GRQ Measurement Implementation
Version 5.0
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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.

1.2 Relation to other PRDs

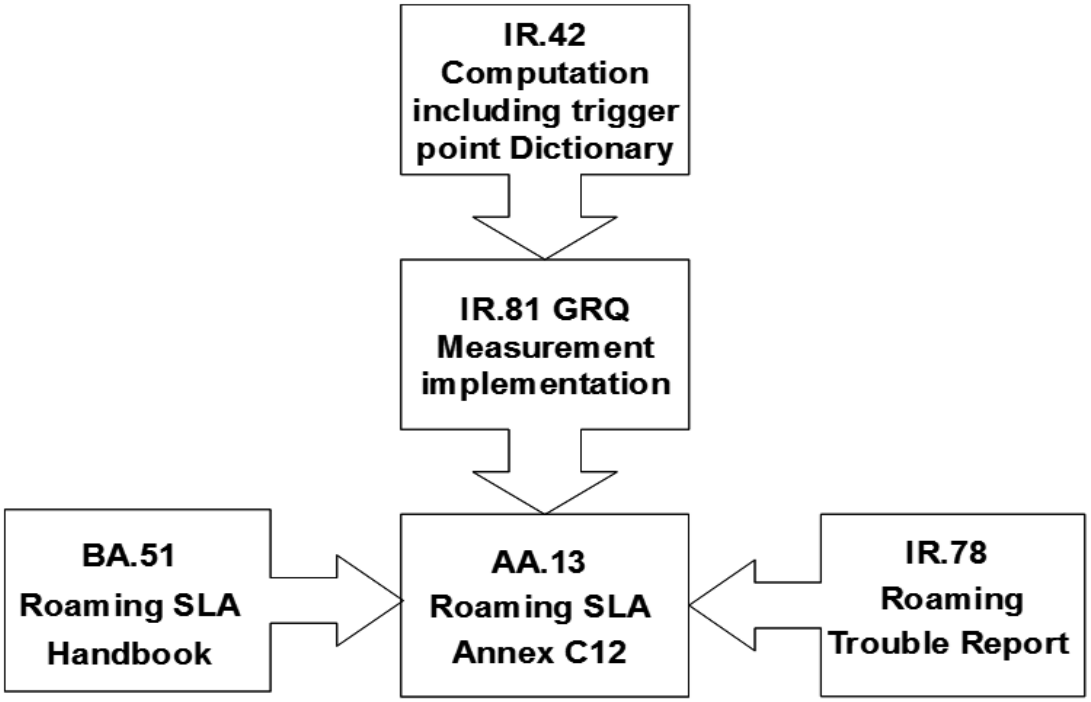

Figure 1: Relation of IR.81 to other PRD

1.3 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
GTP	GPRS Tunneling Protocol
HPMN	Home Public Mobile Network
IMSI	International Mobile Subscriber Identity
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
MAP	Mobile Application Part
MSC	Mobile Switching Centre
PDD	Post-Dial Delay
QoS	Quality of Service
SS7	Signalling System 7
STP	Signaling Transfer Point
VPMN	Visited Public Mobile Network

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)"

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 later 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 is 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.

3.1 Voice QoS Parameters

3.1.1 CS voice QoS parameters

QoS Aspects	QoS Parameters
1. Network Accessibility (customer being able to register on the network)	1. Circuit Switched LU success rate (*) 2. Circuit Switched LU delay (*)
2. 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)
3. 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)

4. Connection retain-ability (from a successful establishment of the call until service is terminated)	11. CCR (success ratio) 12. ALOC (duration)[1]
5. Connection quality	13.CLI transparency 14.SpQ (Speech Quality)

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

[1] Not relevant for a roaming QoS SLA.

3.1.2 Voice CSFB QoS parameters

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

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) 5. PDD-MO or STT-MO (setup time) 6. PDD-MT or 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.	

3.1.2 PS voice QoS parameters

Editor note: this section is a placeholder for VoLTE

3.2 SMS QoS Parameters

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.

3.3 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
1. Network Accessibility (customer being able to register on the network)	31. Packet Switched Location Update success rate (*) 32. Packet Switched Location Update Delay (*)
2. Service accessibility (from customer hitting the send / connection button until accessing the data bearer)	33. PDP Context Activation success rate 34. PDP Context Activation time
3. Connection establishment (from customer hitting the send button until a successful establishment of the service)	No QoS Parameter defined (service specific parameters may be defined in the future).
4. 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].
5. Connection quality	37. Throughput (Kbit/sec) [2] 38. Goodput (Kbit/sec) 39. Roundtrip time (expressed in milliseconds) [3] 40. Packet loss[4]

[2] Because a 'bearer level' approach adopted for the data services QoS monitoring, these parameters have to be measured at the 'bit pipe' level and not at the User Application level (for example HTTP).
[3] See 'Delay' in section 8 of PRD IR.34 'Inter-Service Provider IP Backbone Guidelines'.
[4] See 'Packet Loss Rate' in section 8 of PRD IR.34 'Inter-Service Provider IP Backbone Guidelines'

(*) 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 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.

[5] See RFC 5166 Metrics for the Evaluation of Congestion Control Mechanisms (http://tools.ietf.org/html/rfc5166)

3.3.2 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.

3.4 IPX QoS Monitoring

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.

4.1 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 Rate (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)
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,CS 20)
ISUPv2 signalling transparency (OCN and RDN)	10	N Not applicable	N Not applicable	N	N	N (CS8)	Y.(CS10),(C S13)	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)
CLI Transparency	13	N Not applicable	N Not applicable	N Not applicable	Y	N (CS4)	Y (CS10, CS13)	Y	N (CS17)	N (CS18)

Speech Quality (SpQ)	14	N Not applicable	N Not applicable	N Not applicable	Y	N (CS9)	N (CS14)	Y	N (CS11)	N (CS18)

Table 1: 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 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 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.

- (CS20) The measurements are done on an interface (Um/Uu) or a protocol field (CAMEL), which is directly linked to what is observed on the ISUP interface.

4.2 SMS

Table 2: 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 the a roamer in the VPMN
- (SM7) There is no knowledge to identify when the message is sent from the HPMN.

		Monitoring by Roaming Hubbing Provider (R)			Monitoring by HPMN (H)			Monitoring by VPMN (V)		
	Methods:	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 3: Packet Switched Test Parameters

4.3 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.

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.

4.4 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
Setup Time Telephony – MO	5	N	N	Y	Y	N	Y	Y	Y	Y
Setup Time Telephony – MT	6	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

4.5 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

4.6 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} session success ratio	133a/ 133b	N	N		Y	N		Y	N	
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	143	N	N		Y	N		Y	N	

session success ratio										
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	

5 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.

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.

5.1 End-To-End Active Testing and Monitoring

5.1.1 General Information

5.1.1.1 When to measure:

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.

5.1.1.4 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)

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.

5.1.1.5 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.

5.1.2 GSM/GPRS and UMTS Test Specification

GRQ Test Code	Parameter	How to Measure	Test Specifics
CIRCUIT-SWITCHED			
1AH	LU update success rate	Force a location update via the modem, if there is steering the end result has to be the last location update of maximum five (5) attempts.	
1AV	LU update success rate	Force a location update via the modem, if there is steering the end result has to be the last location update of maximum 5 attempts.	
2AH	LU delay	Force a location update via the modem, if there is steering the delay of the last location update has to be taken onto account. It is important that before starting the simcards is registered on a different LAC in order to have a full location update.	
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 onto account. It is important that before starting the simcards is registered on a different LAC in order to have a full location update.	
3AH	NER-MO (Network Effectiveness Ratio on Mobile Originated calls in the visited network)	Generate a call with from the probe located in the VPMN to a simcard from the probe located in the HPMN. The test is successful if the probe on the VPMN detects a ringing signal for the	

GRQ Test Code	Parameter	How to Measure	Test Specifics
		call he has generated.	
	NER-MO (Network Effectiveness 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 from the probe located in the HPMN. The test is successful if the probe on the VPMN detects a ringing signal for the call he has generated.	
4AH	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 from the probe located in the VPMN. The test is successful if the probe on the HPMN detects a ringing signal for the call he has generated.	
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 from the probe located in the VPMN. The test is successful if the probe on the HPMN detects a ringing signal for the call he has generated.	
5AH	PDD-MO (Post Dialling Delay)	Generate a call with a simcard from the probe located in the VPMN to a simcard from 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.	
5AV	PDD-MO (Post Dialling Delay)	Generate a call with a simcard from the probe located in the VPMN to a simcard from 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	PDD-MT (Post Dialling Delay)	Generate a call with a simcard from the probe located in the HPMN to a simcard from 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.	
6AV	PDD-MT (Post Dialling Delay)	Generate a call with a simcard from the probe located in the HPMN to a simcard from 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	

GRQ Test Code	Parameter	How to Measure	Test Specifics
		detected on the HPMN.	
7AH	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 from the probe located in the HPMN. The test is successful if the probe on the HPMN detects the ringing and picked up the call.	
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 from 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	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 from the probe located in the VPMN. The test is successful if the probe on the VPMN detects the ringing and picked up the call.	
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 from 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	REL (ISUPv2 signalling transparency)	Generate a call with a simcard from the probe located in the VPMN to a simcard from the probe located in the HPMN. At the end of the call, check if the release code is the same on both sides.	
9AV	REL (ISUPv2 signalling transparency)	Generate a call with a simcard from the probe located in the VPMN to a simcard from the probe located in the HPMN. At the end of the call, check if the release code is the same on both sides.	
10AH	OCN and RDN (ISUPv2 signalling transparency)	Generate a call with a simcard from the probe located in the HPMN to a simcard from the probe located in the VPMN. Forward this call to the HPMN and check if the OCN and RDN is correct.	
10AV	OCN and RDN (ISUPv2 signalling transparency)	Generate a call with a simcard from the probe located in the HPMN to a simcard from the probe located in the	

GRQ Test Code	Parameter	How to Measure	Test Specifics
		VPMN. Forward this call to the HPMN and check if the OCN and RDN is correct.	
11AH	CCR (Call Completion Rate Circuit)	Generate a call with a simcard from the probe located in the VPMN to a simcard from the probe located in the HPMN. Answer the calls 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.
11AV	CCR (Call Completion Rate Circuit)	Generate a call with a simcard from the probe located in the VPMN to a simcard from the probe located in the HPMN. Answer the calls 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	ALOC	N/A	
12AV	ALOC	N/A	
13AH	CLI transparency	Generate a call with a simcard from the probe located in the VPMN to a simcard from the probe located in the HPMN. Check at the HPMN if the CLI is in a dialable format to call back the A-party	
13AV	CLI transparency	Generate a call with a simcard from the probe located in the VPMN to a simcard from 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	SpQ (Speech Quality)	Generate a call with a simcard from the probe located in the VPMN to a simcard from 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/analyzed multiple times, the	Reasonable radio level required: RxLev > -70dbm.

GRQ Test Code	Parameter	How to Measure	Test Specifics
		end-result of the test is the average of the individual voice quality assessments. If the sample is played/analyzed multiple times, the end-result of the test is the average of the individual voice quality assessments.	
14AV	SpQ (Speech Quality)	Generate a call with a simcard from the probe located in the VPMN to a simcard from 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/analyzed 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	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 the positive acknowledgement of the SMSC is received the tests is OK.	
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 the positive acknowledgement of the SMSC is received the tests is OK.	
22AH	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.
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.

GRQ Test Code	Parameter	How to Measure	Test Specifics
23AH	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.	
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	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.
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	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.
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.	Reasonable radio level required: RxLev > -70dbm.

GRQ Test Code	Parameter	How to Measure	Test Specifics
		Measure the time between sending the SMS and receiving the notification on the B-party that the message has arrived.	
26AH	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.
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	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.	
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 – D)	Start manually a GPRS attach on the VPLMN, after the GSM location has been performed. Measure the time between start and end of the GPRS attach.	
32AV	Packet Switched Location Update Delay (PS LU – D)	Start manually a GPRS attach on the VPLMN, after the GSM location has been performed. Measure the time between start and end of the GPRS attach.	
33AH	Service accessibility for PSD (PDP-context activation success rate)	Start the PDP context activation after the GPRS attach on the VPLMN. If the PDP context has been confirmed, the test is successful	
33AV	Service accessibility for PSD (PDP-context	Start the PDP context activation after the GPRS attach on the VPLMN. If the	

GRQ Test Code	Parameter	How to Measure	Test Specifics
	activation success rate)	PDP context has been confirmed, the test is successful	
34AH	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.	
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	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.
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	Average PDP Context Session Time (per APN)	N/A	
36AV	Average PDP Context Session Time (per APN)	N/A	
37AH	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.
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	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.
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	Roundtrip time	Measure the time between sending and a TCP packet and receiving the acknowledgement of the pack.	
39AV	Roundtrip time	Measure the time between sending	

GRQ Test Code	Parameter	How to Measure	Test Specifics
		and a TCP packet and receiving the acknowledgement of the pack.	
40AH	Packet loss	Count the TCP packets sent and count the TCP packets received for a file transfer.	Reasonable radio level required: RxLev > -70dbm.
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 4: 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	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.	
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	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.	
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	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 (with or without CSFB) and release the call. Observe whether the network type indicator on the UE display switches to LTE.	GSM or UMTS power level: RxLev > -70dbm.
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 (with or without CSFB) 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	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 (with or without CSFB) and release the call. Observe whether the network type indicator on the UE display switches to LTE.	GSM or UMTS power level: RxLev > -70dbm.
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 (with or without CSFB) 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	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 (with or without CSFB) 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.
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 (with or without CSFB) and release the call. Measure the time from the CS call release to	GSM or UMTS power level: RxLev > -70dbm.

		the UE returning to LTE.	
104bAH	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 (with or without CSFB) 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.
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 (with or without CSFB) 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	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
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 the ALERTING message is received at R-party and H-party rings.	GSM or UMTS power level: RxLev > -70dbm
4AH	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
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
5AH	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
5AV	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
6AH	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
6AV	Setup Time Telephony	UE registered in VPMN and the network type	GSM or UMTS

	– MT (PDD-MT)	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.	power level: RxLev > -70dbm
7AH	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 picked up the call.	GSM or UMTS power level: RxLev > -70dbm
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 picked up the call.	GSM or UMTS power level: RxLev > -70dbm
8AH	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 picked up the call.	GSM or UMTS power level: RxLev > -70dbm
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 picked 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	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.	
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	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.	
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	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.	
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	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.	.
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	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.	
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	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 indicates that the message has arrived.	
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	

		indicates that the message has arrived.	
25AH	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.	
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	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.	
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.	

5.1.3.3 LTE Data

GRQ Test Code	Parameter	How to Measure	Test specifics
101AH	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 end result shall be the last location update of maximum five (5) attempts.	
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 end result shall be the last location update of maximum five (5) attempts.	
102AH	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.	
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	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.	
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	Default EPS bearer context activation time	Trigger an EPS attach at UE and measure the time between UE sending attach request and attach complete	
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	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.	
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	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.	
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	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).	
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	FTP download IP service access success ratio	Initiate in VPMN to download an FTP binary file from an FTP server. Observe whether the file contents downloading starts.	

131aAV	FTP download IP service access success ratio	Initiate in VPMN to download an FTP binary file from an FTP server. Observe whether the file contents downloading starts.	
131bAH	FTP upload IP service access success ratio	Initiate in VPMN to upload an FTP binary file to an FTP server. Observe whether the file contents uploading starts.	
131bAV	FTP upload IP service access success ratio	Initiate in VPMN to upload an FTP binary file to an FTP server. Observe whether the file contents uploading starts.	
132aAH	FTP download IP service setup time	Initiate in VPMN to download an FTP binary file from an FTP server. Measure the time between the initiation and the start of the file contents downloading.	
132aAV	FTP download IP service setup time	Initiate in VPMN to download an FTP binary file from an FTP server. Measure the time between the initiation and the start of the file contents downloading.	
132bAH	FTP upload IP service setup time	Initiate in VPMN to upload an FTP binary file to an FTP server. Measure the time between the initiation and the start of the file contents uploading.	
132bAV	FTP upload IP service setup time	Initiate in VPMN to upload an FTP binary file to an FTP server. Measure the time between the initiation and the start of the file contents uploading.	
133aAH	FTP download session success ratio	Initiate in VPMN to download an FTP binary file from an FTP server. Observe whether the complete file is downloaded.	
133aAV	FTP download session success ratio	Initiate in VPMN to download an FTP binary file from an FTP server. Observe whether the complete file is downloaded.	
133bAH	FTP upload session success ratio	Initiate in VPMN to upload an FTP binary file to an FTP server. Observe whether the complete file is uploaded.	
133bAV	FTP upload session success ratio	Initiate in VPMN to upload an FTP binary file to an FTP server. Observe whether the complete file is uploaded.	
134aAH	FTP download session time	Initiate in VPMN to download an FTP binary file from an FTP server. Measure the time between the initiation and the complete file contents downloaded.	
134aAV	FTP download session time	Initiate in VPMN to download an FTP binary file from an FTP server. Measure the time between the initiation and the complete file contents downloaded.	
134bAH	FTP upload session	Initiate in VPMN to upload an FTP binary file to an FTP server. Measure the time between the	

	time	initiation and the complete file contents uploaded.	
134bAV	FTP upload session time	Initiate in VPMN to upload an FTP binary file to an FTP server. Measure the time between the initiation and the complete file contents uploaded.	
135aAH	FTP download mean data rate	Initiate in VPMN to download an FTP binary file from an FTP server. Measure the time between the first data packet received containing the file contents and the last data packet received containing the file contents.	
135aAV	FTP download mean data rate	Initiate in VPMN to download an FTP binary file from an FTP server. Measure the time between the first data packet received containing the file contents and the last data packet received containing the file contents.	
135bAH	FTP upload mean data rate	Initiate in VPMN to upload an FTP binary file to an FTP server. Measure the time between the first data packet sent containing the file contents and the last data packet sent containing the file contents.	
135bAV	FTP upload mean data rate	Initiate in VPMN to upload an FTP binary file to an FTP server. Measure the time between the first data packet sent containing the file contents and the last data packet sent containing the file contents.	
136aAH	FTP download data transfer success ratio	Initiate in VPMN to download an FTP binary file from an FTP server. Observe whether all data packets containing the file contents (from the first one to the last one) are successfully received.	
136aAV	FTP download data transfer success ratio	Initiate in VPMN to download an FTP binary file from an FTP server. Observe whether all data packets containing the file contents (from the first one to the last one) are successfully received.	
136bAH	FTP upload data transfer success ratio	Initiate in VPMN to upload an FTP binary file to an FTP server. Observe whether all data packets containing the file contents (from the first one to the last one) are successfully sent.	
136bAV	FTP upload data transfer success ratio	Initiate in VPMN to upload an FTP binary file to an FTP server. Observe whether all data packets containing the file contents (from the first one to the last one) are successfully sent.	
137aAH	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.	

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	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.	
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	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.	
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	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.	
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	HTTP / HTTPS session success ratio	Initiate in VPMN to download an HTTP / HTTPS Web page. Observe whether the complete Web page contents are downloaded.	
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	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.	
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	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 contents and the last data packet received containing the Web page contents.	
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 contents and the last data packet received containing the Web page contents.	
146AH	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 contents (from the first one to the last one) are successfully received.	
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 contents (from the first one to the last one) are successfully received.	
147AH	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.
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	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.	
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	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.	
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	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.	
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.	

5.2 Passive Monitoring

5.2.1 General Information

5.2.1.1 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.

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.

5.2.1.2 Where to measure:

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).

5.2.1.4 GRQ Monitoring Pre-requisites

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 the visited network)	N/A	Home network has no visibility on Voice Call without CAMEL
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	Measure Time between reception of	For RP applying MNP,

GRQ Test Code	Parameter	How to Measure	Test Specifics
	Delay)	ISUP ACM and attempts (ISUP IAM)	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 Succes 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 Succes 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 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	N/A	Home network has no visibility on Voice Call

GRQ Test Code	Parameter	How to Measure	Test Specifics
	signalling transparency)		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, 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.	For RP applying MNP, additional info to be extracted (IMSI/MSISDN in the loc.up) for assuring measurement on the roaming partner
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

GRQ Test Code	Parameter	How to Measure	Test Specifics
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	
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	N/A	

GRQ Test Code	Parameter	How to Measure	Test Specifics
	for SMS-MT		
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	
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	Measure time between the MAP_PDP	

GRQ Test Code	Parameter	How to Measure	Test Specifics
	Session Time (per APN)	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 5: Parameter mesaurament table

5.2.3 LTE test specification

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

5.3 CAMEL Monitoring

5.3.1 General Information

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.

5.3.1.1 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.

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.

5.3.1.2 Where to measure:

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.

5.4 Call Flow

5.4.1 Location update

5.4.1.1 Bilateral case

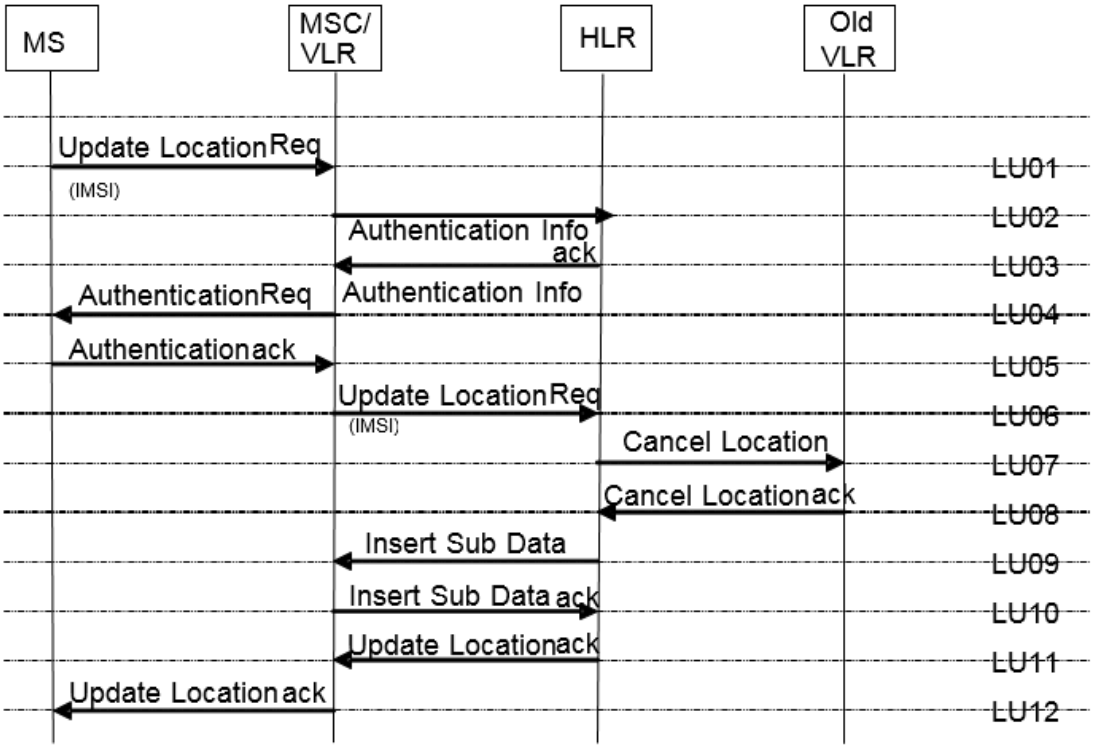

Figure 2: Location update with HLR and VLR

5.4.1.2 Roaming Hubbing Provider case (only GRQ monitoring relevant procedures)

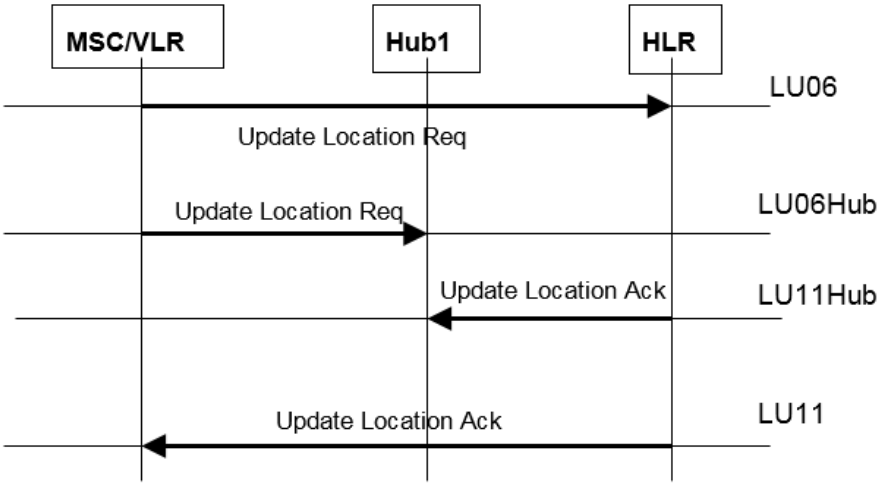

Figure 3: Location Update with Roaming Hubbing Provider

Note: LU06 and LU11 are for reference only

5.4.2 Voice call MO

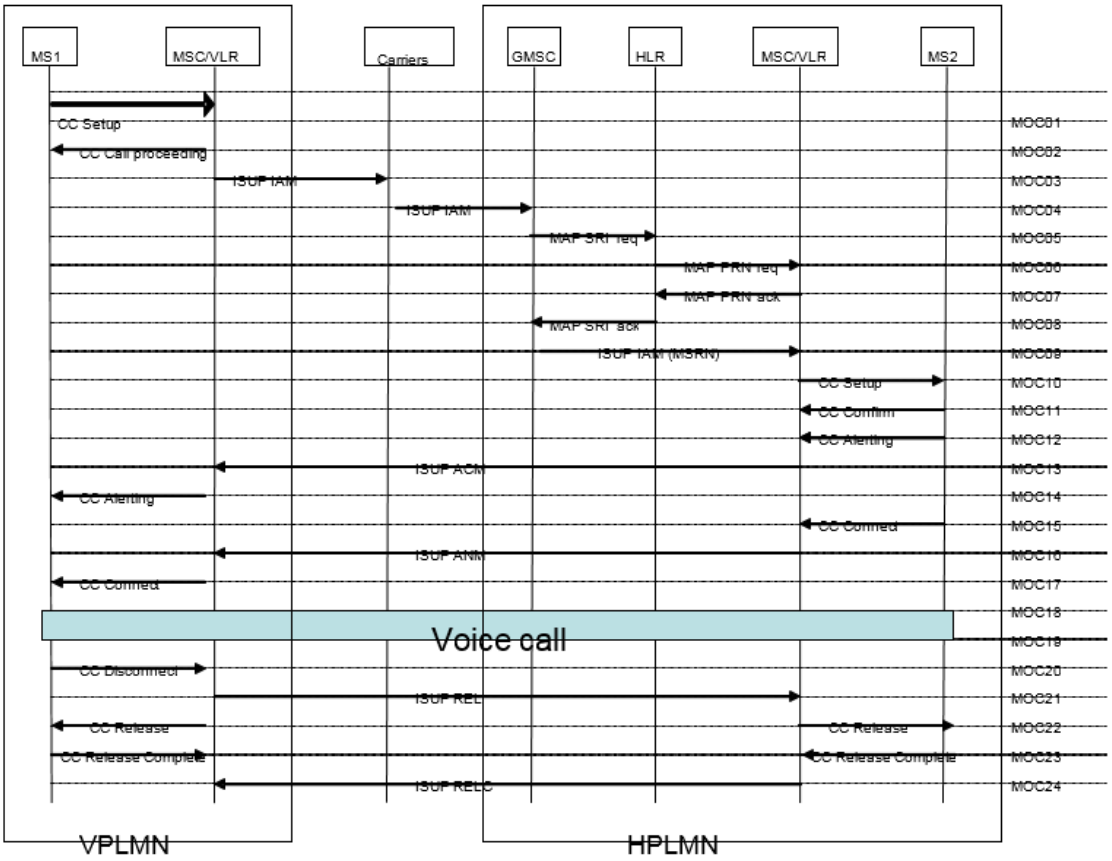

Figure 4: CS voice call MO

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

5.4.3 Voice call MT

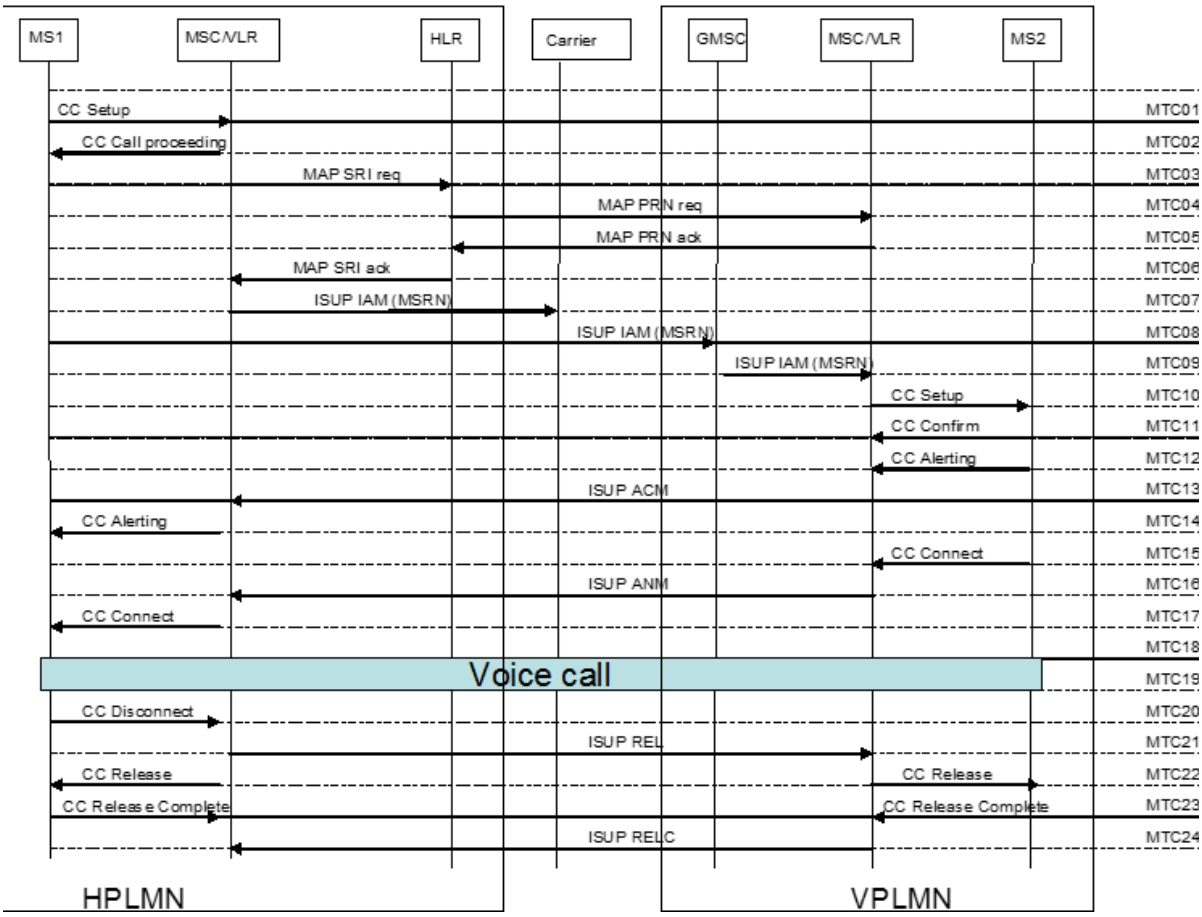

Figure 5: CS voice call MT

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

5.4.4 SMS and SMSoSGs

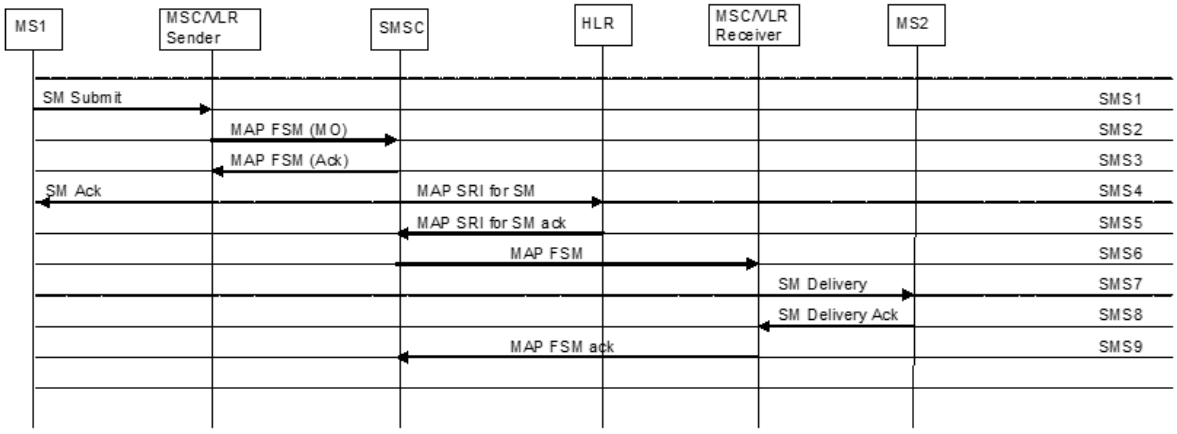

Figure 6: SMS and SMSoSGs

5.4.5 Packet Switched/GPRS

5.4.5.1 Bilateral case

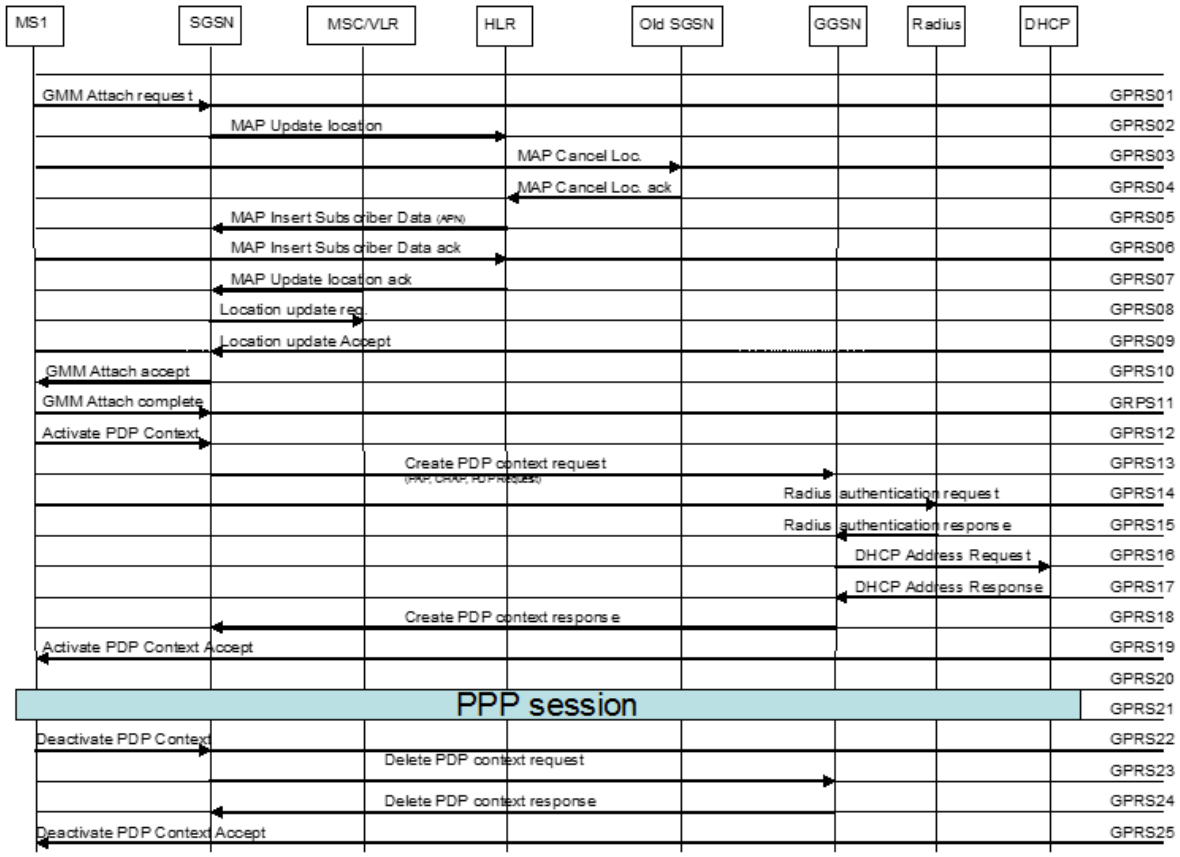

Figure 7: GPRS PDP context and data transfer in bilateral case

5.4.5.2 Roaming Hubbing Provider Case (only relevant procedures)

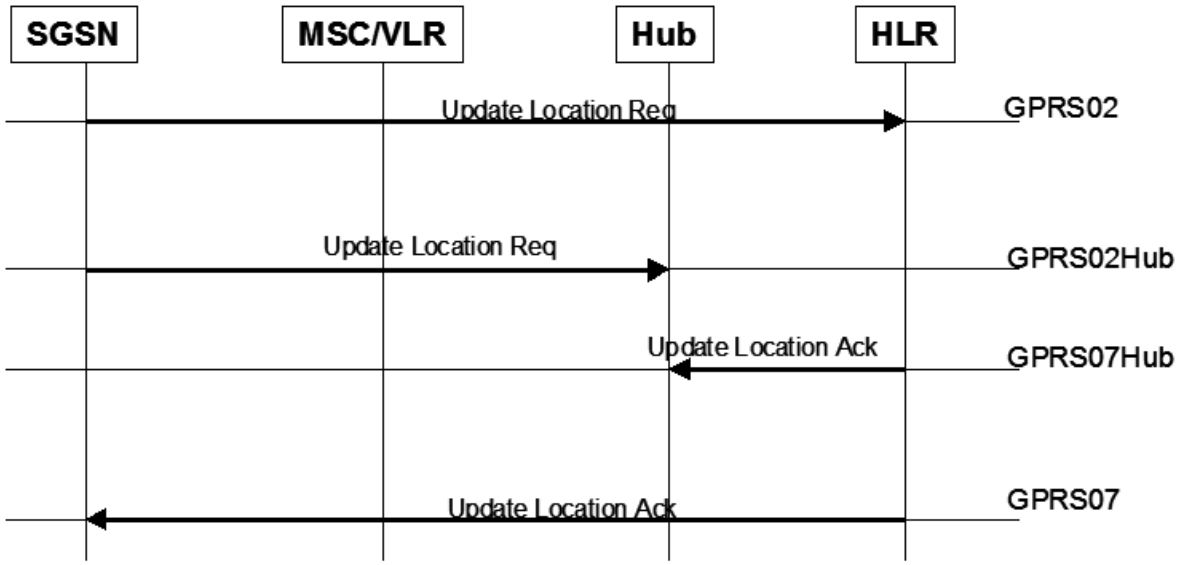

Figure 8: Packet Switch flow for Roaming Hub Provider

5.4.6 FTP

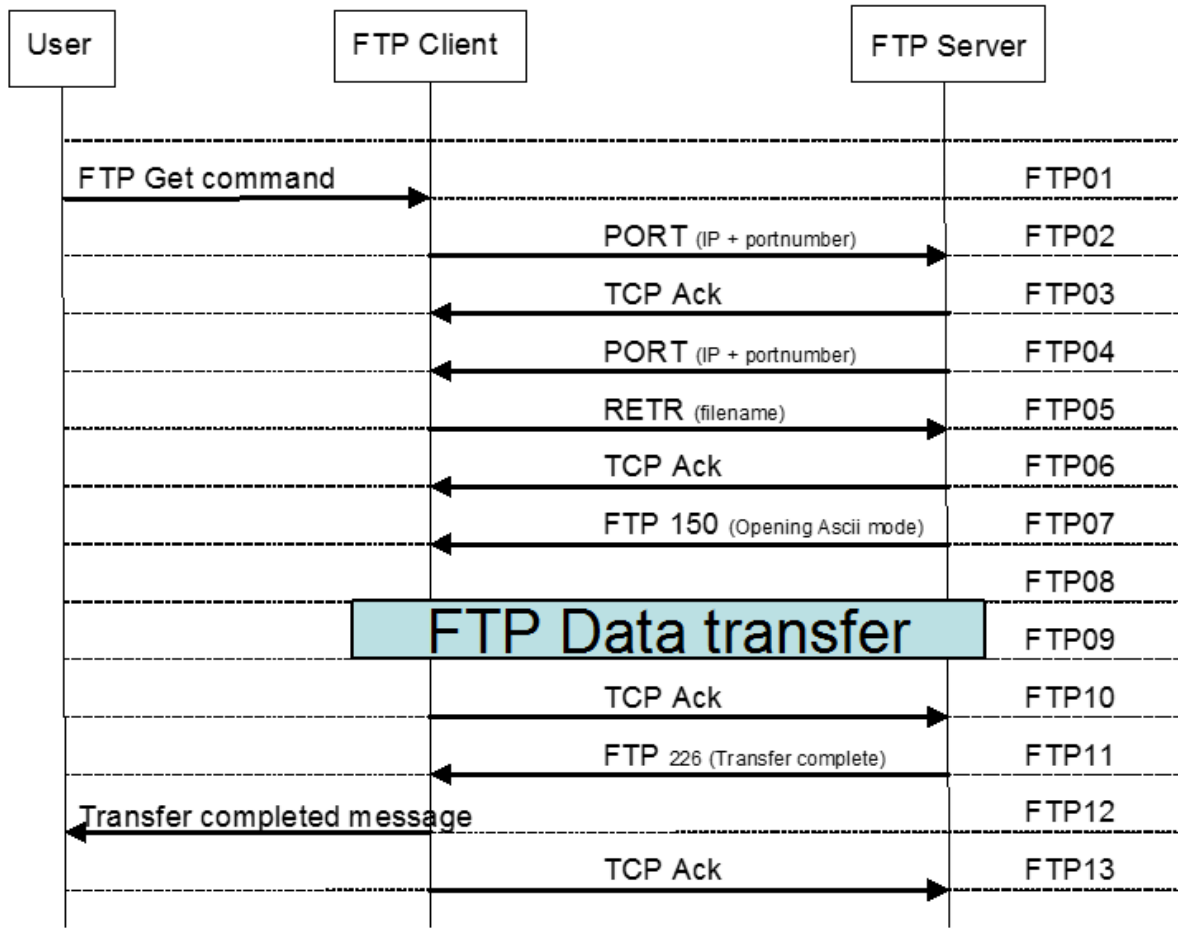

Figure 9: FTP

Note: FTP00: The time to initiate FTP

5.4.7 Ping

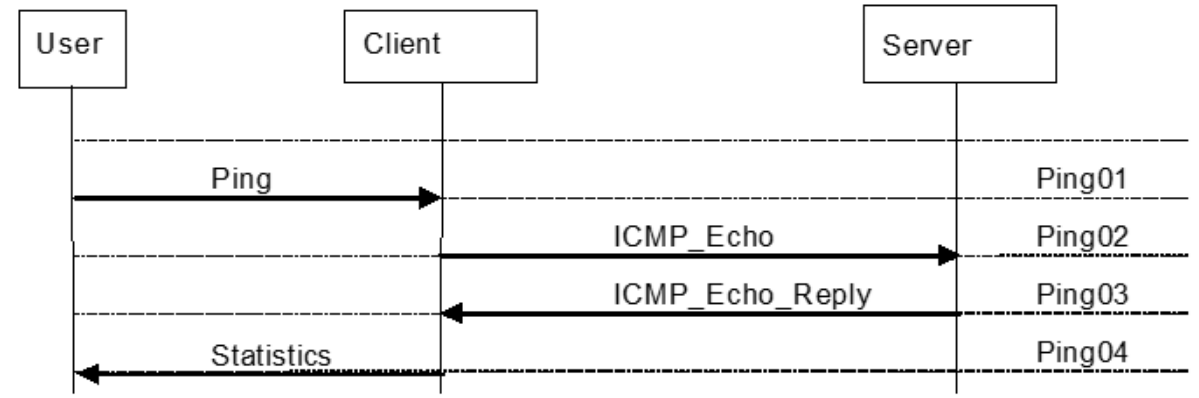

Figure 10: Ping

5.4.8 HTTP/HTTPS

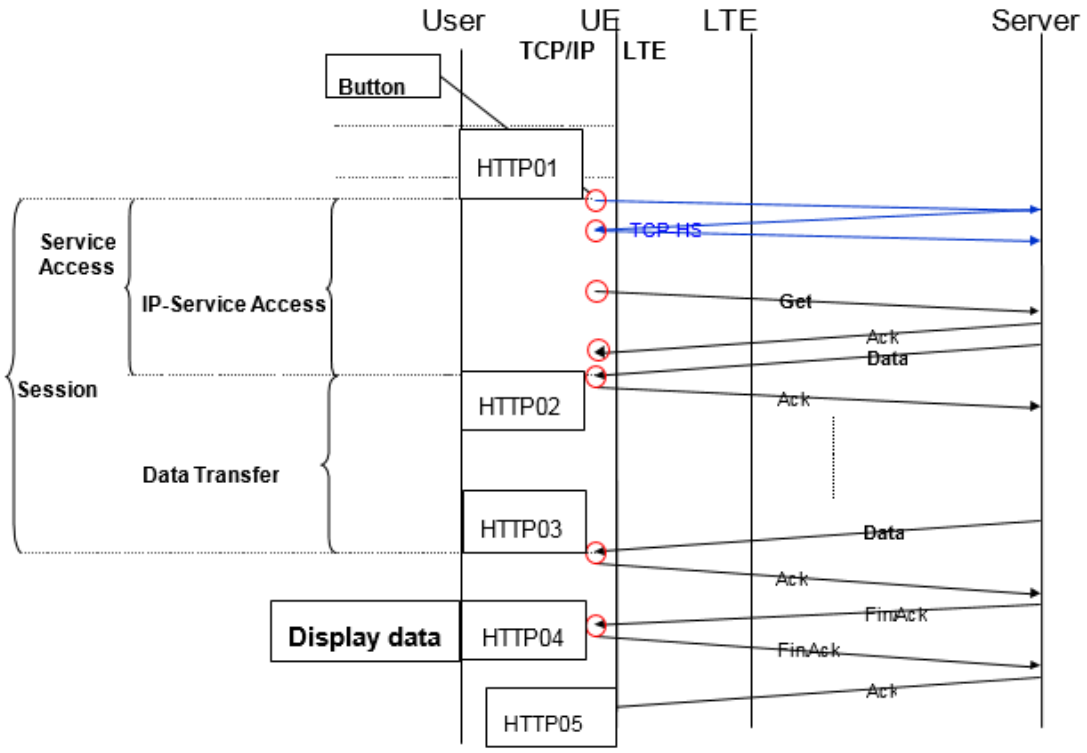

Figure 11: HTTP/HTTPS session flow

5.4.9 EPS

5.4.9.1 EPS attach

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.

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

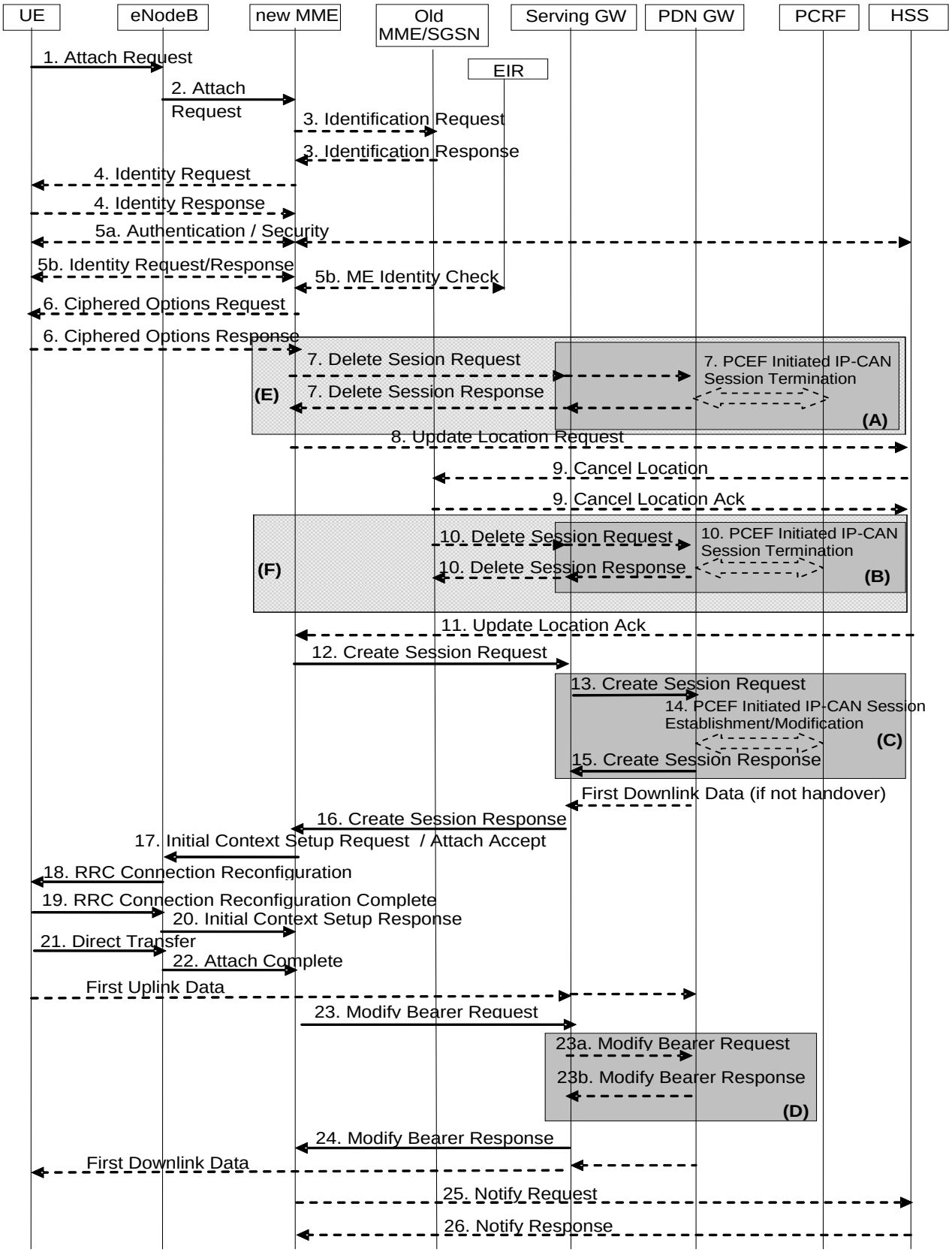

Figure 12 EPS attach

5.4.9.2 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.

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

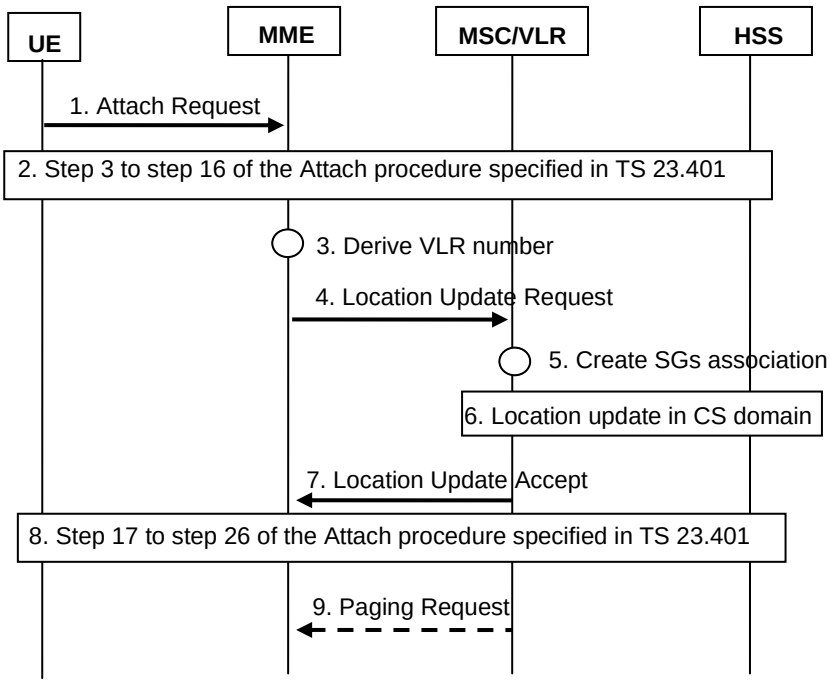

Figure 13: Combined EPS /IMSI attach

5.5 Trigger Table

5.5.1 GSM/GPRS and UMTS trigger points

Test	Parameter	Reference flow	Start point	End Point
CIRCUIT-SWITCHED				
1AH 1BH	LU update success ratio	Location update	LU01 (Active) LU06 (Passive)	LU12 (Active) LU11(Passive)
1AV 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 2BH	LU delay	Location update	LU01 (Active) LU06 (Passive)	LU12 (Active) LU11(Passive)

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

Test	Parameter	Reference flow	Start point	End Point
7AV 7BV	CSSR-MO (Call Setup Succes Ratio on Mobile Originated calls in the visited network)	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC17 (Active) MOC16 (Passive)
8AH 8BH	CSSR-MT (Call Setup Succes Ratio on Mobile Terminated calls in the visited network)	Voice call MT	MTC01 (Active) MTC07 (Passive)	MOC17 (Active) MOC16 (Passive)
8AV 8BV	CSSR-MT (Call Setup Succes Ratio on Mobile Terminated calls in the visited network)	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC17 (Active) MTC16 (Passive)
9BH	REL (ISUPv2 signalling transparency)	Voice call MO	MOC20	MOC22
9BV	REL (ISUPv2 signalling transparency)	Voice call MO	MOC20	MOC22
10BH	OCN and RDN (ISUPv2 signalling transparency)	No flow available		
10BV	OCN and RDN (ISUPv2 signalling transparency)	No flow available		
11AH 11BH	CCR (Call Completion Rate Circuit)	Voice call MO	MOC14 (Active) MOC13 (Passive)	MOC20 (Active) MOC21 (Passive)
11AV 11BV	CCR (Call Completion Rate Circuit)	Voice call MO	MOC14 (Active) MOC13 (Passive)	MOC20 (Active) MOC21 (Passive)
12BH	ALOC	Voice call MO	MOC03	MOC21
12BV	ALOC	Voice call MO	MOC03	MOC21
13AH 13BH	CLI transparency	Voice call MO	MOC02	MOC10
13AV 13BV	CLI transparency	Voice call MO	MOC02	MOC10
14AH 14BH	SpQ (Speech Quality)	Voice call MO	MOC18	MOC19
14AV 14BV	SpQ (Speech Quality)	Voice call MO	MOC18	MOC19

Test	Parameter	Reference flow	Start point	End Point
SMS				
21AH 21BH	Service Accessibility SMS MO (SA SMS MO)	SMS	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
21AV 21BV	Service Accessibility SMS MO (SA SMS MO)	SMS	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
22AH 22BH	Service Accessibility SMS MT (SA SMS MT)	SMS	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
22AV 22BV	Service Accessibility SMS MT (SA SMS MT)	SMS	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
23AH 23BH	Access Delay SMS MO (AD SMS-MO)	SMS	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
23AV 23BV	Access Delay SMS MO (AD SMS-MO)	SMS	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
24AH 24BH	Access Delay SMS MT (AD SMS-MT)	SMS	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
24AV 24BV	Access Delay SMS MT (AD SMS-MT)	SMS	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
25AH 25BH	End-to-End Delivery Time for SMS-MO	SMS	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
25AV 25BV	End-to-End Delivery Time for SMS-MO	SMS	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
26AH 26BH	End-to-End Delivery Time for SMS-MT	SMS	SMS01 (Active) SMS02	SMS08 (Active) SMS09 (Passive)

Test	Parameter	Reference flow	Start point	End Point
			(Passive)	
26AV 6BV	End-to-End Delivery Time for SMS-MT	SMS	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
PACKET-SWITCHED				
31AH 31BH	Packet Switched LU Success Rate (PS LU - SR)	GPRS	GPRS01 (Active) GPRS02 (Passive)	GPRS10 (Active) GPRS09 (Passive)
31AV 31BV	Packet Switched LU Success Rate (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 32BH	Packet Switched Location Update Delay (PS LU - D)	GPRS	GPRS01 (Active) GPRS02 (Passive)	GPRS10 (Active) GPRS09 (Passive)
32AV 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 33BH	Service accessibility for PSD (PDP-context activation success rate)	GPRS	GPRS12 (Active) GPRS13 (Passive)	GPRS19 (Active) GPRS18 (Passive)
33AV 33BV	Service accessibility for PSD (PDP-context activation success rate)	GPRS	GPRS12 (Active) GPRS13 (Passive)	GPRS19 (Active) GPRS18 (Passive)
34AH 34BH	Set-up Delay (ST PSD)	GPRS	GPRS12 (Active) GPRS13 (Passive)	GPRS19 (Active) GPRS18 (Passive)
34AH 34BV	Set-up Delay (ST PSD)	GPRS	GPRS12 (Active) GPRS13 (Passive)	GPRS19 (Active) GPRS18 (Passive)

Test	Parameter	Reference flow	Start point	End Point
35AH 35BH	PDP Context Cut-Off Ratio (session Stability measured at PDP context or PS level)	GPRS	GPRS19 (Active) GPRS18 (Passive)	GPRS25 (Active) GPRS24 (Passive)
35AV 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 36BH	Average PDP Context Session Time (per APN)	GPRS	GPRS20	GPRS21
36AV 36BV	Average PDP Context Session Time (per APN)	GPRS	GPRS20	GPRS21
37AH 37BH	Throughput (Kbits/sec)	FTP / GPRS	FTP01 (Active) GPRS21 (Passive)	FTP12 (Active) GPRS21 (Passive)
37AV 37BV	Throughput (Kbits/sec)	FTP / GPRS	FTP01 (Active) GPRS21 (Passive)	FTP12 (Active) GPRS21 (Passive)
38BH 38BH	Goodput (Kbits/sec)	FTP / GPRS	FTP01 (Active) GPRS21 (Passive)	FTP12 (Active) GPRS21 (Passive)
38BV 38BV	Goodput (Kbits/sec)	FTP / GPRS	FTP01 (Active) GPRS21 (Passive)	FTP12 (Active) GPRS21 (Passive)
39AH 39BH	Roundtrip time	Ping / GPRS	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)
39AV 39BV	Roundtrip time	Ping / GPRS	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)
40AH 40BH	Packet loss	Ping / GPRS	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)

Test	Parameter	Reference flow	Start point	End Point
40AV 40BV	Packet loss	Ping / GPRS	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)

5.5.2 LTE trigger points

Test code	Parameter	Reference flow	Start point	End Point
Voice CSFB				
101AH 101BH	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]
101AV 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 102BH	PS location update delay	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) LU06 (Passive)	EPS18 (Active) EPS11 (Passive) LU11 (Passive)
102AV 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	CSFB return to LTE success ratio	-	Disconnect voice call (Active)	Return to LTE (Active)
103AH	CSFB return to LTE success ratio	-	Disconnect voice call (Active)	Return to LTE (Active)
104AH	CSFB return to LTE time	-	Disconnect voice call (Active)	Return to LTE (Active)
104AV	CSFB return to LTE time	-	Disconnect voice call (Active)	Return to LTE (Active)

[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
3AH 3BH	Service Accessibility Telephony – MO	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
3AV 3BV	Service Accessibility Telephony – MO	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
4AH 4BH	Service Accessibility Telephony – MT	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)
4AV 4BV	Service Accessibility Telephony – MT	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)
5AH 5BH	Setup Time Telephony – MO	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
5AV 5BV	Setup Time Telephony – MO	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
6AH 6BH	Setup Time Telephony – MT	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)
6AV 6BV	Setup Time Telephony – MT	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)

Test code	Parameter	Reference flow	Start point	End Point
SMSoSGs				
101AH 101BH	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]
101AV 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 102BH	PS location update delay	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) LU06 (Passive)	EPS18 (Active) EPS11 (Passive) LU11 (Passive)

Test code	Parameter	Reference flow	Start point	End Point
102AV 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 21BH	Service Accessibility SMS MO (SA SMS MO)	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
21AV 21BV	Service Accessibility SMS MO (SA SMS MO)	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
22AH 22BH	Service Accessibility SMS MT (SA SMS MT)	SMS and SMSoSGs	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
22AV 22BV	Service Accessibility SMS MT (SA SMS MT)	SMS and SMSoSGs	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
23AH 23BH	Access Delay SMS MO (AD SMS-MO)	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
23AV 23BV	Access Delay SMS MO (AD SMS-MO)	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
24AH 24BH	Access Delay SMS MT (AD SMS-MT)	SMS and SMSoSGs	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
24AV 24BV	Access Delay SMS MT (AD SMS-MT)	SMS and SMSoSGs	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
25AH 25BH	End-to-End Delivery Time for SMS-MO	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
25AV 25BV	End-to-End Delivery Time for SMS-MO	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
26AH 26BH	End-to-End Delivery Time for SMS-MT	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
26AV 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 101BH	PS location update success ratio	EPS attach	EPS01 (Active) EPS08 (Passive) $EPS09_{hv}$ (Passive) $EPS07_{vh}$ (Passive)[6]	EPS18 (Active) EPS11 (Passive) $EPS09_{vh}$ (Passive) $EPS07_{hv}$ (Passive)[6]

Test code	Parameter	Reference flow	Start point	End Point
			EPS10$_{vh}$ (Passive)[6]	EPS10$_{hv}$ (Passive)[6]
101AV 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 102BH	PS location update delay	EPS attach	EPS01 (Active) EPS08 (Passive)	EPS18 (Active) EPS11 (Passive)
102AV 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 105BH	Default EPS bearer context activation success ratio	EPS attach	EPS18 (Active) EPS12 (Passive) EPS13 (Passive)[6]	EPS21 (Active) EPS16 (Passive) EPS15 (Passive)[6]
105AV 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	Default EPS bearer context activation time	EPS attach	EPS18 (Active) EPS12 (Passive)	EPS21 (Active) EPS16 (Passive)
106AV	Default EPS bearer context activation time	EPS attach	EPS18 (Active) EPS12 (Passive)	EPS21 (Active) EPS16 (Passive)
107AH	DNS host name resolution success ratio	-	DNS request (Active)	DNS data packet (type A) received (Active)
107AV	DNS host name resolution success ratio	-	DNS request (Active)	DNS data packet (type A) received (Active)
108AH	DNS host name resolution time	-	DNS request (Active)	DNS data packet (type A) received (Active)
108AV	DNS host name resolution time	-	DNS request (Active)	DNS data packet (type A) received (Active)
109AH	Default EPS bearer context cut-off ratio	EPS attach		
109AV	Default EPS bearer context cut-off ratio	EPS attach		
131AH	FTP {download | upload} IP service access success ratio	FTP	FTP00 (active)	FTP08 (active)

Test code	Parameter	Reference flow	Start point	End Point
131AV	FTP {download | upload} IP service access success ratio	FTP	FTP00 (active)	FTP08 (active)
132AH	FTP {download | upload} IP service setup time	FTP	FTP00 (active)	FTP08 (active)
132AV	FTP {download | upload} IP service setup time	FTP	FTP00 (active)	FTP08 (active)
133AH	FTP {download | upload} session success ratio	FTP	FTP00 (active)	FTP09 (active)
133AV	FTP {download | upload} session success ratio	FTP	FTP00 (active)	FTP09 (active)
134AH	FTP {download | upload} session time	FTP	FTP00 (active)	FTP09 (active)
134AH	FTP {download | upload} session time	FTP	FTP00 (active)	FTP09 (active)
135AH	FTP {download | upload} mean data rate	FTP	FTP00 (active)	FTP09 (active)
135AV	FTP {download | upload} mean data rate	FTP	FTP00 (active)	FTP09 (active)
136AH	FTP {download | upload} data transfer success ratio	FTP	FTP00 (active)	FTP11 (active)
136AV	FTP {download | upload} data transfer success ratio	FTP	FTP00 (active)	FTP11 (active)
137AH	FTP {download | upload} data capacity	FTP	FTP00 (active)	Reached max. capacity (active)
137AV	FTP {download | upload} data capacity	FTP	FTP00 (active)	Reached max. capacity (active)
141AH	HTTP / HTTPS IP service access success ratio	HTTP/HTTPS	HTTP01 active)	HTTP02 active)
141AV	HTTP / HTTPS IP service access success ratio	HTTP/HTTPS	HTTP01 active)	HTTP02 active)
142AH	HTTP / HTTPS IP service setup time	HTTP/HTTPS	HTTP01 active)	HTTP02 active)
142AV	HTTP / HTTPS IP service setup time	HTTP/HTTPS	HTTP01 active)	HTTP02 active)

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

Annex A Document Management

A.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

Other Information

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