GRQ Measurement Implementation
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Table of Contents

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.

1.2 GRQ Framework

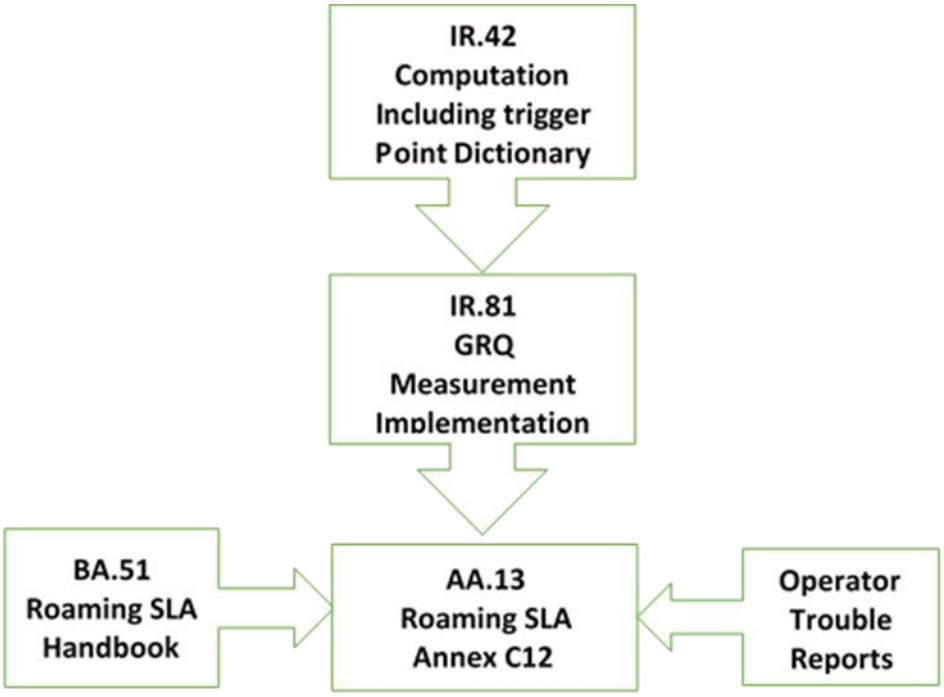

Figure 1: Relation of GSMA PRD IR.81 to other PRDs in the GRQ Framework

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 Scope and Purpose

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

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

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

1.4 Definition of Terms

Term	Description
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

1.5 Document Cross-References

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

No.	Document	Description
[1]	GMSA PRD IR.42	Definition of Quality of Service parameters and their computation
[2]	ETSI TS 102 250-4	"Speech Processing, Transmission and Quality Aspects (STQ); QoS aspects for popular services in GSM and 3G networks; Part 4: Requirements for Quality of Service measurement equipment ".
[3]	ETSI TR 103 114	"Speech Processing, Transmission and Quality Aspects (STQ); QoS parameters and measurement methodology for smartphone".
[4]	3GPP TS 23.272	"Circuit Switched Fallback in Evolved Packet System; Stage 2"
[5]	3GPP TS 23.401	"GPRS Enhancements for E-UTRAN Access"
[6]	3GPP TS 29.272	"MME and SGSN related interfaces based on Diameter protocol"
[7]	3GPP TS 29.274	"Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C); Stage 3"

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
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

Table 1: VoLTE GRQ parameters

(1) The Applet captures IMS Registration but not failures

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)

Table 2 SMS over GSM, UMTS and LTE

(*) 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 Voice 5G QoS parameters

3.2.2.1 Voice Service in 5G

3.2.2.1.1 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 + Protocol involved	Parameter covered by Passive Monitoring Applet/Crowd Related + Protocol involved
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.	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.	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

Connection Quality	519	Echo Return Loss (ERL): The amount of echo that is heard by the user on the receiving end. High ERL can result in feedback and reduce voice clarity.	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.	YES	YES	TBC	NO
Service Establishment	512	Call setup time :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)

Table 3 Voice Service

(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

3.2.2.2 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

3.3 SMS SERVICE QoS Parameters

3.3.1 SMS over GSM, UMTS and LTE

QoS Aspects	QoS Parameters	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. 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 (*)	21 YES 22 YES 23 YES 24.YES	21 YES 22 NO 23 YES 24.NO	21 TBC 22 TBC 23 TBC 24.TBC	21 YES 22 NO 23 NO 24.NO
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.**	25. YES 26. YES	25. YES 26. YES	25. TBC 26. TBC	25. TBC 26. TBC

Table 4 UMTS and LTE

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

SMS over SGs applies the same QoS parameters for SMS.

3.3.2 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	Parameter covered by Passive Monitoring Applet/Crowd Related
1. SMSoIP Accessibility	201 202	IMS Registration success ratio IMS Registration success time	201 YES 202 YES	201 YES 202 YES	201 TBC 202 TBC	201 NO (1) 202 NO
2. Service accessibility	221 222 223 224	SMSoIP-MO accessibility SMSoIP-MT accessibility SMSoIP-MO access delay SMSoIP-MT access delay	221 YES 222 YES 223 YES 224 YES	221 YES 222 YES 223 YES 224 YES	221 TBC 222 TBC 223 TBC 224 TBC	221 YES 222 NO 223 NO 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

Table 5: SMSoIP GRQ parameters

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

3.3.3 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 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
Connection Establishment	TO BE ADDED D520	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	522	Error Rate : The percentage of SMS messages that fail to send or are lost during transmission. A high error rate can indicate network congestion or other issues that affect SMS service quality.	TBC	NO	TBC	YES (1)
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)

Table 6 SMS over 5G

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.

3.4 DATA SERVICE QoS Parameters

3.4.1 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
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

Table 7 GPRS / UMTS

(*) 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)

3.4.2 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.					

Table 8 LTE Parameters

1. implementing DNS related KPI under evaluation

3.4.3 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'

3.4.3.1 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.

3.4.3.2 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

RF Conditions	RSRP [dBm]	RSRQ [dB]	SINR [dB]
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)

Table 9 EN-DC QoS Parameters

3.5 VIDEO SERVICE QoS Parameters

3.5.1 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	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

		OIP transparency MO (CLI transparency) OIP transparency MT (CLI transparency) 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	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)	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	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	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	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

	355 356 357	Dedicated EPS bearer UL GBR (video) Dedicated EPS bearer DL GBR (video) 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	355 YES 356 YES 357 YES	355 YES 356 YES 357 YES	355 TBC 356 TBC 357 TBC	355 NO 356 NO 357 NO
RTP transport quality for ViLTE	260 261 262	RTP max packet delay variation R2H (A-B)	260 YES 261 YES 262 YES	260 YES 261 YES 262 YES	260 TBC 261 TBC 262 TBC	260 NO 261 NO 262 NO

service - audio	263 264 265 266 267 268 269 270 271 272 273 274 275 276 277	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)	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	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	263 TBC 264 TBC 265 TBC 266 TBC 267 TBC 268 TBC 269 TBC 270 TBC 271 TBC 272 TBC 273 TBC 274 TBC 275 TBC 276 TBC 277 TBC	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
RTP transport quality for ViLTE service - video	360 361 362 363 364 365 366 367 368 369	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)	360 YES 361 YES 362 YES 363 YES 364 YES 365 YES 366 YES 367 YES 368 YES 369 YES	360 YES 361 YES 362 YES 363 YES 364 YES 365 YES 366 YES 367 YES 368 YES 369 YES	360 TBC 361 TBC 362 TBC 363 TBC 364 TBC 365 TBC 366 TBC 367 TBC 368 TBC 369 TBC	360 NO 361 NO 362 NO 363 NO 364 NO 365 NO 366 NO 367 NO 368 NO 369 NO

	370 371 372 373 374 375 376 377	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)	370 YES 371 YES 372 YES 373 YES 374 YES 375 YES 376 YES 377 YES	370 YES 371 YES 372 YES 373 YES 374 YES 375 YES 376 YES 377 YES	370 TBC 371 TBC 372 TBC 373 TBC 374 TBC 375 TBC 376 TBC 377 TBC	370 NO 371 NO 372 NO 373 NO 374 NO 375 NO 376 NO 377 NO

Table 10: ViLTE GRQ parameters

3.6 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

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

Table 11 MioT Parameters

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

3.7 IPX SERVICE QoS Parameters – TO BE COMPLETED

QoS Aspects	QoS Parameters
	Jitter Packet Loss Latency

Table 12: MIoT test descriptions for active test methodology

4 QoS Parameter-Method Grid

4.1 Circuit Switched

Methods:		Monitoring by Roaming Hubbing Provider (R)			Monitoring by HPMN (H)		
		End-to-end Active Testing and Monitoring	SS7 Monitoring	CAMEL Monitoring (CS11)	End-to-end Active Testing and Monitoring	SS7 Monitoring	C M
QoS Parameter	GRQ Test Code	A	B	C	A	B	C
Circuit Switched LU Success Ratio (CS LU – SR)	1	N Not applicable	Y (CS2)	N Not applicable	Y	Y (CS2)	N N a
Circuit Switched Location Update Delay	2	N Not applicable	Y (CS3)	N Not applicable	Y (CS1)	Y (CS3)	N N a
Service Accessibility Telephony – MO (SA-T-MO)	3	N Not applicable	N Not applicable	Y (CS10)	Y	N (CS4)	Y
Service Accessibility Telephony – MT (SA-T-MT)	4	N Not applicable	N Not applicable	N	Y	Y	Y
Setup Time Telephony – MO (ST-T-MO)	5	N Not applicable	N Not applicable	Y (CS10)	Y	N (CS5)	Y
Setup Time Telephony – MT (ST-T-MT)	6	N Not applicable	N Not applicable	N	Y	Y	Y
Call Setup Success Ratio (CSSR – MO)	7	N Not applicable	N Not applicable	Y (CS10)	Y	N (CS5)	Y
Call Setup Success Ratio (CSSR – MT)	8	N Not applicable	N Not applicable	N	Y	Y (CS6)	Y
ISUP signalling transparency (REL)	9	N Not applicable	N Not applicable	N	Y (CS20)	N (CS7)	Y
ISUPv2 signalling transparency (OCN and RDN)	10	N Not applicable	N Not applicable	N	N	N (CS8)	Y S

Call Completion Rate Circuit Switched Telephony (CCR-CS-T)	11	N Not applicable	N Not applicable	Y (CS12)	Y	N (CS5)	Y
Average Length of a Call (ALOC)	12	N Not applicable	N Not applicable	Y (CS12, CS19)	N	N (CS4)	Y
CLI Transparency	13a, 13b	N Not applicable	N Not applicable	N Not applicable	Y	N (CS4)	Y C
Speech Quality (SpQ)	14a, 14b	N Not applicable	N Not applicable	N Not applicable	Y	N (CS9)	N

Table 13: Circuit Switched Test Parameters

Remarks:

- (CS1) The measurement might vary depending on the handset integrated in the active probe.
- (CS2) It is assumed that the Location Update (LU) success ratio is visible in the MAP signalling and can be monitored. In other words, it is assumed that the data-fill of the VLR is correct. The failures only happen at the HLR level and Steering of Roaming (SoR)-induced errors are filtered out.
- (CS3) Only for successful LU's and the measured duration is not the same as in VPMN
- (CS4) HPMN does not know when a call fails.
- (CS5) HPMN does not know when a call starts.
- (CS6) It is assumed that there is no cross talk.
- (CS7) HPMN cannot know which kind of release has been used.
- (CS8) HPMN cannot know which network was used for the call forwarding.
- (CS9) The method is non-intrusive.
- (CS10) It is assumed CAMEL works properly and the appropriate CAMEL capabilities are implemented/available.
- (CS11) Always in combination with a SS7 monitoring system
- (CS12) It is assumed the correct CAMEL parameters have been loaded for this call (that is BCSM Event Reports are in use).
- (CS13) Only in case of Home Routing.
- (CS14) CAMEL cannot measure voice quality.
- (CS15) The VPMN cannot know which release the B-party receives
- (CS16) The VPMN cannot know the OCN and RDN at the end of the call.
- (CS17) The VPMN cannot know the CLI of the B-Party
- (CS18) The SCP is at the HPMN side
- (CS19) Need to take into account the customer profile. Best to use only if HPMN customers are all CAMEL enabled.

4.1.7 5G

To be completed to cover all parameters defined section 3.6

4.1.7.1 5G SA Option 2

To be completed

4.1.7.2 5G NSA Option 3

4.1.7.2.1 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 transfer success ratio	Calculation of the 5G MBB data transfer success ratio uses the same formula referred to the KPI 146 (HTTP / HTTPS data transfer success ratio), with an exception of the HTTP / HTTPS data transfer on pure MCG bearer type (i.e. only on the LTE resource) is considered as a fail due to be missing the SCG resource usage. It implies a lower data rate. Aggregation of multiple tests yields the MBB data transfer success ratio.	

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

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

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

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 "

4.1.7.3 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).			

4.1.7.4 Voice Service in 5G

4.1.7.4.1 Voice Service in Option 2

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

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.	

4.1.7.4.2 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

4.1.7.5 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	Test specifics
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	
522AH, 522AV	Error Rate		
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.	

4.1.7.6 Video Service in 5G

Section to be completed

Active testing is a methodology where test traffic is generated to simulate real user traffic and then sent and received through the network to measure its performance and quality. Here's how the key Quality of Service (QoS) parameters for Video Streaming in 5G can be measured using active testing methodology. These KPIs result from calculating the video-quality KPIs from the captured video after converting it to raw format. Initially these KPIs are calculated for each video-frame and in the end, the average value is used for the final KPI value.

1. Blockloss: Block loss occurs when some of the data packets forming the compressed stream of video are lost during one of the transmission stages
2. Blur: Blur (blurring) shows as a reduction of edge sharpness and spatial detail
3. Spatial Activity: The degree of detail in a video, such as the presence of sharp edges, minute details, and texture
4. Freezing: is caused by the use of an inadequate sampling/display or transmission delays of the coded bit-stream to the decoder.

4.1.7.7 Where to measure:

4.1.7.7.1 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.

4.1.7.7.2 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.

4.1.7.7.3 Known Limitations:

4.1.7.7.4 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).

4.1.7.7.5 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.

4.1.8 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 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.
	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.	-

GRQ Test Code	Parameter	Measurement	Specifics
COVERAGE			
	Service retention	**% of all time connected to VPLMN**	**Qualified by VPLMN**
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.

Table 14: Parameter measurement table

4.1.9 LTE Probe Test Specification

to be added

4.1.10 Volte/Vilte and SMSoIP

to be added

4.1.11 MIoT

to be added

4.1.12 5G

To be added to cover all parameters defined section 3.6

4.1.12.1 5G SA Option 2

To be completed

4.1.12.2 5G NSA Option 3

4.1.12.3 Voice Service in 5G

4.1.12.3.1 Voice Service in Option 3

to be completed

4.1.12.4 SMS Service in 5G

to be completed

4.1.12.5 Video Service in 5G

to be completed

4.1.13 SMS, SMSoSGs and SMSoIP

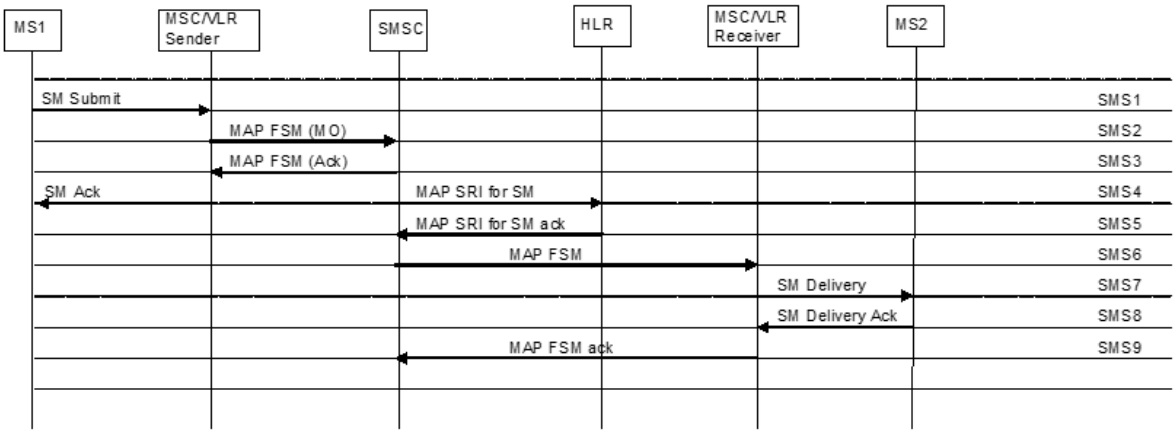


Figure 2: SMS and SMSoSGs

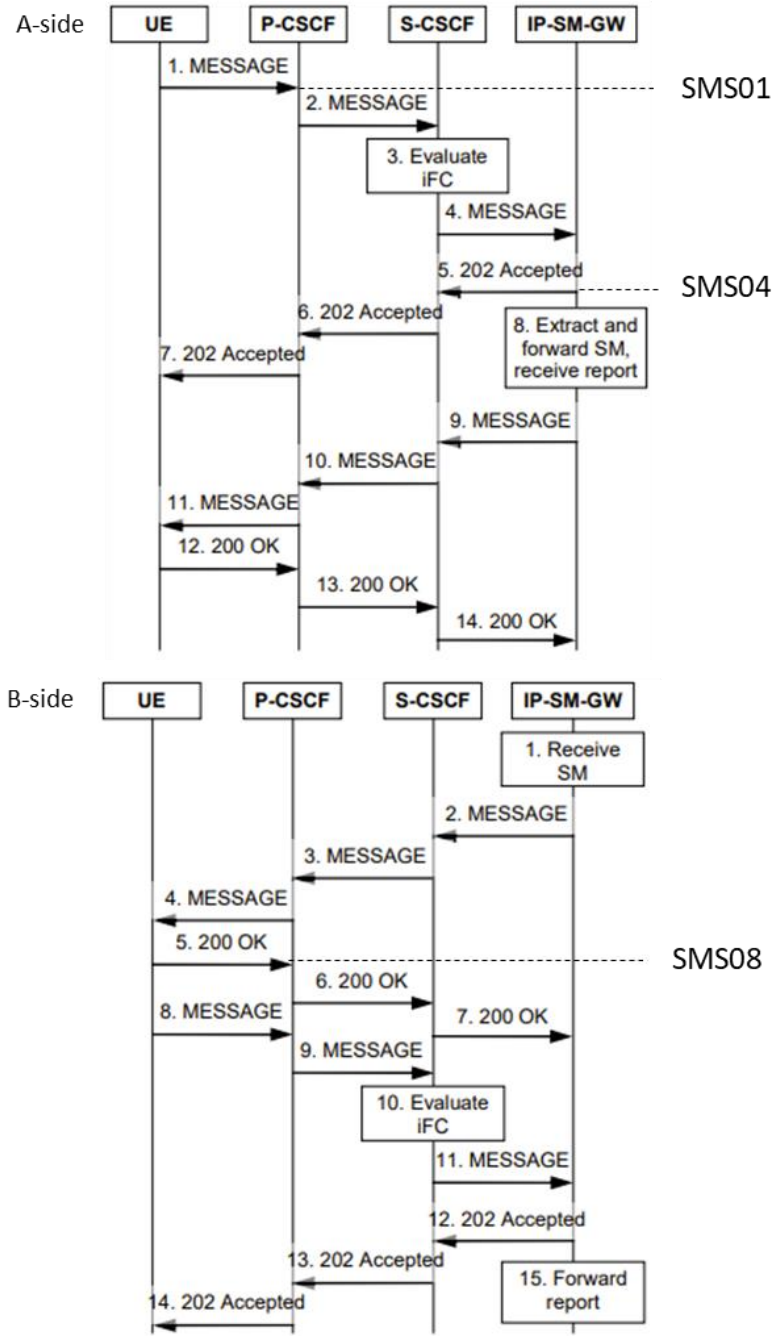
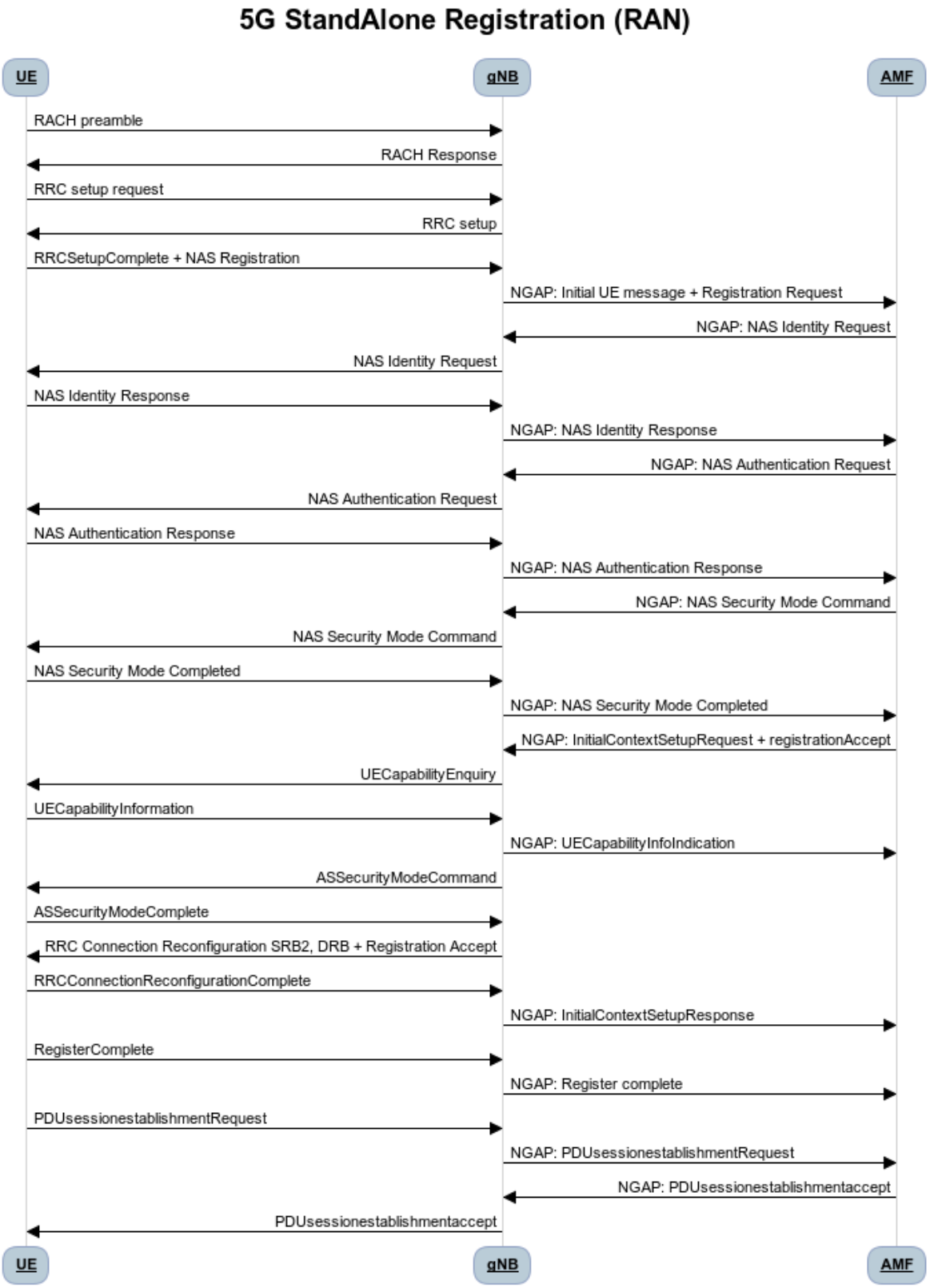
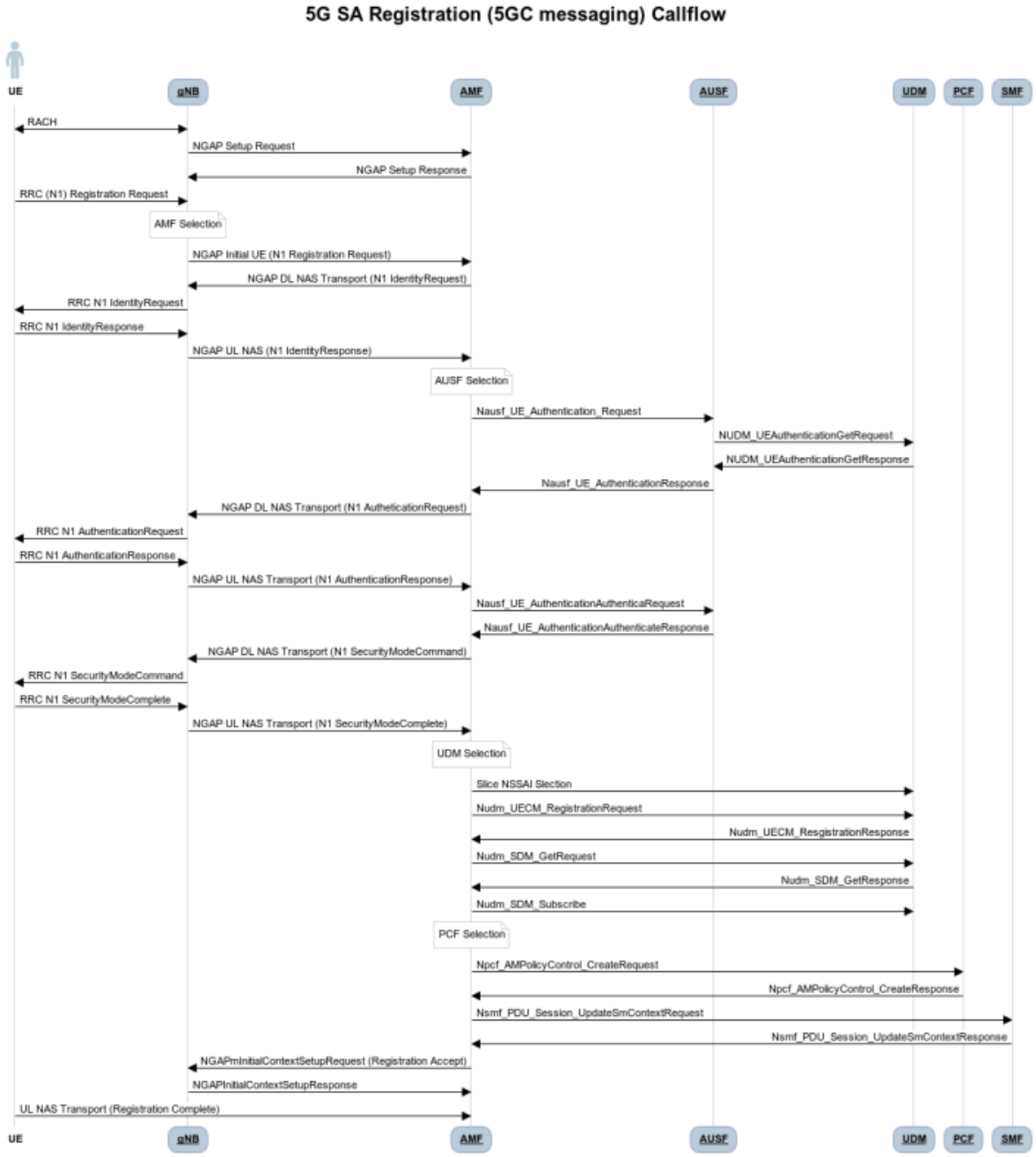


Figure 3: SMSoIP (SIP)

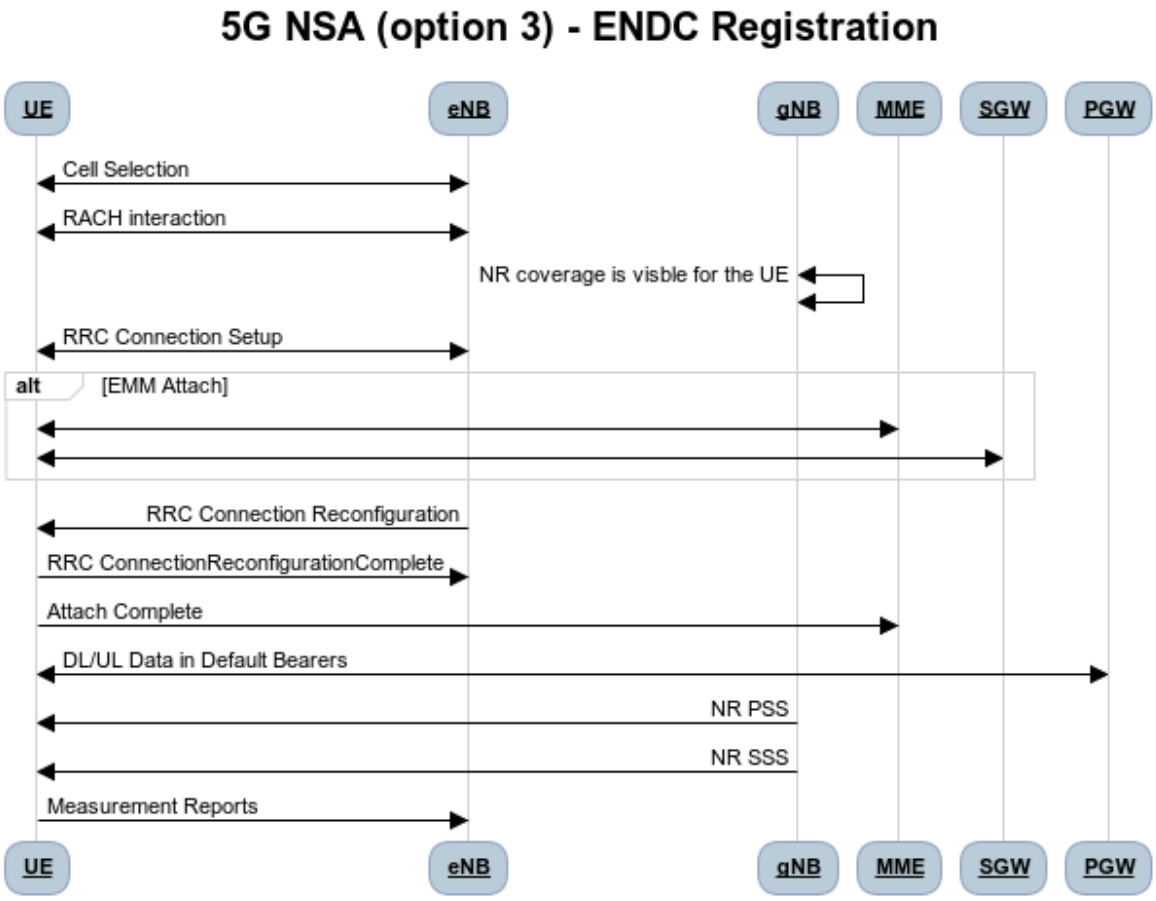
4.1.13.1 5.4.10.1 5G StandAlone Registration (RAN) procedure



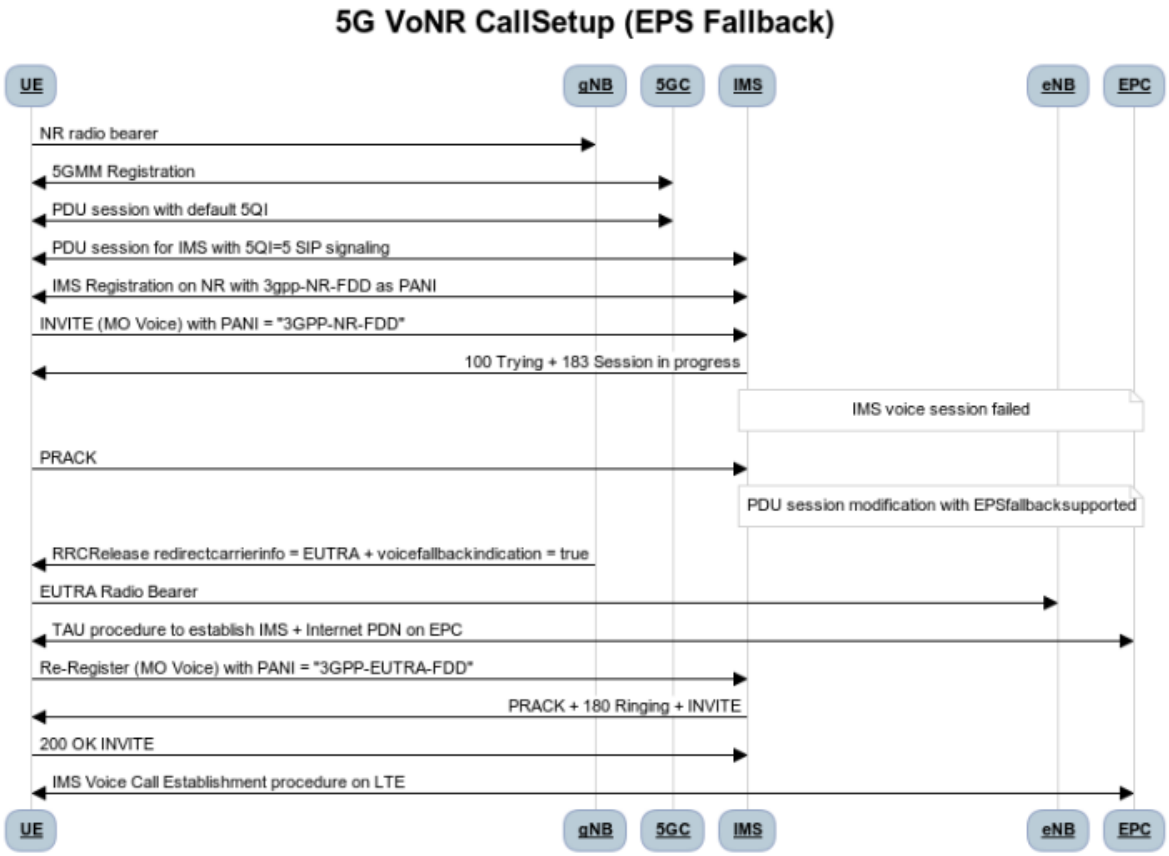
4.1.13.1.1 5.4.10.2 5G StandAlone Registration (CORE Network details)



4.1.13.2 5.4.10.3 5G NSA Registration (option3)



4.1.13.3 5.4.10.4 5G VoNR callsetup (EPS Fallback)



4.1.13.4 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)

4.1.14 Reporting of KPI from Passive Measurement by Applet

Figure 4: Service Accessibility – Voice KPI per VPLMN

Time on PLMN

PLMN	Brand	Country	Connected Hours	% Connected Time
364:		Bahamas	195,113,424	96.5
334:		Mexico	1,579,112	0.8
222:		Italy	696,358	0.3
515:		Philippines	603,817	0.3
370:		Dominican Republic	520,111	0.3
302:		Canada	116,603	0.1

<< < > >> Page 1 of 82 Go to page: 1

Figure 5: Network Accessibility – Time on each VPLMN

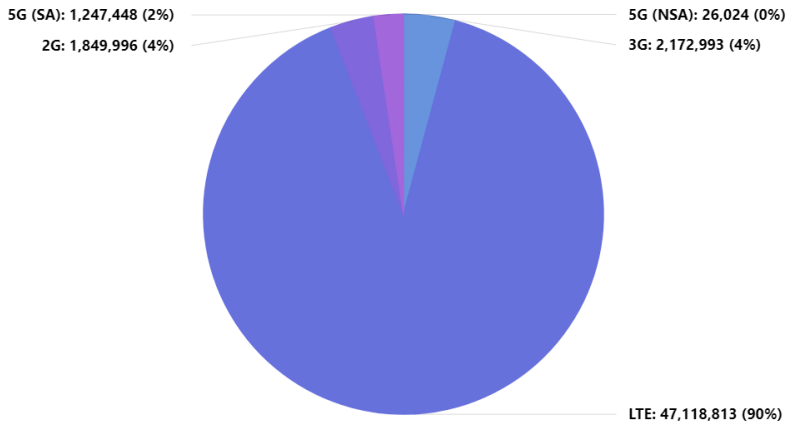


Figure 6: Service Accessibility – Packet Data Attempts

Figure 7: Network Rejects - VPLMN **Service Accessibility – Network Rejections**

PLMN	Brand	Country	Failures
310:		United States	1,164,610
311:		United States	304,887
334:		Mexico	267,895
310:		United States	202,794
234:		United Kingdom	145,494
311:		United States	141,758
901:			141,372
440:		Japan	139,686
234:		United Kingdom	123,056
208:		France	82,637

<< < > >> Page 1 of 77 Go to page: 1

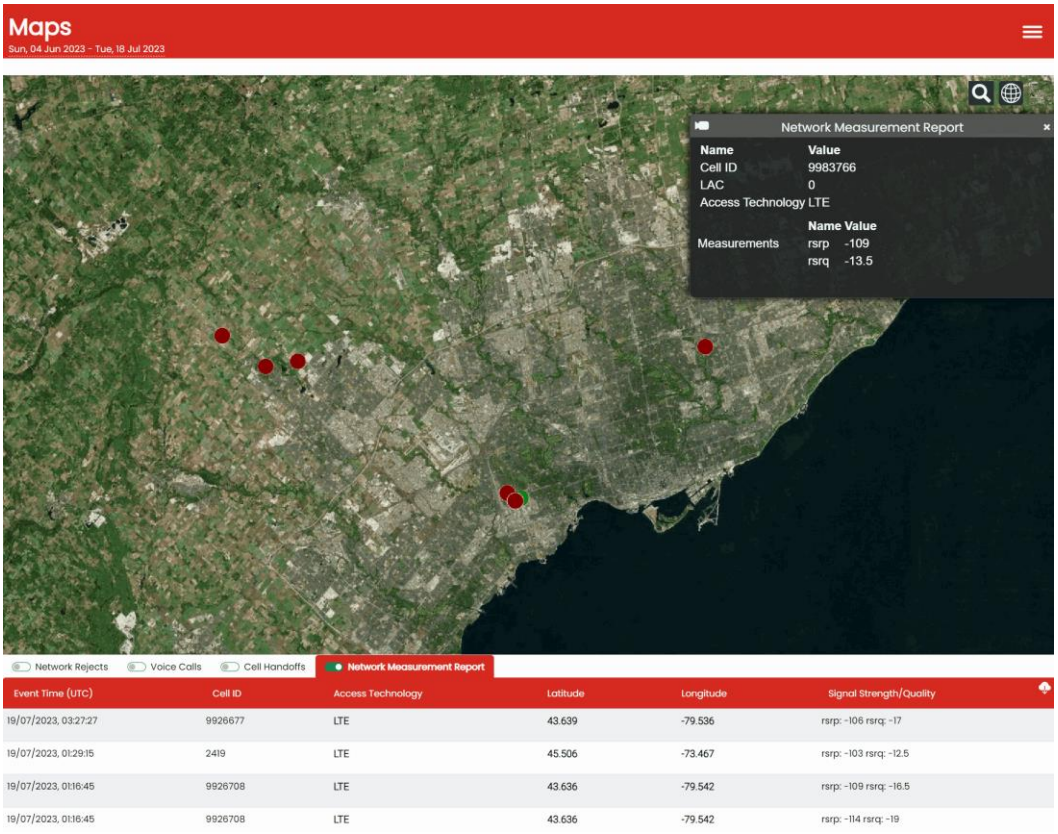


Figure 8: Service Accessibility – Radio Measurements by Location

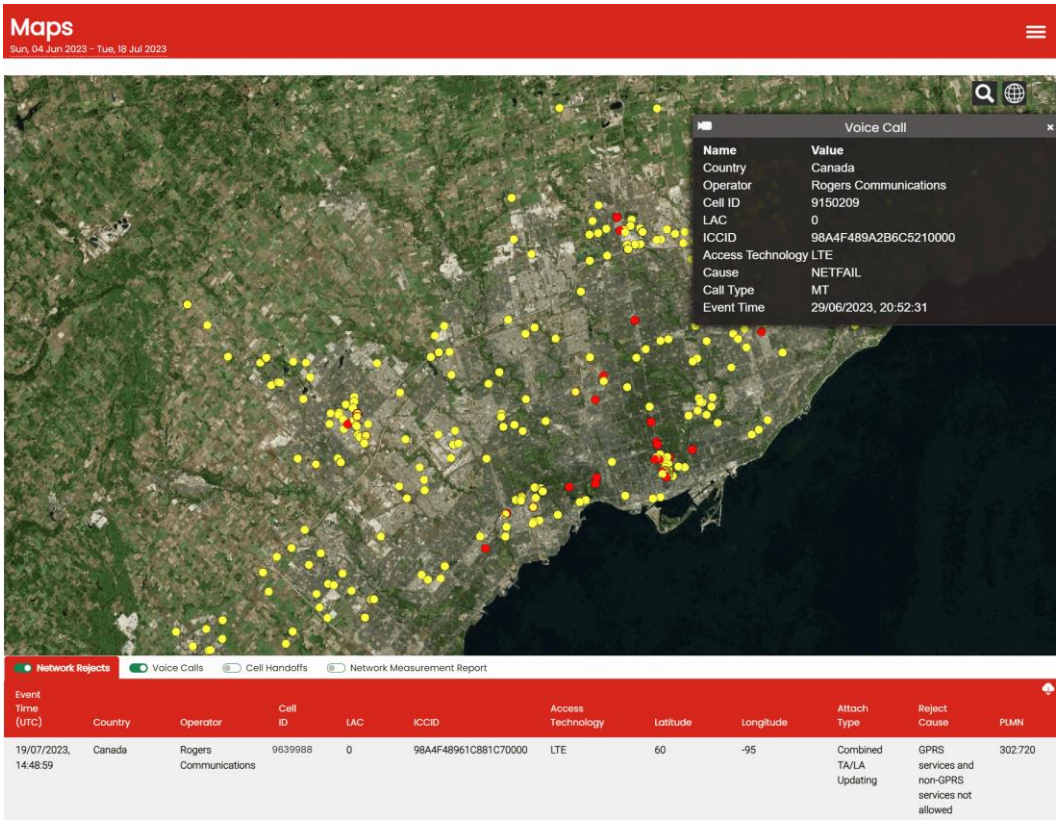


Figure 9: Service Accessibility – Service Measurement by Location

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[9] [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
108	DNS host name resolution time (ms)	≤ 250	≤ 550	User experience

[9] 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.

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

152	PING round trip time (ms)	≤ 100	≤ 370	User experience

Table 15: GRQ KPI Threshold for LTE data roaming

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

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

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

A.2 Voice CSFB and SMSoSGs GRQ KPI Thresholds

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

GRQ KPI Definition		Threshold		Relevance
GRQ Identifier	**QoS parameter (KPI)**	**Geo-distance < 4000 km**	**Geo-distance ≥ 4000 km**	
101	Location update (combined) success ratio (%)	≥ 99.00		Network access
102	Location update (combined) delay (s)	≤ 6	≤ 9.5	User experience
103a	CSFB return to LTE success ratio - MO (%)	≥ 99.00		Service access
103b	CSFB return to LTE success ratio - MT (%)	≥ 99.00		Service access
104a	CSFB return to LTE time - MO (s)	≤ 9	≤ 11	User experience
104b	CSFB return to LTE time - MT (s)	≤ 9	≤ 13,5	User experience
3	CSFB voice service access success ratio - NER-MO (%)	≥ 99.00		Service access
4	CSFB voice service access success ratio - NER-MT (%)	≥ 99.00		Service access
115	CSFB voice service setup time PDD-MO (s)	≤ 12	≤ 20	User experience
116	CSFB voice service setup time PDD-MT (s)	≤ 13.5	≤ 13.5	User experience

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

Table 16: GRQ KPI thresholds for voice CSFB and SMSoSGs roaming

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

Table 17: GRQ KPI thresholds for GSM / GPRS and UMTS

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

A.4 5G GRQ KPI Thresholds (1)

GRQ Identifier	QoS parameter (KPI)	Threshold	Relevance
500	5G Coverage Indication	⩾ 98.00	Network access
501	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.

Document Management

Document History

Table 18Version	Table 19Date	Table 20Brief Description of Change	Table 21Approval Authority	Table 22Editor / Company
0.5	26 Aug 2008	Clean version for SIGNAL and PACKET comments.	N/A –draft only	David Gillot, Roamware
0.51	23 Sep 2008	Editorial corrections to trigger table as noted by Inge Menschaert, Vodafone.		
0.52	10 Oct 2008	Editorial corrections as noted by Magnus Zimmerman, Polystar.		
0.6	12 Dec 2008	Further revisions and editorial changes		
0.7	22 Dec 2008	Editorial and formatting corrections		David Maxwell, GSMA
1.0	20 Feb 2009	New PRD - GRQ Measurement Implementation	IREG-EMC	David Gillot, Roamware
2.0	Nov 2009	Adding of roaming Hubbing Providing references	IREG-EMC	David Gillot, Roamware
3.0	June 2011	Submitted to DAG and EMC for approval	EMC	David Gillot, Roamware
4.0	May 2015	Including LTE GRQ	NG	Javier Sendin (GSMA)
5.0	October 2015	Major CR1002 included: Differentiation of GRQ Codes and add missing KPIs	NG	Veronique Verhé, SIGOS GmbH
6.0	November 2015	Major CR1003 included: New annex with LTE GRQ Thresholds	NG	Veronique Verhé, SIGOS GmbH
7.0	November 2016	Major CR1004 included: New annex with 2G and 3G Thresholds Major CR1005 included: VoLTE and ViLTE roaming quality KPIs	NG	Veronique Verhé, SIGOS GmbH

Table 18Version	Table 19Date	Table 20Brief Description of Change	Table 21Approval Authority	Table 22Editor / 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
12.1	Mar 2023	Major CR1017 to include document re-organization, 5G KPIs (NSA and SA) for GRQ	NG	Ariel Vergara, Mobileum Inc.
13.0	Feb 2023	IR.81 CR1017 5G QoS	NG	Javier Sendin, GSMA