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Standard Operating Procedure
for
QoS Measurement Through OSS Method

(Related to Bylaw regarding Telecommunications Service Quality 2073)

Nepal Telecommunications Authority

Jamal, Kathmandu

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Table of Contents

1. Introduction

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".

As per the provision of Sub-Section (f) of Section 13 of the Telecommunication Act, 1997, the Authority has to prescribe, fix and approve the standard and quality standard of the plant and equipment relating to the Telecommunications and the Telecommunications Service. And as per Section 14 of the same act, the Authority shall determine the quality and standard of the machine, equipment and facilities relating to the Telecommunications and the Telecommunications Service and prescribe the minimum standard to be maintained by a Licensee in operating the Telecommunications Service. For further regulation of service quality of telecommunication services, the Authority has issued Bylaw Regarding Telecom Service Quality, 2016. This Bylaw describes the minimum level of QoS, which needs to be achieved by Telecommunication Service Providers in Nepal.

As per the provision of Bylaw (Annex-1 of Clause 3) of Bylaw Regarding Telecom Service Quality, 2016, this standard operating procedure has been issued to measure Quality of Service (QoS) Key Performance Indicators (KPIs) of Mobile Telecommunication Service. The operators are instructed to perform QoS assessment through OSS method monthly and submit test report trimester-wise.

2. Mobile Telecommunication Service QoS parameters

Study of existing QoS bylaw revealed that there is combined Quality of service parameters defined for different services which are not relevant on current scenario. Thus, here we are initiating to differentiate QoS parameters according to service type and recommending additional parameter to monitor 2G, 3G, 4G and internet networks' quality of service precisely.

International regulatory organizations are using ITU recommended QoS parameter to monitor quality of services of any network. ITU has recommended four-layer method to monitor and verify the quality of service of mobile tele-communication. Parameters related to network availability is at the top layer and it is followed by Network accessibility, service accessibility, service retainability and service integrity.

KPI related with the network availability will be formulated to check the probability that the services are offered to end user via a network infrastructure. Next, QoS will be proposed at service user's point of view which will deal with basic requirement for all the other QoS parameters. At third layer, service access, service integrity and service retainability will be addressed. Similarly, different services will be located in the fourth layer.

2.1 Network Availability

Network availability is the first layer and it is measure of probability that the services are offered to a user via a network infrastructure. Based on the network infrastructure, we can divided whole network into three types of availability parameters namely, core-network, data-network and radio-network. Core-network consist MSC/MME, HLR, HSS, BSC and RNC whereas data-network's

elements are SGSN, GGSN, PGW, and SGW. Similarly, radio network are BTS, NodeB and E-nodeB.

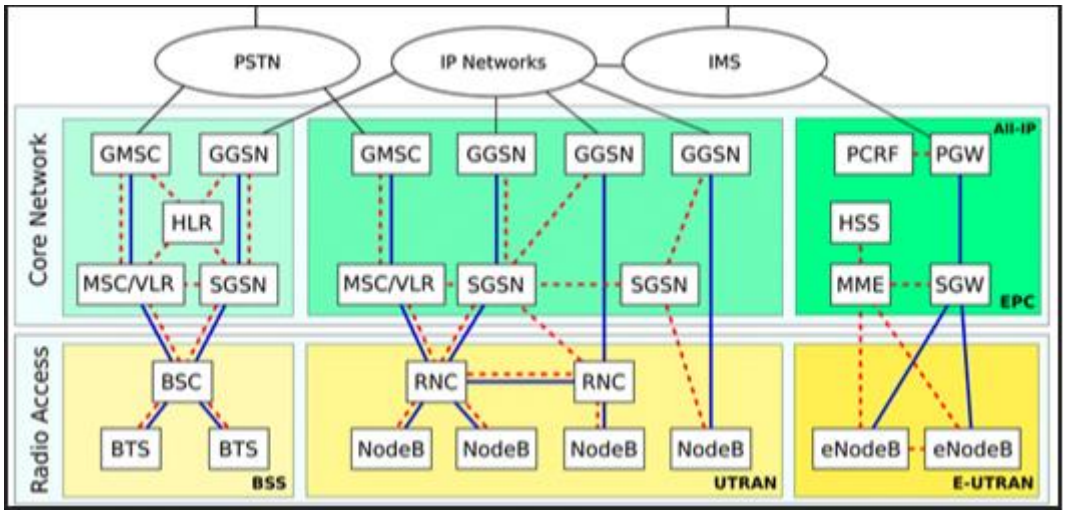

Figure 1 Basic 2G, 3G and 4G network architecture diagram

Availability of these parameters determine the complete network availability and they should be measured for a whole day i.e. 24 hrs a day and average over a measurement period (recommended measurement period 30 days).

A	Network Availability [Unit %] for 24hrs a day		Benchmarking Criteria
SN	Name of Parameter	Point of Control and Observation At	
1	Core Network	MSC/MME, HLR, HSS, BSC and RNC	>99.999 %
2	Data Network	SGSN, GGSN, PGW, and SGW	>= 99.999 %
3	Radio Networks	BTSs, Node-B, eNode-B	>= 99 %

Table 1 Network Availability QoS Parameters

a) Core Network

It is calculated as ratio of sum of available core nodes up-time and sum of total available time of core nodes.

$$\textbf{Network Availability of Core Network} = \frac{\sum(Core\ nodes\ Uptime(min))}{\sum(no.of\ Core\ nodes*24*60)} * 100\ \%$$

b) Data Network

It is calculated as ratio of sum of available data network nodes up-time and sum of total available time of data nodes.

$$\textbf{Network Availability of Data Network} = \frac{\sum(SGSN\ and\ SGW\ nodes\ Uptime\ (min))}{\sum(no.of\ SGSN\ and\ SGW\ nodes * 24 * 60)} * 100\%$$

c) Radio Networks

It is calculated as ratio of sum of available radio network nodes up-time and sum of total available time of radio nodes.

$$\textbf{Network Availability of Radio Network} = \frac{\sum(Cell\ or\ Site\ Uptime(min))}{\sum(no.of\ Cell\ or\ Site * 24 * 60)} * 100\%$$

2.2 Network/ Service Accessibility

Accessibility is used to measure the probability that a user accesses the network and requests services in the given operating conditions. RRC connection and RAB setup are the main procedures of accessibility so parameters related to these setups effect the accessibility and success rate of these setups will play vital role to determine the quality of service. These parameters should be measure at busy hour per day and average over a measurement period of 30 days.

B	Network/Service Accessibility [Unit %] at BH per day		Benchmarking Criteria
SN	Name of Parameter	PCO At	
1	SMS/MMS delivery Success	2G/3G/4G Network	>= 99.5 %
2	Paging Channel Congestion Rate	2G/3G/4G Network	<= 1 %
3	SDCCH Block Rate	2G Radio Network	<= 1 %
4	RRC Block Rate	3G Radio Network	< = 1 %
5	E-RRC Block Rate	4G Radio Network	< = 1 %
6	2G Block Rate CS	2G Radio Network	<= 1 %
7	3G Block Rate CS	3G Radio Network	<= 1 %
8	4G Block Rate PS	4G Radio Network	< = 1 %
9	VoLTE Block Rate	4G Network	<=1%
10	Call Connection Time	Core network	<= 5 sec
11	POI Congestion Rate-with operator ABC at BH	Core Network-Media Gateway	< = 1 %
	POI Congestion Rate-with operator XYZ at BH		
12	SRVCC to UTRAN Success Rate	4G Radio Network	98%

13	Inter RAT Handover Success Rate	Radio Network	98%
14	Intra RAT Handover Success Rate 2G	Radio Network	98%
15	Intra RAT Soft Handover Success Rate 3G		98%
16	Intra Frequency Handover Success Rate 4G		98%
17	Inter Frequency Handover Success Rate 4G	Radio Network	98%

Table 2 Network/ Service Accessibility QoS Parameters

1) SMS/MMS delivery Success Rate

It can be calculated as the ratio of number of SMS/MMS successful delivery by total request attempts of SMS/MMS. Count of these sms/mms should be done for all the technologies.

Formula,

$$\frac{\mathbf{SMS}}{\mathbf{MMS}}\textbf{delivery Success Rate} = \left(\frac{\sum_{N=1}^{N=k}\frac{\mathbf{SMS}}{\mathbf{MMS}}\textbf{successful delivery}}{\sum_{N=1}^{N=k}\textbf{Total request attempts of}\frac{\mathbf{SMS}}{\mathbf{MMS}}}\right)\mathbf{100}\%$$

Where,

N = measurement period of 30 days for whole network

2) Paging Channel (PCH) Congestion Rate

It can be calculated as the ratio of number of failed Page due to paging overload by Total number of paging attempts. Count of these paging should be done for all the technologies.

Formula,

$$\textbf{PCH Congestion Rate} = \left(\frac{\sum_{N=1}^{N=k}\textbf{Failed Page due to paging overload in the network}}{\sum_{N=1}^{N=k}\textbf{Total number of paging attempts in the network}}\right)\mathbf{100}\%$$

Where,

N = measurement period of 30 days for whole network

3) SDCCH Block Rate

SDCCH Block rate is 2G network QoS parameter. It is calculated as:

Formula,

SDCCH Block Rate (sector-level) over a measurement period

= ((SDCCH Seizure Requests - Successful SDCCH Seizures) / SDCCH Seizure Requests) * 100 %

$$\textbf{SDCCH Block Rate (Sector} - \textbf{level)} = \left(\frac{\sum_{n=1}^{n=k}\textbf{SDCCH Seizure Requests} - \sum_{n=1}^{n=k}\textbf{Successful SDCCH Seizures}}{\sum_{n=1}^{n=k}\textbf{SDCCH Seizure Requests}}\right) * \mathbf{100}\%$$

SDCCH Block Rate (network level) over a measurement period

= over a measurement period [100*((sum of SDCCH Seizure Requests of all sectors - sum of Successful SDCCH Seizures of all cells) / sum of SDCCH Seizure Requests of all cells) %]

$$\textbf{SDCCH Block Rate (network} - \textbf{level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{SDCCH Seizure Requests} - \sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful SDCCH Seizures}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{SDCCH Seizure Requests}}\right) * \mathbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

4) RRC Block Rate

RRC Block Rate is 3G network QoS parameter which can be calculated as:

Formula,

RRC Block Rate (cell-level) over a measurement period

= 100*(CS-RRC Seizure Requests - Successful CS-RRC Seizures) / CS-RRC Seizure Requests) %

$$\textbf{RRC Block Rate (Cell} - \textbf{level)} = \left(\frac{\sum_{n=1}^{n=k} \textbf{CS-RRC Seizure Requests} - \sum_{n=1}^{n=k} \textbf{Successful CS-RRC Seizures}}{\sum_{n=1}^{n=k} \textbf{CS-RRC Seizure Requests}}\right) * \mathbf{100}\%$$

RRC Block Rate (network level) over a measurement period:

$$\textbf{RRC Block Rate (network} - \textbf{level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{CS-RRC Seizure Requests} - \sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful CS-RRC Seizures}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{CS-RRC Seizure Requests}}\right) * \mathbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

5) E-RRC Block Rate

E-RRC block rate is LTE QoS parameter. It can be calculated as:

Formula,

E-RRC Block Rate (cell-level) over a measurement period

= 100*(E-RRC Seizure Requests - Successful E-RRC Seizures) / E-RRC Seizure Requests) %

$$\textbf{E} - \textbf{RRC Block Rate (Cell} - \textbf{level)} = \left(\frac{\sum_{n=1}^{n=k} \textbf{E-RRC Seizure Requests} - \sum_{n=1}^{n=k} \textbf{Successful E-RRC Seizures}}{\sum_{n=1}^{n=k} \textbf{E-RRC Seizure Requests}}\right) * \mathbf{100}\%$$

E-RRC Block Rate (network level) over a measurement period:

$$\mathbf{E-RRC\ Block\ Rate\ (network-level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \mathbf{E-RRC\ Seizure\ Requests} - \sum_{m=1,n=1}^{m=l,n=k} \mathbf{Successful\ E-RRC\ Seizures}}{\sum_{m=1,n=1}^{m=l,n=k} \mathbf{E-RRC\ Seizure\ Requests}}\right) * \mathbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

6) 2G Block Call Rate CS

It is 2G network's QoS parameter which calculates the Block Call Rate of traffic channel on the network. It is calculated as:

Formula,

2G Block Call Rate CS (sector-level) over a measurement period

= 100*(TCH Seizure Requests - Successful TCH Seizures) / TCH Seizure Requests) %

$$\mathbf{2G\ Block\ Call\ Rate\ (Sector-level)} = \left(\frac{\sum_{n=1}^{n=k} \mathbf{TCH\ Seizure\ Requests} - \sum_{n=1}^{n=k} \mathbf{Successful\ TCH\ Seizures}}{\sum_{n=1}^{n=k} \mathbf{TCH\ Seizure\ Requests}}\right) * \mathbf{100}\%$$

2G Block Call Rate CS (network level) over a measurement period:

$$\mathbf{2G\ Block\ Call\ Rate\ (network-level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \mathbf{TCH\ Seizure\ Requests} - \sum_{m=1,n=1}^{m=l,n=k} \mathbf{Successful\ TCH\ Seizures}}{\sum_{m=1,n=1}^{m=l,n=k} \mathbf{TCH\ Seizure\ Requests}}\right) * \mathbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

7) 3G Block Call Rate CS

It is 3G network's QoS parameter which calculates the Block Call Rate of the network. It is calculated as:

Formula,

3G Block Call Rate (sector-level) over a measurement period

= 100*(CS-RAB Seizure Requests - Successful CS-RAB Seizures) / CS-RAB Seizure Requests) %

$$\mathbf{3G\ Block\ Call\ Rate\ (Cell-level)} = \left(\frac{\sum_{n=1}^{n=k} \mathbf{CS-RAB\ Seizure\ Requests} - \sum_{n=1}^{n=k} \mathbf{Successful\ CS-RAB\ Seizures}}{\sum_{n=1}^{n=k} \mathbf{CS-RAB\ Seizure\ Requests}}\right) * \mathbf{100}\%$$

3G Block Call Rate CS (network level) over a measurement period:

$$\textbf{3G Block Call Rate (network - level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{CS-RAB Seizure Requests} - \sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful CS-RAB Seizures}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{CS-RAB Seizure Requests}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

8) 4G Block Call Rate PS

It is LTE network QoS parameter which calculates the BLOCK rate of E-RAB on the network. It can be calculated as:

Formula,

4G Block Call Rate (sector-level) over a measurement period

= 100*(E-RAB Seizure Requests - Successful E-RAB Seizures) / E-RAB Seizure Requests) %

$$\textbf{4G Block Call Rate(Cell - level)} = \left(\frac{\sum_{n=1}^{n=k} \textbf{E - RAB Seizure Requests} - \sum_{n=1}^{n=k} \textbf{Successful E - RAB Seizures}}{\sum_{n=1}^{n=k} \textbf{E - RAB Seizure Requests}}\right) * \textbf{100}\%$$

4G Block Call Rate PS (network level) over a measurement period:

$$\textbf{4G Block Call Rate (network - level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{E-RAB Seizure Requests} - \sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful E-RAB Seizures}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{E-RAB Seizure Requests}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

9) VoLTE Block Rate

It is LTE network QoS parameter which calculates the BLOCK rate of VoLTE (E-RAB QCI1) on the network. It can be calculated as:

VoLTE Block Call Rate (sector-level) over a measurement period

= 100*(E-RAB Seizure Requests (QCI1) - Successful E-RAB Seizures (QCI 1)) / E-RAB Seizure Requests (QCI1))%

$$\textbf{VoLTE Block Call Rate (Cell - level)} = \left(\frac{\sum_{n=1}^{n=k} \textbf{E - RAB Seizure Requests(QCI1)} - \sum_{n=1}^{n=k} \textbf{Successful E - RAB Seizures(QCI1)}}{\sum_{n=1}^{n=k} \textbf{E - RAB Seizure Requests(QCI1)}}\right) * \textbf{100}\%$$

VoLTE Block Call Rate PS (network level) over a measurement period:

$$\textbf{VoLTE Block Call Rate (network - level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{E-RAB Seizure Requests(QCI1)} - \sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful E-RAB Seizures(QCI1)}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{E-RAB Seizure Requests } (QCI1)}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

10) Call Connection Time

Call Connection Time should calculate as the average of all calls' connection time.

Formula,

Call Connection Time = Average of all calls' connection time over a measurement period

$$\textbf{Call Connection Time} = \left(\frac{\sum_{N=1}^{N=k} \text{Calls' connection time}}{\sum_{N=1}^{N=k} \text{Number of Calls in each day}}\right) * \mathbf{100}\%$$

Where,

N = measurement period of 30 days for whole network

11) POI Answer to Seizure Ration with operator ABC

It is calculated as average of ratio of answered calls divided by seizure call of individual POI for incoming and outgoing in the Network Busy Hour.

Formula,

POI Answer to Seizure Ratio with operator **ABC** over a measurement period

= over a measurement period [Average of [(Incoming answered/Incoming Seizure) *100% and (Outgoing answered/Outgoing Seizure) *100%]

$$\textbf{Call Connection Time} = \left\{\frac{\frac{\sum_{N=1}^{N=k} \text{Incoming answered}}{\sum_{N=1}^{N=k} \text{Incoming Seizure}} + \frac{\sum_{N=1}^{N=k} \text{Outgoing answered}}{\sum_{N=1}^{N=k} \text{Outgoing Seizure}}}{\mathbf{2}}\right\} * \mathbf{100}\%$$

Where,

N = measurement period of 30 days for whole network

12) SRVCC to UTRAN Success Rate : (VOLTE)

This metric defines the SRVCC to UTRAN Success Rate over measurement period.

$$\textbf{SRVCC to UTRAN Success Rate (Cell} - \textbf{Level)} = \mathbf{100} * \left(\frac{\boldsymbol{HoPrepSuccSrvcc}}{\boldsymbol{HoPrepAttSrvcc}}\right) * \left(\frac{\boldsymbol{HoExeSuccSrvcc}}{\boldsymbol{HoExeAttSrvcc}}\right)$$

Where,

HoPrepSuccSrvcc counts the number of successful SRVCC handover to UTRAN preparations.

HoPrepAttSrvcc counts the number of SRVCC handover to UTRAN preparation attempts

HoExeAttSrvcc counts the number of SRVCC handover to UTRAN execution attempts.

HoExeSuccSrvcc counts the number of successful SRVCC handovers to UTRAN.

13) Inter RAT Handover Success Rate

This KPI describes the ratio of number of successful inter RAT handover to the total number of the attempted inter RAT handover from UMTS to GSM for CS domain.

This KPI is obtained by the number of successful inter RAT handover divided by the total number of the attempted inter RAT handover from UMTS to GSM for CS domain over the measurement period.

$$\mathbf{IRATHO}_{CS(Cell-level)} = \left(\frac{IRATHO.SuccOutCS}{IRATHO.AttRelocPrepOutCS}\right)\mathbf{*100}$$

Where,

SuccOutCS=Successful Out Handover CS

AttRelocPrepOutCS=Attempt Relocation Preparation Out CS

14) Intra RAT Handover Success Rate 2G

This KPI describes the ratio of number of successful handover to the total number handover attempts.

This KPI is obtained by the number of successful handover divided by the total number of handover attempt over measurement period.

$$\mathbf{HOSR(Cell-Level)} = \left(\frac{Total\ Successful\ Handover}{Total\ Handover\ Attempt}\right) * \mathbf{100}$$

15) Intra RAT Soft Handover Success Rate 3G

This KPI describes the ratio of number of successful radio link additions to the total number of radio link addition attempts.

This KPI is obtained by the number of successful radio link additions divided by the total number of radio link addition attempts over measurement period.

$$\mathbf{SHOSR(Cell-level)} = \left(\frac{SHO.SuccRLAddUESide}{SHO.AttRLAddUESide}\right) * \mathbf{100}$$

Where,

SuccRLAddUESide= Successful Radio Link Addition UE Side

AttRLAddUESide= Attempt Radio Link Addition UE Side

16) Intra Frequency Handover Success Rate LTE

This system performance KPI measures Intra LTE Intra Frequency Mobility Success rate including both preparation of target cell resources and move from the source cell to the target cell.

$$\textbf{Intra Frequency Handover Success Rate LTE (Cell} - \textbf{Level)} = \left(\frac{\boldsymbol{HoPrepSuccLteIntraF}}{\boldsymbol{HoAttSuccLteIntraF}}\right) * \left(\frac{\boldsymbol{HoExeSuccLteIntraF}}{\boldsymbol{HoExeAttLteIntraF}}\right) * \mathbf{100}$$

Where,

HoPrepSuccLteIntraF counts the number of successful intra LTE intra frequency handover preparations.

HoPrepAttLteIntraF counts the number of attempts to start intra LTE intra frequency handover preparation.

HoExeSuccLteIntraF counts the number of successful intra LTE intra frequency handovers.

HoExeAttLteIntraF counts the number of intra LTE intra frequency handover execution attempts.

17) Inter Frequency Handover Success Rate LTE

Inter Frequency Handover Success Rate LTE This system performance KPI measures Intra LTE Inter Frequency Mobility Success rate including both preparation of target cell resources and move from the source cell to the target cell.

$$\text{Inter Frequency Handover Success Rate LTE (sector} - \text{level)} = \left(\frac{HoPrepSuccLteInterF}{HoPrepAttLteInterF}\right) * \left(\frac{HoExeSuccLteInterF}{HoExeAttLteInterF}\right) * 100$$

Where, HoPrepSuccLteInterF counts the number of successful intra LTE Inter Frequency handover preparations. HoPrepAttLteInterF counts the number of attempts to start intra LTE Inter Frequency handover preparation. HoExeSuccLteInterF counts the number of successful intra LTE Inter Frequency handovers. HoExeAttLteInterF counts the number of intra LTE Inter Frequency handover execution attempts.

2.3 Service Retainability

Service retainability describes the termination of services. In another words, retainability is defined as the ability of a user to retain its requested service for the desired duration once connected. For Examples retainability parameters are all kinds of cut-off parameters such as the Call cut-off ratio or the Data cut-off ratio. Retainability parameters evaluate whether the system can maintain a certain level of service quality and it is measured for the whole day i.e. 24 hrs a day and average over a measurement period of 30 days. To measure parameters of retainability, a previously performed successful service access is a precondition.

C	Service Retainability [Unit %] for 24hrs a day		Benchmarking Criteria
SN	Name of Parameter	PCO At	
1	2G Call Drop Rate	2G Radio Network	<=2 %
2	3G Call Drop Rate	3G Radio Network	<= 2 %
3	3G Data Drop Rate	3G Radio Network	<= 2 %
4	4G Data Drop Rate	4G Radio Network	<= 2 %
5	4G VoLTE Call Drop Rate	4G Radio Network	<= 2 %

Table 3 Service Retainability QoS Parameters

a) 2G Call Drop Rate

This QoS parameter describes the ratio of number of call drops on TCH to number of successful TCH seizures (TCH).

Formula,

2G Call Drop Rate (sector-level) over a measurement period

= Number of call drops on TCH/Number of successful TCH seizures (TCH) x 100%

$$\textbf{2G Call Drop Rate (Sector - level)} = \left(\frac{\sum_{n=1}^{n=k} \textbf{Call drops on TCH}}{\sum_{n=1}^{n=k} \textbf{Successful TCH seizures (TCH)}}\right) * \textbf{100}\%$$

2G Call Drop Rate (network-level) over a measurement period:

$$\textbf{2G Call Drop Rate (network - level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Call drops on TCH}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful TCH seizures (TCH)}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

b) 3G Call Drop Rate

This QoS parameter describes the ratio of the CS RAB drop due to abnormal Releases to the total successful CS RAB seizures.

Formula,

3G Call Drop Rate (cell-level) over a measurement period

= Number of call drops on CS-RAB/Number of successful CS-RAB seizures x 100%

$$\textbf{3G Call Drop Rate (Cell - level)} = \left(\frac{\sum_{n=1}^{n=k} \textbf{Call drops on CS-RAB}}{\sum_{n=1}^{n=k} \textbf{Successful CS-RAB seizures}}\right) * \textbf{100}\%$$

3G Call Drop Rate (Network-level) over a measurement period:

$$\textbf{3G Call Drop Rate (network - level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Call drops on CS-RAB}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful CS-RABseizures}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

c) 3G Data-call Drop Rate

This QoS parameter describes the ratio of number of call drops on PS-RAB by number of successful PS-RAB seizures (packet service).

Formula,

3G Data-call Drop Rate (cell-level) over a measurement period

= Number of call drops on PS-RAB/Number of successful PS-RAB seizures x 100%

$$\textbf{3G Data Call Drop Rate (Cell - level)} = \left(\frac{\sum_{n=1}^{n=k} \textbf{Call drops on PS-RAB}}{\sum_{n=1}^{n=k} \textbf{Successful PS-RAB seizures}}\right) * \textbf{100}\%$$

3G Data-call Drop Rate (Network-level) over a measurement period

$$\textbf{3G Date Call Drop Rate (network - level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Call drops on PS-RAB}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful PS-RAB seizures}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

d) 4G Data-call Drop Rate

This QoS parameter describes the ratio of number of call drops on E-RAB to number of successful E-RAB seizures.

Formula,

4G Data-call Drop Rate (cell-level) over a measurement period

= Number of call drops on E-RAB/Number of successful E-RAB seizures x 100%

$$\textbf{4G Data Call Drop Rate (Cell - level)} = \left(\frac{\sum_{n=1}^{n=k} \textbf{Call drops on E-RAB}}{\sum_{n=1}^{n=k} \textbf{Successful E-RAB seizures}}\right) * \textbf{100}\%$$

4G Data-call Drop Rate (network-level) over a measurement period:

$$\textbf{4G Data Call Drop Rate (network - level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Call drops on E - RAB}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful E - RAB seizures}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

e) 4G VoLTE Call Drop Rate

This QoS parameter describes the ratio of number of call drops on VoLTE E-RAB to number of successful VoLTE E-RAB seizures.

Formula,

4G VoLTE Call Drop Rate (cell-level) over a measurement period

= Number of call drops on **VoLTE** E-RAB / Number of successful **VoLTE** E-RAB seizures x 100%

$$\textbf{4G VoLTE Call Drop Rate (Cell} - \textbf{level)} = \left(\frac{\sum_{n=1}^{n=k} \textbf{Call drops on VoLTE E-RAB}}{\sum_{n=1}^{n=k} \textbf{Successful VoLTE E-RAB seizures}}\right) * \textbf{100}\%$$

4G VoLTE Call Drop Rate (network-level) over a measurement period:

$$\textbf{4G VoLTE Call Drop Rate (network} - \textbf{level)} = \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Call drops on VoLTE E} - \textbf{RAB}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Successful VoLTE E} - \textbf{RAB seizures}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

2.4 Service Integrity

The service integrity KPIs can be calculated for each cell or radio network. In another words, Service Integrity KPIs mainly indicates the service capabilities for PS/HSPA throughput on busy hour in each cell and the service UL Average BLER for evaluating the UL BLER value of services in each cell. It is measured at busy hour and average over a measurement period of 30 days.

D	Service Integrity at BUSY HOUR	
S N	Name of Parameter	Point of Control and Observation At
1	3G DL Average network Throughput (Mbps)	3G Network
2	3G UL Average network Throughput (Mbps)	3G Network
3	4G DL Average network Throughput (Mbps)	4G Network
4	4G UL Average network Throughput (Mbps)	4G Network

Table 4 Service Integrity QoS Parameters

a) 3G DL Average Network Throughput

This KPI can be calculated for each cell or radio network. To calculate cell-level Average Downlink (DL) Throughput following formula can be used:

Formula,

3G DL Average Cell Throughput (Mbps) over a measurement period

= Cell Downlink BH Traffic Volume of HSDPA Service / [1024*1024*Cell Downlink Time Period]

$$\textbf{3G DL average throughput (Cell} - \textbf{level), Mbps} = \frac{1}{1024*1024} * \left(\frac{\sum_{n=1}^{n=k} \textbf{Cell Downlink BH Traffic Volume of HSDPA Service}}{\sum_{n=1}^{n=k} \textbf{Cell Downlink Time Period}}\right) * \textbf{100}\%$$

3G DL Average Network Throughput (Mbps) over a measurement period:

$$\textbf{3G DL average throughput (Network} - \textbf{level), Mbps} = \frac{1}{1024*1024} * \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Cell Downlink BH Traffic Volume of HSDPA Service}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Cell Downlink Time Period}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

b) 3G UL Average Network Throughput

To calculate cell-level Average Uplink (UL) Throughput following formula can be used:

Formula,

3G UL Average Cell Throughput (Mbps) over a measurement period

= Cell Uplink BH Traffic Volume of HSUPA / [1024*1024*Cell Uplink Time Period]

$$\textbf{3G UL average throughput (Cell} - \textbf{level), Mbps} = \frac{1}{1024*1024} * \left(\frac{\sum_{n=1}^{n=k} \textbf{Cell Uplink BH Traffic Volume of HSUPA Service}}{\sum_{n=1}^{n=k} \textbf{Cell Uplink Time Period}}\right) * \textbf{100}\%$$

3G UL Average Network Throughput (Mbps) over a measurement period:

$$\textbf{3G UL average throughput (Network} - \textbf{level), Mbps} = \frac{1}{1024*1024} * \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Cell Uplink BH Traffic Volume of HSUPA Service}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Cell Uplink Time Period}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

c) 4G DL Average network Throughput (Mbps)

To calculate 4G cell-level Average Downlink (DL) throughput following formula can be used:

Formula,

4G DL Average Cell Throughput (Mbps) over a measurement period

= 4G Cell Downlink BH Traffic Volume / [1024*1024*Cell Downlink Time Period]

$$\textbf{4G DL average throughput (Cell} - \textbf{level), Mbps} = \frac{1}{\textbf{1024} * \textbf{1024}} * \left(\frac{\sum_{n=1}^{n=k} \textbf{Cell Downlink BH Traffic Volume}}{\sum_{n=1}^{n=k} \textbf{Cell Downlink Time Period}}\right) * \textbf{100}\%$$

4G DL Average Network Throughput (Mbps) over a measurement period:

$$\textbf{4G DL average throughput (Network} - \textbf{level), Mbps} = \frac{1}{\textbf{1024}*\textbf{1024}} * \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Cell Downlink BH Traffic Volume}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Cell Uplink Time Period}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

d) 4G UL Average network Throughput (Mbps)

To calculate 4G cell-level Average uplink (UL) throughput following formula can be used:

Formula,

4G UL Average Cell Throughput (Mbps) over a measurement period

= 4G Cell Uplink BH Traffic Volume / [1024*1024*Cell Downlink Time Period]

$$\textbf{4G UL average throughput (Cell} - \textbf{level), Mbps} = \frac{1}{\textbf{1024} * \textbf{1024}} * \left(\frac{\sum_{n=1}^{n=k} \textbf{Cell Uplink BH Traffic Volume}}{\sum_{n=1}^{n=k} \textbf{Cell Uplink Time Period}}\right) * \textbf{100}\%$$

4G UL Average Network Throughput (Mbps) over a measurement period:

$$\textbf{4G UL average throughput (Network} - \textbf{level), Mbps} = \frac{1}{\textbf{1024}*\textbf{1024}} * \left(\frac{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Cell Uplink BH Traffic Volume}}{\sum_{m=1,n=1}^{m=l,n=k} \textbf{Cell Uplink Time Period}}\right) * \textbf{100}\%$$

Where,

n = measurement period of 30 days of a sector

m = cells/sectors in the network

k = measurement period

l = total cells/sectors in the network

3. Methodology

Following method shall be used to measure the QoS KPIs through OSS of the operator to submit report to NTA in the specified format attached in Appendix- 1.

3.1 Network availability

i. Shall extract Network availability parameters related to core network, data network and radio network. The radio network availability shall be extracted at sector level or cell level.

ii. At first these extracted raw parameters shall be for a period of 24 hours a day and shall be averaged over a measurement period of one month.

iii. Calculation of availability parameters shall be done using formula defined by NTA and result shall be provided individually for each network type such as for core network, data network and radio network.

3.2 Network/Service Accessibility

i. To collect QoS parameter of network/service accessibility, shall extract raw parameters of accessibility at cell or sector level at Busy Hour of a day.
ii. Raw parameters of accessibility are those parameters defined in the formula of NTA.
iii. Shall assure that derived network/service accessibility QoS parameters are as per the formula defined by NTA. And QoS parameters shall be calculated at busy hour per day over the measurement period.
iv. Calculated Result of QoS parameters shall be provided at National level, province level or any other NTA recommended level.

3.3 Service Retainability

i. Shall import retainability raw parameters from OSS system for a period of 24 hours a day. Raw parameters shall be imported technology-wise and these raw data shall be averaged over a measurement period using formula defined by NTA.
ii. Top five worst cell shall be found out based on the calculated Retainability QoS parameters.

3.4 Service Integrity

i. Shall find out the busy hour DL and UL data volume separately over a measurement period for 3G and 4G network individually.
ii. NTA formula shall be used to find the network throughput.

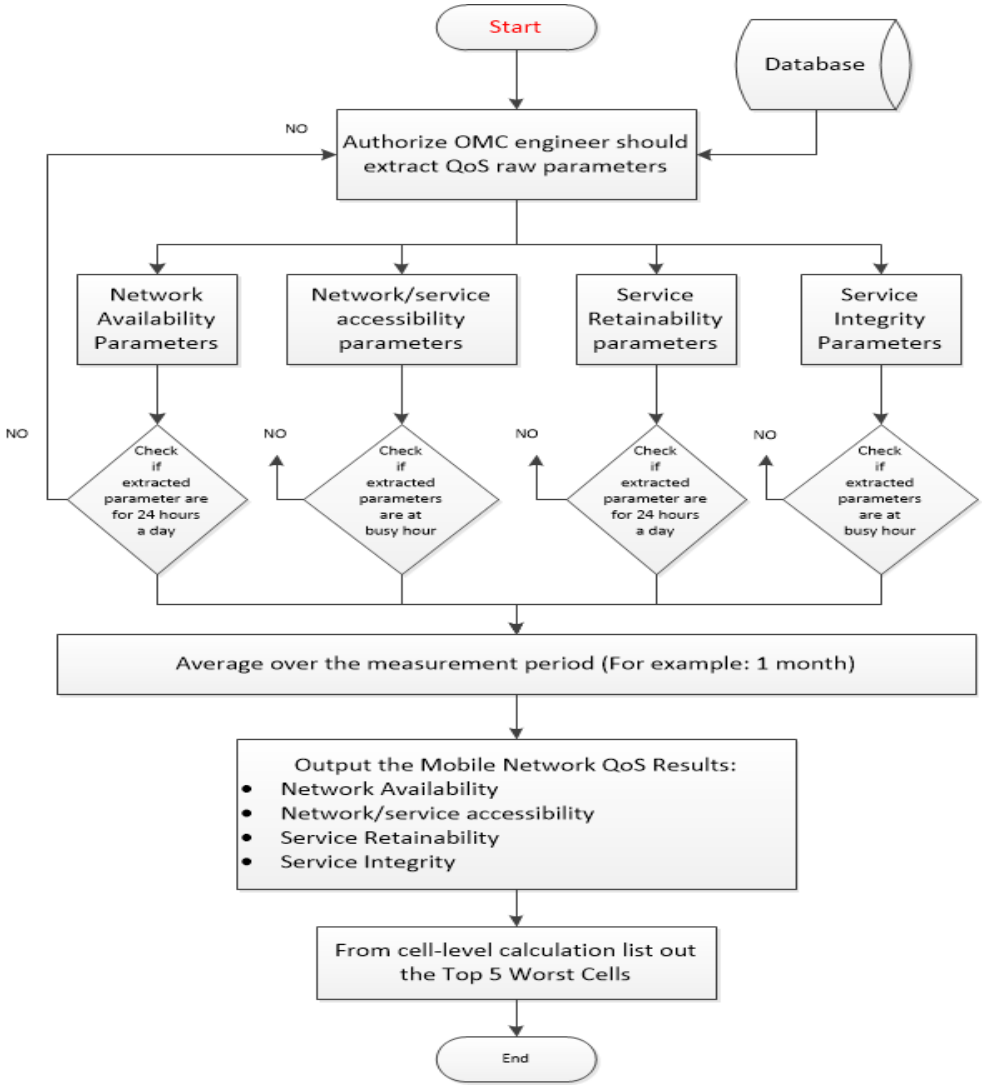

Figure: Flowchart of QoS Calculation Process

Finally, the operator shall find out the top five worst cells for each KPI from network/service accessibility, service Retainability parameters, and availability of radio network.

4. QoS Parameters Extracted Period

Extractions of the QoS parameters shall be on following period.

SN	QoS Parameters	Time Period	Measurement Period	Yes/No
1	Network Availability	24 hrs a day	Average of 1 month period	
2	Network/ Service Accessibility	At Busy Hour		
3	Service Retainability	24 hrs a day		
4	Service Integrity	At Busy Hour		

5. Complete Network (Whole Nepal) QoS Test Results

SN	Name of Parameter	Threshold	Unit	Result	Remarks
1	Core Network availability	>= 99.999 %	%		
2	Data Network availability	>= 99.999 %	%		
3	Radio Networks availability	>= 99 %	%		
4	SMS/MMS delivery Success	>= 99.5 %	%		
5	Paging Channel Congestion Rate	<=1%	%		
6	SDCCH Block Rate	<=1%	%		
7	RRC Block Rate	<=1%	%		
8	E-RRC Block Rate	<=1%	%		
9	2G Block Rate CS	<=1%	%		
10	3G Block Rate CS	<=1%	%		
11	4G Block Rate PS	<=1%	%		
12	VoLTE Block Rate	<=1%	%		
13	Call Connection Time	<= 5 sec	sec		
14	POI Congestion Rate-with operator ABC at BH	< = 1 %	%		
	POI Congestion Rate-with operator XYZ at BH				
15	2G Call Drop Rate	<=2%	%		
16	3G Call Drop Rate	<=2%	%		
17	3G Data Drop Rate	<=2%	%		
18	4G Data Drop Rate	<=2%	%		
19	4G VoLTE Call Drop Rate	<=2%	%		
20	SRVCC to UTRAN Success Rate	>=98%	%		
21	Inter RAT Handover Success Rate	>=98%	%		
22	Intra RAT Handover Success Rate 2G	>=98%	%		
23	Intra RAT Soft Handover Success Rate 3G	>=98%	%		
24	Intra Frequency Handover Success Rate LTE	>=98%	%		
25	Inter Frequency Handover Success Rate LTE	>=98%	%		
26	3G DL Average network Throughput (Mbps)		Mbps		
27	3G UL Average network Throughput (Mbps)		Mbps		

28	4G DL Average network Throughput (Mbps)	Mbps		
29	4G UL Average network Throughput (Mbps)	Mbps		

6. Top Five Worst Cell/Sector

SN	Name of Parameter	Unit	1st cell/sector ID & Name	2nd cell/sector ID & Name	3rd cell/sector ID & Name	4th cell/sector ID & Name	5th cell/sector ID & Name
1	Radio Network availability	%	[cell name/ID-value]				
2	SDCCH Block Rate	%					
3	RRC Block Rate	%					
4	E-RRC Block Rate	%					
5	2G Block Rate CS	%					
6	3G Block Rate CS	%					
7	4G Block Rate PS	%					
8	VoLTE Block Rate	%					
9	2G Call Drop Rate	%					
10	3G Call Drop Rate	%					
11	3G Data Drop Rate	%					
12	4G Data Drop Rate	%					
13	4G VoLTE Call Drop Rate	%					
14	SRVCC to UTRAN Success Rate	%					
15	Inter RAT Handover Success Rate	%					

16	Intra RAT Handover Success Rate 2G	%					
17	Intra RAT Soft Handover Success Rate 3G	%					
18	Intra Frequency Handover Success Rate LTE	%					
19	Inter Frequency Handover Success Rate LTE	%					

Appendix- 1: Format of Trimester Report of QoS Measurement Through OSS Method

1. Details of Operator and Contact Person

Name of Operator:	…….
Address of Operator:	……... ……
Phone Number:	…….
Name of Contact Person:	…….
Designation of Contact Person:	…….
Mobile Number of Contact Person:	…….

2. QoS Parameters Extracted Period

Extractions of the QoS parameters on following period:

SN	QoS Parameters	Time Period	Measurement Period	Yes/No
1	Network Availability	24 hrs a day	Average of 1 month period	
2	Network/ Service Accessibility	At Busy Hour		
3	Service Retainability	24 hrs a day		
4	Service Integrity	At Busy Hour		

3. Complete Network (Whole Nepal) QoS Test Results of <Name of Month >

SN	Name of Parameter	Threshold	Unit	Result	Remarks
1	Core Network availability	>= 99.999 %	%		
2	Data Network availability	>= 99.999 %	%		
3	Radio Networks availability	>= 99 %	%		
4	SMS/MMS delivery Success	>= 99.5 %	%		
5	Paging Channel Congestion Rate	<=1%	%		
6	SDCCH Block Rate	<=1%	%		
7	RRC Block Rate	<=1%	%		
8	E-RRC Block Rate	<=1%	%		

9	2G Block Rate CS	<=1%	%		
10	3G Block Rate CS	<=1%	%		
11	4G Block Rate PS	<=1%	%		
12	VoLTE Block Rate	<=1%	%		
13	Call Connection Time	<= 5 sec	sec		
14	POI Congestion Rate-with operator ABC at BH	< = 1 %	%		
	POI Congestion Rate-with operator XYZ at BH				
15	2G Call Drop Rate	<=2%	%		
16	3G Call Drop Rate	<=2%	%		
17	3G Data Drop Rate	<=2%	%		
18	4G Data Drop Rate	<=2%	%		
19	4G VoLTE Call Drop Rate	<=2%	%		
20	SRVCC to UTRAN Success Rate	>=98%	%		
21	Inter RAT Handover Success Rate	>=98%	%		
22	Intra RAT Handover Success Rate 2G	>=98%	%		
23	Intra RAT Soft Handover Success Rate 3G	>=98%	%		
24	Intra Frequency Handover Success Rate LTE	>=98%	%		
25	Inter Frequency Handover Success Rate LTE	>=98%	%		
26	3G DL Average network Throughput (Mbps)		Mbps		
27	3G UL Average network Throughput (Mbps)		Mbps		
28	4G DL Average network Throughput (Mbps)		Mbps		
29	4G UL Average network Throughput (Mbps)		Mbps		

4. Top Five Worst Cell/Sector of <Name of Month>

SN	Name of Parameter	Unit	1st cell/sector ID & Name	2nd cell/sector ID & Name	3rd cell/sector ID & Name	4th cell/sector ID & Name	5th cell/sector ID & Name
1	Radio Network availability	%	[cell name/ID-value]				
2	SDCCH Block Rate	%					

3	RRC Block Rate	%					
4	E-RRC Block Rate	%					
5	2G Block Rate CS	%					
6	3G Block Rate CS	%					
7	4G Block Rate PS	%					
8	VoLTE Block Rate	%					
9	2G Call Drop Rate	%					
10	3G Call Drop Rate	%					
11	3G Data Drop Rate	%					
12	4G Data Drop Rate	%					
13	4G VoLTE Call Drop Rate	%					
14	SRVCC to UTRAN Success Rate	%					
15	Inter RAT Handover Success Rate	%					
16	Intra RAT Handover Success Rate 2G	%					
17	Intra RAT Soft Handover Success Rate 3G	%					
18	Intra Frequency Handover Success Rate LTE	%					
19	Inter Frequency	%					

	Handover Success Rate LTE						

5. Comments and Conclusion:

(Please indicate any comments/ remarks and conclusion of this report)

List of acronyms

QoS	Quality of Service
OSS	Operational Support System
KPI	Key Performance Indicator
PCO	Point of Control and Observation
2G	Second Generation of Telecom Cellular Network
3G	Third Generation of Telecom Cellular Network
4G	Fourth Generation of Telecom Cellular Network
NTA	Nepal Telecommunication Authority
MSC	Mobile Switching Center
MME	Mobile Management Entity
HLR	Home Location Register
HSS	Home Subscriber Server
BSC	Base Station Controller
RNC	Radio Network Controller
SGSN	Serving GPRS Support Node
GGSN	Gateway GPRS Support Node
PGW	Packet Data Network Gateway
SGW	Signaling Gateway
BTS	Base Transceiver Station
GSM	Global System for Mobile Communication
UTRAN	UMTS Terrestrial Radio Access Network
LTE	Long Term Evolution
VoLTE	Voice over Long-Term Evolution

HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
BH	Busy Hour
E-Node B	Evolved Node B
RRC	Radio Resource Control
E-RRC	Evolved Radio Resource Control
CS	Circuit Switched
PS	Packet Switched
RAB	Radio Access Bearer
E-RAB	Evolved-Radio Access Bearer
CS-RAB	Circuit Switched-Radio Access Bearer
PS-RAB	Packet Switched-Radio Access Bearer
TCH	Traffic Channels
PCH	Paging Channel
SDCCH	Stand Alone Dedicated Control Channel
SRVCC	Single Radio Voice Call Continuity
RAT	Radio Access Techonlogy
POI	Point of Interface
DL	Download
UL	Upload
SMS	Short Message Service
MMS	Multimedia Messaging Service