GRQ Measurement Implementation
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1 Introduction

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

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

1.1 Overview

This document describes the implementation procedures for measuring the quality of SMS, voice, data, video, and IoT roaming services end-to-end both in the bilateral and in the Roaming Hub scenarios. Parameters to measure quality of roaming services covers mobile technologies through 5G: the list of QoS parameters is made to provide the mobile operator ability to measure quality in different scenarios with different methods. The parameters list can be extended in the future. QoS parameters defined by this document cover QoS requirements for roaming service level agreement, when available. Other QoS parameters are defined to provide an extensive monitoring capability for mobile operator implementing a QoS monitoring solution.

The document consists of three 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 GSMA PRD IR.42 [1].

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

A fourth 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 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 (oOther parameters may complement GRQ monitoring). The GSMA GRQ framework has been designed to standardize the parameters, measurement and implementation of roaming quality KPIs and to provide the guidelines and supporting information for operators to deploy those quality KPIs within end to end roaming SLAs.

This document is intended for mobile operators, roaming Hub 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 Hub Providers will find information about the most important QoS parameters and common monitoring methods that can be natively measured/performed by roaming Hub 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.

1.2 GRQ Framework

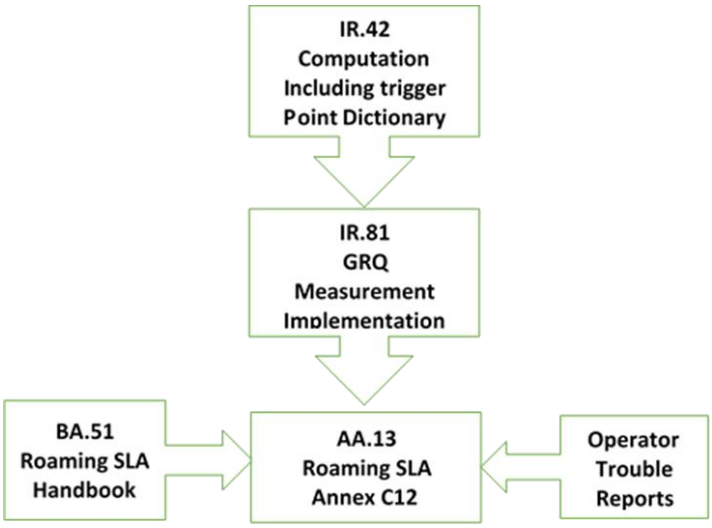

Figure 1: Relation of GSMA PRD IR.81 to other PRDs in the GRQ Framework

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

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

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

When this document is used by operators wishing to establish an end-to-end Roaming Service Level Agreement, GSMA PRD BA.51 is the Permanent Reference Document providing guidelines on how to implement the parameters that are to be measured with roaming partners.

1.3 Definition of Terms

Term	Description
5GC	5G Core network
ACD	Average Call Duration
AMF	Access & Mobility Function
ASR	Answer-Seize Ratio
AUSF	Authentication Server Function
CAMEL	Customized Applications for Mobile networks Enhanced Logic
CE	Coverage Enhancement
eDRX	Extended idle mode Discontinuous Reception
EN-DC	E-UTRA-NR Dual Connectivity
en-gNB	Enhanced gNB (a node providing NR user plane and control plane protocol terminations towards the UE and connected via the S1-U interface to the EPC and to the eNB via X2. Acts as the SN for EN-DC).
gNB	g-node 5G radio access station
GTP	GPRS Tunnelling Protocol
HPMN	Home Public Mobile Network
IMSI	International Mobile Subscriber Identity
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
KPI	(QoS) Key Performance Indicator
LBO-HR	Local Breakout HPMN Routing (roaming architecture)
LBO-VR	Local Breakout VPMN Routing (roaming architecture)
LTE	Long Term Evolution
LTE-M	Long-Term Evolution Machine Type Communications
LwM2M	Lightweight Machine to Machine
MAP	Mobile Application Part
MCG	Master Cell Group
MIoT	Mobile Internet of Things
MN	Master Node
MOS	Mean Opinion Score
MQTT	Message Queuing Telemetry Transport
MQTT-SN	MQTT for Sensor Networks
MSC	Mobile Switching Centre
MTU	Maximum Transmission Unit
NB-IoT	Narrowband IoT
NFV	Network Function Virtualisation
NR	New Radio (provided by gNB)
NSA	(5G) Non Stand-Alone
PCF	Policy Control Function

Term	Description
PDD	Post-Dial Delay
PSM	Power Save Mode
PTW	Paging Time Window
QoS	Quality of Service
RSRP	Reference Signal Received Power
SCG	Secondary Cell Group
SMF	Session Management Function
SN	Secondary Node
SQI	Single Quality Indicator
SRVCC	Single Radio Voice Call Continuity
SS7	Signalling System 7
SSI	Single Service Indicator
S8HR	S8 Home-Routed (roaming architecture)
STP	Signalling Transfer Point
TAU	Tracking Area Update
UDM	Unified data Function
UPF	User Plane Function
ViLTE	(conversational) Video over LTE
VoLTE	Voice over LTE

1.4 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"

No.	Document	Description
[8]	3GPP TS 29.281	"General Packet Radio System (GPRS) Tunnelling Protocol User Plane (GTPv1-U)"
[9]	GMSA PRD IR.65	IMS roaming and interworking guidelines
[10]	GMSA PRD IR.88	LTE Roaming Guidelines
[11]	GMSA PRD IR.92	IMS Profile for Voice and SMS
[12]	GMSA PRD IR.94	IMS Profile for Conversational Video Service
[13]	3GPP TS 34.229-1	Internet Protocol (IP) multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); User Equipment (UE) conformance specification; Part 1: Protocol conformance specification
[14]	3GPP TS 36 508	Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Common Test Environments for User Equipment (UE) Conformance Testing
[15]	3GPP TS 36 523-1	Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC); User Equipment (UE) conformance specification; Part 1: Protocol conformance specification
[16]	ITU-T P.863	Perceptual Objective Listening Quality Assessment (POLQA)
[17]	ITU-T G.107.1	Wideband E-Model
[18]	ITU-T J.247	Objective perceptual multimedia video quality measurement in the presence of a full reference
[19]	3GPP TS 37.340	Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity
[20]	GSMA PRD NG.113	5G ODTemplate
[21]	GSMA PRD NG.114	IMS Profile for Voice, Video and Messaging in 5GS
[22]	3GPP TS 28.554	5G end to end Key Performance Indicators
[23]	GSMA PRD BA.51	Roaming Service Level Agreement Guidelines
[24]	GSMA PRD IR.34	Guidelines for IPX provider networks

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 is 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. Ad-hoc tests 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:

2.1 End-to-end Active Testing and Monitoring
- 2.1 1 Active probes
- 2.1.2 Smartphones
- 2.1.3 Drive Testing

2.2 Passive Monitoring
- 2.2.1 Network related
- 2.2.2 User, device application/crowd testing related

Additional methods may be added in the future.

2.1 End-to-end Active Testing and Monitoring

2.1.1 Active probes

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.

2.1.2 Use of smartphone for QoS test

Instead of using RF probes as described under 2.1, smartphones can be used for active testing. These smartphones can be controlled via a programming interface providing the possibility to run exactly the same applications (Apps) as used by real subscribers. Also, parallel usage of different Apps is possible, enabling complex test scenarios similar to end user experience, also known as Quality of Experience (QoE).

Using smartphones, similar KPIs to the ones used in the scope of GRQ framework can be produced, while enriched with additional QoE related measurements.

2.1.3 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.

Drive Testing method focuses on the domestic environment because in roaming scenarios its use can be costly and impractical for continuous monitoring.

Drive testing in roaming scenarios could be more relevant in the future with new use cases.

2.2 Passive Monitoring

2.2.1 Network related monitoring

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

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

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

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

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

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

In this document, CAMEL Monitoring refers to passive probes monitoring CAP signaling.

The Passive Monitoring method extracts traffic directly from the core network focusing on both control and user plane roaming traffic. Unlike active testing, passive monitoring does not generate traffic to emulate subscriber behavior; instead, it passively monitors real traffic from inbound and outbound roaming users. In parallel, it can act complementary to active testing by offering test traffic visibility on multiple points in the network, thus, facilitating the

evaluation of end-to-end roaming services quality as well as assisting on live troubleshooting through a drill-down approach.

Passive monitoring can be implemented through different approaches including network Test Access Point (TAP) and Switch Port ANalyzer (SPAN) techniques. Network TAPs can be further categorized to passive probes (e.g., passive optical splitters) and active probes, while SPAN is a technique where the network packets seen on a switch port are copied to a special SPAN port that is used for monitoring. Another categorization of passive monitoring techniques is between virtual TAPs (vTAPs), i.e., software-based solutions supporting diverse mirroring techniques (e.g., vSwitch and NIC mirroring), and physical TAPs (pTAPs), i.e., hardware-based solutions that are connected directly into the cabling infrastructure. The selection of the appropriate passive monitoring techniques depends on multiple factors such as the volume and the type of traffic, the underlying physical or virtual infrastructure as well as the vendor-specific capabilities.

There are a variety of core network interfaces to which the above passive monitoring techniques could be applied. Depending on the accessibility of those interfaces and the actual monitoring needs, interfaces in the IPX (interconnection of IP networks) or level (connections between elements of the same network) may be considered. IPX level gives the capability to monitor performance staying at distance from the core network premises. On the other hand, passive monitoring domestically in VPMN or HPMN gives the advantage of delivering holistic view of network performance due to multiple interfaces and protocols that can be captured in parallel. Along with the interfaces that are directly used in 5GS and EPS roaming scenarios, (such as S8, S6a, S9, N9 and N32), passive monitoring can be applied to additional reference points aiming to gain insight on valuable information. Examples of additional reference points are user location, device model, application category, etc., used for the assessment of roaming quality.

Considering the latest technologies of 5G, LTE and VoLTE that dominate modern networks, passive monitoring may give access to the following protocols. For convenience, there is a split of protocols in the categories of UP (user plane) and CP (control plane).

UP protocols per core network technology
- 5G, LTE: GTP-U
- VoLTE: RTP

CP protocols per core network technology
- 5G: HTTP2/JSON (SBI), only for domestic: NGAP, PFCP
- LTE: GTP-C, Diameter, only for domestic: S1AP
- VoLTE: SIP

Deep Packet Inspection (DPI) on the traffic of monitored core network interfaces enables detailed assessment of roaming performance. Important information elements included in packets of milestone procedures/operations should be logged and processed to support ladder diagrams, KPIs and further analytics regarding provided services.

CP traffic is either non-encrypted or encrypted with the relative decryption keys obtained by other interfaces captured in the network. On the other hand, most UP traffic is encrypted with keys exclusively shared between server and individual subscriber. Thus, DPI cannot extensively apply, blocking the direct calculation of KPIs related to customer experience, e.g., video playout quality, web page download time. In that case, ML and AI algorithms can

be leveraged to infer key quality indicators and evaluate user experience without being hampered by encryption.

2.2.2 User, device, application layer Monitoring

2.2.2.1 Use Applets in SIMs for QoE Monitoring

Javacard Applets installed in the subscribers' SIMs can be used to measure their Quality of Experience. By aggregation of QoE data from individual Applets, a measure of device performance and serving network performance can be achieved per the quality measurements/KPI of the GRQ framework.

Using API in SIM Application Toolkit as standardized through 3GPP and ETSI, a Javacard Applet can acquire performance related data from host retail mobile phones and IoT devices, package it into data structures that describe service received and transmit it to server-side aspects that further process the data into management reporting.

As the SIM is present where the subscriber uses a network, JavaCard reporting covers service measurements in both Home and Visited networks. The type of services measured includes Radio Access Network performance, voice quality, and the number of attempts to use Packet data and Network Rejections. Measurements are qualified by;

The identity of the subscriber

The device used at the time of measurement

The Time-of-Day when a service was measured

The serving network identify addressed by Cell Global ID (CGI)

Service-related cause codes transmitted to the User Equipment by the serving network, i.e. call end causes for voice calls.

Radio measurements for the serving and neighboring cells

Calculated approximate latitude/longitude position of the subscriber

Depending upon the subscribers' service provider requirements, privacy is assured by;

The Applet obfuscating Subscriber ID with an irreversible hashing algorithm.

Application of unique key encryption implemented by the Javacard Applet. Unique keys are derived by the Applet and not pre-shared.

Encryption of data at rest by ensuring KPI stores are encrypted and datacentre access is limited.

Disabling the transmission of ID data by each Applet.

All device types used to measure service including Smartphones, fixed feature phones and IoT devices.

The bearer service used to upload data from the Applet is chosen by the MNO. The suggested default is for the Applet to attempt upload by IP with fall back to SMS first, then fallback to buffering when no bearer service is available. Rules with respect to upload of data are determined by the MNO, that is, upload from a visited network may not be allowed so the Applet will buffer data for subsequent upload when the subscriber returns to their Home network.

Additionally, Applet performance is controlled remotely and securely. For example, Applets are distributed in all physical and embedded SIMs with central control enabling the Applet as required.

The use of the Javacard Applet does not require intervention by the Subscriber. The Applet exports no User Interface, does not accelerate battery drain and uses minimal bearer service to carry data to the network. The amount of physical data uploaded by each Applet ranges from 130 bytes to less than 2k bytes.

2.2.2.2 Crowd testing/Monitoring

With reference to 2.2.2.1, a Javacard Applet in the SIM supports crowdsourcing of QoE/QoS data from Subscriber terminals so the number of Applets deployed should be significant with respect to the size of the target networks Subscriber base. As a guideline, at least 10% of the base should be enabled with an Applet.

By deploying the Applet in pSIMs and eSIMs, the Subscriber's service provider can measure their service nationwide, 24x7. As the Applet in the SIM accompanies the Subscriber on their user journey, all visited networks are measured as well. KPI/Data arising from the aggregation of SIM QoE data includes;

Performance of any Radio Access Network used. Radio measurements are provided with latitude/longitude position of the Subscriber when the radio is measured and Radio Link Failures are reported. These measurements address basic accessibility in 2G, 3G, 4G, 5G NSA & 5G SA (for example, see sections below with respect to voice KPI).

Voice calls to include CSFB with CSSR, CSR and HOSR, location and ID of serving network and device (see section **Error! Reference source not found.**).

Attempts for Packet Data with indication of APN settings and Access Technology.

Network Rejects with indication of currently used network, the rejecting network the update type and rejection cause.

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2.2.3 PROTOCOLS

2.2.3.1 CAMEL

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.

2.2.3.2 Most DIAMETER

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

2.2.3.3 2.GTP-C / -U

Operators with CAMEL-enabled limit its support to CAMEL Phase 2.

2.2.3.4 IP Monitoring

IP monitoring applies to IPX connectivity, both when a single IPX provider provides the roaming path or when two IPX Providers provide the roaming path via a IPX-IPX interconnection, i.e. IPX peering relationship. Interconnection framework for IP (GSMA PRD IR.34) provides network level QoS monitoring of IP traffic between mobile operators and interconnection providers.

When this document is used by operators wishing to establish an end-to-end Roaming Service Level Agreement, GSMA PRD BA.51 is the document providing guidelines to define the parameters to be measured.

3 Overview of Roaming QoS Parameters

This 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 below QoS aspects defined in GSMA PRD IR.42, and represents the customer experience. It 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 below QoS aspects defined in GSMA PRD IR.42, and represents the customer experience.

QoS aspects:

Network Accessibility: Probability that the user performs a successful registration on the PMN. (In SIM QoE, the successful registration to a VPMN is explicit and not a probability). The customer is registering to the network (either the circuit switched network for CS 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 the parameters can be natively monitored by a roaming Hub Provider. In 5G, accessibility refer to the ability for the users to register to the network and to a network slice

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).)

In Applet solution, the Applet reports all service consumed on a VPMN. For voice, the Applet reports call control (the user dials a number), call connect (set-up completes and voice starts) nad call end. For all call end, the end cause code is provided. Attach for data and network rejects are also reported.

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, for newest technologies 3G/LTE/5G, http(s) successful connection to a public web site.

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. In 5G, retainability refers to abnormally loss of a QoS flow during the time the QoS flow is used, abnormal loss of a Data Radio Bearer (DRB) during the time the DRB is active.

Integrity

In 5G, Integrity refers to Latency/Delay, throughput for network and Network Slice Instance

Utilization

In 5G, Utilization KPI refers Mean number of PDU sessions of network and network Slice Instance, PDU session establishment time of network slice

In Applet solution, the Applet records all attempts to attach for packet data across 2G, 3G, 4G and 5G.

Mobility

In 5G, Mobility refers to NG-RAN handover success rate, Inter-gNB handover which related to one single network slice, 5GS to EPS handover success rate.-

In Applet solution, the Applet can capture every Location Status Update (cell handover). As there are so many handoffs, to attenuate the number being reported by suitably setting Applt configurations applies.

Connection Quality

This describes the Quality of Service during service use. The connection is not impaired by quality problems, such as reduced speech quality for voice or data rate and increased latency for data services.

In Applet solution, the Applet reports logical data such as call end causes and network reject update/reject codes. There is also scope to use the Applet to capture radio data during voice calls. Radio measurement includes signal strength and quality. These last 2 measures can be viewed as relative to the quality of the call.

For Packet Switched services, there are two approaches

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 aligns 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.

3.1 Voice QoS Parameters

3.1.1 CS voice QoS parameters

QoS Aspects	QoS Parameters	Parameter covered by Active Testing probes related	Parameter covered by Active Testing related	Parameter covered by Passive Monitoring	Parameter covered by Passive Monitoring
Network Accessibility (customer being able to register on the network)	1. Circuit Switched LU success ratio (*) 2. Circuit Switched LU delay (*)	1.YES 2. YES	1.YES 2. YES	1 TBC 2. TBC	1 YES (1) 2. NO
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. YES 4. YES 5 YES 6 YES	3. YES 4. YES 5 YES 6 YES	3. TBC 4.TBC 5 TBC 6.TBC	3. YES4.YES 5 NO 6.NO (2)
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)	7,YES 8, YES 9.YES 10.YES	7,YES 8, YES 9.NO 10.NO	7,TBC 8, TBC 9. TBC 10. TBC	7,YES 8, YES 9. NA (3) 10. YES
Connection retain-ability (from a successful establishment of the call	11. CCR (success ratio) 12. ALOC (duration)[1]	11.YES 12.YES	11.YES 12.YES	11.TBC 12.TBC	11.YES 12.YES (4)

[1] Not relevant for a roaming QoS SLA.

until service is terminated)					
Connection quality	13a. CLI transparency (MO) 13b. CLI transparency (MT) 14a. Speech Quality (SpQ_received_R_side) 14b. Speech Quality (SpQ_received_H_side)	13a.YES 13b.YES 14a. YES 14b. YES	13a.YES 13b.YES 14a. YES 14b. YES	13a.TBC 13b.TBC 14a.TBC 14b. TBC	13a.YES 13b.YES 14a.NO 14b. NO

(*) Natively supported by roaming Hubbing Providers; other parameters may be supported through CAMEL.(1) The Applet provides explicit indication of a successful connect to a roaming partner. If there is no connection, then the Applet reports the availability of a network for emergency/limited service or the fact that the UE receives no radio whatsoever.

(2) Timers in the SIM do not reliably provide the required resolution in time.

(3) The Applet does receive the cause location and end cause values so the ratio in the Applet world is always 100%

(4) The duration of all calls is reported by the Applet. These can be reported individually or subject to server-side aggregation to derive ALOC.

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	Parameter covered by Active Testing probes related	Parameter covered by Active Testing related	Parameter covered by Passive Monitoring	Parameter covered by Passive Monitoring et/Crowd ed tocol ved
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	101.YES 102, YES 103a. YES 103b. YES 104a.YES 104B. YES	101.YES 102, YES 103a. YES 103b. YES 104a.YES 104B. YES	101.TBC 102, TBC 103a.TBC 103b. TBC 104a.TBC 104B.TBC	101.YES 102, NO 103a.YES (1) 103b. YES 104a.NO 104B.NO
CS voice accessibility	3. NER-MO or SAT-MO (success ratio) 4. NER-MT or SAT-MT (success ratio) 115. CSFB PDD-MO or CSFB STT-MO (setup time) 116. CSFB PDD-MT or CSFB STT-MT (setup time)	3.YES 4.YES 115 .YES 116.YES 7. YES 8.YES	3.YES 4.YES 115 .YES 116.YES 7. YES 8.YES	3.TBC 4.TBC 115 TBC 116.TBC 7.TBC 8.TBC	3.YES 4.YES 115 NO 116.NO 7.YES 8.YES

	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.					
Reported by the Applet as update ot serving cell + access technology					

3.1.3 VoLTE QoS parameters

QoS Aspects	QoS Parameters					
	GRQ Id	KPI description	Parameter covered by Active Testing probes related	Parameter covered by Active Testing Smartphone related	Parameter covered by Passive Monitoring Network Related + Protocol involved	Parameter covered by Passive Monitoring Applet/Crowd Related + Protocol involved
VoLTE service Accessibility	201 202	IMS Registration success ratio IMS Registration time	201 YES 202.YES	201 YES 202.YES	201 TBC 202 TBC	201 NO 202 NO
VoLTE service integrity and retainability	203 204 205 206 207 208 211 212 213 210	Voice MO accessibility (NER-MO or SAT-MO success ratio) Voice MT accessibility (NER -MT or SAT-MT success ratio) Voice MO session setup time (PDD-MO or STT-MO duration) Voice MT session setup time (PDD-MT or STT-MT duration) Voice MO session setup ratio (CSSR-MO)	203,YES 204.YES 205.YES 206.YES 207.YES 208.YES 211.YES 212.YES 213.YES 210.YES	203,YES 204.YES 205.YES 206.YES 207.YES 208.YES 211.YES 212.YES 213.YES 210.YES	203 TBC 204 TBC 205 TBC 206 TBC 207 TBC 208 TBC 211 TBC 212 TBC 213 TBC 210 TBC	203 YES 204 YES 205 NO 206 NO 207 YES 208 YES 211 YES 212 YES 213 YES 210 YES

	214 215 216 217	Voice MT session setup ratio (CSSR-MT) Voice MO session duration Voice MT session duration OIP transparency MO (CLI transparency) OIP transparency MT (CLI transparency) Speech quality on call basis at R-party Speech quality on call basis at H-party Speech quality R-factor at R-party Speech quality R-factor at H-party	214 .YES 215.YES 216.YES 217.YES	214 .YES 215.YES 216.NO 217.NO	214 TBC 215 TBC 216 TBC 217 TBC	214 NO 215 NO 216 NO 217 NO
VoLTE service mobility	230 231 232 233	SRVCC MO success ratio SRVCC MT success ratio SRVCC MO time SRVCC MT time	230.YES 231.YES 232.YES 233.YES	230.NO 231.YES 232.YES 233.NO	230 TBC 231 TBC 232 TBC 233 TBC	230 YES 231 YES 232 NO 233 NO
LTE network quality for VoLTE service	240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257	Default EPS bearer context activation success ratio Default EPS bearer context activation time Default EPS bearer QCI Default EPS bearer UL AMBR Default EPS bearer DL AMBR Dedicated EPS bearer context activation success ratio (audio) Dedicated EPS bearer context activation time (audio) Dedicated EPS bearer QCI (audio) Dedicated EPS bearer UL GBR (audio) Dedicated EPS bearer DL GBR (audio) IP data volume received on QCI5 bearer at R-party IP data volume transmitted on QCI5 bearer at R-party IP data volume received on QCI5 bearer at H-party IP data volume transmitted on QCI5 bearer at H-party IP data volume received on QCI1 bearer at R-party IP data volume transmitted on QCI1 bearer at R-party	240.YES 241 YES 242.YES 243.YES 244.YES 245.YES 246.YES 247.YES 248.YES 249.YES 250.YES 251.YES 252.YES 253.YES 254.YES 255.YES 256.YES 257.YES	240.YES 241 YES 242.YES 243.YES 244.YES 245.YES 246.YES 247.YES 248.YES 249.YES 250.YES 251.YES 252.YES 253.YES 254.YES 255.YES 256.YES 257.YES	240 TBC 241 TBC 242 TBC 243 TBC 244 TBC 245 TBC 246 TBC 247 TBC 248 TBC 249 TBC 250 TBC 251 TBC 252 TBC 253 TBC 254 TBC 255 TBC 256 TBC 257 TBC	240 TBC 241 NO 242 NO 243 NO 244 NO 245 NO 246 NO 247 NO 248 NO 249 NO 250 NO 251 NO 252 NO 253 NO 254 NO 255 NO 256 NO 257 NO

		IP data volume received on QCI1 bearer at H-party IP data volume transmitted on QCI1 bearer at H-party				
Voice media transport qualit y for VoLTE service	260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277	RTP max packet delay variation R2H (A-B) RTP max packet delay variation H2R (B-A) RTP mean packet delay variation R2H (A-B) RTP mean packet delay variation H2R (B-A) RTP mean interarrival jitter of incoming streaming R2H (A-B) RTP mean interarrival jitter of incoming streaming H2R (B-A) RTP mean data rate transmitted R2H (A-B) RTP mean data rate received H2R (B-A) RTP mean data rate transmitted H2R (B-A) RTP mean data rate received R2H (A-B) RTP packets lost R2H (A-B) RTP packets lost H2R (B-A) RTP packet lost ratio R2H (A-B) RTP packet lost ratio H2R (B-A) RTP round-trip delay (RTD RHR A-B-A) RTP round-trip delay (RTD HRH B-A-B) RTP one-way delay (OWD R2H A-B) RTP one-way delay (OWD H2R B-A)	260.YES 261.YES 262.YES 263.YES 264.YES 265.YES 266,YES 267.YES 268.YES 269.YES 270.YES 271.YES 272.YES 273.YES 274.YES 275.YES 276.YES 277.YES	260.YES 261.YES 262.YES 263.YES 264.YES 265.YES 266,YES 267.YES 268.YES 269.YES 270.YES 271.YES 272.YES 273.YES 274.YES 275.YES 276.YES 277.YES	260 TBC 261 TBC 262 TBC 263 TBC 264 TBC 265 TBC 266 TBC 267 TBC 268 TBC 269CTBC 270 TBC 271 TBC 272 TBC 273 TBC 274 TBC 275 TBC 276 TBC 277 TBC	260 NO 261 NO 262 NO 263 NO 264 NO 265 NO 266 NO 267 NO 268 NO 269 NO 270 NO 271 NO 272 NO 273 NO 274 NO 275 NO 276 NO 277 NO

(1) The Applet captures IMS Registration but not failures

3.1.4 Voice 5G QoS parameters

3.1.4.1 Voice Service in 5G

3.1.4.2 Voice Service in Option 2

Voice over IMS via 5G SA (VoNR)

QoS Aspects	QoS Parameters					
	GRQ Id	KPI description	Parameter covered by Active Testing probes related	Parameter covered by Active Testing Smartphone related	Parameter covered by Passive Monitoring Networ Related	Parameter covered by Passive Monitoring Applet/Crowd Related
Connection Quality	515	Packet Loss Rate: The percentage of voice packets that are lost during transmission. A high packet loss rate can result in choppy or distorted voice quality. (Tx & Rx)	YES	YES	TBC	NO
Service Retainability	514	Jitter : The variation in the delay of voice packets as they traverse the network. High jitter can lead to uneven or unpredictable voice quality. (Tx & Rx)	YES	YES	TBC	NO
Connection Quality	516	Latency :The time it takes for voice packets to travel from the sender to the receiver. High latency can result in delays or lag in the conversation.	YES	YES	TBC	NO
Connection Quality	517	MOS (Mean Opinion Score : A subjective measure of the overall voice quality experienced by the user. MOS is typically rated on a scale from 1 to 5, with 5 indicating excellent voice quality.	YES	YES	TBC	NO
Network Accesibility	519	5QI: The 5G QoS Identifier value corresponds to a set of QoS characteristics that should be used for the QoS flow. These characteristics include guaranteed and maximum bitrates, priority levels, and limits on latency, jitter, and error rate. Based on document defined by 3GPP TS23.501 section 5.7.4	YES	NO	TBC	NO

Network Accessibility	511	Signal-to-Noise Ratio (SNR):The ratio of the voice signal strength to background noise. High SNR can result in clear and distinct voice quality.	YES	NO	TBC	NO
Connection Quality	518	Bit Rate :The amount of data transmitted per unit of time. High bit rate can result in better voice quality, but also requires more bandwidth. (Tx & Rx)	YES	YES	TBC	NO
Service Establishment	512	Call setup time (IMS Session Establishment delay) :The time taken to establish a voice call, including authentication, authorization, and call routing. A long call setup time can reduce user satisfaction and lead to call drops.	YES	YES	TBC	NO
Service Retainability	513	Call drop rate :The percentage of voice calls that are disconnected prematurely. High call drop rates can indicate network congestion or other issues that affect voice continuity.	YES	YES	TBC	NO (1)
Network Accesibility	522	SST: Service Slice Type, It is recommended that the S-NSSAI standard value for eMBB [SST=1 and no SD] is supported globally for roaming as a globally by all 5GS PMNs available network slice and be present in Subscribed S-NSSAIs in UDM for subscriptions using e.g. Internet access and IMS services. Other S-NSSAIs can be provided as Subscribed S-NSSAIs if required	YES	NO	TBC	TBC

(1) Currently not supported in the API used by the Applet (SIM Application Toolkit). We await 3GPP/ETSI to update TS 31.111/TS 12 223 to include

3.1.4.1.2 Voice Service in Option 3

Voice services provided as Voice over IMS via EPS (VoLTE)

QoS parameters are same than VoLTE call, please refer to 3.1.3 section

3.2 SMS QoS Parameters

3.2.1 SMS over GSM, UMTS and LTE

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

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

SMS over SGs applies the same QoS parameters for SMS.

3.2.2 SMS over 5G

For SMS service over the 5GC we still will find the alternatives over signaling (NAS) and the SMS over IP through the IMS

Bottom line, there are parameters coming from end user perspective which are valid, then for instance we can keep monitoring the traditional:

QoS Aspects	QoS Parameters					
	GRQ Id	KPI description	Parameter covered by	Parameter covered by Active Testing	Parameter covered by	Parameter covered by Passive

			Active Testing probes related	**Smartphone related**	**Passive Monitoring** **Network Related** **+ Protocol involved**	**Monitoring** **Applet/Crowd Related** **+ Protocol involved**
Connection Establishment	520	SMS submission success rate: Message indication as sent received at UE	YES	TBC	TBC	NO
Connection Establishment	521	SMS submission delay: Time to reach Cx network and receive confirmation at MO side (message sent)	YES	TBC	TBC	NO
Connection Quality	523	Message Success Rate :The percentage of SMS messages that are successfully delivered to the recipient. A high success rate indicates good network performance and reliability.	YES	YES	TBC	NO (1)
Connection Quality	524	Latency (END TO END Delivery time): The time it takes for SMS messages to be sent and received. High latency can result in delays in message delivery and response times.	YES	YES	TBC	NO
Utilization	526	Throughput (Traffic load): The amount of SMS message traffic that can be handled by the network per unit of time. High throughput is necessary to support high volumes of SMS traffic.	NO	NO	TBC	NO

Service retainability	525	Retransmission Rate :The percentage of SMS messages that require retransmission due to errors or other issues. A high retransmission rate can indicate network congestion or other issues that affect SMS service quality.	NO	NO	TBC	YES (1)

1. The Applet has no access to User SMS but can use SMS itself as a bearer of data to the network. Integrity checking in the Applet to server protocol shows failre/retries and dropped SMS.

3.2.2.1 SMS over IP

QoS Aspects	**QoS Parameters**					
	GRQ Id	**KPI description**	Parameter covered by Active Testing probes related	Parameter covered by Active Testing Smartphone related	Parameter covered by Passive Monitoring Network Related + Protocol involved	Parameter covered by Passive Monitoring Applet/Crowd Related + Protocol involved
1. SMSoIP Accessibility	201	IMS Registration success ratio	201 YES	201 YES	201 TBC	201 NO (1)
	202	IMS Registration success time	202 YES	202 YES	202 TBC	202 NO
2. Service accessibility	221	SMSoIP-MO accessibility	221 YES	221 YES	221 TBC	221 YES
	222		222 YES	222 YES	222 TBC	222 NO
	223		223 YES	223 YES	223 TBC	223 NO

	224	SMSoIP-MT accessibility SMSoIP-MO access delay SMSoIP-MT access delay	224 YES	224 YES	224 TBC	224 NO
3. Connection establishment	225 226	SMSoIP-MO e2e delay SMSoIP-MT e2e delay	225 YES 226 YES	225 YES 226 YES	225 TBC 226 TBC	225 NO 226 NO

1. The Applet does capture IMS Registration but there is no failure case data that enables a success/fail ratio

2. The Applet does capture IMS Registration but there is no failure case data that enables a success/fail ratio

3.3 DATA SERVICE QoS Parameters

3.3.1 GPRS / UMTS

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

QoS Aspects	QoS Parameters	Parameter covered by Active Testing probes related	Parameter covered by Active Testing related	Parameter covered by Passive Monitoring	Parameter covered by Passive Monitoring olet/Crowd ated rotocol olved
Network Accessibility (customer being able to register on the network)	31. Packet Switched Location Update success ratio (*) 32. Packet Switched Location Update Delay (*)	31. YES 32. YES	31. YES 32. YES	31,TBC 32. TBC	31,NO 32. NO
Service accessibility (from customer hitting the send / connection button until accessing the data bearer)	33. PDP Context Activation success ratio 34. PDP Context Activation time	33 YES 34. YES	33 YES 34. YES	33 TBC 34. TBC	33 NO 34. NO
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**Error! Bookmark not defined.**	35 YES. 36.YES	35 YES. 36.YES	35 TBC 36.TBC	35 NO 36.NO
Connection quality	37. Throughput (Kbit/sec) [2] 38. Goodput (Kbit/sec)	37. YES 38. YES 39. YES	37. YES 38. YES 39. YES	37. TBC 38. TBC 39. TBC	37. NO 38. NO 39. NO

[2] Because a 'bearer level' approach is adopted for the data services QoS monitoring, these parameters have to be measured at the 'bit pipe' level.

	39. Roundtrip time (expressed in milliseconds) [3] 40. Packet loss[4]	40.YES	40.YES	40 TBC	40 NO
HTTP / HTTPS WEB browsing service quality	142. HTTP / HTTPS IP service setup time 143. HTTP / HTTPS session success ratio 144. HTTP / HTTPS session time 145. HTTP / HTTPS mean data rate 146. HTTP / HTTPS data transfer success ratio	142.YES 143 YES 144.YES 145YES 146.YES	142.YES 143 YES 144.YES 145YES 146.YES	142 TBC 143 TBC 144.TBC 145 TBC 146. TBC	142 NO 143 NO 144.NO 145 NO 146. NO

(*) 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.

[3] See ‘Delay’ in section 8 of GSMA PRD IR.34 ‘Inter-Service Provider IP Backbone Guidelines’.
[4] See ‘Packet Loss Ratio’ in section 8 of GSMA PRD IR.34 ‘Inter-Service Provider IP Backbone Guidelines’
[5] See RFC 5166 Metrics for the Evaluation of Congestion Control Mechanisms (http://tools.ietf.org/html/rfc5166)

3.3.2 LTE data

QoS Aspects	QoS Parameters	Parameter covered by Active Testing probes related	Parameter covered by Active Testing Smartphone related	Parameter covered by Passive Monitoring Networ Related + Protocol involved	Parameter covered by Passive Monitoring Applet/Crowd Related + Protocol involved
Network Accessibility (customer being able to register on the network)	31. Packet Switched Location Update success ratio (*) 32. Packet Switched Location Update Delay (*)	31. YES 32. YES	31. YES 32. YES	31,TBC 32. TBC	31,NO 32. NO
Service accessibility (from customer hitting the send / connection button until accessing the data bearer)	33. PDP Context Activation success ratio 34. PDP Context Activation time	33 YES 34. YES	33 YES 34. YES	33 TBC 34. TBC	33 NO 34. NO
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**Error! Bookmark not defined.**	35 YES. 36.YES	35 YES. 36.YES	35 TBC 36.TBC	35 NO 36.NO
Connection quality	37. Throughput (Kbit/sec) [6] 38. Goodput (Kbit/sec) 39. Roundtrip time (expressed	37. YES 38. YES 39. YES 40.YES	37. YES 38. YES 39. YES 40.YES	37. TBC 38. TBC 39. TBC 40 TBC	37. NO 38. NO 39. NO 40 NO

[6] Because a 'bearer level' approach is adopted for the data services QoS monitoring, these parameters have to be measured at the 'bit pipe' level.

	in milliseconds) [7] 40. Packet loss[8]				
HTTP / HTTPS WEB browsing service quality	142. HTTP / HTTPS IP service setup time 143. HTTP / HTTPS session success ratio 144. HTTP / HTTPS session time 145. HTTP / HTTPS mean data rate 146. HTTP / HTTPS data transfer success ratio	142.YES 143 YES 144.YES 145YES 146.YES	142.YES 143 YES 144.YES 145YES 146.YES	142 TBC 143 TBC 144.TBC 145 TBC 146. TBC	142 NO 143 NO 144.NO 145 NO 146. NO
PING service quality	151. PING packet loss ratio 152. PING round trip time	151.YES 152. YES	151.YES 152. YES	151 TBC 152. TBC	151. NO 152. NO
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.					

1. implementing DNS related KPI under evaluation

3.3.3 5G data

Both SA and NSA network architecture options are covered.

As deployment options, most common adopted options are covered, as the standardisation of these two options have already been completed:

- 5G NSA Option 3
- 5G SA Option 2

[7] See 'Delay' in section 8 of GSMA PRD IR.34 'Inter-Service Provider IP Backbone Guidelines'.
[8] See 'Packet Loss Ratio' in section 8 of GSMA PRD IR.34 'Inter-Service Provider IP Backbone Guidelines'

3.3.3.1 5G SA Option 2

Roaming scenarios in 5G SA Option 2 are designed to provide seamless connectivity and mobility for users traveling between different geographical areas or countries. In particular, Local Breakout (LBO) and Home Routing (HR) are two common modes of operation for roaming scenarios in 5G SA Option 2.

In LBO mode, the data traffic of the roaming user is routed locally in the visited network to reach the internet or other external services. This allows the user to access services directly from the visited network without going through the home network, reducing latency and improving network performance. LBO mode is particularly useful for data-intensive services such as video streaming, which require high bandwidth and low latency.

In HR mode, the data traffic of the roaming user is routed back to the home network, which then forwards it to the external services. This mode is useful for services that require a high level of security or specialized functionality that is only available in the home network, such as corporate VPNs or specialized applications. HR mode can also be used to enforce policy and compliance requirements for data traffic.

The combination of LBO and HR modes in roaming scenarios allows mobile network operators to optimize network resources, improve network performance, and provide a better user experience for their customers. By choosing the appropriate mode for each user and service, operators can ensure that their network resources are used efficiently and effectively while providing the desired level of service quality.

3.3.3.2 5G NSA Option 3 - EN-DC QoS Parameters

QoS Aspects	QoS Parameters	Parameter covered by Active Testing probes related		Parameter covered by Passive Monitoring	Parameter covered by Passive Monitoring
EN-DC NR accessibility & availability	500. 5G coverage indication 501. NR RSRP (Note 2) 502. Restrict DCNR	500 YES 501.YES 502. YES	500 YES 501.YES 502. YES	500 TBC 501.TBC 502. TBC	500 YES 501.NO 502. NO

en-gNB resource availability	503. ENDC EPS bearer configuration 5G bearer context activation time, as 106 in LTE 504. 5G ENDC_Used allocated 505. Default EPS bearer QoS parameters	503. YES YES 504. YES 505. YES	503. YES YES 504. NO 505. YES	503. TBC TBC 504. TBC 505. YES	503. NO NO 504. NO 505. NO
MBB data rate & latency	510. HTTP / HTTPS MBB data transfer success ratio 530. HTTP/HTTPS MBB Download Rate Mbits/s (*) 531. HTTP/HTTPS MBB Upload Rate Mbits/s (*) 532. HTTP/HTTPS MBB Latency milliseconds (**) PING packet loss ratio specifically for 5G NSA, as 151 in LTE	510. YES 530. YES 531. YES 532 YES YES	510. YES 530. YES 531. YES 532. YES YES	510. TBC 530. TBC 531. TBC 532. TBC NO	510. NO 530. NO 531. NO 532. NO NO

Note 1: An EPS attach is a precondition for testing QoS parameters 501 – 505, 145 and 152.

(*) Add specific metrics for download rate and upload rate based in MBB environment

(**) Add specific metric for Latency in ms for MBB environment

Note 2: In combination with RSRP in such of frequency band would be more accurate to also include RSRQ and SINR as part of the global RF Conditions metrics

		RSRP [dBm]	RSRQ [dB]	SINR [dB]
RF Conditions	Excellent	>= -80	>= -10	>= 20
	Good	-80 to -90	-10 to -15	13 to 20
	Poor	-90 to -100	-15 to -20	0 to 13
	Very Poor	< -100	< -20	<= 0

NR RF Conditions = 40%*RSRP + 40%*RSRQ + 20%*SINR (New KPI)

3.4 VIDEO SERVICE QoS Parameters

3.4.1 VILTE

QoS Aspects	QoS Parameters					
	GRQ Id	KPI description	Parameter covered by Active Testing probes related	Parameter covered by Active Testing Smartphone related	Parameter covered by Passive Monitoring Network Related + Protocol involved	Parameter covered by Passive Monitoring Applet/Crowd Related + Protocol involved
ViLTE service Accessibility	301 302	IMS Registration success ratio IMS Registration time	301YES 302 YES	301YES 302 YES	301 TBC 302 TBC	301 NO 302 NO
ViLTE service integrity and retainability	303 304 305 306 307 308 311 312 313 310 314 315 216 217 318 319	ViLTE MO accessibility (NER-MO or SAT-MO success ratio) ViLTE MT accessibility (NER -MT or SAT-MT success ratio) ViLTE MO session setup time (PDD-MO or STT-MO duration) ViLTE MT session setup time (PDD-MT or STT-MT duration) ViLTE MO session setup ratio (CSSR-MO) ViLTE MT session setup ratio (CSSR-MT) ViLTE MO session duration ViLTE MT session duration OIP transparency MO (CLI transparency) OIP transparency MT (CLI transparency)	303 YES 304 YES 305 YES 306 YES 307.YES 308 YES 311YES 312 YES 313 YES 310 YES 314 YES 315 YES 216 YES 217 YES 318 YES 319 YES	303 YES 304 YES 305 YES 306 YES 307.YES 308 YES 311YES 312 YES 313 YES 310 YES 314 YES 315 YES 216 NO 217 NO 318 YES 319 YES	303 TBC 304 TBC 305 TBC 306 TBC 307 TBC 308 TBC 311 TBC 312 TBC 313 TBC 310 TBC 314 TBC 315 TBC 216 TBC 217 TBC 318 TBC 319 TBC	303 NO 304 NO 305 NO 306 NO 307 NO 308 NO 311 NO 312 NO 313 NO 310 NO 314 NO 315 NO 216 NO 217 NO 318 NO 319 NO

		Speech quality on sample basis at R-party Speech quality on sample basis at H-party Speech quality R-factor at R-party Speech quality R-factor at H-party Video quality on sample basis at R-party Video quality on sample basis at H-party				
ViLTE service mobility	230 231 232 233	SRVCC MO success ratio SRVCC MT success ratio SRVCC MO time SRVCC MT time	230 YES 231 YES 232 YES 233 YES	230 YES 231 YES 232 YES 233 YES	230 TBC 231 TBC 232 TBC 233 TBC	230 NO 231 NO 232 NO 233 NO
LTE network quality for ViLTE service	240 241 242 243 244 247 248 249 345 346 347 348 349 343 344 250 251 252 253 254 255 256 257 354 355 356 357	Default EPS bearer context activation success ratio Default EPS bearer context activation time Default EPS bearer QCI Default EPS bearer UL AMBR Default EPS bearer DL AMBR Dedicated EPS bearer QCI (audio) Dedicated EPS bearer UL GBR (audio) Dedicated EPS bearer DL GBR (audio) Dedicated EPS bearer context activation success ratio (audio&video) Dedicated EPS bearer context activation time (audio&video) Dedicated EPS bearer QCI (video) Dedicated EPS bearer UL GBR (video) Dedicated EPS bearer DL GBR (video)	240 YES 241 YES 242 YES 243 YES 244 YES 247 YES 248 YES 249 YES 345 YES 346 YES 347 YES 348 YES 349 YES 343 YES 344 YES 250 YES 251 YES 252 YES 253 YES 254 YES 255 YES 256 YES 257 YES 354 YES 355 YES 356 YES 357 YES	240 YES 241 YES 242 YES 243 YES 244 YES 247 YES 248 YES 249 YES 345 YES 346 YES 347 YES 348 YES 349 YES 343 YES 344 YES 250 YES 251 YES 252 YES 253 YES 254 YES 255 YES 256 YES 257 YES 354 YES 355 YES 356 YES 357 YES	240 TBC 241 TBC 242 TBC 243 TBC 244 TBC 247 TBC 248 TBC 249 TBC 345 TBC 346 TBC 347 TBC 348 TBC 349 TBC 343 TBC 344 TBC 250 TBC 251 TBC 252 TBC 253 TBC 254 TBC 255 TBC 256 TBC 257 TBC 354 TBC 355 TBC 356 TBC 357 TBC	240 NO 241 NO 242 NO 243 NO 244 NO 247 NO 248 NO 249 NO 345 NO 346 NO 347 NO 348 NO 349 NO 343 NO 344 NO 250 NO 251 NO 252 NO 253 NO 254 NO 255 NO 256 NO 257 NO 354 NO 355 NO 356 NO 357 NO

		Dedicated EPS bearer UL AMBR (video) Dedicated EPS bearer DL AMBR (video) IP data volume received on QCI5 bearer at R-party IP data volume transmitted on QCI5 bearer at R-party IP data volume received on QCI5 bearer at H-party IP data volume transmitted on QCI5 bearer at H-party IP data volume received on QCI1 bearer at R-party IP data volume transmitted on QCI1 bearer at R-party IP data volume received on QCI1 bearer at H-party IP data volume transmitted on QCI1 bearer at H-party IP data volume received on QCI2/8/9 bearer at R-party IP data volume transmitted on QCI2/8/9 bearer at R-party IP data volume received on QCI2/8/9 bearer at H-party IP data volume transmitted on QCI2/8/9 bearer at H-party				
RTP transport quality for ViLTE service - audio	260 261 262 263 264 265 266	RTP max packet delay variation R2H (A-B) RTP max packet delay variation H2R (B-A) RTP mean packet delay variation R2H (A-B)	260 YES 261 YES 262 YES 263 YES 264 YES 265 YES 266 YES	260 YES 261 YES 262 YES 263 YES 264 YES 265 YES 266 YES	260 TBC 261 TBC 262 TBC 263 TBC 264 TBC 265 TBC 266 TBC	260 NO 261 NO 262 NO 263 NO 264 NO 265 NO 266 NO

	267 268 269 270 271 272 273 274 275 276 277	RTP mean packet delay variation H2R (B-A) RTP mean interarrival jitter of incoming streaming R2H (A-B) RTP mean interarrival jitter of incoming streaming H2R (B-A) RTP mean data rate transmitted R2H (A-B) RTP mean data rate received H2R (B-A) RTP mean data rate transmitted H2R (B-A) RTP mean data rate received R2H (A-B) RTP packets lost R2H (A-B) RTP packets lost H2R (B-A) RTP packet lost ratio R2H (A-B) RTP packet lost ratio H2R (B-A) RTP round-trip delay (RTD RHR A-B-A) RTP round-trip delay (RTD HRH B-A-B) RTP one-way delay (OWD R2H A-B) RTP one-way delay (OWD H2R B-A)	267 YES 268 YES 269 YES 270 YES 271 YES 272 YES 273 YES 274 YES 275 YES 276 YES 277 YES	267 YES 268 YES 269 YES 270 YES 271 YES 272 YES 273 YES 274 YES 275 YES 276 YES 277 YES	267 TBC 268 TBC 269 TBC 270 TBC 271 TBC 272 TBC 273 TBC 274 TBC 275 TBC 276 TBC 277 TBC	267 NO 268 NO 269 NO 270 NO 271 NO 272 NO 273 NO 274 NO 275 NO 276 NO 277 NO
RTP transport quality for ViLTE service - video	360 361 362 363 364 365 366 367 368 369 370 371 372 373	RTP max packet delay variation R2H (A-B) RTP max packet delay variation H2R (B-A) RTP mean packet delay variation R2H (A-B) RTP mean packet delay variation H2R (B-A) RTP mean interarrival jitter of incoming streaming R2H (A-B) RTP mean interarrival jitter of incoming streaming H2R (B-A)	360 YES 361 YES 362 YES 363 YES 364 YES 365 YES 366 YES 367 YES 368 YES 369 YES 370 YES 371 YES 372 YES 373 YES	360 YES 361 YES 362 YES 363 YES 364 YES 365 YES 366 YES 367 YES 368 YES 369 YES 370 YES 371 YES 372 YES 373 YES	360 TBC 361 TBC 362 TBC 363 TBC 364 TBC 365 TBC 366 TBC 367 TBC 368 TBC 369 TBC 370 TBC 371 TBC 372 TBC 373 TBC	360 NO 361 NO 362 NO 363 NO 364 NO 365 NO 366 NO 367 NO 368 NO 369 NO 370 NO 371 NO 372 NO 373 NO

	374 375 376 377	RTP mean data rate transmitted R2H (A-B) RTP mean data rate received H2R (B-A) RTP mean data rate transmitted H2R (B-A) RTP mean data rate received R2H (A-B) RTP packets lost R2H (A-B) RTP packets lost H2R (B-A) RTP packet lost ratio R2H (A-B) RTP packet lost ratio H2R (B-A) RTP round-trip delay (RTD RHR A-B-A) RTP round-trip delay (RTD HRH B-A-B) RTP one-way-delay (OWD R2H A-B) RTP one-way-delay (OWD H2R B-A)	374 YES 375 YES 376 YES 377 YES	374 YES 375 YES 376 YES 377 YES	374 TBC 375 TBC 376 TBC 377 TBC	374 NO 375 NO 376 NO 377 NO

3.5 MIoT SERVICE QoS Parameters

QoS Aspects	MIoT QoS Parameters					
	GRQ Id	KPI description	Parameter covered by Active Testing probes related	Parameter covered by Active Testing Smartphone related MIoT parameters are not supported by Smart phones due to MIot device nature (i.e. this requires specific MIoT device).	Parameter covered by Passive Monitoring Networ Related + Protocol involved	Parameter covered by Passive Monitoring Applet/Crowd Related + Protocol involved
MIoT service availability & network connectivity	101	PS location update success ratio	101YES	101 NO	101TBC	101 YES
	102	PS location update delay	102 YES	102 NO	102 TBC	102 NO
	105	Default EPS bearer context activation success ratio	105 YES	105 NO	105 TBC	105 NO (1)
	106	Default EPS bearer context activation time	106 YES	106 NO	106 TBC	106 NO
	400	LPWA access type	400 YES	400 NO	400 TBC	400 NO (2)
	401	Attach type with additional update type	401 YES	401 NO	401 TBC	401 NO (2)
	402	Detach type	402 YES	402 NO	402 TBC	402 NO
	403	Detach delay	403 YES	403 NO	403 TBC	403 NO
	404	PDN type	404 YES	404 NO	404 TBC	404 YES
	405	Serving PLMN rate control (NB-IoT)	405 YES	405 NO	405 TBC	405 NO
	406	APN rate control (NB-IoT)	406 YES	406 NO	406 TBC	406 NO
	407	APN rate control for exception data (NB-IoT)	407 YES	407 NO	407 TBC	407 NO
	408	NAS signalling low priority (LTE-M)	408 YES	408 NO	408 TBC	408 NO
	409	Non-IP link MTU size (NB-IoT)	409 YES	409 NO	409 TBC	409 NO
	410	IPv4 link MTU size (NB-IoT)	410 YES	410 NO	410 TBC	410 NO
	411		411 YES	411 NO	411 TBC	411 NO
	412		412 YES	412 NO	412 TBC	412 NO
	413		413 YES	413 NO	413 TBC	413 NO
	414		414 YES	414 NO	414 TBC	414 NO
	150		150 YES	150 NO	150 TBC	150 NO
	151		151 YES	151 NO	151 TBC	151 NO

	152 153 154 155 156 157 158	Half-duplex (FDD) RSRP CE Mode (LTE-M) CE Level (NB-IoT) PING Host PING packet loss ratio PING round trip time Number of packets received Number of packets sent PING interval PING packet payload size Sum of bytes received Sum of bytes sent	152 YES 153 YES 154 YES 155 YES 156 YES 157 YES 158 YES	152 NO 153 NO 154 NO 155 NO 156 NO 157 NO 158 NO	152 TBC 153 TBC 154 TBC 155 TBC 156 TBC 157 TBC 158 TBC	152 NO 153 NO 154 NO 155 NO 156 NO 157 NO 158 NO
MIoT Power saving & eDRX	420 421 422 423 424 425 426 427 428 431 432 433 434 435 436 437 438	PSM enable / disable PSM status NW-accepted PSM TAU period UE-requested (T3412 extended) PSM TAU period NW-accepted (T3412 extended) PSM UE active timer UE-requested (T3324) PSM UE active timer NW-accepted (T3324) PSM Hibernate ratio NW-accepted PSM MT data transfer success ratio PSM SMS MT accessibility eDRX UE-config enable / disable eDRX status NW-accepted eDRX cycle UE- requested eDRX cycle NW-accepted eDRX PTW UE- requested eDRX PTW NW-accepted eDRX MT data transfer success ratio eDRX SMS MT accessibility	420 YES 421 YES 422 YES 423 YES 424 YES 425 YES 426 YES 427 YES 428 YES 431 YES 432 YES 433 YES 434 YES 435 YES 436 YES 437 YES 438 YES	420 NO 421 NO 422 NO 423 NO 424 NO 425 NO 426 NO 427 NO 428 NO 431 NO 432 NO 433 NO 434 NO 435 NO 436 NO 437 NO 438 NO	420 TBC 421 TBC 422 TBC 423 TBC 424 TBC 425 TBC 426 TBC 427 TBC 428 TBC 431 TBC 432 TBC 433 TBC 434 TBC 435 TBC 436 TBC 437 TBC 438 TBC	420 NO 421 NO 422 NO 423 NO 424 NO 425 NO 426 NO 427 NO 428 NO 431 NO 432 NO 433 NO 434 NO 435 NO 436 NO 437 NO 438 NO
MIoT service integrity and retainability	109 440 441 442 443 444 445 446	Default EPS bearer context cut-off ratio MO TCP data transfer success ratio MO TCP data transfer payload size MO TCP data transfer throughput MO TCP data transfer duration	109 YES 440 YES 441 YES 442 YES 443 YES 444 YES 445 YES 446 YES	109 NO 440 NO 441 NO 442 NO 443 NO 444 NO 445 NO 446 NO	109 TBC 440 TBC 441 TBC 442 TBC 443 TBC 444 TBC 445 TBC 446 TBC	109 NO 440 NO 441 NO 442 NO 443 NO 444 NO 445 NO 446 NO

	447	MO TCP data RTT	447 YES	447 NO	447 TBC	447 NO
	448	MO UDP data transfer success ratio	448 YES	448 NO	448 TBC	448 NO
	449		449 YES	449 NO	449 TBC	449 NO
	450	MO UDP data transfer payload size	450 YES	450 NO	450 TBC	450 NO
	451		451 YES	451 NO	451 TBC	451 NO
	452	MO UDP data transfer throughput	452 YES	452 NO	452 TBC	452 NO
	453		453 YES	453 NO	453 TBC	453 NO
	454	MO UDP data transfer duration	454 YES	454 NO	454 TBC	454 NO
	455	MO UDP data RTT	455 YES	455 NO	455 TBC	455 NO
	456	MT TCP data transfer success ratio	456 YES	456 NO	456 TBC	456 NO
	457		457 YES	457 NO	457 TBC	457 NO
	460	MT TCP data transfer payload size	460 YES	460 NO	460 TBC	460 NO
	461		461 YES	461 NO	461 TBC	461 NO
	462	MT TCP data transfer throughput	462 YES	462 NO	462 TBC	462 NO
	463	MT TCP data transfer duration	463 YES	463 NO	463 TBC	463 NO
	464	MT UDP data transfer success ratio	464 YES	464 NO	464 TBC	464 NO
	465		465 YES	465 NO	465 TBC	465 NO
	466	MT UDP data transfer payload size	466 YES	466 NO	466 TBC	466 NO
	467		467 YES	467 NO	467 TBC	467 NO
		MT UDP data transfer throughput				
		MT UDP data transfer duration				
		MO Non-IP data transfer success ratio				
		MO Non-IP data transfer payload size				
		MO Non-IP data transfer throughput				
		MO Non-IP data transfer duration				
		MT Non-IP data transfer success ratio				
		MT Non-IP data transfer payload size				
		MT Non-IP data transfer throughput				
		MT Non-IP data transfer duration				
MIoT SMS	471	SMSinMME-MO accessibility	471YES	471. NO	471. TBC	471. NO
	472	SMSinMME-MO access delay	472 YES	472 . NO	472 . TBC	472 . NO
	473	SMSinMME-MT accessibility	473 YES	473 . NO	473 . TBC	473 . NO
	474	SMSinMME-MT access delay	474 YES	474 . NO	474 . TBC	474 . NO
Note 1: An EPS attach is applied to QoS parameters 101 and 102.						

1. The Applet does observe the attempt but there is no failure information to support the derivation of a ratio

2. Feature not yet developed by Wadaro

3.6 IPX SERVICE QoS Parameters – TO BE COMPLETED

QoS Aspects	QoS Parameters
	Jitter Packet Loss Latency

4 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.

4.1 End-To-End Active Testing and Monitoring

4.1.1 General Information

4.1.1.1 4.1.1 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.

4.1.1.2 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)

4.1.1.3 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.

4.1.1.4 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.

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.

GRQ test code

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

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

4.1.2 GSM/GPRS and UMTS Test Specification

GRQ Test Code	Parameter	How to Measure	Test Specifics
CIRCUIT-SWITCHED			
1AH, 1AV	LU update success ratio	Force a location update via the modem, if there is steering the final result has to be the last location update of a maximum of five (5) attempts.	
2AH, 2AV	LU delay	Force a location update via the modem, if there is steering the delay of the last location update has to be taken into account. It is important that before starting, the simcards are registered on a different LAC in order to have a full location update.	
3AH, 3AV	NER-MO (Network Effectiveness Ratio on Mobile Originated calls in the visited network)	Generate a call from the probe located in the VPMN to a simcard of the probe located in the HPMN. The test is successful if the probe on the VPMN detects a ringing signal for the generated call.	
4AH, 4AV	NER-MT (Network Effectiveness Ratio on Mobile Terminated calls in the visited network)	Generate a call with a simcard from the probe located in the HPMN to a simcard on the probe located in the VPMN. The test is successful if the probe on the HPMN detects a ringing signal for the generated call.	
5AH, 5AV	PDD-MO (Post Dialling Delay)	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN. The delay is the time between the point where the call has been initiated and the ringing has been detected on the VPMN.	
6AH, 6AV	PDD-MT (Post Dialling Delay)	Generate a call with a simcard from the probe located in the HPMN to a simcard on the probe	

GRQ Test Code	Parameter	How to Measure	Test Specifics
		located in the VPMN. The delay is the time between the point where the call has been initiated and the ringing has been detected on the HPMN.	
7AH, 7AV	CSSR-MO (Call Setup Success Ratio on Mobile Originated calls in the visited network)	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN. The test is successful if the probe on the HPMN detects the ringing and picked up the call.	
8AH, 8AV	CSSR-MT (Call Setup Success Ratio on Mobile Terminated calls in the visited network)	Generate a call with a simcard from the probe located in the HPMN to a simcard on the probe located in the VPMN. The test is successful if the probe on the VPMN detects the ringing and picked up the call.	
9AH, 9AV	REL (ISUPv2 signalling transparency)	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN. At the end of the call, check if the release code is the same on both sides.	
10AH, 10AV	OCN and RDN (ISUPv2 signalling transparency)	Generate a call with a simcard from the probe located in the HPMN to a simcard on the probe located in the VPMN. Forward this call to the HPMN and check if the OCN and RDN is correct.	
11AH, 11AV	CCR (Call Completion Rate Circuit)	Generate a call with a simcard on the probe located in the VPMN to a simcard from the probe located in the HPMN. Answer the call and after a time hang up the call again. If the call has not been interrupted, the call is successful.	Reasonable radio level required: RxLev > -70dbm.

GRQ Test Code	Parameter	How to Measure	Test Specifics
		Recommended duration: 2 minutes.	
12AH , 12AV	ALOC	N/A	
13AH , 13AV	CLI transparency	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN. Check at the HPMN if the CLI is in a dialable format to call back the A-party	
14AH , 14AV	SpQ (Speech Quality)	Generate a call with a simcard from the probe located in the VPMN to a simcard on the probe located in the HPMN and answer the call. Uplink voice quality: play a standard file in the VPMN and record this file in the HPMN and calculate the voice quality. Downlink voice quality: play a standard file in the HPMN and record this file in the VPMN and calculate the voice quality. Recommended duration: 2 minutes. If the sample is played/analysed multiple times, the end-result of the test is the average of the individual voice quality assessments. If the sample is played/analysed multiple times, the end-result of the test is the average of the individual voice quality assessments.	Reasonable radio level required: RxLev > -70dbm.
SMS			
21AH , 21AV	Service Accessibility SMS MO (SA SMS MO)	Send and SMS from a subscriber from the HPMN located on the VPLMN to a subscriber from the HPMN located in the HPMN using the HPMN SMSC, if the positive	

GRQ Test Code	Parameter	How to Measure	Test Specifics
		acknowledgement of the SMSC is received the tests is OK.	
22AH, 22AV	Service Accessibility SMS MT (SA SMS MT)	Send and SMS from a subscriber from the HPMN located on the HPMN to a subscriber from the HPMN located in the VPLMN using the HPMN SMSC, if the SMS is received the test is OK.	Reasonable radio level required: RxLev > -70dbm.
23AH, 23AV	Access Delay SMS MO (AD SMS-MO)	Send and SMS from a subscriber from the HPMN located on the VPLMN to a subscriber from the HPMN located in the HPMN using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification from the SMSC that the message has been sent.	
24AH, 24AV	Access Delay SMS MT (AD SMS-MT)	Send an SMS from a subscriber from the HPMN located on the HPMN to a subscriber from the HPMN located in the VPLMN using the HPMN SMSC. Measure the time between the notification from the SMSC that the message has been sent and the notification on the B-party that the message has arrived.	Reasonable radio level required: RxLev > -70dbm.
25AH, 25AV	End-to-End Delivery Time for SMS-MO	Send an SMS from a subscriber from the HPMN located on the VPLMN to a subscriber from the HPMN located in the HPMN using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification on the B-party that the message has arrived.	Reasonable radio level required: RxLev > -70dbm.
26AH, 26AV	End-to-End Delivery Time for SMS-MT	Send an SMS from a subscriber from the HPMN located on the HPMN to a subscriber from the HPMN located in the VPLMN using	Reasonable radio level required: RxLev > -70dbm.

GRQ Test Code	Parameter	How to Measure	Test Specifics
		the HPMN SMSC. Measure the time between sending the SMS and receiving the notification on the B-party that the message has arrived.	
PACKET-SWITCHED			
31AH, 31AV	Packet Switched LU Success Ratio (PS LU – SR)	Start manually a GPRS attach on the VPLMN, after the GSM location has been performed. If the GPRS attached is confirmed, the test is OK.	
32AH, 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, 33AV	Service accessibility for PSD (PDP-context activation success ratio)	Start the PDP context activation after the GPRS attach on the VPLMN. If the PDP context has been confirmed, the test is successful	
34AH, 34AV	Set-up Delay (ST PSD)	Start the PDP context activation after the GPRS attach on the VPLMN. Measure the time between the start and the acknowledgement of the PDP context activation.	
35AH, 35AV	PDP Context Cut-Off Ratio (session Stability measured at PDP context or PS level)	Start a PDP context, keep it open during a certain time and close it again. If the session is still open the test is OK.	Reasonable radio level required: RxLev > -70dbm.
36AH, 36AV	Average PDP Context Session Time (per APN)	N/A	

GRQ Test Code	Parameter	How to Measure	Test Specifics
37AH, 37AV	Throughput (Kbits/sec)	Start downloading a reference file and measure the time from the start of the download till the end of file detection.	Reasonable radio level required: RxLev > -70dbm.
38AH, 38AV	Goodput (Kbits/sec)	Start downloading a reference file and measure the time from the start of the download till the end of file detection and count the used bytes	Reasonable radio level required: RxLev > -70dbm.
39AH, 39AV	Roundtrip time	Measure the time between sending a TCP packet and receiving the acknowledgement of the reception.	
40AH, 40AV	Packet loss	Count the TCP packets sent and count the TCP packets received for a file transfer.	Reasonable radio level required: RxLev > -70dbm.

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.

4.1.3 Voice CSFB

The CSFB feature is enabled at VPMN.

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

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

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

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

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

8AH, 8AV	CSSR-MT (Call Setup Success Ratio on Mobile Terminated calls in the visited network)	Generate a MT call with a SIM card from the probe located in the HPMN to a SIM card from the probe located in the VPMN. The test is successful if the probe on the VPMN detects the ringing and picks up the call.	GSM or UMTS power level: RxLev > -70dbm

4.1.4 SMSoSGs

VPMN supports and enables SMSoSGs.

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

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

GRQ Test Code	Parameter	How to Measure	Test specifics
101AH, 101AV	PS location update success ratio	Configure the UE in CS/PS mode and initiate a combined location update (EPS/IMSI attach) in VPMN. Observe whether the network type indicator is LTE. If there is steering the final result shall be the last location update of maximum five (5) attempts.	
102AH, 102AV	PS location update delay	Configure the UE in CS/PS mode and initiate a combined location update (EPS/IMSI attach) in VPMN. In order to ensure a full location update, the USIM was registered on a different TAC and LAC before testing. Measure the time between the initiation of attach and LTE network type indicated. If there is steering the delay of the last location update is taken into account.	
21AH, 21AV	Service Accessibility SMS MO (SA SMS MO)	Send an SMS from R-party to H-party, using the HPMN SMSC, Observe if the positive acknowledgement of the SMSC is received.	
22AH, 22AV	Service Accessibility SMS MT (SA SMS MT)	Send an SMS from H-party to R-party, using the HPMN SMSC. Observe if the positive acknowledgement of the SMSC is received.	.

23AH, 23AV	Access Delay SMS MO (AD SMS-MO)	Send an SMS from R-party to H-party, using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification from the SMSC that the message has been sent.	
24AH, 24AV	Access Delay SMS MT (AD SMS-MT)	Send an SMS from H-party to R-party, using the HPMN SMSC. Measure the time between the notification from the SMSC that the message has been sent and the notification at the R-party that indicates that the message has arrived.	
25AH, 25AV	End-to-End Delivery Time for SMS-MO	Send an SMS from R-party to H-party, using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification at the H-party that the message has arrived.	
26AH, 26AV	End-to-End Delivery Time for SMS-MT	Send an SMS from H-party to R-party, using the HPMN SMSC. Measure the time between sending the SMS and receiving the notification on the R-party that the message has arrived.	

4.1.5 LTE Data

GRQ Test Code	Parameter	How to Measure	Test specifics
101AH, 101AV	PS location update success ratio	Configure the UE in PS mode and initiate a location update (EPS attach) in VPMN. Observe whether the network type indicator is LTE. If there is steering the final result shall be the last location update of maximum five (5) attempts.	
102AH, 102AV	PS location update delay	Configure the UE in PS mode and initiate a combined location update (EPS attach) in VPMN. In order to ensure a full location update, the USIM was registered on a different TAC before testing. Measure the time between the initiation of attach and LTE network type indicated. If there is	

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

133bAH, 133bAV	FTP upload session success ratio	Initiate in VPMN to upload a FTP binary file to a FTP server. Observe whether the complete file is uploaded.	
134aAH, 134aAV	FTP download session time	Initiate in VPMN to download a FTP binary file from a FTP server. Measure the time between the initiation and the complete file content downloaded.	
134bAH, 134bAV	FTP upload session time	Initiate in VPMN to upload a FTP binary file to a FTP server. Measure the time between the initiation and the complete file content uploaded.	
135aAH, 135aAV	FTP download mean data rate	Initiate in VPMN to download a FTP binary file from a FTP server. Measure the time between the first data packet received containing the file contents and the last data packet received containing the file content.	
135bAH, 135bAV	FTP upload mean data rate	Initiate in VPMN to upload a FTP binary file to a FTP server. Measure the time between the first data packet sent containing the file contents and the last data packet sent containing the file content.	
136aAH, 136aAV	FTP download data transfer success ratio	Initiate in VPMN to download a FTP binary file from a FTP server. Observe whether all data packets containing the file content (from the first one to the last one) is successfully received.	
136bAH, 136bAV	FTP upload data transfer success ratio	Initiate in VPMN to upload a FTP binary file to a FTP server. Observe whether all data packets containing the file content (from the first one to the last one) is successfully sent.	
137aAH, 137aAV	FTP download data capacity	Initiate in VPMN multiple TCP/IP connections to download one or multiple FTP files from one or multiple FTP servers in parallel. Observe the max. capacity of the data pipe is reached.	
137bAH, 137bAV	FTP upload data capacity	Initiate in VPMN multiple TCP/IP connections to upload one or multiple FTP files to one or multiple FTP servers in	

		parallel. Observe the max. capacity of the data pipe is reached.	
141AH, 141AV	HTTP / HTTPS IP service access success ratio	Initiate in VPMN to download an HTTP / HTTPS Web page. Observe whether downloading the Web page contents starts.	
142AH, 142AV	HTTP / HTTPS IP service setup time	Initiate in VPMN to download an HTTP / HTTPS Web page. Measure the time between the initiation and the start of downloading the Web page contents.	
143AH, 143AV	HTTP / HTTPS session success ratio	Initiate in VPMN to download an HTTP / HTTPS Web page. Observe whether the complete Web page contents are downloaded.	
144AH, 144AV	HTTP / HTTPS session time	Initiate in VPMN to download an HTTP / HTTPS Web page. Measure the time between the initiation and the complete Web page contents downloaded.	
145AH, 145AV	HTTP / HTTPS mean data rate	Initiate in VPMN to download an HTTP / HTTPS Web page. Measure the time between the first data packet received containing the Web page content and the last data packet received containing the Web page content.	
146AH, 146AV	HTTP / HTTPS data transfer success ratio	Initiate in VPMN to download an HTTP / HTTPS Web page. Observe whether all data packets containing the Web page content (from the first one to the last one) is successfully received.	
147AH, 147AV	HTTP / HTTPS content compression ratio	Initiate in VPMN to download an HTTP / HTTPS Web page. Measure the entire size of the Web page contents received and compare with the original HTTP / HTTPS contents sent.	The size of the original Web page content sent is known.
148AH, 148AV	HTTP / HTTPS download data capacity	Initiate in VPMN multiple TCP/IP connections to download one or multiple Web pages from one or multiple HTTP / HTTPS servers in parallel. Observe the max. capacity of the data pipe is reached.	

151AH, 151AV	PING packet loss ratio	From VPMN send an ICMP echo request with a certain number of PING packets to be sent as parameter. Observe whether ICMP echo reply is received.	
152AH, 152AV	PING round trip time	From VPMN send an ICMP echo request with a certain number of PING packets to be sent as parameter. Measure the time between ICMP echo sent and ICMP echo reply received.	

4.1.6 VoLTE / ViLTE and SMSoIP test specification

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

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

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

4.1.6.1 VoLTE

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

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

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

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
201AH, 201AV	IMS Registration success ratio	Initiate an IMS registration in VPMN for IMS multimedia telephony service (VoLTE) at test probe. Observe whether the registration is successfully completed by receiving NOTIFY for registration event	

		package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to TS 34.229-1, C.2 [13]). To ensure a full IMS registration, initiate an (UE) deregistration if it is already IMS registered.	
202AH, 202AV	IMS Registration time	Initiate an IMS registration in VPMN for IMS multimedia telephony service (VoLTE). Measure the time between the test probe sending the initial REGISTER request for IMS registration and receiving NOTIFY for registration event package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to 3GPP TS 34.229-1, C.2 [13]). To ensure a full IMS registration, initiate an (UE) deregistration if it is already IMS registered.	
203AH, 203AV	Voice MO accessibility	Initial a VoLTE MO call from a test probe at VPMN to HPMN. The call is successful if 180 Ringing is received at VPMN. The test probe at HPMN shall send 180 Ringing unreliably i.e. not containing "Require: 100rel".	
204AH, 204AV	Voice MT accessibility	Initial a VoLTE MT call from HPMN to a test probe at VPMN. The call is successful if 180 Ringing is received at HPMN from the test probe at VPMN. The test probe at VPMN shall send 180 Ringing unreliably, i.e. not containing "Require: 100rel".	
205AH, 205AV	Voice MO session setup time	Make a successful VoLTE MO call from a test probe at VPMN to HPMN. Measure the time between sending INVITE and receiving 200 OK (INVITE) (ref. to 3GPP TS 34.229-1, C.21 [13]). The time for the HPMN user accepting the incoming call is excluded in the calculation.	
206AH, 206AV	Voice MT session setup time	Make a successful VoLTE MT call from HPMN to a test probe at VPMN. Measure the time between receiving INVITE and receiving ACK for 200 OK (INVITE) (ref. to 3GPP TS 34.229-1, C.11 [13]). The time for	

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

		audio reference file: 8 - 32s. The sample is played/analysed. The end-result of the test is a pre-aggregation of the measured MOS-LQO values to *one value per call*.	
215AH, 215AV	SpQ on call basis at H-party	Make a successful VoLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the probe at VPMN and record this file in the probe at HPMN and calculate the voice quality per POLQA as specified in ITU-T P.863 [16]. Recommended duration of the audio reference file: 8 - 32s. The sample is played/analysed. The end-result of the test is a pre-aggregation of the measured MOS-LQO values to *one value per call*.	
216AH, 216AV	SpQ R-factor at R-party	Make a successful VoLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the test probe at HPMN and record this file in the test probe at VPMN and calculate the voice quality. The sample is played/analysed. Recommended duration of the audio reference file: 8 - 32s. The end-result of the test is the R-factor LQ (Listening Quality) calculated per ITU-T G.107 [17].	
217AH, 217AV	SpQ R-factor at H-party	Make a successful VoLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the probe at VPMN and record this file in the probe at HPMN and calculate the voice quality. The sample is played/analysed. Recommended duration of the audio reference file: 8 - 32s. The end-result of the test is the R-factor LQ (Listening Quality) calculated per ITU-T G.107 [17].	
230AH, 230AV	SRVCC MO success ratio	Make a VoLTE MO call from a test probe at VPMN to a test probe at HPMN and trigger an SRVCC PS to CS event at VPMN. The test is successful if a TMSI REALLOCATION COMMAND message is received by the test probe in the target 2G/3G cell of VPMN, and - In case of SRVCC pre-alerting phase, CS call establishment is continued,	

		CC_ALERTING and CONNECT are received (ref. to 3GPP TS 36.523-1, 13.4.3.7 [15]). - In case of SRVCC alerting phase, CS call establishment is continued, CONNECT is received (ref. to 3GPP TS 36.523-1, 13.4.3.21 [15]). The voice channel is through connected in the target 2G/3G cell of VPMN. - In case of SRVCC mid-call phase, the voice channel is through connected in the target 2G/3G cell of VPMN.	
231AH, 231AV	SRVCC MT success ratio	Make a VoLTE MT call from HPMN to a test probe at VPMN and trigger an SRVCC PS to CS event at VPMN. The test is successful if a TMSI REALLOCATION COMMAND message is received by the test probe in the target 2G/3G cell of VPMN, and - In case of SRVCC pre-alerting or alerting phase, CS call establishment is continued, CONNECT ACKNOWLEDGE is received (ref. to 3GPP TS 36.523-1, 13.4.3.10 [15]). The voice channel is through connected in the target 2G/3G cell of VPMN. - In case of SRVCC mid-call phase, the voice channel is through connected in the target 2G/3G cell of VPMN.	
232AH, 232AV	SRVCC MO success time	Make a VoLTE MO call from a test probe at VPMN to a test probe at HPMN and trigger an SRVCC PS to CS event at VPMN. - In case of SRVCC pre-alerting or alerting phase, measure the time between receiving MobilityFromEUTRACommand in the E-UTRAN cell and receiving CONNECT in the target 2G/3G cell (ref. to 3GPP TS 36.523-1, 13.4.3.7 [15]). - In case of SRVCC mid-call phase, two test methods are applied.	

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

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
Network quality parameters (ref. to 3GPP TS 36.508 [14])			
240AH, 240AV	Default EPS bearer context activation success ratio	The test probe initiates an EPS attach in VPMN and create the PDN connection to the IMS well-known APN (ref. to GSMA IR.88, 6.3 [10]). The test is successful if the default bearer with QCI 5 is established.	
241AH, 241AV	Default EPS bearer context activation time	The test probe initiates an EPS attach in VPMN and create the PDN connection to the IMS well-known APN. Measure the time between sending ATTACH REQUEST and sending ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT piggybacked on ATTACH COMPLETE (ref. to 3GPP TS 36.508, 4.5.2 [14]).	
242AH, 242AV, 243AH, 243AV, 244AH, 244AV	Default EPS bearer QCI, Default EPS bearer UL AMBR, Default EPS bearer DL AMBR	Read ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST (NAS): QCI, AMBR Note: AMBR values for a non-GBR bearer are applied to across all non-GBR bearers for the IMS “well known” APN	
245AH, 245AV	Dedicated EPS bearer context activation success ratio (audio)	By initiating an MO call in VPMN, the test probe creates the dedicated EPS bearer context for the voice media. The test is successful if the dedicated bearer with QCI 1 is established.	
246AH, 246AV	Dedicated EPS bearer context activation time (audio)	Create a dedicated EPS bearer context for the voice media and measure the time between receiving ACTIVATE DEDICATED EPS BEARER CONTEXT REQUEST and sending ACTIVATE DEDICATED EPS BEARER CONTEXT ACCEPT (ref. to 3GPP TS 36.508, 4.5A.6 [14]).	
247AH, 247AV, 248AH, 248AV, 249AH,	Dedicated EPS bearer QCI, Dedicated EPS bearer UL GBR,	Read from *EPS quality of service* information element in ACTIVATE DEDICATED EPS BEARER CONTEXT REQUEST (NAS):	

249AV	Dedicated EPS bearer DL GBR	QCI, Guaranteed bit rate for uplink and Guaranteed bit rate for downlink	
250AH, 250AV	IP data volume received on QCI5 bearer at R-party	Count the accumulated data received in a certain period at the IP ports (TCP and UDP) on the QCI5 EPS AM bearer in the test probe at VPMN	
251AH, 251AV	IP data volume transmitted on QCI5 bearer at R-party	Count the accumulated data transmitted in a certain period at the IP ports (TCP and UDP) on the QCI5 EPS AM bearer in the test probe at VPMN	
252AH, 252AV	IP data volume received on QCI5 bearer at H-party	Count the accumulated data received in a certain period at the IP ports (TCP and UDP) on the QCI5 EPS AM bearer in the test probe at HPMN	
253AH, 253AV	IP data volume transmitted on QCI1 bearer at H-party	Count the accumulated data transmitted in a certain period at the IP ports (TCP and UDP) on the QCI5 EPS AM bearer in the test probe at HPMN	
254AH, 254AV	IP data volume received on QCI1 bearer at R-party	Count the accumulated data received in a certain period at the IP port (UDP) on the QCI1 EPS UM bearer in the test probe at VPMN	
255AH, 255AV	IP data volume transmitted on QCI1 bearer at R-party	Count the accumulated data transmitted in a certain period at the IP port (UDP) on the QCI1 EPS UM bearer in the test probe at VPMN	
256AH, 256AV	IP data volume received on QCI1 bearer at H-party	Count the accumulated data received in a certain period at the IP port (UDP) on the QCI1 EPS UM bearer in the test probe at HPMN	
257AH, 257AV	IP data volume transmitted on QCI1 bearer at H-party	Count the accumulated data transmitted in a certain period at the IP port (UDP) on the QCI1 EPS UM bearer in the test at HPMN	
RTP transport quality parameters (ref. to IR.42 [1])			
260AH, 260AV, 261AH,	RTP max packet delay variation R2H, RTP max packet delay variation H2R,	Make the test probe at VPMN an MO call, analyse the RTP streams at the both ends (for a duration of the audio reference file in 8 - 32s) and calculate the max. and mean packet delay variations (ref. to GSMA IR.42	

261AV, 262AH, 262AV, 263AH, 263AV	RTP mean packet delay variation R2H, RTP mean packet delay variation H2R	[1]) in the R2H direction at HPMN, and in the H2R direction at VPMN	
264AH, 264AV, 265AH, 265AV	RTP mean interarrival jitter of incoming streaming R2H RTP mean interarrival jitter of incoming streaming H2R	Make the test at VPMN an MO call, analyse the RTP streams at the both ends (for a duration of the audio reference file in 8 - 32s) and calculate the RTP mean interarrival jitter of incoming streaming (ref. to GSMA IR.42 [1]) in the R2H direction at HPMN, and in the H2R direction at VPMN	
266AH, 266AV, 267AH, 267AV	RTP mean data rate transmitted R2H (audio) RTP mean data rate received H2R (audio)	Make the test probe at VPMN an MO call, count the total data transmitted and received respectively in a certain period, and calculate the average data rate (ref. to IR.42 [1]) transmitted and received of the probe at VPMN at that period.	
268AH, 268AV, 269AH, 269AV	RTP mean data rate transmitted H2R (audio) RTP mean data rate received R2H (audio)	Make a VoLTE MT call from HPMN to a test probe at VPMN, count the total data transmitted and received respectively at the VoLTE test probe of HPMN in a certain period and calculate the average data rate (ref. to IR.42 [1]) transmitted and received of the probe at HPMN at that period.	
270AH, 270AV, 271AH, 271AV	RTP packets lost R2H RTP packets lost H2R	Make the test at VPMN an MO call to a test probe at HPMN, count the total number of the missing RTP sequence numbers in a certain period at the home probe of HPMN and at the roaming probe of VPMN.	
272AH, 272AV, 273AH, 273AV	RTP packets lost ratio R2H RTP packets lost ratio H2R	Make the test probe at VPMN an MO call to a test probe at HPMN, within a certain period: - Count the total number of the missing RTP sequence numbers - Count the total number of RTP packets received	

		- Calculate the portion of lost packets (ref. to GSMA IR.42 [1]) at the roaming probe of VPMN and at the home probe of HPMN.	
274AH, 274AV, 275AH, 275AV	RTP round-trip delay (RHR) RTP round-trip delay (HRH)	Make the test probe at VPMN an MO call to a test probe at HPMN, within a certain period calculate the average transfer time of RTP packets (ref. to GSMA IR.42 [1]) - from the roaming probe of VPMN to the home probe of HPMN and looped back to the roaming probe, - from the home probe of HPMN to the roaming probe of VPMN and looped back to the home probe	

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

4.1.6.2 ViLTE

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

- GSMA IR.92 [11], annex C.3, with the exception that the parameter “Voice and/or Video over LTE allowed while roaming” is set to “voice over LTE allowed while roaming”.
- GSMA IR.94 [12], annex C.3, with the exception that the parameter “Voice and/or Video over LTE allowed while roaming” is set to “voice and Video over LTE allowed while roaming”.

The test probe is attached to the LTE network.

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

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

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
301AH, 301AV	IMS Registration success ratio (ViLTE)	Initiate an IMS registration in VPMN for IMS multimedia conversational video service (ViLTE) at test probe. Observe whether the registration is successful	

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

		receiving ACK for 200 OK (INVITE) (ref. to 3GPP TS 34.229-1, C.26 [13]). The time for the VPMN user accepting the incoming call is excluded in the calculation.	
307AH, 307AV	ViLTE MO session setup ratio	Initial a VoLTE MO call from a test probe at VPMN to HPMN. The session is successfully established if 200 OK (INVITE) is received at VPMN.	
308AH, 308AV	ViLTE MT session setup ratio	Initial a VoLTE MT call from HPMN to a test probe at VPMN. The call is successfully established if ACK for 200 OK (INVITE) is received by the test probe at VPMN.	
311AH, 311AV	ViLTE MO session duration	Make a successful ViLTE MO call from a test probe at VPMN to HPMN. Measure the time at the test probe of VPMN between receiving 200 OK (INVITE) and receiving 200 OK (BYE) – using the MO call release in the test (ref. to 3GPP TS 34.229-1, C.25, C.32 [13]).	
312AH, 312AV	ViLTE MT session duration	Make a successful ViLTE MT call from HPMN to a test probe at VPMN. Measure the time at the test probe of HPMN between receiving ACK for 200 OK (INVITE) and receiving BYE – using the MT call release in the test (ref. to 3GPP TS 34.229-1, C.26 [13]).	
313AH, 313AV	OIP transparency MO (ViLTE)	Make a successful ViLTE MO call from a test probe at VPMN to HPMN and check at the test probe of HPMN if the OIP results in a dial able format (ref. to GSMA IR.92, 2.3.12 [11]) to call back the call originator at VPMN.	
310AH, 310AV	OIP transparency MT (ViLTE)	Make a successful ViLTE MT call from HPMN to a test probe at VPMN and check at the test probe of VPMN if the OIP results in a dial able format to call back the call originator at HPMN.	
314AH, 314AV	SpQ on sample basis at R-party (ViLTE)	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the test probe at HPMN and record this file in the	

		test probe at VPMN and calculate the voice quality per POLQA as specified in ITU-T P.863 [1]. Recommended duration of the audio reference file: 8 - 32s. The selected samples are played/analysed. The end-result of the test is an average value of the measured MOS-LQO values *per sample*.	
315AH, 315AV	SpQ on sample basis at H-party (ViLTE)	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the probe at VPMN and record this file in the probe at HPMN and calculate the voice quality per POLQA as specified in ITU-T P.863 [1]. Recommended duration of the audio reference file: 8 - 32s. The selected samples are played/analysed. The end-result of the test is an average value of the measured MOS-LQO values *per sample*.	
216AH, 216AV	SpQ R-factor at R-party	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the test probe at HPMN and record this file in the test probe at VPMN and calculate the voice quality. The samples are played/analysed. Recommended duration of the audio reference file: 8 - 32s. The end-result of the test is the R-factor LQ (Listening Quality) calculated per ITU-T G.107 [17].	
217AH, 217AV	SpQ R-factor at H-party	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the probe at VPMN and record this file in the probe at HPMN and calculate the voice quality. The samples are played/analysed. Recommended duration of the audio reference file: 8 - 32s. The end-result of the test is the R-factor LQ (Listening Quality) calculated per ITU-T G.107 [17].	
318AH, 318AV	Video quality on sample basis at R-party	Make a successful ViLTE MO call from a test probe at VPMN to a test probe at HPMN. Play a standard file in the test probe at HPMN and record this file in the test probe at VPMN and calculate the video quality per PEVQ as specified in ITU-T J.247 [18]. The selected samples are	

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

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

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
Network quality parameters (ref. to 3GPP TS 36.508 [14])			
345AH, 345AV	Dedicated EPS bearer context activation success ratio (voice & video)	By initiating a ViLTE MO session in VPMN, the test probe creates the dedicated EPS bearer context for the voice and video media. The test is successful if the dedicated bearer is established with QCI1 and QCI2 or QCI8 or QCI9.	
346AH, 346AV	Dedicated EPS bearer context activation time (voice & video)	Create a dedicated EPS bearer context for the voice and video media and measure the time between receiving ACTIVATE DEDICATED EPS BEARER CONTEXT REQUEST and sending ACTIVATE DEDICATED EPS BEARER CONTEXT ACCEPT (ref. to 3GPP TS 36.508, 4.5A.8 [14]).	
347AH, 347AV, 348AH,	Dedicated EPS bearer QCI,	Read from EPS quality of service information element in ACTIVATE DEDICATED EPS BEARER CONTEXT REQUEST (NAS): QCI, guaranteed bit rate	

348AV, 349AH, 349AV, 343AH, 343AV, 344AH, 344AV	Dedicated EPS bearer UL GBR, Dedicated EPS bearer DL GBR Dedicated EPS bearer UL AMBR, Dedicated EPS bearer DL AMBR	for uplink and Guaranteed bit rate for downlink (for QCI2) Read from ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST (NAS): QCI, AMBR (for QCI8 or QCI9) Note: AMBR values for a non-GBR bearer are applied to across all non GBR bearers for the IMS “well known” APN	
354AH, 354AV	IP data volume received on QCI2/8/9 bearer at R-party	Count the accumulated data received in a certain period at the test probe of VPMN at the IP port (UDP) on the EPS bearer - QCI2 (UM) or QCI8 (AM) or QCI9 (AM)	
355AH, 355AV	IP data volume transmitted on QCI2/8/9 bearer at R-party	Count the accumulated data transmitted in a certain period at the test probe of VPMN at the IP port (UDP) on the EPS bearer - QCI2 (UM) or QCI8 (AM) or QCI9 (AM)	
356AH, 356AV	IP data volume received on QCI2/8/9 bearer at H-party	Count the accumulated data received in a certain period at the test probe of HPMN at the IP port (UDP) on the EPS bearer - QCI2 (UM) or QCI8 (AM) or QCI9 (AM)	
357AH, 357AV	IP data volume transmitted on QCI2/8/9 bearer at H-party	Count the accumulated data transmitted in a certain period at the test probe of HPMN at the IP port (UDP) on the EPS bearer - QCI2 (UM) or QCI8 (AM) or QCI9 (AM)	
RTP transport quality parameters			
360AH, 360AV, 361AH, 361AV, 362AH, 362AV, 363AH, 363AV	RTP max packet delay variation R2H, RTP max packet delay variation H2R, RTP mean packet delay variation R2H, RTP mean packet delay variation H2R	Make the test probe at VPMN an MO call, analyse the RTP streams at the both ends (for a duration of the audio reference file in 8 - 32s) and calculate the max. and mean packet delay variations (ref. to IR.42 [1]) in the R2H direction at HPMN, and in the H2R direction at VPMN	

364AH, 364AV, 365AH, 365AV	RTP mean interarrival jitter of incoming streaming R2H RTP mean interarrival jitter of incoming streaming H2R	Make the test probe at VPMN an MO call, analyse the RTP streams at the both ends (for a duration of the audio reference file in 8 - 32s) and calculate the RTP mean interarrival jitter of incoming streaming (ref. to GSMA IR.42 [1]) in the R2H direction at HPMN, and in the H2R direction at VPMN	
366AH, 366AV, 367AH, 367AV	RTP mean data rate transmitted R2H (audio) RTP mean data rate received H2R (audio)	Make the test probe at VPMN an MO call, count the total data transmitted and received respectively in a certain period, and calculate the average data rate (ref. to GSMA IR.42 [1]) transmitted and received of the probe at VPMN at that period.	
368AH, 368AV, 369AH, 369AV	RTP mean data rate transmitted H2R (audio) RTP mean data rate received R2H (audio)	Make a VoLTE MT call from HPMN to a test probe at VPMN, count the total data transmitted and received respectively at the VoLTE test probe of HPMN in a certain period and calculate the average data rate (ref. to GSMA IR.42 [1]) transmitted and received of the probe at HPMN at that period.	
370AH, 370AV, 371AH, 371AV	RTP packets lost R2H RTP packets lost H2R	Make the test probe at VPMN an MO call to a test probe at HPMN, count the total number of the missing RTP sequence numbers in a certain period at the home probe of HPMN and at the roaming probe of VPMN.	
372AH, 372AV, 373AH, 373AV	RTP packets lost ratio R2H RTP packets lost ratio H2R	Make the test probe at VPMN an MO call to a test probe at HPMN, within a certain period: - Count the total number of the missing RTP sequence numbers - Count the total number of RTP packets received - Calculate the portion of lost packets (ref. to GSMA IR.42 [1]) at the roaming probe of VPMN and at the home probe of HPMN.	
374AH,	RTP round-trip delay (RHR)	Make the test probe at VPMN an MO call to a test probe at HPMN, within a certain	

374AV, 375AH, 375AV	RTP round-trip delay (HRH)	period calculate the average transfer time (ref. to GSMA IR.42 1]) of RTP packets - from the roaming probe of VPMN to the home probe of HPMN and looped back to the roaming probe, - from the home probe of HPMN to the roaming probe of VPMN and looped back to the home probe	

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

If EPS GBR bearer QCI2 is assigned for the video media, the GRQ test codes for GBR (348AH, 348AV, 349AH, 349AV) are applied to the ViLTE GRQ test.

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

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

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

4.1.6.3 Preconditions of SRVCC GRQ test

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

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

indicate IMS PS voice preferred, CS Voice as secondary,

support SRVCC to GERAN or UTRAN in MS Classmark 2,

support SRVCC to GERAN in MS Classmark 3.

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

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

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

g.3gpp.mid-call

g.3gpp.srvcc-alerting

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

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

g.3gpp.ps2cs-srvcc-orig-pre-alerting feature-capability indicator in a Feature-Caps header field of SIP 183 Session Progress,

g.3gpp.srvcc-alerting

media feature tag in a Contact header field of SIP 180 Ringing,

feature-capability indicator in a Feature-Caps header field of SIP 180 Ringing,

g.3gpp.mid-call media feature tag in the Contact header field of SIP 200 OK (INVITE)

4.1.7 SMSoIP

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
201AH, 201AV	IMS Registration success ratio (VoLTE)	Initiate an IMS registration in VPMN for IMS multimedia conversational video service (VoLTE) at test probe. Observe whether the registration is successful completed by receiving NOTIFY for registration event package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to 3GPP TS 34.229-1, annex C.2 [13]). To ensure a full IMS registration, initiate an (UE) deregistration if it is already IMS registered.	
202AH, 202AV	IMS Registration time	Initiate an IMS registration in VPMN for IMS multimedia telephony service (VoLTE). Measure the time between the test probe sending the initial request for IMS registration and receiving NOTIFY for registration event package from P-CSCF. The test probe shall subscribe to its registration event package (ref. to 3GPP TS 34.229-1, annex C.2 [13]).	

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

		- Receiving a 202 ACCEPTED from SMSC acknowledging to the SIP MESSAGE request (UL) including a vnd.3gpp.sms payload that contains a delivery report (ref. to 3GPP TS 34.229-1, 18.2.4 [13]).	
225AH, 225AV	SMSoIP-MO e2e delay	Send an SM included in the SIP MESSAGE request from a test probe at VPMN, using HPMN IP-SM-GW/SMSC, to a test probe at HPMN. Measure the time between - Sending a SIP MESSAGE request (UL) including a vnd.3gpp.sms payload that contains a short message at R-party, and - Receiving a SIP MESSAGE request (DL) including a vnd.3gpp.sms payload that contains that short message at H-party (ref. to 3GPP TS 34.229-1, 18.1.4, 18.2.4 [13]). Note: A clock accuracy of the test system ≤ 30ms	
226AH, 226AV	SMSoIP-MT e2e delay	Send an SM included in the SIP MESSAGE request from a test probe at HPMN to a test probe at VPMN using the HPMN IP-SM-GW/ SMSC. Measure the time between - Sending a SIP MESSAGE request (UL) including a vnd.3gpp.sms payload that contains a short message at H-party, and - Receiving a SIP MESSAGE request (DL) including a vnd.3gpp.sms payload that contains that short message at R-party (ref. to 3GPP TS 34.229-1, 18.1.4, 18.2.4 [13]). Note: A clock accuracy of the test system ≤ 30ms	

4.1.8 MIoT

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

The RX power level RSRP > - 79 dbm.

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

		- VPMN MME indicates 'SMS only' in 'Additional update result'	
102AH, 102AV	PS location update delay	Resulted from KPI 101. Measure the time between the initiation of attach and the attach is accepted.	
105AH, 105AV	Default EPS bearer context activation success ratio	Resulted from KPI 101 for the default PDN connection. Verify whether ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message is received by the UE. Aggregation of multiple tests yields the corresponding success ratio.	Note 2, Note 3
106AH, 106AV	Default EPS bearer context activation time (Data-up delay)	Resulted from KPI 101 for the default PDN connection and measure the time between UE sending ATTACH REQUEST and ATTACH COMPLETE containing ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT.	Note 2, Note 3
109AH, 109AV	Default EPS bearer context cut-off ratio	Verify whether the UE in VPMN is detached by the network initiation after each EPS attach or after each MIoT usage (waking-up, data transferring). Aggregation of multiple tests yields the corresponding bearer context cut-off ratio (the MIoT module shall be kept attached).	
150AH, 150AV	PING Host	Host server in HPMN or at a 3rd party having an IPv4 or IPv6 address.	Note 2
151AH, 151AV	PING packet loss ratio	From VPMN, UE sends an ICMP echo request with a certain number of PING packets to be sent as parameter. Verify whether ICMP echo reply is received. Aggregation of multiple tests yields the corresponding packet loss ratio.	Note 2
152AH, 152AV	PING round trip time	Result from KPI 151, measure the time between ICMP echo sent and ICMP echo reply received.	Note 2
153AH, 153AV	Number of packets received	Result from KPI 151, indicate the number of received packets.	Note 2
154AH, 154AV	Number of packets sent	Result from KPI 151, indicate the number of sent packets.	Note 2
155AH, 155AV	PING interval	Result from KPI 151, indicate the break time between two consecutive PINGs (parameter).	Note 2

156AH, 156AV	PING packet payload size	Result from KPI 151, indicate the size of a packet without header (parameter).	Note 2
157AH, 157AV	Sum of bytes received	Result from KPI 151, indicate the total bytes received including headers.	Note 2, Note 11
158AH, 158AV	Sum of bytes sent	Result from KPI 151, indicate the total bytes sent including headers.	Note 2, Note 11
400AH, 400AV	LPWA access type	Configure UE in WB LTE-M or NB-IoT, if it is configurable for the LPWA access type.	
401AH, 401AV	Attach type with additional update type	Configure UE for EPS attach with a suitable value of 'additional update type' 1) No additional information 2) User plane CIoT EPS optimization 3) Control plane CIoT EPS optimization with SMS only 4) Control plane CIoT EPS optimization with PDN	Note 4
402AH, 402AV	Detach type	Trigger UE for EPS detach in VPMN, whereby the detach type is either EPS detach 'Normal detach' or 'Switch-off'	
403AH, 403AV	Detach delay	Resulted from KPI 402, measure the time between UE sending DETACH REQUEST and receiving DETACH ACCEPT from VPMN.	
404AH, 404AV	PDN type	Configure UE accordingly in one of the following PDN types. - IPv4, IPv6, IPv4v6, Non-IP	Note 2, Note 3
405AH, 405AV	Serving PLMN rate control (NB-IoT)	Trigger NB-IoT module to initiate EPS attach with PDN connection. Verify whether 'Serving PLMN rate control' is received in ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message from VPMN, and which value is assigned if received.	Note 2, Note 3, Note 5
406AH, 406AV	APN rate control (NB-IoT)	Trigger NB-IoT module to initiate EPS attach with PDN connectivity request.	Note 2, Note 3,

		Ensure that the support of APN rate control for uplink data is indicated in Protocol Configuration Options (PCO), if the module supports this feature. Verify whether 'APN rate control' is received in PCO of ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message, and which value is assigned if received.	Note 5
407AH, 407AV	APN rate control for exception data (NB-IoT)	Trigger NB-IoT module to initiate EPS attach with PDN connectivity request. Ensure that the support of APN rate control for exception uplink data is indicated in Protocol Configuration Options (PCO), if the module supports this feature. Verify whether 'APN rate control for exception data' is received in PCO of ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message, and which value is assigned if received.	Note 2, Note 3, Note 5
408AH, 408AV	NAS signalling low priority (LTE-M)	Configure LTE-M module for NAS signalling low priority and trigger the module in VPMN to initiate EPS attach with PDN connectivity request. Verify whether low priority indicator is set to "MS is configured for NAS signalling low priority" in Device Properties of ATTACH REQUEST, and whether the attach is accepted by VPMN.	Note 7
409AH, 409AV	Non-IP link MTU size (NB-IoT)	Trigger NB-IoT module to initiate EPS attach with PDN connectivity request. Ensure that 'Non-IP link MTU' is requested in Protocol Configuration Options (PCO), if the module supports this feature. Verify whether 'Non-IP link MTU' is received in PCO of ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message, and which value is assigned by the network.	max. user data sent in container of ESM DATA TRANSPORT Note 5, Note 6
410AH, 410AV	IPv4 link MTU size	Trigger the module to initiate EPS attach with PDN connectivity request. Ensure that 'IPv4 link MTU' is requested in Protocol Configuration Options (PCO), if the module supports this feature.	max. user data sent via S1-U interface, Note 6

		Verify whether 'IPv4 link MTU' is received in PCO of ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message, and which value is assigned by the network.	
411AH, 411AV	Half-duplex (FDD)	Configured LTE-M or NB-IoT FDD module in half-duplex mode. Attached in VPMN, indicate whether the module is operated in half-duplex mode on the supporting frequency band.	
412AH, 412AV	RSRP	Attached in VPMN, indicate reference signal received power at the antenna of the module.	
413AH, 413AV	CE Mode (LTE-M)	Configure LTE-M module in CE mode B, if it is capable. Attached in VPMN, indicate which CE mode (A or B) the UE is operated.	Note 7, Note 10
414AH, 414AV	CE Level (NB-IoT)	Configure NB-IoT module in CE mode. Attached in VPMN, indicate which CE level (0, 1, 2, 3) the UE is operated.	Note 5, Note 10
420AH, 420AV	PSM enable / disable	- Configure module to enable PSM with the corresponding HPMN- recommended values: PSM TAU period (T3412 extended) - PSM UE active timer (T3324) Initiate an EPS attach in VPMN with or without PDN. Indicate: - PSM status NW-accepted, Verify the completion of the attach procedure and compare the NW-accepted values with the corresponding UE-requested values - PSM TAU period NW-accepted (T3412 extended) - PSM UE active timer NW-accepted (T3324). Verify that UE performs the periodic TAU procedure.	
421AH, 421AV	PSM status NW-accepted	Resulted from KPI 420, if NW-accepted T3324 value is received from VPMN, it implies that the VPMN supports PSM and accepts the use of PSM.	

422AH, 422AV	PSM TAU period UE-requested (T3412 extended)	Resulted from KPI 420, indicate the PSM TAU period (T3412 extended) requested by UE in ATTACH REQUEST.	
423AH, 423AV	PSM TAU period NW-accepted (T3412 extended)	Resulted from KPI 420, indicate the PSM TAU period (T3412 extended) granted by VPMN.	
424AH, 424AV	PSM UE active timer UE-requested (T3324)	Resulted from KPI 420, indicate the requested timer T3324 value (being different from "deactivated").	
425AH, 425AV	PSM UE active timer NW-accepted (T3324)	Resulted from KPI 420, indicate the timer T3324 value granted by VPMN (being different from "deactivated").	
426AH, 426AV	PSM Hibernate ratio NW-accepted	PSM Hibernate ratio = (T3412 extended - T3324) / T3412 extended	
427AH, 427AV	PSM MT data transfer success ratio	Activate PSM and initiate attach in VPMN with PDN, Trigger UE to prepare sending UL data and prepare sending DL data to UE. Verify that - the UE performs periodic TAU procedure - the UE transmits UL data following the completion of the TAU procedure, or paging UE for EPS service if UE already returns to Idle mode. - Sending DL data to UE following the completion of the UL data transfer - Verify the total DL data is completely received. Aggregation of multiple tests yields the corresponding success ratio.	
428AH, 428AV	PSM SMS MT accessibility	1) Activate PSM and initiate attach in VPMN with PDN, Trigger UE to prepare sending UL data and prepare sending SMS to UE. Verify that - the UE performs periodic TAU procedure	Note 8

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

433AH, 433AV	eDRX cycle UE-requested	Resulted from KPI 431, indicate eDRX cycle length requested by UE in ATTACH REQUEST.	
434AH, 434AV	eDRX cycle NW-accepted	Resulted from KPI 431, indicate eDRX cycle length granted by VPMN.	
435AH, 435AV	eDRX PTW UE-requested	Resulted from KPI 431, indicate eDRX PTW value requested by UE.	
436AH, 436AV	eDRX PT NW-accepted	Resulted from KPI 431, indicate eDRX PTW value granted by VPMN.	
437AH, 437AV	eDRX MT data transfer success ratio	Activate eDRX and initiate attach in VPMN with PDN. Trigger UE to prepare sending UL data and prepare sending DL data to UE. Verify that - the UE transmits UL data - Paging UE within eDRX PTW and sending DL data to UE after the completion of the UL data transfer - Verify the total DL data is completely received. Aggregation of multiple tests yields the corresponding success ratio.	
438AH, 438AV	eDRX SMS MT accessibility	1) Activate eDRX and initiate attach in VPMN with PDN, Trigger UE to prepare sending UL data and prepare sending SMS to UE. Verify that - the UE transmits UL data - MT SMS is delivered after the completion of the UL data transfer, or paging UE for SMS within the eDRX PTW if UE already returns to Idle mode, - Verify the SMS is received by UE. 2) Activate eDRX and initiate attach in VPMN without PDN and SMS only, Trigger UE to submit an MO SMS. - the UE transmits MO SMS - MT SMS is delivered after the completion of MO SMS, or paging UE for SMS within the eDRX PTW if UE already returns to Idle mode, - Verify the MT SMS is received by UE.	Note 8

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

		Aggregation of multiple tests yields the corresponding success ratio.	
451AH, 451AV	MT TCP data transfer payload size	Vary the payload size, repeat the KPI 450 test and indicate how the payload size affects the MT TCP DL data transfer success ratio.	Note 2
452AH, 452AV	MT TCP data transfer throughput	Result from KPI 450, indicate MT TCP DL data transfer throughput.	Note 2
453AH, 453AV	MT TCP data transfer duration	Result from KPI 450, indicate MT TCP DL data transfer duration.	Note 2
454AH, 454AV	MT UDP data transfer success ratio	Trigger UE an EPS attach in VPMN with PDN and PDN type IP. Initiate MT UDP DL data transfer. Aggregation of multiple tests yields the corresponding success ratio.	Note 2
455AH, 455AV	MT UDP data transfer payload size	Vary the payload size, repeat the KPI 455 test and indicate how the payload size affects the MT UDP DL data transfer success ratio.	Note 2
456AH, 456AV	MT UDP data transfer throughput	Result from KPI 455, indicate MT UDP DL data transfer throughput.	Note 2
457AH, 457AV	MT UDP data transfer duration	Result from KPI 455, indicate MT UDP DL data transfer duration.	Note 2
460AH, 460AV	MO Non-IP data transfer success ratio	Trigger UE an EPS attach in VPMN with PDN and PDN type Non-IP. Initiate MO UL data transfer by sending one or more ESM DATA TRANSPORT message(s) including the payload data to be sent in the User data container. Aggregation of multiple tests yields the corresponding success ratio.	Note 3, Note 5
461AH, 461AV	MO Non-IP data transfer payload size	Vary the payload size, repeat the KPI 460 test and indicate how the payload size affects the MO Non-IP UL data transfer success ratio.	Note 3, Note 5
462AH, 462AV	MO Non-IP data transfer throughput	Result from KPI 460, indicate MO Non-IP UL data transfer throughput.	Note 3, Note 5

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

472AH, 472AV	SMSinMME-MT accessibility (SA SMS MT)	Trigger the module to initiate EPS attach in VPMN with PDN connectivity request, or SMS only without PDN. From HPMN to send an SMS to the UE (as R-party) in VPMN. Verify that the UE receives the SMS sent via one or more DOWNLINK NAS TRANSPORT message(s). Aggregation of multiple tests yields the corresponding success ratio.	Note 5, Note 9
473AH, 473AV	SMSinMME-MO access delay (AD SMS-MO)	Resulted from KPI 471. Measure the time between sending the SMS and receiving the notification from the home SMSC that the message has been sent. A clock accuracy of the test system $\leqslant$ 30ms	Note 5, Note 9
474AH, 474AV	SMSinMME-MT access delay (AD SMS-MT)	Resulted from KPI 472. Measure the time between the notification from the home SMSC that the message has been sent at the H-party and the notification at the R-party indicating that the message has arrived. A clock accuracy of the test system $\leqslant$ 30ms	Note 5, Note 9

Note 1: Test scenarios 1 & 2 described in the Test Method are **not** mutually exclusive. The same is valid for test scenarios 2 & 3. Note 2: The KPI is applicable to the MIoT modules capable of using IP PDN.

Note 3: The KPI is applicable to the MIoT modules capable of using non-IP PDN.

Note 4: LTE-M module is configured to case 1) or 2), NB-IoT module is configured to case 3) or 4).

Note 5: The KPI is applicable to CP CIoT EPS optimization (normative for NB-IoT).

Note 6: The max. Non-IP, IPv4 link MTU size for NB-IoT and the max. IPv4 link MTU size for LTE-M are limited to 1358 octets. The IPv6 link MTU size is sent to the module by including it in the IPv6 Router Advertisement message, the same information is not conveyed by the network via the default EPS bearer context establishment.

Note 7: The KPI is applicable to LTE-M.

Note 8: The scenario 2 is applicable to NB-IoT modules configured with EPS service SMS only, without PDN.

Note 9: If the LTE-M module supports SMS, but does not support SMS in MME, KPI 471 – 474 are replaced with

- KPI 21-24 if the LTE-M module supports SMSoSGs, or

- KPI 221-224 if the LTE-M module supports SMSoIP.

Note 10: The RX power level RSRP can be < - 79 dbm.

Note 11: The header bytes (IP header 20 + ICMP 8 = 28 bytes) are included in the calculations.

4.1.9 SA Option 2

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
519	5QI	Verify during process 5GSM PDU session establishment accept, the allocation of initial 5QI (default) which can be modified according to service request in 5GSM PDU session modification command (dedicated)	
522	SST	Verify during process 5GSM PDU session establishment accept, the network allocates the SST	

4.1.10 5G NSA Option 3

4.1.10.1 EN-DC GRQ

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

LTE RSRP > - 85 dBm,

FR1 NR RSRP > -88 dBm.

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

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

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics

500AH, 500AV	5G coverage indication	Verify receiving an *upperLayerIndication* bit in *SystemInformationBlockType2*. The upperLayerIndication in SIB2 is an indication to upper layers that the UE has entered a coverage area offering 5G capabilities.	Note 1
501AH, 501AV	NR RSRP	The measured NR RSRP value (-dBm) by the UE / test probe during the test. Aggregation of multiple tests yields the corresponding an average measured NR RSRP value.	
502AH, 502AV	Restrict DCNR	With a 5G subscription SIM, an EN-DC UE performs an EPS ATTACH procedure. Ensure to indicate the DCNR bit in the UE network capability IE of the ATTACH REQUEST message. Verify in the ATTACH ACCEPT the *RestrictDCNR* bit being set as “Use of dual connectivity with NR is not restricted” in the *EPS network feature support* IE. Verify whether the ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST message is received by the UE. The default APN corresponds to the internet access in the U plane reflecting an IP connectivity.	
503AH, 503AV	ENDC EPS bearer configuration	Resulted either from a KPI 501, or from a subsequent test step, e.g. via Service Request for MO data, verify whether a SCG or a Split data bearer has been established. Verify which one of the EN-DC bearers is configured in the set of an EN-DC bearer configurations (MCG, SCG, Split, MCG+SCG, MCG+Split, SCG+Split, MCG+SCG+Split).	Note 2
504AH, 504AV	5G ENDC_Used allocated	It verifies the UE and network have negotiated the dual connectivity and the corresponding bearers was allocated, then RAT for User Plane is 5G NSA	Note 3
505AH 505AV	Default EPS bearer QoS parameters	Resulted from EPS attach to verify the QoS parameters in the default EPS bearer context	Note 4
510AH, 510AV	HTTP / HTTPS MBB data	Calculation of the 5G MBB data transfer success ratio uses the same formula referred to the KPI 146 (HTTP / HTTPS data transfer success ratio), with	

	transfer success ratio	an exception of the HTTP / HTTPS data transfer on pure MCG bearer type (i.e. only on the LTE resource) is considered as a fail due to be missing the SCG resource usage. It implies a lower data rate. Aggregation of multiple tests yields the MBB data transfer success ratio.	

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

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

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

Specifi metric to be checkled are to be finalized

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

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

Note 4: *"We suggest to take here the pop session activation,i.e.* the metric will be "pdp context action success rate"

4.1.11 Voice Service in 5G SA Option 2

The voice service offered in this architecture is based on voice over IP.

Here are the steps to measure the key QoS parameters using active testing methodology:

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics
511AH, 511AV	5G Siignal to Noise (SNR)	By taking the radio parameters at call establishment from cell information	

512AH, 512AV	5G Call Setup Time	To measure call setup time, test calls can be initiated and the time it takes for the call to be established can be measured. This can be done by measuring the time between initiating the call and receiving a response from the destination.	
513AH, 513AV	Call drop Rate	To measure call drop rate, a large number of test calls can be made and the percentage of calls that are dropped during the call can be calculated. This can be done by counting the number of dropped calls and dividing it by the total number of calls made	
514AH, 514AV	Jitter	To measure jitter, test voice packets can be sent through the network and the variation in delay between packets can be measured. This can be done by calculating the difference in delay between consecutive packets.	
515AH, 515AV	Packet Loss	To measure packet loss, test voice packets can be sent through the network and the percentage of packets lost during transmission can be calculated. This can be done by counting the number of lost packets and dividing it by the total number of packets sent.	
516AH, 516AV	Latency	To measure latency, test voice packets can be sent through the network and the time it takes for the packets to travel from the source to the destination and back can be measured. This can be done by measuring the time between sending the packet and receiving the acknowledgement packet from the destination.	
517AH, 517AV	MOS	To measure the MOS (Mean Opinion Score) for voice calls, Objective testing can also be conducted using specialized equipment that simulates the human ear and records the call quality, like wireless interface module.	
518AH, 518AV	BitRate	To measure the bit rate, during voice call system will verify the transmission rate for the packet content in both directions (Tx and Rx)	

4.1.12 Voice Service in Option 3

Voice service offered in 5G NSA option3 is VoLTE so it will be used the same methodology described in section 5.1.4.1

4.1.13 SMS Service in 5G

Active testing is a methodology where test traffic is generated to simulate real user traffic and then sent through the network to measure its performance and quality. Here's how the key Quality of Service (QoS) parameters for SMS and voice services in 5G option 2 architecture with 5GC can be measured using active testing methodology:

GRQ Test Code	Parameter (KPI)	Test Method for Implementation
520AH, 520AV	SMS Submission Success	To measure the message, test SMS can be sent from source to destination and get the ACK from network that sms was accepted at core platform level (message sent in the UE)
521AH, 521AV	SMS Submission Delay	Submission delay will be measured by calculating difference between sms send timestamp and ack received timestamp in source side
523AH, 523AV	End To End Success	To measure the message success rate, a large number of test SMS messages can be sent and the percentage of messages that are successfully delivered to the destination can be calculated. This can be done by counting the number of successful message deliveries and dividing it by the total number of messages sent (single sms success will count if destination received the message)
524AH, 524AV	Latency (End To End Delivery Time)	To measure the message delivery time, a test SMS message can be sent from the source to the destination and the time taken for the message to be delivered and acknowledged can be measured. This can be done by measuring the time between sending the message and receiving an acknowledgement message from the destination
525AH, 525AV	Retransmission Rate	To measure the retransmission rate, a large number of test SMS or voice packets can be sent and the percentage of packets that require retransmission due to errors or other issues can be calculated. This can be done by counting the number of retransmitted packets and dividing it by the total number of packets sent.

4.1.14 Data in 5G

GRQ Test Code	Parameter (KPI)	Test Method for Implementation	Test specifics

530AH, 530AV	HTTP/HTTPS MBB Download Rate Mbits/s	Initiate in VPMN speed test based on HTTP/HTTPS to identify the average download rate	Note 4
531AH, 531AV	HTTP/HTTPS MBB Upload Rate Mbits/s	Initiate in VPMN speed test based on HTTP/HTTPS to identify the average upload rate	Note 4
532AH, 532AV	HTTP/HTTPS MBB Latency milliseconds	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.	Note 4
Note 4: For those KPIs the recommendation is to take the results effectively executed over 5G NSA User Plane (linked with 504).			

4.2 4.2 Passive Monitoring

4.2.1 General Information

4.2.1.1 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.

4.2.1.2 Where to measure:

4.2.1.2.1 Probing

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 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.

4.2.1.2.2 SIM Applet

Applets are distributed across multiple SIMs in Subscriber UE and IoT devices and those Applets report on all of the Subscrbers' QoE wherever they connect to a VPLMNs.

4.2.1.2.3 Known Limitations

Probing:

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).

4.2.2 Probing 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.	

GRQ Test Code	Parameter	How to Measure	Test Specifics
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

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

GRQ Test Code	Parameter	How to Measure	Test Specifics
9BH	REL (ISUPv2 signalling transparency)	N/A	Home network has no visibility on Voice Call without CAMEL
9BV	REL (ISUPv2 signalling transparency)	N/A	Visited network has no visibility on the actual release cause
10BH	OCN and RDN (ISUPv2 signalling transparency)	N/A	Home network has no visibility on Voice Call without CAMEL
10BV	OCN and RDN (ISUPv2 signalling transparency)	N/A	Home network has no visibility on RDN/OCN transparency at destination side
11BH	CCR (Call Completion Ratio Circuit)	N/A	Home network has no visibility on Voice Call without CAMEL
11BV	CCR (Call Completion Ratio Circuit)	Measure ratio between successfully released calls (reception of ISUP RLC) of dropped calls and answered (ISUP ANM). A drop call definition based on the release call that is if call is released because of network specific errors, then it will be counted as call dropped. For example, if REL cause code is one of - (NO_ROUTE_TO_SPECIFIED_TRANSIT_NETWORK = 2, NO_ROUTE_TO_DESTINATION = 3, CHANNEL_UNACCEPTABLE = 6,	For RP applying MNP, additional info to be extracted (IMSI/MSISDN in the loc.up) for assuring measurement on the roaming partner

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

GRQ Test Code	Parameter	How to Measure	Test Specifics
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 for SMS-MT	N/A	
PACKET-SWITCHED			

GRQ Test Code	Parameter	How to Measure	Test Specifics
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	

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

GRQ Test Code	Parameter	How to Measure	Test Specifics
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

4.2.3 4.2.3 LTE test specification

to be added

4.2.4 4.2.4 Volte/Vilte ans SMSoIP

to be added

4.2.5 4.2.5 MIoT

to be added

4.2.6 4.2.6 5G

4.2.6.1 4.2.6.1 5G SA Option 2

GRQ Test Code	Parameter	How to Measure	Test Specifics

4.2.6.2 5G NSA Option 3

GRQ Test Code	Parameter	How to Measure	Test Specifics

4.2.6.3 Voice Service in 5G

4.2.6.3.1 Voice Service in Option 2

GRQ Test Code	Parameter	How to Measure	Test Specifics

4.2.6.3.2 Voice Service in Option 3

Idem VoLTE

4.2.6.4 SMS Service in 5G

GRQ Test Code	Parameter	How to Measure	Test Specifics

4.2.6.4.1 SIM Applet

Measurement is indicative of Subscriber QoE when roaming so the HPMN service provider will acquire an essential measure of their partner networks performance. However, some detailed measurements are not accessible via SIM API. For example, there is no indication of data throughput for packet.

4.2.7 GPRS / UMTS/LTE Applet Monitoring Specification

GRQ Test Code	Parameter	Measurement	Specifics
COVERAGE			
	Service retention	**% of all time connected to VPLMN**	**Qualified by VPLMN**
VOICE			
	LU update success ratio	Derived from a fully qualified cell handover record	
	NER-MO (Network Effectiveness Ratio on Mobile Originated calls in the visited network)	Fully qualified voice call record	Qualifications include serving cell, geographic location, A- and B-Party addresses, length of conversation and call end casue code.
	NER-MT (Network Effectiveness Ratio on Mobile Terminated calls in the visited network)	Fully qualified voice call record	Qualifications include serving cell, geographic location, A- and B-Party addresses, length of conversation and call end casue code.
	PDD-MT (Post Dialling Delay)	Measure time between successful calls by observing sequential call records with start and end timestamps	
	CSSR-MO (Call Setup Success Ratio on Mobile Originated calls in the visited network)	Derived from fully qualified call records.	Cause being radio link failure of network failure is available for each call attempt.
	CSSR-MT (Call Setup Success Ratio on Mobile Terminated	Derived from fully qualified call records.	Cause being radio link failure of network failure is

GRQ Test Code	Parameter	Measurement	Specifics
COVERAGE			
	Service retention	**% of all time connected to VPLMN**	**Qualified by VPLMN**
	calls in the visited network)		available for each call attempt.
	CCR (Call Completion Ratio Circuit)	Derived from fully qualified call records.	-
	ALOC	Derived from fully qualified call records.	-
	CLI transparency	Derived from fully qualified call records.	-
	CLI transparency	Derived from fully qualified call records.	-
SMS			
	Service Accessibility SMS MO (SA SMS MO)	MO SMS transmit/retry	Based on Applet use of SMS as bearer of data to the HPLMN.

4.2.8 LTE Probe Test Specification

to be added

4.2.9 Volte/Vilte and SMSoIP

to be added

4.3 4.3 CAMEL Monitoring

4.3.1 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.

4.3.1.1 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.

4.3.1.2 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.

4.3.1.3 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)

4.3.1.4 GRQ Monitoring Pre-requisites

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

4.3.2 Test specification

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

4.4 4.4 Call Flows

4.4.1 Location update

4.4.1.1 Bilateral case

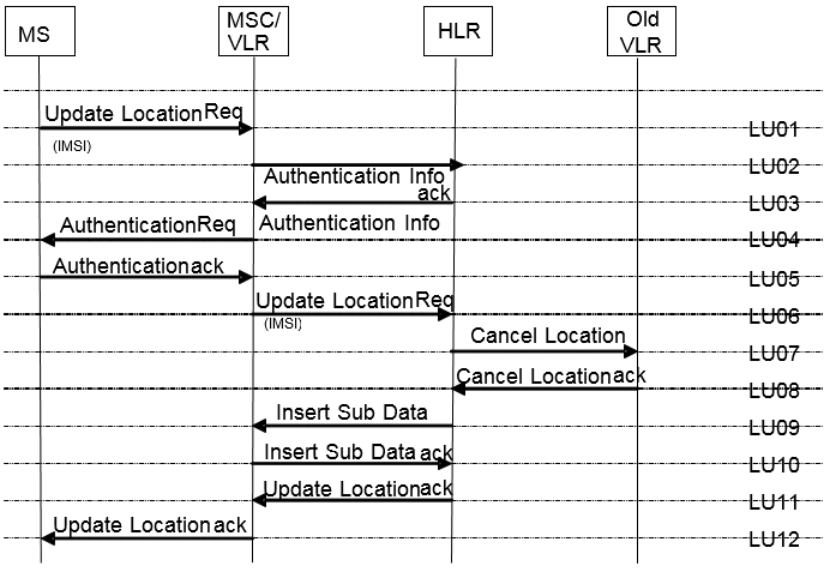


Figure 1 : Location update with HLR and VLR

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

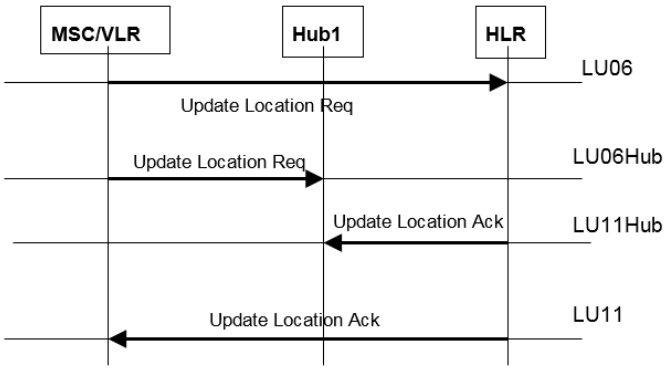


Figure 2: Location Update with Roaming Hubbing Provider

Note: LU06 and LU11 are for reference only

4.4.2 Voice call MO

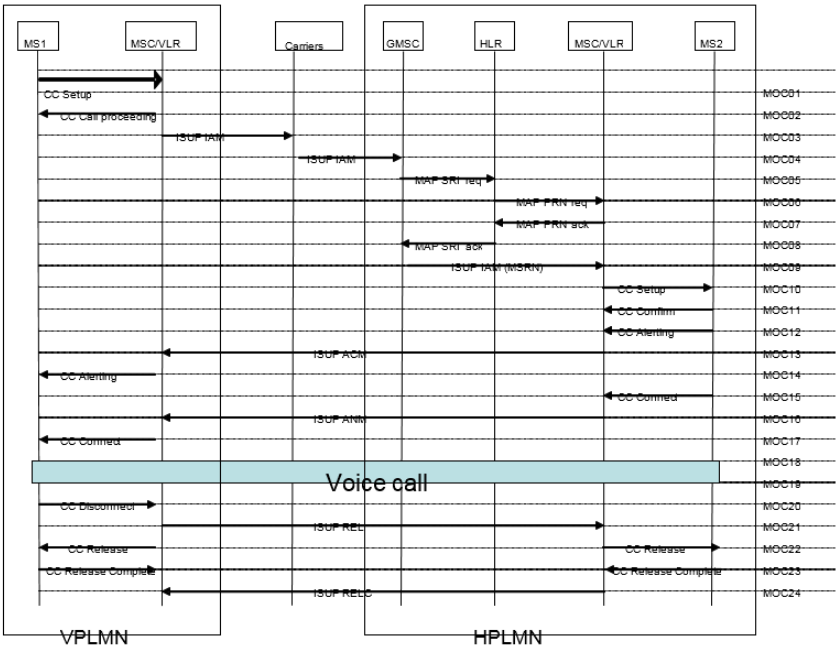


Figure 3: CS voice call MO

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

4.4.3 Voice call MT

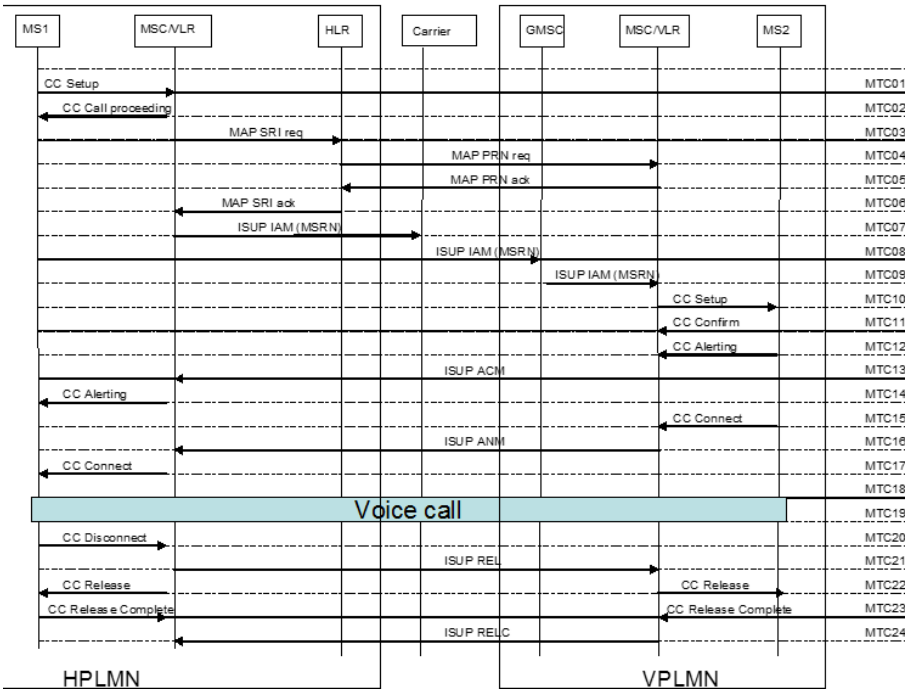


Figure 4: CS voice call MT

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

4.4.4 Packet Switched/GPRS

4.4.4.1 Bilateral case

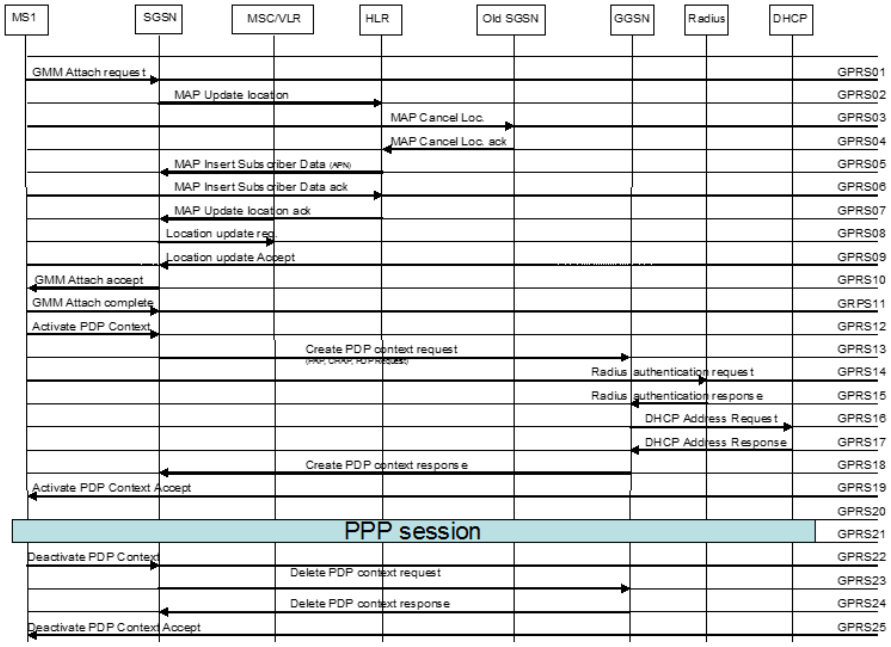


Figure 5: GPRS PDP context and data transfer in bilateral case

4.4.4.2 4.4.4.2 Roaming Hubbing Provider Case (only relevant procedures)

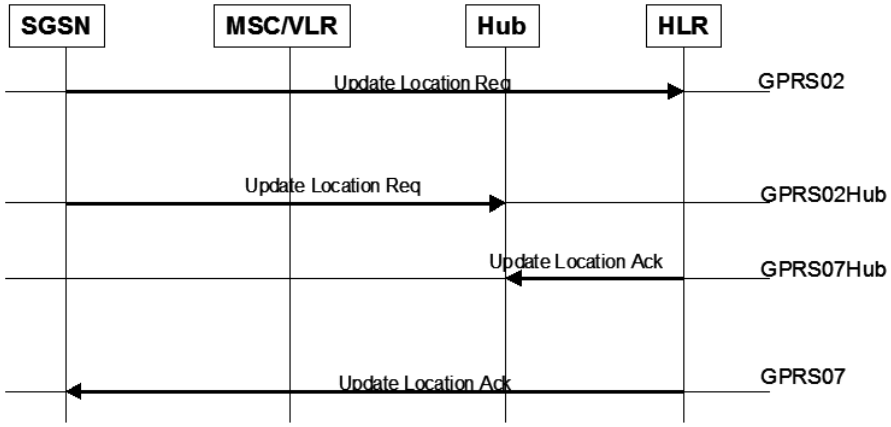


Figure 6: Packet Switch flow for Roaming Hub Provider

4.4.5 4.4.5 FTP

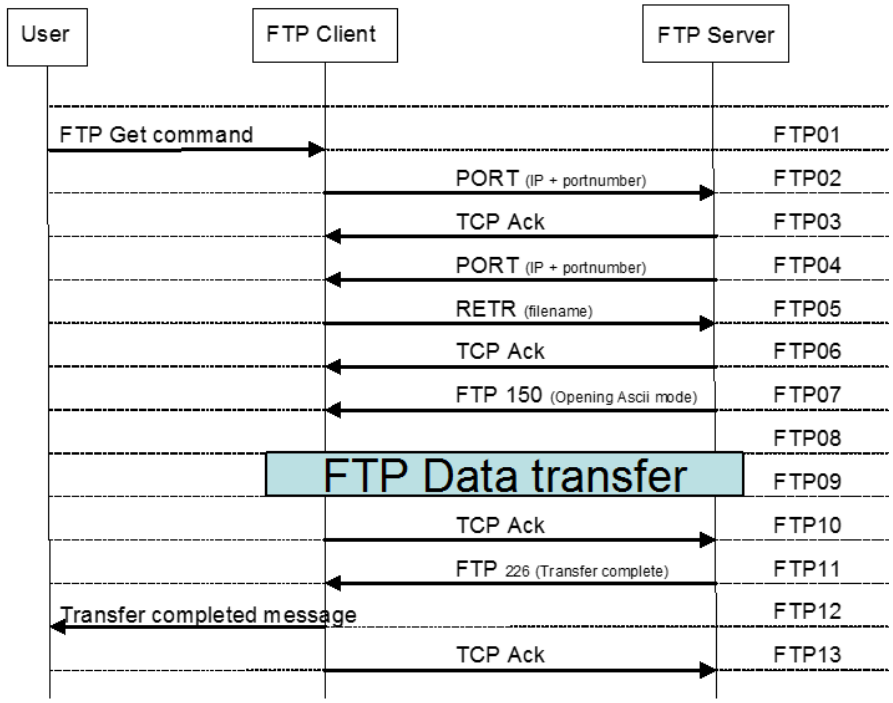


Figure 7: FTP

Note: FTP00: The time to initiate FTP

4.4.6 Ping

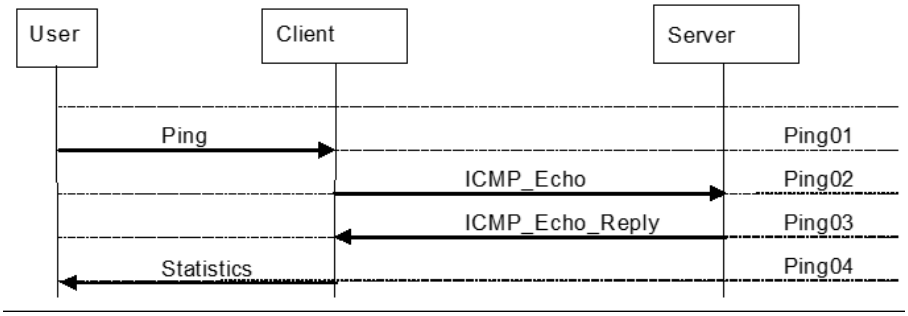


Figure 8: Ping

4.4.7 HTTP/HTTPS

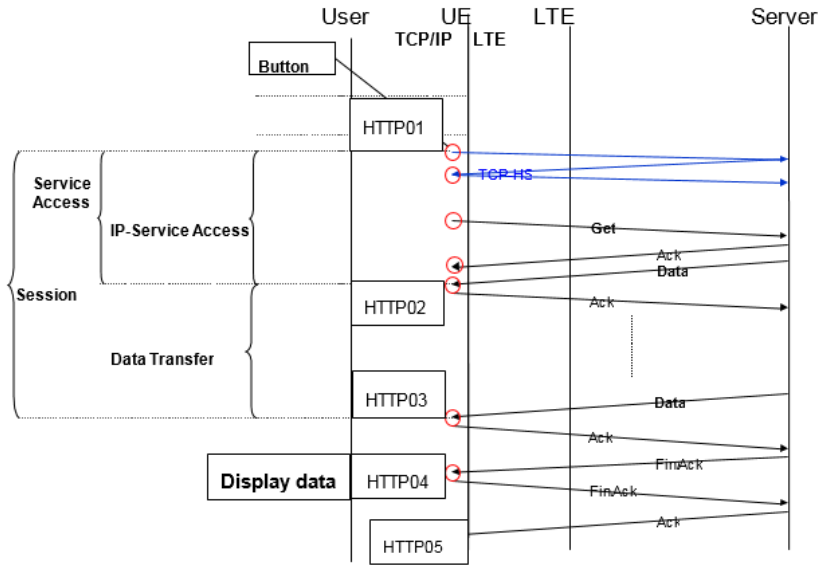


Figure 9: HTTP/HTTPS session flow

4.4.8 SMS, SMSoSGs and SMSoIP

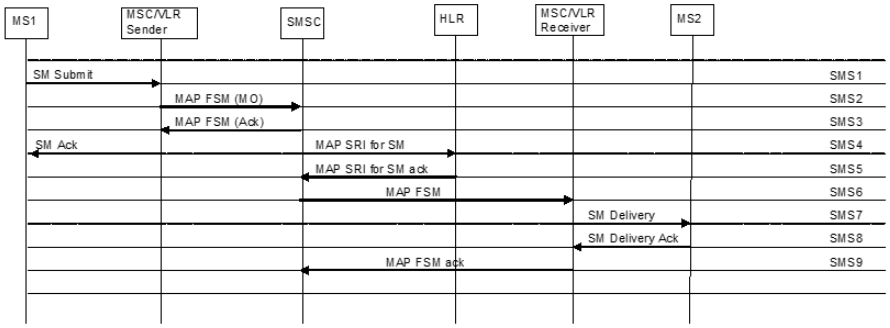


Figure 10: SMS and SMSoSGs

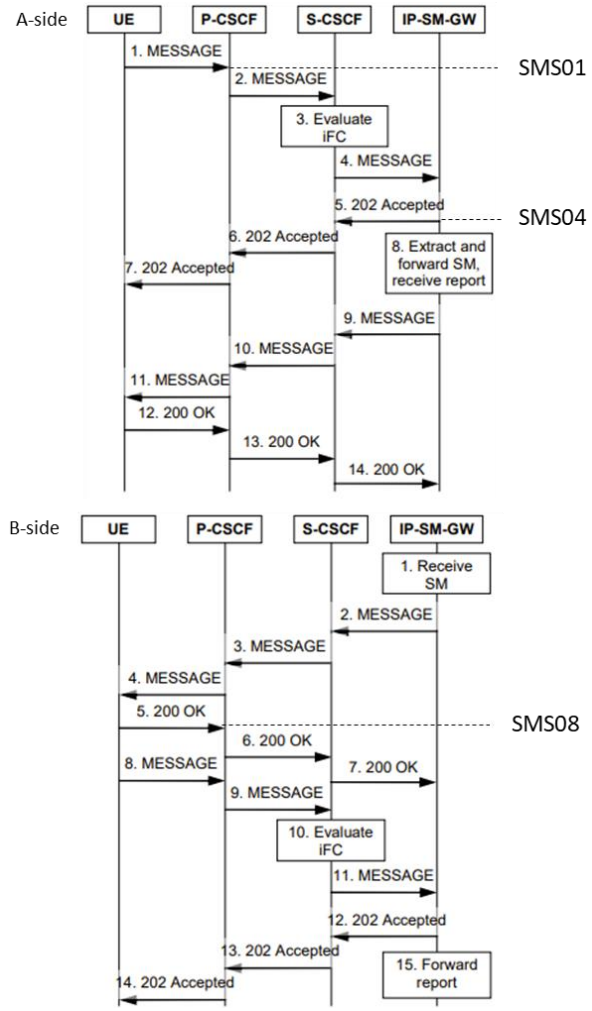


Figure 11: SMSoIP (SIP)

4.4.9 4.4.9 EPS

4.4.9.1 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

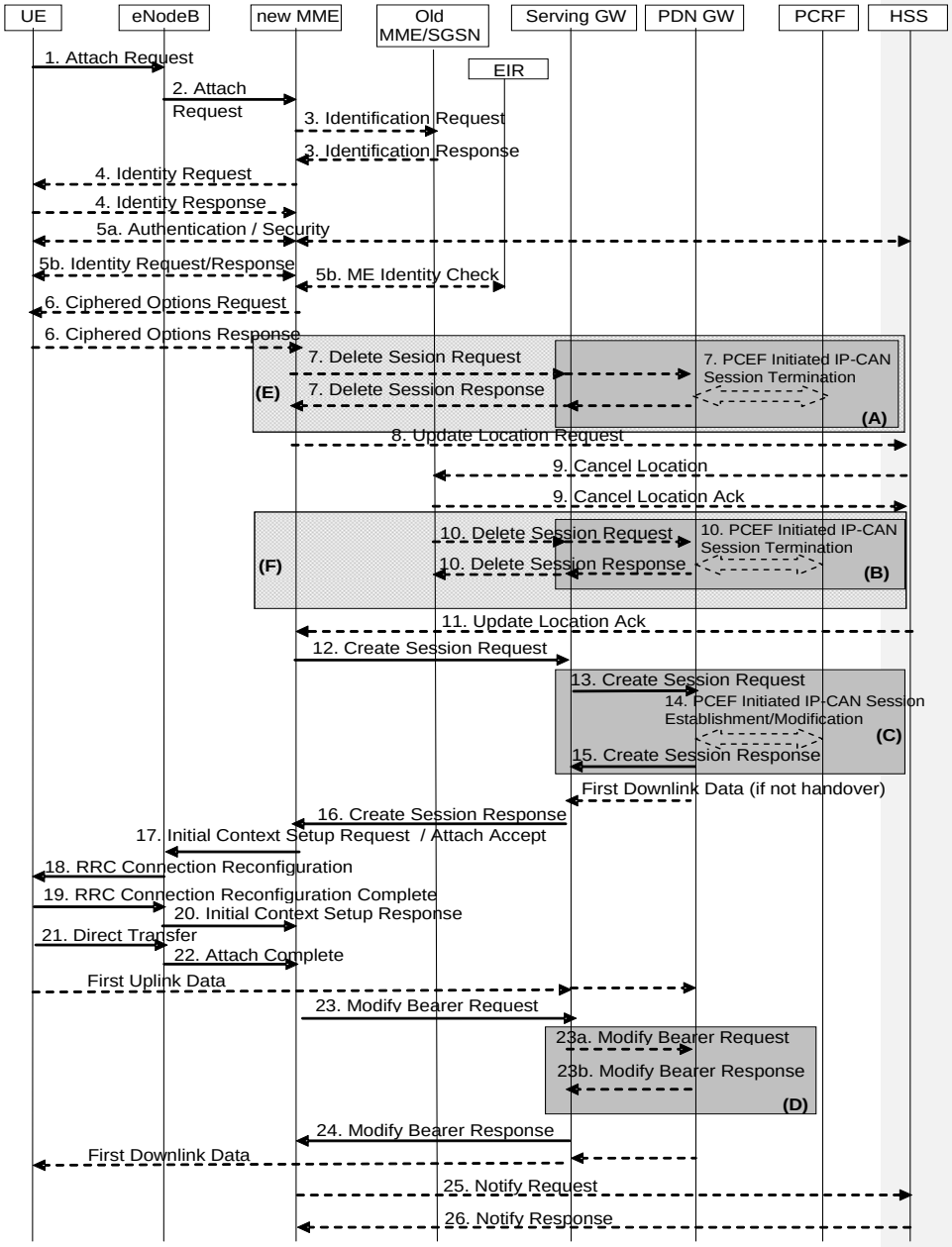


Figure 12 EPS attach

4.4.9.2 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

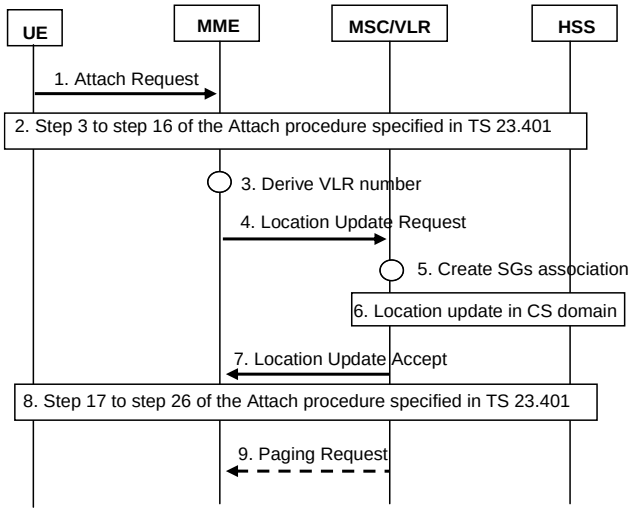


Figure 13: Combined EPS /IMSI attach

4.4.9.3 Voice CSFB MO call

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

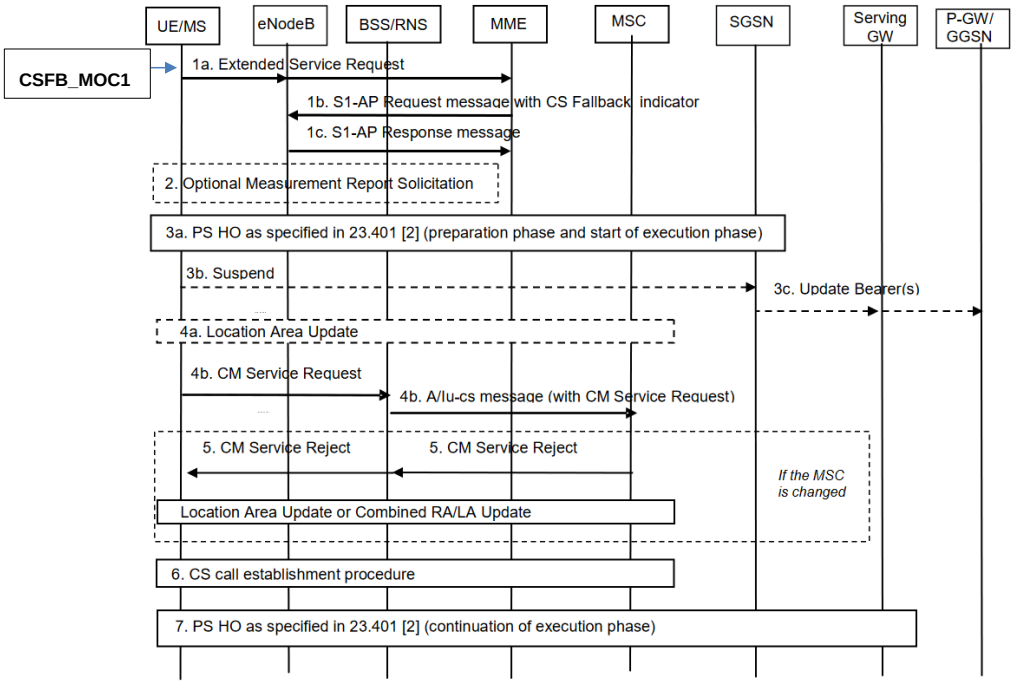


Figure 14: Voice CSFB MO call with PS / CS HO [4]

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

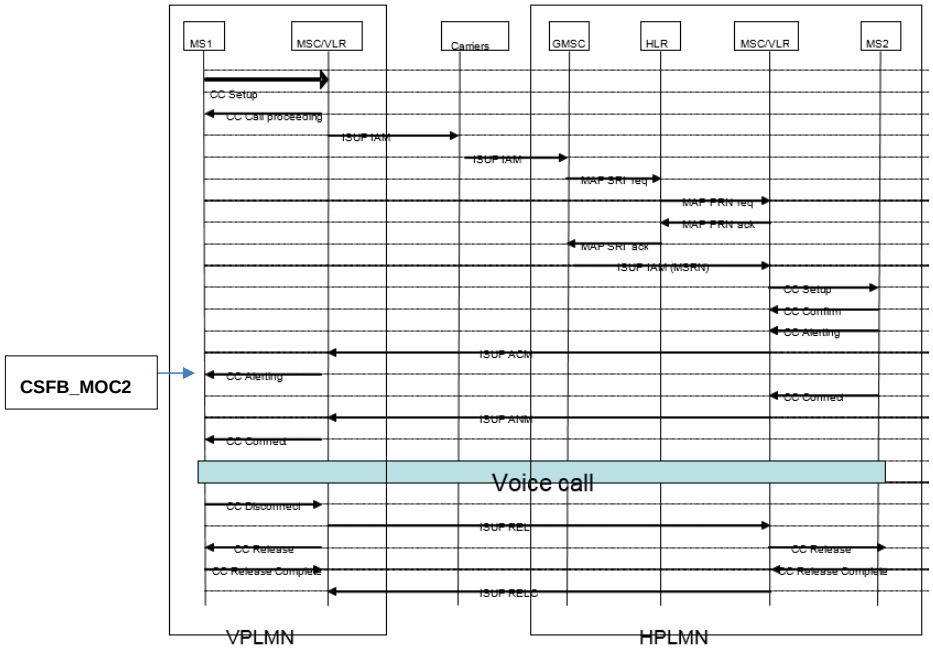


Figure 15: CS MO call establishment

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

4.4.9.4 Voice CSFB MT call

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

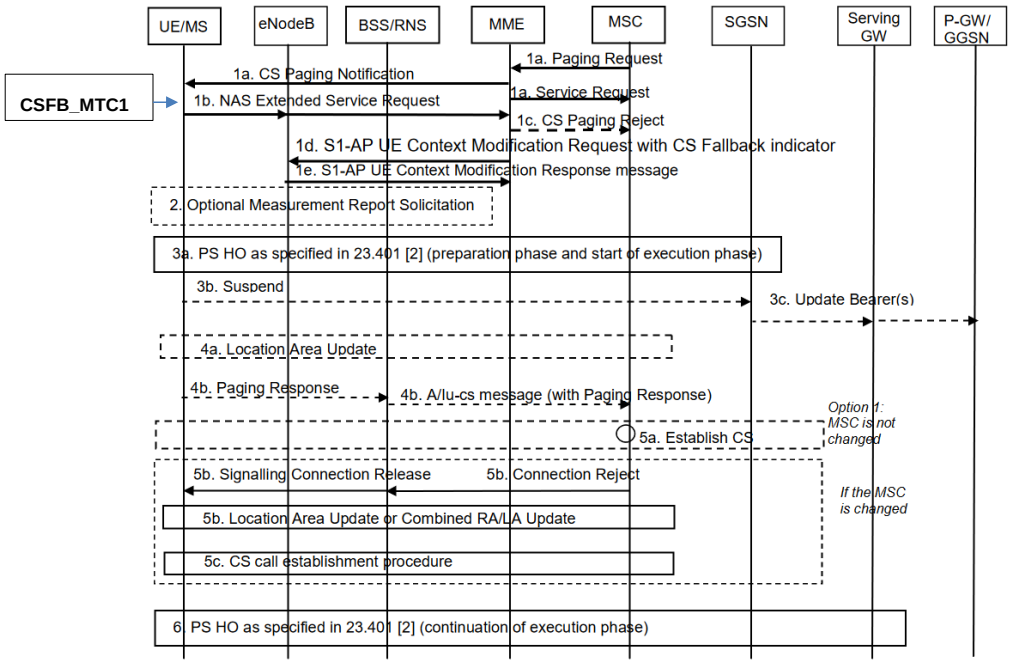


Figure 16: Voice CSFB MT call with PS / CS HO [4]

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

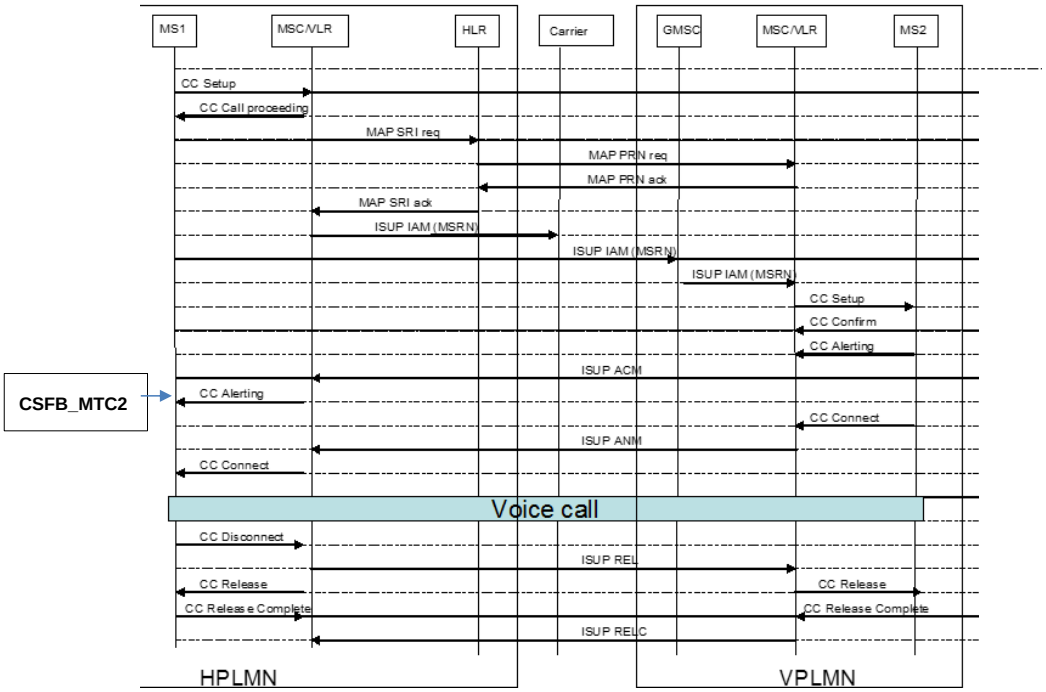
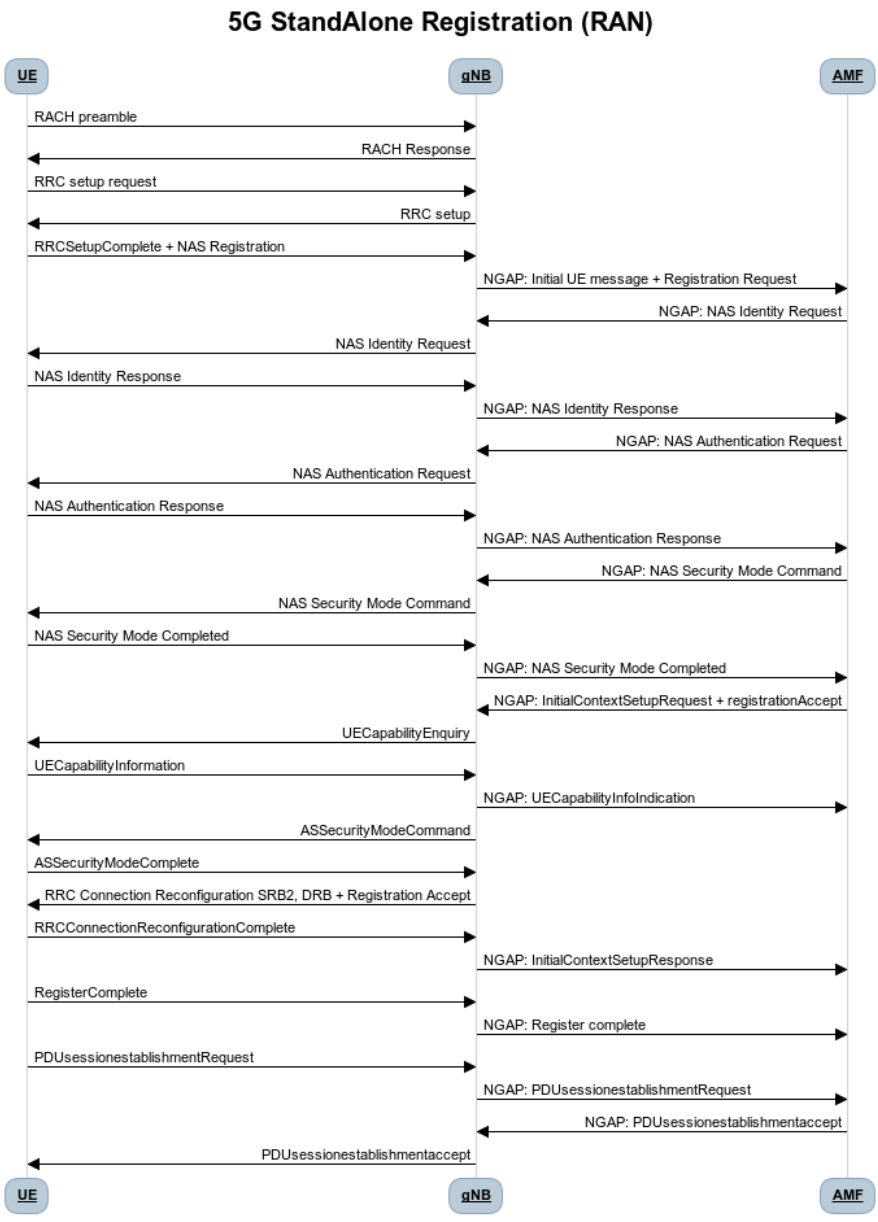


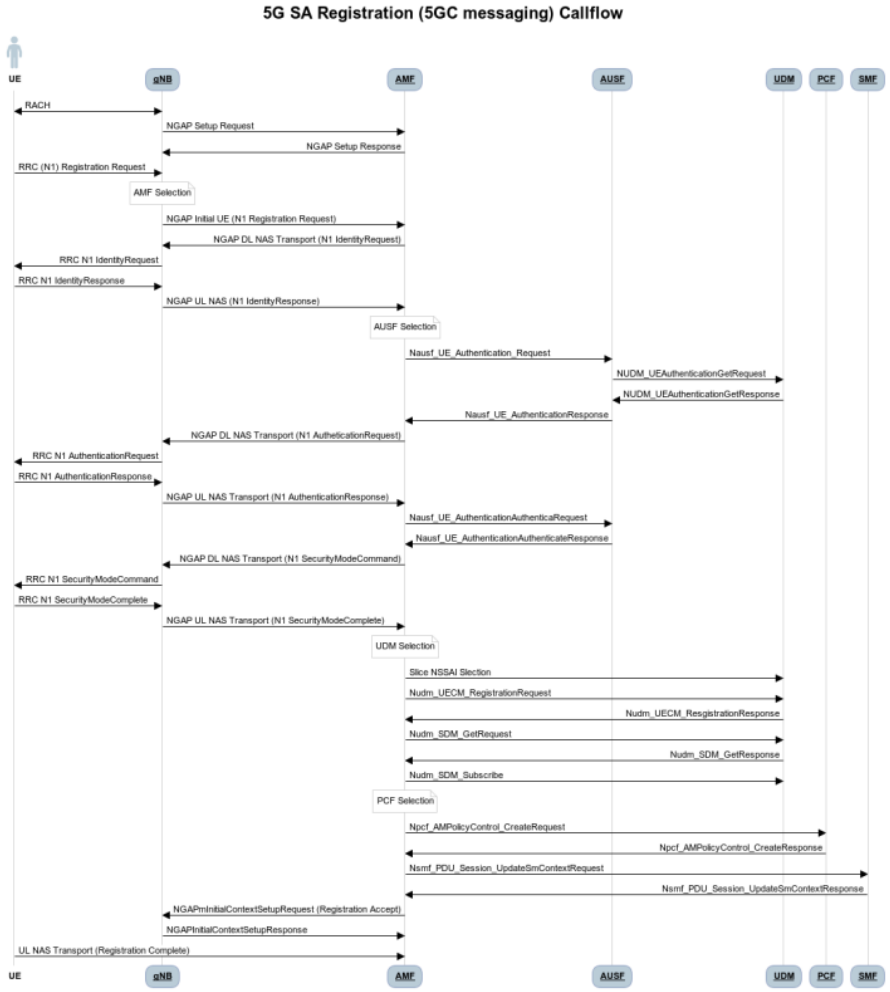
Figure 17: CS MT call establishment

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

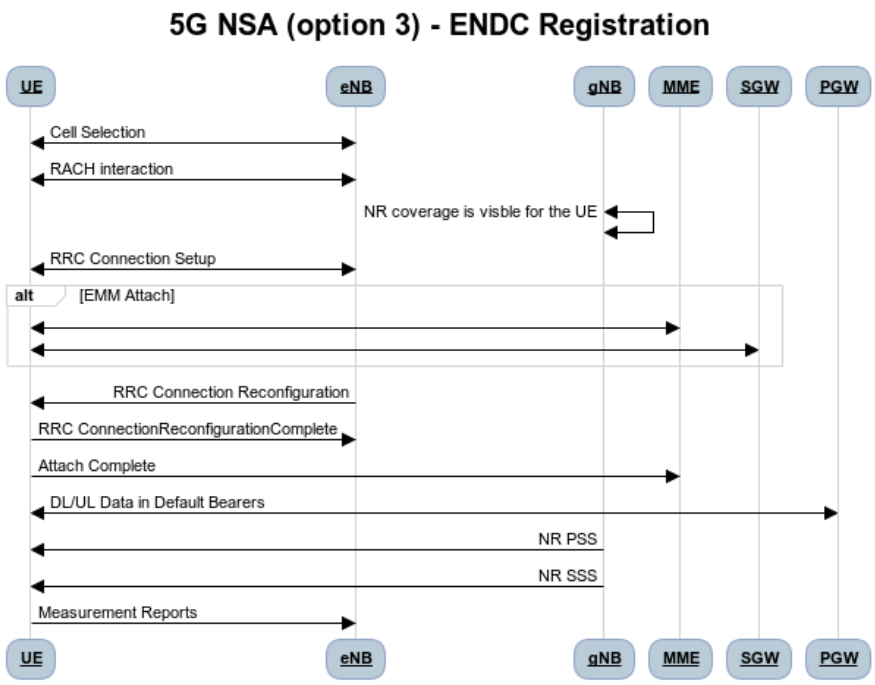
4.4.10 5G StandAlone Registration (RAN) procedure



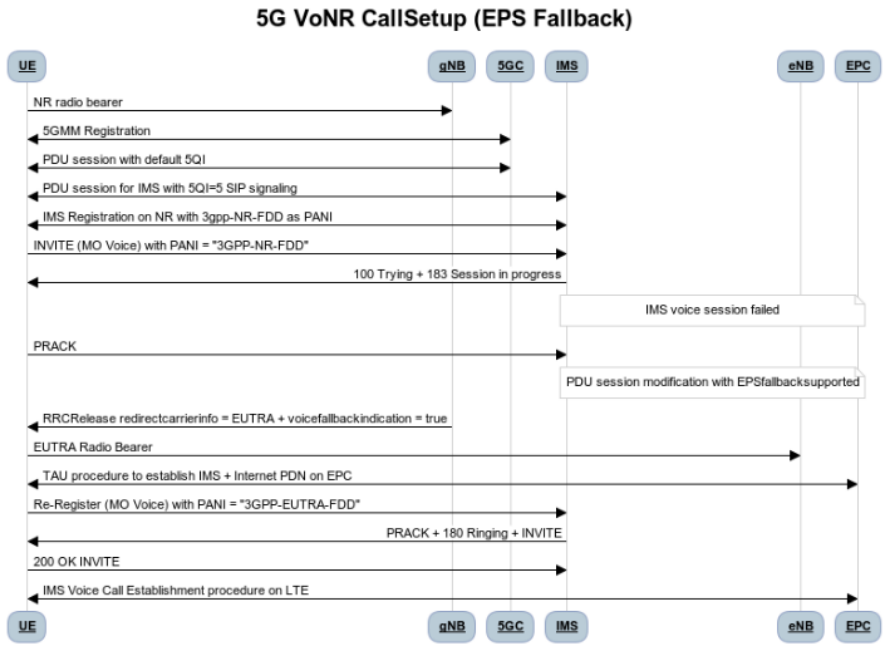
4.4.11 5G StandAlone Registration (CORE Network details)



4.4.12 5G NSA Registration (option3)



4.4.13 VoNR callsetup (EPS Fallback)



4.5 Trigger Table

4.5.1 GSM/GPRS and UMTS trigger points

Test	Parameter	Reference flow	Start point	End Point
CIRCUIT-SWITCHED				
1AH, 1AV, 1BH, 1BV	LU update success ratio	Location update	LU01 (Active) LU06 (Passive)	LU12 (Active) LU11(Passive)
1BR	LU update success ratio	Location update	LU06HUB	LU11Hub
2AH, 2AV, 2BH, 2BV	LU delay	Location update	LU01 (Active) LU06 (Passive)	LU12 (Active) LU11(Passive)

Test	Parameter	Reference flow	Start point	End Point
2BR	LU delay	Location update	LU06Hub	LU11Hub
3AH, 3AV, 3BH, 3BV	NER-MO (Network Effectiveness Ratio on Mobile Originated calls in the visited network)	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
4AH, 4AV, 4BH, 4BV	NER-MT (Network Effectiveness Ratio on Mobile Terminated calls in the visited network)	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)
5AH, 5AV, 5BH, 5BV	PDD-MO (Post Dialling Delay)	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
6AH, 6AV, 6BH, 6BV	PDD-MT (Post Dialling Delay)	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)
7AH, 7AV, 7BH, 7BV	CSSR-MO (Call Setup Success Ratio on Mobile Originated calls in the visited network)	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC17 (Active) MOC16 (Passive)
8AH, 8AV, 8BH, 8BV	CSSR-MT (Call Setup Success Ratio on Mobile Terminated calls in the visited network)	Voice call MT	MTC01 (Active) MTC07 (Passive)	MOC17 (Active) MOC16 (Passive)
9BH, 9BV	REL (ISUPv2 signalling transparency)	Voice call MO	MOC20	MOC22
10BH, 10BV	OCN and RDN (ISUPv2 signalling transparency)	No flow available		
11AH, 11AV, 11BH, 11BV	CCR (Call Completion Rate Circuit)	Voice call MO	MOC14 (Active) MOC13 (Passive)	MOC20 (Active) MOC21 (Passive)
12BH, 12BV	ALOC	Voice call MO	MOC03	MOC21
13aAH, 13aAV, 13aBH, 13aBV	CLI transparency (MO)	Voice call MO	MOC01 (Active) MOC02 (Passive)	MOC10 (Active), (Passive)
13bAV,	CLI transparency (MT)	Voice call MT	MTC01 (Active)	MTC10

Test	Parameter	Reference flow	Start point	End Point
13bBV, 13bBH, 13bBV			MTC02 (Passive)	(Active), (Passive)
14aAH, 14aAV	Speech Quality (SpQ_received_R_side)	Voice call MO	MOC18 (Active)	MOC19 (Active)
14bAV, 14bAV	Speech Quality (SpQ_received_H_side)	Voice call MO	MOC18 (Active)	MOC19 (Active)
SMS				
21AH, 21AV, 21BH, 21BV	Service Accessibility SMS MO (SA SMS MO)	SMS	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03 (Passive)
22AH, 22AV, 22BH, 22BV	Service Accessibility SMS MT (SA SMS MT)	SMS	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
23AH, 23AV, 23BH, 23BV	Access Delay SMS MO (AD SMS-MO)	SMS	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03 (Passive)
24AH, 24AV, 24BH, 24BV	Access Delay SMS MT (AD SMS-MT)	SMS	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
25AH, 25AV, 25BH, 25BV	End-to-End Delivery Time for SMS-MO	SMS	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
26AH, 26AV, 26BH, 26BV	End-to-End Delivery Time for SMS-MT	SMS	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
PACKET-SWITCHED				
31AH, 31AV, 31BH, 31BV	Packet Switched LU Success Ratio (PS LU - SR)	GPRS	GPRS01 (Active) GPRS02 (Passive)	GPRS10 (Active) GPRS09 (Passive)
31BR	Packet Switched LU Success Rate (PS LU - SR)	GPRS	GPRS02Hub	GPRS07Hub
32AH, 32AV, 32BH, 32BV	Packet Switched Location Update Delay (PS LU - D)	GPRS	GPRS01 (Active) GPRS02 (Passive)	GPRS10 (Active) GPRS09 (Passive)

Test	Parameter	Reference flow	Start point	End Point
32BR	Packet Switched Location Update Delay (PS LU - D)	GPRS	GPRS02Hub	GPRS07Hub
33AH, 33AV, 33BH, 33BV	Service accessibility for PSD (PDP-context activation success rate)	GPRS	GPRS12 (Active) GPRS13 (Passive)	GPRS19 (Active) GPRS18 (Passive)
34AH, 34AV, 34BH, 34BV	Set-up Delay (ST PSD)	GPRS	GPRS12 (Active) GPRS13 (Passive)	GPRS19 (Active) GPRS18 (Passive)
35AH, 35AV, 35BH, 35BV	PDP Context Cut-Off Ratio (session Stability measured at PDP context or PS level)	GPRS	GPRS19 (Active) GPRS18 (Passive)	GPRS25 (Active) GPRS24 (Passive)
36AH, 36AV, 36BH, 36BV	Average PDP Context Session Time (per APN)	GPRS	GPRS20	GPRS21
37AH, 37AV, 37BH, 37BV	Throughput (Kbits/sec)	FTP / GPRS	FTP01 (Active) GPRS21 (Passive)	FTP12 (Active) GPRS21 (Passive)
38BH, 38BV, 38BH, 38BV	Goodput (Kbits/sec)	FTP / GPRS	FTP01 (Active) GPRS21 (Passive)	FTP12 (Active) GPRS21 (Passive)
39AH, 39AV, 39BH, 39BV	Roundtrip time	Ping / GPRS	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)
40AH, 40AV, 40BH, 40BV	Packet loss	Ping / GPRS	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)
142AH, 142AV	HTTP / HTTPS IP service setup time	HTTP/HTTPS	HTTP01 (active)	HTTP02 (active)
143AH, 143AV	HTTP / HTTPS session success ratio	HTTP/HTTPS	HTTP01 (active)	HTTP03 (active)
144AH, 144AV	HTTP / HTTPS session time	HTTP/HTTPS	HTTP01 (active)	HTTP03 (active)
145AH, 145AV	HTTP / HTTPS mean data rate	HTTP/HTTPS	HTTP01 (active)	HTTP03 (active)

Test	Parameter	Reference flow	Start point	End Point
146AH, 146AV	HTTP / HTTPS data transfer success ratio	HTTP/HTTPS	HTTP01 (active)	HTTP04 (active)

4.5.2 LTE trigger points

Test code	Parameter	Reference flow	Start point	End Point
Voice CSFB				
101AH, 101AV, 101BH, 101BV	PS location update success ratio	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) EPS09$_{hv}$ (Passive) LU06 (Passive) EPS07$_{vh}$ (Passive)[9] EPS10$_{vh}$ (Passive)[6]	EPS18 (Active) EPS11 (Passive) EPS09$_{vh}$ (Passive) LU11 (Passive) EPS07$_{hv}$ (Passive)[6] EPS10$_{hv}$ (Passive)[6]
101BR	PS location update success ratio	Combined EPS / IMSI attach	EPS08Hub (Passive) EPS09$_{hv}$Hub(Passive) LU06Hub (Passive)	EPS11Hub (Passive) EPS09$_{vh}$Hub(Passive) LU11Hub (Passive)
102AH, 102AV, 102BH, 102BV	PS location update delay	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) LU06 (Passive)	EPS18 (Active) EPS11 (Passive) LU11 (Passive)
102BR	PS location update delay	Combined EPS / IMSI attach	EPS08Hub (Passive) LU06Hub (Passive)	EPS11Hub (Passive) LU11Hub (Passive)
103AH, 103AV	CSFB return to LTE success ratio	-	Disconnect voice call (Active)	Return to LTE (Active)
104AH, 104AV	CSFB return to LTE time	-	Disconnect voice call (Active)	Return to LTE (Active)
3AH, 3AV, 3BH, 3BV	Service Accessibility Telephony – MO	Voice call MO	MOC01 (Active) MOC03 (Passive)	MOC14 (Active) MOC13 (Passive)
4AH, 4AV, 4BH, 4BV	Service Accessibility Telephony – MT	Voice call MT	MTC01 (Active) MTC07 (Passive)	MTC14 (Active) MTC13 (Passive)
115AH, 115AV, 5BH, 5BV	CSFB Setup Time Telephony – MO	CSFB Voice call MO	CSFB MOC1 (Active) MOC03 (Passive)	CSFB MOC2 (Active) MOC13 (Passive)
116AH, 116AV, 6BH, 6BV	CSFB Setup Time Telephony – MT	CSFB Voice call MT	CSFB MTC1 (Active) MTC07 (Passive)	CSFB MTC2 (Active) MTC13 (Passive)

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

Test code	Parameter	Reference flow	Start point	End Point
SMSoSGs				
101AH, 101AV, 101BH, 101BV	PS location update success ratio	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) EPS09$_{hv}$ (Passive) LU06 (Passive) EPS07$_{vh}$ (Passive)[6] EPS10$_{vh}$ (Passive)[6]	EPS18 (Active) EPS11 (Passive) EPS09$_{vh}$ (Passive) LU11 (Passive) EPS07$_{hv}$ (Passive)[6] EPS10$_{hv}$ (Passive)[6]
101BR	PS location update success ratio	Combined EPS / IMSI attach	EPS08Hub (Passive) EPS09$_{hv}$Hub(Passive) LU06Hub (Passive)	EPS11Hub (Passive) EPS09$_{vh}$Hub(Passive) LU11Hub (Passive)
102AH, 102AV, 102BH, 102BV	PS location update delay	Combined EPS / IMSI attach	EPSC01 (Active) EPS08 (Passive) LU06 (Passive)	EPS18 (Active) EPS11 (Passive) LU11 (Passive)
102BR	PS location update delay	Combined EPS / IMSI attach	EPS08Hub (Passive) LU06Hub (Passive)	EPS11Hub (Passive) LU11Hub (Passive)
21AH, 21AV, 21BH, 21BV	Service Accessibility SMS MO (SA SMS MO)	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
22AH, 22AV, 22BH, 22BV	Service Accessibility SMS MT (SA SMS MT)	SMS and SMSoSGs	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
23AH, 23AV, 23BH, 23BV	Access Delay SMS MO (AD SMS-MO)	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS04 (Active) SMS03(Passive)
24AH, 24AV, 24BH, 24BV	Access Delay SMS MT (AD SMS-MT)	SMS and SMSoSGs	SMS04 (Active) SMS06 (Passive)	SMS08 (Active) SMS09 (Passive)
25AH, 25AV, 25BH, 25BV	End-to-End Delivery Time for SMS-MO	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)
26AH, 26AV, 26BH, 26BV	End-to-End Delivery Time for SMS-MT	SMS and SMSoSGs	SMS01 (Active) SMS02 (Passive)	SMS08 (Active) SMS09 (Passive)

Test code	Parameter	Reference flow	Start point	End Point
LTE data				
101AH, 101AV, 101BH, 101BV	PS location update success ratio	EPS attach	EPS01 (Active) EPS08 (Passive) EPS09$_{hv}$ (Passive) EPS07$_{vh}$ (Passive)[6] EPS10$_{vh}$ (Passive)[6]	EPS18 (Active) EPS11 (Passive) EPS09$_{vh}$ (Passive) EPS07$_{hv}$ (Passive)[6] EPS10$_{hv}$ (Passive)[6]
101BR	PS location update success ratio	EPS attach	EPS08Hub (Passive) EPS09$_{hv}$Hub(Passive)	EPS11Hub (Passive) EPS09$_{vh}$Hub(Passive)
102AH, 102AV, 102BH, 102BV	PS location update delay	EPS attach	EPS01 (Active) EPS08 (Passive)	EPS18 (Active) EPS11 (Passive)
102BR	PS location update delay	EPS attach	EPS08Hub (Passive)	EPS11Hub (Passive)
105AH, 105AV, 105BH, 105BV	Default EPS bearer context activation success ratio	EPS attach	EPS18 (Active) EPS12 (Passive) EPS13 (Passive)[6]	EPS21 (Active) EPS16 (Passive) EPS15 (Passive)[6]
106AH, 106AV	Default EPS bearer context activation time	EPS attach	EPS18 (Active) EPS12 (Passive)	EPS21 (Active) EPS16 (Passive)
107AH, 107AV	DNS host name resolution success ratio	-	DNS request (Active)	DNS data packet (type A) received (Active)
108AH, 108AV	DNS host name resolution time	-	DNS request (Active)	DNS data packet (type A) received (Active)
109AH, 109AV	Default EPS bearer context cut-off ratio	EPS attach		
131AH, 131AV	FTP {download | upload} IP service access success ratio	FTP	FTP00 (active)	FTP08 (active)
132AH, 132AV	FTP {download | upload} IP service setup time	FTP	FTP00 (active)	FTP08 (active)
133AH, 133AV	FTP {download | upload} session success ratio	FTP	FTP00 (active)	FTP09 (active)
134AH, 134AV	FTP {download | upload} session time	FTP	FTP00 (active)	FTP09 (active)
135AH, 135AV	FTP {download | upload} mean data rate	FTP	FTP00 (active)	FTP09 (active)
136AH, 136AV	FTP {download | upload} data transfer success ratio	FTP	FTP00 (active)	FTP11 (active)

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

4.5.3 NSA EN-DC GRQ trigger points

Test code	Parameter	Reference flow	Start point	End Point
500AH, 500AV,	5G coverage indication	NSA Registration (option3)	NR coverage is visible for the UE	
501AH 501AV	NR RSRP	HTTP/HTTPS	KPI collected during HTTP/HTTPS session	
502AH 502AV	Restrict DCNR	NSA Registration (option3)	From content of ATTACH REQUEST	From content of ATTACH ACCEPT
503AH 503AV	ENDC EPS bearer configuration	NSA Registration (option3)		
504AH 504AV	5G ENDC_Used allocated	NSA Registration (option3)	Pdp context activation	pdp context deactivation
505AH 505AV	Default EPS bearer QoS parameters	NSA Registration (option3)		
510AH 510AV	HTTP/HTTPS MBB data transfer success ratio	HTTP/HTTPS	HTTP01 (active)	HTTP04 (active)
5xxAH 5xxAV	5G bearer context activation time	NSA Registration (option3)	RRC Connection Reconfiguration with NR	NR SSS
530AH 530AV	HTTP / HTTPS download data specifically for 5G NSA	HTTP/HTTPS	HTTP01 (active)	Reached max. capacity (active)
531AH 531AV	HTTP / HTTPS upload data specifically for 5G NSA	HTTP/HTTPS	HTTP01 (active)	Reached max. capacity (active)
532AH 532AV	PING round trip time specifically for 5G NSA	PING	Ping 01 (Active) During TCP session (Passive)	Ping04 (Active) During TCP session (Passive)

4.5.4 5G SA option 2 GRQ trigger points

Test code	Parameter	Reference flow	Start point	End Point
519	5QI	SA Registration (option2)	5GSM PDU session establishment accept	
522	SST	SA Registration (option2)	5GSM PDU session establishment accept	
511AH, 511AV	5G Siignal to Noise (SNR)	SA Registration (option2)	Attach Acceptance	
512AH, 512AV	5G Call Setup Time	SIP session establishment	SIP_Invite, SIP_End	SIP_Ringing
513AH, 513AV	Call drop Rate	SIP session establishment	SIP_INVITE	SIP_BYE_END
514AH, 514AV	Jitter	SIP session establishment		
515AH, 515AV	Packet Loss	SIP session establishment		
516AH, 516AV	Latency	SIP session establishment		
517AH, 517AV	MOS	SIP session establishment		
518AH, 518AV	BitRate	SIP session establishment		

4.5.5 5G SMS GRQ trigger points

Test code	Parameter	Reference flow	Start point	End Point
520AH, 520AV	SMS Submission Success	SMS over IP	SMS_Submit	SMS_SubmitACK
521AH, 521AV	SMS Submission Delay	SMS over IP	SMS_SubmitACK	
523AH, 523AV	End To End Success	SMS over IP	SMS_Received	
524AH, 524AV	Latency (End To End Delivery Time)	SMS over IP	SMS_Submit	SMS_Received

5 GRQ Test Result Presentations

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

5.1 KPI Matrix presentation

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

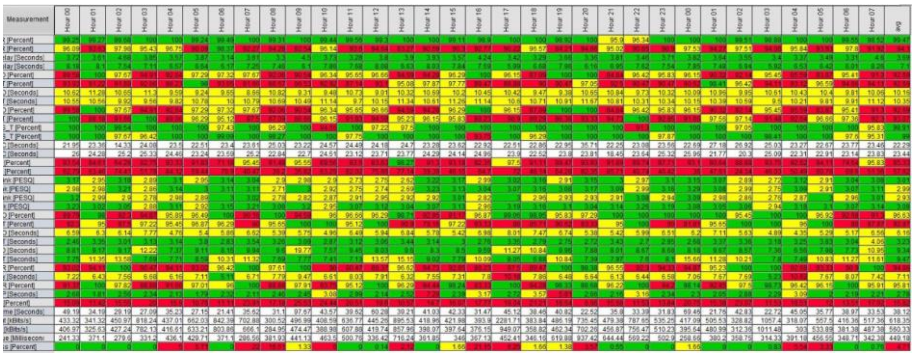


Figure 18: KPI matrix presentation

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

5.2 KPI chart presentations

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

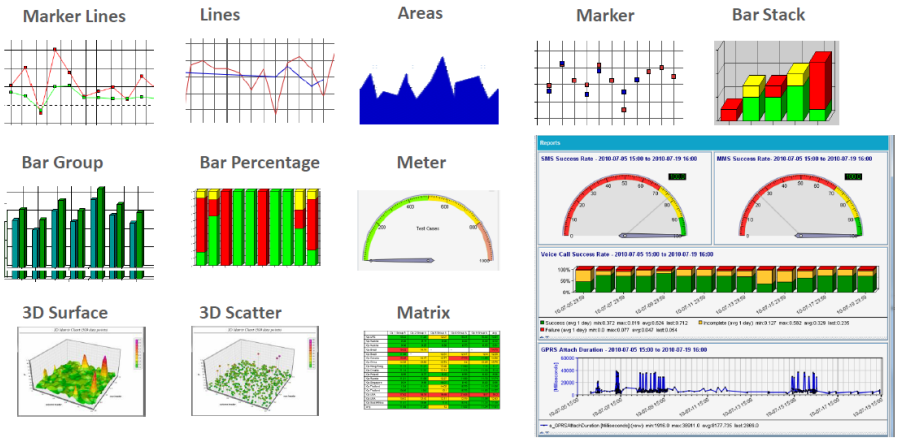


Figure 19: Different chart types

5.3 Single Service Indicator and Single Quality Indicator

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

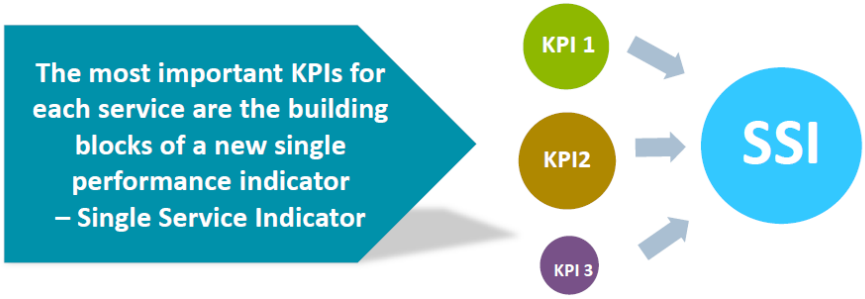


Figure 20: Single Service Indicator

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

5.3.1 SSI and SQI for roaming

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

The SSI is defined at the service level. The SQI can be defined at the level per visited network or per country, depending on the purpose. For example, in case it is required to

compare the performance of a specific service among several operators the SSI per service can be used. However, to have a general overview of the performance in a visited network, the SQI gives a single performance value per VPMN. In a similar way, SQI can provide a single performance value per country.

5.3.2 SSI and SQI in 2G or 3G roaming

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

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

5.3.2.1 CS Voice SSI

The CS voice service is evaluated from the user perspective by considering the VPMN capability of delivering a voice call to the HPMN as the most essential roaming service indicator. Therefore, the 1st important KPI is contributed to a call setup. The second important KPI is the voice quality, this has also an impact on the operator's revenue, because a poor voice quality might lead to a reduced conversation time. The capability of retaining a call and to release it correctly is considered with a lower weight, the least impacting the KPI is, the biggest delay experienced by the user after dialling the destination number (PDD) is. This is because a typical user in roaming tends to be more tolerant to such a delay.

Commented [AV1]: I would propose to modify this and exchange it by CLI Received

The outbound roaming voice SSI is defined as:

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

Where:

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

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

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher-Lower Limit	Scoring Mode
Voice	7	CSSR call set up success ratio	CSSR_MO	40	100 – 0	Higher is better
	14	MOS voice quality score	SpQ_received_R_side_MO	15	3 - 2,5	Higher is better
	14	MOS voice quality score	SpQ_received_H_side_MO	15	3 - 2,5	Higher is better

	11	CCR call completion success ratio	CCR_CS_T	20	100 – 0	Higher is better
	5	PDD post dial delay (sec)	PDD-ST_T_MO	10	15 - 8	Lower is better

5.3.2.2 SMS SSI

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

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

Where:

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

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

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

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

5.3.2.3 PS Data SSI

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

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

Where:

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

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

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

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

5.3.2.4 SQI per VPMN

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

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

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

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

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher -Lower Limit	Scoring Mode
Voice	7	CSSR call set up success ratio	CSSR_MO	16	100 – 0	Higher is better
	14	MOS voice quality score	SpQ_received_R_side_MO	6	3 - 2,5	Higher is better
	14	MOS voice quality score	SpQ_received_H_side_MO	6	3 - 2,5	Higher is better
	11	CCR call completion success ratio	CCR_CS_T	8	100 – 0	Higher is better
	5	PDD post dial delay (sec)	PDD-ST_T_MO	4	15 - 8	Lower is better

SMS	21	SMS success ratio	SA_SMS_MO	14	100 – 0	Higher is better
	25	End-to-End Delivery Time for SMS-MO (sec)	E2E delivery time	6	240-0	Lower is better
Data	33	PDP context activation success ratio	PDP_CA_SR	10	100 – 0	Higher is better
	38	Download Throughput in Mbps	Goodput	20	2 - 0,5	Higher is better
	35	PDP context cut off ratio	PDP_C_COR	10	100 - 0	Lower is better

5.3.2.5 SQI per country

A countrywide SSI allows to compare the overall user experience among different visited countries. In this case the correct weighting is applied to the steering of roaming. In this way the preferred operator performances are weighted more than the non-preferred where it is expected to have less traffic. However, in most cases this information is confidential. Therefore, the criteria to be used option for the countywide SSI is the simple arithmetical average of the SSI_VPMN with equal weights.

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

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

5.3.3 SSI and SQI in 4G roaming

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

5.3.3.1 Voice CSFB

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

The outbound roaming voice CSFB SSI is defined as:

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

Where:

- NER-MO: Service Accessibility Telephony (Network Efficiency Ratio) - MO,

- Return to LTE: CSFB return to LTE success ratio,
- CSFB PDD: CSFB Post Dial Delay.

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

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

5.3.3.2 SMSoSGs

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

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

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

Where:

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

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

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

5.3.3.3 HTTP / HTTPS SSI

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

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

Where:

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

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

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

5.3.3.4 LTE data network performance SSI

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

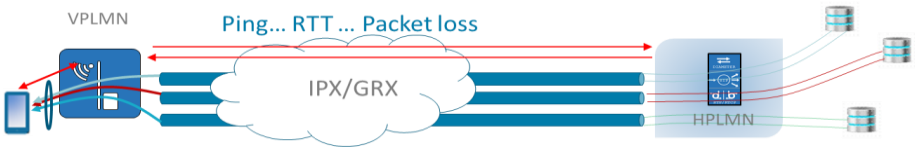


Figure 21: S8HR or LBO-HR data network SSI

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

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

Where:

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

Service	GRQ Number	KPI Name	GRQ KPI	KPI Weight	Higher-Lower Limit	Scoring Mode
LTE data network performance	152	PING round trip time (ms)	RTT	25	370 – 0	Lower is better
	137	FTP download data capacity (mbps)	Max Throughput	50	13.5 - 1	Higher is better
	151	PING packet loss ratio	Packet Loss	25	100 - 0	Lower is better

5.3.3.5 SQI per VPMN

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

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

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

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

	146	HTTP / HTTPS data transfer success ratio	HTTP session completion	15	100 - 0	Higher is better

5.3.4 Reporting of KPI from Passive Measurement by Applet

Figure 22: Service Accessibility – Voice KPI per VPLMN

Figure 23: Network Accessibility – Time on each VPLMN

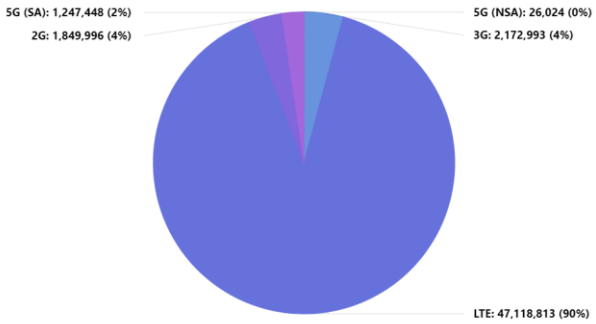


Figure 24: Service Accessibility – Packet Data Attempts

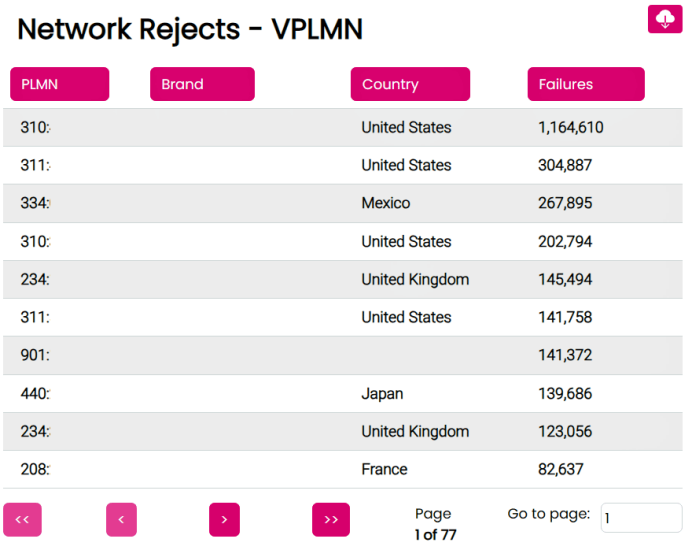


Figure 25: Service Accessibility – Network Rejections

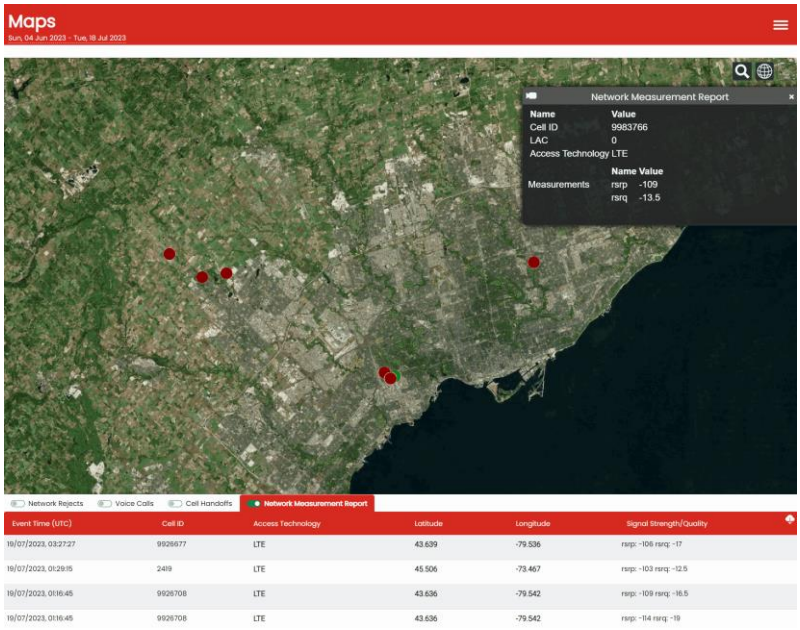


Figure 26: Service Accessibility – Radio Measurements by Location

Figure 27: Service Accessibility – Service Measurement by Location

Annex A GRQ KPI Thresholds

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

A.1 GRQ LTE KPI Thresholds

The thresholds have resulted from the LTE GRQ pilot project performed in Sept 2015[10] [9]. There are two key recommendations for the KPI thresholds for roaming quality in LTE networks.

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

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

A.1.1 LTE Data GRQ KPI Thresholds

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

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

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

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

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

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

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

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

A.2 Voice CSFB and SMSoSGs GRQ KPI Thresholds

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

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

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

A.3 GRQ GSM/GPRS and UMTS KPI Thresholds

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

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

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

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

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

A.4 5G NSA GRQ KPI Thresholds (1)

GRQ Identifier	QoS parameter (KPI)	Threshold	Relevance
500	5G Coverage Indication	⩾ 98.00	Network access
	NR RSRP	⩾ -90.0	Network access
502	Restrict DCNR	⩽ 10.0	Network access
503	ENDC EPS bearer configuration	⩾ 95.00	Service access
504	5G ENDC_Used allocated	>= 85.00	Service access
505	Default EPS bearer QoS parameters	⩾ 95.00	Service access
510	HTTP/HTTPS MBB data transfer success ratio	⩾ 98.00	User experience
530	HTTP/HTTPS MBB Download Rate Mbits/s	⩾ 100	User experience
531	HTTP/HTTPS MBB Upload Rate Mbits/s	⩾ 40	User experience
532	HTTP/HTTPS MBB Latency milliseconds	⩽ 200	User experience

1. thresholds for 5G data should be subjected to be modified after trial period due to “environment” conditions, i.e. Latency could be affected by distance to the node, same with speed, and certain radio conditions.

A.5 5G SA GRQ KPI Thresholds (1)

GRQ Identifier	QoS parameter (KPI)	Threshold	Relevance
519	5QI	⩾ 98.00	Network access
522	SST	⩾ 98.0	Network access
511	5G Siignal to Noise (SNR)		Network access
512	5G Call Setup Time	⩽ 8.0	Service access
513	Call drop Rate	⩽ 2.0	User experience

514	Jitter	⩽ 3.0	User experience
515	Packet Loss	⩽ 3.0	User experience
516	Latency	⩽ 200	User experience
517	MOS	⩾ 4.0	User experience
518	BitRate	⩾ 20.00	User experience
520	SMS Submission Success	⩾ 98.00	Service access
521	SMS Submission Delay	⩽ 600	User experience
523	End To End Success	⩾ 90.00	User experience
524	Latency (End To End Delivery Time)	⩽ 1500	User experience

2. thresholds for 5G data should be subjected to be modified after trial period due to “environment” conditions, i.e. Latency could be affected by distance to the node, same with speed, and certain radio conditions.

Document Management

Document History

Table 1Version	Table 2Date	Table 3Brief Description of Change	Table 4Approval Authority	Table 5Editor / 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		
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1.0	20 Feb 2009	New PRD - GRQ Measurement Implementation	IREG-EMC	David Gillot, Roamware
2.0	Nov 2009	Adding of roaming Hubbing Providing references	IREG-EMC	David Gillot, Roamware
3.0	June 2011	Submitted to DAG and EMC for approval	EMC	David Gillot, Roamware
4.0	May 2015	Including LTE GRQ	NG	Javier Sendin (GSMA)
5.0	October 2015	Major CR1002 included: Differentiation of GRQ Codes and add missing KPIs	NG	Veronique Verhé, SIGOS GmbH
6.0	November 2015	Major CR1003 included: New annex with LTE GRQ Thresholds	NG	Veronique Verhé, SIGOS GmbH
7.0	November 2016	Major CR1004 included: New annex with 2G and 3G Thresholds Major CR1005 included: VoLTE and ViLTE roaming quality KPIs	NG	Veronique Verhé, SIGOS GmbH

Table 1Version	Table 2Date	Table 3Brief Description of Change	Table 4Approval Authority	Table 5Editor / Company
8.0	June 2017	Major CR1006 included: Add SSI and SQI, CR1007 included: Clean-up GRQ codes, CR1008 inlcuded: Correction 2G and 3G thresholds	NG	Veronique Verhé, SIGOS GmbH
9.0	October 2017	Major CR1009 included: Update 2G and 3G GRQ Major CR1010 included: Introduction of 4G SSI and SQI	NG	Veronique Verhé, SIGOS GmbH
9.1	May 2018	Minor CR1012 included: Correction of MBR to AMBR for non-GBR bearer	NG	Veronique Verhé, SIGOS GmbH
10.0	Nov 2018	Minor CR1011 included: Remove reference to IR.78 Minor CR1013 inlcuded: Correction of wrong unit Major CR1014 inlcuded: Add missing CSFB call flows	NG	Veronique Verhé, SIGOS GmbH
11.0	Nov 2019	Major CR1015 included: MIoT GRQ Test Descriptions	NG	Veronique Verhé, SIGOS GmbH
12.0	Oct 2020	Major CR1016 included: NSA EN-DC GRQ	NG	Veronique Verhé, SIGOS GmbH
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13.0	Feb 2023	IR.81 CR1017 5G QoS	NG	Javier Sendin, GSMA
14	Jan 2025	IR.81 CR1018	5G SA QoS Parameters	Mnuela Montagna, HTK