer context activation success ratio	The test probe initiates an EPS attach in VPMN and create the PDN connection to the IMS well-known APN (ref. to GSMA IR.88, 6.3 [10]). The test is successful if the default bearer with QCI 5 is established.	
241AH, 241AV	Default EPS bearer context activation time	The test probe initiates an EPS attach in VPMN and create the PDN connection to the IMS well-known APN. Measure the time between sending ATTACH REQUEST and sending ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT piggybacked on ATTACH COMPLETE (ref. to 3GPP TS 36.508, 4.5.2 [14]).	
242AH, 242AV, 243AH, 243AV,	Default EPS bearer QCI, Default EPS bearer UL AMBR, Default EPS bearer DL	Read ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST (NAS): QCI, AMBR Note: AMBR values for a non-GBR bearer are	

244AH, 244AV	AMBR	applied to across all non-GBR bearers for the IMS “well known” APN	
245AH, 245AV	Dedicated EPS bearer context activation success ratio (audio)	By initiating an MO call in VPMN, the test probe creates the dedicated EPS bearer context for the voice media. The test is successful if the dedicated bearer with QCI 1 is established.	
246AH, 246AV	Dedicated EPS bearer context activation time (audio)	Create a dedicated EPS bearer context for the voice media and measure the time between receiving ACTIVATE DEDICATED EPS BEARER CONTEXT REQUEST and sending ACTIVATE DEDICATED EPS BEARER CONTEXT ACCEPT (ref. to 3GPP TS 36.508, 4.5A.6 [14]).	
247AH, 247AV, 248AH, 248AV, 249AH, 249AV	Dedicated EPS bearer QCI, Dedicated EPS bearer UL GBR, Dedicated EPS bearer DL GBR	Read from *EPS quality of service* information element in ACTIVATE DEDICATED EPS BEARER CONTEXT REQUEST (NAS): QCI, Guaranteed bit rate for uplink and Guaranteed bit rate for downlink	
250AH, 250AV	IP data volume received on QCI5 bearer at R-party	Count the accumulated data received in a certain period at the IP ports (TCP and UDP) on the QCI5 EPS AM bearer in the test probe at VPMN	
251AH, 251AV	IP data volume transmitted on QCI5 bearer at R-party	Count the accumulated data transmitted in a certain period at the IP ports (TCP and UDP) on the QCI5 EPS AM bearer in the test probe at VPMN	
252AH, 252AV	IP data volume received on QCI5 bearer at H-party	Count the accumulated data received in a certain period at the IP ports (TCP and UDP) on the QCI5 EPS AM bearer in the test probe at HPMN	
253AH, 253AV	IP data volume transmitted on QCI1 bearer at H-party	Count the accumulated data transmitted in a certain period at the IP ports (TCP and UDP) on the QCI5 EPS AM bearer in the test probe at HPMN	
254AH, 254AV	IP data volume received on QCI1 bearer at R-party	Count the accumulated data received in a certain period at the IP port (UDP) on the QCI1 EPS UM bearer in the test probe at VPMN	
255AH, 255AV	IP data volume transmitted on QCI1 bearer at R-party	Count the accumulated data transmitted in a certain period at the IP port (UDP) on the QCI1 EPS UM bearer in the test probe at VPMN	
256AH, 256AV	IP data volume received on QCI1 bearer at H-party	Count the accumulated data received in a certain period at the IP port (UDP) on the QCI1 EPS UM bearer in the test probe at HPMN	
257AH, 257AV	IP data volume transmitted on QCI1 bearer at H-party	Count the accumulated data transmitted in a certain period at the IP port (UDP) on the QCI1 EPS UM bearer in the test at HPMN	
RTP transport quality parameters (ref. to IR.42 [1])			
260AH, 260AV, 261AH, 261AV, 262AH, 262AV, 263AH, 263AV	RTP max packet delay variation R2H, RTP max packet delay variation H2R, RTP mean packet delay variation R2H, RTP mean packet delay variation H2R	Make the test probe at VPMN an MO call, analyse the RTP streams at the both ends (for a duration of the audio reference file in 8 - 32s) and calculate the max. and mean packet delay variations (ref. to GSMA IR.42 [1]) in the R2H direction at HPMN, and in the H2R direction at VPMN	

264AH, 264AV, 265AH, 265AV	RTP mean interarrival jitter of incoming streaming R2H RTP mean interarrival jitter of incoming streaming H2R	Make the test at VPMN an MO call, analyse the RTP streams at the both ends (for a duration of the audio reference file in 8 - 32s) and calculate the RTP mean interarrival jitter of incoming streaming (ref. to GSMA IR.42 [1]) in the R2H direction at HPMN, and in the H2R direction at VPMN	
266AH, 266AV, 267AH, 267AV	RTP mean data rate transmitted R2H (audio) RTP mean data rate received H2R (audio)	Make the test probe at VPMN an MO call, count the total data transmitted and received respectively in a certain period, and calculate the average data rate (ref. to IR.42 [1]) transmitted and received of the probe at VPMN at that period.	
268AH, 268AV, 269AH, 269AV	RTP mean data rate transmitted H2R (audio) RTP mean data rate received R2H (audio)	Make a VoLTE MT call from HPMN to a test probe at VPMN, count the total data transmitted and received respectively at the VoLTE test probe of HPMN in a certain period and calculate the average data rate (ref. to IR.42 [1]) transmitted and received of the probe at HPMN at that period.	
270AH, 270AV, 271AH, 271AV	RTP packets lost R2H RTP packets lost H2R	Make the test at VPMN an MO call to a test probe at HPMN, count the total number of the missing RTP sequence numbers in a certain period at the home probe of HPMN and at the roaming probe of VPMN.	
272AH, 272AV, 273AH, 273AV	RTP packets lost ratio R2H RTP packets lost ratio H2R	Make the test probe at VPMN an MO call to a test probe at HPMN, within a certain period: - Count the total number of the missing RTP sequence numbers - Count the total number of RTP packets received - Calculate the portion of lost packets (ref. to GSMA IR.42 [1]) at the roaming probe of VPMN and at the home probe of HPMN.	
274AH, 274AV, 275AH, 275AV	RTP round-trip delay (RHR) RTP round-trip delay (HRH)	Make the test probe at VPMN an MO call to a test probe at HPMN, within a certain period calculate the average transfer time of RTP packets (ref. to GSMA IR.42 [1]) - from the roaming probe of VPMN to the home probe of HPMN and looped back to the roaming probe, - from the home probe of HPMN to the roaming probe of VPMN and looped back to the home probe	

Table 3: VoLTE network / transport level GRQ test descriptions for active test methodology

5.1.4.2 The transport level KPIs are tested if the two ends (R-party and H-party) are VoLTE capable, i.e. RTP packets are end-to-end transported between the two end entities.

ViLTE

For the ViLTE GRQ test, the test probe shall be configured in accordance with

- GSMA IR.92 [11], annex C.3, with the exception that the parameter “Voice and/or Video over LTE allowed while roaming” is set to “voice over LTE allowed while roaming”.

- GSMA IR.94 [12], annex C.3, with the exception that the parameter “Voice and/or Video over LTE allowed while roaming” is set to “voice and Video over LTE allowed while roaming”.

The test probe is attached to the LTE network.

The LTE network shall indicate at the (UE) EPS attach that the IMS voice over PS session in S1 mode supported.

H-party is a subscriber from the HPMN located in the HPMN. R-party is a subscriber from the HPMN located in the VPMN.

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
301AH, 301AV	IMS Registration success ratio (ViLTE)	Initiate an IMS registration in VPMN for IMS multimedia conversational video service (ViLTE) at test probe. Observe whether the registration is successful completed by receiving NOTIFY for registration event package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to 3GPP TS 34.229-1, C.2 [13]). To ensure a full IMS registration, initiate an (UE) deregistration if it is already IMS registered.	
302AH, 302AV	IMS Registration time (ViLTE)	Initiate an IMS registration in VPMN for IMS multimedia conversational video service (ViLTE). Measure the time between the test probe sending the initial request for IMS registration and receiving NOTIFY for registration event package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to 3GPP TS 34.229-1, annex C.2 [13]). To ensure a full IMS registration, initiate an (UE) deregistration if it is already IMS registered.	
303AH, 303AV	ViLTE MO accessibility	Initial a ViLTE MO call from a test probe at VPMN to HPMN. The call is successful if 180 Ringing is received at VPMN. The test probe at HPMN shall send 180 Ringing unreliably, i.e. not containing "Require: 100rel”.	
304AH, 304AV	ViLTE MT accessibility	Initial a ViLTE MT call from HPMN to a test probe at VPMN. The call is successful if 180 Ringing is received at HPMN from the test probe at VPMN. The test probe at VPMN shall send 180 Ringing unreliably, i.e. not containing "Require: 100rel”.	
305AH, 305AV	ViLTE MO session setup time	Make a successful ViLTE MO call from a test probe at VPMN to HPMN. Measure the time between sending INVITE and receiving 200 OK (INVITE) (ref. to 3GPP TS 34.229-1, C.25 [13]). The time for the HPMN user accepting the incoming call is excluded in the calculation.	
306AH, 306AV	ViLTE MT session setup time	Make a successful ViLTE MT call from HPMN to a test probe at VPMN. Measure the time between receiving INVITE and receiving ACK for 200 OK (INVITE) (ref. to 3GPP TS 34.229-1, C.26 [13]). The	

		time for the VPMN user accepting the incoming call is excluded in the calculation.	
307AH, 307AV	ViLTE MO session setup ratio	Initial a VoLTE MO call from a test probe at VPMN to HPMN. The session is successfully established if 200 OK (INVITE) is received at VPMN.	
308AH, 308AV	ViLTE MT session setup ratio	Initial a VoLTE MT call from HPMN to a test probe at VPMN. The call is successfully established if ACK for 200 OK (INVITE) is received by the test probe at VPMN.	
311AH, 311AV	ViLTE MO session duration	Make a successful ViLTE MO call from a test probe at VPMN to HPMN. Measure the time at the test probe of VPMN between receiving 200 OK (INVITE) and receiving 200 OK (BYE) – using the MO call release in the test (ref. to 3GPP TS 34.229-1, C.25, C.32 [13]).	
312AH, 312AV	ViLTE MT session duration	Make a successful ViLTE MT call from HPMN to a test probe at VPMN. Measure the time at the test probe of HPMN between receiving ACK for 200 OK (INVITE) and receiving BYE – using the MT call release in the test (ref. to 3GPP TS 34.229-1, C.26 [13]).	
313AH, 313AV	OIP transparency MO (ViLTE)	Make a successful ViLTE MO call from a test probe at VPMN to HPMN and check at the test probe of HPMN if the OIP results in a dial able format (ref. to GSMA IR.92, 2.3.12 [11]) to call back the call originator at VPMN.	
310AH, 310AV	OIP transparency MT (ViLTE)	Make a successful ViLTE MT call from HPMN to a test probe at VPMN and check at the test probe of VPMN if the OIP results in a dial able format to call back the call originator at HPMN.	
314AH, 314AV	SpQ on sample basis at R-party (ViLTE)	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the test probe at HPMN and record this file in the test probe at VPMN and calculate the voice quality per POLQA as specified in ITU-T P.863 [1]. Recommended duration of the audio reference file: 8 - 32s. The selected samples are played/analysed. The end-result of the test is an average value of the measured MOS-LQO values *per sample*.	
315AH, 315AV	SpQ on sample basis at H-party (ViLTE)	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the probe at VPMN and record this file in the probe at HPMN and calculate the voice quality per POLQA as specified in ITU-T P.863 [1]. Recommended duration of the audio reference file: 8 - 32s. The selected samples are played/analysed. The end-result of the test is an average value of the measured MOS-LQO values *per sample*.	
216AH, 216AV	SpQ R-factor at R-party	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the test probe at HPMN and record this file in the test probe at VPMN and calculate the voice quality. The samples are played/analysed.	

		Recommended duration of the audio reference file: 8 - 32s. The end-result of the test is the R-factor LQ (Listening Quality) calculated per ITU-T G.107 [17].	
217AH, 217AV	SpQ R-factor at H-party	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the probe at VPMN and record this file in the probe at HPMN and calculate the voice quality. The samples are played/analysed. Recommended duration of the audio reference file: 8 - 32s. The end-result of the test is the R-factor LQ (Listening Quality) calculated per ITU-T G.107 [17].	
318AH, 318AV	Video quality on sample basis at R-party	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the test probe at HPMN and record this file in the test probe at VPMN and calculate the video quality per PEVQ as specified in ITU-T J.247 [18]. The selected samples are played/analysed. Recommended duration of the video reference file: 8 - 32s. The end-result of the test is an average value of the measured MOS values *per sample*.	
319AH, 319AV	Video quality on sample basis at H-party	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the probe at VPMN and record this file in the probe at HPMN and calculate the video quality per PEVQ as specified in ITU-T J.247 [18]. The selected samples are played/analysed. Recommended duration of the video reference file: 8 - 32s. The end-result of the test is an average value of the measured MOS values *per sample*.	

Table 4: ViLTE service level GRQ test descriptions for active test methodology

The following table shows only the video part of the ViLTE Network / Transport GRQ Test description. The corresponding audio part is referred to the table of VoLTE Network / Transport GRQ Test description in 5.1.4.1, except (245AH, 245AV, 246AH, 246AV) replaced with (345AH, 345AV, 346AH, 346AV).

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
345AH, 345AV	Dedicated EPS bearer context activation success ratio (voice & video)	By initiating a ViLTE MO session in VPMN, the test probe creates the dedicated EPS bearer context for the voice and video media. The test is successful if the dedicated bearer is established with QCI1 and	

		QCI2 or QCI8 or QCI9.	
346AH, 346AV	Dedicated EPS bearer context activation time (voice & video)	Create a dedicated EPS bearer context for the voice and video media and measure the time between receiving ACTIVATE DEDICATED EPS BEARER CONTEXT REQUEST and sending ACTIVATE DEDICATED EPS BEARER CONTEXT ACCEPT (ref. to 3GPP TS 36.508, 4.5A.8 [14]).	
347AH, 347AV, 348AH, 348AV, 349AH, 349AV, 343AH, 343AV, 344AH, 344AV	Dedicated EPS bearer QCI, Dedicated EPS bearer UL GBR, Dedicated EPS bearer DL GBR Dedicated EPS bearer UL AMBR, Dedicated EPS bearer DL AMBR	Read from EPS quality of service information element in ACTIVATE DEDICATED EPS BEARER CONTEXT REQUEST (NAS): QCI, guaranteed bit rate for uplink and Guaranteed bit rate for downlink (for QCI2) Read from ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST (NAS): QCI, AMBR (for QCI8 or QCI9) Note: AMBR values for a non-GBR bearer are applied to across all non GBR bearers for the IMS “well known” APN	
354AH, 354AV	IP data volume received on QCI2/8/9 bearer at R-party	Count the accumulated data received in a certain period at the test probe of VPMN at the IP port (UDP) on the EPS bearer - QCI2 (UM) or QCI8 (AM) or QCI9 (AM)	
355AH, 355AV	IP data volume transmitted on QCI2/8/9 bearer at R-party	Count the accumulated data transmitted in a certain period at the test probe of VPMN at the IP port (UDP) on the EPS bearer - QCI2 (UM) or QCI8 (AM) or QCI9 (AM)	
356AH, 356AV	IP data volume received on QCI2/8/9 bearer at H-party	Count the accumulated data received in a certain period at the test probe of HPMN at the IP port (UDP) on the EPS bearer - QCI2 (UM) or QCI8 (AM) or QCI9 (AM)	
357AH, 357AV	IP data volume transmitted on QCI2/8/9 bearer at H-party	Count the accumulated data transmitted in a certain period at the test probe of HPMN at the IP port (UDP) on the EPS bearer - QCI2 (UM) or QCI8 (AM) or QCI9 (AM)	
RTP transport quality parameters			
360AH, 360AV, 361AH, 361AV, 362AH, 362AV, 363AH, 363AV	RTP max packet delay variation R2H, RTP max packet delay variation H2R, RTP mean packet delay variation R2H, RTP mean packet delay variation H2R	Make the test probe at VPMN an MO call, analyse the RTP streams at the both ends (for a duration of the audio reference file in 8 - 32s) and calculate the max. and mean packet delay variations (ref. to IR.42 [1]) in the R2H direction at HPMN, and in the H2R direction at VPMN	
364AH, 364AV, 365AH, 365AV	RTP mean interarrival jitter of incoming streaming R2H RTP mean interarrival jitter of incoming streaming H2R	Make the test probe at VPMN an MO call, analyse the RTP streams at the both ends (for a duration of the audio reference file in 8 - 32s) and calculate the RTP mean interarrival jitter of incoming streaming (ref. to GSMA IR.42 [1]) in the R2H direction at HPMN, and in the H2R direction at VPMN	
366AH, 366AV, 367AH,	RTP mean data rate transmitted R2H (audio) RTP mean data rate	Make the test probe at VPMN an MO call, count the total data transmitted and received respectively in a certain period, and calculate the average data rate	

367AV	received H2R (audio)	(ref. to GSMA IR.42 [1]) transmitted and received of the probe at VPMN at that period.	
368AH, 368AV, 369AH, 369AV	RTP mean data rate transmitted H2R (audio) RTP mean data rate received R2H (audio)	Make a VoLTE MT call from HPMN to a test probe at VPMN, count the total data transmitted and received respectively at the VoLTE test probe of HPMN in a certain period and calculate the average data rate (ref. to GSMA IR.42 [1]) transmitted and received of the probe at HPMN at that period.	
370AH, 370AV, 371AH, 371AV	RTP packets lost R2H RTP packets lost H2R	Make the test probe at VPMN an MO call to a test probe at HPMN, count the total number of the missing RTP sequence numbers in a certain period at the home probe of HPMN and at the roaming probe of VPMN.	
372AH, 372AV, 373AH, 373AV	RTP packets lost ratio R2H RTP packets lost ratio H2R	Make the test probe at VPMN an MO call to a test probe at HPMN, within a certain period: - Count the total number of the missing RTP sequence numbers - Count the total number of RTP packets received - Calculate the portion of lost packets (ref. to GSMA IR.42 [1]) at the roaming probe of VPMN and at the home probe of HPMN.	
374AH, 374AV, 375AH, 375AV	RTP round-trip delay (RHR) RTP round-trip delay (HRH)	Make the test probe at VPMN an MO call to a test probe at HPMN, within a certain period calculate the average transfer time (ref. to GSMA IR.42 1]) of RTP packets - from the roaming probe of VPMN to the home probe of HPMN and looped back to the roaming probe, - from the home probe of HPMN to the roaming probe of VPMN and looped back to the home probe	

Table 5: ViLTE network / transport level GRQ test descriptions for active test (video part)

The GRQ test codes (348AH, 348AV, 349AH, 349AV) and (343AH, 343AV, 344AH, 344AV) are mutually exclusive.

- If EPS GBR bearer QCI2 is assigned for the video media, the GRQ test codes for GBR (348AH, 348AV, 349AH, 349AV) are applied to the ViLTE GRQ test.
- If EPS non-GBR bearer QCI8 or QCI9 is assigned for the video media, the GRQ test codes for AMBR (343AH, 343AV, 344AH, 344AV) are applied to the ViLTE GRQ test.

The transport level KPIs are tested if the two ends (R-party and H-party) are ViLTE capable, i.e. RTP packets are end-to-end transported between the two end entities.

The ViLTE media uses two separate RTP connections to transport audio and video streams. The audio and video RTP quality KPI are separately measured under the condition when two RTP connections are present during the test.

Preconditions of SRVCC GRQ test

The SRVCC GRQ test is performed in terms of a handover from E-UTRAN to UTRAN or GERAN, depending upon the VPMN radio access technologies deployed. The test is applied to the LBO HR and LBO VR roaming architectures, but not applied to the S8HR.

5.1.4.3

The test probe at VPMN shall in ATTACH REQUEST of the E-UTRAN attach procedure:

- indicate IMS PS voice preferred, CS Voice as secondary,
- support SRVCC to GERAN or UTRAN in MS Classmark 2,
- support SRVCC to GERAN in MS Classmark 3.

In the IMS registration, the test probe at VPMN shall include the media feature tag *g.3gpp.accesstype* in the Contact header field of the SIP REGISTER request.

The test probe shall be capable of supporting SRVCC procedures in the pre-alerting, alerting or MSC-assisted mid-call phase.

When initiating a VoLTE MO call, the test probe includes in the Contact header field of SIP INVITE request the following media feature tags (ref. to TS 34.229-1 [13] annex A.2.1):

- g.3gpp.mid-call
- g.3gpp.srvcc-alerting
- g.3gpp.ps2cs-srvcc-orig-pre-alerting

At the VoLTE or ViLTE MT call when receiving a SIP INVITE request including the feature-capability indicator *g.3gpp.mid-call* or *g.3gpp.srvcc-alerting* in a Feature-Caps header field, the test probe includes (ref. to TS 34.229-1 [13] annex A.2.3, A.2.6, A.2.9):

- *g.3gpp.ps2cs-srvcc-orig-pre-alerting* feature-capability indicator in a Feature-Caps header field of SIP 183 Session Progress,
- *g.3gpp.srvcc-alerting*
  - media feature tag in a Contact header field of SIP 180 Ringing,
  - feature-capability indicator in a Feature-Caps header field of SIP 180 Ringing,
- *g.3gpp.mid-call* media feature tag in the Contact header field of SIP 200 OK (INVITE)

5.1.5

SMSoIP

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
201AH, 201AV	IMS Registration success ratio (VoLTE)	Initiate an IMS registration in VPMN for IMS multimedia conversational video service (VoLTE) at test probe. Observe whether the registration is successful completed by receiving NOTIFY for registration event package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to 3GPP TS 34.229-1, annex C.2 [13]). To ensure a full IMS registration, initiate an (UE) deregistration if it is already IMS registered.	

202AH, 202AV	IMS Registration time	Initiate an IMS registration in VPMN for IMS multimedia telephony service (VoLTE). Measure the time between the test probe sending the initial request for IMS registration and receiving NOTIFY for registration event package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to 3GPP TS 34.229-1, annex C.2 [13]). To ensure a full IMS registration, initiate an (UE) deregistration if it is already IMS registered.	
221AH, 221AV	SMSoIP-MO accessibility	Send an SM included in the SIP MESSAGE request from a test probe at VPMN, using HPMN IP-SM-GW/SMSC, to a test probe at HPMN. If the submit report in the MESSAGE request from SMSC is received (ref. to 3GPP TS 34.229-1, 18.1.4 [13]), the test is successful.	
222AH, 222AV	SMSoIP-MT accessibility	Send an SM included in the SIP MESSAGE request from a test probe at HPMN to a test probe at VPMN using the HPMN IP-SM-GW/ SMSC. The test is successful if the SM is correctly delivered at R-party and 202 (Accepted) is received from SMSC for responding the delivery report from R-party (ref. to 3GPP TS 34.229-1, 18.2.4 [13]).	
223AH, 223AV	SMSoIP-MO access delay	Send an SM included in the SIP MESSAGE request from a test probe at VPMN, using HPMN IP-SM-GW/SMSC, to a test probe at HPMN. Measure the time at R-party between - sending a SIP MESSAGE request (UL) including a vnd.3gpp.sms payload that contains a short message, and - responding with 200 OK (UL) to a SIP MESSAGE request including a vnd.3gpp.sms payload that contains the short message submission report indicating a positive acknowledgement from SMSC (ref. to 3GPP TS 34.229-1, 18.1.4 [13]).	
224AH, 224AV	SMSoIP-MT access delay	Send an SM included in the SIP MESSAGE request from a test probe at HPMN to a test probe at VPMN using the HPMN IP-SM-GW/ SMSC. Measure the time at H-party between - Receiving a SIP MESSAGE request (DL) including a vnd.3gpp.sms payload that contains a short message, and - Receiving a 202 ACCEPTED from SMSC acknowledging to the SIP MESSAGE request (UL) including a vnd.3gpp.sms payload that contains a delivery report (ref. to 3GPP TS 34.229-1, 18.2.4 [13]).	
225AH, 225AV	SMSoIP-MO e2e delay	Send an SM included in the SIP MESSAGE request from a test probe at VPMN, using HPMN IP-SM-GW/SMSC, to a test probe at HPMN. Measure the time between - Sending a SIP MESSAGE request (UL) including a vnd.3gpp.sms payload that contains a short message at R-party, and - Receiving a SIP MESSAGE request (DL)	

		including a vnd.3gpp.sms payload that contains that short message at H-party (ref. to 3GPP TS 34.229-1, 18.1.4, 18.2.4 [13]). Note: A clock accuracy of the test system ≤ 30ms	
226AH, 226AV	SMSoIP-MT e2e delay	Send an SM included in the SIP MESSAGE request from a test probe at HPMN to a test probe at VPMN using the HPMN IP-SM-GW/ SMSC. Measure the time between - Sending a SIP MESSAGE request (UL) including a vnd.3gpp.sms payload that contains a short message at H-party, and - Receiving a SIP MESSAGE request (DL) including a vnd.3gpp.sms payload that contains that short message at R-party (ref. to 3GPP TS 34.229-1, 18.1.4, 18.2.4 [13]). Note: A clock accuracy of the test system ≤ 30ms	

Table 6: SMSoIP GRQ test descriptions for active test methodology

5.1.6 MIoT GRQ

The GRQ parameters (KPI) specified in the present section are valid for NB-IoT and LTE-M modules. It is assumed that a MIoT module has selected a VPMN cell supporting the corresponding MIoT type (either NB-IoT or LTE-M) and is configured as suitable for testing.

The RX power level RSRP > - 79 dbm.

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
101AH, 101AV	PS location update success ratio	Configure the UE (MIoT module) in PS mode, initiate an EPS attach in VPMN. In order to ensure a full location update, the USIM was registered on a different TAC before testing. Aggregation of multiple tests yields the corresponding EPS attach success ratio. 1) LTE-M or NB-IoT with PDN Ensure in ATTACH REQUEST: 'ESM message container' containing PDN CONNECTIVITY REQUEST 2) NB-IoT with PDN or without PDN Ensure in ATTACH REQUEST: - 'CP CIoT' is set in 'UE network capability' - 'CP CIoT EPS optimization' ('01'B) is set as 'Preferred CIoT network behaviour' (PNB-CIoT) in 'additional update type' Verify in ATTACH ACCEPT - VPMN MME indicates 'CP CIoT EPS optimization accepted' in 'Additional update result' 3) NB-IoT without PDN (SMS only) Ensure in ATTACH REQUEST: - 'ESM message container' containing ESM DUMMY MESSAGE - 'Additional update type' indicating 'SMS only' Verify in ATTACH ACCEPT - VPMN MME indicates 'SMS only' in 'Additional update result'	Note 1
102AH,	PS location update	Resulted from KPI 101. Measure the time between the initiation of	

102AV	delay	attach and the attach is accepted.	
105AH, 105AV	Default EPS bearer context activation success ratio	Resulted from KPI 101 for the default PDN connection. Verify whether ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message is received by the UE. Aggregation of multiple tests yields the corresponding success ratio.	Note 2, Note 3
106AH, 106AV	Default EPS bearer context activation time (Data-up delay)	Resulted from KPI 101 for the default PDN connection and measure the time between UE sending ATTACH REQUEST and ATTACH COMPLETE containing ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT.	Note 2, Note 3
109AH, 109AV	Default EPS bearer context cut-off ratio	Verify whether the UE in VPMN is detached by the network initiation after each EPS attach or after each MIoT usage (waking-up, data transferring). Aggregation of multiple tests yields the corresponding bearer context cut-off ratio (the MIoT module shall be kept attached).	
150AH, 150AV	PING Host	Host server in HPMN or at a 3rd party having an IPv4 or IPv6 address.	Note 2
151AH, 151AV	PING packet loss ratio	From VPMN, UE sends an ICMP echo request with a certain number of PING packets to be sent as parameter. Verify whether ICMP echo reply is received. Aggregation of multiple tests yields the corresponding packet loss ratio.	Note 2
152AH, 152AV	PING round trip time	Result from KPI 151, measure the time between ICMP echo sent and ICMP echo reply received.	Note 2
153AH, 153AV	Number of packets received	Result from KPI 151, indicate the number of received packets.	Note 2
154AH, 154AV	Number of packets sent	Result from KPI 151, indicate the number of sent packets.	Note 2
155AH, 155AV	PING interval	Result from KPI 151, indicate the break time between two consecutive PINGs (parameter).	Note 2
156AH, 156AV	PING packet payload size	Result from KPI 151, indicate the size of a packet without header (parameter).	Note 2
157AH, 157AV	Sum of bytes received	Result from KPI 151, indicate the total bytes received including headers.	Note 2, Note 11
158AH, 158AV	Sum of bytes sent	Result from KPI 151, indicate the total bytes sent including headers.	Note 2, Note 11
400AH, 400AV	LPWA access type	Configure UE in WB LTE-M or NB-IoT, if it is configurable for the LPWA access type.	
401AH, 401AV	Attach type with additional update type	Configure UE for EPS attach with a suitable value of 'additional update type' 1) No additional information 2) User plane CIoT EPS optimization 3) Control plane CIoT EPS optimization with SMS only 4) Control plane CIoT EPS optimization with PDN	Note 4
402AH, 402AV	Detach type	Trigger UE for EPS detach in VPMN, whereby the detach type is either EPS detach 'Normal detach' or 'Switch-off'	
403AH, 403AV	Detach delay	Resulted from KPI 402, measure the time between UE sending DETACH REQUEST and receiving DETACH ACCEPT from VPMN.	

404AH, 404AV	PDN type	Configure UE accordingly in one of the following PDN types. - IPv4, IPv6, IPv4v6, Non-IP	Note 2, Note 3
405AH, 405AV	Serving PLMN rate control (NB-IoT)	Trigger NB-IoT module to initiate EPS attach with PDN connection. Verify whether 'Serving PLMN rate control' is received in ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message from VPMN, and which value is assigned if received.	Note 2, Note 3, Note 5
406AH, 406AV	APN rate control (NB-IoT)	Trigger NB-IoT module to initiate EPS attach with PDN connectivity request. Ensure that the support of APN rate control for uplink data is indicated in Protocol Configuration Options (PCO), if the module supports this feature. Verify whether 'APN rate control' is received in PCO of ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message, and which value is assigned if received.	Note 2, Note 3, Note 5
407AH, 407AV	APN rate control for exception data (NB-IoT)	Trigger NB-IoT module to initiate EPS attach with PDN connectivity request. Ensure that the support of APN rate control for exception uplink data is indicated in Protocol Configuration Options (PCO), if the module supports this feature. Verify whether 'APN rate control for exception data' is received in PCO of ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message, and which value is assigned if received.	Note 2, Note 3, Note 5
408AH, 408AV	NAS signalling low priority (LTE-M)	Configure LTE-M module for NAS signalling low priority and trigger the module in VPMN to initiate EPS attach with PDN connectivity request. Verify whether low priority indicator is set to "MS is configured for NAS signalling low priority" in Device Properties of ATTACH REQUEST, and whether the attach is accepted by VPMN.	Note 7
409AH, 409AV	Non-IP link MTU size (NB-IoT)	Trigger NB-IoT module to initiate EPS attach with PDN connectivity request. Ensure that 'Non-IP link MTU' is requested in Protocol Configuration Options (PCO), if the module supports this feature. Verify whether 'Non-IP link MTU' is received in PCO of ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message, and which value is assigned by the network.	max. user data sent in container of ESM DATA TRANSPORT Note 5, Note 6
410AH, 410AV	IPv4 link MTU size	Trigger the module to initiate EPS attach with PDN connectivity request. Ensure that 'IPv4 link MTU' is requested in Protocol Configuration Options (PCO), if the module supports this feature. Verify whether 'IPv4 link MTU' is received in PCO of ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message, and which value is assigned by the network.	max. user data sent via S1-U interface, Note 6
411AH, 411AV	Half-duplex (FDD)	Configured LTE-M or NB-IoT FDD module in half-duplex mode. Attached in VPMN, indicate whether the module is operated in half-duplex mode on the supporting frequency band.	
412AH, 412AV	RSRP	Attached in VPMN, indicate reference signal received power at the antenna of the module.	
413AH, 413AV	CE Mode (LTE-M)	Configure LTE-M module in CE mode B, if it is capable. Attached in VPMN, indicate which CE mode (A or B) the UE is operated.	Note 7, Note 10
414AH, 414AV	CE Level (NB-IoT)	Configure NB-IoT module in CE mode. Attached in VPMN, indicate which CE level (0, 1, 2, 3) the UE is operated.	Note 5, Note 10

420AH, 420AV	PSM enable / disable	- Configure module to enable PSM with the corresponding HPMN- recommended values: PSM TAU period (T3412 extended) - PSM UE active timer (T3324) Initiate an EPS attach in VPMN with or without PDN. Indicate: - PSM status NW-accepted, Verify the completion of the attach procedure and compare the NW-accepted values with the corresponding UE-requested values - PSM TAU period NW-accepted (T3412 extended) - PSM UE active timer NW-accepted (T3324). Verify that UE performs the periodic TAU procedure.	
421AH, 421AV	PSM status NW-accepted	Resulted from KPI 420, if NW-accepted T3324 value is received from VPMN, it implies that the VPMN supports PSM and accepts the use of PSM.	
422AH, 422AV	PSM TAU period UE-requested (T3412 extended)	Resulted from KPI 420, indicate the PSM TAU period (T3412 extended) requested by UE in ATTACH REQUEST.	
423AH, 423AV	PSM TAU period NW-accepted (T3412 extended)	Resulted from KPI 420, indicate the PSM TAU period (T3412 extended) granted by VPMN.	
424AH, 424AV	PSM UE active timer UE-requested (T3324)	Resulted from KPI 420, indicate the requested timer T3324 value (being different from "deactivated").	
425AH, 425AV	PSM UE active timer NW-accepted (T3324)	Resulted from KPI 420, indicate the timer T3324 value granted by VPMN (being different from "deactivated").	
426AH, 426AV	PSM Hibernate ratio NW-accepted	PSM Hibernate ratio = (T3412 extended - T3324) / T3412 extended	
427AH, 427AV	PSM MT data transfer success ratio	Activate PSM and initiate attach in VPMN with PDN, Trigger UE to prepare sending UL data and prepare sending DL data to UE. Verify that - the UE performs periodic TAU procedure - the UE transmits UL data following the completion of the TAU procedure, or paging UE for EPS service if UE already returns to Idle mode. - Sending DL data to UE following the completion of the UL data transfer - Verify the total DL data is completely received. Aggregation of multiple tests yields the corresponding success ratio.	
428AH, 428AV	PSM SMS MT accessibility	1) Activate PSM and initiate attach in VPMN with PDN, Trigger UE to prepare sending UL data and prepare sending SMS to UE. Verify that - the UE performs periodic TAU procedure - the UE transmits UL data following the completion of the TAU procedure. - MT SMS is delivered following the completion of the UL data transfer, or paging UE for SMS if UE already returns to Idle mode, - Verify the SMS is received by UE 2) Activate PSM and initiate attach in VPMN without PDN and	Note 8

		SMS only, Trigger UE to submit an MO SMS. - the UE performs periodic TAU procedure - the UE transmits MO SMS following the completion of the TAU procedure. - MT SMS is delivered following the completion of MO SMS, or paging UE for SMS if UE already returns to Idle mode, - Verify the MT SMS is received by UE. Aggregation of multiple tests yields the corresponding success ratio.	
431AH, 431AV	eDRX UE-config enable / disable	Configure UE to enable eDRX with the corresponding HPMN-recommended values: - eDRX cycle length - Paging time window PTW Initiate an EPS attach in VPMN with or without PDN. Indicate: - eDRX status NW-accepted, Verify the completion of the attach procedure and compare the NW-accepted values with the corresponding UE-requested values - eDRX cycle NW-accepted - eDRX PTW NW-accepted.	
432AH, 432AV	eDRX status NW-accepted	Resulted from KPI 431, if eDRX parameters are received from VPMN in ATTACH ACCEPT, it implies that VPMN supports eDRX and accepts the use of eDRX.	
433AH, 433AV	eDRX cycle UE-requested	Resulted from KPI 431, indicate eDRX cycle length requested by UE in ATTACH REQUEST.	
434AH, 434AV	eDRX cycle NW-accepted	Resulted from KPI 431, indicate eDRX cycle length granted by VPMN.	
435AH, 435AV	eDRX PTW UE-requested	Resulted from KPI 431, indicate eDRX PTW value requested by UE.	
436AH, 436AV	eDRX PT NW-accepted	Resulted from KPI 431, indicate eDRX PTW value granted by VPMN.	
437AH, 437AV	eDRX MT data transfer success ratio	Activate eDRX and initiate attach in VPMN with PDN. Trigger UE to prepare sending UL data and prepare sending DL data to UE. Verify that - the UE transmits UL data - Paging UE within eDRX PTW and sending DL data to UE after the completion of the UL data transfer - Verify the total DL data is completely received. Aggregation of multiple tests yields the corresponding success ratio.	
438AH, 438AV	eDRX SMS MT accessibility	1) Activate eDRX and initiate attach in VPMN with PDN, Trigger UE to prepare sending UL data and prepare sending SMS to UE. Verify that - the UE transmits UL data - MT SMS is delivered after the completion of the UL data transfer, or paging UE for SMS within the eDRX PTW if UE already returns to Idle mode, - Verify the SMS is received by UE. 2) Activate eDRX and initiate attach in VPMN without PDN and SMS only, Trigger UE to submit an MO SMS. - the UE transmits MO SMS - MT SMS is delivered after the completion of MO SMS, or paging UE for SMS within the eDRX PTW if UE already returns to Idle mode,	Note 8

		- Verify the MT SMS is received by UE. Aggregation of multiple tests yields the corresponding success ratio.	
440AH, 440AV	MO TCP data transfer success ratio	Trigger UE an EPS attach in VPMN with PDN and PDN type IP. Initiate MO TCP UL data transfer. Aggregation of multiple tests yields the corresponding success ratio.	Note 2
441AH, 441AV	MO TCP data transfer payload size	Vary the payload size, repeat the KPI 440 test and indicate how the payload size affects the MO TCP UL data transfer success ratio.	Note 2
442AH, 442AV	MO TCP data transfer throughput	Result from KPI 440, indicate MO TCP UL data transfer throughput.	Note 2
443AH, 443AV	MO TCP data transfer duration	Result from KPI 440, indicate MO TCP UL data transfer duration.	Note 2
444AH, 444AV	MO TCP data RTT	Result from KPI 440, indicate MO TCP data transfer RTT by using echo-reply at the data receiving side.	Note 2
445AH, 445AV	MO UDP data transfer success ratio	Trigger UE an EPS attach in VPMN with PDN and PDN type IP. Initiate MO UDP UL data transfer. Aggregation of multiple tests yields the corresponding success ratio.	Note 2
446AH, 446AV	MO UDP data transfer payload size	Vary the payload size, repeat the KPI 445 test and indicate how the payload size affects the MO UDP UL data transfer success ratio.	Note 2
447AH, 447AV	MO UDP data transfer throughput	Result from KPI 445, indicate MO UDP UL data transfer throughput.	Note 2
448AH, 448AV	MO UDP data transfer duration	Result from KPI 445, indicate MO UDP UL data transfer duration.	Note 2
449AH, 449AV	MO UDP data RTT	Result from KPI 445, indicate MO UDP UL data transfer RTT by using echo-reply at the data receiving side.	Note 2
450AH, 450AV	MT TCP data transfer success ratio	Trigger UE an EPS attach in VPMN with PDN and PDN type IP. Initiate MT TCP DL data transfer towards the module. Aggregation of multiple tests yields the corresponding success ratio.	Note 2
451AH, 451AV	MT TCP data transfer payload size	Vary the payload size, repeat the KPI 450 test and indicate how the payload size affects the MT TCP DL data transfer success ratio.	Note 2
452AH, 452AV	MT TCP data transfer throughput	Result from KPI 450, indicate MT TCP DL data transfer throughput.	Note 2
453AH, 453AV	MT TCP data transfer duration	Result from KPI 450, indicate MT TCP DL data transfer duration.	Note 2
454AH, 454AV	MT UDP data transfer success ratio	Trigger UE an EPS attach in VPMN with PDN and PDN type IP. Initiate MT UDP DL data transfer. Aggregation of multiple tests yields the corresponding success ratio.	Note 2
455AH, 455AV	MT UDP data transfer payload size	Vary the payload size, repeat the KPI 455 test and indicate how the payload size affects the MT UDP DL data transfer success ratio.	Note 2

456AH, 456AV	MT UDP data transfer throughput	Result from KPI 455, indicate MT UDP DL data transfer throughput.	Note 2
457AH, 457AV	MT UDP data transfer duration	Result from KPI 455, indicate MT UDP DL data transfer duration.	Note 2
460AH, 460AV	MO Non-IP data transfer success ratio	Trigger UE an EPS attach in VPMN with PDN and PDN type Non-IP. Initiate MO UL data transfer by sending one or more ESM DATA TRANSPORT message(s) including the payload data to be sent in the User data container. Aggregation of multiple tests yields the corresponding success ratio.	Note 3, Note 5
461AH, 461AV	MO Non-IP data transfer payload size	Vary the payload size, repeat the KPI 460 test and indicate how the payload size affects the MO Non-IP UL data transfer success ratio.	Note 3, Note 5
462AH, 462AV	MO Non-IP data transfer throughput	Result from KPI 460, indicate MO Non-IP UL data transfer throughput.	Note 3, Note 5
463AH, 463AV	MO Non-IP data transfer duration	Result from KPI 460, indicate MO Non-IP UL data transfer duration.	Note 3, Note 5
464AH, 464AV	MT Non-IP data transfer success ratio	Trigger UE an EPS attach in VPMN with PDN and PDN type Non-IP. Initiate MT DL data transfer by sending one or more ESM DATA TRANSPORT message(s) including the payload data to be sent in the User data container. Aggregation of multiple tests yields the corresponding success ratio.	Note 3, Note 5
465AH, 465AV	MT Non-IP data transfer payload size	Vary the payload size, repeat the KPI 464 test and indicate how the payload size affects the MT Non-IP DL data transfer success ratio.	Note 3, Note 5
466AH, 466AV	MT Non-IP data transfer throughput	Result from KPI 464, indicate MT Non-IP DL data transfer throughput.	Note 3, Note 5
467AH, 467AV	MT Non-IP data transfer duration	Result from KPI 464, indicate MT Non-IP DL data transfer duration.	Note 3, Note 5
471AH, 471AV	SMSinMME-MO accessibility [4] (SA SMS MO)	Trigger the module to initiate EPS attach in VPMN with PDN connectivity request, or SMS only without PDN. Trigger the UE (as R-party) to send one or more UPLINK NAS TRANSPORT message(s) including the SMS to a NB-IoT device in HPMN (as H-party). Verify the SMS sent from the NB-IoT device in VPMN is received by the NB-IoT device in HPMN. Aggregation of multiple tests yields the corresponding success ratio.	Note 5, Note 9
472AH, 472AV	SMSinMME-MT accessibility (SA SMS MT)	Trigger the module to initiate EPS attach in VPMN with PDN connectivity request, or SMS only without PDN. From HPMN to send an SMS to the UE (as R-party) in VPMN. Verify that the UE receives the SMS sent via one or more DOWNLINK NAS TRANSPORT message(s). Aggregation of multiple tests yields the corresponding success	Note 5, Note 9

		ratio.	
473AH, 473AV	SMSinMME-MO access delay (AD SMS-MO)	Resulted from KPI 471. Measure the time between sending the SMS and receiving the notification from the home SMSC that the message has been sent. A clock accuracy of the test system ⩽ 30ms	Note 5, Note 9
474AH, 474AV	SMSinMME-MT access delay (AD SMS-MT)	Resulted from KPI 472. Measure the time between the notification from the home SMSC that the message has been sent at the H-party and the notification at the R-party indicating that the message has arrived. A clock accuracy of the test system ⩽ 30ms	Note 5, Note 9
Note 1: Test scenarios 1 & 2 described in the Test Method are **not** mutually exclusive. The same is valid for test scenarios 2 & 3. Note 2: The KPI is applicable to the MIoT modules capable of using IP PDN. Note 3: The KPI is applicable to the MIoT modules capable of using non-IP PDN. Note 4: LTE-M module is configured to case 1) or 2), NB-IoT module is configured to case 3) or 4). Note 5: The KPI is applicable to CP CIoT EPS optimization (normative for NB-IoT). Note 6: The max. Non-IP, IPv4 link MTU size for NB-IoT and the max. IPv4 link MTU size for LTE-M are limited to 1358 octets. The IPv6 link MTU size is sent to the module by including it in the IPv6 Router Advertisement message, the same information is not conveyed by the network via the default EPS bearer context establishment. Note 7: The KPI is applicable to LTE-M. Note 8: The scenario 2 is applicable to NB-IoT modules configured with EPS service SMS only, without PDN. Note 9: If the LTE-M module supports SMS, but does not support SMS in MME, KPI 471 – 474 are replaced with - KPI 21-24 if the LTE-M module supports SMSoSGs, or - KPI 221-224 if the LTE-M module supports SMSoIP. Note 10: The RX power level RSRP can be < - 79 dbm. Note 11: The header bytes (IP header 20 + ICMP 8 = 28 bytes) are included in the calculations.			

Table 7: MIoT GRQ test descriptions for active test methodology

5.1.7 EN-DC GRQ

For FR1 corresponding to frequency range 450 – 6000 MHz, it is recommended at EN-DC GRQ testing:

- LTE RSRP > - 85 dBm,
- FR1 NR RSRP > -88 dBm.

An EN-DC capable UE, including test probe, considers itself to be configured with EN-DC if it is configured with NR SecondaryCellGroup and it is connected to the EPC.

When configured with the EN-DC, user data carried by a data bearer may either be transferred via MCG, via NR SCG or via both MCG and NR SCG (split bearer). Also, RRC signalling carried by an SRB may either be transferred via MCG or via both MCG and NR SCG [19].

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
500AH, 500AV	5G coverage indication	Verify receiving an *upperLayerIndication* bit in *SystemInformationBlockType2*. The upperLayerIndication in SIB2 is an indication to upper layers that the UE has	Note 1

		entered a coverage area offering 5G capabilities.	
501AH, 501AV	NR RSRP	The measured NR RSRP value (-dBm) by the UE / test probe during the test. Aggregation of multiple tests yields the corresponding an average measured NR RSRP value.	
502AH, 502AV	Restrict DCNR	With a 5G subscription SIM, an EN-DC UE performs an EPS ATTACH procedure. Ensure to indicate the DCNR bit in the UE network capability IE of the ATTACH REQUEST message. Verify in the ATTACH ACCEPT the *RestrictDCNR* bit being set as "Use of dual connectivity with NR is not restricted" in the *EPS network feature support* IE. Verify whether the ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message is received by the UE. The default APN corresponds to the internet access in the U plane reflecting an IP connectivity.	
503AH, 503AV	ENDC EPS bearer configuration	Resulted either from a KPI 501, or from a subsequent test step, e.g. via Service Request for MO data, verify whether a SCG or a Split data bearer has been established. Verify which one of the EN-DC bearers is configured in the set of an EN-DC bearer configurations (MCG, SCG, Split, MCG+SCG, MCG+Split, SCG+Split, MCG+SCG+Split).	Note 2
504AH, 504AV	S1-U termination	Resulted from KPI 502, verify which S1-U termination is configured for that bearer type, either S1-U_{mn} or S1-U_{sn}.	Note 3
505AH 505AV	Default EPS bearer QoS parameters	Resulted from EPS attach to verify the QoS parameters in the default EPS bearer context	
510AH, 510AV	HTTP / HTTPS MBB data transfer success ratio	Calculation of the 5G MBB data transfer success ratio uses the same formula referred to the KPI 146 (HTTP / HTTPS data transfer success ratio), with an exception of the HTTP / HTTPS data transfer on pure MCG bearer type (i.e. only on the LTE resource) is considered as a fail due to be missing the SCG resource usage. It implies a lower data rate. Aggregation of multiple tests yields the MBB data transfer success ratio.	

Note 1: Upon receiving SIB2, *upperLayerIndication*, a 5G logo may appear on the mobile screen. It, however, doesn't require the UE to scan for NR carriers.

Note 2: Although mixed EN-DC bearer combination, e.g. MCG+SCG or MCG+split etc. could be configured, the transferring user plane data over the Uu interface either involves MCG or SCG radio resources or both:

- For MCG bearers, only MCG radio resources are involved.
- For SCG bearers, only SCG radio resources are involved.
- For split bearers, both MCG and SCG radio resources are involved.

Note 3: For MN terminated bearers, the user plane connection to the CN entity (SGW) is terminated at the Master Node over S1-U_{mn} interface; for SN terminated bearers, the user plane connection to the CN entity is terminated at the Secondary Node over S1-U_{sn} interface.

KPI 503 and 504 are independent from each other, e.g. an SCG bearer can terminate at S1-U_{mn} or S1-U_{sn}.

Passive Monitoring

General Information

5.2

When to measure:

5.2.1.1 The measurement is made continuously that is as soon as live traffic generates relevant data. The KPI calculated over a daily time window and is aggregated for the Month.

5.2.1.1

Example – Day 1 – KPI = 90%, Day 2 – KPI = 95% and so on Day 3 – KPI = 88%

GRQ KPI is the average of the daily KPI.

A daily measurement is considered as valid if there is at least one (1) measure every four (4) hours (6/day or 180/Month) or according to a mutual agreement between the HPMN and VPMN.

Where to measure:

5.2.1.2 The passive monitoring occurs on the international links (SS7 links, voice interconnect links and IP/Gp links).

It is recommended operators to agree on the I International Mobile Subscriber Identity/ Mobile Subscriber ISDN Number (MSI/MSISDN) being used by the active probes in order that the same IMSI/MSISDN is being used between roaming partner using passive probes. If one operator uses active probes and the other Operating Company (OpCo) uses passive probes, the MSISDN needs to be agreed in order to be able to compare the results.

Between passive probes address ranges, they have to monitor: Country Code/ national destination code (CC/NDC) ranges, Mobile Station Roaming Number (MSRN) Ranges, IP Ranges of GPRS Nodes.

5.2.1.3

Known Limitations:

The measurements are done on live traffic. Therefore, it can only bring information on node where the roaming service is correctly configured. Typically, Radio failure or Network configuration failure cannot be monitored by SS7 Monitoring alone.

Additionally, as it is linked to the actual usage on the network, the values observed may be vary from one operator under observation to another due to various ‘normal’ conditions:

- the prepaid/postpaid market share may have an impact on the Qos linked to chargeable events as credit exhaustion will prevent or stop the service abruptly. It may also influence the behaviour of the roamers (calls without answer (old-fashioned 2 rings and call me back), SMS oriented, and so on)
- the country may have an influence - numbering plan may be "closed" (known finite numbers of digits) or open. In the case of open numbering plans, the switch has to go through a wait period before deciding to connect the call
- the service provided to users (for example do the subscriber have a Voice Mail? The absence/presence of such service may the observed ASR (a Voice Mail system is supposed to always answer a call that is forwarded to it).

GRQ Monitoring Pre-requisites

5.2.1.4 Steering of Roaming could influence some results. Actually, the error messages generated by SoR system will be filtered out: the HPMN operator shall provide information about its SoR configuration for enabling the parties to exclude the effect of the SoR on the measurements.

Filter out error that are non-roaming related or do not affect the roaming service: MAP version fallback, User Error (Roaming Not Allowed), and so on

In the case the operators want to compare throughput/goodput across technologies (that is GPRS, EDGE, UMTS, HSDPA, etc.) the operators have, for the time being to identify the technology based on the involved core network element (SGSN). While the technology is not explicitly identified in the protocol, the node origin address may help operator distinguish 2G / 3G elements, if the VPMN use non-hybrid core network elements (2G-3G nodes).

It is noted that 3GPP TS 29.060 V6.18.0 (2007-09) specifies a new information element called “RAT Type” (radio access technology) that the SGSN may include in the signalling (it is an optional parameter) for facilitating the future measurements and their comparison. However, such release version is not implemented by SGSN vendors at the time of writing this document.

5.2.2 GPRS / UMTS Test Specification

GRQ Test Code	Parameter	How to Measure	Test Specifics
VOICE			
1BH	LU update success ratio	Measure MAP Update Location procedure. Can be measured on SCCP and TCAP level.	
1BV	LU update success ratio	Measure MAP Update Location procedure. Can be measured on SCCP and TCAP level.	
1BR	LU update success ratio	Measure MAP Update Location procedure. Can be measured on SCCP and TCAP level.	
2BH	LU delay	Measure the time between the MAP UL request until the MAP UL ACK	Only applicable for successful transaction
2BV	LU delay	Measure the time between the MAP UL request until the MAP UL ACK	Only applicable for successful transaction
2BR	LU delay	Measure the time between the MAP UL request until the MAP UL ACK	Only applicable for successful transaction
3BH	NER-MO (Network Effectiveness Ratio on Mobile Originated calls in	N/A	Home network has no visibility on Voice Call without CAMEL

GRQ Test Code	Parameter	How to Measure	Test Specifics
	the visited network)		
3BV	NER-MO (Network Effectiveness Ratio on Mobile Originated calls in the visited network)	Measure ratio between successful calls (reception of ISUP ACM) and attempts (ISUP IAM)	For RP applying MNP, additional info to be extracted (IMSI/MSISDN in the loc.up) for assuring measurement on the roaming partner
4BH	NER-MT (Network Effectiveness Ratio on Mobile Terminated calls in the visited network)	Measure ratio between successful calls (reception of ISUP ACM for calls towards MSRN) and attempts (MAP PRN with MSRN)	The success of an MT depends on the combined success of MAP PRN operation and ISUP towards MSRN
4BV	NER-MT (Network Effectiveness Ratio on Mobile Terminated calls in the visited network)	Measure ratio between successful calls (reception of ISUP ACM for call towards MSRN) and attempts MAP PRN with MSRN)	The success of an MT depends on the combined success of MAP PRN operation and ISUP towards MSRN
5BH	PDD-MO (Post Dialling Delay)	N/A	Home network has no visibility on Voice Call without CAMEL
5BV	PDD-MO (Post Dialling Delay)	Measure Time between reception of ISUP ACM and attempts (ISUP IAM)	For RP applying MNP, additional info to be extracted (IMSI/MSISDN in the loc.up) for assuring measurement on the roaming partner
6BH	PDD-MT (Post Dialling Delay)	Measure time between successful calls (reception of ISUP ACM) and MT procedure start (MAP PRN with MSRN)	
6BV	PDD-MT (Post Dialling Delay)	Measure time between successful calls (reception of ISUP ACM) and MT procedure start (MAP PRN with MSRN)	
7BH	CSSR-MO (Call Setup Success Ratio on Mobile Originated calls in the visited network)	N/A	Home network has no visibility on Voice Call without CAMEL
7BV	CSSR-MO (Call Setup Success Ratio on Mobile Originated calls in the visited network)	Measure ratio between successful calls (reception of ISUP ANM) and attempts (ISUP IAM)	For RP applying MNP, additional info to be extracted (IMSI/MSISDN in the loc.up) for assuring measurement on the roaming partner. Takes into account destination behaviour (user

GRQ Test Code	Parameter	How to Measure	Test Specifics
			busy, presence of VM, and so on) – risk of result bias
8BH	CSSR-MT (Call Setup Success Ratio on Mobile Terminated calls in the visited network)	Measure ratio between successful calls (reception of ISUP ANM for call towards MSRN and attempts (MAP PRN with MSRN)	The success of an MT depends on the combined success of MAP PRN operation and ISUP towards MSRN
8BV	CSSR-MT (Call Setup Success Ratio on Mobile Terminated calls in the visited network)	Measure ratio between successful calls (reception of ISUP ANM for call towards MSRN) and attempts (MAP PRN with MSRN)	The success of an MT depends on the combined success of MAP PRN operation and ISUP towards MSRN
9BH	REL (ISUPv2 signalling transparency)	N/A	Home network has no visibility on Voice Call without CAMEL
9BV	REL (ISUPv2 signalling transparency)	N/A	Visited network has no visibility on the actual release cause
10BH	OCN and RDN (ISUPv2 signalling transparency)	N/A	Home network has no visibility on Voice Call without CAMEL
10BV	OCN and RDN (ISUPv2 signalling transparency)	N/A	Home network has no visibility on RDN/OCN transparency at destination side
11BH	CCR (Call Completion Ratio Circuit)	N/A	Home network has no visibility on Voice Call without CAMEL
11BV	CCR (Call Completion Ratio Circuit)	Measure ratio between successfully released calls (reception of ISUP RLC) of dropped calls and answered (ISUP ANM). A drop call definition based on the release call that is if call is released because of network specific errors, then it will be counted as call dropped. For example, if REL cause code is one of - (NO_ROUTE_TO_SPECIFIED_TRANSIT_NETWORK = 2, NO_ROUTE_TO_DESTINATION = 3, CHANNEL_UNACCEPTABLE = 6,	For RP applying MNP, additional info to be extracted (IMSI/MSISDN in the loc.up) for assuring measurement on the roaming partner

GRQ Test Code	Parameter	How to Measure	Test Specifics
		EXCHANGE_ROUTING_ERROR = 25, DESTINATION OUT OF ORDER = 27, NETWORK_OUT_OF_ORDER = 38, TEMPORARY_FAILURE = 41, RECOVERY_ON_TIMER_EXPIRY = 102), then count the call as Call Dropped.	
12BH	ALOC	N/A	Home network has no visibility on Voice Call without CAMEL
12BV	ALOC	Measure Time between reception of call answer ISUP ANM and call release (ISUP REL)	For RP applying MNP, additional info to be extracted (IMSI/MSISDN in the loc.up) for assuring measurement on the roaming partner
13BH	CLI transparency	N/A	Home network has no visibility on Voice Call without CAMEL
13BV	CLI transparency	N/A	Home network has no visibility on CLI transparency at destination side
14BH	SpQ (Speech Quality)	N/A	SS7 monitoring is non intrusive. It only monitors signalling message.
14BV	SpQ (Speech Quality)	N/A	SS7 monitoring is non intrusive. It only monitors signalling message.
SMS			
21BH	Service Accessibility SMS MO (SA SMS MO)	N/A	
21BV	Service Accessibility SMS MO (SA SMS MO)	Measure ratio between successful SMS-SUBMIT and attempts	
21BR	Service Accessibility SMS MO (SA SMS MO)	Measure ratio between successful SMS-SUBMIT and attempts	
22BH	Service Accessibility SMS MT (SA SMS MT)	Measure ratio between successful SMS-DELIVER and attempts	
22BV	Service Accessibility SMS MT (SA SMS MT)	N/A	
23BH	Access Delay SMS MO (AD SMS-MO)	N/A	
23BV	Access Delay SMS MO (AD SMS-MO)	Measure time between SMS-SUBMIT and acknowledgement	

GRQ Test Code	Parameter	How to Measure	Test Specifics
23BR	Access Delay SMS MO (AD SMS-MO)	Measure time between SMS-SUBMIT and acknowledgement	
24BH	Access Delay SMS MT (AD SMS-MT)	Measure time between successful SMS-DELIVER and acknowledgement	
24BV	Access Delay SMS MT (AD SMS-MT)	N/A	
25BH	End-to-End Delivery Time for SMS-MO	Measure time stamp between MAP-FWD-SM (SMS-Submit) operation and MAP-FWD-SM (SMS-Deliver) operation acknowledgement	
25BV	End-to-End Delivery Time for SMS-MO	N/A	
26BH	End-to-End Delivery Time for SMS-MT	Measure time stamp between MAP-FWD-SM (SMS-Submit) operation and MAP-FWD-SM (SMS-Deliver) operation acknowledgement	
26BV	End-to-End Delivery Time for SMS-MT	N/A	
PACKET-SWITCHED			
31BH	Packet Switched LU Success Ratio (PS LU – SR)	Measure MAP GPRS Update Location procedure. Can be measure on SCCP and TCAP level.	
31BV	Packet Switched LU Success Ratio (PS LU – SR)	Measure MAP GPRS Update Location procedure. Can be measure on SCCP and TCAP level.	
31BR	Packet Switched LU Success Ratio (PS LU – SR)	Measure MAP GPRS Update Location procedure. Can be measure on SCCP and TCAP level.	
32BH	Packet Switched Location Update Delay (PS LU – D)	Measure the time between the MAP UL request until the MAP UL ACK	
32BV	Packet Switched Location Update Delay (PS LU – D)	Measure the time between the MAP UL request until the MAP UL ACK	
32BR	Packet Switched Location Update Delay (PS LU – D)	Measure the time between the MAP UL request until the MAP UL ACK	
33BH	Service accessibility for PSD (PDP-context activation success ratio)	Measure ratio between successful MAP_PDP_Context Activation and attempts	
33BV	Service accessibility for PSD (PDP-context activation success ratio)	Measure ratio between successful MAP_PDP_Context Activation and attempts	

GRQ Test Code	Parameter	How to Measure	Test Specifics
34BH	Set-up Delay (ST PSD)	Measure timing between successful MAP_PDP_Context Activation Request and Response	
34BV	Set-up Delay (ST PSD)	Measure timing between successful MAP_PDP_Context Activation Request and Response	
35BH	PDP Context Cut-Off Ratio (session Stability measured at PDP context or PS level)	N/A	
35BV	PDP Context Cut-Off Ratio (session Stability measured at PDP context or PS level)	N/A	
36BH	Average PDP Context Session Time (per APN)	Measure time between the MAP_PDP Activation and the MAP_PDP_Delete message	
36BV	Average PDP Context Session Time (per APN)	Measure time between the MAP_PDP Activation and the MAP_PDP_Delete message	
37BH	Throughput (Kbits/sec)	Measure UDP Packet volume exchanged	
37BV	Throughput (Kbits/sec)	Measure UDP Packet volume exchanged	
38BH	Goodput (Kbits/sec)	Measure UDP Packet volume exchanged, corrected by filtering UDP containing TCP retransmission	only application based on TCP
38BV	Goodput (Kbits/sec)	Measure UDP Packet volume exchanged, corrected by filtering UDP containing TCP retransmission	only application based on TCP
39BH	Roundtrip time	Measure UDP roundtrip based on encapsulated TCP acknowledgement mechanisms	only application based on TCP
39BV	Roundtrip time	Measure UDP roundtrip based on encapsulated TCP acknowledgement mechanisms	only application based on TCP
40BH	Packet loss	Measure UDP Packet Loss based on TCP retransmission mechanisms	only application based on TCP
40BV	Packet loss	Measure UDP Packet Loss based on TCP retransmission mechanisms	only application based on TCP

Table 8: Parameter measurement table

LTE test specification

A detailed test specification for passive KPI monitoring to be added in this section

5.2.3

CAMEL Monitoring

General Information

5.3 Although CAMEL Monitoring was not trialled by GRQ project Jan-Apr 2008, this method is similar to SS7 Monitoring. The general information below is for information only.

5.3.1

When to measure:

The measurement is made continuously that is as soon as live traffic generates relevant data. The KPI calculated over a daily time window and is aggregated for the Month.

5.3.1.1

Example – Day 1 – KPI = 90%, Day 2 – KPI = 95% and so on Day 3 – KPI = 88%

GRQ KPI is the average of the daily KPI.

A daily measurement is considered as valid if there is at least 1 measure every 4 hours (6/day or 180/Month) or according to a mutual agreement between the HPMN and VPMN.

Where to measure:

5.3.1.2 The passive monitoring occurs on the operator's and Hubbing Provider's international links (SS7 links, voice interconnect links and IP/Gp links).

All parties have to agree on the address ranges they have to monitor CC/NDC ranges, MSRN Ranges, IP Ranges of GPRS Nodes.

5.3.1.3 #### Known Limitations:

The measurements are done on the live traffic. Therefore, it brings information on node where the roaming service is correctly configured. Typically, Radio failure or Network configuration failure is not unambiguously detectable.

CAMEL is activated per subscriber. Therefore, the kind of subscriber having a CAMEL mark may influence results (Prepaid, VPN, Postpaid, and so on)

5.3.1.4

GRQ Monitoring Pre-requisites

Requires SS7 monitoring capabilities for most of the tests. Requires CAMEL support from the Operators and the Hubbing Providers

5.3.2

Test specification

Test information will be appended at a later stage when this method has been tested against the GRQ Framework.

Call Flows

Location update

5.4 Bilateral case

5.4

5.4

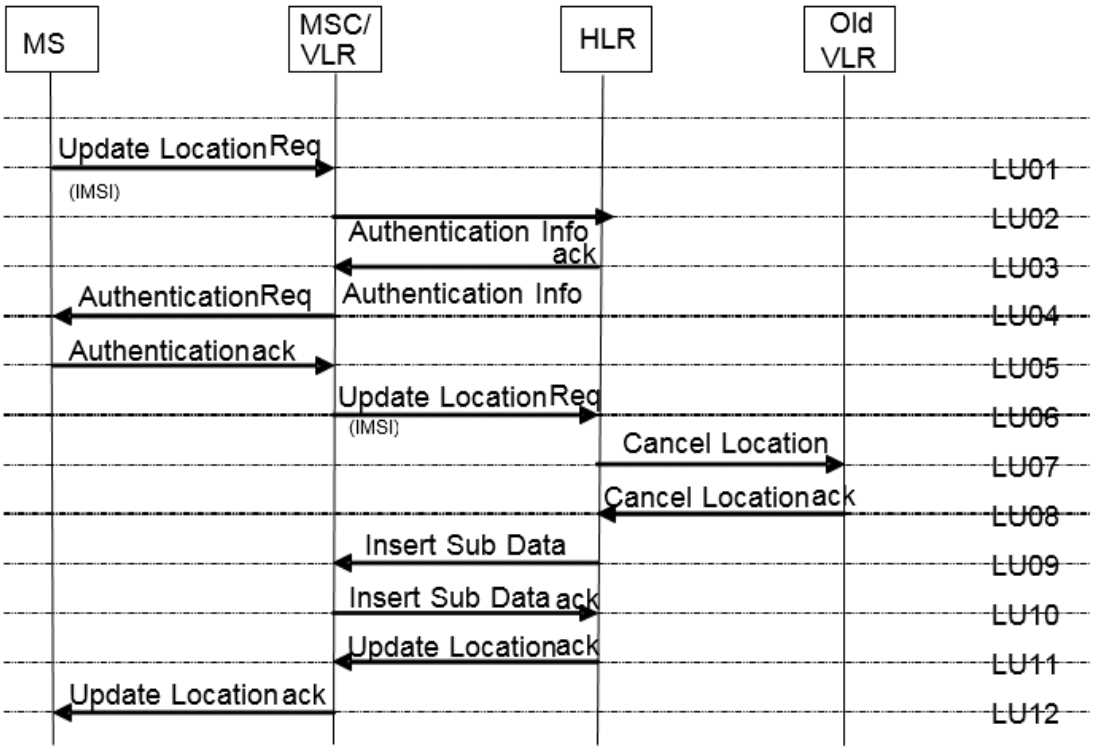

Figure 2: Location update with HLR and VLR

Roaming Hubbing Provider case (only GRQ monitoring relevant procedures)

5.4.1.2

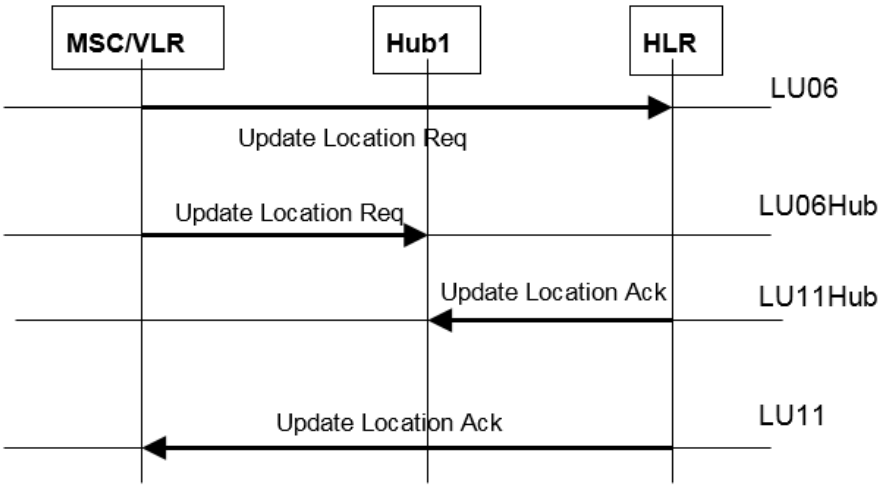

Figure 3: Location Update with Roaming Hubbing Provider

Note: LU06 and LU11 are for reference only

Voice call MO

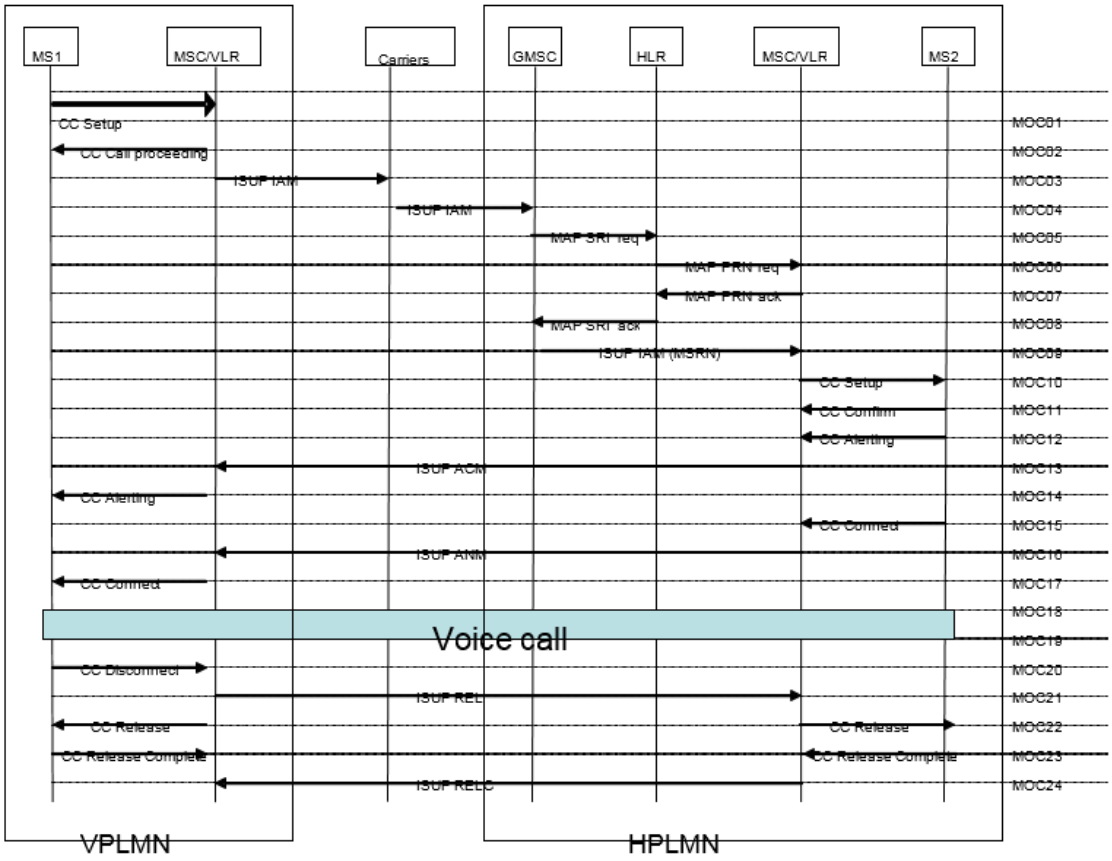

Figure 4: CS voice call MO

Note: Although some signalling may pass through the roaming Hubbing Provider the diagram only refers to the bilateral case.

Voice call MT

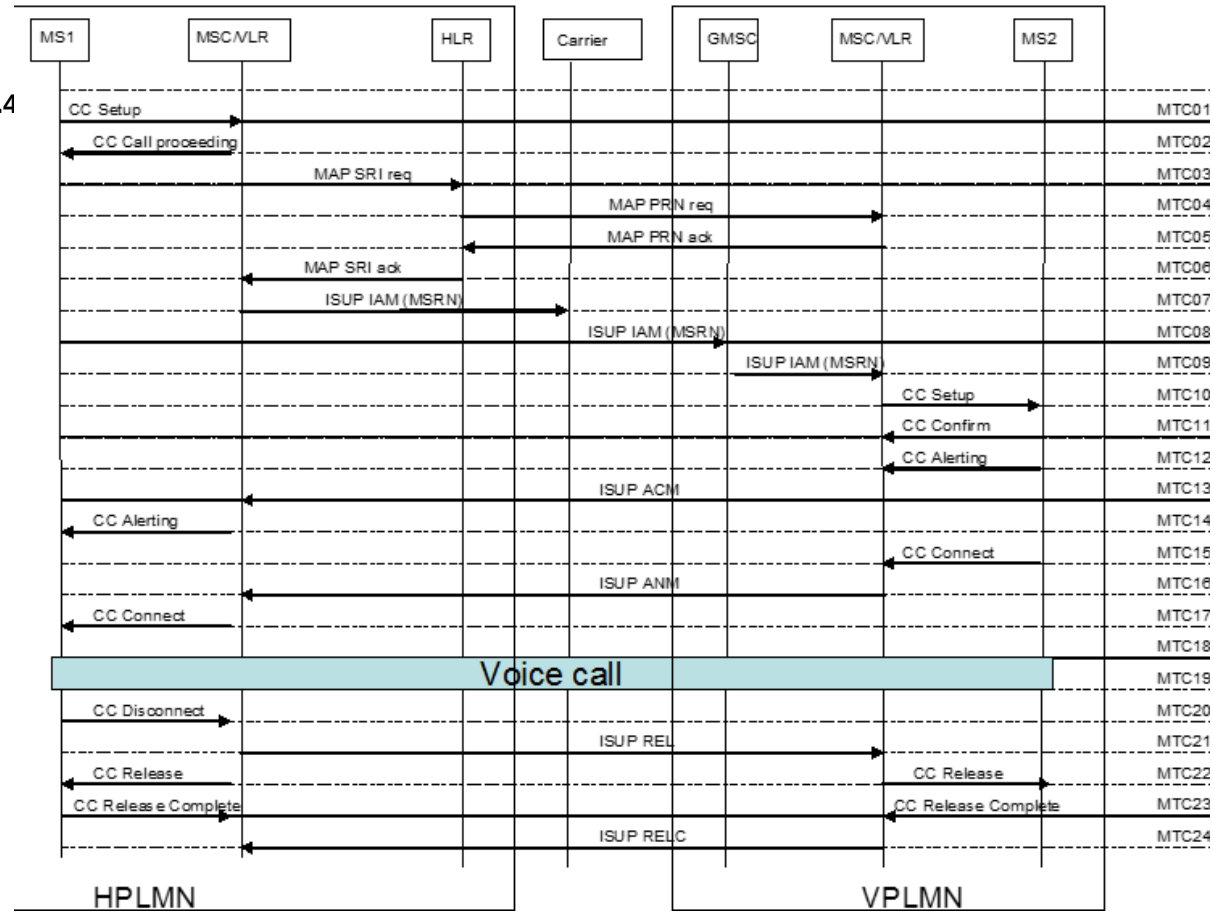

Figure 5: CS voice call MT

Note: Although some signalling may pass through the roaming Hubbing Provider the diagram only refers to the bilateral case

5.4.4 SMS and SMSoSGs

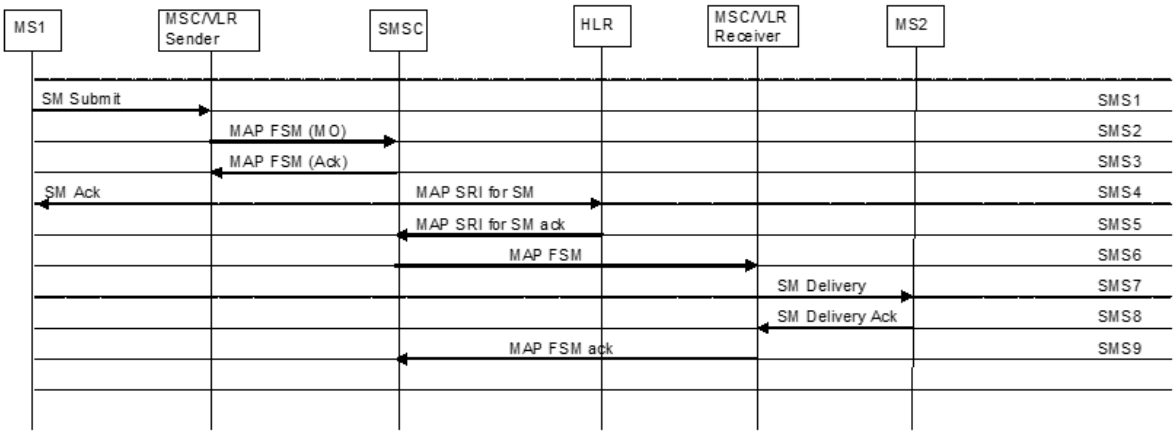

Figure 6: SMS and SMSoSGs

Packet Switched/GPRS

Bilateral case

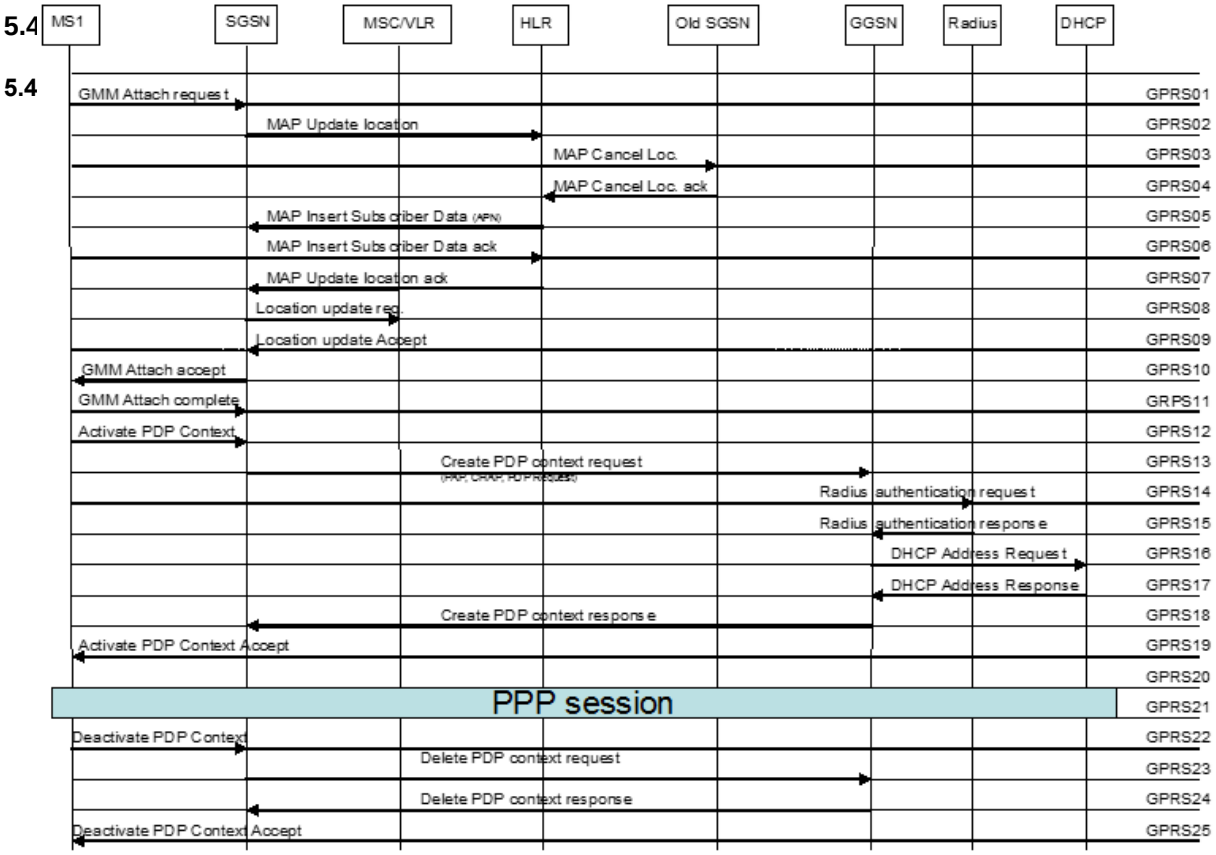

Figure 7: GPRS PDP context and data transfer in bilateral case

Roaming Hubbing Provider Case (only relevant procedures)

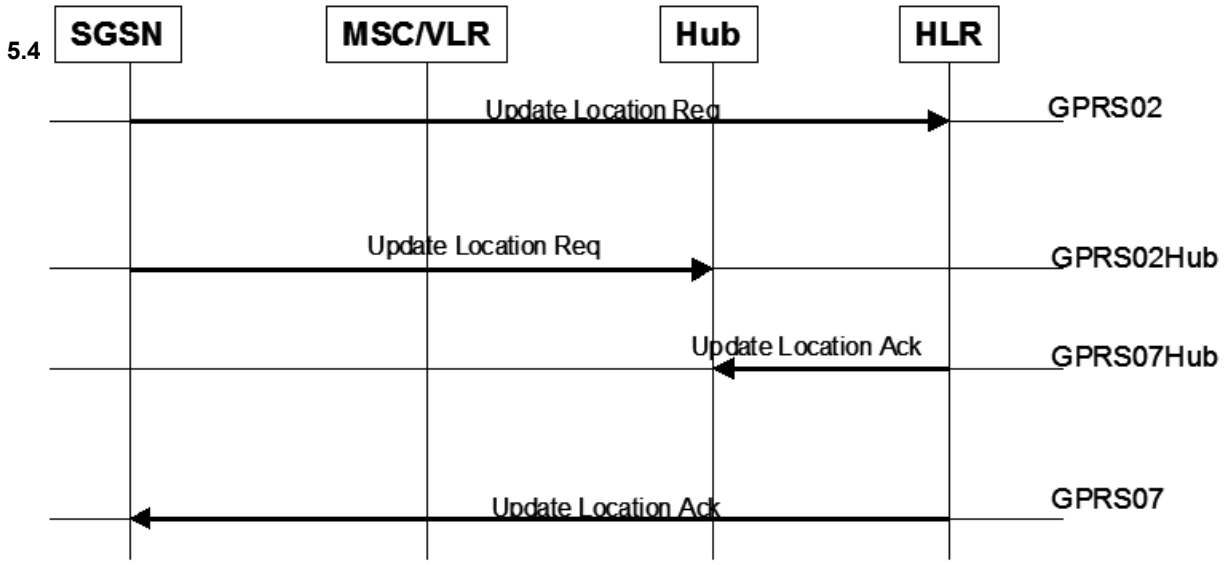

Figure 8: Packet Switch flow for Roaming Hub Provider

5.4 FTP

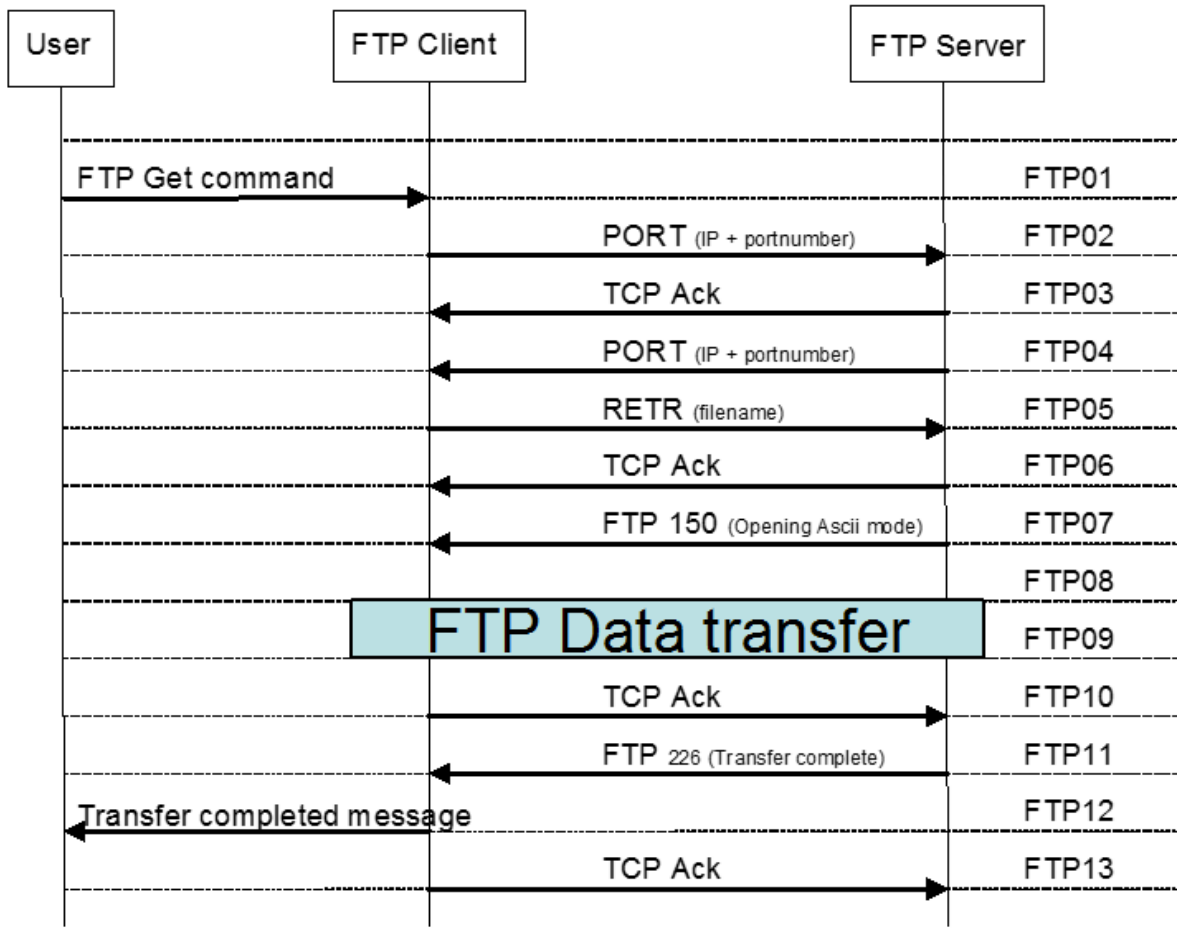

Figure 9: FTP

Note: FTP00: The time to initiate FTP

5.4.7 Ping

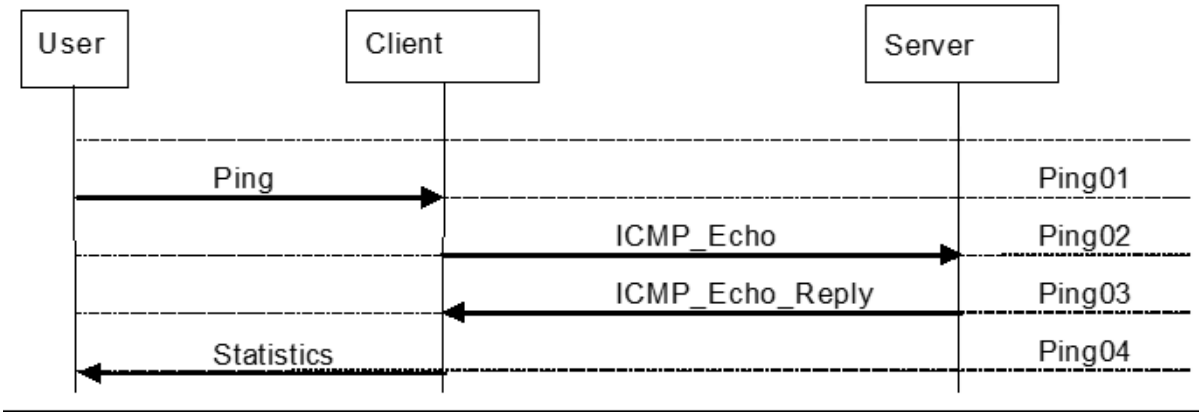

Figure 10: Ping

5.4 HTTP/HTTPS

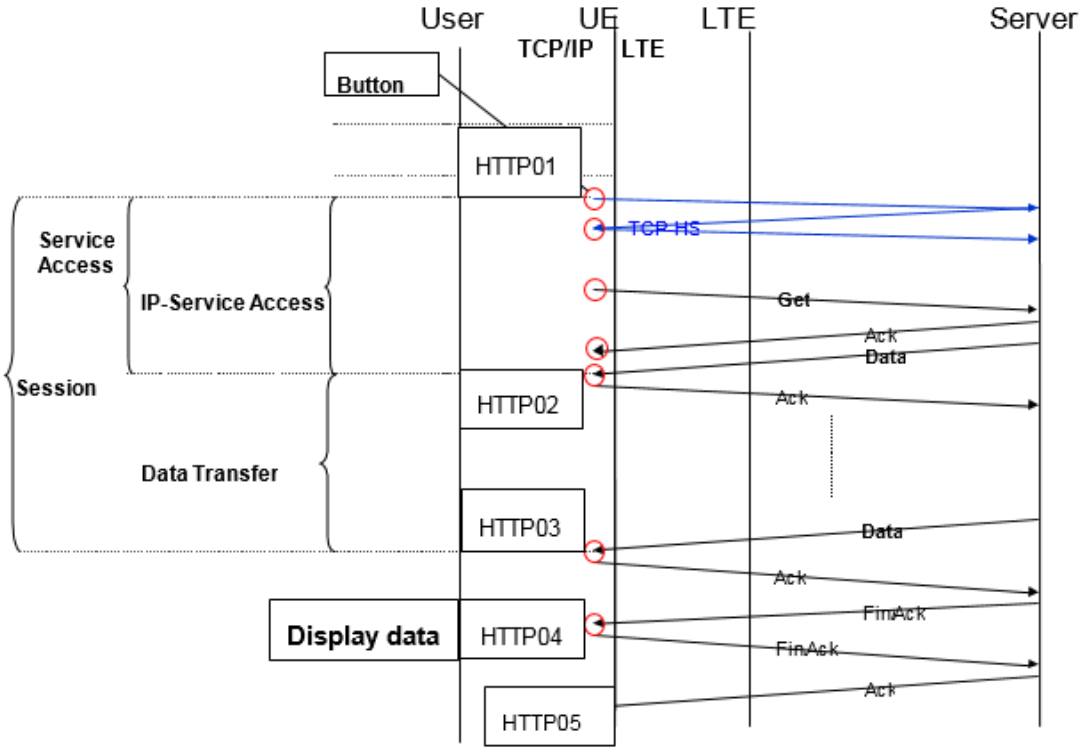

Figure 11: HTTP/HTTPS session flow

EPS

EPS attach

5.4.9 The EPS attach signalling flow refers to 3GPP TS 23.401 [5]. The trigger / observation points are numbered by using the same procedural step numbers in the figure. The reference interface and the supported protocol at the trigger points are listed in the following table.

5.4.9.1

Trigger point	EPS attach procedural step number	Description	Interface / protocol
EPS01	1	UE attach request	LTE-Uu / NAS
$EPS05_{vh}$	5a	Authentication / security	S6a / Diameter
$EPS05_{hv}$	5a	Authentication / security	S6a / Diameter
$EPS07_{vh}$	7	Delete session request	S8 or S11 / GTPv2-C
$EPS07_{hv}$	7	Delete session response	S8 or S11 / GTPv2-C
EPS08	8	Update location request	S6a / Diameter
$EPS09_{hv}$	9	Cancel location	S6a / Diameter
$EPS09_{vh}$	9	Cancel location Ack	S6a / Diameter
$EPS10_{vh}$	10	Delete session request	S8 or S11 / GTPv2-C
$EPS10_{hv}$	10	Delete session response	S8 or S11 / GTPv2-C
EPS11	11	Update location Ack	S6a / Diameter
EPS12	12	Create session request	S11 / GTPv2-C
EPS13	13	Create session request	S8 / GTPv2-C
EPS15	15	Create session response	S8 / GTPv2-C
EPS16	16	Create session response	S11 / GTPv2-C
EPS18	18	RRC connection reconfiguration	LTE-Uu / NAS
EPS21	21	Direct transfer	LTE-Uu / NAS

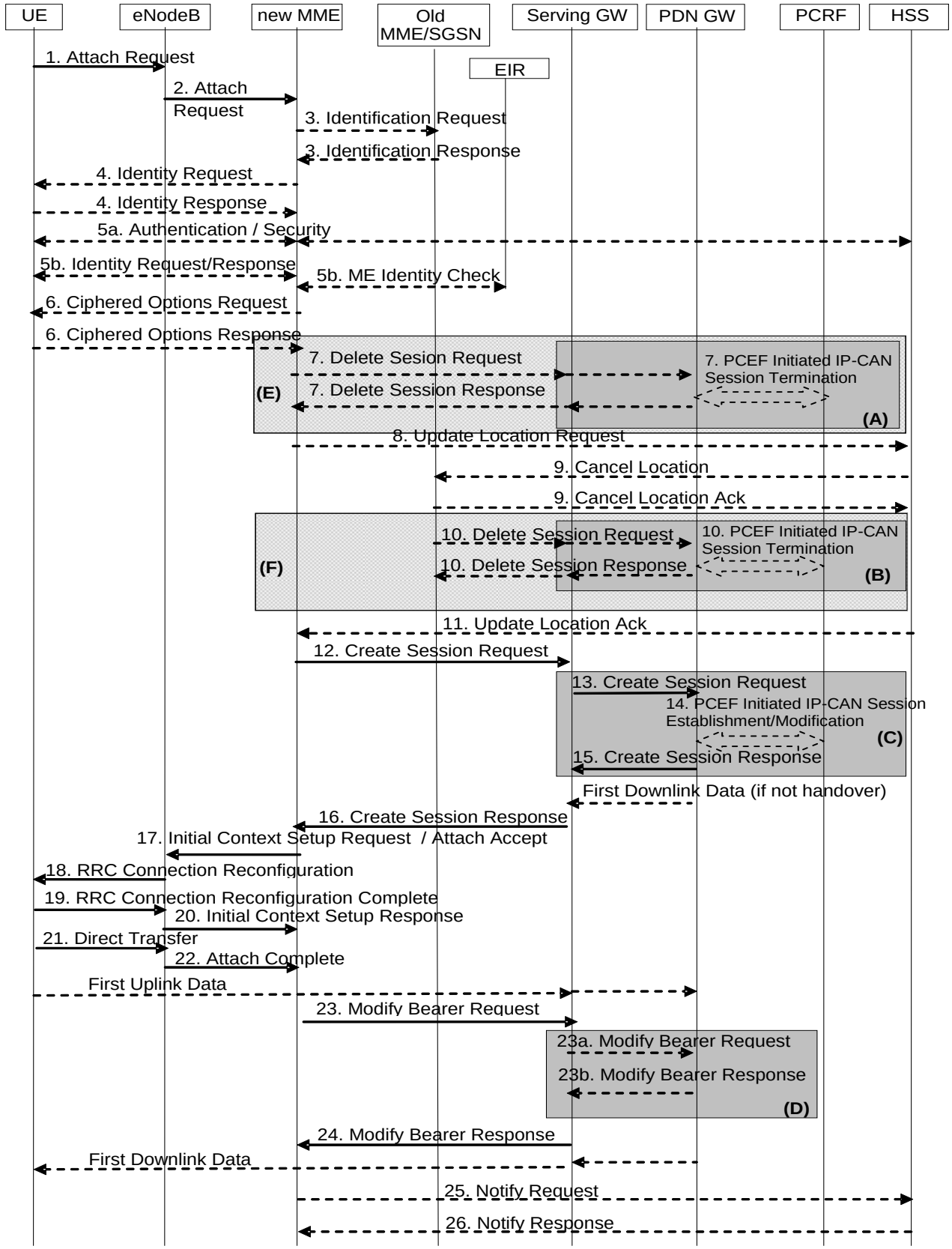

Figure 12 EPS attach

Combined EPS / IMSI attach

The signalling flow of the combined EPS /IMSI attach refers to 3GPP TS 23.272 [4]. The trigger / observation points are numbered by using the same procedural step numbers in the figure.

5.4.9.2

Trigger point	attach procedural step number		Description	Interface / protocol
	Combined EPS/IMSI	EPS		
EPSC01	1	-	UE combined attach request	LTE-Uu / NAS
$EPS05_{vh}$	-	5a	Authentication / security	S6a / Diameter
$EPS05_{hv}$	-	5a	Authentication / security	S6a / Diameter
$EPS07_{vh}$	-	7	Delete session request	S8 or S11 / GTPv2-C
$EPS07_{hv}$	-	7	Delete session response	S8 or S11 / GTPv2-C
EPS08	-	8	Update location request	S6a / Diameter
$EPS09_{hv}$	-	9	Cancel location	S6a / Diameter
$EPS09_{vh}$	-	9	Cancel location Ack	S6a / Diameter
$EPS10_{vh}$	-	10	Delete session request	S8 or S11 / GTPv2-C
$EPS10_{hv}$	-	10	Delete session response	S8or S11 / GTPv2-C
EPS11	-	11	Update location Ack	S6a / Diameter
EPS12	-	12	Create session request	S11 / GTPv2-C
EPS13	-	13	Create session request	S8 / GTPv2-C
EPS15	-	15	Create session response	S8 / GTPv2-C
EPS16	-	16	Create session response	S11 / GTPv2-C
LU06	5	-	Update location request	D / SS7
LU11	5	-	Update location Ack	D / SS7
EPS18	-	18	RRC connection reconfiguration	LTE-Uu / NAS
EPS21	-	21	Direct transfer	LTE-Uu / NAS

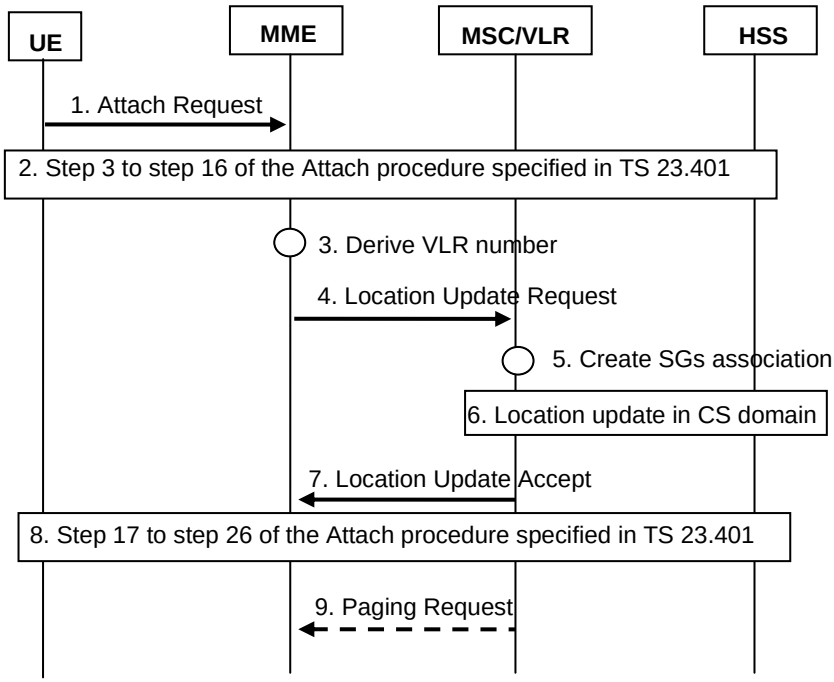

Figure 13: Combined EPS /IMSI attach

Voice CSFB MO call

The voice CSFB MO call flow consists of two diagrams, the handovers between EPS to CS domains before and after a CS MO call and the CS MO call establishment.

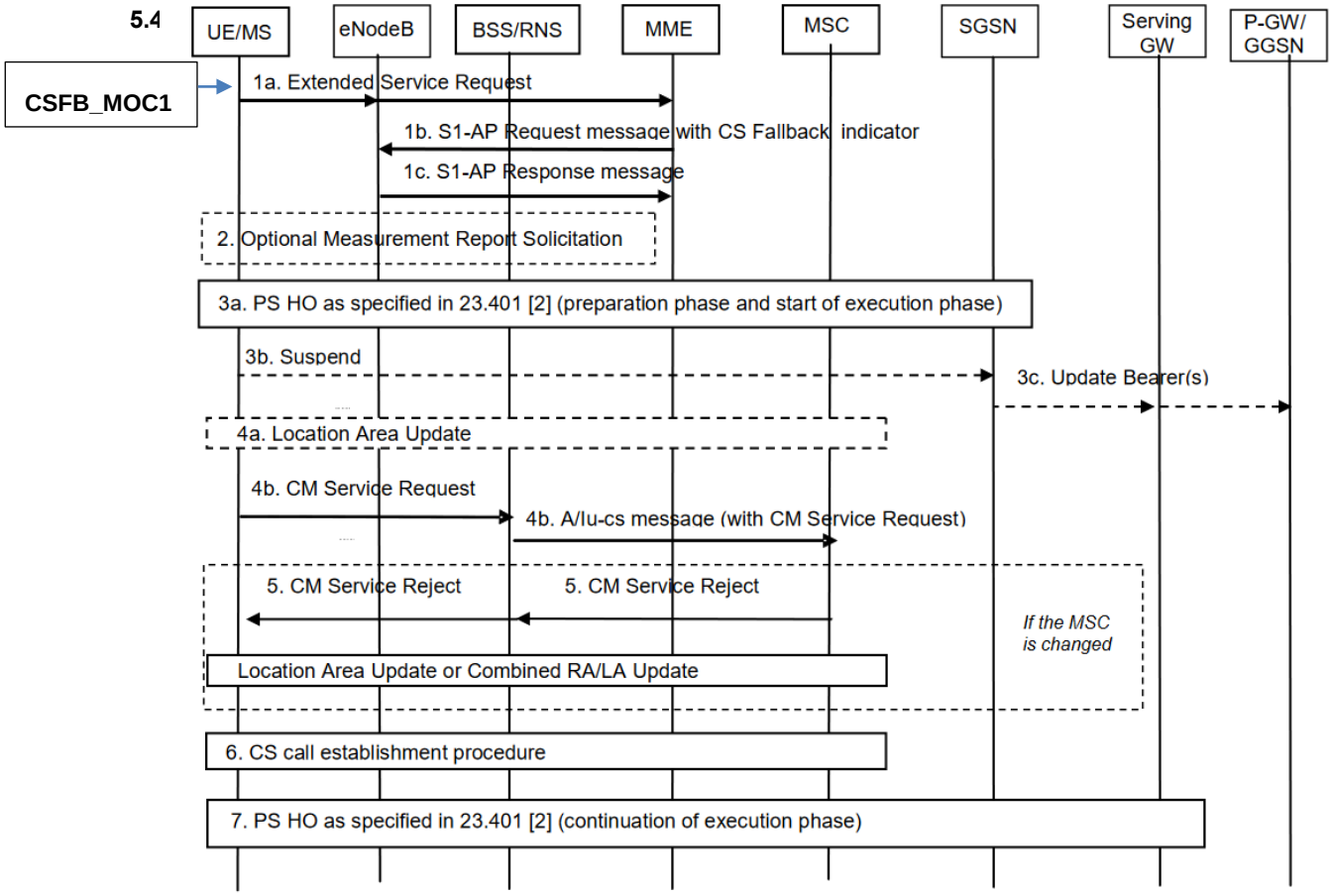

Figure 14: Voice CSFB MO call with PS / CS HO [4]

The call flow below is the expansion of procedure 6 for the CS call establishment procedure in the previous flow.

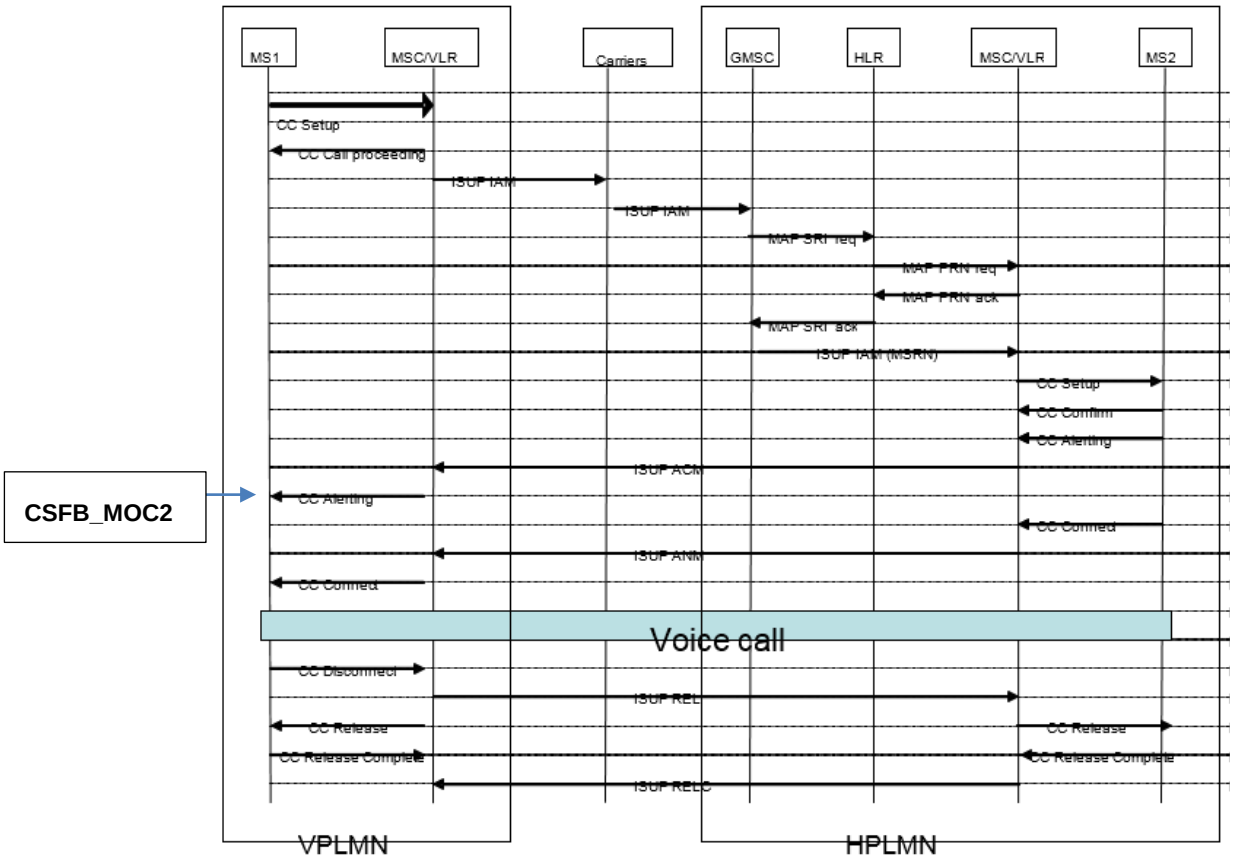

Figure 15: CS MO call establishment

The CSFB PDD-MO is defined as the time between CSFB_MOC2 - CSFB_MOC1.

Voice CSFB MT call

The voice CSFB MT call flow consists of two diagrams, the handovers between EPS to CS domains before and after a CS MT call and the CS MT call establishment.

5.4.9.4

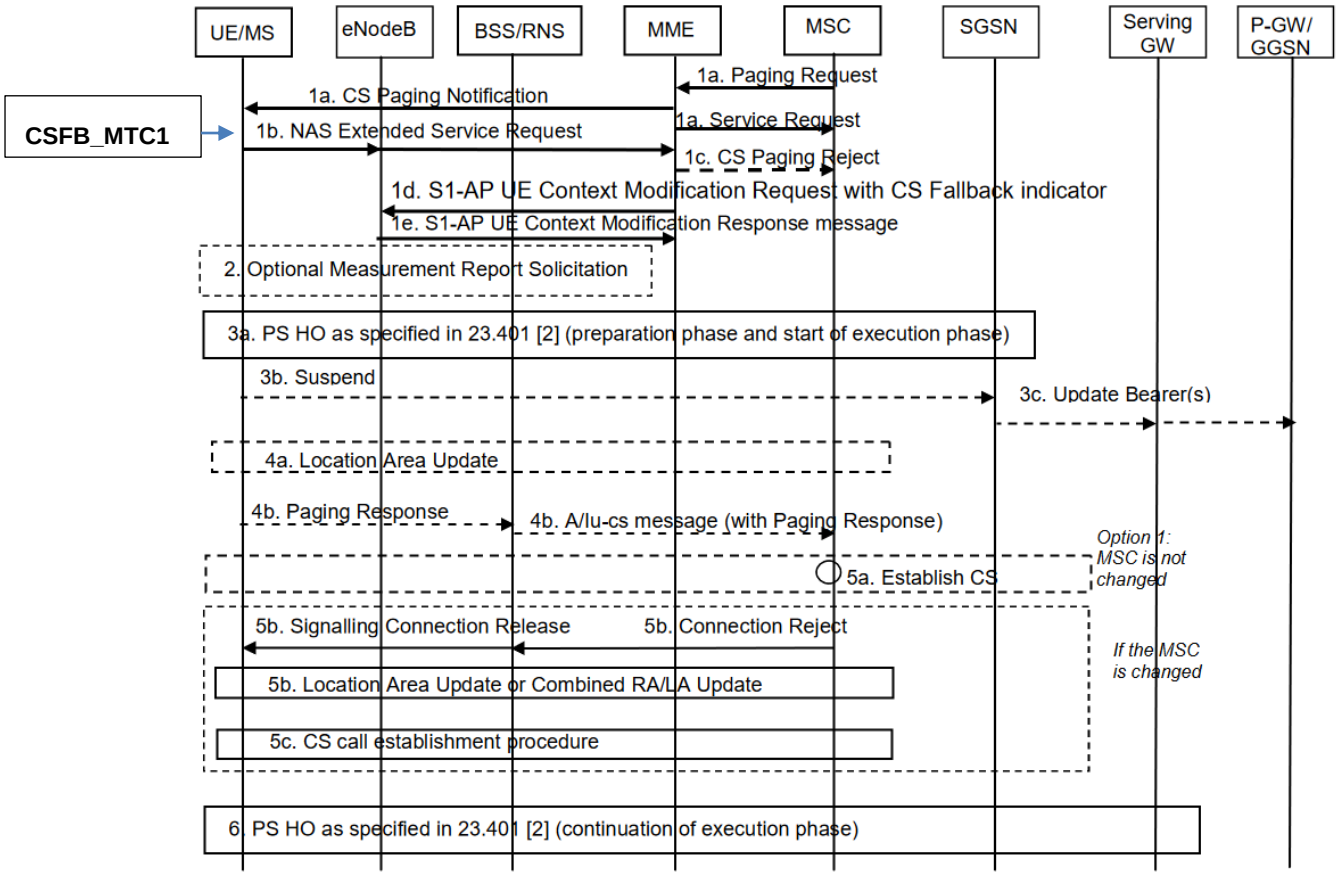

Figure 16: Voice CSFB MT call with PS / CS HO [4]

The call flow below is the expansion of procedure 5c for the CS call establishment procedure in the previous flow.

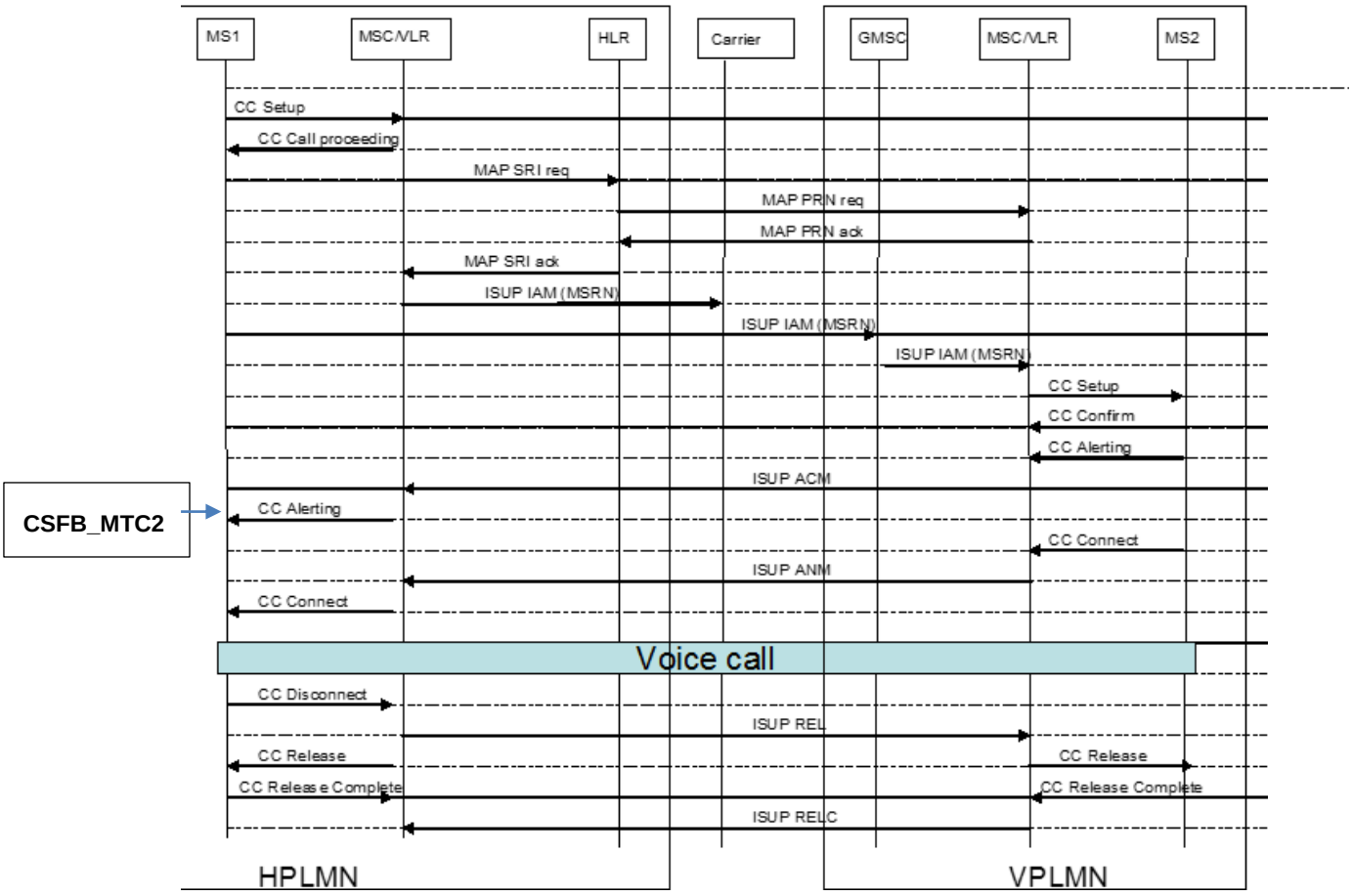

Figure 17: CS MT call establishment

The CSFB PDD-MT is defined as the time between CSFB_MTC2 - CSFB_MTC1.

Trigger Table

GSM/GPRS and UMTS trigger points

5.5

Test	Parameter	Reference flow	Start point	End Point
CIRCUIT-SWITCHED				
1AH, 1AV, 1BH, 1BV	LU update success ratio	Location update	LU01 (Active) LU06 (Passive)	LU12 (Active) LU11(Passive)
1BR	LU update success ratio	Location update	LU06HUB	LU11Hub
2AH, 2AV, 2BH, 2BV	LU delay	Location update	LU01 (Active) LU06 (Passive)	LU12 (Active) LU11(Passive)
2BR	LU delay	Location update	LU06Hub	LU11Hub
3AH, 3AV, 3BH, 3BV	NER-MO (Network Effectiveness Ratio on Mobile Originated calls in the visited network)	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
4AH, 4AV, 4BH, 4BV	NER-MT (Network Effectiveness Ratio on Mobile Terminated calls in the visited network)	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)
5AH, 5AV, 5BH, 5BV	PDD-MO (Post Dialling Delay)	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
6AH, 6AV, 6BH, 6BV	PDD-MT (Post Dialling Delay)	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)
7AH, 7AV, 7BH, 7BV	CSSR-MO (Call Setup Success Ratio on Mobile Originated calls in the visited network)	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC17 (Active) MOC16 (Passive)
8AH, 8AV, 8BH, 8BV	CSSR-MT (Call Setup Success Ratio on Mobile Terminated calls in the visited network)	Voice call MT	MTC01 (Active) MTC07 (Passive)	MOC17 (Active) MOC16 (Passive)

Test	Parameter	Reference flow	Start point	End Point
9BH, 9BV	REL (ISUPv2 signalling transparency)	Voice call MO	MOC20	MOC22
10BH, 10BV	OCN and RDN (ISUPv2 signalling transparency)	No flow available		
11AH, 11AV, 11BH, 11BV	CCR (Call Completion Rate Circuit)	Voice call MO	MOC14 (Active) MOC13 (Passive)	MOC20 (Active) MOC21 (Passive)
12BH, 12BV	ALOC	Voice call MO	MOC03	MOC21
13aAH, 13aAV, 13aBH, 13aBV	CLI transparency (MO)	Voice call MO	MOC01 (Active) MOC02 (Passive)	MOC10 (Active), (Passive)
13bAV, 13bBV, 13bBH, 13bBV	CLI transparency (MT)	Voice call MT	MTC01 (Active) MTC02 (Passive)	MTC10 (Active), (Passive)
14aAH, 14aAV	Speech Quality (SpQ_received_R_side)	Voice call MO	MOC18 (Active)	MOC19 (Active)
14bAV, 14bAV	Speech Quality (SpQ_received_H_side)	Voice call MO	MOC18 (Active)	MOC19 (Active)
SMS				
21AH, 21AV, 21BH, 21BV	Service Accessibility SMS MO (SA SMS MO)	SMS	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03 (Passive)
22AH, 22AV, 22BH, 22BV	Service Accessibility SMS MT (SA SMS MT)	SMS	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
23AH, 23AV, 23BH, 23BV	Access Delay SMS MO (AD SMS-MO)	SMS	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03 (Passive)
24AH, 24AV, 24BH, 24BV	Access Delay SMS MT (AD SMS-MT)	SMS	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
25AH, 25AV, 25BH, 25BV	End-to-End Delivery Time for SMS-MO	SMS	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)

Test	Parameter	Reference flow	Start point	End Point
26AH, 26AV, 26BH, 26BV	End-to-End Delivery Time for SMS-MT	SMS	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
PACKET-SWITCHED				
31AH, 31AV, 31BH, 31BV	Packet Switched LU Success Ratio (PS LU - SR)	GPRS	GPRS01 (Active) GPRS02 (Passive)	GPRS10 (Active) GPRS09 (Passive)
31BR	Packet Switched LU Success Rate (PS LU - SR)	GPRS	GPRS02Hub	GPRS07Hub
32AH, 32AV, 32BH, 32BV	Packet Switched Location Update Delay (PS LU - D)	GPRS	GPRS01 (Active) GPRS02 (Passive)	GPRS10 (Active) GPRS09 (Passive)
32BR	Packet Switched Location Update Delay (PS LU - D)	GPRS	GPRS02Hub	GPRS07Hub
33AH, 33AV, 33BH, 33BV	Service accessibility for PSD (PDP-context activation success rate)	GPRS	GPRS12 (Active) GPRS13 (Passive)	GPRS19 (Active) GPRS18 (Passive)
34AH, 34AV, 34BH, 34BV	Set-up Delay (ST PSD)	GPRS	GPRS12 (Active) GPRS13 (Passive)	GPRS19 (Active) GPRS18 (Passive)
35AH, 35AV, 35BH, 35BV	PDP Context Cut-Off Ratio (session Stability measured at PDP context or PS level)	GPRS	GPRS19 (Active) GPRS18 (Passive)	GPRS25 (Active) GPRS24 (Passive)
36AH, 36AV, 36BH, 36BV	Average PDP Context Session Time (per APN)	GPRS	GPRS20	GPRS21
37AH, 37AV, 37BH, 37BV	Throughput (Kbits/sec)	FTP / GPRS	FTP01 (Active) GPRS21 (Passive)	FTP12 (Active) GPRS21 (Passive)
38BH, 38BV, 38BH, 38BV	Goodput (Kbits/sec)	FTP / GPRS	FTP01 (Active) GPRS21 (Passive)	FTP12 (Active) GPRS21 (Passive)
39AH, 39AV,	Roundtrip time	Ping / GPRS	Ping 01 (Active) During TCP	Ping04 (Active) During TCP

Test	Parameter	Reference flow	Start point	End Point
39BH, 39BV			session (Passive)	session (Passive)
40AH, 40AV, 40BH, 40BV	Packet loss	Ping / GPRS	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)
142AH, 142AV	HTTP / HTTPS IP service setup time	HTTP/HTTPS	HTTP01 (active)	HTTP02 (active)
143AH, 143AV	HTTP / HTTPS session success ratio	HTTP/HTTPS	HTTP01 (active)	HTTP03 (active)
144AH, 144AV	HTTP / HTTPS session time	HTTP/HTTPS	HTTP01 (active)	HTTP03 (active)
145AH, 145AV	HTTP / HTTPS mean data rate	HTTP/HTTPS	HTTP01 (active)	HTTP03 (active)
146AH, 146AV	HTTP / HTTPS data transfer success ratio	HTTP/HTTPS	HTTP01 (active)	HTTP04 (active)

LTE trigger points

Test code	Parameter	Reference flow	Start point	End Point
Voice CSFB				
101AH, 101AV, 101BH, 101BV	PS location update success ratio	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) $EPS09_{hv}$ (Passive) LU06 (Passive) $EPS07_{vh}$ (Passive)[6] $EPS10_{vh}$ (Passive)[6]	EPS18 (Active) EPS11 (Passive) $EPS09_{vh}$ (Passive) LU11 (Passive) $EPS07_{hv}$ (Passive)[6] $EPS10_{hv}$ (Passive)[6]
101BR	PS location update success ratio	Combined EPS / IMSI attach	EPS08Hub (Passive) $EPS09_{hv}$Hub(Passive) LU06Hub (Passive)	EPS11Hub (Passive) $EPS09_{vh}$Hub(Passive) LU11Hub (Passive)
102AH, 102AV, 102BH, 102BV	PS location update delay	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) LU06 (Passive)	EPS18 (Active) EPS11 (Passive) LU11 (Passive)
102BR	PS location update delay	Combined EPS / IMSI attach	EPS08Hub (Passive) LU06Hub (Passive)	EPS11Hub (Passive) LU11Hub (Passive)
103AH, 103AV	CSFB return to LTE success ratio	-	Disconnect voice call (Active)	Return to LTE (Active)
104AH, 104AV	CSFB return to LTE time	-	Disconnect voice call (Active)	Return to LTE (Active)
3AH, 3AV, 3BH, 3BV	Service Accessibility Telephony – MO	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
4AH, 4AV, 4BH, 4BV	Service Accessibility Telephony – MT	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)
115AH, 115AV, 5BH, 5BV	CSFB Setup Time Telephony – MO	CSFB Voice call MO	CSFB MOC1 (Active) MOC03 (Passive)	CSFB MOC2 (Active) MOC13 (Passive)
116AH, 116AV, 6BH, 6BV	CSFB Setup Time Telephony – MT	CSFB Voice call MT	CSFB MTC1 (Active) MTC07 (Passive)	CSFB MTC2 (Active) MTC13 (Passive)

[6] The S8 interface and the trigger point referring to the interface are valid for the home routed architecture via PGW at HPMN.

Test code	Parameter	Reference flow	Start point	End Point
SMSoSGs				
101AH, 101AV, 101BH, 101BV	PS location update success ratio	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) $EPS09_{hv}$ (Passive) LU06 (Passive) $EPS07_{vh}$ (Passive)[6] $EPS10_{vh}$ (Passive)[6]	EPS18 (Active) EPS11 (Passive) $EPS09_{vh}$ (Passive) LU11 (Passive) $EPS07_{hv}$ (Passive)[6] $EPS10_{hv}$ (Passive)[6]
101BR	PS location update success ratio	Combined EPS / IMSI attach	EPS08Hub (Passive) $EPS09_{hv}$Hub(Passive) LU06Hub (Passive)	EPS11Hub (Passive) $EPS09_{vh}$Hub(Passive) LU11Hub (Passive)
102AH, 102AV, 102BH, 102BV	PS location update delay	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) LU06 (Passive)	EPS18 (Active) EPS11 (Passive) LU11 (Passive)
102BR	PS location update delay	Combined EPS / IMSI attach	EPS08Hub (Passive) LU06Hub (Passive)	EPS11Hub (Passive) LU11Hub (Passive)
21AH, 21AV, 21BH, 21BV	Service Accessibility SMS MO (SA SMS MO)	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
22AH, 22AV, 22BH, 22BV	Service Accessibility SMS MT (SA SMS MT)	SMS and SMSoSGs	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
23AH, 23AV, 23BH, 23BV	Access Delay SMS MO (AD SMS-MO)	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
24AH, 24AV, 24BH, 24BV	Access Delay SMS MT (AD SMS-MT)	SMS and SMSoSGs	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
25AH, 25AV, 25BH, 25BV	End-to-End Delivery Time for SMS-MO	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
26AH, 26AV, 26BH, 26BV	End-to-End Delivery Time for SMS-MT	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)

Test code	Parameter	Reference flow	Start point	End Point
LTE data				
101AH, 101AV, 101BH, 101BV	PS location update success ratio	EPS attach	EPS01 (Active) EPS08 (Passive) $EPS09_{hv}$ (Passive) $EPS07_{vh}$ (Passive)[6] $EPS10_{vh}$ (Passive)[6]	EPS18 (Active) EPS11 (Passive) $EPS09_{vh}$ (Passive) $EPS07_{hv}$ (Passive)[6] $EPS10_{hv}$ (Passive)[6]
101BR	PS location update success ratio	EPS attach	EPS08Hub (Passive) $EPS09_{hv}$Hub(Passive)	EPS11Hub (Passive) $EPS09_{vh}$Hub(Passive)
102AH, 102AV, 102BH, 102BV	PS location update delay	EPS attach	EPS01 (Active) EPS08 (Passive)	EPS18 (Active) EPS11 (Passive)
102BR	PS location update delay	EPS attach	EPS08Hub (Passive)	EPS11Hub (Passive)
105AH, 105AV, 105BH, 105BV	Default EPS bearer context activation success ratio	EPS attach	EPS18 (Active) EPS12 (Passive) EPS13 (Passive)[6]	EPS21 (Active) EPS16 (Passive) EPS15 (Passive)[6]
106AH, 106AV	Default EPS bearer context activation time	EPS attach	EPS18 (Active) EPS12 (Passive)	EPS21 (Active) EPS16 (Passive)
107AH, 107AV	DNS host name resolution success ratio	-	DNS request (Active)	DNS data packet (type A) received (Active)
108AH, 108AV	DNS host name resolution time	-	DNS request (Active)	DNS data packet (type A) received (Active)
109AH, 109AV	Default EPS bearer context cut-off ratio	EPS attach		
131AH, 131AV	FTP {download | upload} IP service access success ratio	FTP	FTP00 (active)	FTP08 (active)
132AH, 132AV	FTP {download | upload} IP service setup time	FTP	FTP00 (active)	FTP08 (active)
133AH, 133AV	FTP {download | upload} session success ratio	FTP	FTP00 (active)	FTP09 (active)
134AH, 134AV	FTP {download | upload} session time	FTP	FTP00 (active)	FTP09 (active)
135AH, 135AV	FTP {download | upload} mean data rate	FTP	FTP00 (active)	FTP09 (active)
136AH, 136AV	FTP {download | upload} data transfer success ratio	FTP	FTP00 (active)	FTP11 (active)

Test code	Parameter	Reference flow	Start point	End Point
137AH, 137AV	FTP {download | upload} data capacity	FTP	FTP00 (active)	Reached max. capacity (active)
141AH, 141AV	HTTP / HTTPS IP service access success ratio	HTTP/HTTPS	HTTP01 (active)	HTTP02 (active)
142AH, 142AV	HTTP / HTTPS IP service setup time	HTTP/HTTPS	HTTP01 (active)	HTTP02 (active)
143AH, 143AV	HTTP / HTTPS session success ratio	HTTP/HTTPS	HTTP01 (active)	HTTP03 (active)
144AH, 144AV	HTTP / HTTPS session time	HTTP/HTTPS	HTTP01 (active)	HTTP03 (active)
145AH, 145AV	HTTP / HTTPS mean data rate	HTTP/HTTPS	HTTP01 (active)	HTTP03 (active)
146AH, 146AV	HTTP / HTTPS data transfer success ratio	HTTP/HTTPS	HTTP01 (active)	HTTP04 (active)
147AH, 147AV	HTTP / HTTPS content compression ratio	HTTP/HTTPS	HTTP01 (active)	HTTP04 (active)
148AH, 148AV	HTTP / HTTPS {download | upload} data capacity	HTTP/HTTPS	HTTP01 (active)	Reached max. capacity (active)
151AH, 151AV, 151BH, 151BV	PING packet loss ratio	PING	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)
152AH, 152AV, 152BH, 152BV	PING round trip time	PING	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)

5.6 Monitoring Values

Please refer to the GRQ Handbook (BA.51) for information on the GRQ trial observed measurements and how to define Service Level, trigger values

6 GRQ Test Result Presentations

Visualisation of test result data stored is always of great importance. Presentation of quality KPIs values, collected at active testing of network interconnect or roaming, is the key step of the visualisation and displaying of the test results towards the human users involved. Much attention in KPIs presentation is given to the interconnect network complexity and roaming service challenges that arise. A good presentation of the GRQ test results, provides to human users a new and rich way of quality analysis with good user experience.

KPI Matrix presentation

A fundamental and probably the most popular form to present the KPI test result is in a matrix, not only because the matrix is easily stored and can be retrieved from a KPI database, but also a two-dimensional matrix is suitably displayed in a rectangular screen.

6.1

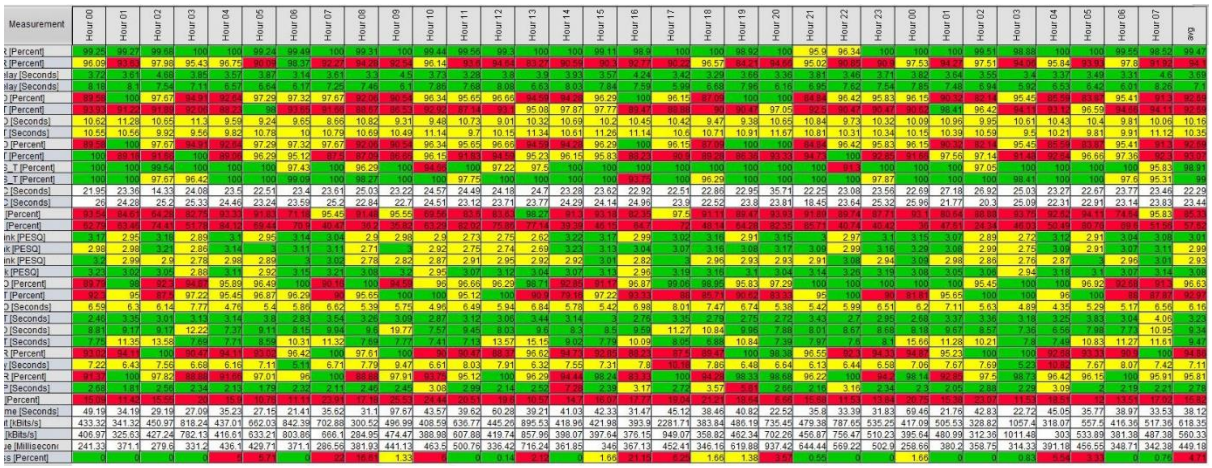

Figure 18: KPI matrix presentation

Very often, the measured GRQ KPI values are presented as a matrix group with at least 3 dimensions in a large size with axes of GRQ KPIs and VPMN partners with possibly more locations and testing time. A rectangular screen is selected to display or visualize a single matrix. Multiple screens are used for displaying multiple matrixes.

6.2 KPI chart presentations

Extracted from the original primary KPI matrix, a submatrix can present one or more of the concerned KPIs of interest. In these simplified cases, KPI charts are used. There exist different chart types which are often used in a dashboard for the presentation of a partial, but characterized test result.

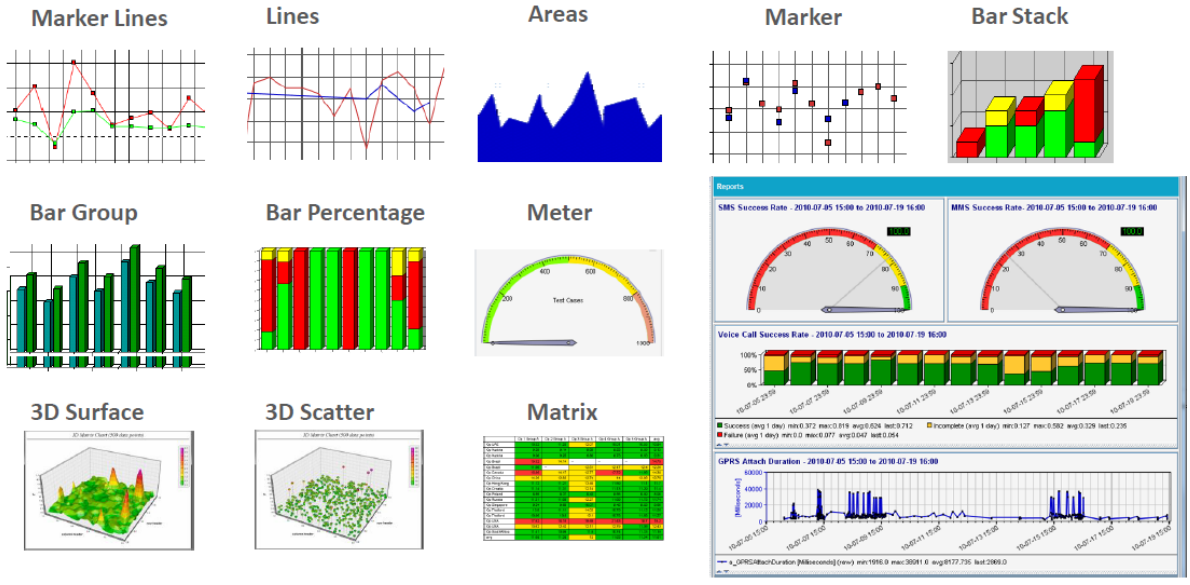

Figure 19: Different chart types

Single Service Indicator and Single Quality Indicator

Single Service Indicator (SSI) is a composite performance indicator of a particular service. The main purpose of having a SSI is to provide an executive management view of quality with a single and unique service indicator. The most relevant quality KPIs are selected, combined and weighted in a calculation according to their importance. The SSI abstract calculation can be found in IR.42, section 5 [1].

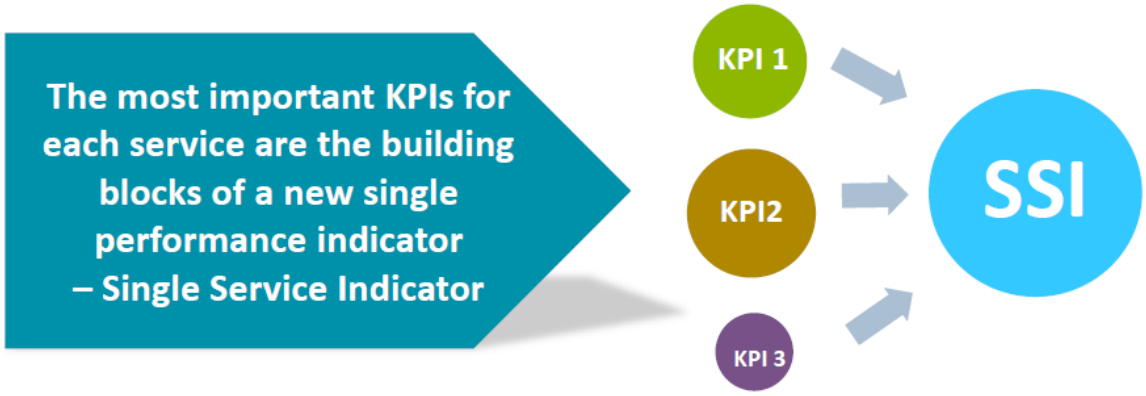

Figure 20: Single Service Indicator

Similar to SSI, Single Quality Indicator (SQI) combines a number of weighted SSIs and provides a single unique quality score of performance.

6.3 SSI and SQI for roaming

In a roaming environment, an SSI is more focussed on the service accessibility and user experience, rather than the network accessibility (location or routing area update) in a VPMN, as steering of roaming at the VPMN may alter the result.

The SSI is defined at the service level. The SQI can be defined at the level per visited network or per country, depending on the purpose. For example, in case it is required to compare the performance of a specific service among several operators the SSI per service can be used. However, to have a general overview of the performance in a visited network, the SQI gives a single performance value per VPMN. In a similar way, SQI can provide a single performance value per country.

6.3.1 SSI and SQI in 2G or 3G roaming

The SSI and SQI abstract calculations are found in IR.42 [1], section 5.1.2 and 5.2.1, respectively.

The relevant KPIs are selectively included in the SSI calculation. The main criteria are to select those KPIs which reflect the better user experience of each service and give them an opportune weight according to their importance. The unselected KPIs are masked in the calculation with the zero weight.

6.3.2.1 CS Voice SSI

The CS voice service is evaluated from the user perspective by considering the VPMN capability of delivering a voice call to the HPMN as the most essential roaming service indicator. Therefore, the 1st important KPI is contributed to a call setup. The second

important KPI is the voice quality, this has also an impact on the operator's revenue, because a poor voice quality might lead to a reduced conversation time. The capability of retaining a call and to release it correctly is considered with a lower weight, the least impacting the KPI is, the biggest delay experienced by the user after dialling the destination number (PDD) is. This is because a typical user in roaming tends to be more tolerant to such a delay.

The outbound roaming voice SSI is defined as:

$$SSI\_Voice = 40\% * CSSR + \ 30\% * MOS + 20\% * CCR + \ 10\% * PDD$$

Where:

- CSSR: Call Set up Success Ratio,
- MOS: Mean Opinion Score, based on the POLQA algorithm,
- CCR: Call Completion Success Ratio,
- PDD: Post Dial Delay.

The table below summarizes the weighted value applied to those voice GRQ KPIs which derive the voice SSI per VPMN.

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher-Lower Limit	Scoring Mode
Voice	7	CSSR call set up success ratio	CSSR_MO	40	100 – 0	Higher is better
	14	MOS voice quality score	SpQ_received_R_side_MO	15	3 - 2,5	Higher is better
	14	MOS voice quality score	SpQ_received_H_side_MO	15	3 - 2,5	Higher is better
	11	CCR call completion success ratio	CCR_CS_T	20	100 – 0	Higher is better
	5	PDD post dial delay (sec)	PDD-ST_T_MO	10	15 - 8	Lower is better

Table 9: CS Voice roaming SSI calculation

6.3.2.2 SMS SSI

The SMS is quite simple from the user perspective; the most important the factor is, the biggest chances to deliver the SMS within a reasonable time. A default timer of 240 seconds is assumed, after that time out, the test will be failed. The SMS has not been delivered. Therefore, the KPIs considered are the SMS success ratio and the end-to-end delivery time:

$$SSI_{SMS} = 70\% * \ SMS\ Success\ Ratio + 30\% * E2E\ delivery\ time$$

Where:

- SMS success ratio: Service Accessibility SMS MO (SA SMS MO),

- E2E delivery time: End-to-End Delivery Time for SMS-MO.

This means that an outbound roaming SMS (MO) shall be delivered successfully within four minutes.

The table below summarizes the weighted value applied to SMS GRQ KPI which derives the SSI per VPMN.

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher-Lower Limit	Scoring Mode
SMS	21	SMS success ratio	SA_SMS_MO	70	100 – 0	Higher is better
	25	End-to-End Delivery Time for SMS-MO (sec)	E2E delivery time	30	240 - 0	Lower is better

Table 10: SMS Roaming SSI calculation

PS Data SSI

6.3.2.3 The data services are evaluated by considering first the accessibility of the data network, meaning the PDP context activation. Without the success of this procedure the data is not available at all, therefore this has a high weight. A second criteria for evaluation is the data speed and the PDP cut off ratio that measures the retain ability of the data connection.

$$SSI\_Data = 25\% * PDP\ CA\ SR + \ 50\% * Download_{rate} + 25\% * PDP\ Cut\ off\ ratio$$

Where:

- PDP_CA_SR: PDP context activation Success Ratio,
- Download rate: the measured *Goodput* download bit rate expressed in Mbps,
- PDP Context Cut off ratio: the percentage of the PDP cut off during a data session.

Regarding the data download rate, the *Goodput* is considered because this does not include the overhead and the retransmissions. This way, only the application throughput is considered and the real user experience evaluated.

The table below summarizes the weighted value applied to those KPIs which derive the SSI per VPMN.

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher-Lower Limit	Scoring Mode
Data	33	PDP context activation success ratio	PDP_CA_SR	25	100 – 0	Higher is better
	38	Download Goodput (Mbps)	Goodput	50	2 - 0,5	Higher is better
	35	PDP context cut off ratio	PDP_C_COR	25	100 - 0	Lower is better

Table 11: PS data roaming SSI calculation

SQI per VPMN

SQI_VPMN is defined to aggregate the services in the VPMN. The indicator aggregates the individual SSI of each service by means of a weighted sum according to the following criteria:

6.3.2.4

$$SQI\_VPMN = 40\% * Voice\ (SSI) + \ 40\% * Data\ (SSI) + 20\% * SMS\ (SSI)$$

The voice and the data services are considered with equal weight, because in roaming the data services, influence the customer experience at least in the same way as the voice service. This is due to the expansion of OTT services, internet browsing and for business travellers the email is particularly important. This explains also why the SMS plays a less role, as part of the messaging person-to-person is sent via OTT applications.

The table below summarizes the weighted value applied to those KPIs which derive the SSI per VPMN.

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher -Lower Limit	Scoring Mode
Voice	7	CSSR call set up success ratio	CSSR_MO	16	100 – 0	Higher is better
	14	MOS voice quality score	SpQ_received_R_side_MO	6	3 - 2,5	Higher is better
	14	MOS voice quality score	SpQ_received_H_side_MO	6	3 - 2,5	Higher is better
	11	CCR call completion success ratio	CCR_CS_T	8	100 – 0	Higher is better
	5	PDD post dial delay (sec)	PDD-ST_T_MO	4	15 - 8	Lower is better
SMS	21	SMS success ratio	SA_SMS_MO	14	100 – 0	Higher is better
	25	End-to-End Delivery Time for SMS-MO (sec)	E2E delivery time	6	240-0	Lower is better
Data	33	PDP context activation success ratio	PDP_CA_SR	10	100 – 0	Higher is better
	38	Download Throughput in Mbps	Goodput	20	2 - 0,5	Higher is better
	35	PDP context cut off ratio	PDP_C_COR	10	100 - 0	Lower is better

6.3.2.5

Table 12: Roaming SQI calculation per VPMN

SQI per country

A countrywide SSI allows to compare the overall user experience among different visited countries. In this case the correct weighting is applied to the steering of roaming. In this way the preferred operator performances are weighted more than the non-preferred where it is

expected to have less traffic. However, in most cases this information is confidential. Therefore, the criteria to be used option for the countywide SSI is the simple arithmetical average of the SSI_VPMN with equal weights.

$$SQI\_Country = average(SSI\_VPMN)$$

The SQI per country allows to have an overall indication on the user roaming experience in each visited country. This information can also be used for benchmarking purposes.

SSI and SQI in 4G roaming

In the 4G roaming environment, the SSI and SQI have three service aspects, voice, data and messaging services.

6.3.3

Voice CSFB

6.3.3.1

The voice CS Fallback service is evaluated from the user perspective by considering the VPMN capability of delivering a voice call when the UE has been attached under a combined EPS/IMSI in VPMN. Therefore, the first important KPI contributes to initiate a CS voice call setup (NER-MO). The second important KPI is to measure the capability of redirecting the UE back to 4G after the established voice call is released. The third KPI is the user waiting time from the initiation of the call till ringing (PDD).

The outbound roaming voice CSFB SSI is defined as:

$$SSI_{\text{voice\_CSFB}} = 60\% * NER_{MO} + 30\% * Return_{to_{LTE}} + 10\% * CSFB\ PDD$$

Where:

- NER-MO: Service Accessibility Telephony (Network Efficiency Ratio) - MO,
- Return to LTE: CSFB return to LTE success ratio,
- CSFB PDD: CSFB Post Dial Delay.

The table below summarizes the weighted value applied to those voice CSFB KPIs which derive the voice SSI per VPMN.

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher-Lower Limit	Scoring Mode
Voice CSFB	3	Service Accessibility Telephony – MO	NER_MO	60	100 – 0	Higher is better
	103a	CSFB return to LTE success ratio - MO	Return to LTE	30	100 – 0	Higher is better
	115	CSFB PDD post dial delay (sec)	CSFB PDD-ST_T_MO	10	20 - 0	Lower is better

Table 13: Voice CSFB roaming SSI calculation

SMSoSGs

6.3.3.2

The SMSoSGs service is evaluated from the user perspective whether the VPMN is capable of delivering SMS when the UE has been attached under a combined EPS/IMSI in VPMN.

Therefore, the first important KPI is the Service Accessibility SMS MO (SA SMS MO). The second important KPI is to measure End-to-End Delivery Time for SMS-MO, to deliver the SMS within a reasonable time. A default timer of 240 seconds is assumed, after that time out, the test will be failed. This means that an outbound roaming SMS (MO) shall be delivered successfully within four minutes.

$$SSI_{SMSoSGs} = 70\% * SMS\ success\ ratio + 30\% * E2E\ delivery\ time$$

Where:

- SMS success ratio: Service Accessibility SMS MO (SA SMS MO),
- E2E delivery time: End-to-End Delivery Time for SMS-MO.

The table below summarizes the weighted value applied to SMSoSGs GRQ KPI which derives the SSI per VPMN.

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher-Lower Limit	Scoring Mode
SMSoSGs	21	SMS success ratio	SA_SMS_MO	70	100 – 0	Higher is better
	25	End-to-End Delivery Time for SMS-MO (sec)	E2E delivery time	30	240 - 0	Lower is better

Table 14: SMSoSGs Roaming SSI calculation

6.3.3.3

HTTP / HTTPS SSI

The HTTP / HTTPS data service is evaluated by considering first the accessibility to the data network, when the default EPS bearer context is activated. Without the success of this procedure the data service is not available at all. Therefore, it has a higher weight. A second criteria for evaluation is the HTTP /HTTPS download data speed and the success ratio of downloading a complete contents of the WEB page.

$$SSI_{HTTP} = 25\% * EPSbearer\ actv + 50\% * Download_{rate} + 25\% * HTTPsession\ completion$$

Where:

- EPSbearer actv: Default EPS bearer context activation success ratio,
- $Download_{rate}$: HTTP / HTTPS mean data rate in mbps, it is recommended to have at least three TCP sessions in parallel,
- HTTPsession completion: HTTP / HTTPS data transfer success ratio.

The table below summarizes the weighted value applied to those KPIs which derive the SSI per VPMN.

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher-Lower Limit	Scoring Mode
HTTP / HTTPS	105	Default EPS bearer context activation success ratio	EPS bearer actv	25	100 – 0	Higher is better
	145	HTTP / HTTPS mean data rate (mbps)	Download rate	50	11 - 1	Higher is better
	146	HTTP / HTTPS data transfer success ratio	HTTP session completion	25	100 - 0	Higher is better

Table 15: 4G HTTP / HTTPS SSI calculation

6.3.3.4 LTE data network performance SSI

The LTE data network SSI indicates the transport network performance for the maximum roaming data capability between the VPMN and the HPMN interconnected via IPX / GRX (illustrated in the figure below).

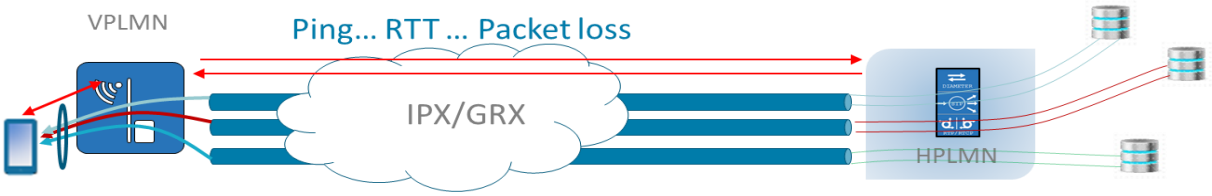

Figure 21: S8HR or LBO-HR data network SSI

The SSI is based on the data capacity KPI (i.e. maximum throughput available to the end user in roaming), but also on the latency caused by VPMN – HPMN distance, as well as the packet loss ratio affecting the user experience.

$$SSI_{4Gdata} = 25\% * RTT + 50\% * MaxThroughput + 25\% * PacketLoss$$

Where:

- RTT: PING round trip time,
- Max Throughput: FTP download data capacity in mbps,
- Packet Loss: PING packet loss ratio
- The table below summarizes the weighted value applied to those KPIs which derive the SSI per VPMN.

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher-Lower Limit	Scoring Mode
LTE data network performance	152	PING round trip time (ms)	RTT	25	370 – 0	Lower is better
	137	FTP download data	Max	50	13.5 - 1	Higher is

		capacity (mbps)	Throughput			better
	151	PING packet loss ratio	Packet Loss	25	100 - 0	Lower is better

Table 16: LTE data network SSI calculation

SQI per VPMN

6.3.3.5

Similar to 2G/3G, 4G SQI_VPMN is defined to aggregate the 4G services in the VPMN. The indicator aggregates the individual SSI of each service by means of a weighted sum according to the following criteria:

$$4G\_SQI\_VPMN = 30\% * CSFB\ (SSI) + \ 60\% * \mathrm{HTTPd}ata\ (SSI) + 10\% * SMSoSGs\ (SSI)$$

The table below summarizes the weighted value applied to those KPIs which derive the SSI per VPMN.

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher -Lower Limit	Scoring Mode
Voice CSFB	3	Service Accessibility Telephony – MO	NER_MO	18	100 – 0	Higher is better
	103a	CSFB return to LTE success ratio - MO	Return to LTE	9	100 – 0	Higher is better
	115	CSFB PDD post dial delay (sec)	CSFB PDD-ST_T_MO	3	20 - 0	Lower is better
SMSoSGs	21	SMS success ratio	SA_SMS_MO	7	100 – 0	Higher is better
	25	End-to-End Delivery Time for SMS-MO (sec)	E2E delivery time	3	240-0	Lower is better
HTTP/ HTTPS Data	105	Default EPS bearer context activation success ratio	EPS bearer actv	15	100 – 0	Higher is better
	145	HTTP / HTTPS mean data rate (mbps)	Download rate	30	11 - 1	Higher is better
	146	HTTP / HTTPS data transfer success ratio	HTTP session completion	15	100 - 0	Higher is better

Table 17: 4G Roaming SQI calculation per VPMN

Annex A GRQ KPI Thresholds

The GRQ KPI thresholds characterize the end-to-end quality for mobile services in roaming. The threshold values are applied to both outbound and inbound roaming, independently of whether the KPIs are tested by using active or passive test methods.

A.1 GRQ LTE KPI Thresholds

The thresholds have resulted from the LTE GRQ pilot project performed in Sept 2015[7] [9]. There are two key recommendations for the KPI thresholds for roaming quality in LTE networks.

- KPI threshold for success ratio of services ⩾ 99%
  Consequently, Loss ratio, cut-off ratio etc. ⩽ 1%
- Some KPI thresholds depend on geo-distance between HPMN and VPMN.
  Data rate such as data capacity, delay / setup time etc. have two thresholds, depending on whether the geo-distance between HPMN and VPMN is less or more than 4000 km

Although the KPI thresholds have resulted from outbound roaming active tests they can also be referenced for inbound roaming KPI.

A.1.1 LTE Data GRQ KPI Thresholds

The following table contains the referenced LTE GRQ KPI thresholds for data roaming.

GRQ KPI Definition		Threshold		Relevance
GRQ Identifier	**QoS parameter (KPI)**	**Geo-distance < 4000 km**	**Geo-distance ≥ 4000 km**	
101	PS location update success ratio (%)	≥ 99.00		Network access
102	PS location update delay (s)	≤ 5.5	≤ 5.5	User experience
105	Default EPS bearer context activation success ratio (%)	≥ 99.00		Network access
106	Default EPS bearer context activation time (ms)	≤ 30		User experience
107	DNS host name resolution success ratio (%)	≥ 99.00		Network access

[7] The LTE GRQ pilot project was led by the NG LTE GRQ task force and managed by the GSMA Network 2020 programme. Vodafone group, Orange Group, Telecom Italia Group, Bouygues Telecom and SIGOS participated in the pilot project.

108	DNS host name resolution time (ms)	≤ 250	≤ 550	User experience
131a	FTP download IP service access success ratio (%)	≥ 99.00		Service access
131b	FTP upload IP service access success ratio (%)	≥ 99.00		Service access
132a	FTP download IP service setup time (s)	≤ 2	≤ 5.5	User experience
132b	FTP upload IP service setup time (s)	≤ 2	≤ 5	User experience
133a	FTP download session success ratio (%)	≥ 99.00		Service access
133b	FTP upload session success ratio (%)	≥ 99.00		Service access
134a	FTP download session time (s)	≤ 2	≤ 5.5	User experience
134b	FTP upload session time (s)	≤ 30	≤ 50	User experience
135a	FTP download mean data rate (Mbit/s)	≥ 13.5	≥ 6	Service access
135b	FTP upload mean data rate (Mbit/s)	≥ 6	≥ 2.5	Service access
136a	FTP download data transfer cut-off ratio (%)	≤ 1.00		Service access
136b	FTP upload mean data transfer cut-off ratio (%)	≤ 1.00		Service access
137a	FTP download data capacity (Mbit/s)	≥ 26.5	≥ 17	User experience
137b	FTP upload data capacity (Mbit/s)	≥ 13	≥ 13	User experience
141	HTTP IP service access success ratio (%)	≥ 99.00		Service access
142	HTTP IP service setup time (ms)	≤ 250	≤ 800	User experience
143	HTTP session success ratio (%)	≥ 99.00		Service access
144	HTTP session time (ms)	≤ 250	≤ 750	User experience
145	HTTP mean data rate (Mbit/s)	≥ 11	≥ 5	User experience
146	HTTP data transfer cut-off ratio (%)	≤ 1.00		User experience
148	HTTP download data capacity (Mbit/s)	≥ 33.5	≥ 18	User experience

151	PING packet loss ratio (%)	≤ 1.00		Service access
152	PING round trip time (ms)	≤ 100	≤ 370	User experience

Table 18: GRQ KPI Threshold for LTE data roaming

Many parameters will affect the FTP test result. It is therefore recommended to use a file size of 20 MB for the FTP download test and 10 MB for the FTP upload test by using a single TCP/IP connection. The FTP server is located in the HPMN, and fully reliable and reachable through the mobile network from roaming, in order to ensure that the FTP server performance will not affect the LTE network performance during the test.

For the FTP data capacity (download or upload) and HTTP capacity testing, 10 TCP/IP connections, as a maximum, are recommended.

For HTTP tests, it is recommended to download a 20 MB file by using a single TCP/IP connection.

A.1.2 Voice CSFB and SMSoSGs GRQ KPI Thresholds

The following table contains the referenced LTE GRQ KPI thresholds at roaming for voice CSFB and SMSoSGs.

GRQ KPI Definition		Threshold		Relevance
GRQ Identifier	**QoS parameter (KPI)**	**Geo-distance < 4000 km**	**Geo-distance ≥ 4000 km**	
101	Location update (combined) success ratio (%)	≥ 99.00		Network access
102	Location update (combined) delay (s)	≤ 6	≤ 9.5	User experience
103a	CSFB return to LTE success ratio - MO (%)	≥ 99.00		Service access
103b	CSFB return to LTE success ratio - MT (%)	≥ 99.00		Service access
104a	CSFB return to LTE time - MO (s)	≤ 9	≤ 11	User experience
104b	CSFB return to LTE time - MT (s)	≤ 9	≤ 13,5	User experience
3	CSFB voice service access success ratio - NER-MO (%)	≥ 99.00		Service access
4	CSFB voice service access success ratio - NER-MT (%)	≥ 99.00		Service access
115	CSFB voice service setup time PDD-MO (s)	≤ 12	≤ 20	User experience

116	CSFB voice service setup time PDD-MT (s)	≤ 13.5	≤ 13.5	User experience
7	CSFB call setup success ratio – CSSR-MO (%)	≥ 99.00		Service access
8	CSFB call setup success ratio – CSSR-MT (%)	≥ 99.00		Service access
21	Service accessibility SMS-MO (%)	≥ 99.00		Service access
22	Service accessibility SMS-MT (%)	≥ 99.00		Service access
23	Access delay SMS-MO (s)	≤ 1.5	≤ 3	User experience
24	Access delay SMS-MT (s)	≤ 2.5	≤ 3	User experience
25	End-to-end delivery time SMS-MO (s)	≤ 4	≤ 5.5	User experience
26	End-to-end delivery time SMS-MT (s)	≤ 4.5	≤ 5.5	User experience

Table 19: GRQ KPI thresholds for voice CSFB and SMSoSGs roaming

A.2 GRQ GSM/GPRS and UMTS KPI Thresholds

This section contains the GRQ KPI thresholds for GSM/GPRS and UMTS technologies.

GRQ Identifier	QoS parameter (KPI)	Threshold	Relevance
1	CS LU SR (CS location update success ratio) (%)	⩾ 98.00	Network access
2	CS LU Delay (CS location update delay) (s)	⩽ 10.0	User experience
3	NER-MO (MO CS voice service access success ratio) (%)	⩾ 98.00	Service access
4	NER-MT (MT CS voice service access success ratio) (%)	⩾ 98.00	Service access
5	PDD-MO (MO CS voice service setup time) (s)	⩽ 8.0	User experience
6	PDD-MT (MT CS voice service setup time) (s)	⩽ 8.0	User experience
7	CSSR-MO (MO CS call setup success ratio) (%)	⩾ 98.00	Service access
8	CSSR-MT (MT CS call setup success ratio) (%)	⩾ 98.00	Service access
11	CCR (CS voice call completion ratio for MO call) (%)	⩾ 98.00	Service access

13	CLI (CLI transparency ratio) (%)	⩾ 98.00	Service access
14	SpQ (speech quality on call-basis)	⩾ 3.0	User experience
21	SA-MO (Service accessibility SMS-MO) (%)	⩾ 98.00	Service access
22	SA-MT (Service accessibility SMS-MT) (%)	⩾ 98.00	Service access
23	AD-MO (Access delay SMS-MO) (s)	⩽ 4.0	User experience
24	AD-MT (Access delay SMS-MT) (s)	⩽ 4.0	User experience
25	E2E DT-MO (End-to-end delivery time SMS-MO) (s)	⩽ 10.0	User experience
26	E2E DT-MT (End-to-end delivery time SMS-MT) (s)	⩽ 10.0	User experience
31	PS LU SR (PS location update success ratio) (%)	⩾ 98.00	Service access
32	PS LU Delay (PS location update delay) (s)	⩽ 6.0	User experience
33	PDPC Act SR (PDP context activation success ratio) (%)	⩾ 98.00	Service access
34	PDPC Act Time (PDP context activation time) (s)	⩽ 3.0	User experience
35	PDPC Cut-off ratio (PDP context cut-off ratio) (%)	⩽ 2.00	Service access
37	Throughput GPRS (FTP) (kbit/s)	⩾ 29	User experience
38	Goodput GPRS (FTP) (kbit/s)	⩾ 32	User experience
39	Roundtrip Time GPRS (Ping) (ms)	⩽ 1200	User experience
40	Packet Loss GPRS (Ping) (%)	⩽ 2.00	Service access
133a	FTP download session success ratio (%)	≥ 99.00	Service access
135a	FTP download mean data rate (Mbit/s)	2.5	User experience
136a	FTP download data transfer cut-off ratio (%)	≤ 1.00	Service access
143	HTTP session success ratio (%)	≥ 99.00	Service access

145	HTTP mean data rate (Mbit/s)	7.5	User experience
146	HTTP data transfer cut-off ratio (%)	≤ 1.00	User experience

Table 20: GRQ KPI thresholds for GSM / GPRS and UMTS

Note: The thresholds of the 2G / 3G PS part shall be revisited after a test pilot project.

Annex B Document Management

B.1 Document History

Version	Date	Brief Description of Change	Approval Authority	Editor / Company
0.5	26 Aug 2008	Clean version for SIGNAL and PACKET comments.	N/A –draft only	David Gillot, Roamware
0.51	23 Sep 2008	Editorial corrections to trigger table as noted by Inge Menschaert, Vodafone.		
0.52	10 Oct 2008	Editorial corrections as noted by Magnus Zimmerman, Polystar.		
0.6	12 Dec 2008	Further revisions and editorial changes		
0.7	22 Dec 2008	Editorial and formatting corrections		David Maxwell, GSMA
1.0	20 Feb 2009	New PRD - GRQ Measurement Implementation	IREG-EMC	David Gillot, Roamware
2.0	Nov 2009	Adding of roaming Hubbing Providing references	IREG-EMC	David Gillot, Roamware
3.0	June 2011	Submitted to DAG and EMC for approval	EMC	David Gillot, Roamware
4.0	May 2015	Including LTE GRQ	NG	Javier Sendin (GSMA)
5.0	October 2015	Major CR1002 included: Differentiation of GRQ Codes and add missing KPIs	NG	Veronique Verhé, SIGOS GmbH
6.0	November 2015	Major CR1003 included: New annex with LTE GRQ Thresholds	NG	Veronique Verhé, SIGOS GmbH
7.0	November 2016	Major CR1004 included: New annex with 2G and 3G Thresholds Major CR1005 included: VoLTE and ViLTE roaming quality KPIs	NG	Veronique Verhé, SIGOS GmbH
8.0	June 2017	Major CR1006 included: Add SSI and SQI, CR1007 included: Clean-up GRQ codes, CR1008 inlcuded: Correction 2G and 3G thresholds	NG	Veronique Verhé, SIGOS GmbH
9.0	October 2017	Major CR1009 included: Update 2G and 3G GRQ Major CR1010 included: Introduction of 4G SSI and SQI	NG	Veronique Verhé, SIGOS GmbH
9.1	May 2018	Minor CR1012 included: Correction of MBR to AMBR for non-GBR bearer	NG	Veronique Verhé, SIGOS GmbH
10.0	Nov 2018	Minor CR1011 included: Remove reference to IR.78 Minor CR1013 inlcuded: Correction of wrong unit Major CR1014 inlcuded: Add missing CSFB call flows	NG	Veronique Verhé, SIGOS GmbH
11.0	Nov 2019	Major CR1015 included: MIoT GRQ Test Descriptions	NG	Veronique Verhé, SIGOS GmbH

Version	Date	Brief Description of Change	Approval Authority	Editor / Company
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Other Information

Type	Description
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