2021

Consultation Paper

Cellular Mobile Network Quality of Service (QoS) Regulations 2021

Pakistan Telecommunication Authority

CONTENTS

1. INTRODUCTION

1.1. Background and Purpose

1.1.1. Quality of Service (QoS) refers to the ability of a network or service to satisfy the end user. QoS is primarily linked with the aspects of services that are directly experienced by the consumers. With the increase of the subscriber base, customer's dissatisfaction is increasing and complaints against the network are also increasing. Growing concerns on various QoS parameters specially Call Drop, Call Quality and Data Throughput have been observed recently.

1.1.2. To ensure a level playing field along with a competitive environment and subscriber satisfaction, performance measurement with a common standard regarding QoS is a must. QoS parameters can be measured both from network monitoring terminals and field surveys through Drive Test. Customers' opinion should also be taken into consideration in this regard. With the adaptation of 3G and 4G technology, it is about time to set some benchmarks/thresholds for Cellular Mobile Operators (CMOs) which they must comply with in order to ensure consumers' satisfaction. The purpose of this consultation paper is to seek stakeholders' feedback before finalizing and notifying Cellular Mobile Network QoS Regulations 2021.

1.2. Quality of Service

1.2.1. International Standardization Organizations such as International Telecommunication Union (ITU), International Organization for Standardization (ISO) and European Telecommunication Standard Institute (ETSI) define QoS as:

a. ITU-T Rec.E.800: ***"Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service".***

b. ETSI-TR102157: ***"Quality of Service (QoS): the ability to segment traffic or differentiate between traffic types in order for the network to treat certain traffic differently from others".***

c. ISO-8402: ***"The totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs"***

1.3. Network Performance

1.3.1. ITU.T Recommendation E.800 defines Network Performance (NP) as, ***"The ability of a network or network portion to provide the functions related to communications between users."*** The performance of any network can be gauged by measuring performance of its network elements one by one, or by measuring the performance of the whole network i.e. the combination of the performance of all single elements. In fact, QoS consists of network performance and non-network performance, as shown in **Figure 1.1.**

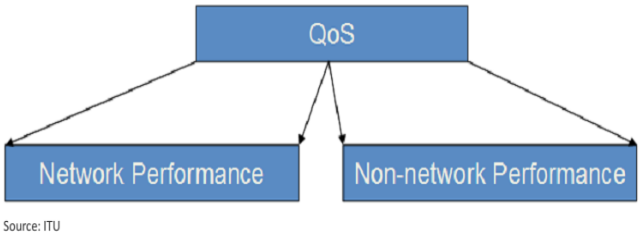

Figure 1.1: QoS-Combination of Network Performance & Non-Network Performance

1.4. Quality of Experience

1.4.1. ITU-T Recommendation P.10/G.100 defines Quality of Experience (QoE) as ***"the overall acceptability of an application or service, as perceived subjectively by the end-user".*** In 2016, this definition has been modified by ITU-T Study Group 12, as "***Quality of experience (QoE) is the degree of delight or annoyance of the user of an application or service".*** QoE is influenced by the psychological profiles and emotional state of a user, due to its subjective nature of measurement and customer perception regarding a specific service.

1.5. Relationship of QoS, NP and QoE

1.5.1. The functions of a service depend on the performance of the network elements and the performance of user terminal equipment. QoS is always end-to-end, i.e. user-to-user or user-to-content. Therefore, QoS measurements are also carried out end-to-end. End-to-End QoS depends on the contributions made by the components, including user, user equipment, access network, IP transport, core network, and the rest of the path end-to-end (e.g. through the Internet). QoE has a broader scope as it is impacted by QoS as well as by user expectations and context. The relationship among QoS, NP and QoE is shown in **Figure 1.2.**

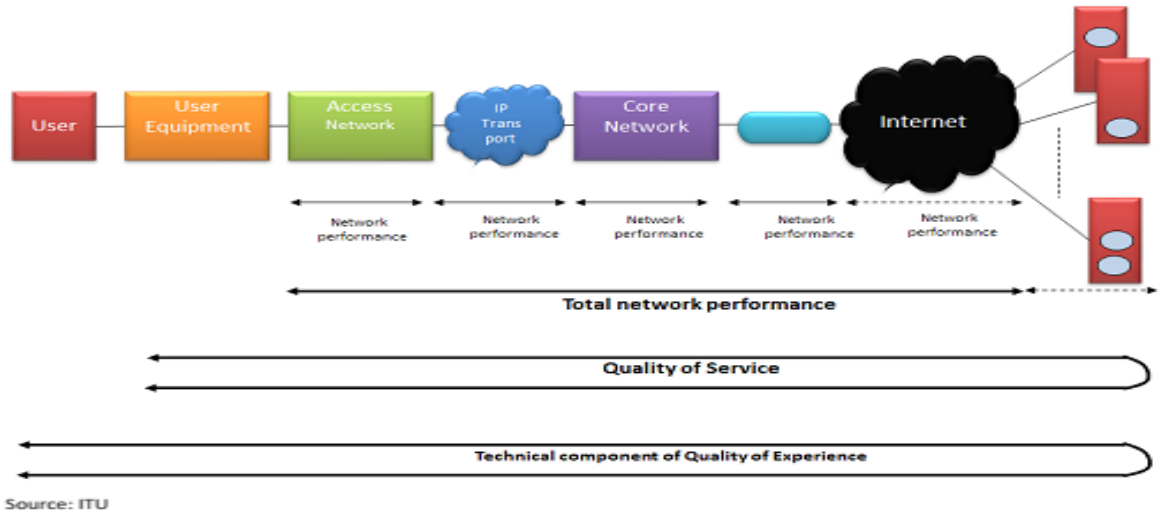

Figure 1.2: Relationship between QoS, NP & QoE

1.6. QoS Regulatory Framework

1.6.1. QoS Regulatory Framework starts with setting Standards defined by international standard organizations such as ITU-T as well as regional bodies e.g. ETSI in Europe. These Standards can be implemented as part of the license conditions as well as regulations or industry guidelines. QoS is defined through a given set of parameters that are measurable. Such quality parameters that are defined for QoS measurements in a given country are referred to as Key Performance Indicators (KPIs). QoS KPIs can be technical and non-technical. Examples of technical KPIs include Call Setup Success Rate, Call Drop Rate and Call Setup Time etc. Non-technical KPIs are customer centric and may include parameters such as billing accuracy, network outage, etc. After defining QoS KPIs, different measurement methods can be used, which may differ from one country to another.

1.6.2. Different approaches exist in the monitoring of technical and customer centric KPIs. Technical monitoring of KPIs can be performed by network auditing, drive tests, probe stations on selected locations and crowed sourcing etc. The customer focused KPIs are monitored by consumer surveys. The purpose of monitoring the values of the defined KPIs is to detect degradation of the QoS when it appears, and to apply appropriate actions to enforce QoS. Such QoS enforcement can be performed by publishing KPI monitoring results on a public website, through press releases, via directives etc., with the aim of informing consumers. However, if such enforcement approaches are not enough to enforce QoS, then more drastic QoS enforcement should be undertaken through financial penalties or through dispute resolution mechanisms. This QoS Regulatory Framework is as shown in **Figure 1.3:**

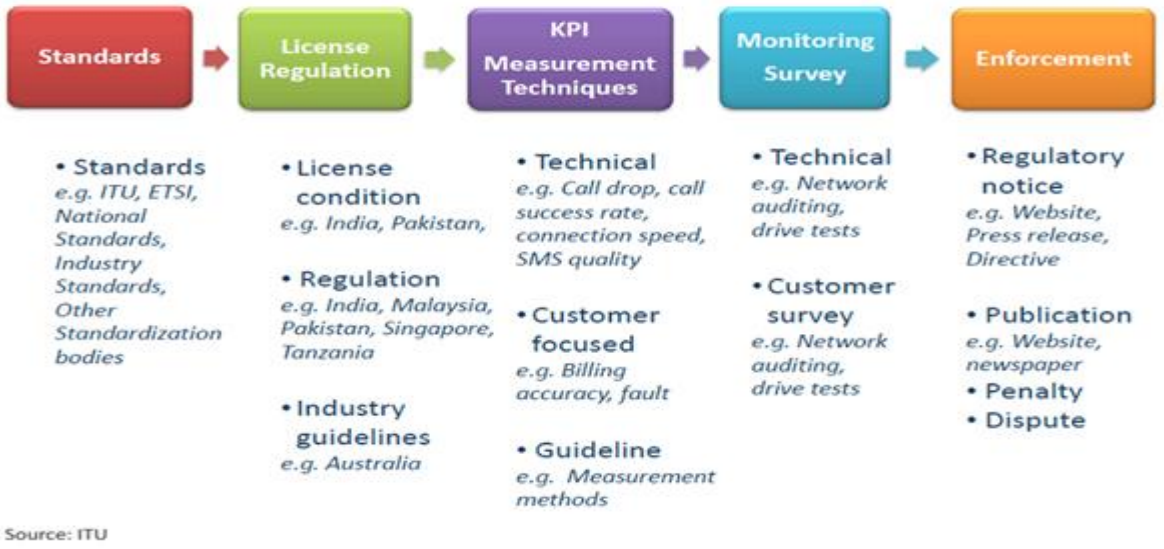

Figure 1.3: QoS Regulatory Framework

1.6.3. A harmonized and common approach to regulate QoS is necessary to enable greater quality prospects for consumer, irrespective of their locations. ITU-T Rec.G.1000 define terms which provide the general QoS Framework divided into seven QoS criteria specified as **Speed, Accuracy, Availability, Reliability, Security, Simplicity** and **Flexibility.**

1.7. Selection of KPIs and Target Values

1.7.1. QoS KPIs characterize the level of the service quality and customer satisfaction. QoS parameters represent subjective and abstract user perception of quality in terms of numeric values. QoS KPIs are essential for effective QoS management. They should be simple to use, provide accurate representation of customer perception, and be commonly accepted as standards. It should be possible to distinguish between parameters for specific service types.

1.7.2. While defining QoS KPIs involvement of operators is beneficial and desirable. The factors need to be considered are the practicability for operators to measure the parameter, practicability for regulator and independent third party to audit the results and the measurement should retain the customer experience aspect.

1.7.3. QoS Regulations are based on the definition of QoS KPIs that will be monitored for the purposes of QoS enforcement. A target is defined as a potential value for a parameter that must be reached if quality is to be regarded as satisfactory. Three (3) classes of KPIs determine the user

experience i.e. a) Customer Interface, b) Network Infrastructure KPIs and c) Service Functionality KPIs. The Service functionality KPIs are organized according to service type (such as Voice, SMS, etc.) rather than by operator type (fixed wireless, mobile, etc.) to ensure comparability between countries and consistency in the treatment of operators.

1.7.4. KPIs targets are set by the Regulator based upon consultation, keeping in view current KPIs values obtained through monitoring operators' data. Aggregated performance targets involve number of different observations that can be formulated in two different ways:

a. Percentage of events that exceed or fail to meet a target level of performance (e.g. % Calls established in less than X seconds). In this case, X indicates a target level.

b. Number of hours within which 90 percent of SIMs were activated. In this case, no target level is indicated. If compensation is going to be given, then the measurement must have a simple pass or fail criterion for each individual customer.

1.8. Compliance and Enforcement

1.8.1. QoS Results are published by the Regulator in order to carry out comparisons between operators' performance. The main purpose of publishing information on QoS is to better inform consumers. Regulators should publish information on performance on their websites while requiring operators to send this information periodically to consumers, along with their bills. QoS information examples that should be published include the QoS results from the network audit campaign (drive test, consumer survey, etc.). This information should be made available as soon as possible.

1.8.2. Ensuring compliance is highly recommended in QoS regulation. There are two (2) approaches in implementing QoS regulations i.e. Encouragement Approach and Enforcement Approach. For the regulator to proceed with the enforcement approach, it may start with recommendations and move towards obligations. The regulator can adopt a range of techniques, starting from naming-and-shaming strategies to tighter regulation, financial penalties and finally more drastic legal enforcements. However, doing so can involve extensive legal processes and may take a long time. A schedule of penalties may be announced publicly to ease implementation.

1.8.3. As a general principle, it is recommended that both encouragement and enforcement should be graduated and proportional. Whenever feasible, the regulator should engage in constructive dialogue with operators on quality problems. This should not be seen as a process of telling the operator how to run their business, but of asking targeted questions that can trigger the operators to review and reconsider their approach in areas with specific problems.

2. INTERNATIONAL BEST PRACTICES

2.1. Choosing QoS KPIs

2.1.1. There is a degree of flexibility allowed when deciding which QoS KPIs are to be chosen and measured by the Regulator. The Regulators in consultation with stakeholders are free to choose among the QoS KPIs that are appropriate, taking into account national circumstances and other factors, such as, the meaningfulness and usefulness of KPI, the underlying costs, time needed to implement the measurement and possible monitoring systems, changes required to adapt and modify current methodologies and allowing for the possibility of comparing new results with previous records. For example, the QoS KPIs implemented in different countries of Europe for measurement of Voice and Internet Services in mobile networks are mentioned in **Table 2.1:**

Service	KPI	Definition
Voice	Call Setup Success Rate	Probability that the end-user can access the mobile telephony service.
	Call Setup Time	Time period between sending of complete address information by the originating user and call establishment or receiving alerting message.
	Call Drop Rate	Probability that a successful established attempt is ended unintentionally.
	Speech Quality	Represents the quantification of the end-to-end speech transmission quality.
	Service Coverage Area	Coverage are of the mobile network where received signal strength at mobile terminal allows making a voice call.
Internet	Download / Upload Speed	Download/Upload Speed is the speed that information on the Internet/Mobile (e.g., text and graphics) is transferred to Mobile/Internet.
	Packet Delay	The time difference between the occurrences of two corresponding IP packet reference events.
	Packet Delay Variation	The difference between the one-way delay of IP packet and reference IP packet transfer delay.
	Packet Loss Ratio	The ratio of total number of lost IP packets to the total number of transmitted IP packets in a given measurement

Table 2.1: QoS KPIs for Voice and Internet Services

2.2. 3GPP QoS KPIs

2.2.1. 3rd Generation Partnership Project (3GPP) unites Seven telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as "Organizational Partners" and provides their members with a stable environment to produce the Reports and Specifications that define 3GPP technologies. 3GPP has defined technical specifications regarding QoS KPIs for UMTS and GSM in 3GPP TS 132 410 and QoS KPIs for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) in 3GPP TS 132.450 i.e. Definitions and 3GPP TS 132.451 i.e. Requirements. In these technical specification, six major categories are defined which are **Accessibility, Retainability, Integrity, Availability, Mobility** and **Utilization**. For example, some of the KPIs defined in these documents are mentioned in **Table 2.2 below:**

Technology	Category	Key Performance Indicators
TS 132 410		
3G	Accessibility	RAB Establishment Success Rate
		RAB Establishment Success Rate for Speech
		RAB Establishment Success Rate for Video telephony
2G		RRC Connection Establishment Success Rate
3G		UTRAN Service Access Success Rate
2G		GERAN Service Access Success Rate for CS Domain
3G		UMTS PDP Context Activation Success Rate
3G		UMTS Switched Call Success Rate
3G	Retainability	RAB Abnormal Release Rate
2G		GERAN Service Abnormal Release Rate
2G/3G		Combined 2G 3G Call Drop Ratio
3G	Mobility	Soft Handover Success Rate
3G		Outgoing Intra-system Hard Handover Success Rate
2G/3G		Outgoing Inter RAT Handover Success Rate for CS Domain
2G/3G		Outgoing Inter RAT Handover Success Rate for PS Domain
2G		Handover Success Rate (BSC and Cell)
3G	Utilization	Percentage of Established RABs, CS Speech
3G		Percentage of Established RABs CS 64kbps(Video telephony)
3G		Percentage of Established RABs, Total PS
3G	Availability	UTRAN Cell Availability
TS 132 450		
4G	Accessibility	E-RAB Accessibility
	Retainability	E-RAB Retainability
	Integrity	E-UTRAN IP Throughput
		E-UTRAN IP Latency
	Availability	E-UTRAN Cell Availability
	Mobility	E-UTRAN Mobility

Table 2.2: Example of 3GPP QoS KPIs

2.3. BEREC QoS KPIs & Measurement Method

2.3.1. The QoS, as perceived by the end-user, is a crucial factor for both customers and service providers and with the profusion of ever evolving technologies, networks and services with different levels of QoS, it is becoming increasingly more complex to manage, measure and regulate QoS. Indeed, quality can be impacted by many factors at the network level and along the value chain, including the device, hardware, infrastructure, service and applications. Body of European Regulators for Electronic Communications (BEREC) suggested a list of QoS parameters, definitions and measurement methods shown in **Table 2.3** to be used, where appropriate.

QoS KPI	Definition
Supply time for initial connection	ETSI EG 202 057-1 (clause 5.1) The duration from the instant of a valid service order being received by a direct service provider to the instant a working service is made available for use. This should exclude cancelled orders.

QoS KPI	Definition
Call setup time	ETSI EG 202 057-2 (clause 5.2) The call set up time is the period starting when the address information required for setting up a call is received by the network and finishing when the called party busy tone or ringing tone or answer signal is received by the calling party. Where overlap signaling is used the measurement starts when sufficient address information has been received to all the network to begin routing the call.
	3GPP TS 32.454 clause 5.1.2 Session setup time Applicable for IMS (VoLTE KPI)
Bill correctness complaints	ETSI EG 202 057-1 (clause 5.11) The proportion of bills resulting in a customer complaint about the correctness of a given bill per service.
Voice connection quality	ETSI EG 202 057-2 (clause 5.3) ETSI TR 102 506 Evaluation of speech quality per call. The end-user perceived voice quality.
Dropped call ratio	ETSI EG 202 057-3 (clause 6.4.2) The proportion of incoming and outgoing calls which, once they have been correctly established and therefore have an assigned traffic channel, are dropped or interrupted prior to their normal completion by the user, the cause of the early termination being within the operator's network.
	3GPP TS 32.454 clause 5.2.1 Call drop for IMS session Applicable for IMS (VoLTE KPI) The number of dropped sessions divided by the number of successful session establishments.
Unsuccessful call ratio	ETSI EG 202 057-2 (clause 5.1) ETSI EG 201 769-1 (clause 5.4) Unsuccessful call ratio is defined as the ratio of unsuccessful calls to the total number of call attempts in a specified time period.
Call set up failure probability	ETSI TS 102 024-9 (clause 4.1.1) The ratio of total call setup attempts that result in call setup failure to the total call setup attempts in a population of interest.
Call signaling delays	ETSI TS 102 024-9 (clause 4.2) It involves three different scenarios: call setup, call answer and call release. The Call Setup Delay (CSD) is the time between the calling terminal providing sufficient address information to set up the call, and the calling party receiving a confirmation from the called terminal that the called party is being alerted. The Call Answer Signal Delay (CASD) is the time between the called terminal indicating that it is ready to initiate the call and receipt of that indication by the calling terminal. The Call Release Delay (CRD) is the time between the clearing terminal initiating a call clear down, and its receipt of clearing confirmation by the called terminal.
Response time for operator services	ETSI EG 202 057-1 (clause 5.6.1) Time elapsed between the end of dialing to the instant the human operator answers the calling user to provide the service requested. Applicable to both fixed and mobile services.
Frequency of customer complaints	ETSI EG 202 057-1 (clause 5.9.1) ETSI EG 202 843 The number of complaints logged per customer per data collection period.

QoS KPI	Definition
Customer complaints resolution time	ETSI EG 202 057-1 (clause 5.10.1) The duration from the instant a customer complaint is notified to the published point of contact of a service provider and is not found to be invalid to the instant the cause for the complaint has been resolved.
Successful SMS Ratio	ETSI EG 202 057-2 (clause 5.6.1) Probability that a user can send a Short Message successfully from a terminal equipment to a Short Message Center
SMS delivery time	ETSI EG 202 057-2 (clause 5.6.3) The end-to-end delivery time for SMS is the period starting when sending a SMS from a terminal equipment to a Short Message Center and finishing when receiving the very same SMS on another terminal equipment. ETSI EG 102 250-2 (clause 7.4.5)
Latency	ITU-T Y.2617 The time between the first bit of a packet of a source entering a network, being received by the destination, which immediately sent a bit back to the source, and then the last bit of the packet arriving at the source across the network (round trip delay).
Jitter	ITU-T Y.2617 The difference between the delays of the selected packets.
Packet Loss Ratio	ITU-T Y.2617 The total number of packets failing to deliver through the network divided by the total number of transmitted packets within a specific time window.

Table 2.3: BEREC Suggested QoS KPIs

2.4. QoS KPIs in Regional Countries

2.4.1. The QoS KPIs of mobile services (i.e. Voice, SMS & Mobile Broadband) applicable in some regional countries are discussed in succeeding paragraphs alongwith its threshold values to be followed by the service providers.

2.4.1. Bangladesh

2.4.1.1. Some of the QoS KPIs to be measured through drive testing in Bangladesh, the Bangladesh Telecommunication Regulatory Commission in its (ANS Operators' Quality of Service) Regulations 2018 are mentioned in **Table 2.4.1**:

S. #.	QoS Parameters	Threshold	
1	Service Coverage	Out-door Coverage: City Corporations Area >= -80 dBm	
2	Service Coverage	Rest of the licensed Area >= -90 dBm	
3	Call Setup Success Rate	>= 97%	
4	Call Drop Rate	< = 2%	
5	Mean Opinion Score (MOS)	> = 3.5	
6	Call Setup Time	< = 7 sec	
7	CSFB Call setup time (4G/LTE)	< = 8 sec	
8	Data Throughput (FTP)3G	Download	> =2 Mbps
		Upload	>=128 Kbps
9	Data Throughput (FTP) 4G	Download	> =7 Mbps
		Upload	>=1 Mbps

Table 2.4.1: QoS KPIs in Bangladesh

2.4.2. Afghanistan

2.4.2.1. Some of the QoS KPIs defined in Afghanistan by the Telecom Regulatory Authority of Afghanistan are mentioned in **Table 2.4.2:**

Technology	Service	KPI	Indicator	Threshold
2G/3G	Voice	Call Blocking Rate	-	≤2%
2G/3G	Voice	Call Setup Success Rate	-	≥ 98%
2G/3G	Voice	Call Drop Rate	-	≤ 3%
2G/3G	Voice	Call Success Rate	-	> 95%
3G	Voice	Ec/Io	Good > -8dB	*Bad Quality Rate <2%*
3G	Voice	Ec/Io	Fair -14 dB < Ec/Io <-8 dB	*Bad Quality Rate <2%*
3G	Voice	Ec/Io	Bad < -14dB	*Bad Quality Rate <2%*
2G	Coverage	RxQual	Good	[0,3]
2G	Coverage	RxQual	Fair	[4,5]
2G	Coverage	RxQual	Bad	[6,7]
3G	Coverage	RSCP	Indoor > -80dBm	Indoor ≥ 90%
3G	Coverage	RSCP	In Car > -90dBm	In Car ≥ 95%
3G	Coverage	RSCP	Outdoor > -100dBm	Indoor ≥ 98%
3G	Data	Data Service Access Rate	-	> 80%
3G	Data	3G Data Transmission Rate	Upload (5MB)	> 80%
3G	Data	3G Data Transmission Rate	Download (10MB)	> 80%
3G	Data	Application Throughput	Upload	1MB
3G	Data	Application Throughput	Download	2MB

Table 2.4.2: QoS KPIs in Afghanistan

2.4.3. Nepal

2.4.3.1. Nepal Telecommunication Authority (NTA) published Consultation Paper on Draft Quality of Service Regulation in 2013 and subsequently issued Quality of Service Bylaws. In accordance with these Bylaws, some of the QoS KPIs are mentioned in **Table 2.4.3**:

S.#.	Service	KPI	Threshold
1	Voice	Network Down-Time	< 1%
2	Voice	Call Connection Time	≤ 5 seconds
3	Voice	Call Completion Ratio	> 98%
4	Voice	End-to-End Speech Quality *(Mean Opinion Score for A2B and B2A)*	> 3
5	Voice	Intra-Network Call Connection Loss	≤ 3%
6	Voice	Inter-Network Call Connection Loss	≤ 3%
7	Voice	Mobile Network Accessibility	> 99%
8	Voice	Grade of Service	≤ 2%
9	Data	Data Download Attempt Success Rate	> 80%
10	Data	Data Upload Attempt Success Rate	> 75%
11	Data	Throughput *(of the Subscribed Speed)*	> 75%

Table 2.4.3: QoS KPIs in Nepal

2.4.4. India

2.4.4.1. The Telecom Regulatory Authority of India (TRAI) also undertake field measurements to assess the quality of networks using Independent Drive tests (IDT) and Operator Assisted Drive tests (OADT). In IDT, TRAI engages agencies with drive test kits, the drive tests are conducted

under supervision of TRAI and comparative results are published. While in OADT Service providers conduct the drive tests under supervision of TRAI appointed agencies. The QoS KPIs measured through drive tests in different cities of India in IDT are mentioned in **Table 2.4.4**:

S. #.	Technology	Service	KPI	Threshold Value
1	2G/3G/4G	Voice	Blocked Call Rate	< 3%
2	2G/3G/4G	Voice	Call Setup Success Rate	≥ 95%
3	2G/3G/4G	Voice	Call Drop Rate	≤ 2%
4	2G/3G/4G	Voice	Handover Success Rate	≥ 95%
5	2G/3G/4G	Voice	Rx Quality	≥ 95%
6	2G	RF Coverage	Signal Strength (Rx Level)	≥ -85dBm
7	3G	RF Coverage	Signal Strength (RSCP)	≥ -90dBm
8	4G	RF Coverage	Signal Strength (RSRP)	≥ -110dBm
9	2G	Voice Quality	RxQual <=5	≥ 95%
10	3G	Voice Quality	Ec/No >=-14dBm	≥ 95%
11	4G	Voice Quality	SINR >0	≥ 95%

Table 2.4.4: QoS KPIs in India

2.4.5. United Arab Emirate

2.4.5.1. In United Arab Emirates (UAE), the Telecom Regulatory Authority (TRA) defined QoS KPIs alongwith its threshold values are mentioned in **Table 2.4.5**:

S. #.	Technology	Service	KPI	Threshold
1	2G/3G/4G	Voice	Call Setup Time	< 6.0 s
2	2G/3G/4G	Voice	CSFB Call Setup Time	< 2.0 s
3	2G/3G/4G	Voice	Call Setup Success Rate (CSSR)	> 98.5%
4	2G/3G/4G	Voice	Successful Call (End to End)	> 98.5%
5	2G/3G/4G	Voice	Drop Call Rate (DCR)	< 1%
6	2G/3G/4G	Voice	Voice Quality MOS (POLQA)	> 3.8
7	3G	Data	HTTP Capacity Download Mean User Data Rate	> 2000 kbit/s
8	3G	Data	HTTP Capacity Upload Mean User Data Rate	1000 kbit/s
9	3G	Data	FTP Download Mean User Data Rate	> 2000 kbit/s
10	3G	Data	HTTP Upload Mean User Data Rate	> 1000 kbit/s
11	3G	Data	Average Ping Duration	< 200 ms
12	3G	Data	Average YouTube Video Quality VMOS	> 2.2
13	3G	Data	Average Email Send Time	< 5 s
14	3G	Data	Email Send Success Rate	> 98 %
15	3G	Data	Average Email Receive Time	10 s
16	4G	Data	HTTP Capacity Download Mean User Data Rate	> 20000 kbit/s
17	4G	Data	HTTP Capacity Upload Mean User Data Rate	> 15000 kbit/s
18	4G	Data	FTP Download Mean User Data Rate	> 10000 kbit/s
19	4G	Data	HTTP Upload Mean User Data Rate	> 5000 kbit/s
20	4G	Data	Ping Duration	< 60 ms
21	4G	Data	YouTube Video Quality VMOS	> 2.5
22	4G	Data	Email Send Time	< 6 s
23	4G	Data	Email Send Success Rate	> 98 %
24	4G	Data	Email Receive Time	< 6 s
25	2G/3G/4G	SMS	SMS Send Time	< 3 s
26	2G/3G/4G	SMS	SMS End to End Time	< 6 s

Table 2.4.5: QoS KPIs in UAE

2.5. Network Benchmarking

2.5.1. Network Benchmarking is carried out to find best performing network with respect to consumer experience as it is the ultimate goal to assess the performance of a mobile network. It is easy to compare network performance on individual KPI levels (Drop Rate, Call Setup Time, single file download speed, etc.). However, the real problem is losing the bigger picture of what is best for the end users while comparing and optimizing so many KPIs. There are many different scores in the market for benchmarking network quality. Few of the examples are Connect Score/P3 Score, Chip Score, Ookla and RootMetrics Score etc.

2.5.2. The benchmarking and scoring of networks covering large geographic areas require careful consideration of number of factors which include deployed technology, extent of coverage, customer device population, customer population distribution and network usage and tariff offerings. While scoring the networks, following steps needs to be observed:

a. **Fair Play**. Benchmarking outcomes can be significantly influenced by specific targeting of test devices for superior performance. In such cases the results obtained no longer reflect the experience of a customer using that network. Steps should be taken to ensure that the measured results are truly representative of the real customer experience.

b. **Coverage**. Often networks are built with differing coverage objectives. Network rollout often varies between operators. This is often an important differentiator for consumers making decisions about which network is best for them. Benchmarking should be performed in such a way that it highlights coverage differences in the results. From a scoring perspective, operators should never be penalized for providing coverage where other operators do not. In fact, they should instead be rewarded in the scoring system. It should be the intention of any comprehensive mobile benchmark to include coverage comparison as a differentiating factor in the scoring.

c. **Deployed Technology**. Network evolution and the adoption rate of new technologies often varies between operators. Benchmarking should be performed in such a way that it incorporates the use of the latest technology available. This is to reflect the network capability and customer experience available with the latest devices. Benchmark scoring should account for Operators who offer performance differentiation through early adoption of new technologies by way of a 'bonus' for such deployment.

3. PROPOSED QUALITY OF SERVICE PARAMETERS

3.1. Scope & Applicability

3.1.1. The Cellular Mobile Network Quality of Service (QoS) Regulations, 2011 and subsequent amendment in 2012 has a scope and applicability to all cellular mobile communication service for the purpose of identifying the minimum quality of service standards and associated measurement. However, with the award of Next Generation Mobile Services (NGMS) licensees, the Regulations needs to be amended in accordance with NGMS licenses and keeping in view the international best practices and to ensure provision of best service quality to consumers of mobile services.

3.2. Existing QoS KPIs

3.2.1. The existing Regulations provide Key Performance Indicators (KPIs) and measurement procedure which are primarily concerned with Voice Service and Short Messaging Service (SMS). The Regulations have not defined any KPI for NGMS or Mobile Broadband Service. The QoS KPIs in Cellular Mobile Network Quality of Service (QoS) Regulations 2011, of Voice and SMS Services are listed in **Table 3.1.**

KPI	**Definition & Measurement Formula**	**Threshold**
Network Accessibility	Definition. *"The probability that mobile services are available to an end customer by display of the network indicator on the mobile test equipment throughout the entire duration of the samples."* Measurement. To be measured through drive test/ survey in accordance with the methodology provided at Annex-A.	*>99%*
Network Downtime	Definition. *"The probability that mobile services are not available to end customer."* Measurement. To be measured as average across all sites from the Network Management System (NMS) of the operator.	*<1%*
Grade of Service	Definition. "*The probability that the end customer cannot access the mobile services when requested if it is offered by display of the network indicator on the mobile equipment."* Measurement. Grade of Service (%) = [total no. of unsuccessful calls/total no. of calls] x 100.	*≤ 2%*
Call Connection Time	Definition. "*The time between sending of complete call initiation information by the caller (A-party) and in return receipt of call setup notification."* Measurement. Call Connection Time $= t_2 - t_1$, Whereas, t_2 = point of time where connect is established (B-party) ***(e.g.*** alerting or subscriber busy is detected by test equipment) and t_1 = point of time when send button on mobile equipment (A-party) is pressed	*≤ 6.5 Seconds*
Call Completion Ratio	Definition. *"The probability that a service, once obtained, will continue to be provided under given conditions for a given time duration or until deliberately terminated by either A-party or B-party".* Measurement. Call Completion Ratio (%) = [Total No. of end user Intentionally terminated calls / Total number of successful calls] x100%	*> 98%*

KPI	Definition & Measurement Formula	Threshold
End-to-End Speech Quality	Definition. *"The degree of speech quality that a listener perceives at the terminal with a talker at the other end."* Measurement. (1) Measurement will be based on PESQ Algorithm (ITU-T P .862) or subsequent ITU MOS standards as adopted by the Authority. (2) Average MOS values shall be considered for each direction of communication for the duration of the testing for each designated area under testing.	*MOS > 3*
SMS Success Rate	Definition. *"Probability that the short message service is delivered successfully, end-to end when requested and display of the relevant information on the mobile equipment".* Measurement. SMS Success Rate (%) SMS = [Total no of successful SMS / Total number of SMS attempts] x 100%	*> 99%*
SMS End-to-End Delivery Time	Definition. *"The time between sending a short message to a short message center and receiving the very same short message at intended mobile terminal (B-Party)".*	*≤ 12 Seconds*

Table 3.1: Voice & SMS Service QoS KPIs

3.3. Proposed Amendments in Existing QoS KPIs

3.3.1. Few of the amendments are suggested in the existing QoS KPIs regarding its measurement procedure and threshold values etc., are listed in **Table 3.2**.

KPI	Proposed Amendment in Measurement	Threshold
Network Accessibility	Measurement. • Network Accessibility (%) = [1 – Percentage of time mobile device is reporting "No Service" or "Emergency" as served technology during the drive test duration]. • "No Service" or "Emergency" is the period mobile services are neither available to an end customer nor display of the network indicator on the mobile equipment.	> 99%
Network Downtime	Measurement. • Network downtime shall be measured from Network Management System (NMS) of the operator as average of one month either across all the outdoor sites deployed by the operator in the surveyed area and as well any other area i.e. District, Tehsil etc., provide by the Authority. • The sites on which services are restricted on the direction of the Authority shall be excluded in the calculation of this KPI. Only those dates will be excluded for restricted sites which are mentioned in closure instructions. • Network downtime will be calculated separately for 2G (GSM), 3G (UMTS/HSPA+ etc.) and 4G (LTE) sites located in the mentioned area. • It is ratio of Total Time Network was not available to the Total Time during which measurement is taken.	< 1%
Grade of Service	• It is the percentage of all attempts to make a call that do not result in a connection to the dialed number. It can be calculated as: [total no. of unsuccessful calls attempts/total no. of attempts] x 100.	≤ 1%
Call Connection Time	Following amendments are suggested in this KPI based upon the ITU Recommendation ITU-T E.807 Recommendation 7.1.5 (i.e. Target)	≤ 7.5 Seconds

KPI	Proposed Amendment in Measurement	Threshold
	which states that *"Ninety-five per cent of these connected calls should have a call set-up time less than 10 seconds. Thus, the call set-up time is determined at the 95th percentile of the calls connected".* • The benchmark value of Call Connection Time is suggested to be ≤ 7.5 Seconds (including CSFB time). • Time duration should be measured between CM Service Request and Alerting message in case voice call is initiated from 2G and 3G. Time duration should be measured between Extended Service Request and Alerting message for CSFB.	
End-to-End Speech Quality	• End-to-End Service Quality (Mean Opinion Score) is represented by the average value of ITU-T P.863 'Perceptual objective listening quality prediction' (POLQA) predicted MOS of all speech samples in successfully established calls. • Measurement will be based on the latest version of ITU- P.863 to achieve the correct relative service quality between VoLTE, HD-Voice and legacy narrowband telephony. • Average MOS values shall be considered for each direction of communication for the duration of the testing for each designated area under testing. • This KPI has to be achieved with 90% confidence based on the sample count in the surveyed area.	MOS > 3 with 90% Confidence

Table 3.2: Proposed Amendment in Existing QoS KPIs

3.4. Proposed New QoS KPIs

3.4.1. The award of Next Generation Mobile Service (NGMS) licenses has paved the way for the introduction of new QoS KPIs for Voice and as well as Mobile Broadband. The suggested QoS KPIs to be made part of the QoS Regulations are mentioned in **Table 3.4.**

S. #.	Technology	Service	Suggested KPIs
1.	2G, 3G & 4G	Voice	Call Setup Success Rate (CSSR), Call Drop Rate, RAB Setup Success Rate & Inter System Handover for CS Voice
2.	2G, 3G & 4G	Voice & Data	Signal Strength *(Rx Level, RSCP & RSRP)*
3.	2G, 3G & 4G	Voice & Data	Signal Strength Quality *(Rx-Qual, Ec/No & RSRQ)*
4.	3G & 4G	Voice & Data	Session Abnormal Release Rate
5.	3G & 4G	Data Transfer	Download / Upload Success Ratio & User Data Throughput
6.	3G & 4G	Video Streaming	Video Streaming Success Ratio, Setup Time & MOS
7.	3G & 4G	Browsing	Webpage Browsing Success Ratio & Access Time
8.	3G & 4G	Social Media	Social Media Success Ratio & Access Time
9.	3G & 4G	Data	Ping (Latency, Jitter & Packet Loss)
10.	4G	Data	E-RAB Setup Success Rate

Table 3.4: New Proposed QoS KPI of Voice and Mobile Broadband Service

3.5. Definition and Measurement Procedure of New QoS KPIs

3.5.1. The definition, threshold value and measurement procedure of new proposed QoS KPIs proposed are defined in succeeding paragraphs.

3.5.1. Call Setup Success Rate & Call Drop Rate

3.5.1.1. Call Setup Success Rate (CSSR) is defined as the percentage of all attempts to make a call that result in a connection to the dialed number. Whereas, Call Drop Rate (CDR) is the percentage of calls that were cut off due to technical reasons before the A & B parties finished their

conversation and before one of them intentionally hung up. CDR is measured as a percentage of all successfully established calls.

KPI	*Definition*	*Benchmark*
Call Setup Success Rate	*CSSR = [Number of successfully established calls / Number of attempts]x 100* *Successfully established calls shall include completed calls and established but dropped calls. Whereas attempts include completed, dropped and failed calls.*	*> 98%*
Call Setup Success Rate	*CDR = [Number of dropped calls/ Number of completed + Number of dropped calls] x 100* The formula only considers completed and dropped calls as successfully established:	*< 2%*

3.5.2. RAB Setup Success Rate & ISHO Success Rate for CS Voice

3.5.2.1. The purpose of a Radio Access Bearer (RAB) is to provide a connection segment using the WCDMA Radio Access Network (WCDMA RAN) for support of a UMTS bearer service. The WCDMA RAN can provide Radio Access Bearer connections with different characteristics in order to match requirements for different UMTS bearers. This KPI describes the ratio of all successful RAB establishments to RAB establishment attempts for UTRAN network and is used to evaluate service accessibility across UTRAN. This KPI is obtained by the number of all successful Radio Bearer Setup establishments divided by the total number of attempted for Radio Bearer Setup establishments.

3.5.2.2. Inter System Handover is the measurement of successfulness of Handover in 3G/2G for Circuit Switched Voice.

KPI	*Definition & Formula*	*Benchmark*
RAB Setup Success Rate	*The probability that RAB would be assigned to mobile user for any service when requested.* *RAB Setup Success Rate (%) = [Total No. of Successful RAB Setup Requests/ Total No. of RAB Setup Requests] x 100%* *Measurement* *This KPI will be measured during voice testing for 3G (UMTS/HSPA+ etc.) technologies.*	*≥ 98%*
ISHO for CS Voice Only	The probability that Inter System Hand Over will be successfully done for Circuit Switched voice. ISHO for CS Voice (%) = [Total No. of Successful ISHO/ Total No. of ISHO Requests] x 100%	≥ 98%

3.5.3. Signal Strength (RX Level, RSCP, RSRP)

3.5.3.1. Signal strength values are defined by a few different measurements which vary even more for different service modes. These measurements are as follows:

a. **RX Level:** RX Level is the strength of the signal that our mobile receives from a BTS.

b. **RSCP:** In the UMTS cellular communication system, received signal code power (RSCP) denotes the power measured by a receiver on a particular physical communication channel. It is used as an indication of signal strength.

c. **RSRP:** (Reference Signal Receive Power) is the average power of Resource Elements (RE) that carry cell specific Reference Signals (RS) over the entire bandwidth, so RSRP is only measured in the symbols carrying RS.

KPI	***Definition***	
Signal Strength	*RX Level*	*The power level corresponding to the average received signal strength in the downlink as measured by the mobile station.*
	RSCP	*Received Signal Code Power (RSCP) for 3G and Reference Signal Receive Power (RSRP) for 4G and denotes the power measured by a receiver on a particular physical communication channel.*
	RSRP	
Technology	***Threshold***	***Confidence Level***
Rx Level (2G)	*≥ -80 dBm*	*With 90% Confidence measured for the complete surveyed area and calculated on sample count.*
RSCP (3G)	≥ -100 dBm	
RSRP (4G)	≥ -100 dBm	

3.5.4. Signal Strength Quality

3.5.4.1. Signal Strength Quality indicates the quality of the signal i.e. how much noise is present in the signal. For different service modes their measurements are as following:

a. **Rx-Qual:** Rx-Qual is used in GSM and is a part of the Network Measurement Reports (NMR). This is an integer value which can be between 0 and 7 and reflects the quality of voice. 0 is the best quality, 7 is the worst.

b. **Ec/No:** Ec/No is the ratio between the received energy from the pilot signal CPICH per chip (Ec) to the noise density (No). In other way, we can tell, that it is the ratio of the received signal level (RSCP) to the sum of all levels of signals on the same frequency (RSSI). Therefore, the higher Ec / No, the better are difference between the signal and noise.

c. **RSRQ:** RSRQ is a calculated value from RSRP and RSSI is measure of signal and interference. As RSRQ is a ration of two signal powers with same unit i.e. dBm so RSRQ uses dB as a measurement unit.

KPI	***Definition***	
Signal Strength Quality	*Rx Qual*	*Received Quality (RXQUAL) is a value that represents the quality of the received signal. The MS determines the Bit Error Rate (BER) of the signal and reports it back to the network. The BER is simply a percentage of the number of bits it receives that did not pass error checking. The higher the BER the lower the signal quality.*
	Ec/No	*The Received Energy per Chip (Ec) divided by the Total Noise Power Density (No) in the band.*
	RSRQ	*Reference Signal Received Quality (RSRQ) is defined as the ratio N×RSRP/ (E-UTRA carrier RSSI), where N is the number of Radio Bearers' of the E-UTRA carrier RSSI measurement bandwidth. The measurements in the numerator and denominator shall be made over the same set of resource blocks.*
Suggested Benchmark Value		
Technology	***Threshold***	***Confidence Level***

KPI	Definition	
Rx Qual (2G)	*≤ 4*	*For 80% Samples*
Ec/No (3G)	*≥ -13 dB*	*For 80% Samples*
RSRQ (4G)	*≥ -16 dB*	*For 80% Samples*

3.5.5. Session Abnormal Release Rate

3.5.5.1. The ability of a user to retain the RAB or E-RAB once connected for the desired duration is Session Abnormal Release Rate (SARR).

KPI	Definition & Formula	Benchmark
Session Abnormal Release Rate	*The probability of abnormal release of any type of Voice and Data Service, after successful assignment of RAB (3G) or E-RAB (4G). Session Abnormal Release Rate (%) =[Total No. of Abnormal Session Releases/ Total No. of Session Releases] x 100%*	*≤ 2%*

3.5.6. Data Transfer (Success Ratio & User Data Throughput)

3.5.6.1. Data throughput is what users experience most of the time while using a data service. It depends on many protocol issues such as transmission schemes (slower schemes are used at longer distances from the access point due to better redundancy), packet retransmission and packet size. The typical throughput is often lower due to traffic sharing inside the same network or cell, interference or even limited fixed line capacity from the base station onwards.

3.5.6.2. The Download/Upload Success Ratio measures the data service availability /accessibility. It is the ratio of successfully completed tests (completed downloads and uploads) to all started tests.

KPI	Definition & Formula	Benchmark
DL /UL Success Ratio	*Download/Upload Success Ratio = [Number of successfully completed tests /Number of attempts]x 100*	*≥ 99%*

3.5.6.3. Downlink/Upload User Data Throughput is basically the mobile internet download/upload speed at user end. Throughput refers to how much data can be transferred from one location to another in a given amount of time. Thresholds for throughputs are added in QoS regulations separately for 3G & 4G technologies to ensure better data rate for end consumers.

KPI	Definition	
Downlink User Data Throughput	*Downlink User Data Throughput is measure of the average Internet speed in the downlink available on the testing mobile equipment during the testing session.*	
Uplink User Data Throughput	*Uplink User Data Throughput is measure of the average Internet speed in the Uplink available on the testing mobile equipment during the testing session.*	
Technology	**Threshold**	**Confidence Level**
3G (Download)	*≥ 1 Mbps*	*With 70% confidence till 1st year of Effective Date of QoS Regulations*
		With 80% confidence till 2nd year of Effective Date of QoS Regulations
		With 100% confidence from 3rd year onwards from Effective Date of QoS Regulations

KPI	*Definition*	
4G (Download)	*≥ 4 Mbps*	*With 70% confidence till 1st year of Effective Date of QoS Regulations*
		With 80% confidence till 2nd year of Effective Date of QoS Regulations
		With 100% confidence from 3rd year onwards from Effective Date of QoS Regulations
3G (Upload)	*≥ 256Kbps*	*With 70% confidence till 1st year of Effective Date of QoS Regulations.*
		With 80% confidence till 2nd year of Effective Date of QoS Regulations.
		With 100% confidence from 3rd year onwards from Effective Date of QoS Regulations
4G (Upload)	*≥ 1Mbps*	*With 70% confidence till 1st year of Effective Date of QoS Regulations*
		With 80% confidence till 2nd year of Effective Date of QoS Regulations
		With 100% confidence from 3rd year onwards from Effective Date of QoS Regulations

3.5.7. Video Streaming (Video Success Ratio, Setup Time & MOS)

3.5.7.1. Video services consume the majority of data transferred in mobile networks and therefore have to be considered. Video Streaming test can be divided into two phases: the video access phase and the video play-out phase. The video access phase starts with the video request and continues until the first picture is displayed. This time is measured by the KPI video setup time. Video setup time is the time interval from the point when a request to play a video is made to the moment when the video starts to play. It measures the overall performance of the network in terms of accessibility to video streaming services.

KPI	*Definition & Formula*	*Benchmark*
Video Success Ratio	Video success ratio considers all tests that achieve the defined display time of the video. These tests are classified as completed. Video success ratio = [Number of successfully completed tests / Number of attempts] x 100 Attempts include Completed, Dropped and Failed attempts	*≥ 99%*
Video Setup Time	Video Setup Time is the average value of all measured times to first picture (TTFP) for all completed and dropped tests. It quantifies the average length of the video access phase.	*< 7 Seconds*
Video MOS	Video MOS average is calculated for all successfully completed tests. It is defined as the average of already averaged video MOS (ITU J.341) per test. It incorporates all visible degradations during the video display into a MOS.	*> 3*

3.5.8. Ping (Latency, Jitter & Packet Loss)

3.5.8.1. Latency is a measure of delay. In a network, latency measures the time it takes for some data to get to its destination across the network. It is usually measured as a round trip delay - the time taken for information to get to its destination and back again.

3.5.8.2. Jitter refers to small intermittent delays during data transfers. It can be caused by a number of factors including network congestion, collisions, and signal interference.

Technically, jitter is the variation in latency or the delay between when a signal is transmitted and when it is received.

3.5.8.3. Packet loss occurs when one or more packets of data travelling across a network fail to reach their destination.

KPI	*Definition & Formula*	*Benchmark*
Latency	*Latency is the round trip time for data packets from mobile handset to any global/international server decided by the Authority and back to the sending endpoint.*	*3G < 300mSec*
		4G < 150mSec
Jitter	*The fluctuating rate of delays in data transfers is called jitter which mostly occurs during packet switching, but which can be monitored by following the ratio of the sum of average delays in each packet (variable delay) and the volume of packet received.*	*3G < 70mSec*
		4G < 50mSec
Packet Loss	*This indicator measures the percentage of the data packets transmitted from the source and fails to arrive at their destinations.* *Packet Loss (%) =[Total No. of Packet Lost/ Total No. of Packet Sent] x 100%*	*≤ 3%*

3.5.9. Browsing (Webpage Success Ratio & Access Time)

3.5.9.1. Web Browsing is one of the mostly used service. It contributes much less to the amount of transferred data than video, but users spend considerable time using such services and therefore checking its performance is essential for the perceived network performance.

3.5.9.2. Compared to Data Transfer from/to a dedicated server, the Web Browsing test includes problems in the wider core network and especially the Content Delivery Network (CDN), and best reflects the user's perception. The performance of Web Browsing not only depends on the performance of the mobile network, but also on individual constellations of the CDN behind it.

KPI	*Definition & Formula*	*Benchmark*
Web Browsing Success Ratio	*Browsing Success Ratio is the ratio of successfully loaded webpages.* *Browsing success ratio = Number of successful tests / Number of successful tests + Number of failed tests] x 100*	*> 99%*
Web Browsing Access Time	*Time required for loading a website is known as webpage access time.* *Measured by loading a different web pages and recording the amount of time that this page takes to load.*	*≤ 5 Seconds*

3.5.10. Social Media (Webpage Success Ratio & Setup Time)

3.5.10.1. Social Media applications are heavily used by today's subscribers. They contribute much less to the amount of transferred data than video, but users spend considerable time using such services and therefore their performance is essential for the perceived network performance.

3.5.10.2. A social media session can involve actions such as opening the home page, opening several posts, commenting on posts, liking posts and creating posts. The social media test includes creating or uploading a post that includes transferring a media file.

KPI	*Definition & Formula*	*Benchmark*
Social Media Success Ratio	*Social Media Success Ratio is the ratio of successfully completed action* *Social Media Success Ratio = Number of successful tests / Number of successful tests + Number of failed tests] x 100*	*> 99%*
Social Media Duration	*Social media duration is a KPI that measures the time of uploading to social media in a specific time interval.*	*≤ 15 Seconds*

3.5.11. E-RAB Setup Success Rate

3.5.11.1. An E-RAB uniquely identifies the concatenation of an S1 Bearer and the corresponding Data Radio Bearer. When an E-RAB exists, there is a one-to-one mapping between this E-RAB and an EPS bearer of the Non-Access Stratum (NAS). E-RAB Setup Success Rate is the probability that E-RAB would be assigned to mobile user for any service when requested.

KPI	*Definition & Formula*	*Benchmark*
E-RAB Setup Success Rate	*The probability that E-RAB would be assigned to mobile user for any service when requested.* *E-RAB Setup Success Rate (%) = [Total No. of Successful E-RAB Setup Requests/ Total No. of E-RAB Setup Requests] x 100%*	*≥ 98%*

4. NETWORK PERFORMANCE SCORE

4.1. Why Aggregate Score?

4.1.1. The perceived technical performance of a network depends on how satisfied users are with the quality and availability of telecommunications services. Smartphones are not only used for telephony and text messaging services; today, they are predominately used for mobile broadband services. There is a demand for an efficient method of calculating an overall score that reflects the perceived technical performance of a network or one of its subsets, such as a region, a period of time or a technology.

4.2. Network Performance Score

4.2.1. Network Performance Score (NPS) is a single metric that characterizes the overall network performance. NPS compares the quality of mobile networks and visualizes Quality of Experience (QoE) that the end users perceive when using common applications. ETSI has released its technical report in August 2019 i.e. TR 103 559 on NPS, which defines best practices for network QoS benchmark testing. PTA can also measure the NPS as per the methodology of stated standard and publish the results for the information of general public.

4.2.2. NPS considers and weights the Key Performance Indicators (KPIs) for a wide range of services that are essential for and representative of the service quality and combines them into an overall performance score. This score can be calculated for individual regions such as cities, towns and highways. The scores of the individual regions are then aggregated in an overall network performance score.

4.2.3. The scoring mechanism allows very efficient comparison of operators in a market, of different measurement campaigns in regions and countries, or before and after deployment of new technology or software. The transparent structure of the score allows efficient drilldown to the region, service or even the KPIs responsible for a non-optimal overall score.

4.3. NPS KPIs

4.3.1. The structure of the network performance score is highly transparent and consists of different layers of weighting and accumulation. NPS score is based on telephony and data services sub scores, each of which is scaled separately from 0 to 100 %. Each of these two sub scores consists of a set of comprehensive KPIs or contributors. Today, the sub scores have weightings of 40 % telephony and 60 % data services and form a complete network score. It is possible to apply an additional intermediate weighting layer that gives different weightings for individual regions and categories such as cities, connecting roads, hotspots and rural areas. The weighted and cumulative scores for the sub-region have again range from 0 to 100 %. The number, categorization and weighting of these regions is flexible and can be defined to meet regional or national needs.

4.3.2. The KPIs of NPS for Voice Services are broadly categorized into Accessibility/ Sustainability, Setup Time and Speech Quality. Whereas in case of Data Services, KPIs are measured for HTTP Transfer, Video Streaming, Browsing and Social Media. All the KPIs are shown in below table.

INTEGRAED NETWORK PEROFRMANCE SCORE	
VOICE (40%)	**DATA (60%)**
Accessibility / Sustainability	***Data Transfer***
• Call Setup Success Ratio – CSSR • Call Drop Ratio	• Single File Download/Upload Success Rate • Average Download / Upload Throughput • 10 Percentile Download / Upload Throughput • 90 Percentile Download/Upload Throughput
Call Setup Time	***Video Streaming***
• Average Call Setup Time • Call Setup Time > 15 Seconds • 10 Percentile Call Setup Time	• Success Ratio • Time to Transfer First Picture • Video Quality – MOS • 10 Percentile Video MOS • Video Setup Time > 10 s Ratio
Speech Quality	***Browsing & Social Media***
• Average MOS – Super Wide Band • MOS < 1.6 • 90 Percentile MOS - SWB	• Browsing Success Ratio • Browsing Duration Average • Browsing Duration > 6s Ratio • Social Media Success Ratio • Social Media Duration Average • Social Media Duration > 15s Ratio

4.4. Measurement of NPS

4.4.1. In order to improve overall QoS and ranking of mobile networks in Pakistan, PTA shall also measure NPS as per ETSI TR 103 559 recommendations. The results will be published for the information of general public as well as with Cellular Mobile Operators (CMOs) to take corrective measures and improve its overall network ranking.

5. MONITORING AND ENFORCEMENT

5.1. QoS Surveys

5.1.1. In order to ensure that users of telecommunication services get such Quality of Service standards as per laid down standards, the inspections, surveys and benchmarking exercise are either carried out from time to time, either independently by the Regulator or jointly with Service Providers or through a Third Party. Following needs to be ensured for each type of survey:

a. Independent QoS Survey

i. Regulator itself shall carry out independent QoS Survey.

ii. The report of such tests / surveys shall be shared with CMOs for compliance after taking all the corrective measures based upon the root cause analysis of the drive test logs.

iii. The concerned CMOs shall carryout Root Cause Analysis and submit compliance report consisting of following:

- Detailed Root Cause Analysis of the degraded QoS KPIs, consisting of analysis of each abnormal event or patch wise analysis of the degraded KPI need to be done.
- Details of the problematic cells or area impacting the QoS KPI along with the steps taken to resolve the issue
- The Confirmatory Testing shall be performed on the identified Cells/Areas. Multiple tests will be performed to confirm the resolution of the identified issues only.
- A new testing in overall city, without resolution of the identified issue at particular location will not be considered as compliance.
- Compliance Report shall also include the log files and or any other supporting evidences/OSS KPIs as the case may be.

ii. The compliance report shall be analyzed by the Regulator and if found incomplete or if required an independent QoS Survey shall be carried. However, in case the performance is again found deteriorated, then enforcement action shall be initiated.

b. Joint QoS Survey

i. Regulator shall carry out QoS Surveys jointly with CMOs using their own drive test equipment.

ii. As the log files are already available with CMOs, therefore, without waiting for any report from Regulator, the CMOs shall submit compliance after taking all the corrective measures based upon the root cause analysis of the drive test logs.

c. Third Party QoS Survey

i. The Authority may itself or direct CMOs to engage, if circumstances so require, third party/consultant to conduct quality of service audit, as per international best practices.

iii. The report of such tests / surveys shall be shared with CMOs for compliance after taking all the corrective measures based upon the root cause analysis of the drive test logs.

iii. The concerned CMOs shall carryout Root Cause Analysis and submit compliance report consisting of following:

- Root Cause Analysis of Non-Conforming Event / Drive Test Logs
- Details of Corrective/Remedial Measures
- Confirmatory tests/surveys in accordance with Drive Test Methodology

iv. The compliance report shall be analyzed by the Third Party and if found incomplete or non-compliant, then enforcement action shall be initiated.

5.2. Measurement & Monitoring by CMOs

5.2.1. CMOs as per their issued licenses are bound to meet and exceed the Quality of Service at all time. In order to ensure the same, CMOs shall monitor the quality of telecommunication service being provided to its users. As per direction of the Authority, the CMOs shall also carry out tests and surveys and submit monitoring report. The CMOs shall also submit compliance report of QoS KPIs extracted from their Network Management System. All such report shall be submitted as per the direction of the Authority and may include QoS KPIs of each Site, Tehsil, District, Division, Province and National Level etc.

5.3. Coverage

5.3.1. Mobile Operators built their networks keeping in view different coverage priorities, which may result in varied network coverage in any particular area. However, this single factor becomes an important differentiator for consumers to decide which network is best for them. Therefore, The Authority is of the view that in future, benchmarking surveys shall be carried out in such a way that it highlights coverage differences in the results. Any operator shall get benefit for better coverage in any particular area in comparison to the operator which do not have presence or weak coverage for the said area. The drive test shall be carried out keeping in view the following:

a. The city, town and road shall be selected keeping in view the coverage maps of the CMOs.

b. If any one of the CMOs has coverage in any particular area, the same shall be considered covered and selected for service quality testing.

c. The testing shall be carried using different scenarios. In this regard, any combination of ON-NET, OFF-NET Calls, SMS and Data Testing (i.e. Web Browsing, Video Streaming, Social Media and Data Transfer etc.) shall be carried out.

d. Both A-Party and B-Party can be kept moving or any one of them can be static.

5.4. Publication of Results

5.4.1. The Authority shall publish the QoS Survey Results so that users may be able to compare between the operators. Another aim is to engage CMOs in constructive dialogue on quality problems. This is not the case to tell the operator how to run their business, but to compel the CMOs to review and reconsider their approach in areas with specific problems.

5.4.2. The Authority shall publish the report of each parameter that is reportable for a service, for each reporting area and for each reporting period and shall contain the name of service, type of survey, the target values and scored results. Further, in case of joint surveys, any explanatory remarks of CMOs, if accepted by the Authority, including but not limited to remarks about changes in operational conditions that could not have reasonably been foreseen by the Licensee shall be made part of the report.

6. QUESTIONS FOR CONSULTATION

Q1. Whether prescribed QoS KPIs, as per existing QoS Regulations, sufficient to effectively monitor QoS of Voice and SMS Services? Please provide suggestions with justifications.

Q2. Whether the ranges and values prescribed for existing QoS KPIs reasonable, relaxed or strict? Please justify with reasons.

Q3. Whether amendments suggested in existing QoS KPIs are reasonable, relaxed or strict? Please justify with reasons.

Q3. Whether the new proposed QoS KPIs, sufficient to effectively monitor QoS of Mobile Broadband networks? Please provide suggestions with justifications.

Q4. Whether the ranges and values prescribed for new proposed QoS KPIs reasonable, relaxed or strict? Please justify with reasons.

Q5. Whether the methodology proposed in new QoS regulations for Network Downtime is the best technique for assessment? Please provide details with justifications.

Q7. Suggestion are required whether it is a good option to adopt NPS as an alternate mechanism for QoS / QoE measurement.

Q8. Do you agree with the concept of introducing penalties for degraded KPIs? If so, what should be the amount?

Q9. Any other feedback which is relevant to QoS Regulations?

7. REFERENCES

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9. 3GPP Recommendations related to Quality of Service
10. ITU Recommendations related to Quality of Service