Standard Operating Procedure
for
QoS Measurement through Drive Test
(Related to Bylaw regarding Telecommunications Service Quality 2073)

Nepal Telecommunications Authority

Standard Operating Procedure
for
QoS Measurement through Drive Test
(Related to Bylaw regarding Telecommunications Service Quality 2073)

ITU-T Rec. E. 800 defines quality of services (QoS) as *"Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service"*.

'Bylaw regarding Telecommunications Service Quality 2073' describes the minimum level of QoS, which needs to be achieved by Telecommunication Service Providers in Nepal. Furthermore, operators are required to perform QoS assessment regularly and submit test report trimester-wise.

The QoS assessment shall be performed as follows:

A. Drive Test (DT)
B. Network Management System (NMS) Report
C. Customer Service and Billing Performance

1. Drive Test

Drive Test is a performance-oriented method of measuring and assessing the coverage, performance, and service quality of a mobile radio network. In the Drive Test process, testing tools mounted on a moving vehicle collect key performance indicators (KPI) of the cellular network by repeatedly making voice or data calls or keeping at idle mode.

1.1 Drive Test Details

1.1.1 Drive Test Tool, Mobile Station and SIM Cards

Devices required for Drive Test are as follows:

1. **Drive Test Tool**
2. **Analysis or Post-processing Tool**
3. **Mobile Station**

Any devices compatible with voice, SMS and data services are recommended. However, operators should inform NTA about their Drive Test Tool, Mobile Station and other accessories used in the test. Based on the mobile service technology (e.g. GSM, UMTS, LTE, CDMA etc.), selection of devices may vary.

The operators themselves should acquire SIM cards. There should not be addition of any priorities to the test numbers.

1.1.2 Routes, Vehicle Speed and Time

The drive test routes for each trimester will be provided by NTA. The vehicle should be driven at a steady speed (not more than 35 kmph in cities and 60 kmph in highways) over the selected route.

Furthermore, NTA may ask to perform static tests in commercial and residential buildings.

The tests should be carried out at the Time Consistent Busy Hours (TCBH).

1.2 Voice and SMS Test

A free mode (2G, 3G and 4G mode) mobile station should be used to attempt a call, followed by a 2 minutes conversation. The same call should be used for Mean Opinion Score (MOS) test as well. After that, the mobile station should wait for 3 seconds before sending four SMS in same network. This combined test should keep on going in loop for whole drive test route.

Equipment requirement for Voice and SMS Test is as follows:

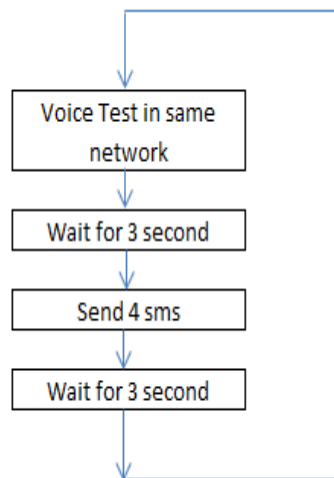- One mobile at free mode
- MOS test equipment

Figure 1-1 Flow Chart of Voice and SMS Test

1.2.1 Voice and SMS Test Script

For the testing of voice calls and text messages, below script should be used.

Voice Call Script	
Originate Mode	free mode (2G, 3G and 4G)
Call Type	Call by Call
Call Setup Timeouts (sec)	30
Call Duration (sec)	120
Test Interval (sec)	10
Call Start Mode	Idle

3

SMS Script	
Test Count	4
Message	Hello NTA, SMS test from NT/Ncell/..

Table 1-1 Voice and SMS Test Script

1.3 Data Test

In the Data Test, firstly, Mobile Station should be detached followed by waiting for 2 seconds and attaching the mobile. Then dialup process should start. After successful dialup process, the ping (4nos) test should be performed followed by http browsing test. All tests should repeat in the loop for the whole test period.

Another Mobile Station should be used to perform http download and upload test.

Equipment requirement for Data Test is as follows:

- One mobile at free data mode (2G, 3G and 4G) for Ping and Browsing Test
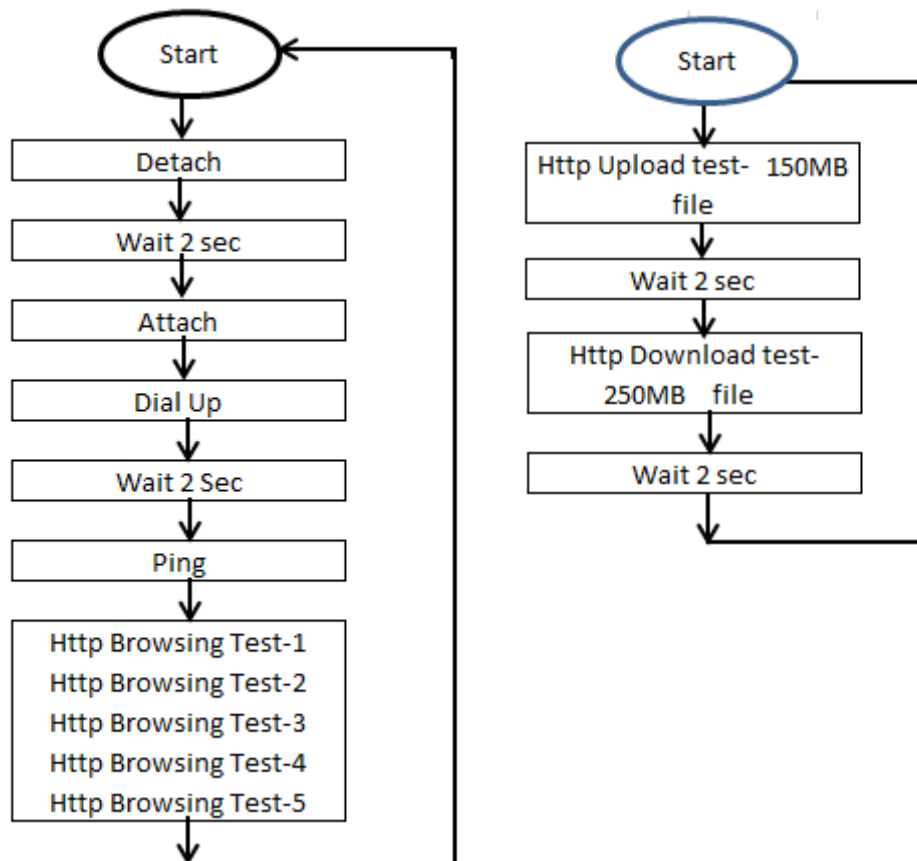- One mobile at free data mode (2G, 3G and 4G) for Upload/Download Test

Figure 1-2 Flow Charts of Data Test

1.3.1 Data Test Script

For the testing of data performance following script should be used.

Detach	
Timeout (sec)	15

Attach	
Attach Mode	Reattach when Attach Failure
Timeout (sec)	15
Reattach Interval	5

HTTP Browsing Test	
URL (Test-1)	As specified by NTA
URL (Test-2)	As specified by NTA
URL (Test-3)	As specified by NTA
URL (Test-4)	As specified by NTA
URL (Test-5)	As specified by NTA
Finish Mode	Receive all Data
Test Count	1

HTTP Download	
URL	As specified by NTA
Test count	1
File Size	250 MB

HTTP Upload	
URL	As specified by NTA
Test count	1
File Size	150 MB

Ping	
Remote Address	As specified by NTA
Test Count	4

Table 1-2 Data Test Script

1.4 Coverage Test

To test coverage, separate mobile stations should be connected with drive test tool in following configuration:

- One mobile for 2G only at idle mode
- One mobile for 3G only at idle mode
- One mobile for 4G only at idle mode

1.5 Mode of Collecting DT KPIs

In the process of Drive Test, the testing tool will collect many QoS parameters related to accessibility, retainability, mobility, throughput, traffic, quality and many more. However, the mode of connection of mobile station can be different for different parameters. For each KPI, the testing mode is presented in the following table.

SN	Drive Test KPI Item	Unit	DT Mode	Formula
1	Call Setup Success Rate (Mobile Network Accessibility)	%	Free Mode-voice	(Successful call attempts/ Total call requests)*100
2	Call Drop Rate	%	Free Mode-voice	(Total number of dropped calls /Total number of successful calls)*100
3	MOS (End-to-End Speech Quality)	value	Free Mode-voice	Algorithm: PESQ
4	Handover Success Rate	%	Free Mode-voice	(Number of successful handovers / Number of attempted handovers)*100
5	Voice Call Setup Time (MO/MT) (Call Connection Time)	s	Free Mode-voice	Average call connection time of total successful calls
6	Grade of Service (Call Block Rate)	%	Free Mode-voice	(Number of failed or lost calls due radio or others reason/Number of call attempts)x100
7	SMS Delivery Success Rate (within 2minutes)	%	Free Mode-Idle	(Total number of successfully delivered SMS /Total number of sent SMS)*100
8	PDP Context Activation Success Ratio	%	Free Mode-data	(Number of successful PDP activations / PDP activation requests)*100
9	Ping 32bytes RTT (www.facebook.com)	ms	Free Mode-data	Average time of total successful ping requests
10	HTTP Browsing Display Success Rate	%	Free Mode-data	(Total number of successful HTTP browsing displays /Total number of HTTP browsing display requests)*100
11	Average HTTP Browsing Display Delay	ms	Free Mode-data	Average time of total successful HTTP browsing displays
12	Average Download Throughput (HTTP) 250MB	Mbps	Free Mode-data	Average of all download attempts
13	Average Upload Throughput (HTTP) 150MB	Mbps	Free Mode-data	Average of all upload attempts
14	Peak Download Throughput (HTTP)	Mbps	Free Mode-data	Peak download value
15	Peak Upload Throughput (HTTP)	Mbps	Free Mode-data	Peak upload value
16	Download Success Rate (HTTP)	%	Free Mode-data	(Successful download attempts/ Total number of download requests)*100
17	Upload Success Rate (HTTP)	%	Free Mode-data	(Successful upload attempts/ Total number of upload requests)*100
18	Rx level (2G) –(level -82dBm)	%	Free Mode-idle	
19	RSCP (3G) –(level -87dBm)	%	Free Mode-idle	
20	RSRP (4G) –(level -87dBm)	%	Free Mode-idle	

Table 1-3 Mode of Collecting QoS Parameters

1.6 Drive Test on CDMA Network

In case of telecommunication operator with CDMA Network, CDMA mobile sets should be used as specified below:

- One mobile at CDMA mode for Voice and SMS Test
- One mobile at CDMA data mode for Ping and Browsing Test
- One mobile at CDMA data mode for Upload/Download Test
- One mobile at CDMA idle mode for Coverage Test

6

2. NMS Report

NMS is system used by telecommunications service providers to support and manage the operation of their telephone and data network. Different QoS KPIs can be extracted from the NMS.

2.1 Mode of Collecting OSS KPIs

The OSS KPIs shall be measured by the operators as per the SOP prescribed from the Nepal Telecommunications Authority. Monthly as well as quarterly averages of all the KPIs should be reported as applicable. Monthly average can be calculated as the aggregate of daily averages if necessary.

3. Customer Care and Billing (CCB) Performance

QoS depends not only on the technical aspects of the network and terminals, but also on the non-technical aspects such as billing and customer care.

3.1 Mode of Collecting CCB KPIs

SN	OSS KPI Item	Unit	Formula
1	Service Activation and Provisioning	%	(Number of service requests activated within 4 hours/ Total service activation requests in a month)*100%
2	Billing Dispute (Postpaid & Prepaid)	%	(Number of billing disputes/ Total active subscribers)*100%
3	Billing Dispute Resolution I (Postpaid & Prepaid)	%	(Number billing disputes resolved within 15 days/ Total billing disputes over a month)*100%
4	Billing Dispute Resolution II (Postpaid & Prepaid)		(Number billing disputes resolved within 30 days/ Total billing disputes over a month)*100%
9	Complaint Resolution	%	(Number complaints resolved within 30 days/ Total complaints over a month)*100%

Monthly as well as quarterly averages of all the KPIs should be reported. Monthly average can be calculated as the aggregate of daily averages if necessary.

4. Report Format and Attachments

The format of the Measurement report should be as prescribed by the Authority in the bylaw on "Telecommunications Quality of service, 2073". The drive Test information shall be in format as per Appendix I attached herewith. Along with the Report, following items should be attached (via email).

- Softcopy of Report
- Drive Test log-files/ and cell-files (Original)
- Tab files of snapshot provided in the Report

5. Definitions of KPIs

5.1 Network Down Time

This metric indicates the fraction of time for which network is not available for services.

$$\text{Network Down Time} = \frac{\text{Total outage time (hours) of all sectors}}{\text{Total time (hours) of observation} * \text{No. of sectors in the network}} * 100$$

5.2 Call Setup Success Rate (Mobile Network Accessibility)

It is the probability of having continuous access to the network. It is measured as the ratio of established calls to total call attempts. Established calls are those for which TCH is allocated and the call is routed to the outwards path of the concerned MSC.

$$\text{Call Setup Success Rate} = \frac{\text{Successful call attempts}}{\text{Total call requests}} * 100$$

5.3 Call Drop Rate

Dropped calls are those that are not terminated by caller or by called party. Call drop rate represents the inability of service provider to maintain a call once it is established. This includes calls dropped due to failure of handover, radio loss and network congestion. It is measured as the ratio of the calls terminated abnormally (neither by caller nor by called party) to the total number of successfully established calls.

$$\text{Call Drop Rate} = \frac{\text{Total number of dropped calls}}{\text{Total number of successful calls}} * 100$$

5.4 End-to-End Speech Quality

It is the quality of talkers' voice over the telephone as perceived by the listener.

Mean Opinion Score (MOS) is one of the methods to evaluate the end-to-end speech quality. It is a quality of experience indicator and is evaluated using Perceptual Evaluation of Speech Quality (PESQ) Algorithm.

MOS Rating	5	4	3	2	1
Label	Excellent	Good	Fair	Poor	Bad

5.5 Intra-Network Call Connection Loss

Intra-network call connection loss is defined as the rate of call failure due to congestion, network issues or other technical reasons on calls originated from one trunk and terminated on another trunk of the same network.

$$\text{Intra} - \text{Network Call Connection Loss } = \frac{\text{Number of failed or lost calls (intra} - \text{network)}}{\text{Number of call attempts}} * 100$$

5.6 Inter-Network Call Connection Loss

Inter-network call connection loss is defined as the rate of call failure due to lack of interconnection or other technical reasons on calls originated from trunk of one service provider and terminated on trunk of another service provider.

$$\text{Inter} - \text{Network Call Connection Loss } = \frac{\text{Number of failed or lost calls (inter} - \text{networks)}}{\text{Number of call attempts}} * 100$$

5.7 Handover Success Rate

Handover is the process by which a mobile call is transferred from one base station to another as the subscriber passes the boundary of a cell. As a means of radio link control, handover enables users to communicate continuously when they travel along different cells. The handover success rate is the ratio of the number of successful handovers to the number of handover requests.

$$\text{Handover Success Rate} = \frac{\text{Number of successful handovers}}{\text{Number of attempted handovers}} * 100\%$$

5.8 Voice Call Setup Time (MO/MT) (Call Connection Time)

Call Connection Time is the time difference between call attempt and call alert. During a drive test, it is measured as the average call connection time of all successful calls.

$$\text{Call Connection Time } = \text{ Average call connection time of all successful calls}$$

5.9 Grade of Service (Call Block Rate)

Grade of service is the probability that a call attempt will be blocked even when there is network coverage. It is the measure of traffic congestion of a telephone network.

$$\text{Grade of Service } = \frac{\text{Number of failed or lost calls}}{\text{Number of call attempts}} * 100$$

9

5.10 SMS Delivery Success Rate

SMS Delivery Success Rate gives the quality measurement value of SMS services of telecom operators. The mobile phones used to receive SMS will be at a fixed location in an area served by a strong radio signal from the Mobile Operators. The mobile phones transmitting the SMS will be in the field with the testing team.

$$SMS\ Delivery\ Success\ Rate = \frac{Total\ number\ of\ successfully\ delivered\ SMS}{Total\ number\ of\ SMS\ delivered} * 100\%$$

5.11 PDP Context Activation Success Ratio

This KPI is ratio of successful PDP context activation procedures initiated by MS and attempted PDP context activation procedures initiated by MS.

$$PDP\ Context\ Activation\ Success\ Ratio = \frac{Number\ of\ Successful\ PDP\ Activations}{PDP\ Activation\ Requests} * 100\%$$

5.12 Ping 32bytes Round Trip Time

Round Trip Time (RTT) is the time a signal takes to reach a specified destination plus the time the acknowledgement of that signal to takes to reach the source. A networking utility called ping is used to calculate the RTT or the data latency of the network.

$$Round\ Trip\ Time = Average\ time\ of\ total\ successful\ ping\ requests$$

5.13 HTTP Browsing Display Success Rate

It is the rate of successfully displaying the http request completely in certain time (20 sec). It reflects the user experience of browsing.

$$HTTP\ Browsing\ Display\ Success\ Rate = \frac{Total\ number\ of\ Successful\ HTTP\ Browsing\ Display}{Total\ number\ of\ HTTP\ Browsing\ Display\ requests} * 100\%$$

5.14 Average HTTP Browsing Display Delay

It is the time taken by an http request on displaying the whole webpage. It reflects how much time it took to load a page completely.

$$Average\ HTTP\ Browsing\ Display\ Delay = Average\ time\ of\ total\ successful\ HTTP\ Browsing\ Display$$

5.15 **Average Download/Upload Throughput**

It is the average throughput value while downloading/uploading the specified file to the http server.

$$\text{Average Download/Upload Throughput } = \text{ Average Throughput of all download/upload attempts}$$

5.16 **Download/Upload Peak Value Throughput**

It is the peak throughput value while downloading/uploading the specified file to the http server.

$$\text{Peak Download/Upload Throughput } = \text{ Maximum Throughput of all download/upload attempts}$$

5.17 **Download/Upload Success Rate**

Data download/upload success is the attempt until and unless data download/upload is successful. Download/upload success rate is the ratio of successful download/upload attempts and the total download/upload requests.

$$\text{Download/Upload Success Rate} = \frac{\text{Successful download/upload attempts}}{\text{Total number of download/upload requests}} * 100\%$$

5.18 **DNS Resolution Time**

It is the time difference between DNS request and DNS response.

$$\text{DNS Resolution Time } = \text{ Time difference between DNS request and DNS response}$$

5.19 **Rx level, RSCP and RSRP**

Rx level is measurement counter for 2G signal level to check geographical coverage. Its unit is dBm. It will give probability of coverage level at certain level. Higher the signal level, better will be mobile received signal.

$$\text{Rx level (2G) } = \text{ Percentage of Rx level } - 82\text{dBm}$$

Likewise, RSCP is measured in 3G network to check geographical coverage where as RSRP is used in 4G for same purpose.

$$\text{RSCP (3G) } = \text{ Percentage of RSCP level } - 87\text{dBm}$$

$$\text{RSRP (4G) } = \text{ Percentage of RSRP level } - 87\text{dBm}$$

Rx level, RSCP and RSRP are obtained by performing idle test.

5.20 Service Activation and Provisioning

Service Activation and Provisioning refers the ability of the service provider to activate the data services within specified time after the subscriber requests the same.

$$\text{Service Activation and Provisioning} = \frac{\text{Number of service requests activated within specified time}}{\text{Total service activation requests}} * 100\%$$

5.21 Billing Performance

Billing Performance refers to the integrity and trustworthiness of the billing system deployed for flawless billing and prompt dispute resolution.

Billing dispute represents issues such as incorrectly charging, over-charging, multiple charging, charging without notification, late notification, disparity between charges and bill generated and other complaints related to telecommunications service charges.

$$\text{Billing Dispute} = \frac{\text{Number of billing disputes}}{\text{Total bills generated}} * 100\%$$

$$\text{Dispute Resolution} = \frac{\text{Number billing disputes resolved within specified time}}{\text{Total billing disputes}} * 100\%$$

5.22 Complaint Resolution

Complaint Resolution refers to the process of addressing complaints related to telecommunications services.

$$\text{Complaint Resolution} = \frac{\text{Number complaints resolved within specified time}}{\text{Total complaints}} * 100\%$$

Appendix I: Drive Test Reporting Format

1. Drive Test Details

1.1 Schedule

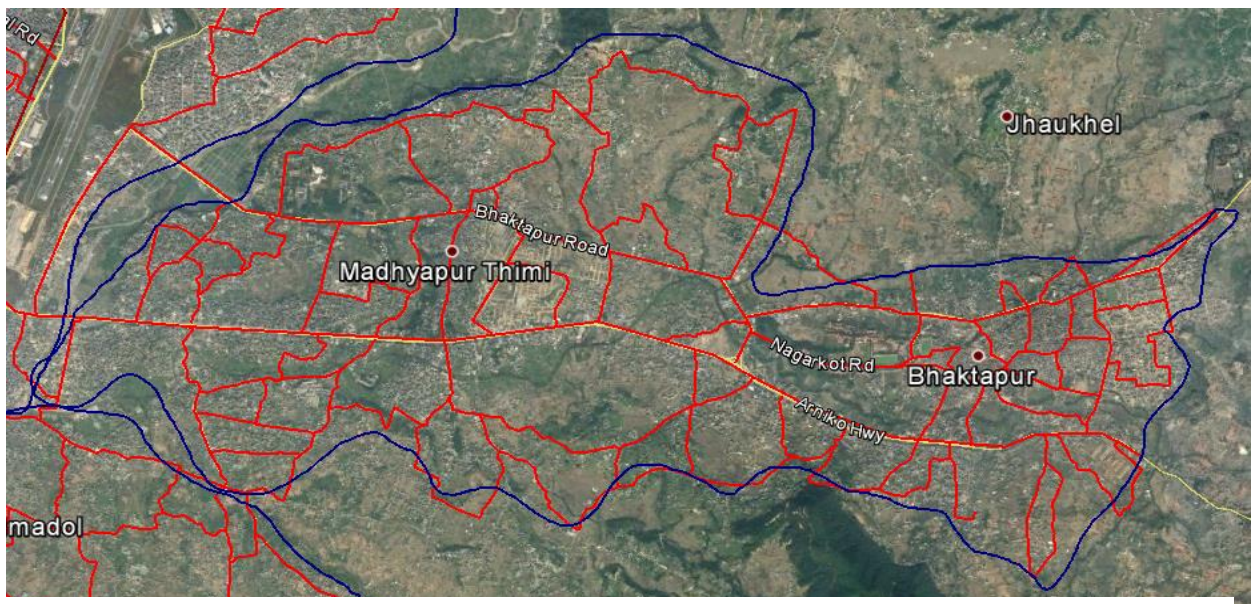| SN	Date	Time	
		From	To
1			
2			
3			
4			
5			
6			
7			
…			
…			

1.2 Routes

Figure 1 Sample: Cluster boundary with drive route

Area covered: *major landmarks, institutions, roads*

Please specify reasons if any route segment specified by NTA was missed.

2. Drive Test Results

2.1 Voice Test

2.1.1 Call Setup Success Rate

SN	Drive Test KPI Item	Result	Unit	Call Attempts	Call Setup Failure	Formula
1	Call Setup Success Rate					(Successful call attempts/ Total call requests)*100
Remarks:						

Please include map showing locations of call setup failure.

2.1.2 Call Drop Rate

SN	Drive Test KPI Item	Result	Unit	Successful Calls	Call Dropped	Formula
1	Call Drop Rate					(Total number of dropped calls/ Total number of successful calls)*100
Remarks:						

Please include map showing locations of call drop.

2.1.3 MOS

SN	Drive Test KPI Item	Result	Unit	Remark	Formula
1	MOS		Value		Algorithm: PESQ
Remarks:					

2.1.4 HO Success Rate

SN	Drive Test KPI Item	Result	Unit	Number of successful handovers	Handover Failure	Formula
1	HO Success Rate					(Number of successful handovers/ Number of attempted handovers)*100
Remarks:						

Please include map showing locations of handover failure.

2.1.5 Call Connection Time

SN	Drive Test KPI Item	Result	Unit	Remarks	Formula
1	Call Connection Time		sec		Average call connection time of all successful calls

2.1.6 Grade of Service

SN	Drive Test KPI Item	Result	Unit	Number of Call attempts	fail or lost calls due Radio + others reason	Formula
1	Grade of Service					(Number of failed or lost calls

	(Call Block Rate)					due radio or others reason/ Number of call attempts)*100
Remarks:						

2.2 **SMS Test**

SN	Drive Test KPI Item	Result	Unit	Number of Successfully delivered SMS	Number of SMSs delivered	Formula
1	SMS Success Rate					(Total number of successfully delivered SMS/Total number of sent SMS)*100
Remarks:						

2.3 **Data Test**

2.3.1 **PDP Context Activation Success Ratio**

SN	Drive Test KPI Item	Result	Unit	PDP Activation Requests	Number of Successful PDP Activations	Formula
1	PDP Context Activation Success Ratio					(Number of successful PDP activations/ PDP activation requests)*100
Remarks:						

2.3.2 **Ping 32bytes RTT on www.facebook.com**

SN	Drive Test KPI Item	Result	Unit	Remarks	Formula
1	Ping 32bytes RTT		ms		Average time of total successful ping requests

2.3.3 **HTTP Browsing Display Success Rate**

SN	Drive Test KPI Item	Result	Unit	HTTP Browsing Display requests	Successful HTTP Browsing Display	Formula
1	HTTP Browsing Display Success Rate					(Total number of successful HTTP browsing displays/ Total number of HTTP browsing display requests)*100
Remarks:						

2.3.4 **Average HTTP Browsing Display Delay**

SN	Drive Test KPI Item	Result	Unit	Remarks	Formula
1	Average HTTP Browsing Display Delay		ms		Average time of total successful HTTP browsing displays

2.3.5 **Throughputs**

SN	Drive Test KPI Item	Result	Unit	Attempts	Remarks

1	Average Download Throughput -HTTP		Mbps		Average of all download attempts
2	Average Upload Throughput -HTTP		Mbps		Average of all upload attempts
3	Peak Download Throughput - HTTP		Mbps		peak download value
4	Peak Upload Throughput - HTTP		Mbps		peak upload value
Remarks:						

2.3.6 Download Success Rate

SN	Drive Test KPI Item	Result	Unit	total number of download requests	Successful download attempts	Formula
1	Download Success Rate-HTTP					(Successful download attempts/ Total number of download requests)*100
Remarks:						

2.3.7 Upload Success Rate

SN	Drive Test KPI Item	Result	Unit	total number of upload requests	Successful upload attempts	Formula
1	Upload Success Rate-HTTP					(Successful upload attempts/ Total number of upload requests)*100
Remarks:						

2.4 Coverage

*Please use **distance binning** during analysis*

2.4.1 2G coverage (Received Level)

Range (dBm)	Count	Cumulative(%)	Density(%)
[-72,-20]			
[-82,-72]			
[-92,-82]			
[-105,-92]			
[-125,-105)			

Please include map showing 2G coverage (received Level)

2.4.2 3G coverage (RSCP)

Range (dBm)	Count	Cumulative(%)	Density(%)
[-77,-20]			
[-87,-77]			
[-95,-87]			
[-105,-95]			
[-125,-105)			

Please include map showing 3G coverage (received Level)

2.4.3 4G coverage (RSRP)

Range (dBm)	Count	Cumulative(%)	Density(%)
[-77,-20]			
[-87,-77]			
[-95,-87]			
[-105,-95]			
[-125,-105)			

Please include map showing 4G coverage (received Level)

3. Drive Test KPIs Summary

SN	DT KPI	Unit	NTA Threshold	Result
1	Call Setup Success Rate (Mobile Network Accessibility)	%		
2	Call Drop Rate	%		
3	MOS	value		
4	HO success rate	%		
5	Voice Call Setup Time(MO/MT) (Call Connection Time)	s		
6	Grade of Service (Call Block Rate)	%		
7	SMS Delivery Success Rate (within 2minutes)	%		
8	PDP Context Activation Success Ratio	%		
9	Ping 32bytes RTT	ms		
10	HTTP Browsing Display Success Rate	%		
11	Average HTTP Browsing Display Delay	ms		
12	Average Download Throughput (FTP/HTTP	Mbps		
13	Average Upload Throughput (FTP/HTTP)	Mbps		
14	Peak Download Throughput (FTP/HTTP)	Mbps		
15	Peak Upload Throughput (FTP/HTTP)	Mbps		
16	Download Success Rate-(FTP/HTTP)	%		
17	Upload Success Rate-(FTP/HTTP)	%		
18	Rx level (2G) –(level -82dBm)	%		
19	RSCP (3G) –(level -87dBm)	%		
20	RSRP (4G) –(level -87dBm)	%		

Note: NTA Threshold shall be as per prescribed Bylaws from NTA.

4. Customer Service and Billing Parameters

SN	DT KPI	Unit	NTA Threshold	Result
1	**Service Activation and Provisioning**	%		
2	**Billing Dispute**	%		
3	**Billing Dispute Resolution I**	%		
4	**Billing Dispute Resolution II**	%		
8	**Complaint Resolution**	%		

Note: NTA Threshold shall be as per prescribed Bylaws from NTA.