



**INFORMATION COMMUNICATION TECHNOLOGIES QUALITY OF SERVICE  
AND  
QUALITY OF EXPERIENCE GUIDELINES**

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## **CHAPTER 1 GENERAL PROVISIONS**

### **Article 1: Preamble**

- 1.1. The Botswana Communications Regulatory Authority (BOCRA or the Authority) was established through the Communications Regulatory Authority Act, 2012 (CRA Act) to regulate the communications sector in Botswana, comprising telecommunications, internet and Information and Communications Technologies (ICTs), radio communications, broadcasting, and postal services.
- 1.2. The mandate of the Authority is, among others, to facilitate the provision and availability of efficient, effective, and affordable communication services throughout Botswana; promote the interests of consumers in having a choice of quality and variety of services at good value for money, and to promote effective competition through fair regulation that is conducive to business investment in telecommunications.
- 1.3. In line with the foregoing provisions of the CRA Act, BOCRA has these guidelines to facilitate Monitoring of Quality of Service offered.

### **Article 2: Objective of these Guidelines**

2.0 The objectives of these Guidelines are to:

- a) Protect and to promote the interest of consumers of Internet and Telecommunications services.
- b) Provide measurement options for quality of service.
- c) Monitor quality of experience; and
- d) Promote competition amongst the service providers

### **Article 3: Definition of Terms**

In these Guidelines, unless the context otherwise requires-

**“Act”** means the Communications Regulatory Authority Act 2012.

**“Authority”** means the Botswana Communications Regulatory Authority established under the Communications Regulatory Authority Act, 2012 (CRA Act);

**“Access Network Utilization”** means the total traffic between access node to aggregation node.

**“Billing Accuracy (BA)”** means the discrepancy between the theoretical cost and the real cost in billing.

**“Billing Complaint Rate (BCR)”** means the percentage of customer billing related complaints per the reporting period. Both the level of quality of service offered to the consumer and the perceptions and/ or experience of the quality of service offered are critical factors in monitoring quality of service.

**“Call Centre Operator Response (CCOR)”** means the duration between sending a request to speak to the Operator to the time that the Operator’s response is heard.

**“Call Connection Failure (CCF)”** means the percentage of unsuccessful calls.

**“Call Set-up Success Rate (CSSR)”** means **the** ratio of total number of successful calls to the total number of all call attempts made on the network during a specified period.

**“Call Setup Time (CST)”** means the duration from when a call is made to the time of receiving a ring back tone.

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**Complaint Resolution Time (CRT)**” means the time taken for a service provider to resolve a complaint.

**“Data Access Success Rate”** means the probability of success in connecting to the public server.

**“Data Transmission Rate”** means the speed of data travelling from user to a network and back.

**“DNS Resolution Success Rate”** means the likelihood for a domain name to be converted into an IP address successfully by DNS resolver.

**“DNS Resolution Time”** means the time taken for a DNS domain name to translate website names into IP addresses.

**“DNS Resolver - also known as a resolver”** means a server on the internet that is responsible to convert domain names to IP addresses.

**“Drop Call Ratio (DCR)”** means the percentage of calls connected to intended recipients that ended without the intervention of any of the users.

**“Effective date”** means the date on which this regulation comes into force.

**“FTP”** means the standard network protocol used for computer file transfer between a client and a server

**“FTP Drop Rate”** means the percentage of incomplete data transfers that were started successfully.

**“FTP Mean Data Rate [Mbit/s]”** means the average data transfer rate measured through the entire connect time to the service.

**“FTP Set-up Time”** means the duration to access the service successfully, from starting the dial-up connection to the point of time when the content is sent or received.

**“Handover Success Rate (HSR)”** means the ratio of successful handover calls to the total number of handover call attempts made. Handover is the process by which a mobile telephone call is transferred from one base station to another as the subscriber passes the boundary of a cell. *[Recommendation ITU-T Q.1005]*.

**“HTTP”** means the underlying protocol used by the world wide web that defines how messages are formatted and transmitted and what actions the WEB server and browser should take in response to various commands

**“HTTP/Packet Drop Rate”** means the percentage of incomplete data transfers that were started successfully.

**“HTTP/Packet Mean Data Rate”** means the average data transfer rate measured through the entire connection time to the service.

**“HTTP/Packet Set-up Time”** means the duration between the instant when the request of the web page is sent to the instant when the beginning of the web page is received.

**“Interconnection Route Utilization (IRU)”** means the percentage of provisioned interconnection route(s) that carry traffic.

**“Latency”** means the round-trip time taken by standard packet to travel across network from end user to the test equipment and back to the user.

**“Mean Opinion Score (MOS)”** means a numerical value that measures user experience and the factors that influence voice quality. *[Recommendation ITU-T P.863]*.

**Mean Time To Repair (MTTR)”** means the duration between a reported fault to service restoration.

**“Mobile Coverage Strength”** means the transmitter power output as received by a reference antenna at a distance from the transmitting antenna.

**“Network Availability (NA)”** means the degree to which the network is operable and not in a state of failure or outage at any point in time.

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**“Network Efficiency Ratio (NER)”** means the ability of the network to deliver calls to the furthest terminal. It expresses the relationship between the number of seizures and the sum of number of seizures resulting in either an answer message, or a user busy or a no answer ring. *[Recommendation ITU-T E.425]. [the ability of the network to deliver calls]*

**“Operator”** means an entity that holds a licence to operate mobile telecommunication services.

**“Packet Loss”** means the percentage of data packets transmitted from the source but fail to arrive at their destinations.

**“PDP Context Activation Failure Ratio”** means the probability that the PDP context cannot be activated. It is the proportion of unsuccessful PDP context activation attempts and the total number of PDP context activation attempts (*similar to Call Setup Failure Rate in Voice*)

**“PDP Context Activation Success Rate”** means the probability that the PDP context can be activated. It is the proportion of successful PDP context activation attempts and the total number of PDP context activation attempts (*similar to Call Success Setup Rate in Voice*)

**“PDP Context Activation Time”** means the time period needed for activating the PDP context. (*Similar to Call setup time for vo*)



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**PDP Context Cut-off Ratio** “means the probability that a PDP context is deactivated without being initiated by the user. (*Similar to Drop Call Rate in voice*)

**“Point of Interconnection Congestion”** means the percentage of congestion at point of interconnection. [*Recommendation ITU-T E847*].

**“Post Dialing Delay (PDD)”** means the Time interval in seconds between the end of dialing by the caller and the reception of the network response. Equivalent to Call Setup Time, as defined in [*Recommendation ITU-T E.800*].

**“Provision of Service”** means the time taken to provide service to a location where it is required.

**“Quality of Experience (QoE)”** means the consumer perception, or experience of the quality of the service offered.

**“Quality of Service (QoS)”** means the statement of the level of quality of the service as offered to the consumer by a service provider. [*ITU-T Recommendation G.100*]. **“Quality of Service Guidelines”** means a set of standards and measures that define applicable quality measures.

**“Registration Success Rate (RSR)”** means the ratio of the number of successful established terminating sessions to the number of attempted established terminating sessions. [*ETSI TR 103 219*].

**“Service Availability (SA)”** means the percentage of time the network shall be available to the subscribers.

**“SMS Delivery Success Rate”** means the percentage of sent messages that are received by the intended recipient(s).

**SMS End to End Delivery Time”** means the duration from when an SMS is sent to the time of receiving the SMS by the intended recipient(s).

**“SMS Service Accessibility”** means the probability that a user can access the SMS centre for sending SMS.

“

“**Throughput**” means the speed of uploading and downloading data in Megabits per second between end-user and test equipment.

“**Web Radio Reproduction Cut-off Ratio**” means the percentage that a subscriber cannot successfully complete stream reproduction from a given web radio station for a given period.

“**Web Radio Tune-in Success Rate**” means the percentage that a subscriber can obtain the tune-in information for a web radio streaming server successfully.

“**Web Radio Tune-in Success Time**” means the duration needed to obtain the tune-in information for a web radio streaming server successfully.

#### **Article 4: Abbreviations**

##### **The following abbreviations shall apply**

5G	-	Fifth Generation Network
CSR	-	Call Success Rate
CSSR	-	Call Set Up Success Rate
CST	-	Call Setup Time
DCR	-	Drop Call Ratio
DCR	-	Drop Call Ratio
DNS	-	Domain Name System
DSR	-	Delivery Success Rate
FTP	-	File Transfer Protocol
GSM	-	Global System for Mobiles
HSR	-	Handover Success Rate
HTTP	-	Hypertext Transfer Protocol
ISSR	-	Internet Setup Success Rate
LTE	-	Long Term Evolution

MCS	-	Mobile Coverage Strength
MOS	-	Mean Opinion Score
MTTR	-	Mean Time To Repair
NA	-	Network Availability
NER	-	Network Efficiency Ratio
PDD	-	Post Dialing Delay
POI	-	Point Of Interconnection
QoE	-	Quality of Experience
QoS	-	Quality of Service
RSR	-	Registration Success Rate
RSR	-	Resolution Success Rate
SMS	-	Short Message Service
UMTS	-	Universal Mobile Telecommunications Service
WWW	-	World Wide Web

### **Article 5: Scope of Application**

5.1 These Guidelines shall apply to all licensed Operators, Internet Service Providers, bandwidth distributors and users of communication services in Botswana.

## **CHAPTER 2: TECHNICAL PARAMETERS**

## **Article 6: FIXED VOICE SERVICES**

6.1 The following parameters as defined under definitions are applicable to fixed services:

-

- a) Call Setup Success Rate (CSSR)
- b) Call Setup Time (CST)
- c) Drop Call Ratio (DCR)
- d) Network Availability NA)

## **Article 7: MOBILE VOICE SERVICES**

7.1 The following parameters as defined under definitions are applicable to mobile services:

- a) Mean Opinion Score (MOS)
- b) Call Setup Time (CST)
- c) Call Set-up Success Rate (CSSR)
- d) Drop Call Ratio (DCR)
- e) Handover Success Rate (HSR)

f) Mobile Coverage Strength (MCS)

g) Network Availability (NA)

h) SMS Delivery Success Rate

i) SMS End to End Delivery Time

j) SMS Service Accessibility

k) Network Efficiency Ratio (NER)

l) Post Dialing Delay (PDD)

m) Registration Success Rate (RSR)

n) Service Availability (SA)

#### **Article 8: FIXED INTERNET SERVICES (WIRED AND WIRELESS)**

8.1 The following parameters as defined under definitions are applicable to fixed internet services both wired and wireless. Copper and fiber connection are considered as fixed connections: -

a) PDP Context Activation Failure Ratio

b) PDP Context Activation Success Rate

- c) PDP Context Activation Time
- d) PDP Context Cut-off Ratio
- e) DNS Resolution Success Rate
- f) DNS Resolution Time
- g) Data Transmission Rate
- h) Access Network Utilization
- i) Throughput
- j) Latency
- k) Packet Loss

## **Article 9: MOBILE INTERNET SERVICES**

9.1 The following parameters as defined under definitions are applicable to mobile internet services. Where applicable, different KPI target will be set for different mobile technologies as different technologies have different capabilities: -

- l) PDP Context Activation Failure Ratio

- m) PDP Context Activation Success Rate
  
- n) PDP Context Activation Time
  
- o) PDP Context Cut-off Ratio
  
- p) FTP Drop Rate
  
- q) FTP Mean Data Rate [Mbit/s]
  
- r) FTP Set-up Time
  
- s) HTTP Drop Rate
  
- t) HTTP Mean Data Rate
  
- u) HTTP Set-up Time
  
- v) Average user Throughput (Download and Upload)
  
- w) Access Network Utilization
  
- x) Latency

**Article 10: WEB RADIO STREAMING SERVICE**

10.1 The following parameters as defined under definitions are applicable to web radio streaming services: -

- a) Web Radio Tune-in Success Rate
- b) Web Radio Tune-in Success Time
- c) Web Radio Reproduction Cut-off Ratio

### **Article 11: INTERCONNECTION**

11.1 The following parameters as defined under definitions are applicable to interconnection:

- a) Interconnection Route Utilization
- b) Point of Interconnection Congestion

## **CHAPTER 3: NON-TECHNICAL PARAMETERS**

### **Article 12: Non-Technical Parameters**

12.1 The following parameters as defined under definitions are applicable to non-Technical Services

- a) Service Availability
- b) Provision of Service



- c) Call Centre Operator Response
- d) Mean Time To Repair (MTTR)
- e) Billing Complaint Rate
- f) Billing Accuracy
- g) Complaint Resolution Time (Technical complaints)

## **CHAPTER 4 OBLIGATIONS**

### **Article 13: COMMUNICATION SERVICE LICENSEE OBLIGATIONS**

13.1 The ICT service providers shall: -

- a) provide communication services that meet quality of service parameters as set forth by these Guidelines.
- b) Develop compensation mechanism in leu of services offered below acceptable performance standards that is commensurate to the degree of the failure.
- c) support the intervention of the regulator by allowing access to the network for purposes of collecting network performance data when requested.
- d) continuously measure network performance and keep records of the results of the measurements as per Part V; and
- e) report the same as per Part V of these guidelines.

## **CHAPTER 5: COMPLIANCE REQUIREMENTS**

### **Article 14: COMPLIANCE**

Section 6 (2) a) and c) of the CRA Act, mandates the Authority to: -

a) protect and promote the interests of consumers, purchasers, and other users of the services in the regulated sectors, particularly in respect of the prices charged for, and the availability, quality and variety of services and products, and where appropriate, the variety of services and products offered throughout Botswana, such as will satisfy all reasonable demands for those services and products.

and

c) monitor the performance of the regulated sectors in relation to levels of investment, availability, quantity, quality and standards of services, competition, pricing, the costs of services, the efficiency of production and distribution of services and any other matters decided upon by the Authority.

### **Article 15: Monitoring**

The Authority shall: -

- a) carry out network monitoring, and validate the data against network performance data from the operators
- b) monitor the adherence to Quality-of-Service measurements procedures; and

- c) direct its officers or agents (third party) to carry out investigations on Qualityof-Service measurements.

### **Article 16: Inspection**

16.1 The Authority or any person authorized in writing by the Authority may, upon furnishing reasonable notice, enter upon the premises of the licensee and request access to the network management servers for purposes of ascertaining compliance with these Guidelines.

### **Article 17: Enforcement**

17.1 The Authority shall take appropriate measures to enforce these Guidelines in conjunction with penalties as stipulated in the BOCRA Penalty Framework.

## **CHAPTER 5: REPORTING**

### **Article 18: Reporting**

18.1 The Licensee shall, submit Quality of Service reports as may be required by the Authority from time to time.

18.2 Submit to BOCRA or grant BOCRA access to network performance raw data for the purpose of analysis and reports generation.

### **Article 19: Record Keeping**

19.1 All Licensed Service Providers shall:

- a) maintain documented processes of data collection as per the KPI Formulas for each parameter contained in these Guidelines and submit the same to the Authority as required from time to time.
- b) complete and maintain accurate records of its compliance for each QoS parameter specified in such a manner and in such a format, as may be prescribed by the Authority from time to time.
- c) The Authority may, from time to time, either by order or by direction, specify uniform record keeping procedures and formats including guidelines on measurement methodology for various QoS parameters; and
- d) The Authority may, if it considers it expedient to do so, at any time, direct any of its officers or employees or an agency appointed by the Authority to inspect the records or to get such records audited.

## **Article 20: Auditing**

20.1 The Authority shall:

- a) audit some or all the Quality-of-Service data.
- b) opt to use a **third party** to perform audits on behalf of the Authority.
- c) audit Quality of Experience based on robots/automated systems and Customer Satisfaction Surveys undertaken by the Authority; and
- d) vary the frequency of the audits, reporting areas and reporting periods that require auditing.

## **Article 21: Publication**

21.1 The Authority shall publish, on print media or on the Authority's website or any applicable digital platform, the Quality of Service/ Quality of Experience Report as may be decided by the Authority as follows:

- a) the compliance reports of each Quality of Service and Quality of Experience parameter reported/submitted to it by the service providers under these Guidelines.
- b) the results of the audit and assessment of the Quality of Service and Quality of Experience undertaken by the Authority or its authorized agent.
- c) the Authority may request licensees to publish Quality of Service and Quality of Experience parameter information on their websites, or any digital platforms; and
- d) If so, requested in terms of (c) above, Operators shall publish on their websites, or any applicable digital platform, a Coverage Map showing their network coverage and network availability.

## **Chapter 6: SERVICE INTERRUPTIONS**

Notwithstanding that no subscriber should experience service interruption and not be accorded prompt response, Interruptions affecting at least **50%** of the operator's subscriber base for each service, or totally disconnecting communities from accessing network, **MUST** be considered critical and reported as prescribed below.

### **Article 22: Planned Service Interruptions**

Licensees shall:

- a) issue public notices in advance of any planned interruption of services by publishing such notice in a widely read electronic media or print media at least **48 hours** before the planned interruption of service and send the notice through the Short Messaging System (SMS) or any other applicable digital platform.
- b) issue public notices stating the localities and type of subscribers that will be affected by the planned interruptions; and
- c) provide the information for such service interruptions to the Authority at least **48 hours** before the planned interruption of service.
- d) Planned interruptions for maintenance purposes scheduled between 23:00hrs and 04:00hrs are exempted from publishing.

## **Article 23: Unplanned Service Interruptions**

23.1 In the event of any unplanned service interruption a licensee shall:

- a) within **an hour** of the event, notify the Authority via email of the occurrence of the event, including details on areas affected and numbers of end users affected where possible.
- b) continue to provide updates to the Authority via email as often as possible detailing progress in resolving the issue; and
- c) within **an hour** of resolution of the issue, inform the Regulator of resolution of the issue by phone or email. The Operator will, within **72 hours**, provide the Authority with a formal report detailing the circumstances attributing to the interruptions of the service, and the action taken to remedy the situation.
- d) Upon restoration of the services, send the public notice through the Short Messaging System (SMS) or through any other available digital platform to the impacted customers.

## **Chapter 7: Review**

### **Article 24: REVIEW**

24.1 The Authority may review the Quality of Service and Quality of Experience targets and parameters under these guidelines as and when required.

## **Chapter 8: IMPLEMENTATION**

### **Article 25: IMPLEMENTATION**

These Guidelines shall come into effect on the **1<sup>st</sup> of January 2023**.

## **Chapter 9: SCHEDULES**

The licensee providing services above shall be required to meet targets on Quality-of-Service parameters as specified in **Schedule 1 to 6** of these Guide

**Article 26: SCHEDULE 1**

**QUALITY OF SERVICE PUBLIC SWITCHED TELEPHONE SERVICES**

**TABLE 1: QUALITY OF SERVICE PUBLIC SWITCHED TELEPHONE SERVICES**

<b>Parameter Name</b>	<b>Formula</b>	<b>Measurement Mechanism (standards)</b>	<b>Measurement Tool</b>	<b>Target</b>
Network Availability	$Network\ Availability = [(Total\ Operational\ minutes - Total\ minutes\ of\ service\ downtime) / Total\ operational\ minutes] * 100\%$	Test traffic. ETSI EG 202 057-3	Performance Monitoring System  Test Tool(s)	>99%
Call Set-up Time	$Call\ Set-up\ Time = Time\ of\ Call\ Alerting - Time\ of\ receiving\ Dial\ tone$	Test traffic	Performance Monitoring System  Test Tool(s)	<3sec (local call) <5sec (Toll)
Call Setup Success Rate	$Call\ Set-up\ Success\ Rate = (Total\ number\ of\ successfully\ connected\ calls / Total\ number\ of\ attempts) * 100\%$	Test Traffic	Performance Monitoring System  Test Tool(s)	<98%
Drop Call Ratio	$Drop\ Call\ Ratio = (Number\ of\ Calls\ disconnected\ without\ intervention\ by\ any\ user / Number\ of\ Calls\ connected\ to\ intended\ recipient) * 100\%$	Real Traffic from OSS and or Test traffic. ETSI ES 202 765-2, clause 7.4	Performance Monitoring System  Test Tool(s)	≤ 2%



Voice Quality	Mean Opinion Score is expressed in one number from 1-5, 1 being the worst and 5 being the best. Recommendation ITU-T P.800, ITU-T P.862 and ITU-T P.863.1	Test traffic	Performance Monitoring System  Test Tool(s)	≥3.5
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**Article 27: SCHEDULE 2**

**QUALITY OF SERVICE PARAMETER FOR MOBILE SERVICES**

**TABLE 2: QUALITY OF SERVICE PARAMETER FOR MOBILE SERVICES**

<b>Parameter Name</b>	<b>Formula</b>	<b>Measurement Mechanism</b>	<b>Measurement Tool</b>	<b>Target</b>
Network Availability	$Network\ Availability = [(Total\ Operational\ minutes - Total\ minutes\ of\ service\ downtime) / Total\ operational\ minutes] * 100\%$	Test traffic.	Performance Monitoring System  Test Tool(s),  Crowdsourcing systems	>99% for cluster 6  >98% for cluster 5 & 4  >97% for cluster 3,2 & 1

Call Set-up Time	<i>Call Set-up Time</i> = Time of Call Alerting - Time of receiving Dial tone	Test traffic	Performance Monitoring System  Test Tool(s)	<6.5 sec for GSM (intra network normal traffic) <6.5 sec for UMTS (intra network normal traffic) <8 sec (mobile to fixed to normal traffic)
Drop Call Rate	<i>Drop Call Ratio</i> = (Number of Calls disconnected without intervention by any user / Number of Calls connected to intended recipient) *100%	Real Traffic from OSS and or Test traffic.	Performance Monitoring system  Test Tool(s)	≤ 2%
Call Set-up Success Rate	<i>Call Set-up Success Rate</i> = (Total number of successfully connected calls / Total number of attempts) *100%	Real Traffic from OSS and or Test traffic.	Performance Monitoring system  Test Tool(s)	≥98% for all calls
Handover Successful Rate	Handover Successful Rate = (Total number of Successful handovers / Total number of handover requests) *100%	from OSS and or Test traffic	Performance Monitoring system  Test Tool(s)	≥96%
Mobile Service Coverage Signal Strength	Mobile Service Coverage signal strength = Field strength measurements	Field strength measurements	Test Tool(s)	GSM ≥ -95dBm ((indoor) ≥ -105dBm (outdoors)  UMTS

				<p>≥ -95dBm ((indoor)          ≥ -105dBm (outdoors)</p> <p>LTE          ≥ -105dBm ((indoor)          ≥ -110dBm (outdoors)</p>
SMS Delivery Success Rate	SMS Delivery Success Rate = (Number of SMS received by intended recipients/ number of SMS sent) *100%	Real Traffic from OSS and or Test Traffic	System/ Test Tool(s)	SMS 97% (Excluding absent subscribers)
SMS End to End Delivery Time	SMS End to End Delivery Time = Time SMS received – time SMS sent	Test traffic	Test Tool(s)	SMS should be delivered in less than <5 seconds (Excluding absent subscribers)
Mean Opinion Score (MOS)	Mean Opinion Score is expressed in one number from 1-5, 1 being the worst and 5 being the best.	Test traffic	Test Tool(s)	≥3.0

**Article 28: SCHEDULE 3**

**QUALITY OF SERVICE PARAMETERS FOR FIXED INTERNET SERVICES**

**TABLE 3: QUALITY OF SERVICE PARAMETERS FOR FIXED INTERNET SERVICES**

<i>Parameter Name</i>	<i>Formula</i>	<i>Measurement Mechanism</i>	<i>Measurement Tool</i>	<i>Target</i>
DNS Host Name Resolution Time	<i>DNS Host Name Resolution Time</i> = Time for standard query response received – time standard query sent. [ETSI TS 102 250–2 & ITU-T Y.1540]	Real Traffic from OSS and or Test traffic	Performance Monitoring System  Test Tool(s)	< 10 ms
DNS Host Name Resolution Success Rate	<i>DNS Host Name Resolution Success Rate</i> = (Successful DNS host Name resolution requests/ Total DNS Host name resolution requests) *100 % [ETSI TS 102 250-2]	Real Traffic from OSS and or Test traffic	Performance Monitoring System  Test Tool(s)	< 99%
<i>Data transmission Rate</i>	Data transmission rate  = Size of test file/ The transmission time required for a complete and error free transmission	Test Traffic	Performance Monitoring System  Test Tool(s)  Speed Test	At least 75% of the advertised speed during peak time
Access Network Utilization	<i>Access Network Utilization</i>  = Total traffic between access node / aggregation of traffic at the node	Test Traffic	Performance Monitoring System  Test Tool(s)	uplink utilization must not be more than 75% of uplink bandwidth provided

Throughput	Throughput = Number of test samples greater than or equals QoS throughput) /Total number of test samples) *100%	Test Traffic	Performance Monitoring System  Test Tool(s)  Speed test	Throughput must not be less than: a) 75% of subscribed level of bandwidth for 90% of the time for Contended Fixed Connections (e.g. Copper and wireless)  b) 90% of subscribed level of bandwidth for 90% of the time for Contended Fixed Connections (Fiber).  c) 95% of the subscribed bandwidth for 100 % of the time for Dedicated services (ALL).
Latency	Latency = (Number of test samples less than or equal to 85 ms /Total number of test samples) *100%	Test Traffic	Performance Monitoring System  Test Tool(s)	≤ 85 ms 95% of the time

Packet Loss	$Packet\ Loss = (Total\ no\ of\ packet\ lost / Total\ no\ of\ packets\ sent) * 100\%$	Test Traffic	Performance Monitoring System  Test Tool(s)	≤ 1%
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**Article 29: SCHEDULE 4**

**QUALITY OF SERVICE PARAMETERS FOR MOBILE INTERNET SERVICES**

TABLE 4: QUALITY OF SERVICE PARAMETERS FOR MOBILE INTERNET SERVICES (Applicable to 3G and 4G.)

<b>Parameter Name</b>	<b>Formula</b>	<b>Measurement Mechanism</b>	<b>Measurement Tool</b>	<b>Target</b>
Network Availability	Network Availability = [(Total Operational minutes - Total minutes of service downtime) / Total operational minutes] * 100%	Test traffic.	Performance Monitoring System  Test Tool(s),  Crowdsourcing systems	>99% for <b>Cluster 6</b>  >98% for <b>Cluster 5 &amp; 4</b>  >97% for <b>Cluster 3,2 &amp; 1</b>

PDP Context Activation Time	<b>PDP Context Activation Time[s]</b> = <i>(TPDP- context activation accept – TPDP context activation request)[s]</i>  ETSI TS 132 410	Test traffic	Performance Monitoring System  Test Tool(s),	>98% within 5 seconds
PDP Context Ratio	<b>PDPContext Cut-off Ratio [%]</b> = <i>((PDPcontext losses not initiated by the user)/ (All successfully activated PDP contexts)) x 100</i>  ETSI TS 132 410	Test traffic	Performance Monitoring System  Test Tool(s),	<2%
PDP Context Activation Success Rate	<b>PDP Context Activation Success Rate [%]</b> = <i>((Successful PDPcontext activation attempts)/ (All PDP context activation attempts)) x 100</i> ETSI TS 132 410	Test traffic	Performance Monitoring System  Test Tool(s),	>98%
PDP Context Activation Failure Ratio	<b>PDP Context Activation Failure Ratio [%]</b> = <i>((Unsuccessful PDP context</i>	Test traffic	Performance Monitoring System	>3%

		activation attempts)/ (All PDP context activation attempts)) x 100  ETSI TS 132 410		Test Tool(s),	
Average throughput	User	Call Session Mean Data Rate = User data transferred (Kbit) / (Time Data transfer Complete-Time Data Transfer Start)	Real Traffic from OSS and or Test traffic= user data transferred [Kbits]/ Time data transfer is completed-time data transfer start	Performance Monitoring System  Test Tool(s)	<p><b>For Cluster 6</b></p> <p>UMTS &gt;5 Mbps</p> <p>LTE &gt;15 Mbps (2022-2023) &gt;25 Mbps (2023-2024) &gt;35 Mbps (2024+)</p> <p><b>For Cluster 5 &amp; 4, 3,2 &amp; 1.</b></p> <p>UMTS &gt;3 Mbps</p> <p>LTE &gt;10 Mbps (2022-2023) &gt;15 Mbps (2023-2024) &gt;20 Mbps (2024+)</p>



FTP {download  upload} Set-up Time	<i>FTP {download  upload} Set-up Time = Time Service Access Successful -Time Service Access Start</i>	Real Traffic from OSS and or Test traffic	Performance Monitoring System  Test Tool(s)	< 2 seconds
FTP Drop Rate	<i>FTP Drop Rate = (Number of incomplete data transfers/ Number of transfers started successfully) *100%</i>	Real Traffic from OSS and or Test traffic	Performance Monitoring System  Test Tool(s)	< 1%
FTP {download  upload} Mean Data Rate [Mbit/s]	<i>FTP {download  upload} Mean Data Rate [Mbit/s] = User data transferred (Mbits) / (Time Data transfer Complete-Time Data Transfer Start)</i>	Real Traffic from OSS and or Test traffic	Performance Monitoring System  Test Tool(s)	UMTS 2Mbps  LTE 10Mbps
FTP {download  upload} data transfer success ratio [%]	<i>FTP {download  upload} data transfer success ratio [%] = (completed data transfers /successfully started data transfers) *100%</i>	Real Traffic from OSS and or Test traffic	Performance Monitoring System  Test Tool(s)	95%
Web Radio Tune-in Success Rate	<i>Web Radio Tune-in Success Rate = (Number of Successful tune-in/ Total attempts) * 100%</i>	Test traffic	Test Tool(s)	>98%
Web Radio Tune-in Success Time	<i>Web Radio Tune-in Success Time = Time attempt Tune-in - Time Successful Tune-in</i>	Test Traffic	Test Tool(s)	< 2 seconds

Web Radio Reproduction Cut-off Ratio	<i>Web Radio Reproduction Cut-off Ratio</i> = (Number of Unsuccessful listening attempts/ Total attempts) * 100%	Test Traffic	Test Tool(s)	< 2%
<i>Data Packets</i> <i>Latency</i>		Test Traffic	Performance Monitoring System  Test Tool(s)  Crowdsourcing	<100ms for Local IXP <300ms for International IXP

**Article 30: SCHEDULE 5**

**QUALITY OF SERVICE FOR INTERCONNECTION**

TABLE 6: QUALITY OF SERVICE FOR INTERCONNECTION

<i>Parameter Name</i>	<i>Formula</i>	<i>Measurement Mechanism</i>	<i>Measurement Tool</i>	<i>Target</i>
Interconnection Route Utilization	<i>Interconnection Route</i> <i>Utilization</i> = Capacity in use / Capacity Provisioned) *100%	Real Traffic	Performance monitoring system	< 80%

Point of interconnection Congestion	<i>Point of interconnection Congestion = (Number of blocked call attempts /total</i>	Real traffic from OSS and or test Traffic (ITU-T Recommendation	Performance Monitoring system  Test Tool(s)	<0.5%
	<i>number of call attempts) * 100%</i>	E.847-201703)		

**Article 31: SCHEDULE 6**

**QUALITY OF EXPERIENCE (NON-TECHNICAL PARAMETERS)**

**TABLE 7: QUALITY OF EXPERIENCE (NON-TECHNICAL PARAMETERS)**

<b>Parameter Name</b>	<b>Formula</b>	<b>Measurement Mechanism</b>	<b>Measurement Tool</b>	<b>Target</b>
Service Availability		Test traffic		≥

	$\text{Service Availability} = \frac{(\text{Total Operational minutes} - \text{Total minutes of service downtime})}{\text{Total operational minutes}} \times 100\%$		Performance Monitoring System  Test Tool(s)  QoE robots and Consumer satisfaction survey	98%   90%
Provision of Service	Provision of Service = the time the customer pays for service to the time the customer is provided with service	Complaints	Trouble ticket system	5 business Days
Call Centre Operator Response	<i>Call Centre Operator Response</i> = Percentage of call answered by the operator within set time (currently 30 sec), over the total number of call center incoming calls.	Test traffic	Test Tool(s)	> 70%

Mean Time To Repair (MTTR)	Mean Time To Repair (MTTR) = Time Service Restored- Time Reported	Complaints	Trouble ticket system	MOBILE Cluster 6: 6 hrs. Cluster 5 & 4 :16 hrs. Cluster 3,2 & 1: 72 hrs.  FIXED: < 5 days INTERCONNECTION <1 hrs
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**Article 32: SITE CLASSIFICATIONS**

<b>Cluster 6: Main Cities</b>		
<b>Name of Location</b>	<b>2022 Population</b>	<b>Included locations</b>
Gaborone	246,325	Tlokweng, Mogoditshane, Metsimotlhabe, Kopong, Mmatsetla, Oodi, Matebeleng, Modipane, Bokaa, Gabane, Mokolodi, Botatle, Ramotswa, Taung

Francistown	103,417	Mathangwane, Borolong, Chadibe, Shashe-Mooke, Matshelagabedi, Tati-Siding, Mandunyane, Tonota.
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**NOTE:** This cluster will include ALL location within 30KM radius (line of sight) of each city

<b>Cluster 5 &amp; 4: Population &gt; 10,000 inhabitants</b>	
<b>Name of Location</b>	<b>2022 Population</b>
Mogoditshane	88,006
Maun	84,993
Bobonong	77,504
Molepolole	74,674
Serowe	55,676

Tlokwenng	55,508
Palapye	52,636
Mahalapye	48,431

Kanye	48,028
Selibe Phikwe	42,488
Letlhakane	36,338
Ramotswa	33,271
Lobatse	29,772
Mmopane	25,345
Thamaga	25,297
Moshupa	23,858
Tonota	23,296
West	23,248
Bobonong	21,216
Gabane	20,010
Ghanzi	19,012
Jwaneng	18,784
Tutume	18,582
Kopong	13,816
Mmadinare	13,198

Tati Siding	12,393
Tsabong	11,651
Metsimotlhabe	11,589
Gumare	11,572
Shakawe	10,589
Oodi	10,257

<b>Cluster 3,2 and 1: Population &lt;10,000 inhabitants</b>	
All other villages	Including sites along the highways