DRAFT FRAMEWORK FOR THE QUALITY OF SERVICE (QoS)

ASSESSMENT OF MOBILE SERVICES

DECEMBER 2025

FOR PUBLIC PARTICIPATION

Contents

Acronyms

2G- 2nd Generation of Mobile Radio Access Network (also called GSM)
3G- 3rd Generation Mobile Radio Access Network (also called UMTS)
4G- 4th Generation Mobile Radio Access Network (also called LTE)
5G- 5th Generation Mobile Radio Access Network
5G NSA- 5G Non-Stand-Alone
5G SA- 5G Stand-Alone
CA – Communications Authority of Kenya
CSFB- Circuit-Switched Fall Back
dBm-Decibel-milliwatts
Ec/Io -energy per chip to total interference ratio
EN-DC- E-UTRAN New Radio Dual Connectivity
ETSI- European Telecommunications Standards Institute
HTTP- Hyper Text transfer Protocol
ITU – International Telecommunications Union
KICA – Kenya Information and Communications Act
KICA- Kenya Information and Communications Act
KPI – Key Performance Indicators
Mbps – Megabits Per Second
MNO- Mobile Network Operators
MOS- Mean Opinion Score
NP- Network Performance
OMC- Operations & Maintenance Centre
POLQA – Perceptual Objective Listening Quality Assessment
QoE – Quality of Experience
QoS – Quality of Service
RF- Radio Frequency
RS CP- Received Signal Code Power
RSRP- Reference Signal Received Power
RSRQ- Reference Signal Received Quality
USF-Universal Service Fund
VoLTE- Voice over LTE
VoNR- Voice over New Radio

Definition of Technical terms

Network Availability *(Layer 1):*

This is the degree to which a network is functional and not in a state of failure or outage. This indicator also carries with it the element of network coverage often expressed in the received signal level. Network availability, however, goes beyond coverage in view of the requirement of a network to be reliable and capable of guaranteeing continuity of a service. The QoS parameters in respect of these are aimed at reflecting the user's experience of the performance of the services provided by the service provider within the coverage area. Network coverage information captured and presented in terms of signal strength will also be reflected separately under this KPI category.

Network Accessibility (Layer 2):

This is the degree to which a user can perform a successful registration on the network, which delivers the service. Please note that the network can only be accessed if it is available to the user.

Service Accessibility (Layer 3):

This is the degree to which a user can access the service he wants to use. A given Network Accessibility is a precondition for this phase

Service Integrity (Layer 3):

This describes the QoS during service use and contains elements such as the quality of the transmitted content, speech quality, video quality or number of bit errors in a transmitted file. The Service Integrity can only be determined if the service has been accessed successfully

Service Retain-ability (Layer 3):

This describes the degree to which a service is retained or terminated while in use. Examples for QoS parameters under this KPI are cut-off parameters, e.g. the call drop rate, or the data link drop ratio. A previously performed successful service access is a precondition for this phase.

Quality of experience (QoE):

Quality of Experience relates to the overall quality of service that include the network, devices as well as the users' experience and expectations of a particular service. QoE therefore is more about subjective considerations that vary from person to person. QoE is however determined using objective measurements statistical analysis through Customer Satisfaction Surveys.

1. BACKGROUND

The Communications Authority of Kenya (CA) is the regulatory authority for the ICT sector in Kenya, established by the **Kenya Information and Communications Act, 1998 as amended.** CA is mandated to regulate the fields of Telecommunications, E-commerce, broadcasting, postal/courier services and cyber security and for managing the country's numbering and frequency spectrum resources as well as safeguarding interests of consumers of ICT services. CA is also responsible for managing the country's numbering and frequency spectrum resources and administering the Universal Service Fund (USF) as well as safeguarding the interest of users of ICT services.

The 2023-2027 Strategic mission of the Authority is to *Enable a Sustainable Digital Society through Responsive Regulation* with a commitment to ensuring that everyone in Kenya has access to affordable, reliable, and ***high-quality communication services***. In view of this, the Authority maintains a framework for assessing the Quality of Service for Telecommunication Systems and services which serves as a guide to ensure Kenyans receive Quality services from mobile operators.

The current framework for the assessment of the Quality of Service (QoS) of Telecommunication Systems and Services was *gazetted* on 23rd February 2018 (Gazette Notice no. 1712). Since then, several technological advancements have emerged in the sector, including the deployment of newer mobile technologies such as 4G and 5G. The KPIs for 4G and 5G were not encompassed within the original framework, resulting in challenges when conducting assessments of mobile networks which have a combination of all these technologies.

The framework made provision for regular reviews to cope with the rapid advancements in Technology, coupled with the need to ensure services offered by new technologies to the public meet the quality requirements acceptable by the international best practice. The aim is to ensure that consumers continue to have access to high quality telecommunications services by setting basic minimum quality levels for all operators.

2. INTRODUCTION

The Communications Authority of Kenya (CA) is mandated by the KICA to ensure mobile operators maintain the highest standards of services while offering communication services to the public.

As such, the Authority maintains a framework for monitoring Quality of service (QoS) for mobile Telecommunication industry by setting minimum QoS standards in service delivery for the telecommunications industry in Kenya.

Under the current framework for assessment, the three (3) main components that constitute Mobile Network Quality of Service (QoS) Monitoring framework for Voice, Data and SMS are elaborated as follows:

2.1. Current End-to -End (E2E) Quality of Service (QoS)

The End-to-End (E2E) Quality of Service (QoS) is defined as the totality of characteristics (end-to-end) of a telecommunications service that bear on its ability to satisfy the stated and implied needs of the user of the service (Recommendation ITU-T E.800). These are QoS measurements that takes into account user experience on all network equipment and customer equipment, undertaken using vehicle mounted and backpack QoS monitoring tools.

2.2. Current Network Performance (NP)

The Network Performance (NP) assessment is the gathering and analysing of network statistics called performance indicators to assess the quality of service provided by a telecommunication network. It relates to the assessment of the network part of the service without considering user influencing factors such as devices. It is undertaken through a system connected directly to the mobile networks core interfaces to obtain network QoS counters for quality-of-service assessment.

It is both a quantitative and a qualitative analysis and is a crucial tool for understanding the health of the network.

E2E and NP generally seek to address the following:

Availability
Availability is the measure of the proportion of up-time of each network element (nodes, servers, base stations etc.). With this indicator we understand how long the functioning element was out of work, it is the first indicator to consider when assessing the health of a system.

Accessibility
Accessibility measures the proportion of the ability to access the network which in general is provided by the establishment rate meaning the proportion of channels that could be accessed/used for establishing a call or a data session.

Retainability
Retainability measures the proportion of calls or sessions that went undisturbed during its entirety, meaning the sessions/calls that had no drops, and call drop rate.

Integrity
Integrity measures the proportion of calls/sessions that went undisturbed during its life, so where the real quality is measured in terms of clearness for calls, latency, throughput, jitter and round-trip-time for data sessions.

Usability
Usability is the level of usage of a network meaning the traffic; number of calls and their duration, volume of data, number of simultaneous connections and its time and space distribution.

2.3. Current Quality of Experience (QoE)

The Quality of Experience (QoE) is defined as the overall acceptability of an application or service, as perceived subjectively by the end-user (Recommendation ITU-T P.10/G.100). It is the degree of delight or annoyance of the user of an application or service.

The assessment of QoE relates to the overall quality of service that includes the network, devices as well as the users' experiences and expectations of a particular service. It is a subjective customer perception on QoS, obtained through an objective statistical measurement undertaken through surveys alongside the customer satisfaction surveys.

The E2E QoS, NP and QoE framework is illustrated in figure 1(a) and (b).

Fig 1(a): Architecture of End-to-End QoS, Network Performance & QoE

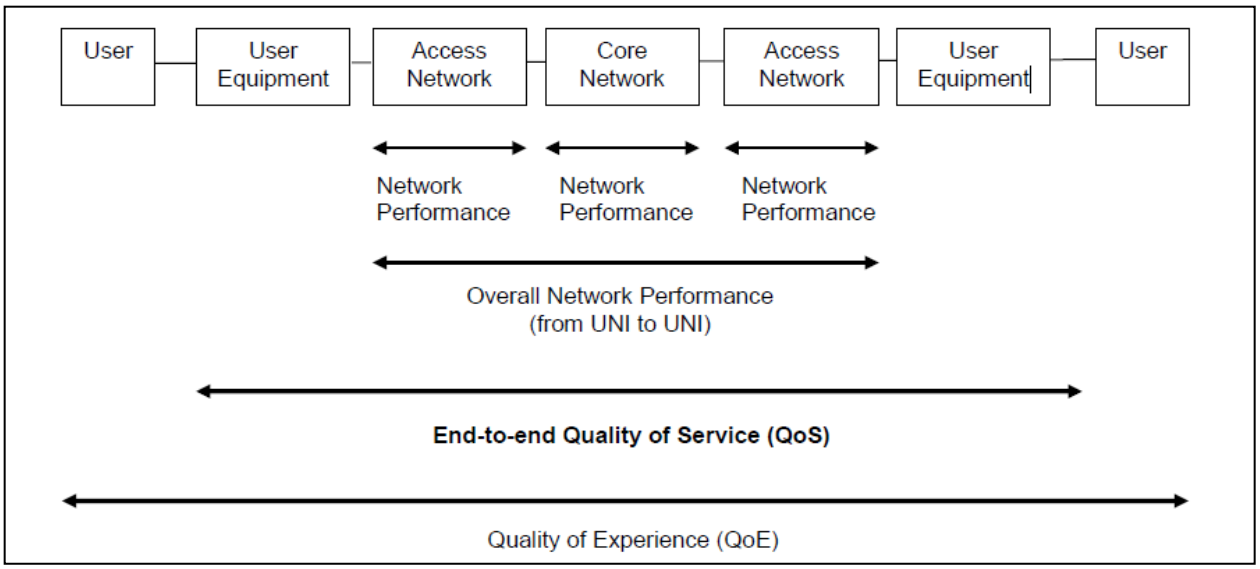
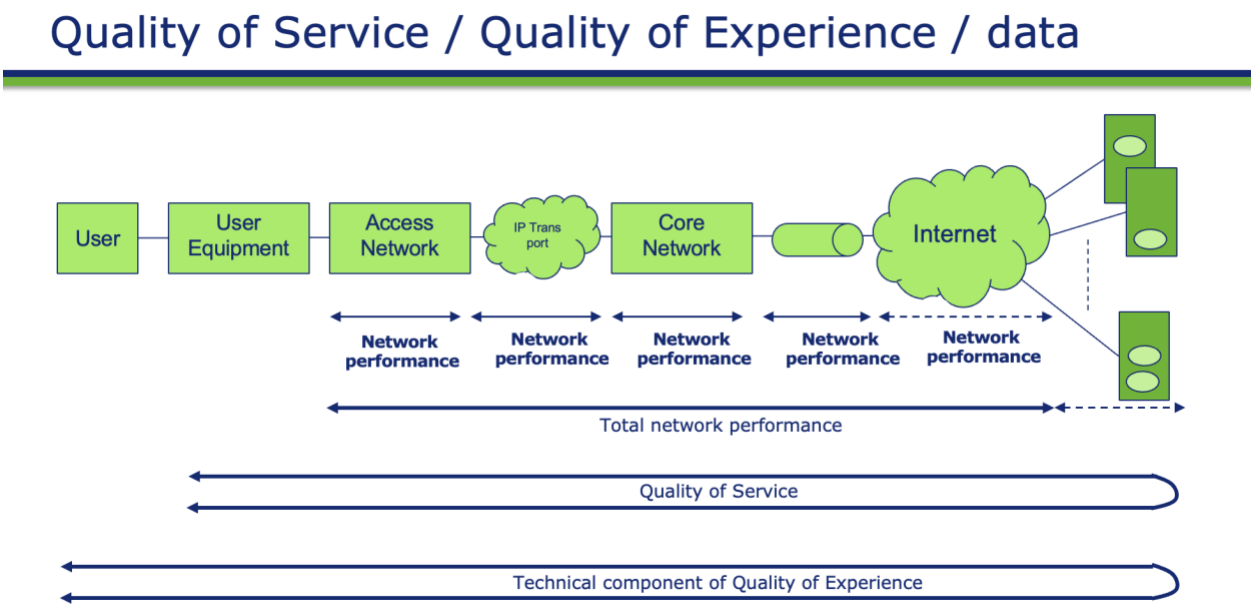


Fig 1(b): Architecture of End-to-End QoS, Network Performance & QoE



2.4. Current QoS Components Weighting

The framework also provided for weightings to be applied on the three components to come up with a weighted average of the QoS performance. The current weighting of the components is provided in Table 1, in which the threshold for compliance was set at 80%.

Table 1: QoS Components' Weighting

QoS Component	Weighting
End to End (E2E) Drive Test QoS	60%
Network Performance QoS	25%
Quality of Experience (QoE)	15%

2.5. Current QoS KPIs QoS Monitored

The current end-to-end QoS Key Performance Indicators (KPIs) for Voice, Data and SMS services that are currently monitored are presented in Table 2, which also presents a comparison with the proposed KPIs.

Table 2: End to End QoS of Voice, Data and SMS Key Performance Indicators (KPIs) Monitored

Service	KPI Hierarchy	Parameter	Technology	Current Target	Proposed Target
Telephony (Voice)	Network Coverage	Coverage roll out	All	≥ 103 dBm	See RF Coverage KPI
	Network Availability	Received Signal Level	All	≥ 95 dBm	
	Accessibility	Unsuccessful Call Ratio	All	< 5%	≤ 4%
		Call Setup Time	2G, 3G, 4G (CSFB)	≤ 8 Sec	≤ 7s
			VoLTE	≤12 Sec	≤ 3s
			5G SA (VoNR)[1]	None	≤ 2s
	Retainability	Drop Call Rate	2G, 3G, 4G	≤ 2%	≤ 2%
			5G SA (VoNR)	None	≤ 2%
		Handover Success Rate	All	> 96%	≥ 98%
	Integrity	Voice Quality (MOS, POLQA)	2G, 3G, 4G	> 3.4	≥ 3.5
			5G SA (VoNR)	None	≥ 4

[1] *5G SA (VoNR) refers to **Voice over New Radio (VoNR)**, a technology that allows voice calls to be made over a standalone (SA) 5G network architecture*

Service	KPI Hierarchy	Parameter	Technology	Current Target	Proposed Target
SMS	Retainability	Completion Rate for SMS	All	≥ 95%	≥ 98%
	Availability/ Integrity	End-to-End Delivery Time for SMS	All	≥ 95%	≤ 5s
		End-to-End delivery time	All	≥ 95% in less than 30s	None
Data	Accessibility	EN-DC Setup Success Rate	5G (NSA)[2]	None	≥ 99%
	Retainability	Download Transfer Failure Ratio	All	≤ 10%	≤ 8%
		Upload Transfer Failure Ratio	All	≤ 10%	≤ 8%
		HTTP Completion Failure Ratio	All	< 90%	≤ 5%
	Integrity	Latency	2G, 3G	≤ 100ms	≤ 100ms
			4G	None	≤ 80ms
			5G SA (VoNR)	None	≤ 10ms
		Jitter	All	≤ 50ms	None
			4G	None	≤ 70ms
			5G SA (VoNR)	None	≤ 30ms
		Packet Loss Ratio	All	< 5%	None
			4G	None	≤ 0.1%
			5G SA (VoNR)	None	≤ 0.1%
		Internet Accessibility	Not specified	≥ 98%	None
		HTTP Completion Time	All	≥ 95% in less than 20s	≤ 5s
		HTTP generic scenario availability	All	≥ 85%	None
		Download throughput	All		

[2] *5G NSA, or Non-Standalone, is the initial deployment method for 5G networks that uses the existing 4G LTE core network to support a new 5G radio access network (RAN)*

Service	KPI Hierarchy	Parameter	Technology	Current Target	Proposed Target
		Upload throughput		≥ 85% of contractual throuput	Informational KPI – No defined threshold

Since the framework was adopted, several technological advancements have emerged in the sector, including the deployment of newer mobile technologies such as 4G and 5G. The current KPIs listed in Table 2 do not encompass parameters for 5G, henced the Authority has reviewed them in line with the **Network QoS benchmark scoring methodology.**

3. REVISED FRAMEWORK FOR MOBILE NETWORK

As indicted above, the Authority carried out a comprehensive review of the current framework for mobile network and proposes the revision of the Mobile Network QoS KPIs and the adoption of **Network QoS benchmark scoring methodology** based on ETSI TR 103 559 standard, which is elaborated below.

3.1. Network QoS Benchmark Scoring Methodology

This methodology considers a set of Key Performance Indicators (KPIs) that distinctly separates **Radio Frequency (RF) Coverage** from **End-to-End (E2E) Service** to ensure that the radio frequency coverage and service dimensions of the mobile network performance are independently and objectively assessed.

a) **Radio Frequency (RF) Coverage KPIs**, which measure the availability and quality of the radio signal; and

b) **End-to-End (E2E) Mobile KPIs**, which assess the user's actual experience in accessing and using mobile services over the network.

This segregation enables the accurate determination whether observed deficiencies arise from coverage limitations or from service-level constraints within the network, thereby enhancing diagnostic precision and regulatory decision-making.

3.1.1. RF Coverage KPIs

The RF Coverage KPIs evaluate the extent of signal availability (**Signal Strength**) and signal integrity (**Signal Quality**) across different areas and technologies. They serve as foundational indicators of network reach, reflecting how effectively an operator's radio infrastructure delivers signal coverage to end users. The assigned weights reflect the relative importance of each metric:

a) **Signal Strength (Weight: 45%)** – Measures the received signal power (e.g., RSRP for 4G/5G, RSCP for 3G, RXLev for 2G) and reflects the network's basic availability. Higher weight is assigned because maintaining minimum signal levels is critical for service accessibility, particularly in areas with high population density.

b) **Signal Quality (Weight: 55%)** – Assesses the quality of the received signal (e.g., RSRQ for 4G/5G, Ec/Io for 3G, RxQual for 2G) and indicates the level of interference and overall radio link integrity. Signal Quality carries slightly higher weight than strength to emphasize service performance and user experience, which can be affected even when coverage exists.

To account for population distribution and network priorities, KPIs are assessed across tiered geographical areas, with assigned weights and rationale as follows:

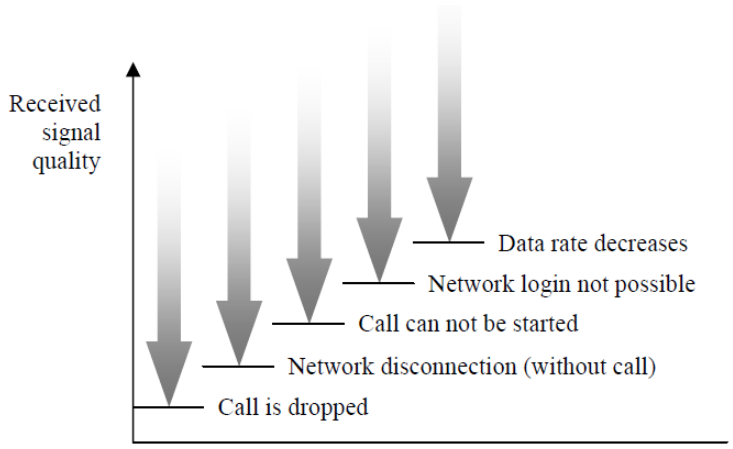
- **Good Tier** (Urban and densely populated cities; Weight: 60%) – ≥ 80% of sampled signal measurements must meet the KPI threshold of –93 dBm or better. Urban areas carry a 60% weighting due to dense population, intensive data usage, and higher service expectations.

- **Average Tier** (Semi-urban, rural, marginalized regions; Weight: 40%) – ≥ 80% of sampled signal measurements must meet the KPI threshold of –98 dBm or better. Semi-urban and rural areas carry a 40% weighting to reflect their importance in providing broader network coverage and ensuring connectivity to underserved populations.

- **Bad Tier** (All areas below minimum coverage; Weight: Small Positive Percentage): This weight represents the MNO's successful **avoidance of service failure**. A small, positive weight is assigned to reward the operator for maintaining the percentage of samples below the unacceptable threshold (e.g., <-98 dBm) within the defined target.

This weighting and tiered approach ensures that RF coverage scoring accurately reflects both network reach and quality, while maintaining comparability across operators and technologies.

The relationship between signal reception quality and performance is illustrated overleaf.



Source: ECC Report 103

If the reception quality gets poorer, the following effects are observed:

- Data rate decreases
- Call that has been established is disconnected ("dropped call")
- New call can not be started
- Equipment is logged out of the network ("network disconnection")
- Equipment can not be logged into the network ("network access")

Table 3 presents the proposed RF Coverage KPI parameters and their respective thresholds.

Table 3: Proposed RF Coverage KPI parameters and the respective thresholds

KPI Metric	Tier	Applicable Areas	Technology	Signal Thresholds	Target of Samples	Worst Acceptable Limit (%)	Excellent Target (%)
Signal Strength	Good	Urban and densely populated cities	All	≥ –93 dBm	≥ 80 %	65	95
	Average	Semi-urban, rural, marginalized regions	All	≥ –98 dBm	≥ 80 %	65	95
	Bad	All areas	All	< –98 dBm	0.5%	2	0
Signal Quality	Good	Urban and densely populated cities	4G/5G	RSRQ ≥ –10 dB	≥ 80 %	65	90
			3G	Ec/Io ≥ –10 dB	≥ 80 %	65	95
			2G	RxQual ≤ 2	≥ 80 %	65	95
	Average	Semi-urban, rural, marginalized regions	4G/5G	RSRQ ≥ –15 dB	≥ 80 %	65	90
			3G	Ec/Io ≥ –13 dB	≥ 80 %	65	95

KPI Metric	Tier	Applicable Areas	Technology	Signal Thresholds	Target of Samples	Worst Acceptable Limit (%)	Excellent Target (%)
			2G	RxQual ≤ 3	≥ 80 %	65	95
	Bad	All areas	4G/5G	RSRQ < –15 dB	0.5%	2	0
			3G	Ec/Io < –13 dB	≤1%	3	0
			2G	RxQual > 3	≤1.5%	4	0

These parameters provide a comprehensive view of the network's radio environment and form the technical basis upon which higher-layer performance indicators, such as speech quality and data throughput, are evaluated.

The definition of the applicable areas requires finer refinement to explore the use of polygons in demarcating urban, semi-urban, rural and marginalized areas based on geographical (administrative units) and population or a combination of both to accurately define the landscape.

The final coverage quantification synthesizes these stratified RF measurements into a composite score. This score represents the network's foundational capability to provide a viable radio link for service initiation and continuity.

3.1.2. E2E Service KPIs

The E2E Service KPIs assesses the actual user experience by measuring service performance service dimensions across the entire network path, from the radio access to the core and external interconnections. Unlike RF Coverage KPIs, which focus on signal availability and quality, E2E KPIs evaluate the actual service outcomes experienced by end users.

These indicators cover Voice, Data, and SMS services, providing insight into network accessibility, retainability, reliability, and overall performance. They form the basis for benchmarking operator compliance with Quality of Service (QoS) standards and for driving continuous service improvement

These E2E KPIs are hierarchically organized into **Accessibility** (Unsuccessful Call Ratio, Call Setup Time), **Retainability** (Drop Call Rate, Handover Success Rate), and **Integrity** (Voice Mean Opinion Score - MOS, Latency, Jitter, Packet Loss) parameters.

Accessibility KPIs measure the network's capability to successfully establish service requests for voice and data traffic, while **Retainability KPIs** gauge the network's ability to maintain those active connections without premature termination, and **Integrity KPIs** quantify the qualitative fidelity of the service experience once a connection is successfully established.

Each KPI is bound by technology-specific thresholds that reflect the performance capabilities of different network generations. These thresholds define the minimum acceptable and target performance levels for each parameter. The collective performance against these thresholds provides a definitive and standardized measure of compliance and service excellence.

Table 4 presents the proposed E2E Mobile KPI parameters and their corresponding performance thresholds.

Table 4: Proposed E2E Mobile KPI parameters and the corresponding performance thresholds

Service	KPI Hierarchy	Parameter	Technology	Service Target	Worst Acceptable Limit	Excellent Target
Telephony (Voice)	Accessibility	Unsuccessful Call Ratio	All	≤ 4%	5.0%	0.5%
		Call Setup Time	2G, 3G, 4G (CSFB)	≤ 7s	10s	4s
			VoLTE	≤ 3s	4s	1.5s
			5G SA (VoNR)[3]	≤ 2s	3s	1.5s
	Retainability	Drop Call Rate	2G, 3G, 4G	≤ 2%	3.5%	1.0%
			5G SA (VoNR)	≤ 2%	2.0%	0.5%
		Handover Success Rate	All	≥ 98%	95.0%	99.0%
	Integrity	Voice Quality (MOS, POLQA)	2G, 3G, 4G	≥ 3.5	3	4
			5G SA (VoNR)	≥ 4	3.5	4.3
SMS	Retainability	Completion Rate for SMS	All	≥ 98%	95.0%	99.0%
	Integrity	End-to-End Delivery Time for SMS	All	≤ 5s	15s	3s
Data	Accessibility	EN-DC Setup Success Rate	5G (NSA)[4]	≥ 99%	98.0%	99.5%

[3] *5G SA (VoNR) refers to **Voice over New Radio (VoNR)**, a technology that allows voice calls to be made over a standalone (SA) 5G network architecture*

[4] *5G NSA, or Non-Standalone, is the initial deployment method for 5G networks that uses the existing 4G LTE core network to support a new 5G radio access network (RAN)*

Service	KPI Hierarchy	Parameter	Technology	Service Target	Worst Acceptable Limit	Excellent Target
	Retainability	Download Transfer Failure Ratio	All	≤ 8%	13.5%	3.0%
		Upload Transfer Failure Ratio	All	≤ 8%	13.5%	3.0%
		HTTP Completion Failure Ratio	All	≤ 5%	11.5%	2.0%
	Integrity	Latency	2G, 3G	≤ 100ms	250ms	80ms
			4G	≤ 80ms	100ms	40ms
			5G SA (VoNR)	≤ 10ms	25ms	8ms
		Jitter	4G	≤ 70ms	80ms	30ms
			5G SA (VoNR)	≤ 30ms	40ms	15ms
		Packet Loss Ratio	4G	≤ 0.1%	1.0%	0.1%
			5G SA (VoNR)	≤ 0.1%	0.5%	0.1%
		HTTP Completion Time	All	≤ 5s	8s	2s
		Download throughput	Informational KPI – No defined threshold			
		Upload throughput				

The selected KPIs align with international best practices and reflect parameters that most directly influence user perception of service quality.

As compared to the current framework, each KPI is defined with technology-specific thresholds and performance targets, ranging from a "Worst Acceptable Limit" to an "Excellent Target," ensuring a multi-dimensional and granular benchmark for service quality.

3.1.3. Scoring Methodology

A weighted scoring framework is adopted to ensure a fair and balanced evaluation of mobile network performance. The approach recognizes that KPI categories and parameters contribute differently to overall service quality and user experience. Each KPI is assigned a weight based on its importance within its service domain (Voice, Data, SMS) and technology layer (2G–5G).

To enable aggregation across KPIs with different scales, raw KPI results are normalized to a standardized 0–100 scale using:

Normalized Value = (Measured Value – Worst Acceptable Limit) / (Excellent Target – Worst Acceptable Limit) × 100

Weighted normalized scores are then aggregated to generate overall performance indicators at both KPI and technology levels.

3.1.4. KPI Weighting Rationale

End-to-End (E2E) Mobile KPIs measure overall service performance across the network, from radio access to core and external interconnections. To ensure the scoring framework reflects user experience, it is proposed that weights are allocated across service domains as presented in Table 5.

Table 5. Proposed weighting across service domains

Service	Weighting	Remarks
Voice (Telephony)	50%	Represents the continued importance of voice communication, especially in rural and semi-urban areas.
Data	45%	Captures the dominant role of mobile internet in urban and semi-urban areas, supporting both personal and economic activities.
SMS	5%	Maintains relevance for notifications, banking, and basic messaging services.

1. Table 6 and Table 7 presents the proposed E2E KPI and RF Coverage weightings parameters, thresholds, assigned weights, and the rationale behind each allocation, ensuring that the scoring framework is proportional, representative, and aligned with desired objectives.

Table 6: E2E Mobile KPI Weighting

Service	KPI Hierarchy	Parameter	Technology	Weight of Service (Data or Telephony or SMS (%)	Weight in Service (%)	Weight in Technology (%)	Overall Weights	Comments / Rationale
Telephony (Voice)	Accessibility	Unsuccessful Call Ratio	All	50	25	100	12.5	Key indicator of call success; applies to all technologies; high weight due to criticality of voice services in rural areas.
		Call Setup Time	2G, 3G, 4G (CSFB)	50	10	45	3.375	Reflects user-perceived delay in legacy technologies; moderate weight since fallback use dominates.
			VoLTE	50	10	35	2.625	Faster call setup on 4G; lower technology weight reflects mixed adoption of VoLTE.
			5G SA (VoNR)	50	10	10	0.75	5G still limited in coverage; technology weight low.
		Call Setup Time > 15 s	All	50	5	10	0.75	Prolonged delay falling outside expected responsiveness for call initiation
	Retainability	Drop Call Rate	2G, 3G, 4G	50	30	90	13.5	Measures call continuity; high weight for main technologies.
			5G SA (VoNR)	50	30	10	1.5	Low technology weight due to limited 5G deployment.
		Handover Success Rate	All	50	5	100	2.5	Ensures seamless mobility across cells; moderate weight in service and overall.
	Integrity	Voice Quality (MOS, POLQA)	2G, 3G, 4G	50	20	80	10.0	Reflects perceptual call quality in main technologies.
			5G SA (VoNR)	50	20	10	1.25	Lower tech weight due to limited coverage.
		MOS < 1.6	All	50	10	10	1.25	Extremely poor, outside expected voice quality

Service	KPI Hierarchy	Parameter	Technology	Weight of Service (Data or Telephony or SMS (%)	Weight in Service (%)	Weight in Technology (%)	Overall Weights	Comments / Rationale
SMS	Retainability	Completion Rate for SMS	All	5	70	100	3.5	SMS reliability important but limited usage; low service weight.
	Integrity	End-to-End Delivery Time for SMS	All	5	30	100	1.5	Time-critical SMS services; low service weight.
Data	Accessibility	EN-DC Setup Success Rate	5G (NSA)	45	10	100	4.5	Critical for initial 5G data connectivity; moderate weight in service.
	Retainability	Download Transfer Failure Ratio	All	45	15	100	6.75	Reflects successful data transfer; high weight for data-intensive users.
		Upload Transfer Failure Ratio	All	45	10	100	4.5	Captures reliability of uplink data; moderate weight.
		HTTP Completion Failure Ratio	All	45	10	100	4.5	Reflects web service reliability; moderate weight.
	Integrity	Latency	2G, 3G	45	25	30	3.375	Critical for user experience on legacy networks; low tech weight reflects legacy coverage.
			4G	45	25	60	6.75	4G latency more relevant; higher tech weight due to adoption.
			5G SA (VoNR)	45	25	10	1.125	Lower tech weight for limited 5G coverage.
		Jitter	4G	45	10	90	4.05	Important for streaming; high tech weight in 4G.

Service	KPI Hierarchy	Parameter	Technology	Weight of Service (Data or Telephony or SMS (%)	Weight in Service (%)	Weight in Technology (%)	Overall Weights	Comments / Rationale
			5G SA (VoNR)	45	10	10	0.45	Limited coverage; lower tech weight.
		Packet Loss Ratio	4G	45	10	90	4.05	Critical for high-quality data services.
			5G SA (VoNR)	45	10	10	0.45	Lower tech weight due to 5G deployment stage.
		HTTP Completion Time	All	45	10	100	4.5	Ensures overall web performance; moderate weight.
		Download throughput	Informational KPI – No defined threshold					Monitored for reference; no defined threshold.
		Upload throughput						Monitored for reference; no defined threshold.
Total							100	

Table 7: RF Coverage KPI Weightings

KPI Metric	Tier	Applicable Areas	Technology	Weight of Metric (Strength or Quality, WC)	Weight in Geographical Area (WA)	Weight in Technology (WT)	Overall Weights	Comments / Rationale
Signal Strength	Good	Urban and densely populated cities	All	45	50	100	22.5	High-priority coverage (50% WA) in areas requiring maximum capacity and reliability.
	Average	Semi-urban, rural, marginalized regions	All	45	40	100	18	Reflects moderate coverage priority (40% WA) in less dense areas. Represents the usable edge of the network.
	Bad	All areas	All	45	10	100	4.5	Reward for Avoidance of Failure: A small positive weight (10% WA) ensures the operator gains a score for successfully meeting the 0% failure target.
Signal Quality	Good	Urban and densely populated cities	4G/5G	55	50	70	19.25	Highest priority (55% WC) for premium 4G/5G data experience in urban centers.
		Urban and densely populated cities	3G	55	50	20	5.5	Ensures performance of 3G fallback network is included, but with low tech weight (20% WT).
		Urban and densely populated cities	2G	55	50	10	2.75	Minimal weight (10% WT) for legacy voice support, primarily for service continuity.
	Average	Semi-urban, rural, marginalized regions	4G/5G	55	40	60	13.2	Rewards average quality in rural areas; reflects 4G/5G is still the dominant tech focus (60% WT).
		Semi-urban, rural, marginalized regions	3G	55	40	20	4.4	Reflects acceptable 3G performance for fallback in less dense areas.

KPI Metric	Tier	Applicable Areas	Technology	Weight of Metric (Strength or Quality, WC)	Weight in Geographical Area (WA)	Weight in Technology (WT)	Overall Weights	Comments / Rationale
		Semi-urban, rural, marginalized regions	2G	55	40	20	4.4	Ensures legacy 2G coverage is included for voice continuity in rural areas.
	Bad	All areas	4G/5G	55	10	60	3.3	Small weight (10% WA) ensures a positive score for keeping 4G/5G failures below the threshold.
		All areas	3G	55	10	20	1.1	Small positive weight for successful avoidance of 3G service failures.
		All areas	2G	55	10	20	1.1	Small positive weight for successful avoidance of 2G service failures.
Total							100	

Within each service domain, technology-specific weights account for adoption, coverage, and relevance. Modern technologies (4G/5G) carry higher weights due to heavy data usage, while legacy technologies (2G/3G) maintain lower weights to reflect coverage and fallback services.

This approach provides for dynamic redistribution that allows the adjustment of weights when data for certain tiers or technologies is missing. Within each tier, adjusted technology weights are also calculated. This approach ensures that all available data fully contributes to the composite score, preserving comparability and fairness across operators and regions, even when some measurements are missing.

To derive an overall network performance score, the framework applies a **weighted scoring approach**, where the **E2E Mobile KPIs** and **RF Coverage KPIs** are combined using a simple weighted aggregation.

- **E2E Mobile KPIs:** 95% – reflecting the dominant role of user-perceived service experience in evaluating network performance.
- **RF Coverage KPIs:** 5% – ensuring minimum network availability and quality is also accounted for.

The **overall network performance score** is calculated as:

$$\textbf{Overall Score (\%)} = (\textbf{E2E Score} \times \mathbf{0.95}) + (\textbf{RF Coverage Score} \times \mathbf{0.05})$$

3.2. Network Performance (NP) QoS

3.2.1. Network Performance (NP) QoS KPIs

Following a similar approach to E2E QoS, the Authority proposes the KPIs to be consired as presented in Table 8. For each KPI, the definition and the corresponding regulatory justification for its inclusion is summarized.

Table 8: NP QoS KPI and rationalle

KPI Hierarchy	KPI	Technology	Definition	Regulatory Purpose
Availability	Cell Availability	All	The percentage of time a radio cell is operational and able to provide service (uptime).	Ensures continuous service coverage and verifies MNO compliance with license obligations.
Accessibility	Call Setup Success Rate (CSSR)	2G	The percentage of successful voice call attempts out of total attempts (CS).	Primary metric of QoE; measures the ability of a user to initiate basic voice service.
		3G	The percentage of successful voice call attempts out of total attempts (CS).	Primary metric of QoE; measures the ability of a user to initiate basic voice service.

KPI Hierarchy	KPI	Technology	Definition	Regulatory Purpose
		4G (VoLTE)	The percentage of successful VoLTE call setup attempts (IMS/SIP signaling).	Measures the successful initiation of high-quality modern voice service.
	CS Fallback Success Rate (CSFB SR)	2G/3G	The success rate of the mobility procedure when a 4G device falls back to 2G/3G for a voice call.	Ensures seamless service continuity when 4G voice fails or is unavailable.
	Session Setup Success Rate (SSSR - Data)	4G (E-RAB)	The percentage of successful attempts to establish the E-RAB data bearer.	Core metric for LTE; measures success in establishing the primary data bearer.
	NSA Access Success Rate (SgNB Addition SR - Data)	5G (NSA)	The percentage of successful attempts to establish the 5G secondary cell (SgNB) for dual connectivity.	Ensures the user successfully connects to the 5G carrier for enhanced service.
Integrity	Call Drop Rate (CDR)	2G, 3G	The percentage of established voice calls (CS) that are abnormally terminated due to a network failure.	Measures session stability; high drops signal network instability and high customer dissatisfaction.
		4G (VoLTE)	The percentage of established VoLTE calls that are abnormally terminated.	Essential for guaranteeing the Quality of Service (QoS) for modern voice service.
	SRVCC Handover Success Rate	4G (VoLTE)	The percentage of successful handovers maintaining an active VoLTE call when falling back to 2G/3G.	Assures service continuity when VoLTE users lose 4G coverage.
Mobility	Inter-/Intra-RAT Handover Success Rate	All	The percentage of successful attempts to transfer an active session between cells or technologies (RATs).	Measures the MNO's ability to maintain a connection seamlessly across different cells and technologies.
Retainability	Data Service Drop Rate	3G, 4G	The percentage of established data bearers that are abnormally terminated due to a network failure.	Measures session stability; high drops signal network instability and poor QoE.
		5G (NSA)	The percentage of established 5G bearers that are abnormally terminated.	Monitors the stability of the new 5G data connection (bearer drop).
Spectrum Utilization	Traffic Channel (TCH) Congestion Rate	2G	The percentage of voice session attempts that fail due to a lack of available TCH resources.	Signals inefficient use of scarce spectrum and identifies capacity blockages.
	Radio Access Bearer (RAB) Congestion Ratio	3G	The percentage of requested voice or data bearers that are blocked due to capacity constraints.	Measures capacity blockages that prevent service establishment.
	Downlink Physical Resource Block (PRB) Utilization	4G	The average percentage of available DL radio resources utilized during the busy hour.	Assesses network load during peak times; signals congestion when utilization approaches the mandatory floor.

KPI Hierarchy	KPI	Technology	Definition	Regulatory Purpose
	NR Downlink PRB Utilization	5G (NSA)	The average percentage of available DL NR radio resources utilized during the busy hour.	Monitors the load on the 5G carrier, ensuring the high-band spectrum is effectively utilized.

3.2.2. Network Performance (NP) QoS Scoring Methodology

The performance for each KPI is benchmarked against two clearly defined thresholds as follows:-

- **Excellent Limit (Target):** The aspirational benchmark representing best practice Quality of Service (QoS) delivery. MNOs must strive to meet this target to maximize their score.
- **Worst Limit (Mandatory Floor):** The minimum acceptable level of performance. Any performance falling below this floor will result in a zero score for that KPI and trigger mandatory regulatory action.

The compliance scoring system uses a **three-tiered hierarchical weighting structure** to ensure the final score accurately reflects the Authoritys strategic priorities.

1. **KPI Area Weight:** Sets the top-level strategic priority, allocating the overall 100% score among foundational areas like Availability, Accessibility, Integrity, Mobility, Retainability and Spectrum Utilization
2. **KPI Weight Factor:** Defines the relative importance of a specific KPI *within* its area (e.g., prioritizing VoLTE accessibility over 2G accessibility).
3. **Technology Weight Factor:** Adjusts the score based on the strategic importance of the technology, prioritizing performance on high-value deployments 4G and 5G over legacy networks.

The final compliance score for an MNO is calculated by combining these three weights with the MNO's observed performance. The scoring is designed to create a normalized scale: any performance exactly at the Excellent Limit receives the maximum weight for that KPI, while performance at or below the Worst Limit receives a score of zero. This ensures that the MNO is rewarded proportionally for every improvement in service quality between the Worst and Excellent limits, with the weighting layers emphasizing that performance in critical areas as presented in Table 9.

Table 9: NP QoS KPI weighting

KPI Hierarchy	KPI	Technology	Excellent Limit (%)	Worst Limit (%)	KPI Area Weight (%)	KPI Weight (%)	Tech. Weight Factor (%)	Overall Weight	Justification for the Weight
Availability	Cell Availability	All	≥99.95	≤99.5	15	100	100	15	A foundational KPI ensuring the network is operational. Since this metric applies across all technologies and geographic areas, it receives the full weight of its area (15%). Failure here implies widespread service collapse.
Accessibility	Call Setup Success Rate (CSSR)	2G	≥98.5	≤95.0	35	35	35	4	Measures the success of initiating the most basic voice service. Receives lower weighting (4%) than 4G/VoLTE, reflecting the technological shift away from 2G as the primary voice bearer, but remains necessary for rural coverage and fallback situations.
		3G	≥98.5	≤95.0	35	35	25	3	Measures success in initiating voice service on 3G. Receives the lowest weighting (3%), reflecting 3G's role as a transitional or secondary voice/data network, de-emphasizing investment here compared to 4G/5G.
		4G (VoLTE)	≥98.5	≤95.0	35	35	40	5	This is the modern, high-quality standard for voice service. It receives the highest weight among direct CSSR metrics, emphasizing the MNO's responsibility to deliver the best voice experience on the latest technology.
	CS Fallback Success Rate (CSFB SR)	2G/3G	≥98.0	≤94.0	35	25	100	9	This KPI ensures users on 4G can successfully initiate a voice call by falling back to 2G/3G. Its high weight reflects its critical role in the user experience of all 4G

KPI Hierarchy	KPI	Technology	Excellent Limit (%)	Worst Limit (%)	KPI Area Weight (%)	KPI Weight (%)	Tech. Weight Factor (%)	Overall Weight	Justification for the Weight
									devices that haven't fully implemented VoLTE, guaranteeing call start success.
	Session Setup Success Rate (SSSR - Data)	4G (E-RAB)	≥99.0	≤96.0	35	25	100	9	Measures the user's ability to establish the primary data bearer (E-RAB) for the main mobile broadband technology (4G). The high weight reflects the importance of successful data access, which is the key service provided by 4G.
	NSA Access Success Rate (SgNB Addition SR - Data)	5G (NSA)	≥98.0	≤95.0	35	15	100	5	Measures the ability of the 4G anchor to successfully connect to the 5G carrier (SgNB). Its moderate weight reflects the MNO's commitment to successfully launching new 5G service, though 4G E-RAB is currently prioritized due to traffic volume.
Integrity	Call Drop Rate (CDR)	2G, 3G	≤1.0	≥3.0	15	70	60	6	A dropped call is a critical failure. The high weight for 2G/3G reflects that, while these technologies are aging, a high number of drops severely impacts older user experience and service perception in basic coverage areas.
		4G (VoLTE)	≤1.0	≥3.0	15	70	40	4	A dropped VoLTE call is an outright failure of the premium voice service. The high weight ensures MNOs prioritize the stability of their modern voice solution, which consumers expect to be flawless.

KPI Hierarchy	KPI	Technology	Excellent Limit (%)	Worst Limit (%)	KPI Area Weight (%)	KPI Weight (%)	Tech. Weight Factor (%)	Overall Weight	Justification for the Weight
	SRVCC Handover Success Rate	4G (VoLTE)	≥98.5	≤95.0	15	30	100	5	This KPI directly measures the success in preventing a critical drop when a VoLTE call moves out of 4G coverage. Its weight highlights the importance of seamless continuity and stability for high-value VoLTE calls.
Mobility	Inter-/Intra-RAT Handover Success Rate	All	≥98.0	≤95.0	5	100	100	5	Measures the user's ability to move between cells/technologies without interruption. As a foundational layer, it receives the full weight of its area (5%), reflecting its necessity for a functional, contiguous network.
Retainability	Data Service Drop Rate	3G, 4G	≤1.0	≥3.0	15	100	60	9	A terminated data session is a major source of customer frustration and is a critical failure of the primary 4G data service. The high weight ensures MNOs invest in the stability and retention of their core broadband connections.
		5G (NSA)	≤1.0	≥3.0	15	100	40	6	Measures the drop rate for the new 5G bearer. Its moderate weight pushes MNOs to ensure the new technology is stable, though 4G/3G retainability still covers a higher volume of current traffic.
Spectrum Utilization	Traffic Channel (TCH) Congestion Rate	2G	≤0.5	≥2.0	15	30	100	5	High congestion indicates inefficient use of 2G spectrum. Its weight encourages MNOs to maintain sufficient 2G capacity or aggressively migrate traffic to newer networks.

KPI Hierarchy	KPI	Technology	Excellent Limit (%)	Worst Limit (%)	KPI Area Weight (%)	KPI Weight (%)	Tech. Weight Factor (%)	Overall Weight	Justification for the Weight
	Radio Access Bearer (RAB) Congestion Ratio	3G	≤1.0	≥3.0	15	30	100	5	High congestion indicates insufficient resources on the 3G layer. Its weight emphasizes the need for capacity maintenance in transitional 3G areas.
	Downlink Physical Resource Block (PRB) Utilization	4G	≤75	≥90	15	30	100	5	This metric allows the regulator to monitor network load before it leads to failed sessions or drops. Its weight encourages proactive capacity planning in the high-demand 4G network.
	NR Downlink PRB Utilization	5G (NSA)	≤80	≥95	15	10	100	2	Measures the load on the new 5G spectrum. Its low weight reflects that 5G traffic volumes are still low, but its inclusion ensures the regulator is monitoring the deployment and utilization of the new spectrum.
Total								**100**	

3.3. Quality of Experience (QoE)

The Authority also assesses the non-technical aspects of QoS, i.e the Quality of Experience (QoE), through the use of questionnaires that are administered annually as part of the process of also assessing the Authority's customer satisfaction survey. The objective is obtain the consumer perception about the services of the Mobile Network Operators with respect to consumer expectations and service management. The core indicators evaluated include service provisioning, billing, complaints handling and the ease of accessing customer-support services.

In keeping pace with the vast nature of the network and growing connected population, the Authority will explore crowdsourcing as a more immediate and continuous way to measure quality of experience distinct from the questionnaire which incorporates human factors like expectations and context.

Crowdsourcing may involve passive data collection where information is retrieved in the background of an application (without user initiation) or active measurements where an application performs tests to gather information upon initiation by a user. The information gathered includes measured and user experience on parameters such as throughput (data speed), latency, stability, as well as geographical location (coverage) where the test was conducted.

The Authority has also reviewed the questionnaire that is currently in use and the content has been reviewed to obtain the most critical elements of QoE, A draft is presented in Annex 4.

3.4. Overall QOS Score and Threshold

To determine the overall QoS Score, the Authority will retain the existing QoS Components weighting as presented in Table 10.

Table 10 QoS Components' Weighting

QoS Component	Weighting
End to End (E2E) Drive Test QoS	60%
Network Performance QoS	25%
Quality of Experience (QoE)	15%

It is further proposed to raise the threshold for compliance from 80% to 90%

4. DATA CAPTURE & SOURCING APPROACH

The data capture and analysis strategy shall be structured based on the 3 QoS components namely: Network Performance, end-to-end QoS Performance and Customer satisfaction assessments as expounded below.

4.1. Overall Network Performance

i. Respective network operators and services providers will provide the network coverage and the overall network performance data and analysis on Quarterly basis to the Authority based on data out of their network operations & maintenance facilities.
ii. The tools they will need may differ from one network/service operator/provider to the other. They include the network Operations & Maintenance Centre (OMC) resources, Protocol Analyzers, Automatic Applications Testers among other tools. Raw data shall be transmitted automatically by the operators' systems to a CA's server on an hourly basis.
iii. At the same time the Licensees will analyse the same data and send the subsequent reports in an agreed format to CA, specifying the manner in which the sampling has been done with sufficient detail to enable the Authority to verify the accuracy of the any given report.
iv. CA on the other hand will randomly sample raw data of particular months, analyse and compare with the relevant reports provided by the Licensees.
v. This will enable CA to independently verify the reports submitted by the Licensees. Recommendation ITU-T E.804 will be the general guiding document in this respect.
vi. It is noted that there exist solutions that can take in near real-time data and perform data analysis on the data dumb from operators' OMC systems to determine QoS performance KPIs, which systems will be procured by the Authority for this purpose.

4.2. E2E Quality of Service (QoS):

End-to-end QoS assessment is normally based on simulation of end user experience. Several methodologies exist in the determination of this QoS assessment. They include the following:

Conducting service usage tests through drive/walk test as presently undertaken by CA;

Based on benchmarks conducted by CA, there are other solutions in place, which employ the use of:

Specialized stationery or mobile units installed on vehicles.

In order to manage the cost of doing this, the sample size will be restricted to the minimal level that is scientifically sufficient to provide an accurate reflection of the end-to-end QoS status of a particular network and service across the coverage area. The weighting will be on population sampling levels only; Recommendation ITU-T E.804 will be the general guiding document in this respect.

4.3. Quality of Experience (QoE)

QoE will be determined based an annual Customer Satisfaction Surveys undertaken with a view to eliciting customers' views relating to Network Availability, Service Quality, Service Tariffs, and Customer Care aspects among others. When evaluating consumer quality of experience, the Authority will evaluate core parameters that tend to mirror what consumers feel directly when accessing and using a service. Core indicators to be evaluated will include network availability, reliability, voice clarity, data speeds, call setup time, call completion rates, and the ease of accessing customer-support services.

In keeping pace with the vast nature of the network and growing connected population, the Authority will explore crowdsourcing as a more immediate and continuous way to measure quality of experience distinct from subjective questionnaire which incorporates human factors like expectations and context.

Crowdsourcing may involve passive data collection where information is retrieved in the background of an application (without user initiation) or active measurements where an application performs tests to gather information upon initiation by a user. The information gathered includes the network parameters such as throughput and well as geographical location where the test was conducted.

4.4. Data Sampling/Processing Guidelines

The data sampling in general shall be guided by international best practices and the guidelines contained herein. This QoS framework has been developed with due regard to international standards, most of which are from ITU-T and ETSI. Measurements shall be made, where relevant, under similar conditions such as tests carried out in an automatic way in order to eliminate the possible subjectivity inherent in human intervention situations.

Time factors with regard to distribution of the tests shall be such that it reflects traffic variations over the period of day and days of the week, and type of calls for example originating vs. terminating, etc. Measurements will be performed wherever there is network availability. The number of observations (sample size) shall aim at obtaining a minimum absolute statistical

accuracy of less or equal to 2 % with a confidence level of 95%. Coverage assessment statistical accuracy shall be, as a minimum, less or equal to 0.5%.

There shall be a pilot period whose results shall form the basis for making any necessary adjustments to the framework. Where contracted entities are using different test platforms/tools, at the beginning of the Pilot Phase, the said platforms/tools shall be appropriately configured, calibration undertaken and confirmed, and necessary adjustments undertaken in order to avoid significant variance of the results.

The test platforms/tools shall be periodically verified by the Authority during field-tests as appropriate. Contracted firms shall use qualified and experienced personnel. Where exceptional conditions arise that may distort assessment measurements, CA may exclude the results of such measurements and may order a retake of the measurements. The QoS Regulatory Framework shall be reviewed and updated periodically.

4.5. Compliance Declaration & Application of Penalties

A licensee will be deemed compliant if they attain an aggregate of 90% or above. In the event of failure by a Licensee, penalties and/or other sanctions will be applied per county and rollout obligations on a quarterly, or as may be varied from time to time in accordance with the Act.

4.6. Publication of QOS Reports

The network coverage/points of presence and the results of the overall QoS assessments as well as the various components assessed shall be analyzed per county or areas with rollout obligations.

The results shall be published on CA's website and/or in local dailies.

4.7. Launch of the Framework and Methodology

This framework has been developed by CA with the input from earlier work done for the Authority by a consultant and was subsequently subjected to a Stakeholders consultation. The comments and suggestions received from respondents have been considered and incorporated to the best extent possible, taking due regard to the rights of every stakeholder. It is scheduled to take effect immediately and to replace the framework and methodology that has been in force since the year 2017.

4.8. Transition from Current Framework to New Framework

It is our desire that a phased approach be taken with regard to the introduction of the revised KPIs of E2E QoS and the Network Performance components of the new framework.

4.9. Implementation of the Framework

The Authority will commence the implementation of this framework by implementing the End-to-End QoS, QoE and the Network Performance components for all the identified Technologies starting upon launch of the framework. The pilot phases will enable the Authority, together with the MNOs, to fine-tune the processes and the tools to be used for the determination of the QoE.

After the respective pilot phases have ended, the various QoS components will be included in the assessment. It should be noted that where any component of the new framework is not operational on account of piloting or other factors, the percentage to be contributed by each component not affected by those factors shall be determined by the Authority and communicated to the Licensees and such weighting shall continue to be applicable until such a time as the relevant component(s) will have come into full operation.

In this regard, the weighting that will be adopted will be based on a proportionate redistribution of the percentage contributed by the component of the framework that cannot be implemented because of the challenge faced. The appropriate weighting set out in the table above will be reinstated thereafter.

4.10. Measurement and Auditing Tools

The Authority reserves the right to apply a combination of the following measurement and auditing tools among other methods that may be used in accordance with this framework and the Act:

i. **Surveys:** One of the ways to evaluate quality and experience perceived by end-user. Concerned service provider will be notified two weeks prior to a consumer quality satisfaction survey.
ii. **Network Performance Measuring System (NP)**: Service providers are obliged to avail their network data for analysis by a network performance (NP) system that shall be resident at the Regulator's server. The NP system shall analyze real-time data from the operators' networks to determine network performance.
iii. **Drive Test for Mobile Measurements (Drive Test)**: Carried out with a calibrated test tool, recording of readings of discrete measurements in frequent, and short intervals (usually every few seconds). The measurement readings can be a multitude of values measured at every time interval in parallel, and therefore comparable. In this setting, multiple probes within one test system can perform multiple test calls in the same time in parallel, for comparative tests of multiple service providers for the same service.

4.11. Reporting and Publishing of measurement results

i. Templates for service providers reporting will be provided by the Authority, and it may modify templates as it deems appropriate to ensure compatibility with post-processing and publishing tools.
ii. Service Providers must publish the indicator reports on their website. CA may decide to publish the results on its website or identify other channels for publishing QoS reports or parts of the reports in such a way that allows the public to evaluate and compare the performance of service providers.

4.12. Network Coverage Reporting Requirements

Other than the publication MNOs are required to publish coverage detailing the areas covered and the services available on their websites for public consumption.

To ensure auditable network integrity and clarify coverage obligations, MNOs are required to submit the following:

- **Geospatial and Technical Submission.** MNOs shall provide **KML/KMZ files** detailing the national site distribution, accompanied by all relevant technical parameters. This is necessary to facilitate transparent validation and accurate simulation of coverage claims.
- **Frequency Band Strategy.** MNOs must indicate the specific **frequency bands** used and provide a detailed explanation of their strategic deployment:

  - **Low-frequency layers** (e.g., 700 MHz, 800 MHz) must be justified for supporting wide-area and deep-indoor coverage.
  - **Higher-frequency layers** (e.g., 1800 MHz, 2100 MHz, 3500 MHz) must be justified for enhancing capacity in densely populated zones.

The MNO must include details on the **rollout extent** of these bands within the applicable coverage areas.

4.13. General Provisions

i. The Authority shall periodically review this framework from time to time and update it to meet the Technological changes in industry.

ii. The Authority has the right to add, remove or modify KPIs and QOS Components and their target values in Annex whenever need arises. Such modification may include specifying target values without the need to update this regulation, provided that relevant service providers will be notified of such changes.

iii. Service providers shall bear all costs related to fulfilling their obligations under these regulations, including, but not limited to costs resulting from measurement procedures related to QoS and experience, or any additional procedures requested by the Authority.

iv. Service providers shall submit Quality of service reports in their networks whenever called upon by the Authority.

5. APPENDICES

5.1. Appendix1: LTE (VoLTE) QOS Parameters

Refs- ITU-T Rec G.1028, E.800, E.804, IR.42)

i) To achieve proper quality of service in LTE networks, MNOs must have;
   a. Internet Protocol Multimedia Subsystem (IMS)
   b. Session Border Control (SBC) for measuring Mean Opinion Score

ii) Single Radio Voice Call Continuity (SRVCC) and Circuit Switched Fall Back (CSFB) are network features that MNOs must put in place to support User Equipment (UE) to ensure continuity/handover of user calls from 2G/3G to 4G and vice versa.

iii) CSFB is required where LTE network has no VoLTE capability. It helps the network to handover/push an attempted call on LTE to 2G/3G network while SRVCC feature enables a call to be made on VoLTE network and handed over to 2G/3G network when signal deteriorates in the LTE network.

iv) The functionalities of these features need to be monitored for effectiveness in delivering quality services to the public.

v) Failure to Monitor the LTE relevant parameters can lead to failure to misleading MNO performance and inability to detect QOS challenges affecting users and therefore inability to find solutions from MNOs on the challenges.

1.1. **RSR (%) : Registration Success Rate** that denotes the probability of UE successfully registering to IMS Network , **Impact of KPI** : With Low RSR , Customers will not be able to use VoLTE Services . Target 99% (ITU-T G.1028)

$$\text{Registration Success Rate (RSR)} = \frac{Count\ of (200OK) for\ registration\ completed}{Count\ of\ SIP\ REGISTERS\ Sent\ from\ UE\ excluding\ 401\ Error\ Attempts} X100\%$$

1.2. **CSSR (%) : Call Setup Success Rate-** indicates the probability of successful calls initiated by the MS , **Impact of KPI** : With Low CSSR , Customers will not be able to use make or Received VoLTE Calls - Target 99%

$$\text{Call Set Up Success Rate (CSSR)} = \frac{Count\ of (Normal\ End\ of\ Call + Call\ Failed\ with\ User\ behavious}{Sum\ of\ All\ Call\ Attempts} X100\%$$

1.3. **CST (s) :Call Setup Time** CST is Time between the start of the call and the moment the phone of the called party starts ringing. **Impact** : High CST will lead to delays & Silence

period before Ring, High CST will obviously will deteriorate user experience - Target 2.5sec

1.4. **Mute Rate (%) – 5age of calls that experience** loss of voice (silence) in both direction of the call occasioned by loss of packets during conversation. **Impact** :- User unable to Talk leading to degraded user experience. Target 1%

% of Calls Muted (samples > 2 or 5s RTP loss in both direction will be treated as Muted call)

1.5. **Mean Opinion Score (MOS) (1-5) -** is a measure of voice quality on a scale of 1-5, to assess the human users opinion of call quality . **Impact** :- Low MOS bad speech Quality measured through the Session Border Control (SBC) or External Probe / Packet capture. IR.42. Target MOS=4, 3.8 , (LTE-LTE, LTE-3G, LTE-2G) (ITU-T G.1028)

1.6. **RTP Packet Loss (%) -** *% Percentage of RTP packets lost in the uplink or Downlink direction.* **Impact** :- High Packet loss will lead to Mutes , One Way talk , Call Drops , Bad Quality , Garbled Voice. Target <1%

1.7. **One Way Calls (%) -** % of Calls having no Voice Packets Counts for 2 or 5 Sec in either the upstream or downstream direction, but not both. **Impact** :- One Way talk , leading to degraded user experience Target <1%

1.8. **Volte Attach Success Rate (%) - Impact**:-Low Success Rate will lead to VoLTE Registration failures and customers will not be able to use VoLTE IMS Service. Target 99%

1.9. **Bearer Activation Success Rate (%) - Impact**:-Low Success Rate will lead to VoLTE Registration failures and customers will not be able to use VoLTE IMS Service,. Target 99%

1.10. **VoLTE Paging Success Rate (%) -** % of Paging responses on ***QCI:5 received at MME.*** **Impact** :- Low QCI:5 PSR will lead to difficulties for users to receive Incoming Calls , They will remain in Out of Coverage. Target 99%

1.11. **CSFB call setup failure ratio**

Definition: Number of calls successfully started by end users on a 4G/LTE network that are unsuccessfully switched to a 2G/3G network, divided by the total number of call attempts, expressed as a percentage. Target <1%

$$\text{CSFB Call Setup Failure Ratio [\%]} = \frac{\text{unsuccessful CSFB call setup attempts}}{\text{Total number of CSFB call setup attempts}} X100\%$$

1.12. CSFB call set-up time

Definition: The time it takes to perform the CSFB procedure, i.e., the total time required to start and complete the CSFB procedure from the UE of the calling party. From the end-user's perspective, this metric is strictly equivalent to post dialing delay. Target 2.5 sec

It corresponds to the sum of the CSFB Time –calling party and of the call setup time on the CS (2G or 3G) network

CSFB Call Setup Time (s) = (t calling party receives alerting tone $-$ t user press call button)

1.13. CSFB return to 4G/LTE time

Definition: The average time (in seconds) it takes for a UE to return to 4G from a legacy (2G/3G) network after a CSFB call has been ended by end-user. It is the time needed by the UE to re-join the LTE network after a CSFB call. Target 2.5secs

$Return\ to\ 4G/LTE[s]$= (t first System information block in LTE received $-t$ call disconnected)

1.14. CSFB return to 4G/LTE failure ratio

Definition: The probability that a UE is able, in a given time interval, to return to 4G from a legacy (2G/3G) network after a CSFB call has been ended by end-user. Target <1%

$$\text{Return to 4G LTE Failure Ratio (\%)} = (1 - \frac{\text{unsuccessful Return to LTE attempts}}{\text{TTotal Return to LTE attempts}})X100\%$$

1.15. SRVCC Success Ratio

Definition: This is the probability that UE successfully handover a VoLTE call to UMTS or GSM. Target 99%

$$SRVCC\ Success\ Ratio\text{o [\%]} = \frac{Successful\ SRVCC\ handovers}{\text{To}tal\ SRVCC\ attempts} X100\%$$

1.16. SRVCC Time

Definition: This is the time taken to successfully handover a VoLTE call to UMTS or GSM for a successful SRVCC handover to UMTS or GSM. Target 2.5 seconds

SRVCC Tme (s) = ($t_{\text{SRVCC handover successfully completed}} - t_{\text{SRVCC invoked}}$)

5.2. Appendix 2 - 5G QoS Parameters

Ref: GSM IR 5.2

2.1. New Radio (NR) Reference Signal Received Power (RSRP)

This is the measurement of the power of the main signal the user equipment (UE) is getting from a single cell tower (gNodeB), a better indicator of signal strength, usually appropriate for LTE and 5G RSRP.

When combined with RSRQ (Reference Signal Received Quality) and SiNR (Signal over noise) will provide an holistic view of Radio Quality for the target network. Target -90dBm

$$RSRP\ SIGNAL\ (dBm) = (\frac{\Sigma\ \text{NR\_RSRP\_measurements\_taken}}{\Sigma\ \text{Total\_Samples}})X100\%$$

2.2. VoNR Call Quality Score

The audio quality perceived calculated based on POLQA algorithm and by comparison on reference audio sent vs audio recorded on other side using POLQA algorithm which will provide a score from 1 to 5 (the higher the better). Target 4 MOS

2.3. VoNR Call Setup Time

This indicates the network delay to route the call from originator to destination. Target 2 secs

$$CallSetup\ Time\ [milliseconds] = AVG\ (InviteAccepted - CallAttempt)$$

2.4. VoNR Call Drop Rate

This indicates when network abnormally releases the call interrupting it from the normal code expected from one of the sides. Target 2%

$$Call\ Drop\ Rate\ \% = (\frac{\Sigma\ Abnormal\ Call\ Release}{\Sigma\ CallConnect})X100\%$$

2.5. Jitter

This refers to variation in delay between packets in during the voice call and indicates the difference delay between consecutives packets calculated in both directions Transmit (Tx) and Receive (Rx) directions.

Jitter Tx(Milliseconds) = RTP-Jitter Tx

Jitter Rx(Milliseconds) = RTP-Jitter Rx

2.6. Packet Loss

The amount of data which does not reach destination, causing degragadation in the communication. It is calculated as a percentage of packets lost during the voice call by calculating the packets which never arrive to destination diving by the total packets sent. The metric is in both side Tx and Rx. Target 5%

$$Packet\ Loss\ Tx\ (\%) = (\frac{\Sigma\ Packets\ Lost\ Tx}{\Sigma\ Packets\ Tx})X100\%$$

$$Packet\ Loss\ Rx\ (\%) = (\frac{\Sigma\ Packets\ Lost\ Rx}{\Sigma\ Totla\ Packets\ Rx})X100\%$$

2.7. Latency

It is the time audio signal takes to travel from source to destination and is the average delay between the reference and the test signal. Target 5-10ms

Latency (Milliseconds) = Average Delay

2.8. Data Rate

This indicates the incoming Rx streams and outgoing Tx streams, in kbits per second, from each side during the communication.

2.9. SMS Submission Success Rate

This KPI indicates the successful sending of SMS from the originating party by a confirmation message “OK” at the sending side

$$SMS\ Submission\ Success\ Rate\ (\%) = (\frac{\Sigma\ Received\ Ack}{\Sigma\ Total\ SMS\ Send\ Attempts})X100\%$$

2.10. SMS Submission Delay

This indicates the time in milliseconds it takes to send the SMS from originating party and getting the ACK from SMSC that was effectively submitted

$$SMS\ Submit\ Delay = SMS\ Submit\ \ Ack - SMS\ Submit$$

2.11. SMS End To End Delivery Success Rate

This indicates the success (OK) on SMS delivery to the destination party

$$E2E\ SMS\ Delivery\ Success\ \% \ = (\frac{\Sigma\ \mathrm{D}elivered < b - side >}{\Sigma\ Total\ \ Attempts})X100\%$$

2.12. SMS End To End Latency

This indicates the time in milliseconds taken for the SMS delivery from origination party to the destination party

$$SMS\ Submit\ Delay\ (Milliseconds) = SMS\ Received\ time - SMS\ Submit\ time$$

5.3. Appendix 3: Detailed Information for End-to-End QoS KPI assessment for mobile Voice, SMS, & Data services

A. TELEPHONY

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
1.	Unsuccessful call ratio	An unsuccessful call is a call attempt to a valid (and supposed not busy) number, properly dialled following dial tone, where no ringing tone, or answer, is recognized on the access line of the calling user within 30 seconds from the instant when the address information required for setting up a call is sent from the user equipment Unsuccessful telephony call ratio is defined as the ratio of unsuccessful calls to the total number of call attempts in a specified time period. The following statistics shall be provided The percentage of unsuccessful telephony "on-net" (inside the same network) calls (including Mobile to Mobile calls), together with the number of observations made and the accuracy limits for 95 % confidence calculated from this number.	≤ 4%	Due to network problems and despite B- party being not busy, it may even be possible for the A-party to receive a busy or not reachable signal. In this case, since no "Alerting" or "Connect" message will be sent, the test sample will be treated as a failure. References: ETSI ES 202 765-2, clause 7.3 ETSI EG 201 769 ETSI EG 202 057-3 V1.1.1 ITU-T E.804, clause 7.3.6.1 (trigger point 7.3.6.1.3) / ETSI EG 202 057-2 V1.3.2, clause 6.6.1 (trigger point 6.6.1.3)
2.	Dropped call ratio	The dropped call telephony dropped call ratio is the probability that a successful call attempt is ended during a standard duration of the communication by a cause other than the intentional termination by the calling or called party.	≤ 2%	References: ETSI ES 202 765-2, clause 7.4 ETSI EG 201 769

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
		Dropped telephony call ratio is defined as the ratio of unintentionally terminated telephony calls to the total of successful call attempts in a specified time period. The following statistics shall be provided: The percentage of dropped telephony "on-net" (inside the same network) calls (including Mobile to Mobile calls), together with the number of observations made and the accuracy limits for 95 % confidence calculated from this number.		ETSI EG 202 057-3 V1.1.1 ITU-T E.804, clause 7.3.6.5 (trigger point 7.3.6.5.3) / ETSI EG 202 057-2 V1.3.2, clause 6.6.5 (trigger point 6.6.5.3)
3.	Call Set-up time	The period starting when the address information, properly dialled following dial tone, to a valid (and supposed not busy) number required for setting up a call is sent from the calling party and finishing when the called party ringing tone, or answer signal, is received by the calling party. The following statistics should be provided: The following statistics shall be provided: The mean value in seconds for "on-net" (inside the same network) calls (including M-M calls) together with the number of observations made and the accuracy limits for 95 % confidence calculated from this number.	≤ 7s	"Alerting" or "Connect" message received by the called party. ETSI ES 202 765-2, clause 7.1 (post dialling delay) ETSI EG 201 769 ETSI EG 202 057-2, clause 5.2} ITU-T E.804, clause 7.3.6.2 (trigger point 7.3.6.2.3) / ETSI EG 202 057-2 V1.3.2, clause 6.6.2 (trigger point 6.6.2.3)
4.	Voice Quality	Represents the intrinsic quality of speech signal after transmission. This indicator takes into account the degradations generated on the signal by the transmission links. The following statistics shall be provided:	≥ 3.5 WB Wideband	Voice quality should be measured using a special equipment enabling to handle ITU- T P.863 (POLQA) References:

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
		The mean value for "on-net" (inside the same network) calls (including M-M calls) together with the number of observations made and the accuracy limits for 95 % confidence calculated from this number.		ITU-T P.863 (09/2014)
5.	Handover Success Rate	The capacity to sustain connection while in motion. Mobility test	≥ 98%	

B. SMS

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
1.	Completion Rate for SMS	Ratio of correctly sent and received SMS between two terminal equipment. The following statistics should be provided separately: a) Ratio of successfully sent and received short messages; b) Number of observations used and the absolute accuracy limits for 95 % confidence calculated from this number.	≥ 98%	This rate is the probability of an SMS to be successfully delivered to its destination, i.e., the rate between the number of messages successfully received at the destination terminal equipment and the number of message sent. An SMS is considered to be received with an error when it has at least one incorrect bit upon reception. Message sent without receiving notification "message sent" are considered failed message. References: ETSI EG 202 009-2 V1.3.1 ETSI EG 202 057-2 V1.3.2 (5.6.2)

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
				ETSI TS 102 250-2 V2.3.1 (7.4.4 – completion failure ratio) ETSI TS 102 250-5 V2.4.1
2.	End-to-End delivery time for SMS	The end-to-end delivery time for SMS is the period starting when sending a SMS from a terminal equipment to a Short Message centre and finishing when receiving the very same SMS on another terminal equipment.	≥ 5s	A message is received within less than 5 seconds if the message is received matching the criteria of the metric 'Completion rate for SMS" and if the receiving time of the received message does not exceed 5 seconds. References: ETSI EG 202 009-2 V1.3.1 ETSI EG 202 057-2 V1.3.2 (5.6.3) ETSI TS 102 250-2 V2.3.1 ETSI TS 102 250-5 V2.4.1

C. DATA/INTERNET

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
1.	Latency	Amount of time it takes for a packet to reach the receiving endpoint after being transmitted from the sending endpoint. This metric includes the definition of Delay (one way transmission time) defined in clause 5.5 of EG 202 057-4 [1], for the ping delay. The following statistics should be provided: o The mean values of the latency in milliseconds The latency is calculated from the ping echo responses delay. Latency [milliseconds] = One_way_delay = average (½ time (Echo Reply Message)) (refer to UIT-T Y.1540 and UIT-T Y.1541 for definition, conditions and calculation)	≤ 100 ms for 2G, 3G ≤ 80 ms for 4G ≤ 10 ms for 5G SA	Tests are carried with a remote test-server in the close vicinity of the Licensee networks Ping (using IP address of the test-server) can be used to measure this latency, in this case delay is half the time, in milliseconds, that is needed for an ICMP Echo Request/Reply Ping delay = average (time (Echo Reply Message)) References: ETSI EG 202 057-4 ETSI ES 202 765-4 RFC 792 UIT-T Y.1540 UIT-T Y.1541
2.	Jitter	The difference in the end-to-end latency between packets. The jitter is assessed by the standard deviation of the delay when ping delay measurements are performed (see latency	≤ 70 ms for 4G ≤ 30 ms for 5G SA	References: ETSI EG 202 057-4 ETSI ES 202 765-4 RFC 792

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
		metric above) Jitter [milliseconds] (refer to UIT-T Y.1540 and UIT-T Y.1541for definition, conditions and calculation)		UIT-T Y.1540 UIT-T Y.1541
3.	EN-DC Set-up Success Rate	5G (NSA)*	≥ 99%	
4.	Download transfer failure ratio	The average throughput of successful data transfer over a communication channel (client/server measurement). o Download in failure ratio [%] = (Download in failure / number of tests) x 100	≤ 8%	
5.	Upload transfer failure ratio	The average throughput of successful data transfer over a communication channel (client/server measurement). o Upload in failure ratio [%] = (Upload in failure / number of tests) x 100	≤ 8%	
6.		The number of packets lost as a percentage of the total number of packets transmitted Packet loss ratio [%] = (Total number of packet lost / Total number of packet transmitted) x 100	≤ 0.1% 4G	Packet loss is impacting for real time data like VoIP/ToIP, video conferencing or gaming regarding end user perception of the quality of service. It is also impacting web browsing regarding delays/slowness.

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
	Ratio of Packet Loss	(Refer to UIT-T Y.1540 and UIT-T Y.1541for definition, conditions and calculation)	≤ 0.1% 5G SA	Tests are carried out with a remote test-server in the close vicinity of the Licensee networks or on a remote (foreign) location or both. Pack loss measurement in the Licensee network assesses the quality of the Licensee own network. Pack loss measurement outside the Licensee (remote server test case) assesses the quality of the service provided to the customers of the Licensee (not considered here). References: UIT-T Y1540 UIT-T Y1541
7.	HTTP Completion failure ratio	HTTP completion failure ratio [%] = (Total number of successful completed downloaded page/Total number of requested pages) x 100	≤5%	HTTP completion Time can only be measured for “established” HTTP connection.
8.	HTTP Completion Time	The HTTP completion Time is the period of time starting from the instant when the connection to the web page is requested to the instant when the complete web page content is fully received. The ratio of web pages that failed to be successfully downloaded / completed is also recorded.	≤5s	HTTP completion Time can only be measured for “established” HTTP connection.

KPI No.	KPI Name	Related indicator definition	Target	Comment / Reference
		T = period of time from the instant when the connection to the web page is requested to the instant when the complete web page content is fully received W = size of the web page in Mbytes Because all web pages do not have the same size it is necessary to scale the download period to the size of the downloaded page. HTTP completion Time [s] = T x 1/W		

5.4. Appendix 4: Draft Quality of Experience (QoE) Survey for Mobile Services

SECTION A: DEMOGRAPHICS

1. Gender: Male ☐ Female ☐
2. Age (years): Below 18☐ 18–24 ☐ 25–34 ☐ 35–44 ☐ 45–54 ☐ Above 54 ☐

SECTION B: QUALITY OF EXPERIENCE (QoE) WITH MOBILE NETWORK SERVICE PROVIDERS

3. Current mobile service provider(s): MNO-A ☐ MNO-B ☐ MNO-C ☐ MNO-D ☐ Other: _____
4. Factors considered when choosing provider (tick all): Coverage ☐ Pricing ☐ Service Quality ☐ Promotions ☐ Other: _____
5. Challenges experienced (tick all): Coverage ☐ Billing ☐ Customer Care ☐ Roaming ☐ Call Drop ☐ Other: _____
6. Frequency of loss of service: All the time ☐ Most ☐ Some ☐ Rarely ☐ Never ☐
7. Able to send SMS? Yes ☐ No ☐ Don't use SMS ☐ | Frequency: Never ☐ Rarely ☐ Often ☐
8. Unsolicited SMS? Yes ☐ No ☐ | Frequency: Daily ☐ Weekly ☐ Monthly ☐ Yearly ☐
9. Mobile Internet quality: Never drops ☐ Stable but varying speed ☐ Drops regularly ☐ Very poor ☐ Don't use mobile internet ☐
10. Mobile internet challenges: Website access issues ☐ Poor customer service ☐ Other: _____
11. Mobile internet satisfaction (1–5; *1 being very dissatisfied and 5 very satisfied*): 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Billing & Charges

12. Billing accuracy (1–5): Calls ☐ SMS ☐ Data ☐
13. Billing clarity: Consistent ☐ Clear ☐ Accurate ☐
14. Billing satisfaction (1–5; *1 being very dissatisfied and 5 very satisfied*): 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Complaints Handling

15. Are you aware of complaint procedures and where to complain? Yes ☐ No ☐
16. Have you ever lodged a complaint? Yes ☐ No ☐ | Ease (1–5): 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
17. Complaint resolution satisfaction (1–5; *1 being very dissatisfied and 5 very satisfied*): 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Customer Care

18. Overall customer care experience (1–5; *1 being very dissatisfied and 5 very satisfied*): 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐
19. Accessibility rating (1–5; *1 being very Inaccessible and 5 very accessible*): 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

SECTION C: OVERALL PERFORMANCE & RECOMMENDATIONS

20. Overall network quality rating: Very poor ☐ Unsatisfactory ☐ Average ☐ Satisfactory ☐ Superior ☐Additional comments: _____