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For Immediate Release

Telecom Regulatory Authority of India

TRAI releases Consultation Paper on 'Review of Quality-of-Service Standards *for* Access Services (Wireless and Wireline) *and* Broadband (Wireless and Wireline) Services'

New Delhi, 18 August 2023 – The Telecom Regulatory Authority of India (TRAI) has today issued its Consultation Paper on 'Review of Quality-of-Service Standards *for* Access Services (Wireless and Wireline) *and* Broadband (Wireless and Wireline) Services''

1. TRAI Act, 1997 mandates the Authority to ensure the quality of Service to protect the interest of the consumers of telecommunication services. Accordingly, TRAI notified following regulations for Quality of Service (QoS) Standards for telecom services.

   (i) "*The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone service regulations, 2009*

   (ii) *Quality of Service of Broadband Service Regulations 2006* and

   (iii) *The Standards of Quality of Service for Wireless Data Services Regulations 2012.* These regulations have been amended from time to time based on induction of new technologies like 4G.

2. TRAI has been receiving number of complaints from the subscribers regarding call drops and other network related issues especially after rollout of 5G services. Upon detailed analysis of quarterly QoS performance reports, the Authority has noted that due to long performance assessment period of a quarter over a large area like LSA, there may be pockets or areas experiencing poor quality of service due to averaging effect while service providers are meeting overall QoS benchmark at LSA level.

3. Accordingly, to have a closer view of the status of QoS, the draft regulations propose monthly QoS performance reporting at State and UT level in addition to at LSA level.

4. The QoS parameters and benchmarks for voice and data services are technology agnostic in present regulations. The relevant terminology for 5G services has also been updated in draft regulations to monitor QoS performance of 5G.

5. As 4G and 5G networks are providing much wider coverage in the country compared to the 2G and 3G networks, the stringent performance benchmarks, especially related to call drops, are preposed for 4G and 5G services to improve consumer experience.

6. The network availability is important requirement for good QoS. Therefore, the performance against service provider's network availability is proposed to be monitored at State and UT level to ensure that consumer get uninterrupted services.

7. To simplify regulatory framework for QoS, it is proposed to have single regulation dealing with QoS standards for all voice and data services irrespective of their access medium i.e., for both wireline and wireless services. Accordingly, present three regulations are proposed to be merged into single regulation.

8. In above context and to address all relevant QoS related issues in a holistic manner, the Authority is issuing this consultation paper for seeking 'stakeholders' comments. Written comments on the consultation paper are invited from the stakeholders latest by 20th September 2023. Counter Comments, if any, may be submitted by 05th October 2023. The comments and counter-comments may be sent, preferably in electronic form on the email address adv-qos1@trai.gov.in.

9. The Consultation paper has been placed on TRAI's website www.trai.gov.in.

10. For any clarification/information, Shri Tejpal Singh, Advisor (QoS-I) TRAI may be contacted at Tel. No. +91-11-23236516.

V. Raghunandan

(V. Raghunandan)
Secretary, TRAI
18 Aug 2023

भारतीय दूरसंचार विनियामक प्राधिकरण

Telecom Regulatory Authority of India

Consultation Paper

on

Review of Quality-of-Service Standards

for

Access Services (Wireless and Wireline)

and

Broadband Services (Wireless and Wireline)

New Delhi
18th August 2023

Mahanagar Door Sanchar Bhawan,
J.L. Nehru Marg, (Old Minto Road)
New Delhi – 110 002, India

Stakeholders are requested to submit their comments, preferably in electronic form, on TRAI website in the specified template with copy to adv-qos1@trai.gov.in by 20th September 2023 and counter comments by 5th October 2023.

For any clarification/information, Tejpal Singh, Advisor (QoS-I) may be contacted at e-mail: adv-qos1@trai.gov.in.

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Chapter-1: Introduction

A. Introduction:

1. Sub-clause (v) of clause (b) of sub-section (1) of section 11 of the Telecom Regulatory Authority of India Act, 1997 (24 of 1997) mandates the Authority to "*lay down the standards of quality of service to be provided by the service providers and ensure the quality of service and conduct the periodical survey of such service provided by the service providers so as to protect the interest of the consumers of telecommunication services*".

2. In the discharge of these functions and to: -

   (i) create conditions for customer satisfaction by making known the QoS that the service provider is required to provide, and the user has a right to expect;

   (ii) measure the QoS provided by the Service Providers from time to time and compare them with the benchmarks to assess the level of performance;

   (iii) to generally protect the interests of consumers of telecommunication services,

   the Authority had notified the "Regulation on Quality of Services (QoS) of Basic and Cellular Mobile Telephone Services, 2000" vide Notification dated 5th of July 2000. The QoS standards, as prescribed, in these regulations have evolved since the year 2000.

3. The QoS standards in the above regulation were reviewed in 2005, keeping in view the performance of service providers against the QoS standards, the international standards on QoS and utility of the laid down QoS parameters. Based on the review of QoS standards undertaken by the Authority in 2005, the QoS standards were re-examined and the revised QoS standards for Basic Service (Wireline) and Basic Service (Wireless) & Cellular Mobile Telephone Service were issued by the Authority on 1st July 2005. In these regulations the parameters for basic service (wireless) and Cellular Mobile

Telephone Service were combined as the Quality-of-Service aspects associated with wireless medium is common for both the services.

4. The Authority undertook public consultation by releasing a consultation paper on 18th December 2008. Based on above consultation, the revised regulations i.e. "'*The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009*" were issued in 2009.

5. The Quality-of-Service Regulations, 2009 were first amended on 7th May 2012 to *inter-alia* include QoS parameters for 3G services. TRAI, in November 2012, had further amended the regulations to provide for Financial Disincentives for delays in the submission of Compliance Reports, non-compliance with the benchmarks for QoS Parameters, and false reporting of QoS performance.

6. The Authority had also reviewed the QoS Standards for Basic Service (Wireline) keeping in view the practical difficulties expressed by the service providers in meeting the benchmarks and issued "*The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Third Amendment) Regulations, 2014*" after rationalizing the benchmark for some of the parameters. At the same time, TRAI tightened the benchmark for some of the parameters concerning call centers to ensure that consumers can register their complaints efficiently. To create deterrents against consecutive non-compliance with the QoS benchmarks, TRAI amended the regulations on 15th October 2015, providing for increased Financial Disincentives (FD) in cases of repetitive non-compliance. These regulations were last amended in 2019 vide '*The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Seventh Amendment) Regulations, 2019'.*

7. The QoS standards for wireline Broadband services were introduced in 2006. In 2012, this regulation was amended to introduce financial disincentive in relation to the performance of service providers against the QoS benchmarks to strengthen the effectiveness and compliance of the said regulations. The

regulation was further amended in 2014 to update the definition of 'Broadband' as revised by the Licensor.

8. To cover the QoS benchmarks for wireless data services, '*The Standards of Quality of Service for Wireless Data Services Regulations, 2012 (26 of 2012)*' were introduced in December 2012. This regulation was amended in year 2014. Vide this amendment, the Authority mandated that in all tariff offers of wireless data services, including tariff offered through tariff plans, vouchers, tariff offered for services provided through dongle or through other means, the minimum download speed shall be specified by the service provider to the customer. Also, such minimum download speed shall be reported to TRAI along with tariff filing.

   Through this amendment, the Authority also decided that, in addition to providing such information on service provider's website and mentioning it in all advertisements, in telephone bill and in vouchers, such information shall also be available in the complaint centers of service providers and their sales offices/outlets. Also, the service providers are required to publish, on a quarterly basis, on their website the minimum download speed achieved for each of the tariff offers.

9. At present, aforesaid three regulations, covering QoS standards for Basic, Cellular and Broadband service, are in force i.e. namely (a) '*Quality of Service of Broadband Service Regulations 2006 (11 of 2006)*' (b) '*The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009 (7 of 2009)*' and (c) '*The Standards of Quality of Service for Wireless Data Services Regulations, 2012 (26 of 2012)'*. The copy of these Regulations, incorporating amendments issued by the Authority from time to time, is available on TRAI website[1].

10. These Regulations provide for a review of the QoS parameters and benchmarks from time to time to meet ongoing needs for an agile regulatory framework for quality of telecom services and to meet consumer

[1] https://trai.gov.in/release-publication/consolidated-regulations/telecom

requirements for QoS. With the widespread coverage of 4G network and latest rollout of 5G services and increasing penetration of wireline broadband services and to address QoS related issues faced by consumers, the Authority has decided to review the present QoS standards for Wireless and Wireline Services (including Broadband) comprehensively in context of emerging use cases and to address consumer concerns with regard to QoS and QoE.

B. Overview of Quality of Service in telecom:

11. QoS in wireless networks:

(i) The services dependent on the voice and data have different tolerance towards delay, delay variation, signal strength, etc. This service dependency requires different minimum quality level requirements for each service. For example, e-mail service is tolerant of high delay or loss as users do not expect instant delivery. Online gaming on the other hand is highly susceptible to any packet errors and even the slightest delay in packet delivery. QoS parameters characterize the quality level of the service being offered and the level of customer satisfaction. QoS parameters can be used by service providers to improve consumer experience and to ensure that their customers are getting the level of quality that they are paying for. Similarly, it enables regulators to ensure that the benchmarks related to QoS are being met by the service providers. The QoS parameters that are measured by the measurement of physical attributes of circuits, networks, and signals are known as Objective QoS parameters. Subjective QoS parameters are obtained by conducting consumer surveys and are determined by customer opinion. QoS parameters or metrics are essential for effective QoS management. They should be simple to use, provide an accurate representation of customer perception, and be commonly accepted as standards. In ITU-T, Study Group 12 (SG12) is responsible for performance, QoS, and QoE. SG12 has done considerable amount of work on QoS parameters benchmarking. The Study Group has defined a standard for QoS

parameters for each data and mobile service that is accessed through Internet Access Services (IAS). The QoS parameters for popular mobile services are defined in ITU-T E.804.

(ii) **QoS Parameters for Voice Services**:

The QoS parameters for voice communication over LTE networks (VoLTE) have been defined by ITU in ITU-T Rec. G.1028 (06/2019) "End-to-end QoS for voice over 4G mobile networks". The end-to-end QoS parameters and their corresponding KPIs are given below:

(i) Registration success rate (Registration success rate)
(ii) Service availability (Network efficiency ratio)
(iii) Post-dialling delay (SIP session set-up time)
(iv) Voice quality (MOS-LQO) (Network quality index and IP Packet loss ratio)
(v) Mouth-to-ear delay (IP packet transfer delay and round-trip time)
(vi) Call drop rate (Session completion rate)
(vii) Speech bandwidth (NB, WB, or SWB) (Codec statistics)

12. **QoS parameters for Internet services:**

(i) ITU has covered QoS parameters definitions for popular mobile services and related trigger points in ITU-T Rec. E.804. The QoS parameters that are defined in the document are divided into (a) service independent QoS parameters that do not depend on the mobile service they are defined for. Instead, they are dependent upon mobile or wireless network technology or may be relevant to all IP-based services like domain name system (DNS) parameters and (b) QoS parameters which are dependent on the mobile services for which they are defined. Further, mobile services are also divided into two different types:

a) Direct mobile services, and
b) Store and forward mobile services.

(ii) The following key parameters are service-independent parameters as defined in ITU-T Rec. E.804:

a) Radio network unavailability
b) Network non-accessibility
c) Attach failure ratio
d) Attach set-up time
e) PDP context activation failure ratio
f) PDP context activation time
g) PDP context cut-off ratio

(iii) From an end-user perspective, there is no difference between a mobile broadband connection with a smartphone and a fixed broadband connection from a laptop. Therefore, the same indicators can be used for measurements, which include the following:

a) Web browsing (HTTP QoS parameters)
b) Voice-over-IP (both signalling and voice data parameters are important)
c) Download DR (Mbit/s)
d) Upload DR (Mbit/s)
e) UDP latency (important for real-time services, such as VoIP and IPTV, which typically use RTP/ UDP/IP, where RTP is the real-time transport protocol)
f) UDP packet loss (important for real-time services, such as VoIP and IPTV, which typically use RTP/UDP/IP)
g) DNS resolution (important for all IP-based services, either real-time or non-real-time)
h) Video streaming (video is one of the most demanding services regarding the bit rates in the downlink, where the demands increase with the resolution of the video content).

C. Organization of the Consultation Paper

13. This consultation paper has been prepared to seek comments and inputs on draft regulation on "*THE STANDARDS OF QUALITY OF SERVICE OF ACCESS SERVICE (WIRELINE AND WIRELESS) AND BROADBAND SERVICE (WIRELINE AND WIRELESS)"* and other QoS and emerging quality of

experience (QoE) related issues**.** The proposed Draft Regulation shall replace the existing three regulations, namely (i) '*Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009 (7 of 2009)*' (ii) '*Standards of Quality of Service for Wireless Data Services Regulations, 2012 (26 of 2012)*' and (iii) **'***Quality of Service of Broadband Service Regulations 2006 (11 of 2006)'.*

14. The consultation paper consists of seven chapters. Chapter-1 provides introduction and overview of QoS in telecom. Chapter-2 covers the need for revision of existing regulations. Chapter-3 contains draft of the proposed regulation while Chapter-4 summarizes the key highlights of the draft regulation. In Chapter-5, the detailed measurement methodology has been provided for measurement of benchmarks against the QoS parameter specified in draft regulation. Chapter-6 covers the emerging trends in area of QoS and shift from QoS to QoE and relevant issues for consultation. Chapter-7 provides summary of issues for consultation with invitation for comments or inputs. **Annexure-I** covers the overview of existing percentile-based Drop Call Rate (DCR) measurement methodology while **Annexure-II** provides global overview of QoS parameters used for the measurement of QoS of wireline and wireless telecom services. **Annexure-III** is the copy of DoT letter dated 14.02.2023 highlighting the need for review of QoS standards.

Chapter-2: Need for revision of QoS Standards

1. The present QoS standards for Broadband and Basic & Cellular Telecom Services were notified by the Authority in October, 2006 and March, 2009 respectively. The QoS standards for Wireless Data services were notified subsequently in December 2012. The revision of these standards has been undertaken by the Authority on need basis during intervening period.

2. Last amendment to "*The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009*" was issued in November 2019. Similarly, '*Quality of Service of Broadband Service Regulations 2006*' were last amended in 2014 while the '*The Standards of Quality of Service for Wireless Data Services Regulations, 2012 (26 of 2012)'* were last revised in July 2014.

3. One of the significant amendments of QoS standards was notified by the Authority in August 2017 to address the issues related to call drop in cellular mobile telecom network i.e., in LTE and 2G/3G network. Vide this amendment, the Authority revised the QoS benchmarks for '**Connection Maintenance**' in the '*The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009*. However, the consumer experience related to call drop and call muting remain unaddressed and continue to be reported through consumer complaints, social media, and newspapers.

4. The *Standards of Quality of Service for Wireless Data Services* were notified in the era of 2G and 3G services wherein data services were delivered over circuit switched networks. As circuit switched networks were not designed to provide data services, their QoS performance benchmarks were set based on the capability of underlying technology. At present, packet core network with LTE, LTE-Advanced and 5G technology constitute more than 75% of the telecom network in the country. These packet core networks support high and guaranteed data rates, as well as very low latencies which are two most important QoS benchmarks for data services. The impact of different generation of mobile technology on core network latency can be seen in the

expectations set by service provider AT&T which is one of the largest service providers in USA.

Technology	LTE	HSPA+	HSPA	EDGE	GPRS
Latency (ms)	40 to 50	100 to 200	150 to 400	600 to 750	600-750

However, the present QoS benchmark envisages latency to be <250ms for wireless data services and <120ms for wireline broadband service which are not in sync with the requirement of present-day applications.

5. After the last amendments of present standards of QoS, telecom sector has seen considerable transformation both from the perspective of technology as well as government policy in last 5-6 years. The telecom reforms rolled out by DoT and continuous focus of the Government on ease of doing business has significantly changed the telecom landscape in the country. The availability of sufficient spectrum and Right-of-Way (RoW) reforms have enabled service providers to achieve fastest roll out 5G network in the world. Such transformational changes in government policy and technology landscape are expected to impact quality of telecom services positively which need to be reflected in QoS standards.

6. The number of mobile subscribers in India has increased to nearly 1.15 billion in January 2023 from 525.15 million in December 2009. This sharp growth signifies that the current market for wireless communication is vastly different as compared to the time when the three regulations were notified.

7. 2G was the dominant cellular technology and 3G technology was being adopted progressively in 2009 in India. 4G services were introduced in the mobile network in 2016. Now, in 2023, 5G services have already been rolled out in many cities. 4G and 5G technologies have fundamentally different architectures i.e., packet-based architecture for voice services rather than circuit-switched call flow. With the emergence of 5G technology, the telecom ecosystem is going through rapid changes and new use cases are emerging on an ongoing basis. These emerging use cases require vastly different and more stringent Key Performance Indicators (KPIs) for QoS.

8. The emerging interactive applications now require more symmetric bandwidth unlike the use cases supported by present LTE networks which support asymmetric bandwidth where upload bandwidth practically varies by a factor of one fourth to one eighth of download bandwidth.

9. Similarly, in the case of Broadband service, the technology shift has taken place from ADSL on copper to Fibre to the Home (FTTH) on optical fibre. The number of FTTH Broadband connections have shown a significant increase in recent years. FTTH connections can support high data rates in the order of 100s of Mbps with low latency. Therefore, QoS standards for broadband services requires suitable revision to factor impact of new technologies and telecom network performance requirement of present and emerging applications.

10. TRAI has been closely monitoring the performance of service providers against the QoS benchmarks through Performance Monitoring Reports (PMRs) submitted by service providers. It has been observed that even with the technological advancement in mobile telecommunications and advancement in performance management tools, the QoE of consumers has not improved as expected though such QoS requirements are supported by technology standards. Even with widespread coverage of 4G networks in the country and rollout of 5G services, there are increasing number of complaints of call drops, call muting, low data throughput etc. which raises question marks on the network design and provisioning of required network resource.

11. Upon detailed analysis of quarterly PMRs submitted by service providers, the Authority has noted that due to the long performance assessment period of a quarter and further averaging over Licensed Service Area, the real issues related to QoS may not get adequately reflected in the quarterly performance reports.

12. Some of the Licensed Service Areas (LSAs) like North East, Bihar etc. span across more than one state. It has been observed that poor QoS performance in some States or Union Territories (UTs) get averaged out with the better performance in other states in the performance monitoring at LSA

level in present framework. This averaging effect may result in continuous poor QoS in certain States despite service provider meeting the benchmark at LSA level. Such instances have been observed especially in the case of north-eastern States.

13. It has also been observed that in case of large LSAs, the performance against some QoS benchmarks like network availability and drop call rates varies across districts. Due to averaging over LSA, even very poor performance against QoS benchmarks in few districts may not get reflected in performance reports. Therefore, in such cases, performance against QoS benchmarks may need to be reviewed at even district level if required.

14. Accordingly, to have a closer view of the status of QoS in States and UTs, the Authority issued the Direction to service providers, on 23rd February 2023, to submit State and UT-wise QoS performance reports. It is pertinent to note that the network size of some of the LSAs in India are more than the size of telecom networks of many individual countries in the world.

15. The analysis of consumer complaints received by the service providers has also shown an increasing trend which does not indicate improvement in QoS. The total number of consumer complaints registered by the service providers, including Basic, Broadband and Cellular Mobile Telecommunication services, have increased from 48.42 million in year 2019 to 65.96 million in year 2022. Almost 70% of these complaints are related to faults and network issues. Though all of network related complaints may not necessarily be related to QoS, but they indicate that there is a large scope for improvement in network planning and operations practices in order to enhance consumer experience.

16. DoT, vide its letter No-5-1/2022-AS-TF dated 14.02.2023, has highlighted the need to have QoS regulations reviewed periodically to update the QoS parameters and benchmarks. The benchmarks referred by DoT for consideration and revision may be seen at **Annexure-III**.

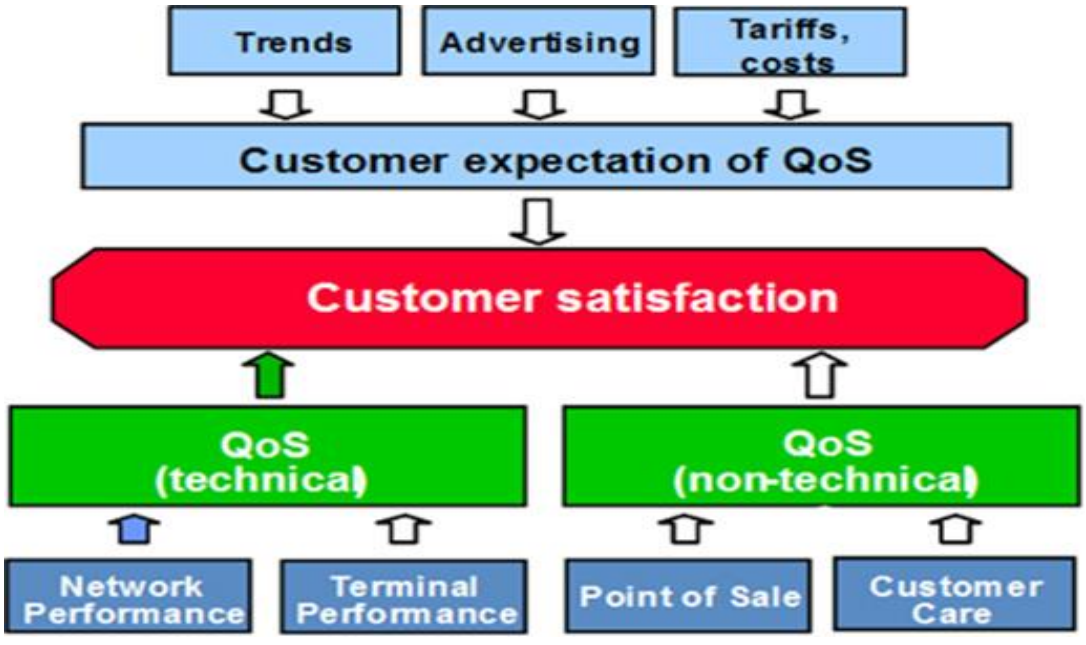
17. It is critical to have comprehensive approach to achieve desired level of QoS to deliver expected QoE by consumers. Quality of telecom services

should not be seen in isolation as it is a sum-total of the quality and provisioning of (a) underlying network resources (b) supporting infrastructure like power backup and backhaul (c) operation & management practices and (d) operation and management manpower.

18. Therefore, the Authority is of the opinion that the service providers are required to adopt the '**QoS-by-Design'** approach to achieve the level of QoS which is already supported by network technologies and expected by the consumers.

19. The delivery of quality telecom services is a win-win situation for all stakeholders including service providers, consumers, Government, and regulators. The ITU-T supplement 9 to Recommendation Series E.800 aptly summarizes technical and non-technical aspects of QoS from the point of view of consumer satisfaction.

Figure-1: QoS technical and non-technical point of view for customer satisfaction



[Source: ITU-T QoS framework]

20. The customer requirement and satisfaction must be major determining factors while introducing new services, setting standards, and designing networks. It is equally applicable for the setting up of QoS benchmarks.

Therefore, the customer requirements and expectations are major considerations for reviewing existing QoS standards.

21. With increasing digitization across different sectors and 'Digital India' initiative of the Government, availability as well as quality of telecom services has become an essential requirement for social and economic activities. Non-availability of telecom services in any part of State or UT adversely impacts social, economic, and e-Governance activities dependent upon availability of telecom services. The QoS standards need to factor such changing requirements and need for availability of telecom services.

22. With the convergence of voice and data into an all-IP architecture irrespective of access network, the Authority is of the view that there is a need to have a single regulation governing wireless and wireline services being offered to the consumers instead of having separate regulations for Wireless Data, Broadband Services, Cellular Mobile Telephone and Basic Telephone Services. Present three regulations have many common features and performance parameters. For example, basic telephone service (wireline) and broadband services have performance parameters for fault and billing performances which are to be reported under separate regulation even though both the services are delivered on common network. The merging of existing three regulations will also help in reduction of compliance burden and reporting requirements for the service providers while enabling more granular insight into QoS to meet consumer expectations.

23. The issues related to quality of telecom services are not only reflected in consumer complaints but also find substantial mention in Parliament Questions.

24. Therefore, to keep pace with present and emerging telecom technologies as well as to meet requirement of user application, regulatory framework for QoS standards need to be agile and ever evolving. Considering aforesaid facts, the Authority has decided to comprehensively review the existing standards for quality of wireline and wireless access services covering voice and broadband.

Chapter 3: Draft Regulation

Based on the background provided in Chapter-1 and the need for revision explained in Chapter-2, the draft of the proposed regulation is as under: -

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THE STANDARDS OF QUALITY OF SERVICE OF ACCESS SERVICE (WIRELINE AND WIRELESS) AND BROADBAND SERVICE (WIRELINE AND WIRELESS) REGULATIONS, 2023

(XX of 2023)

F. No._____.—In exercise of the powers conferred upon it under section 36, read with sub-clauses (i) and (v) of clause (b) of sub-section (1) of section 11, of the Telecom Regulatory Authority of India Act, 1997 (24 of 1997), the Telecom Regulatory Authority of India hereby makes the following regulations, namely:—

SECTION-I

PRELIMINARY

1 Short title, commencement, and application.— (1) These regulations may be called the Standards of Quality of Service of Access Service (Wireline and Wireless) and Broadband Service (Wireline and Wireless) Regulations, 2023.

(2) They shall come into force with effect from_____.

(3) These regulations shall apply to all service providers, having-

(i) Unified Access Service License;

(ii) Unified License with authorization for Access Service; and

(iii) Internet Service Authorisation under any License.

Provided that nothing contained in these regulations shall apply to an Internet Service Provider whose total number of subscribers as on last day of the preceding financial year does not exceed ten thousand numbers or as notified by Authority through order or direction.

2. Definitions.— (1) In these regulations, unless the context otherwise requires,—

(a) **"Act"** means the Telecom Regulatory Authority of India Act, 1997 (24 of 1997);

(b) **"Access Services Authorization"** under Unified License (UL) means collection, carriage, transmission, and delivery of voice and/or non-voice messages over the Licensee's network in the designated Service Area, wherein the Licensee can -

(i) *also provide Internet Telephony, Internet Services including IPTV, Broadband Services, and triple play i.e., voice, video, and data;*

(ii) *interconnect the Internet Telephony network with PSTN/PLMN/GMPCS network, while providing Internet Telephony service;*

(iii) *provide access service, which could be on wireline and/or wireless media with full mobility, limited mobility, and fixed wireless access;*

(c) **"Access Service (Wireless)" —**

(i) means telecommunication service provided through a telecommunication system for the conveyance of messages through the agency of wireless telegraphy where every message that is conveyed thereby has been, or is to be, conveyed using a telecommunication system that is designed or adapted to be capable of being used while in motion;

(ii) refers to the transmission of voice or non-voice messages over the Licensee's Network in real time only but the service does not cover broadcasting of any messages, voice, or non-voice, however, Cell Broadcast is permitted only to the subscribers of the service;

(iii) in respect of which the subscriber (all types, pre-paid as well as post-paid) has to be registered and authenticated at the network point of registration, an approved numbering plan shall be applicable;

(iv) includes any service provided through Global System for Mobile Communications (GSM), Code Division Multiple Access (CDMA), Wideband CDMA-based Universal Terrestrial Radio Access Network (UTRAN), Evolved Universal Terrestrial Radio Access Network (E-

UTRAN) based on Long Term Evolution (LTE) technologies and any other technologies permitted under the Unified License with Access Service Authorization;

(d) **"Access Service (Wireline)"** covers collection, carriage, transmission, and delivery of voice or non-voice messages over the Licensee's Public Switched Telephone Network in a licensed service area and includes the provision of all types of services except those requiring a separate License;

(e) **"Authority"** means the Telecom Regulatory Authority of India established under sub-section (1) of section 3 of the Act;

(f) **"Broadband"** is a data connection, through wireless or wireline access media, that is able to support interactive services including Internet access and has the capability of delivering the minimum download speed, as specified by Licensor from time to time, to an individual subscriber from the point of presence (POP) of the service provider intending to provide Broadband service.

(g) "**Broadband Service"** refers to the service provided using broadband data connection by Internet Service Provider under any License.

(h) **"Call Centre"** means a department or a section or a facility or the complaint centre established by the service provider under regulation 3 of the Telecom Consumers Complaint Redressal Regulations, 2012;

(i) "**Cell**" means an area of radio coverage identified by a Cell Global Identity or CGI;

(j) **"Cell Bouncing Busy Hour"** means the one-hour period in a day during which a cell in a cellular mobile telephone network experiences the maximum traffic;

(k) "**Cell Identity**" or "**CI**" means identity of a cell which is unique within a Location Area (LA) or a Tracking Area (TA);

(l) "**Cell Global Identity**" or "**CGI**" means the Globally Unique Identification of a cell and is the concatenation of the Mobile Country Code (MCC), Mobile Network Code (MNC), Location Area Code (LAC) or Tracking Area Code (TAC) and the Cell Identity (CI);

(m) "**Cell_Q(t)**" or "**Cell Quality of Service Performance Measure for DCR Parameter**" means the t^{th} percentile value in the set of DCR values corresponding to a Cell observed during the assessment period;

(n) "**Cell_Q(90)**" means Cell_Q(t) with t=90 and indicates the 90^{th} percentile DCR value in the set of DCR values observed for a Cell in the assessment period;

Explanation: If a Cell was operating for ninety days during an assessment period and computed DCR values were available for all these ninety days then arranging these ninety DCR values in ascending order and finding 90^{th} percentile DCR value for that Cell would point to 81^{st} DCR value (counted from lowest to highest DCR value). This Cell_Q(90) DCR value will be the representative DCR value for calculation of Spatial Distribution Measure of that Cell during that assessment period;

(o) "**Cellular mobile telephone service**" means telecommunication service provided by means of a telecommunication system for the conveyance of messages through the agency of wireless telegraphy where every message that is conveyed thereby has been, or is to be, conveyed by means of a telecommunication system which is designed or adapted to be capable of being used while in motion;

(p) **“Consumer”** means a consumer of a service provider falling in sub-regulation (3) of regulation 1 of these regulations and includes its customer and subscriber;

(q) "**Day_Q(s)**" or "**Network Quality of Service Performance Measure on a Day for DCR Parameter**" means the s^{th} percentile DCR value in the set of DCR values of all cells of the network on a particular day;

(r) "**Day_Q(97)**" means Day_Q(s) with s=97 and indicates the 97^{th} percentile DCR value in the set of DCR values of all Cells of the network on a particular day;

Explanation: If ten thousand cells were operating in a network on a particular day and computed DCR values were available for all these ten thousand cells then arranging these ten thousand DCR values in ascending order and finding the 97^{th} percentile DCR value would point to the 9700^{th} DCR value (counted from lowest to highest). This Day_Q(97) value will be the representative DCR value for calculation of Temporal Distribution Measure of the network on that day;

(s) **“Down Link (DL) Packet Drop Rate or DL-PDR”** means fraction of Packet Data Convergence Protocol (PDCP) Service Data Units (SDUs), in percentages, which are dropped by the network or lost in the network while transferring data on the downlink for Quality of Service (QoS) Class Identifier (QCI)=1 in LTE or 5G new Radio based radio access networks;

(t) "**Drop Call Rate**" or "**DCR**" means the percentage of voice calls which once having been established are interrupted prior to their normal completion;

(u) "**eNode B**" **or** "**evolved Node B**" **or** "**eNB**" means cell(s) that acts as a logical node in Evolved Universal Terrestrial Radio Access Network (E-UTRAN) based on Long Term Evolution (LTE) technology;

(v) "**Evolved-Universal Terrestrial Radio Access Network (E-UTRAN) Radio Access Bearer**" **or** "**E-RAB**" means a user plane connection between User Equipment (UE) and Serving Gateway (SGW) in the LTE based technology;

(w) "**gNode B**" means cell(s) that acts as a logical node in 5G New Radio based technology;

(x) "**Jitter"** means variation between the maximum packet delay and minimum packet delay within a specific time window in wireless broadband data service;

(y) **"Latency"** means the time taken by a packet to reach the receiving endpoint after being transmitted from the sending point;

(z) **"Licence"** means a licence granted or having effect as if granted under section 4 of the Indian Telegraph Act, 1885 (13 of 1885) or the provisions of the Indian Wireless Telegraphy Act, 1933 (17 of 1933), as amended from time to time;

(aa) **"Licensee"** means any person licensed under sub-section (1) of section 4 of the Indian Telegraph Act, 1885 (13 of 1885), as amended from time to time, for providing specified public telecommunication services;

(bb) "**Location Area**" or "**LA**" means an area in which a mobile station may move freely without updating the Visitor Location Register (VLR) and includes one or several cells in Public Land Mobile Network (PLMN);

(cc) "**Location Area Code**" **or** "**LAC**" means a number of fixed length identification number (of two octets) used for identifying a Location Area (LA) within a Public Land Mobile Network;

(dd) **"Message"** shall have the same meaning assigned to it in clause (3) of section 3 of the Indian Telegraph Act, 1885 (13 of 1885), as amended from time to time;

(ee) **"MTTR" means** mean time to repair**;**

(ff) "**Network_Q_{SD}(s,t)**" or "**Network Quality of Service (QoS) DCR Spatial Distribution Measure**" means the s^{th} percentile value in the set of Cell_Q(t) values for all cells in a network during the assessment period;

Explanation: Network_Q_{SD}(s,t) is a representative DCR spatial distribution value for the entire network during the assessment period and indicates that Cell_Q(t) value of at-least s% of the cells were equal to or lower than the Network_Q_{SD}(s,t) value;

(gg) "**Network_Q_{TD}(s,t)**" or "**Network Quality of Service(QoS) DCR Temporal Distribution Measure**" means the t^{th} percentile value in the set of Day_Q(s) values for a network on all days in the assessment period;

Explanation: Network_Q_{TD}(s,t) is a representative DCR temporal distribution value for the entire network during the assessment period which indicates that the Day_Q(s) value for at-least t% of the days during the assessment period were equal to or lower than the Network_Q_{TD}(s,t) value;

(hh) "**n^{th} Percentile**" or "**n^{th} Percentile Value**" means the smallest data value in a given data set with the property that n% of the data values in that data set are less than or equal to it;

Explanation: Percentile is a measure of relative standing of an observation within the data set, for example, if 90^{th} percentile value is to be calculated in a data set of 200 DCR values each falling in the interval from 0 to 100 (in percent), then it would point to DCR value at 180^{th} position (90% of 200), when all 200 DCR values are arranged in ascending order and say it is 3.45% (DCR value) in this example. The 3.45% DCR value will be the smallest DCR value in the given set of 200 DCR values with the property that 90% of the DCR values in this set

i.e., DCR values from position 1 to 179 in set of values arranged in ascending order, are less than or equal to it. If the data set has many data values in the given data set with 3.45% DCR value, then 90th percentile would point to all such DCR values. In case, n% of the data values comes out to be a number with fraction then rounded up number shall be used;

(ii) "**Node B**" means a base station that acts as a logical node in a Universal Terrestrial Access Network (UTRAN);

(jj) **"OMC"** means operation and maintenance Centre;

(kk) **"Packet Data Protocol context or "PDP context"** means access to an external packet-switching network which contains information such as the type of packet-switching network, the Mobile Station PDP address (IP address), the reference of packet gateway node and the requested QoS;

(ll) **"Paging Channel"** means a signaling control channel to send control, call setup and paging messages used for communication between mobile station (MS), i.e., mobile handset and Base Transceiver Station (BTS) before such mobile station is assigned a Traffic Channel (TCH);

(mm) **"Point of Interconnection" or "POI"** means a mutually agreed point of demarcation where the exchange of traffic between the networks of two service providers takes place;

(nn) **"Public Land Mobile Network"** means a network set up and operated by any of the licensee, under Unified Access Service License or Unified License with authorization for Access Service, for the purpose of providing land-based access services (wireless) to the public and which provides communication facilities to subscribers using mobile stations (MS);

(oo) **"Public Switched Telephone Network"** means a fixed specified switched public telephone network providing a two-way switched telecommunication services to the general public;

(pp) **"Quality of Service" or "QoS"** means the main indicator of the performance of a telecommunication network and the degree to which such network conforms to the standards of such quality of service as specified in these regulations for specified parameters;

(qq) **"Radio Access Bearer" or "RAB"** means a service provided by the Access Stratum to the Non-Access Stratum for the transfer of user data between the User Equipment and the Core Network;

(rr) **"Radio interface"** means the interface between User Equipment and the Universal Terrestrial Radio Access Network access point, which encompasses all the functionality required to maintain such interfaces;

(ss) **"Radio Resource Control" or "RRC"** means a sub layer of radio interface Layer 3 existing in the control plane which provides information transfer service to the Non-Access Stratum and is responsible for controlling the configuration of radio interface Layers 1 and 2;

(tt) "**Regulations**" means the Standards of Quality of Service of Access Service (Wireline and Wireless) and Broadband Service (Wireline and Wireless) Regulations, 2023;

(uu) **"Service provider"** means any service provider to which these regulations apply;

(vv) **"Stand-alone Dedicated Control Channel" or "SDCCH"** means, a GSM control channel for signaling purposes where the majority of call setup occurs, which is used for communication between mobile station

(MS), i.e. mobile handset and Cell before such mobile station is assigned a Traffic Channel (TCH);

(ww) **"Telecommunication service"** means service of any description (including electronic mail, voice mail, data services, audio-tex services, video-tex services, radio paging and cellular mobile telephone services) which is made available to users by means of any transmission or reception of signs, signals, writing images, and sounds or intelligence of any nature, by wire, radio, visual or other electro- magnetic means but shall not include broadcasting services;

(xx) **"Time Consistent Busy Hour" or "TCBH"** means the one-hour period starting at the same time each day for which the average traffic of the resource group concerned is greatest over the days under consideration and such Time Consistent Busy Hour shall be established on the basis of analysis of traffic data for a period of ninety days;

(yy) "**Tracking Area**" or "**TA**" means an area in which a mobile station may move freely without updating the Mobile Management Entity (MME) and includes one or several cells of Evolved Universal Terrestrial Radio Access Network (E-UTRAN);

(zz) "**Tracking Area Code**" **or** "**TAC**" means a fixed length identification number (of 2 octets) used for identifying a Tracking Area within a Public Land Mobile Network;

(aaa) **"Traffic Channel" or "TCH"** means, a logical channel in a GSM or CDMA network which carries either encoded speech or user data;

(bbb) **"Unified Access Services" —**

(i) means telecommunication service provided by means of a telecommunication system for the conveyance of messages through the agency of wired or wireless telegraphy;

(ii) refers to transmission of voice or non-voice messages over Licensee's Network in real time only but service does not cover broadcasting of any messages, voice or non-voice, except, Cell Broadcast which is permitted only to the subscribers of the service; and

(iii)in respect of which the subscriber (all types, pre-paid as well as post-paid) has to be registered and authenticated at the network point of registration and approved numbering plan shall be applicable;

(ccc) **"Up Link (UL) Packet Drop Rate" or "UL-PDR"** means fraction of Packet Data Convergence Protocol (PDCP) Service Data Units (SDUs), in percentages, which are lost in the network while transferring data on the uplink for QoS Class Identifier (QCI)=1 in LTE or 5G New Radio based radio access networks;

(ddd) "**Voice over LTE**" **or** "**VoLTE**" means voice call established, maintained and released using Internet Protocol (IP) Multi-Media Sub-System (IMS);

(eee) "**Voice over New Radio**" **or** "**VoNR"** means voice call established, maintained and released using Internet Protocol (IP) Multi-Media Sub-System (IMS) on 5G New Radio;

(2) Words and expressions used but not defined in these regulations but defined in the Act, and the rules and other regulations made under the Act, shall have the meanings respectively assigned to them in the Act or the rules or the regulations made under the Act, as the case may be.

SECTION II

QUALITY OF SERVICE (QoS) PARAMETERS FOR ACCESS SERVICE (WIRE LINE)

3. Quality of Service Parameters in respect of which compliance reports are to be submitted to the Authority.— (1) Every service provider providing access service (wireline) shall meet the benchmarks for each of the following QoS parameters, namely:—

Serial Number	Name of Parameter	Benchmark	Averaged over a period
(i)	Provision of a service within 7 days of payment of demand note by the applicant	100%	One Month
(ii)	Fault incidences (No. of faults per 100 subscribers per month)	≤5	One Month
(iii)	Fault repair by next working day in Urban areas	≥85%	One Month
(iv)	Fault repair within five days in Urban areas	100%	
(v)	Fault repair by next working day in rural and hilly areas	≥75%	
(vi)	Fault repair within seven days in rural and hilly areas	100%	
	Note: **Rent Rebate for:** (i) Faults pending for >5 days and ≤7 days: **Rent rebate for 7 days.** (ii) Faults pending for >7 days and ≤15 days**: Rent rebate for 15 days.** (iii) Faults pending for >15 days: **rent rebate for one month or** entire duration of the fault, whichever is higher.		

(vii)	Mean Time To Repair (MTTR)	≤10 hours	One Month
(viii)	Metering and billing accuracy – post paid	≤0.1% Explanation: Not more than 1 complaint per 1000 customers, i.e., 0.1% complaints for bills issued should be raised	All Bills issued in the month
(ix)	Metering and billing accuracy –- pre-paid	≤0.1% Explanation: Not more than 1 complaint per 1000 customers, i.e., 0.1% complaints for metering, charging, credit, and validity should be raised	One Month
(x)	Resolution of billing/ charging complaints within six weeks	100%	One Month
(xi)	Application of credit/ waiver/ adjustment to customer's account within one week from the date of resolution of complaints	100%	One Month
(xii)	**Response Time to the customer for assistance**		
	(a) Accessibility of call centre/ customer care	≥95%	One Month
	(b) Percentage of calls answered by the operators (voice to voice) within ninety seconds	≥95%	One Month
(xiii)	Termination/ closure of service within seven days	100%	One Month
(xiv)	Refund of deposits within 45 days of closures	100%	One Month

(2) The compliance of the parameters specified in sub-regulation (1) shall be reported to the Authority by the service provider.

(3) The Authority may, from time to time, through audit and objective assessment of QoS conducted either by its own officers or employees or

through an agency appointed by it, verify and assess the performance of the Quality of Service parameters, specified in sub-regulation (1).

4. Quality of Service parameters in respect of which compliance is to be monitored by the service provider and reported to the Authority.— (1) Every service provider providing access service (wireline) shall meet and monitor the benchmarks of following QoS, namely:—

Serial Number	**Name of Parameter**	**Benchmark**	**Averaged/ measured over a period**
(i)	Registration of demand for new wireline connection irrespective of technical feasibility	100%	One quarter
(ii)	Requests for Shift of Telephone Connection to be attended within three days	95%	One quarter
(iii)	Grade of Service		One quarter
	(a) Junctions between local exchanges	0.002	
	(b) Outgoing junctions from Trunk Automatic Exchange (TAX) to local exchange	0.005	
	(c) Incoming junctions from local exchange to TAX	0.005	
	(d) Incoming or outgoing junctions between TAXs	0.005	
(iv)	Point of Interconnection (POI) Congestion (on individual POI) at LSA level	≤0.5%	One Quarter

(2) The service provider shall monitor the compliance of the parameters and its benchmarks specified under sub-regulation (1) and furnish online quarterly report to the Authority within thirty days of the end of each quarter.

(3) The service provider shall maintain records of its compliance of the benchmark of each QoS parameter for the access service (wireline) specified in sub-regulation (1).

(4) The Authority may, if it considers it expedient so to do, and to ensure compliance of the provisions of sub-regulation (1), at any time,–

(a) direct any of its officers or employees or an agency appointed by the Authority to inspect the records maintained under sub-regulation (3); or,

(b) get the records maintained under sub-regulation (3) audited.

5. Duration of alert for the called party.— (1) The time duration of alert for an incoming voice call, which is neither answered nor rejected by the called party, shall be sixty seconds for access service (wireline).

(2) The terminating network shall, on expiry of sixty seconds in case of access service (wireline), release the incoming voice call and transmit the call release message to the originating network:

Provided that the originating network may release an unanswered call after ninety seconds in case the call release message is not received from the terminating network.

SECTION III

QUALITY OF SERVICE (QoS) PARAMETERS FOR ACCESS SERVICE (WIRELESS)

6. Quality of Service parameters in respect of which compliance reports are to be submitted to the Authority. —(1) Every service provider providing access service (wireless) shall meet the benchmarks of following QoS parameters, namely:—

Serial Number	Name of Parameter	Benchmark	Method and Assessment period
A	**Network Service Quality Parameters:**		
(i)	**Network Availability**		
	(a) % of commissioned cells for	100%	On average basis over a

	which geospatial service coverage map is available on service provider's website		period of one month
	(b) Accumulated downtime (Cells not available for service)	≤1%	On average basis over a period of one month
	(c) Worst affected Cells due to downtime (Cells not available for service for more than cumulative 24 hrs. in a month)	≤1%	On average basis over a period of one month
	(d) Reporting of significant network outage to the Authority within 24 hrs of start of the outage (Services not available in a district or State for more than 4 hours) **Note: For significant network outages of > 24 hrs :** Proportional rent rebate as per plan charges for affected number of days shall be credited in next bill for post-paid consumers registered in the district. For the pre-paid consumers registered in the district, the validity of their pre-paid accounts as on outages start date shall be increased by equal number of days.	100%	All incidence of significant network outage over a period of month
(ii)	**Voice Connection Establishment (Accessibility)**		
	(a) Call Set-up Success Rate for Circuit Switched Voice or Session Establishment Success Rate for VoLTE or DRB Accessibility success rate for VoNR, as applicable (within licensee's own network)	≥98%	On average basis over a period of one month
	(b) SDCCH Congestion/ Paging Channel Congestion/ RRC	≤1%	On average basis over a period of one month

	Congestion		
	(c) Traffic Channel congestion i.e. TCH, RAB, E-RAB, EN-DC (E-UTRAN New Radio Dual Connectivity for NSA to access 4G and 5G both networks at same time) or DRB (Data Radio Bearer for SA) Congestion	≤2%	On average basis over a period of one month
(iii)	**Voice Connection Maintenance (Retainability)**		
	(a) Network QoS DCR Spatial Distribution Measure for I. Circuit Switched (2G/3G) network [CS_QSD(92, 92)] II. Packet Switched (4G/5G and beyond) network [PS_QSD(96, 96)]	≤2% ≤2%	On percentile basis over a period of one month
	(b) Network QoS DCR Temporal Distribution Measure for I. Circuit Switched (2G/ 3G) network [CS_QTD(97, 90)] II. Packet Switched (4G/5G and beyond) network [PS_QTD(97,96)]	≤3% ≤3%	On percentile basis over a period of one month
	(c) Connections with good voice quality [Circuit Switched or Voice over LTE (VoLTE) or VoNR as applicable]	≥95%	On average basis over a period of one month
	(d) DL Packet Drop Rate for Packet Switched Network (4G/5G and beyond) [DLPDR_QSD(96, 96)]	≤2%	On percentile basis over a period of one month
	(e) UL Packet Drop Rate for Packet Switched Network (4G/5G and beyond) [ULPDR_QSD(96, 96)]	≤2%	On percentile basis over a period of one month
(iv)	**Messaging**: Successful SMS delivery within service provider's network in less than 20 seconds	≥95%	On average basis over a period of one month

B	**Customer Service Quality Parameters:**		
(v)	Metering and billing accuracy-post paid	≤0.1% Explanation: Not more than 1 complaint per 1000 customers i.e.	All Bills issued in the month

		0.1% complaints for bills issued should be raised	
(vi)	Metering and billing accuracy-pre-paid	≤0.1% Explanation: Not more than 1 complaint per 1000 customers i.e. 0.1% complaints for metering, charging, credit, and validity should be raised	One month
(vii)	Resolution of billing/ charging complaints within four weeks	100%	One month
(viii)	Application of credit/ waiver/ adjustment to customer's account within one week from the date of resolution of complaints	100%	One month
(ix)	Response Time to the customer for assistance		
	(a) Accessibility of call centre/ customer care	≥95%	One month
	(b)Percentage of calls answered by the operators (voice to voice) within ninety seconds	≥95%	One month
(x)	Termination/ closure of service within seven days	100%	One month
(xi)	Refund of deposits within 45 days after closures	100%	One month

(2) The compliance of the parameters specified in sub-regulation (1) shall be reported to the Authority by the service provider.

(3) The Authority may, from time to time, through audit and objective assessment of QoS conducted either by its own officers or employees or through an agency appointed by it, verify and assess the performance of the QoS parameters, specified in sub-regulation (1) for the access service (wireless).

7. Quality of Service parameter in respect of which compliance is to be monitored by the service provider and reported to the Authority.— (1) Every service provider providing access service (wireless) shall meet and monitor the benchmarks of the following QoS parameters, namely: −

Serial No.	Name of Parameter	Benchmark	Method and Assessment period
1	Registration of demand for wireless services in case services cannot be provided due to non-availability of wireless service	100%	One quarter
2	Service Coverage	(i) Signal strength at street level shall be as specified in TSTP for rollout obligation issued by the Central Government for respective technology (ii) Signal strength in-vehicle shall be up to 10dBm below the street level signal strength for respective technology (iii) Signal strength for indoor as per applicable standard or as per rollout obligation for respective technology	One quarter
3	Point of Interconnection (POI) Congestion for interconnection with circuit switched network(2G/3G) (on individual POI) at LSA level	≤0.5%	On average basis over one quarter
4	Point of Interconnection (POI) performance for interconnection between packet switched networks(4G/5G) at LSA level	(i) Latency<30ms (ii) Jitter<20ms (iii) Packet loss<1%	On average basis over one quarter

(2) The service provider shall monitor the compliance of the parameters and its benchmarks specified under sub-regulation (1) and furnish online quarterly report to the Authority within thirty days of the end of each quarter.

(3) The service provider shall—

(a) measure the service coverage of the access service (wireless) through drive tests at periodic intervals and take remedial action to address problems related to network coverage including interference, call drop and voice quality revealed during such drive tests.

(b) maintain and make available such records as maintained as per clause (a) in specified format online to the Authority; and

(c) provide to the Authority or any agency or representative authorized by the Authority, on demand, for verification, the primary data for the records maintained as per clause (b) above.

(4) The Authority may, through drive tests of the access service (wireless) conducted either by its own officers or employees or through an agency appointed by it or through joint drive tests with the service provider, assess the quality of the service coverage, and the service provider shall facilitate such drive tests.

(5) The service provider shall, *suo-moto*, take all remedial action to rectify shortcomings or deficiencies, if any, detected during the joint drive tests involving service providers without waiting for any communication from the Authority and submit to the Authority—

(a) its action plan, within thirty days of such drive tests, for remedying the shortcomings or deficiencies; and

(b) its final compliance report within such time limit as indicated in the action plan or such reduced time limit as may be indicated by the Authority in response to the action plan of the service provider referred to in clause (a), as the case may be.

(6) In respect of a drive test conducted by the Authority under sub-regulation (4) either by its own officers or employees or through an agency appointed by it, the service provider shall submit to the Authority—

(a) its action plan for removal of the shortcomings or deficiencies, within thirty days of receipt by it of the communication from the Authority about such shortcomings or deficiencies; and

(b) its final compliance report within such time limit as indicated in the action plan or such reduced time limit as may be indicated by the Authority in response to the action plan of the service provider referred to in clause (a), as the case may be.

(7) The Authority may, if it considers it expedient so to do, and to ensure compliance of the provisions of sub-regulation (1), at any time,-

(a) direct any of its officers or employees or an agency appointed by the Authority to inspect the records maintained under sub-regulation (3); or,

(b) get the records maintained under sub-regulation (3) audited.

8. Duration of alert for the called party.—: (1) The time duration of alert for an incoming voice call, which is neither answered nor rejected by the called party, shall be thirty seconds for access service (wireless).

(2) The terminating network shall, on expiry of thirty seconds in case of access service (wireless), release the incoming voice call and transmit the call release message to the originating network:

Provided that the originating network may release an unanswered call after ninety seconds in case the call release message is not received from the terminating network.

SECTION IV

QUALITY OF SERVICE (QoS) PARAMETERS FOR BROADBAND SERVICE (WIRELINE AND WIRELESS)

9. Quality of Service Parameters for which compliance reports are to be submitted to the Authority.— (1) Every Service Provider having Internet Service Authorisation and providing broadband service shall meet the benchmarks for the following QoS parameters, namely:—

Serial Number	Name of the Parameter	Benchmark (Wireless)	Benchmark (Wireline)	Method and Assessment period
1	Latency	<100 ms (in 4G and 5G network)	<50ms	On average basis over a period of one month
2	Jitter	≤50ms (in 4G and 5G network)	≤40	On average basis over a period of one month
3	PDP context activation success rate for wireless data service	≥95%	-	On average basis over a period of one month
4	Packet drop rate	≤2%	≤1%	On average basis over a period of one month
5	Minimum download and upload speed against the minimum subscribed speed in offered data plans	>80% of the minimum speed	100% of the minimum speed	On average basis over a period of one month

(2) The compliance of the parameters specified in sub-regulation (1) shall be reported to the Authority by the service provider providing broadband service (wireless).

(3) The compliance of the parameters specified in sub-regulation (1) of regulation 3 and sub-regulation (1) of regulation 9 shall be reported to the Authority by all the service providers providing broadband service (wireline).

Explanation: For the purposes of this regulation, 'wireline' shall include all fixed wireless and wireline medium including copper, fibre, cables etc.

(4) The Authority may, from time to time, through audit and objective assessment of QoS conducted either by its own officers or employees or through an agency appointed by it, verify, and assess the performance of the QoS parameters, specified in sub-regulation (1).

(5) Every service provider shall, in all its Internet service plans, indicate the minimum download and upload speed available to the consumers.

10. Quality of Service parameters in respect of which compliance is to be monitored by the service provider and reported to the Authority. -(1) Every service provider having Internet Service Authorisation and providing broadband service shall meet and monitor the benchmark of following QoS parameters, namely:-

Serial Number	**Name of Parameter**	**Benchmark (Wireless)**	**Benchmark (Wireline)**	**Averaged/ measured over a period**
(i)	Registration of demand for new wireline broadband connection irrespective of technical feasibility	-	100%	One month
(ii)	Successful packet data transmission download attempts	>80%	>95%	One month
(iii)	Successful packet data transmission upload attempts	>75%	>90%	One month
(iv)	Maximum Bandwidth utilization of any Customer serving node to ISP Gateway Node [Intra-network] or Internet Exchange Point Link(s)	<80% link(s)/route bandwidth utilization during peak hours (TCBH)		One month

(2) The service provider shall monitor the compliance of the parameters and its benchmarks specified under sub-regulation (1) and furnish quarterly report to the Authority within thirty days of the end of each quarter.

(3) The Authority may, from time to time, through audit and objective assessment of QoS conducted either by its own officers or employees or through an agency appointed by it, verify and assess the performance of the QoS parameters specified in sub-regulation (1).

(4) The service provider shall maintain records of its compliance of the benchmark of each QoS parameter for the Broadband service specified in sub-regulation (1).

(5) The Authority may, if it considers it expedient so to do, and to ensure compliance of the provisions of sub-regulation (1), at any time,–

(a) direct any of its officers or employees or an agency appointed by the Authority to inspect the records maintained under sub-regulation (4); or,

(b) get the records maintained under sub-regulation (4) audited

SECTION V

CUSTOMER PERCEPTION OF QUALITY OF SERVICE

11. Quality of Service parameters for customer perception of service.— The performance of the service providers in respect of benchmarks of each of the following QoS parameters for the access service (wireline), access service (wireless), Broadband service (Wireline) or Broadband Service (Wireless), as the case may be, shall be subject to periodic assessment by the Authority through customer satisfaction surveys, which may be conducted by the Authority either through its own officers or employees or through any agency appointed by it, namely :—

Serial Number	Name of the Parameter	Benchmark
(a)	customers satisfied with the provision of service	≥90 %
(b)	customers satisfied with the billing performance	≥95 %
(c)	customers satisfied with network performance, reliability and availability	≥95 %
(d)	customers satisfied with maintainability	≥95 %
(e)	customers satisfied with supplementary and value added services	≥90 %
(f)	customers satisfied with help services including customer grievance redressal	≥90 %
(g)	customers satisfied with overall service quality	≥90 %

SECTION VI

RECORD KEEPING, REPORTING AND PUBLICATION OF QUALITY OF SERVICE PERFORMANCE

12. Record Keeping.— (1) The service provider shall maintain documented process of online collection and processing of data for each QoS parameter specified by the Authority under regulation 3, regulation 4, regulation 6, regulation 7, regulation 9 and regulation 10, as applicable, and submit to the Authority, within sixty days of notification of these regulations, the documented online process of collection and processing of data of each QoS parameter, indicating the correlation with the primary data which are derived from system counters or codes in Operation and Maintenance Centre or Network Management System or Mobile Switching Centre or telephone exchange, along with any aggregation, transformation or computations applied including record keeping procedure.

(2) Every service provider shall maintain and provide online access of complete and accurate records of primary and processed data relating to the compliance of benchmark of each QoS parameters specified in regulations

3, regulation 4, regulation 6, regulation 7, regulation 9 and regulation 10, as applicable, in such manner and in such formats as may be directed by the Authority, from time to time.

(3) The Authority may, from time to time, either by order or by direction, specify record keeping procedures and formats, including guidelines on measurement methodology, deployment of test probes with related infrastructure and publishing the performance of the service provider on its website for various QoS parameters specified in these regulations, to be followed by the service providers.

(4) The Authority may, if it considers it expedient so to do, and to ensure compliance of the provisions of sub-regulations (2) and (3), at any time, direct any of its officers or employees or an agency appointed by the Authority to inspect the records maintained under sub-regulations (2) and (3) or require the concerned service provider to get such records and system audited through an agency as may be specified by the Authority and submit the report in respect of such audit to the Authority and the cost of such audit shall be borne by the concerned service provider.

13. Reporting.— (1)Every service provider shall create secure online system within six months of notification of these regulations for collection of primary data, its processing, generation and submission of online compliance reports to the Authority with online access of required supporting primary data in respect of each QoS parameters specified under regulation 3 , regulation 4, regulation 6, regulation 7, regulation 9 and regulation 10 in such manner and format, at such periodic intervals and within such time limit as may be specified by the Authority, from time to time, by an order or direction.

(2) The benchmark of each QoS parameters specified in sub-regulation (1) shall be measured, reported, and complied at State or Union Territory (UT) and

License Service Area level, as may be specified by order or direction issued by the Authority time to time:

Provided that the Authority may notify list of districts and QoS parameters for measurement, reporting and compliance of QoS benchmarks based on identification of areas experiencing degraded QoS.

14. Publication.— (1) The Authority may publish, in such manner and in such format, as may be decided by the Authority from time to time—

(a) the compliance reports of benchmarks of each QoS parameters reported to it by the service providers in accordance with regulation 13;

(b) the results of the audit and objective assessment of QoS undertaken by the Authority or its authorised agency as per sub-regulation (3) of regulation 3, sub-regulation (3) of regulation 6, sub-regulation (3) of regulation 9 and sub-regulations (4) of regulation 12; and

(c) the results of the customer satisfaction surveys undertaken by the Authority as per regulation 11;

through its website or through press releases or through advertisements in the newspapers, for the information of the general public.

(2) Every service provider shall publish, for the information of the consumers, its performance with respect to the benchmark of QoS parameters specified in regulation 3, regulation 4, regulation 6, regulation 7, regulation 9 and regulation 10, as applicable, in such manner and in such format, as may be directed by the Authority from time to time.

(3) Every service provider providing access service (wireless) shall publish on its website the geospatial service coverage maps indicating the street level and indoor coverage, as applicable, in cities and towns, highways, rail routes where voice or broadband data services are available.

SECTION VII
CONSEQUENCES FOR FAILURE TO COMPLY WITH THE REGULATIONS

15. Consequences for the failure of service providers to meet the benchmark of Quality of Service parameters.- (1) If a service provider fails to meet the benchmark of QoS parameters specified under sub-regulation (1) of regulation 3 or sub-regulation (1) of regulation 6 or sub-regulation (1) of regulation 9, it shall, without prejudice to the terms and conditions of its licence, or the Act or rules or regulations or orders made, or directions issued, thereunder, be liable to pay an amount, by way of financial disincentive, not exceeding rupees one lakh per benchmark for the first contravention as the Authority may, by order, direct:

Provided that if the service provider fails to meet the benchmark of the same parameter consecutively in two or more subsequent months, he shall be liable to pay, by way of financial disincentives, an amount not exceeding rupees one lakh fifty thousand for the second consecutive contravention and not exceeding rupees three lakhs for each consecutive contravention occurring thereafter:

Provided further that no order for payment of any amount by way of financial disincentive shall be made by the Authority unless the service provider has been given a reasonable opportunity of representing against the contravention of the regulation observed by the Authority.

Explanation: If a service provider providing both access service (wireline) and broadband service (wireline) fails to meet the benchmark of the same QoS parameters specified under sub-regulation (1) of regulation 3 for both the services, it shall be liable to pay the financial disincentive, as specified in this regulation, for each service separately.

(2) If the compliance report furnished by the service provider under sub-regulations (2) of regulation 3 or sub-regulations (2) of regulation 6 or sub-regulations (2) and (3) of regulation 9 is false and which the service provider knows or believes to be false or does not believe to be true, it shall, without prejudice to the terms and conditions of its license, or the Act or rules or regulations or orders made, or, directions issued thereunder, be liable to pay an amount, by way of financial disincentive, not exceeding rupees ten lakh per benchmark for which such false report has been furnished, as the Authority may, by order, direct:

Provided that no order for payment of any amount by way of financial disincentive shall be made by the Authority unless the service provider has been given a reasonable opportunity of representing against the contravention of the regulation observed by the Authority.

(3) The amount payable by way of financial disincentive under these regulations shall be remitted to such head of account as may be specified by the Authority.

16. Consequences for failure of the service providers to submit compliance reports.-(1) If a service provider contravenes the provisions of regulation 13, it shall, without prejudice to the terms and conditions of its licence, or the provisions of the Act or rules or regulations or orders made, or, directions issued, thereunder, be liable to pay an amount, by way of financial disincentive, not exceeding rupees twenty five thousand per report for every day during which the default continues, subject to the maximum amount of rupees seven lakh fifty thousand, as the Authority may, by order, direct:

Provided that no order for payment of any amount by way of financial disincentive shall be made by the Authority unless the service provider has been given a reasonable opportunity of representing against the contravention of the regulation observed by the Authority.

(2) The amount payable by way of financial disincentive under these regulations shall be remitted to such head of account as may be specified by the Authority.

17. Consequences for the failure of the service providers to pay financial disincentive within the stipulated time.-(1) If a service provider fails to make payment of financial disincentive under regulation 15 or regulation 16 within the stipulated period, it shall be liable to pay interest at a rate which will be 2% above the one year Marginal Cost of Lending Rate (MCLR) of State Bank of India existing as on the beginning of the Financial Year (namely 1st April) in which last day of the stipulated period falls. The interest shall be compounded annually.

Explanation: For the purposes of this regulation, a part of the month shall be reckoned as a full month for the purpose of calculation of interest and a month shall be reckoned as an English calendar month.

SECTION VIII

MISCELLANEOUS

18. Review. —(1) The QoS parameters specified in regulation 3, regulation 4, regulation 6, regulation 7, regulation 9, regulation 10, regulation 11, regulation 15 and regulation 16 may be reviewed by the Authority from time to time.

(2) The Authority, on reference from any affected party for good and sufficient reasons, may review and modify these regulations.

19. Repeal and Saving.— (1) The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009 (7 of 2009) and the Standards of Quality of Service for Wireless Data Services Regulations, 2012 (26 of 2012), Quality of Service of Broadband Service Regulations 2006 (11 of 2006) and the directions issued thereunder are hereby repealed.

(2) Notwithstanding such repeal, anything done, or any action taken under the said regulations shall be deemed to have been done or taken under the corresponding provisions of these regulations.

20. **Interpretation.—** (1) In case of any doubt regarding interpretation of any of the provisions of these regulations, the clarification of the Authority shall be final and binding.

(Secretary)

Note. The Explanatory Memorandum explains the objects and reasons including measurement methodology for various Quality of Service parameters of "*The Standards of Quality of Service of Access Service (Wireline and Wireless) and Broadband Service (Wireline and Wireless) Regulations, 2023*".

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Chapter 4: Summary of Key Revisions Proposed in Draft Regulation

1. The QoS is an important consideration for both customers (business or individual) and service providers. With rapid evolution of technology in the telecom sector, the measurement of QoS and QoE is becoming more and more complex especially in wireless networks. Further, as telecom networks work in tandem at national as well as at global level, it becomes more complex to deliver QoS with expected level of user experience. Therefore, to deliver end-to-end QoS, it is essential to enforce minimum level of QoS standards in each network segment i.e., in access segment, core segment and in transport (national long distance and international long distance) segment.

2. To ensure telecom networks deliver desired QoS for different services, it is important to monitor and measure QoS in each network segment so that networks are professionally designed and of satisfactory quality. To deliver QoE expected by consumers, it is essential that QoS is ingrained in each network layer of every network segment.

   For example, 5G networks support guaranteed bit rate (GBR) and non-GBR features to service different types of applications with varying requirement of latency and throughput. A QoS Flow ID (QFI) is used to identify the priority of traffic in the 5G systems. To deliver end-to-end QoS supported by 5G network, the transport networks should also be designed and configured for similar or matching prioritization failing which desired QoE cannot be achieved. Thus, the network is to be planned, designed, implemented, and configured to deliver QoS as a design feature. Therefore, the service providers are required to take holistic view of QoS across network segments to realize the full potential of their network and possible return on their investment.

3. QoS is important for consumers and is part of consumer protection. Therefore, the customers should have access to QoS information in a clear, transparent, and appropriate manner.

4. The draft regulation has been proposed considering the need and scope for improvement in consumer experienced QoS, impact of induction of new technologies in telecom networks, policy reforms undertaken by the Government and the requirement of present and emerging use cases and applications. The summary of important provisions applicable for all services is given in following paras. The service specific revisions are covered in subsequent sections of this chapter.

    a. **Reduction in number of Regulations and compliance burden**: With the objective of reducing compliance burden on service providers and enable ease of doing business, the draft regulation proposes to merge three existing regulations namely (i) '*Quality of Service of Broadband Service Regulations 2006 (11 of 2006)*' (ii) '*The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009 (7 of 2009)*' and (iii) '*The Standards of Quality of Service for Wireless Data Services Regulations, 2012 (26 of 2012)'*. The single regulation will reduce reporting and compliance requirement while eliminating duplication across regulations.

    b. **Framework for online reporting to reduce compliance burden and ensuring transparency:** Presently, some service providers compile their QoS performance monitoring reports manually while other have their centralized system for PMR data collection and report generation. Such manual process may result in delayed reporting and possibility of manual errors. The draft regulation provides for online reporting by the service providers through their QoS monitoring and management system. The service providers will update their QoS performance data collection and PMR reporting systems accordingly to generate PMRs under the regulation and

submit /push PMRs online to the Authority and also provide role-based access to download the supporting data. This step will reduce the efforts at the end of service provider considerably and bring transparency in QoS measurement and reporting. With the implementation of online reporting framework, the PMR audit process will also get simpler and result in further reduction of compliance burden. The service provider shall also provide interfaces/ Application Programming Interfaces (APIs) to enable seamless exchange of data with TRAI's proposed central QoS performance reporting platform.

c. **Monthly periodicity of QoS performance compliance reporting**: As explained in Chapter-2, the issues related to QoS may not get adequately reflected in the quarterly PMRs due to long QoS performance assessment periods of over a quarter. Further, quarterly reporting may also result in degraded QoS in certain areas for long duration which gets compensated with better QoS performance in other areas. Therefore, the draft regulation proposes monthly frequency of PMR to overcome the effect of averaging over large period. With the adoption of online reporting framework proposed under draft regulation, the service providers will be able to submit the PMRs without any additional compliance burden.

d. **QoS performance monitoring and reporting at State/UT and LSA level:** Averaging over a large LSA, especially consisting of more than one State or Union Territory, is another reason due to which QoS performance in some states or districts get averaged out with somewhat better performance in other States under present QoS framework. This averaging effect may result in continuous poor QoS in certain districts or States despite the service provider meeting prescribed benchmarks at LSA level. To enable granular insight of QoS being delivered by the service providers, the draft regulation proposes monitoring of performance at LSA and State/UT level.

Further, the Authority may also monitor QoS performance at district level in case poor QoS performance is observed in any State or UT.

e. **Graded application of financial disincentives (FDs)**: There are separate provisions of FD in present regulations and for different services. The summary of existing provisions may be seen in section-9 of Chapter-5. While the FD amount in case of Basic Telephone Services (Wireline) is applicable at flat rate of rupees fifty thousand per parameter, the FD is at graded rates, starting with rupees one lakh per parameter up to five lakh per parameter, for Cellular Mobile Telephone (Wireless) services. The FD in case of Broadband (Wireline) services is also graded form *not exceeding rupees fifty thousand* per parameter. In case of second or subsequent such contravention applicable FD is *not exceeding rupees one lakh per parameter which remains rupees one lakh after any one contravention*. Currently, no FD is applicable for Wireless Broadband services despite Wireless Broadband having more than 97 percent share in overall broadband subscriber base. These FD rates were specified in year 2012.

The draft regulation proposes graded rate of FD for all services to minimize complexity in its application. It has also been observed that many a times, the FD amount is not paid in time by the service providers which defeats the purpose of FD provision in the regulation. Further, unrecovered FD amount also attracts adverse audit observations and the same requires remedial action. Accordingly, any delay in payment of FD beyond the stipulated period shall attract interest on FD amount. Further details may be seen in section-9 of Chapter-5. FD shall be applicable for the specified monthly periodicity of reporting of QoS performance compliance.

f. **Registration of demand for wireline and wireless services for technically non-feasible areas or pockets:** One of the 'Strategic

Objectives' envisaged in the National Digital Communications Policy, 2018 is to accomplish *'Provisioning of Broadband for All'*. It is important to identify and record the demand for wireless and wireline services in different areas of the country to accomplish this objective. The visible demand for telecom service is an important input to service providers in planning their network expansion and capital investment. Further, the aggregated data related to potential demand for telecom services or waiting lists in different geographical areas will also enable the government and regulator to evaluate the requirement of policy measures, if any. Towards this objective, the draft regulation requires that the service providers will register demands for wireless and wireline services in any area which is technically non-feasible.

g. **Refund of deposit after closure of service**: The refund of all deposits is to be made within 45 days in 100% of the cases, in place of 60 days under present regulations. This revision is proposed considering the digitization of subscriber records, availability of digital channels for financial transactions and implementation of centralized billing and metering systems by the service providers.

5. **Access Service (Wireline):** The QoS parameters for wireline services are proposed to be retained in line with present regulations except for following important revisions.
    a. Fault incidence i.e., number of faults per 100 subscribers are proposed to be revised from <=7 to <=5 considering the centralized monitoring and management of faults and RoW reforms undertaken by the Government.
    b. Resolution of billing/ charging complaints is to be completed 100% within six weeks. Presently, there are two benchmarks of 98% resolution in 4 weeks and 100% resolution in 6 weeks. This will simplify the compliance and monitoring at the end of service provider.

6. **Access Service (Wireless):** This section summarizes important provisions of the draft regulation for access services delivered through wireless medium.

    a. **Mobile network geospatial coverage map on service provider's website**: The access to publicly available QoS information in a clear, transparent, and appropriate manner is an important aspect of consumer empowerment for making informed choices. Globally, many countries have made available geospatial mobile and fixed line service coverage maps to consumers. Federal Communications Commission (FCC), USA has mapped[2] telecom infrastructure including fixed and mobile coverage even at the household and business area level. Service providers in USA have published their network coverage maps on their websites[3]. Similarly, the regulator in France[4] has made the geospatial service coverage maps available to the consumers on a website on which key QoS performance parameters are also published periodically.

    Accordingly in line with global trend and empower consumers, a new parameter i.e., *'% of commissioned cells for which geospatial service coverage map is available on service provider's website*' has been introduced in the draft regulation. The availability of a service coverage map will also provide broader boundaries for QoS expectations by the consumers. The service providers are free to use physical or virtual drive tests or crowdsourcing methods for the generation and on-going updating of geospatial coverage maps.

    The mobile network coverage maps are not only useful for consumers but also will provide status of telecom coverage across the country. This will enable evidence-based evaluation of requirement of any regulatory or policy intervention. Therefore, the

[2] https://broadbandmap.fcc.gov/home
[3] https://www.t-mobile.com/coverage/coverage-map
[4] monreseaumobile.arcep.fr

service providers will also enable integration of their maps with TRAI central platform as and when required.

b. **Incorporation of performance benchmarks for 5G services**: 5G networks support three broad service categories i.e. Enhanced Mobile Broadband (eMBB), Ultra Low Latency Communication (uLLC) and Massive Machine Type Communication (mMTC). Present 5G networks, being rolled out by service providers in the country, supports eMBB which can deliver voice and wireless broadband services. The performance parameters in QoS regulations are mostly technology agnostic. However, 5G specific terminology has been updated in the proposed draft of regulation against relevant parameters. The uLCC and mMTC use cases are still evolving in India and globally. The question on QoS benchmarks for these services has been included in Chapter-7 of the consultation paper.

c. **Availability of the network**: Network availability is an essential requirement of QoS. Poor network availability not only impacts the QoS directly served areas by non-available cell(s) but also affects the performance of nearby cells due to overloading and may result in network coverage holes and call drops. Therefore, the benchmark against the downtime is proposed to be revised at cell level in place of BTS level to have a more granular view of availability. Further, the benchmark is proposed to be revised to <=1% from <=2%. Similar revision is proposed in other parameter i.e. 'Worst affected Cells due to downtime (Cells not available for service for more than cumulative 24 hrs. in a month)'.

d. **Reporting of significant network outages**: The quality of telecom service is closely related to the availability of network. The wireless network outage (i.e., when the network is not available for service to subscribers) significantly affects the QoS parameters under 'Connection Establishment' and 'Connection Maintenance'. At present there is no parameter to capture details of such network

outages which affect large number of consumers across wider area like district or State. TRAI comes to know about such network outages through the media reports or when the complaints are received. Therefore, a new parameter has been introduced under '**Network Availability**'. The Authority has already issued the direction in this regard on 28.03.2023 to report such outages. 'Reporting of significant network outage to the Authority within 24 hrs. of start of the outage (Services not available in a district or State for more than 4 hours)' is being introduced. Like the provision of rent rebate in case of wireline services, for significant mobile network outages of more than 24 hrs., proportional rent rebate as per plan charges for affected number of days shall be credited in next bill for post-paid consumers registered in the district. In the case of pre-paid consumers registered in the district, the validity of their pre-paid accounts, as on outages start date, shall be increased by equal number of days.

e. **Separate drop call rate (DCR) benchmarks for circuit switched (2G/3G) and packet based (4G/5G) networks:** Two parameters i.e. (a) Network QoS DCR Spatial Distribution Measure [Network_Q_{SD} (90,90)] with benchmark ≤2%. and (b) Network QoS DCR Temporal Distribution Measure [Network_Q_{TD} (97,90)]≤3% are prescribed for measurement of drop call rate (DCR) in present regulations. Upon detailed analysis of DCR data received from service providers, it has been observed that the impact of averaging effect is still dominant due to which the problem of call drops is not getting reflected with current parameter and benchmarks. It is also observed that 10% of worst cells and 10% worst days of each cell in Network_Q_{SD} (90,90) parameter are getting excluded for calculation of the benchmark for DCR. Therefore, it is proposed to reduce percentage of days and cells which shall be excluded from the DCR dataset for measurement of performance against the DCR. However, the Authority is cognizant of the fact that same DCR performance benchmarks should not be

applied for Circuit Switched (CS) networks (2G/3G) as those applicable for latest technology Packet Switched (PS) networks as the underlying technologies are quite different. Similar is the case for temporal distribution parameter of DCR i.e. Network_Q_{TD} (97,90) which envisages that at least 90% of days, at least 97% of the cells have to achieve DCR equal to or better than 3% DCR value. In this case, 10% of the worst days are getting excluded which may reflect degraded QoS being experienced by the consumers. Therefore, the draft regulation proposes following set of parameters for CS and PS networks separately. There is no change in benchmarks against both parameters except the exclusion of days and cells for the calculation of performance against the benchmark.

(i) Network_Q_{SD}(%cells,%days)<=2%
   a) Circuit Switched (2G/3G) network [CS_Q_{SD}(92, 92)]
   b) Packet Switched (4G/5G and beyond) network [PS_Q_{SD}(96, 96)]

(ii) Network_Q_{TD}(%cells,%days)<=3%
   a) Circuit Switched (2G/ 3G) network [CS_Q_{TD}(97, 90)]
   b) II. Packet Switched (4G/5G and beyond) network [PS_Q_{TD}(97,96)]

f. **Issue of call muting and call muffling in packet switched networks (LTE/5G)**: Parameters DL Packet Drop Rate (DL-PDR) and UL Packet Drop Rate(UL-PDR) were introduced by the Authority vide Sixth Amendment dated 31st July,2018, primarily to address the issue of call muting or voice muffling in VoLTE network. The present benchmarks specify it to be less than or equal to 2% on the average basis in a quarter. Though all the service providers are meeting the benchmarks against this parameter, the issues related to call muting and voice muffling, especially in LTE and 5G networks, are frequently encountered by the consumers. There might be cells or groups of cells in different geographic pockets in the network with

poor packet drop rate, but their poor performance does not get reflected in present benchmarks due to averaging effect over large data set. To overcome this limitation and to have granular view of call muting and call muffling issues in LTE and 5G networks i.e., IP-based voice networks, it is proposed that the UP-PDR and DL-PDR need to be monitored on similar lines as that of Q_{SD} parameter in case of Drop Call Rate. This parameter is only applicable for packet switched networks. The benchmark for ULPDR and DLPDR will be $Q_{SD}(96, 96)$ i.e 96% of the cells should have packet drop rate in uplink and downlink <2% for 96% of the days.

g. **Performance parameter and benchmark for timely delivery of SMSs**: Short Messaging Service (SMS) provides a secure and reliable channel of messaging to the users of mobile services without the use of the internet. Though the adoption of smartphones with internet subscription is increasing in India, which enables messaging over internet, however, there are significant number of feature phone users who are only dependent upon SMS as far as messaging use case is concerned. Further, many of the online applications including banking, e-commerce, e-Office, public service delivery etc., are using SMS for authentication or as an additional factor of authentication or verification. In case of delay in SMS delivery, such authentication or verification attempts may fail which may result in failed transaction and inconvenience to consumers.

Therefore, the draft regulation proposes a new QoS performance parameter for SMS delivery except for promotional commercial messages. Considering the global benchmarks and the fact that there may be need for retries for SMS delivery in case the subscriber is not in coverage area, or their phone is switched off etc., the proposed benchmark is that 95% of the SMS should be delivered within 20 seconds in the service provider's network.

7. **Broadband services (Wireline and Wireless)**: This section summarizes important provisions of the draft regulation regarding broadband services.

    a. **Single Regulation with different benchmarks for Wireless and Wireline Broadband**: Presently, QoS requirements for Broadband services are governed by two separate regulations i.e., *'Standards of Quality of Service for Wireless Data Services Regulations, 2012*' and *'Quality of Service of Broadband Service Regulations 2006' (11 of 2006) as amended from time to time*. The QoS parameters and measurement methodology for broadband services, whether Wireline or Wireless Broadband, remains the same and the difference only lies in the last mile access technology or medium. Therefore, to simplify the QoS standards for broadband services, the Authority has proposed merging of two separate regulations with different benchmarks in order to reduce the compliance burden on service providers. The separate benchmarks have been specified for Wireless and Wireline service for some technology specific parameters.

    b. **Reduction in number of parameters in QoS Standard**: The draft regulation proposes to keep only important parameters like latency, jitter, packet drop rate and minimum download and upload speed against the minimum subscribed speed in offered data plans. Other parameters like uplink bandwidth utilization in wireline broadband and successful data transmission download and upload attempts in case of wireless broadband services have been removed from the list of compliance. However, these parameters will continue to be monitored by the service providers.

    a. **Alignment of Measurement Methodology with ITU-T Recommendation Y1545.1**: The measurement set up of benchmarks against QoS parameters for broadband services is proposed to be aligned with the ITU-T Recommendation Y1545.1 to reflect user experienced performance of service provider's network. The present measurement methodology under '*Standards of Quality*

of Service for Wireless Data Services Regulations, 2012' states that "*To assess the quality of the connection between an end user and an Internet Service Provider (ISP), ideally the Test-Server should be placed as near as possible to the gateway providing the interconnection between access network and ISP network. The location of the test-server as near as possible to the gateway providing the interconnection between access network and ISP network implies that the measurements will not reflect the influence in the QoS of the ISP network, between that gateway and the gateway interconnecting with the Internet.*" Thus, in the present measurement setup, the QoS performance between access network and internet exchange points gets excluded which may not reflect true QoS performance as envisaged in ITU-T Recommendation Y1545.1.

b. **Revision of Latency Performance**: The LTE and 5G networks support low latency for mobile broadband services of less than 50 milliseconds (ms). Factoring the revision in measurement methodology, the QoS benchmark for latency parameter has been proposed to be less than 100ms from the present 250 ms which was prescribed in year 2012 i.e., before the rollout of LTE networks in the country.

   For wireline services, the latency benchmark is proposed to be revised to less than 50 ms (from existing 120 ms) This is in line with the global benchmarks prescribed by different regulators and has also been referred to by DoT in communication dated 14.02.2023.

c. **Introduction of new parameter for Jitter**: Jitter is the variation in inter-packet arrival delay between source and destination. This parameter is important for delay-sensitive or real-time applications like video calls and high-quality video streaming and higher jitter in the network adversely affect the end user experience. This is often caused by network congestion, poor hardware performance and not

implementing packet prioritization. High value of jitter in the network may result in call muffling or even call drop in video or VoIP applications. This parameter is an essential benchmark for measurement of QoS performance in fixed and packet core wireless networks. This parameter has also been suggested by DoT.

Chapter 5: Measurement Methodology

1. Overview

1.1 Currently, there are three regulations i.e. (i) 'Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009 (7 of 2009)' (ii) 'Standards of Quality of Service for Wireless Data Services Regulations, 2012 (26 of 2012)' and (iii) 'Quality of Service of Broadband Service Regulations 2006' which cover QoS standards for voice and data services across wireless and wireline domain.

1.2 The above regulations also prescribe measurement methodologies, for the measurement of different benchmarks against the respective QoS parameters, to ensure that the QoS performance is measured uniformly by all the service providers.

1.3 Therefore, the measurement methodology, for parameters already applicable in present regulations, has been revised wherever applicable or retained as per present regulations. In the case of new parameters, the measurement methodology has been provided with relevant details. The following sections provide service and parameter-wise detailed measurement methodology including measurement process for benchmarks against the respective parameters provided under draft regulation in Chapter-3.

2. <u>Quality of Service Parameters for Access Service (Wireline)</u>

2.1 Provision of a telephone after registration and payment of demand:

2.1.1 As per the existing QoS Regulation, the telephone must be provided within 7 days in all areas where the telephone is available on demand, subject to technical feasibility.

2.1.2 Provision of telephone service after payment of demand note is an important aspect of QoS as the demand note is issued only after ascertaining the technical feasibility. Therefore, the Authority proposes to monitor the performance against this parameter. Accordingly, a new benchmark is

proposed under regulation 3(i) "***provisioning of telephone after payment of demand note by the applicant"***. The provisioning of new wireline connections shall be completed in 100% of cases within working 7 days of payment of the demand note by the applicant. The performance against this parameter shall be reported for all the registration against which demand notes have been paid during the month in the monthly performance reports.

2.2 Fault incidence (No. of faults/100 subscribers/month):

2.2.1 Measurement

Fault incidences – No. of faults/100 subscribers/month =

$$\frac{\text{Total number of faults reported in the month}}{\text{Total No. of wireline connections at the end of the month}} \times 100$$

Considering the streamlining of RoW permission framework and automation of fault monitoring and management processes, the benchmark for this parameter is revised to <=5% from existing <=7%.

2.3 Fault Repair:

2.3.1 Authority has decided to continue with the existing benchmark for the parameter. However, force majeure incidences could be excluded for calculation purposes. Regarding fault repair in rural and hilly areas, the Authority appreciates that in such areas fault repair could take more time due to the topology of the area and other constraints. Considering these, the Authority has already prescribed separate parameters and benchmarks for rural and hilly areas. However, the rent rebate will continue to be uniform for urban and rural/ hilly areas. In the parameter "fault repair by next working day", only those complaints, which have been registered till the close of the business hours of that day, will be considered. Complaints registered after business hours will be taken as being registered in the next day's business hours. However, for the faults which remain unresolved for more than 15

days, the rent rebate for one month or entire duration till the resolution of the fault, whichever is higher, must be provided.

2.4 Mean Time to Repair (MTTR): The existing benchmark for this parameter i.e., <=10 Hrs. shall continue. However, force majeure events could be excluded for calculation purposes.

2.4.1 **Measurement**

$$\text{MTTR} = \frac{\text{Sum of duration of each repair time in hours for all the fault incidences in the month}}{\text{Total number of fault incidences in the month}}$$

2.4.2 For counting the duration of repair time only working hours shall be counted. The duration shall be from the time of the complaint till the time of repair of the fault, excluding non-working hours. Thus, only the actual working hours from the time of lodging of the complaint to the time of rectification of the fault shall be taken for computation of performance. For example, in case a fault is reported at 3.30 PM on Monday, a working day, and if the fault is rectified at 12.30 PM on Tuesday the duration for repair will be 7 hours, where working hours 8 AM to 6 PM is followed.

2.5 Metering and billing accuracy-postpaid:

2.5.1 The existing benchmark for the parameter Metering and Billing Credibility – Post-paid billing shall continue. The types of billing complaints to include could be but are not limited to: —

(a) payment made and not credited to the subscriber account.

(b) payment made on time, but late payment charges levied wrongly.

(c) double charges.

(d) charging for toll-free services.

(e) local call charges billed as STD/ISD or vice versa.

(f) calls or messages made disputed.

(g) validity-related complaint.

(h) credit agreed to be given in resolution of complaint but not accounted in the bill.

(i) charging for services provided without consent.

(j) charging not as per tariff plan or top-up vouchers/special packs etc.

(k) overcharging or undercharging.

In addition to the above, any billing complaint which leads to a billing error, waiver, refund, credit, or any adjustment shall also be included as a valid billing complaint for calculating the number of disputed bills.

2.5.2 The measurement of the parameter "Metering and Billing accuracy – post-paid" is to be done as per the following formula:

$$\text{Metering and Billing accuracy – post-paid} = \frac{\text{Total number of billing disputes received in the month irrespective of billing cycle}}{\text{Total number of bills issued during the month}} \times 100$$

2.6 Metering and billing accuracy-prepaid: The measurement of the parameter "Metering and Billing accuracy – prepaid" is to be done as per the following formula:

Metering and billing accuracy-prepaid

$$= \frac{\text{total number of complaints,relating to Charging, credit } \textit{validity etc., received during the month}}{\text{total number of pre–paid customers at the end of the month}} \times 100$$

2.7 Resolution of billing/charging complaints:

Presently, there are two benchmarks i.e., >=98% of the complaints are to be resolved within 4 weeks and 100% within six weeks. The timelines for these two benchmarks are very close to each other. Further,100% of complaints are to be resolved within six weeks. Therefore, the Authority proposes having only one benchmark i.e., 100% complaints are to be resolved within six weeks. The performance against this parameter is to be measured as per the following formula:

%age of billing complaints (for post-paid customers)/ charging credit & validity (for pre-paid customers) resolved within 6 weeks =

$$\frac{(\text{number of billing complaints for post} - \text{paid customers/charging, credit/validity complaints for pre} - \text{paid customers resolved within 6 weeks during the month})}{\text{number of billing/charging, credit / validity complaints received during the month}} \times 100$$

2.8 Period of all applying credit/ waiver/ adjustment to customer's account from the date of resolution of complaints.

The present benchmark shall continue which envisages that any credit/waiver/adjustment arising out of resolution of that complaint must be made to the post-paid or pre-paid customer's account within one week of resolution of the complaint with intimation to the customer. Further, in the case of a postpaid customer, the same shall also be reflected in the next bill to be issued to the customer.

2.9 Response to the Customer for Assistance

2.9.1 Accessibility of Call Centre/customer care i.e., % age of calls answered which means that the calls should get connected and answered. The present benchmark is a minimum of 95% of calls to be connected successfully and not more than 5% of calls shall encounter congestion or a busy signal or no reply or any other failure. Further, 95% of the calls should be answered by the call center executives within 90 seconds for voice-to-voice assistance.

2.9.2 The accessibility of call center numbers is significant from the perspective of consumer satisfaction and consumer experience. Though the service providers have launched mobile apps and web interfaces for customers, the consumer continues to face problems in registering their complaints due to complicated workflows. This fact is also supported by the fact that the number of calls at call centers has not reduced, and service providers are not able to meet current benchmarks in many cases even after the rollout of mobile apps. Further, there is a significant number of feature phones in the mobile network that cannot use mobile apps for the registration of complaints. Therefore, the Authority is not in favor of relaxing this

benchmark for the sub-parameter accessibility of call center numbers and %age of calls answered by operators (voice to voice). However, the service providers are encouraged to simplify the workflows for registration of complaints through their website and mobile apps so that the number of calls to call centers is reduced automatically.

2.9.3 Regarding computation of the performance against the parameter %age of calls answered by operators (voice to voice), the time taken for connecting to the operator shall be calculated from the time the customer has keyed the relevant number in the IVR option menu, if provided, for speaking to the customer care executive/operator. Further, the menu for speaking to the customer care executive/operator shall be given preference in the menu options and *this menu shall not be below the first sub-menu at the third layer, the first layer being the choice of language and the second layer the service menu.*

2.10 Termination/Closure of Service

The Authority has decided that the present benchmark shall continue. The time for closure shall not be more than 7 days, uniformly for all types of requests. This period would cover any effort to be made by the service provider for retention of the customer and recovery of customer premises equipment (CPE), in case such CPE is the property of the service provider. The service provider shall cease to charge rental or any other charges beyond the period of 7 days of the request for closure made by the customer. Further, bills shall be raised only after adjustment of the security deposit and the closure/ termination of service shall not be made conditional upon payment of dues. Also, the closure/ termination of service shall not be made conditional upon the payment of dues/bills/settlement of the dispute. In all cases the request of closure/ termination, the request is to be complied with within 7 days of such request from the customer.

2.11 Time taken for a refund of deposit after the closure of telephone/ termination of service:

There has been considerable digitization of consumer records and billing systems since the time the regulation was revised in 2009. As per the existing provisions regarding the refund of security deposit, a 100% refund of security deposit is to be made within 60 days, failing which 10% per annum interest is payable. However, the Authority decided to revise the existing benchmark and now refunds are to be made within 45 days after closure/ termination of service. Any delay in refund of deposits will attract an interest of @10% per annum. Here the deposit includes a security deposit and any other refundable deposit taken from the customer. The same benchmark shall also be followed for payment of any other dues payable to the customer at the time of closure/ termination of service. The Authority would also like to make it clear that the fact that interest is paid to the customer for the delay in payment of dues does not absolve the service provider from the responsibility of meeting the prescribed benchmark.

2.12 Registration of demand for wireline connections irrespective of technical feasibility

Registration of demands and maintenance of the waiting list for new wireline connections provide visibility to service providers in planning network expansion and capital investment based on the revenue potential. Further, the data related to potential demand for wireline services and waiting lists in different geographical areas also enable the government and regulator to evaluate the requirement of policy measures, if any. Therefore, the service providers are required to register all demands for wireline connections irrespective of feasibility status. The district-wise number of registered demands at the end of each quarter is required to be reported to the Authority.

2.13 Shift of Telephone Connection

The service provider shall monitor the performance against this parameter every quarter and report to the Authority. 90% of the shifting requests should be completed within 3 days of registration of requests subject to technical

feasibility. In case of non-shifting, the reasons for the same shall be recorded under broad categories.

2.14 Grade of Service

2.14.1 Grade of Service (GoS) is a design parameter of the telephone exchanges for trunk groups. Grade of service is used for planning of local and long-distance junction network or trunk bandwidth i.e., local exchange to local exchange/tandem and local network to TAX and vice-versa. Similarly, the defined parameters of GoS are used for expansion of the network and augmentation of specific circuit groups or bandwidth in IP-based networks. As per the live traffic measured in Erlang during time-consistent busy hour or during route busy hours and thereafter taking traffic projections, the service provider must augment/plan the number of trunk circuits or bandwidth on various traffic destination groups. While projecting the number of circuits for augmentation or IP bandwidth, the grade of service (GoS) as specified in quality-of-service regulations or license conditions is to be applied by the service providers. Traffic needs to be measured at each destination generally as per the route's busy hours and its augmentation periodically to meet the grade of service.

2.14.2 Grade of Service is prescribed for monitoring by the service provider and a summary of the observations is to be reported to the Authority. However, the service providers shall maintain complete records thereof. The measurement of this parameter shall be made during Time Consistent Busy Hours.

2.15 POI Congestion:

2.15.1 Presently there is a parameter on POI congestion for Cellular Mobile Telephone Service. Congestion at the POIs is due to inadequate interconnection commensurate with the outgoing traffic at the Point of Interconnection between two telecom networks. This is applicable both for Wireline as well as Wireless networks.

2.15.2 The present parameter for access services (wireline) with benchmark (≤ 0.5%) shall continue. Only performance affected due to force majeure conditions needs to be excluded for calculation purposes. The PoI congestion shall be calculated during Time Consistent Busy Hours and averaged over the quarter for the LSA.

3. <u>Quality of Service Parameters for Access Service (Wireless):</u>

3.1 The parameters prescribed in these regulations for Access Service (Wireless) shall be equally applicable to basic service (wireless).

A. Network Service Quality Parameters:

3.2 Network availability:

3.2.1 Percentage of commissioned cells for which geospatial service coverage map is available on the service provider's website.

The consumer expectations of QoS in any geographical area have a direct correlation with the easy and transparent availability of coverage information. Many countries have taken initiatives and made available geospatial service coverage maps to consumers. Federal Communications Commission (FCC), USA has mapped telecom infrastructure including fixed and mobile coverage even at the household and business area level. Service providers in USA have published their network coverage map on their website. Similarly, the regulator in France has also made the geospatial service coverage maps available to the consumers on the website on which the key QoS performance parameters are also published periodically. The service providers are responsible for providing and updating the coverage maps and related data. As per the '*Quality of Service Regulation Manual'* 2017 published by ITU-T, a similar initiative of mapping the fixed and mobile telecom network infrastructure and service coverage is also in progress in European Union member states.

Considering the global trends and providing the consumer the information about wireless service coverage in any given area of their interest, the Authority is of the considered opinion that the availability of geospatial service

coverage maps is an important requirement for the consumer's right of making informed choices. Accordingly, a new parameter i.e., **'% of commissioned cells for which geospatial service coverage map is available on service provider's website'** has been introduced. The service providers are already having the details of service coverage and geospatial mapping. These tools are being used for operation and maintenance including network planning and expansion. Now, with the introduction of this parameter, the service providers shall make the geospatial service coverage map available on their website for all commissioned cells showing coverage under different technologies i.e., 2G/3G/4G/5G as applicable. It will be possible to drill down the geospatial coverage map in an intuitive and user-friendly manner using different filters like technology, State, District, pin code, etc. These service coverage maps shall be updated on an ongoing basis and any change (addition/deletion of cells) shall be updated within 2 weeks of the implementation of the change. Each service provider shall also make required secure Application Programmable Interfaces (APIs) available to TRAI to be used by the central platform of TRAI for the presentation of a unified geospatial service coverage map at the pan-India level. As per the benchmark, the geospatial coverage maps for 100% of the commissioned cells (cells available for service to consumers) shall be available at the service provider's website for the respective State or UT. The availability of a service coverage map will also provide broader boundaries of QoS expectations for the consumers. The service providers are free to use physical or virtual drive tests for the generation and on-going updating of geospatial service coverage maps.

3.2.2. Accumulated downtime (cells not available for service) and Worst affected cells due to downtime: Two parameters i.e., "Base Station accumulated downtime (not available for service)" and "Percentage of worst affected Base Station due to downtime" are prescribed currently for network availability. The benchmark of ≤2%, for both the parameters, was prescribed in the year 2009 with the notification of regulation i.e. '*The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009'*. This means that the network should be

available for service for 98% of the time in a month. Vide Fifth Amendment dated 18th August 2017, the 'Assessment Period' in the benchmark was made quarterly in place of monthly.

3.2.3 The current benchmark of ≤2%, for both the parameters, were set in the year 2009. The BTS level network availability measurement does not reflect true status of network availability as BTS is considered 'available' even if its single cell is in service. Further, network availability-related issues not only impact the services directly covered by non-available cells but also affects the performance of nearby cells due to overloading and results in the degradation of QoS in the affected areas. Given technological advancement and increasing coverage of LTE and 5G network, the introduction of advanced O&M tools and network capabilities, improvement in power availability, and streamlining of the RoW process, present benchmarks are being revised from ≤2% to ≤1% for both the parameters.

3.2.4 Measurement Methodology

(a) "**Accumulated downtime (cells not available for service)"** shall measure the downtime of the Cells, including their transmission links/circuits during the period of a month. For measuring the performance against the benchmark for this parameter the down time of each Cell lasting for more than 1 hour at a time during the period of a month shall be taken for computation. The total duration in hours of all such instances of downtime of Cells shall be calculated. Thereafter, the performance against the benchmark shall be measured through the following formula:

Accumulated downtime (cells not available for service) =

$$\frac{\text{Sum of downtime of Cells in a month in hours}\\ \text{i. e. total outage time of all Cells in hours during a month}}{24 \times \text{No. of days in the month} \times \text{No. of Cells in the network of reporting area}} \times 100$$

(3) **Worst affected Cells due to downtime** (Cells not available for service for more than cumulative more than 24 hrs. in a month)- For measuring

this parameter, the downtime of each cell lasting for more than 1 hour at a time during the period of a month shall be recorded and wherever the accumulated downtime of a Cell, during the period of a month exceeds 24 hours, the said Cell shall be taken as worst affected Cell for computation. The total number of such worst-affected Cells in a month shall be determined. Thereafter, the performance against the benchmark shall be measured through the following formula:

$$\text{Worst affected Cells due to downtime} = \frac{\text{No. of Cells having 72ccumulated downtime of} > 24\ \textit{hours in the month} \times 100}{\text{Total No. of Cells in thereporting area}}$$

3.2.5 Further, for computation of performance against the benchmark for these two parameters, performance affected due to force majeure conditions shall be excluded for calculation purposes. All such exclusions with details of force majeure shall be provided with the respective PMR.

3.2.6 Reporting of significant network outages: Significant Network Outage (SNO) is a scenario when telecom service is not available in any district or State/UT or LSA for more than 4 hours due to any reason. For this benchmark, the 'Cells' physically located in the district shall be considered. All such SNOs shall be reported to the Authority within 24 Hrs. from the start of any such outage. After the resolution of an outage, the service provider shall update the root cause against the respective outage within 72 hrs. of fault resolution. The fault codes may be Natural Calamities/Long duration power outages/Fiber cuts/equipment faults/Others. In case any such significant network outage continues for more than 24 hours, the service provider shall provide a rent rebate to postpaid subscribers registered in the affected district and increase the validity of the active plan at the time of the start of the network outage for the equal number of days in case of pre-paid subscribers. The outage duration of more than 6 hours shall be considered equal to one full day for the calculation of rent rebate or extension of validity.

However, force majeure incidences could be excluded for calculation purposes.

3.3 Voice Connection Establishment (Accessibility)

3.3.1 For determining the accessibility there are three important parameters to be monitored, namely (a) Call Setup Success Rate (CSSR) (b) Standalone Dedicated Control Channel (SDCCH) congestion/ Paging Channel Congestion/Radio Resource Control congestion, and (c) Traffic Channel (TCH) congestion. These are discussed below:

3.3.2 Call Set-up Success Rate (CSSR): [*Call Set-up Success Rate for Circuit Switched Voice or Session Establishment Success Rate for VoLTE or DRB Accessibility success rate for VoNR, as applicable*]

(i) Call Setup Success Rate is defined as the ratio of Established Calls to Call Attempts. Established Calls mean the following events have happened in call setup:

a) Attempt is made.
b) The TCH is allocated.
c) The call is routed to the outwards path of the network.

Thus, this parameter includes complete signaling in the call setup process and does not aim to measure the performance of the called network or that of the Point of Interconnection (PoI).

(ii) Call Attempt is defined in the ITU –T E600 (03/93)/2.4 as "an attempt to achieve a connection to one or more devices attached to a telecommunication network". At a given point in the network, a call attempt is manifested by a single unsuccessful bid, or a successful bid and all subsequent activity related to the establishment of the connection.

(iii) The corresponding terms used in 5G technology for Stand Alone Mode (SA) network i.e., DRB Accessibility success rate for VoNR have also been added to the parameter. For 5G Non-Stand Alone (NSA) mode scenario, the corresponding parameter for LTE network shall be applicable.

(iv) Upon the analysis of the PMRs of the period ending June 2022, September 2022, and December 2022, it is observed that all the service providers are having much better performance than the current benchmark. In most cases, the benchmark of 98% CSSR has been achieved by the service providers. The reason for such a significant improvement in performance may be attributed to the induction of the latest technologies and the adoption of O&M best practices by the service providers. CSSR significantly affects QoE of voice services. As the service providers have already made significant improvements in CSSR and to improve the consumer experience, the Authority has decided to revise this benchmark to ≥98% from the existing ≥95%.

(v) The CSSR shall be measured during time consistent busy hours using network-generated data.

3.3.3 Standalone Dedicated Control Channel (SDCCH) and (c) Traffic Congestion [*SDCCH Congestion/ Paging Channel Congestion/ RRC Congestion and Traffic Channel congestion i.e., TCH, RAB, E-RAB, EN-DC (E-UTRAN New Radio Dual Connectivity for NSA to access 4G and 5G both networks at the same time) or DRB (Data Radio Bearer for SA) Congestion]*

(i) SDCCH and TCH congestion in the network leads to non-establishment of the call. The congestion can be in the signaling channel known as a Standalone Dedicated Control Channel (SDCCH) (in respect of GSM network)/ Paging Channel Congestion (in respect of CDMA network) or Radio Resource Control (RRC) in 4G and 5G New Radio. SDCCH is the control channel on which most of the call setup occurs and is used for mobile station (mobile handset) to radio access network (RAN) communication before the mobile station is assigned to TCH/speech

channel. TCH is a logical channel that carries either encoded speech or user data. A blocked call means a call that is not connected because there is no free channel in RAN of a cellular mobile service provider to serve a call attempt. The numbers of blocked calls are those call attempts by subscribers where there is no free channel available to serve a call attempt. Hence connection establishment (accessibility) represents congestion in the radio access network. The congestion may be at SDCCH level or TCH level.

(ii) In present regulations, no change in benchmarks is proposed in both parameters. However, the relevant terms for 5G SA and NSA have been updated in respective parameters which shall be applicable for respective technology and deployment scenario. These parameters shall be measured using network-generated data in Time Consistent Busy Hour (TCBH) over the monthly assessment period.

3.4 Voice Connection maintenance (Retainability) :

(a) and (b) : Call Drop Rate (DCR)

3.4.1 Call drop represents the service provider network's ability to maintain a call once it has been correctly established. The objective of this parameter is to provide the consumer with an expectation of how successful a mobile network will be at retaining the signal throughout the whole duration of the call. This parameter shall include both incoming calls and outgoing calls which, once they have been established and have an assigned traffic channel (TCH), are dropped, or interrupted before their normal completion by the user, the cause of the early termination being within the service provider's network.

3.4.2 This parameter gives a reliable measurement of the mobile network used by the service provider for maintaining a call once it has been correctly established. Failures in coverage, problems with the quality of the signal, network congestion, and network failures, network outages have a significant impact on this parameter. This parameter is affected by inadequate coverage,

and problems with the quality of the signal including interference, radio access network congestion. ETSI EG 202 057-3 v1.1.1 (2005-04) defined Dropped Call Ratio as "*The percentage of calls which, once they have been correctly established and therefore have an assigned traffic channel, are interrupted prior to their normal completion by the user, the cause of the early termination being within the operator's network*". Call drop in the network can be caused by several reasons relating to equipment, transmission, interference, hand-over, antenna, etc.

3.4.3. In initial regulations notified in 2009, the Authority had prescribed a benchmark of ≤2% for the parameter call drop rate.

3.4.4 The measurement methodology prescribed in 2009 was through a data collection system based on the network counters which register the real traffic of the network. The reporting of performance measurements was prescribed to be taken during TCBH. The formula for calculating the percentage of dropped calls was specified as:

$$\frac{(A \times 100)}{B}$$ where:

A = The total number of interrupted calls (dropped calls)
B = The total number of calls successfully established (where traffic channel is allotted)

The formula includes interrupted calls which consist of failures that cause the dropping of the call once the TCH has been successfully established, and the successful seizure of TCH for an originated or terminated call.

3.4.5 However, with increasing consumer complaints regarding frequent call drops and adverse impact on consumer experience, the Authority had revised the parameters and assessment methodology for Call Drop Rate vide '*The Standards of Quality of Service of Basic Telephone Service (Wireline) and*

Cellular Mobile Telephone Service (Fifth Amendment) Regulations, 2017 (4 of 2017)'.

3.4.6 Presently two parameters i.e. (a) Network QoS DCR Spatial Distribution Measure [Network_Q_{SD} (90,90)] with benchmark ≤2%. and (b) Network QoS DCR Temporal Distribution Measure [Network_Q_{TD} (97,90)]≤3% are prescribed for measurement of drop call rate(DCR). The overview of current methodology is placed at **Annexure-I** for reference.

3.4.7 The Authority has observed that all service providers are meeting the present benchmarks as per PMRs submitted by the service providers. However, consumer complaints regarding frequent call drops have increasing trends in recent past.

3.4.8 The Authority has carried out the analysis of the DCR matrix data across service provides for Quarter Ending December,2022 and observed:

a) Service providers are meeting the benchmarks in all the LSAs on an aggregate basis.
b) Even at LSA level, there is significant variation for different technologies and present benchmarks are getting breached if performance is calculated technology wise.
c) If the analysis is further drilled down at district level, there are visible patterns and areas with poor call drop rate.
d) In many of cases, the value of DCR or reason code is found not available.

The above analysis has also been shared with the respective service provider.

3.4.9 Based on the above analysis, the Authority has proposed to revise the parameters and benchmarks as per the following details.

i) The Voice Connection Maintenance related parameters shall now be monitored and reported for different technologies separately i.e., Voice call in Circuit Switched (CS) network [2G and 3G] and Voice call in Packet Switched (PS) network [4G, 5G and beyond].

ii) Considering the CS networks (2G/3G) are in process of phasing out, the Qsd parameter is revised to Network_QSD (92,92) with no change in Q_{TD}.

iii) The packet switched networks are more technologically advanced and support better quality and performance, DCR parameter for performance of Packet Switched Networks (4G, 5G and beyond) is revised to Network_QSD(96,96) and Network_Q_{TD} (97,96).

iv) The benchmark against the Q_{SD} and Q_{TD} parameter shall remain the same i.e. ≤2% and ≤3% respectively.

v) The measurement methodology shall also remain the same.

3.4.10 The following reason codes shall be filled for the cells for which the DCR values are not reported. Same codes shall also apply for the DLPDR_Q_{SD} and ULPDR_Q_{SD} parameters for the percentile-based performance reporting.

DCR Code	Stands for	Reason or purpose
DNE	Does Not Exist	The cell was either not commissioned or de-commissioned in the middle of the quarter and was not part of the network to serve the users in the network.
NOP	Not Operational	The cell was not operational because of planned shutdown or taken out of operation due to technical problem and thus not able to serve the users in the network. It includes force majeure conditions.
NAV	counter values Not Available	If the requisite counter values for computation of DCR for a Cell on a particular day could not be captured due to technical glitch although the cell was operational.

NDM	computation of DCR Not Determinable or irrelevant	In case, computation of DCR observes that mathematically DCR values could not be computed being not in a determinate form or computed value is irrelevant for the purpose of assessment.

(c) Connections with good voice quality [Circuit Switched Voice Quality or Voice over LTE (VoLTE) or VoNR as applicable]:

3.4.11 The existing benchmark for this parameter is >95%. The performance of service providers against this benchmark shall continue to be based on system generated measurement.

(d) and (e) DL Packet Drop Rate for Packet Switched Network (4G/5G and beyond) [DLPDR_Q_{SD}(96, 96)] and UL Packet Drop Rate for Packet Switched Network (4G/5G and beyond) [ULPDR_Q_{SD}(96, 96)] :

3.4.12 Measurement: The measurements must be taken during TCBH. The formula for calculating the percentage of DL Packet Drop Rate and UL Packet Drop Rate are: (A/B)*100

where : For DL Packet Drop Rate:

A =Total number of PDCP SDUs (packets) dropped or lost (not successfully transmitted) in the downlink, for QCI=1.

B = Total number of PDCP SDUs (packets) of bearer entered for transmission, for QCI=1.

The formula includes the packets dropped due to congestion, traffic management etc, and packets lost in the downlink transmission between the eNodeB/gNodeB and UE and between the eNodeB/gNodeB and RNs.

For UL Packet Drop Rate:

A = Total Number of missing UL PDCP sequence numbers, representing packets that are not delivered to higher layers (packets lost), of a data radio bearer with QCI = 1.

B = Total number of UL PDCP sequence number of a bearer, representing packets that are to be delivered to higher layers with QCI=1.

The formula includes the packets lost in the uplink transmission between the eNodeB/gNodeB and UE and between the eNodeB/gNodeB and RNs.

The measurement can be made via an automatic data collection system, based on the network counters which register the real traffic of the network. The counter is available on eNodeB / gNoded B and is recorded 24 hours a day and every day.

The daily values of UL-PDR and DL-PDR as collected during TCBH shall be arranged similar to DCR to calculate **$DLPDR\_Q_{SD}(96, 96)$ and $ULPDR\_Q_{SD}(96, 96)$ which shall be** $\leq$2% for both of these parameters.

3.5 Successful SMS delivery within service provider's network in less than 20 seconds: This QoS parameter with benchmark specify that successful SMS delivery should be completed within 20 seconds in the service provider's network. This benchmark shall be calculated as per the following formula.

% of successfully delivered SMS =

$$\frac{\text{No. of successfully delivered SMS in the LSA within 20 seconds}}{\text{(Total number of SMS generated within LSA in service provider's network} + \text{No. of SMS received in LSA from own and all other service provider's network for delivery in service provider's network)}} * 100$$

B. Customer Service Quality Parameters:

3.6 Metering and billing accuracy:

3.6.1 In the existing regulations there are two parameters relating to billing complaints viz. (i) Metering and Billing accuracy Credibility- post-paid with benchmark of not more than 0.1% of bills issued should be disputed over a billing cycle and (ii) Metering and Billing credibility-pre-paid with benchmark of not more than 1 complaint per thousand customers i.e. 0.1% complaints for metering, charging, credit and validity.

3.6.2 Billing complaints and the billing/charging complaints shall include, but not limited to, the following:

(a) payment made and not credited.
(b) payment made on time, but late payment charges levied wrongly.
(c) double charges.
(d) charging for toll free services.
(e) local call charges billed as STD/ISD or vice versa.
(f) calls or messages made disputed.
(g) wrong roaming charges.
(h) credit agreed to be given in resolution of billing/ charging complaints but not accounted in the bill.
(i) charging for services provided without consent.
(j) charging not as per tariff plan.
(k) overcharging or undercharging

3.6.3 In addition to the above, any billing/charging complaint which leads to billing/ charging error, waiver, refund, credit, or any adjustment shall also be included as billing/charging complaint for calculating the number of disputed bills.

3.6.4 The measurement of the parameter "Metering and Billing accuracy – post-paid" is to be done as per the following formula:

$$\text{Metering and Billing accuracy} - \text{post} - \text{paid} = \frac{\text{total number of billing disputes received in the month X 100}}{\text{total number of bills issued during the month}}$$

3.6.5 The measurement of the parameter "Metering and Billing accuracy – pre-paid" is to be done as per the following formula:

$$\text{Metering and Billing accuracy} - \text{pre} - \text{paid} = \frac{\text{total number of complaints relating to charging, credit } \textit{validity received during the month } X \text{ 100}}{\text{total number of pre} - \text{paid custoers at the end of the month}}$$

3.7 Resolution of Billing/ Charging complaints:

3.7.1 This parameter is intended to facilitate resolution of billing complaints in a timely manner.

3.7.2 The present benchmark for resolution of billing/charging complaints provides two benchmarks i.e.>=98% within four weeks and 100% within 6 weeks. As the two benchmarks are very close with each other and has gap of only two weeks, the Authority is of the view that single benchmark for 100% resolution within 4 weeks should be sufficient to protect consumer interest while reducing the compliance burden on service providers.

3.7.3 The performance against this parameter is to be measured as per the following formula:

%age of billing complaints (for post-paid customers)/ charging, credit & validity (for pre-paid customers) resolved within 4 weeks =

$$\frac{\text{number of billing complaints for postpaid customers/charging, credit/validity complaints for prepaid customers resolved within 4 weeks during the month}}{\text{total number of billing/charging, credit / validity complaints received during the month}} \times 100$$

3.8 Period of applying credit/ waiver/ adjustment to customer's account from the date of resolution of complaints.

3.8.1 Resolution of billing complaints and refund in the form of credit/ waiver/ adjustment are both interrelated activities and therefore one week time should be enough for making credit/waiver/adjustment in case billing/ charging complaint. The present benchmark accordingly provides one week for this activity.

3.8.2 Thus a billing complaint must be resolved within four weeks and any credit/waiver/adjustment arising out of resolution of that complaint has to be made to the customer's account **within one week** of resolution of the complaint and intimation thereto the customer, post-paid/pre-paid. Further, in the case of postpaid customers, the same shall also be reflected in the next bill to be issued.

3.9 Response Time to the customer for assistance:

3.9.1 Quick customer assistance is the most important parameter of any consumer service. With the advancement in consumer care tools, multiple channels for consumer interface have emerged over a period which includes mobile apps, social media channels, service provider website etc. However, no specific standard framework exists for these new and emerging consumer interfaces which can enable uniform user interface or user experience for consumer grievance redressal. Therefore, for many consumers, voice interaction with customer care assistance is the last resort. Further, for feature phone users, IVR channel is the only option. However, the service providers are encouraged to simplify the user interfaces, especially for

registering consumer complaints, in their mobile apps and websites so that the traffic on IVR channels may diminish over a period.

3.9.2 The sub-parameters and benchmark for the parameter "Response time to the customers" are as under:

(a) Accessibility of Call Centre/customer care number i.e., % age of calls answered which basically means that the calls should get connected and answered. The specified benchmark is a minimum of 95% calls to be connected successfully and not more than 5% of calls shall encounter congestion or busy signal or no reply or any other failure.

(b) % age of calls answered by operators (voice to voice) within 90 seconds >= 95% and not more than 5% calls shall encounter busy signal or no reply or any other failure in getting connected to operator.

3.9.3 The computation of the performance against the parameter %age of calls answered by operators (voice to voice), the time taken for connecting to the operator shall be calculated from the time the customer has keyed the relevant number in the IVR option menu, if provided, for speaking to the customer care executive/operator. Further, the menu for speaking to the customer care executive/operator shall be given preference in the menu options and this menu shall not be below the first sub-menu at the third layer, the first layer being the choice of language and the second layer the service menu.

3.10 Termination/Closure of service:

The Authority has decided to continue with the existing benchmark and time for closure shall not be more than 7 days uniformly for all means of request for termination/ closure of any service.

3.11 Time taken for refund of deposits after termination of service:

The present benchmark mandates that 100% refunds of deposits must be made within 60 days. However, as in case of Access Service (Wireline), the Authority has decided to reduce the time from 60 days to 45 days in view of advancements in IT platforms for billing and consumer services. Any delay in the refund of deposits shall attract **interest @10% per annum** payable to the customer. Here also the deposit includes a security deposit and any other refundable deposit taken from the customer. The same benchmark shall also be followed for payment of any other dues payable to the customer after closure/ termination of the service. It is further to clarify that the fact that interest is paid to the customer for the delay in the payment of dues does not absolve the service provider from the responsibility of meeting the prescribed benchmark.

3.12 Measurement Methodology of parameters for which compliance is to be monitored by Service Provider

3.12.1 Registration of demand for wireless services in case service(s) cannot be provisioned due to no service coverage: The service providers are required to register the demand for new wireless services even though the service may not be available or provisioned currently due to no service overage in that area. The district-wise number of registered demands at the end of each quarter is required to be reported to the Authority.

3.12.2 Service Coverage:

(a) This parameter is intended for measuring the coverage in terms of the received signal strength in areas where the service provider has commissioned the service.

(b) The measurement of coverage at street level should continue and in the interest of consumers this should not be left to market forces. Also, there is a need to specify benchmark for coverage measurement in-vehicle. Accordingly, benchmarks have been prescribed for indoor coverage for

which measurement is to be taken at street level, in-vehicle, and in-building (wherever provided by service provider) coverage. The test schedule of Telecom Engineering Centre (TEC) provides signal levels for street level coverage for different technologies for verifying compliance of roll out obligations. However, in the case of in-vehicle assessment/ measurement for coverage the benchmark prescribed shall be up to 10dBm below the street level signal strength specified by TEC for respective technology. Further, the signal strength for indoors shall be as per applicable standard or as per rollout obligation for respective technology. The service providers may use physical, virtual or hybrid approach for drive tests to optimize their networks.

(c) In the post COVID scenario and adoption of working in hybrid mode, indoor coverage is needed to provide seamless QoS and consumer experience. Therefore, service providers are required to ensure signal strength for indoor as per applicable standard or as per rollout obligation for respective technology including accelerated use of Wi-Fi and other emerging standards for voice and SMS delivery.

3.12.3 Point of Interconnection (POI) Congestion:

(i) This parameter signifies the ease by which a customer of one network would be able to communicate with the customer of another network. This parameter also reflects as to how effective is the interconnection between two networks. This parameter with the existing benchmark of < 0.5% shall continue to be monitored on monthly basis. This parameter shall be applicable for interconnection amongst all types of networks and technologies as per network topology within licensing framework.

(ii) The measurement of this parameter shall continue to be made during Time Consistent Busy Hour. Only performance affected due to force majeure conditions need be excluded for calculation purpose.

(iii) The POI interconnection with IP networks (4G/5G) shall be on IP interface to avoid conversion and reconversion of IP data in TDM and vice versa which affects the consumer experience and increases call setup time. The latency, jitter and packet loss performance on IP based POI interconnect shall be measured between the pair of two points of interconnections for pair of LSAs.

(iv) The Service Providers should ensure that the voice calls get the required priority in IP based interconnection for LTE and 5G network in both intra service provider and inter-service provider scenarios.

4. <u>Broadband Services (Wireline and Wireless)</u>: The measurement methodology of QoS parameters for Broadband Services (Wireline and Wireless) is given in following section as per the measurement setup shown in **Figure-2.**

4.1 Latency:

(i) Latency is the amount of time taken by a packet to reach the receiving endpoint after being transmitted from the sending point. This time is termed the "end-to-end delay" occurring along the transmission path. Latency generally refers to network conditions, such as congestion, that may affect the overall time required for transit. The latency tests should measure average round trip time of a series of randomly transmitted User Datagram Protocol (UDP) packets distributed over a long timeframe.

(ii) **Measurement**: Latency shall be measured with the test server for ping connected directly to the server on the same Intranet domain.

4.2 Jitter:

(i) Jitter provides a measure of variation in time in arrival of packets from a source to destination. High value of jitter adversely affects the user experience especially in real time interactive applications.

(ii) ITU-T Rec. Y.1540 defines network parameters that may be used in specifying and assessing IP network performance. The most important performance parameters are-

a. IPTD (IP packet transfer delay): The time difference between the occurrences of two corresponding IP packet reference events (an IP packet reference event is a packet transmission via a given measurement point in the network). There are several types of IPTD, such as:

- minimum IPTD (smallest IP packet delay among all IP packet transfer delays);
- median IPTD (50th percentile of the frequency distribution of IP packet transfer delays);
- average IPTD (arithmetic average of IP packet transfer delays).

b. IPDV (IP packet delay variation, or jitter): The difference between the one-way delay of IP packet and reference IP packet transfer delay (e.g. average IPTD as a reference delay).

(iii) **Measurement:**

The interarrival jitter is the difference in the relative transit time for two packets. The relative transit time is the difference between a packet's RTP timestamp and the receiver's clock at the time of arrival, measured in the same units. If Si is the RTP timestamp from packet i, and Ri is the time of arrival in RTP timestamps units for packet i, then for two packets i and j the inter-arrival jitter D can be expressed as :

D(i,j) = (Rj - Ri) - (Sj - Si)

Similarly, the UDP Jitter will mean round trip time (RTT) of UDP echo requests in microseconds from the mobile device to test server. The Jitter measurements should be conducted as per the test setup for each

technology separately for RTP and UDP. The test calls for Jitter shall be made during TCBH.

4.3 Minimum download and upload speed:

(i) The download speed is defined as the data transmission rate that is achieved for downloading a test file from a test server to a test device. Similarly, the upload speed is the data transmission rate that is achieved for uploading a test file from a test device to a test server.

(ii) **Measurement**: The minimum download and upload speed should be calculated from test calls made according to the measurement set-up for large sized files (minimum1Gb). Test calls are to be made to weigh the results according to the patterns of real traffic during the day busy hour. Minimum download or upload speed shall be average of the lower 10% of all such respective test calls. The download and upload speed test measurements shall be conducted utilizing at least three concurrent TCP connections. The measurement, as per prescribed measurement setup and process, shall be conducted for each committed speed plan offered by the service provider in the reporting area.

4.4 PDP context activation success rate (only for wireless data service):

(i) A Packet Data Protocol (PDP) context specifies access to an external packet-switching network. The data associated with the PDP context contains information such as the type of packet-switching network, the Mobile Station PDP (MS PDP) address that is the IP address, the reference of Packet Gateway and the requested QoS. A PDP context is handled by the MS and concerned packet gateway and is identified by a mobile's PDP address within these entities. Several PDP contexts can be activated at the same time within a given MS.

(ii) **Measurement:** This measurement provides the number of successfully completed PDP context activations through relevant counters.

$$\text{PDP Context Activation Success Rate(\%)} = \frac{\text{number of successfully completed PDP context activations}}{\text{Total attempts of context activation}} \times 100$$

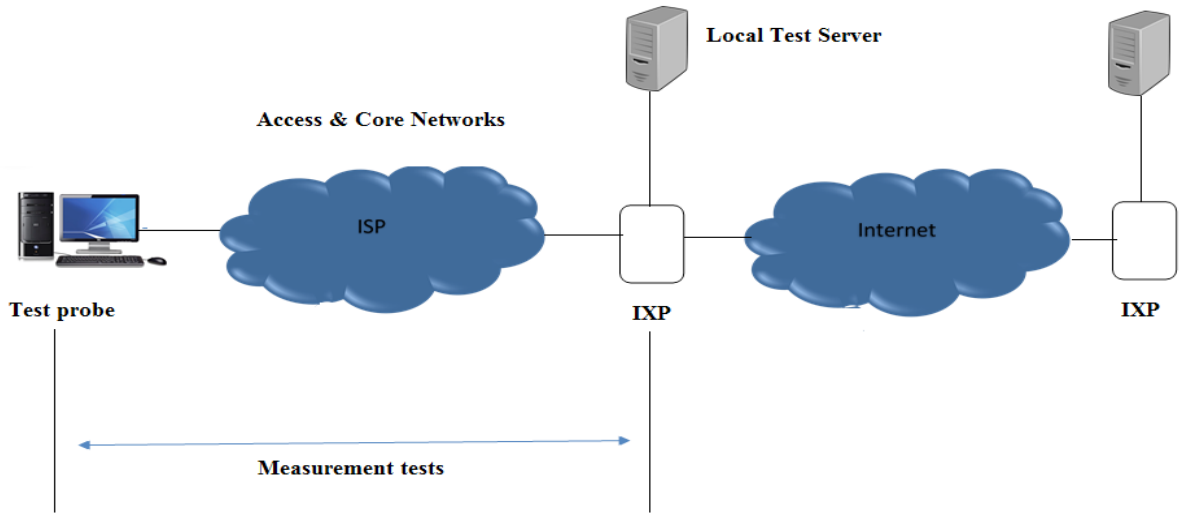
4.5 Packet drop rate: The packet drops, or packet loss rate is total number of packets failing to deliver through the network divided by the total number of transmitted packets within a specific time window. If a packet is not received back within a certain timeout (e.g., 3 seconds), it is considered as lost for the purpose of packet loss measurements. The most common causes of packet loss are congestion leading to buffer overflows or active queue management along the network path. Alternatively, high latency might lead to a packet being counted as lost if it does not arrive within a specified window.

To measure this parameter a large number of IP packets (e.g., at least 1000) are to be sent. Delay and packet loss measurements are to be performed over a longer period in order to allow for the time varying nature of network performance in packet-switched networks. The measurement should include all major types of packets i.e., TCP, UDP and RTP. The UDP packet loss may also be calculated from the UDP latency test measurement.

4.6 Measurement Setup: ITU-T recommendation Y.1545.1 provides the following measurement set up for measurement of Internet QoS parameters at national level.

As per the measurement setup, the test server is to be located at the local Internet Exchange Point (IXP), and probes are installed from the end-user point of view. IXP is a physical network access point or internet gateway through which Internet Service Providers exchange national or international internet traffic. Measurements are to be carried out by the service provider to ensure that the measurement path includes a complete Internet connection from the customer to the test server located at the local IXP.

Figure 2: Measurement Setup for assessment of QoS for Wireless Broadband Data Services [Source: ITU-T recommendation Y.1545.1]



(i) Requirements for the Test-Server:

(a) For all tests, a dedicated test server at IXP should be used as a well-defined reference. The test server may be located at any IXP location of the service provider for all measurements. Under no circumstances a commercial server should be used since the test conditions for such a server may change over time making later reproduction of the results impossible. The test server should be identified by an IP address and not by its Fully Qualified Domain Name (FQDN) to avoid issues with Domain Name Server (DNS) lookup and including the DNS caching strategies of the used operating system in the measurement.

(b) The Transmission Control Protocol (TCP) settings of the server tested against should also be recorded. No detailed recommendation concerning the TCP settings of the server is given. However, the TCP stack of the reference server should at least be capable of the following:

- Maximum Segment Size between 1380 Bytes and 1460 Bytes.
- TCP RX Window Size > 4096 Bytes

- SACK (Selective Acknowledgement) enabled.
- TCP Fast Retransmit.
- TCP Fast Recovery enabled.
- Delayed ACK enabled (200 ms).

(ii) Test File:

The test file should consist of incompressible data i.e., a data file that is already compressed, e.g., like a zip or jpg file. The test file should have at least twice the size (in Mb) of the theoretically maximum data transmission rate per second (in Mb/s) of the wireless data under testing.

(iii) Representativeness or Number of test calls:

(a) The choice of adequate test calls and geographical locations of origin and destination of calls as well as traffic variations, is a crucial point for comparability and validation of the statistics to be calculated for the measured parameters. For each parameter, it is to be ensured that the samples are aggregated over all classes of customers for fairness in reflecting the QoS perceived by the user and the statistics shall be preserved to substantiate the same.

(b) The minimum number of samples (test calls) for respective technology shall be 1067 for each of the State/UT with subscriber base more than 10 lakhs of each technology, 600 for each of the States/UTs with subscriber base of 5-10 lakh of each technology and 384 subscribers for base less than 5 lakhs of each technology for all the parameters.

(iv) Frequency of measurements:

(a) For measurement of QoS parameters, it will be suitable to take measurements monthly during Time Consistent Busy Hour (TCBH). The number of test probes (Test PCs or mobile devices) used in service coverage area should be enough to guarantee that the measurements are representative of the coverage area and sufficient from a statistical perspective. To guarantee the spatial representation of the

measurements, the service providers should establish and deploy test probes, preferably permanent test probes, depending on the number of active customers in each city/town/region, which should consider the market size and demographics in the State/UT concerned.

(b) These test calls must be spread over the State/UT covering all the geographical areas (cities/towns) in proportion of the total number of active customers of respective technology.

4.7 Measurement Methodology of parameters for which compliance is to be monitored by Service Provider

4.7.1 Registration of demand for new wireline broadband connection irrespective of technical feasibility: The service providers are required to register the demand for new broadband wireline services even though the service may not be available or provisioned currently. The district-wise number of registered demands at the end of each quarter is required to be reported to the Authority.

4.7.2 Successful packet data transmission download attempt

(i) The successful data download attempts are defined as the ratio of successful data downloads to the total number of data download attempts in a specified period. A data transmission is successful if a test file is downloaded completely and with no errors.

(ii) **Measurement**: The percentage that is the sum of successful data downloads, divided by the sum of all attempts to download a test file should be provided. The statistics should be calculated from test calls made according to the measurement set-up and considering the representativeness requirements. The successful data download is measured by downloading a test file. An attempt to transmit the test file should be considered unsuccessful if it takes longer than 60 seconds.

(iii) The threshold of 60 seconds refers to the limit for acceptable performance for bulk data transmission/retrieval of ITU-T Recommendation G.1010.

(iv) The transmission time is the period starting when the access network has received the necessary information to start the transmission and ending when the last bit of the test file has been received.

(v) Minimum file size for download shall be taken as 1GB and download attempts shall be tested for each month during TCBH in respective State/UT distributed over mix of urban and rural areas as per measurement methodology prescribed for measurement of wireless broadband service parameters.

4.7.3 Successful data transmission upload attempts:

(i) The successful data upload attempts are defined as the ratio of successful data uploads to the total number of data upload attempts in a specified period. A data upload is successful if a test file is uploaded completely and with no errors.

(ii) **Measurement**: The percentage i.e. sum total of successful data uploads, divided by the sum total of all attempts to upload a test file multiplied by 100 should be provided. The statistics should be calculated from test calls made according to the measurement set-up and taking into account the representativeness requirements. The successful data upload is measured by uploading a test file. An attempt to transmit the test file should be considered unsuccessful if it takes longer than 60 seconds.

(vi) Minimum file size for upload shall be taken as 1GB and upload attempts shall be tested for each month during TCBH in respective State/UT distributed over mix of urban and rural areas as per

measurement methodology prescribed for measurement of wireless broadband service parameters.

4.7.4 Maximum Bandwidth utilization of any Customer serving node to ISP Gateway Node [Intra-network] or Internet Exchange Point Link(s)

(i) The Internet Service Provider (ISP) can offer a good QoS to the customers only if there is enough bandwidth in the access segment, long distance segment and overseas segment of Internet bandwidths. The access segment is entirely managed and operated by the ISP. The broadband service can be provided through DSL, OFC, Cable TV Network, VSAT and Wireless technologies. The national long-distance segment is usually taken on lease from National Long Distance (NLD) Service providers and the overseas nearest access point segment is generally provided by the International Long Distance (ILD) service providers in the form of International Private Leased Circuit (IPLC) or Internet Leased Line (ILL). Therefore, enough bandwidth should be made available in all the three segments to ensure good QoS.

(ii) The service providers are required to monitor the bandwidth utilization during Time Consistent Busy Hours (TCBH) for all network link(s)/route. ISPs/ Service Providers shall report to TRAI the bandwidth utilization (loading) of all the upstream links going to National or International Gateways or Internet Exchange Points with Multi Router Traffic Grapher (MRTG). However, for local links/intranet work links the service provider need to report, only, exceptions having loading more than 80%. In case there is more than one link, then the average utilization of all the route links should not exceed 90% of loading level for a period of at least one month. The service provider is required to make provision for additional bandwidth if the bandwidth utilization of the network links exceeds the 90% loading level for a period of at least one month. Average utilization of bandwidth in a route means utilization of bandwidth capacity on all the links of the route. For example, if there are 3 links consisting of one link of 100 Mbps, two links of 1Gbps Mbps each, in a route from ISP gateway

to International Gateway or IXP then the total bandwidth available in the route is 2.1 Gbps (0.1Gbps +1Gbps+1 Gbps) and 90% of loading means bandwidth utilization of 1.89 Gbps.

(iii) **Measurement Methodology**: Both in Broadband access network/ intra-network links and links to upstream service provider, the bandwidth utilization shall be monitored using Multi Router Traffic Grapher (MRTG). This is a tool to monitor the traffic load on network links. MRTG generates HTML pages containing images which provide a live visual representation of the traffic. These graphs can be embedded into web pages which can be viewed from any Web-browser. In addition to detailed daily view, MRTG also creates visual representations of the traffic over a period. The measurement for reporting purposes is to be made only on working days during TCBH.

5. Customer perception of service for Access Service (Wireline and Wireless) and Broadband Service (Wireline and Wireless):

5.1 Section 11(1)(b)(v) of the TRAI Act, 1997 provides for the Authority to conduct periodical survey of service provided by the service providers to protect the interest of consumers. Keeping in view this mandatory function, the Authority has been conducting customer satisfaction surveys to assess the customer perception of service against the laid down QoS benchmarks. As per the existing Quality of Service Regulations, seven parameters have been prescribed for assessing customer perception of QoS through surveys, both for access service (wireline and wireless) and broadband service (wireline and wireless). These parameters, with benchmark in bracket, are (a) customers satisfied with the provision of service (≥90%); (b) customers satisfied with the billing performance (≥95%); (c) customers satisfied with network performance, reliability and availability (≥95%)(d) customers satisfied with maintainability or maintenance of services (>95%); (e) customers satisfied with supplementary and value added services(≥90%); (f)customers

satisfied with help services including customer grievance redressal (≥90%); and (g) customers satisfied with overall service quality(≥90%);

5.2 There is a direct relationship between Customer Satisfaction and the QoS and thereby quality of experience. The QoS depends on the provider of the service who is responsible for maintaining the network performance and customer care. Network Performance is the ability of a network or network portion to provide the functions related to communications between users. Similarly, performance in customer care depends on the ability of the service providers to address the consumer complaints and requests regarding service, including those related to billing or network related issues.

5.3 The different areas leading to customer satisfaction for different parameters for customer perception of service are further explained below:

(a) Provision of Service:

(i) Satisfaction with time taken to provide/ activate working phone/wireless connection.

(ii) Satisfaction with the time taken for shifting of telephone.

(iii) Satisfaction with re-activation of service in case of disconnection due to non-payment.

(iii)Satisfaction with ease of understanding the offer or tariff plan.

(b) Billing/ Charging Performance:

Post paid:

(i) Satisfaction with the timely receipt of the bill.

(ii) Satisfaction with the accuracy and completeness of the bill.

(iii) Satisfaction with the clarity in bills/ presentation of the billing information in terms of transparency and understandability.

(iv) Satisfaction with the process of resolution of billing complaints.

Prepaid:

(i) Satisfaction with accuracy of charges i.e., correctness of the amount deducted on every usage.

(ii) Satisfaction with the credit and validity correctness.

(iii) Satisfaction with the ease and transparency of recharge.

(iv) Satisfaction related to timely reflection of recharge credit in pre-paid service.

(c) Network Performance, reliability, and the availability:

(i) Satisfaction with the network coverage (signal strength or availability of telephones connections).

(ii) Satisfaction with the ability to make or receive calls easily.

(iii) Number of call drops experienced during conversation.

(v) Satisfaction with the voice quality.

(vi) Satisfaction with the download/upload speed of internet

(d) Maintainability:

(i) Average duration and frequency of network/ exchange outages (signal or dial tone non-availability).

(ii) Satisfaction with the availability of network (signal or telephone dial tone)

(iii) Satisfaction with the restoration of network (signal/ exchange) problems.

(iv) Number and frequency of faults/ problem experienced.

(e) Supplementary Services/ Value Added Services:

(i) Satisfaction with process of activation of supplementary/ value added services.

(ii) Satisfaction with messaging services (SMS/MMS)

(iii) Satisfaction with the roaming services.

(iv) Satisfaction with the voice mail.

(v) Satisfaction with the quality of the supplementary/ value added services.

(f) Help services/ customer care (including customer grievance redressal):

(i) Satisfaction with ease of access of call center/ customer care or help line

(ii) Satisfaction with the response time taken to answer (waiting time) the call by the customer care executive.

(iii) Satisfaction with the time taken by call center/ customer care/ help line to resolve the complaint.

(iv) Satisfaction with the problem-solving ability of the customer care executive.

(v) Satisfaction with the achievement of a satisfactory solution or resolution of complaint.

(vi) Satisfaction with the overall grievance redressal mechanism.

(g) Customer Satisfaction with overall service quality:

Satisfaction with overall quality of total service offering.

5.4 The Authority has decided to continue with the following parameter and their benchmarks accordingly for determining customer perception of service through customer satisfaction surveys.

(a) customers satisfied with the provision of service ≥ 90 %

(b) customers satisfied with the billing performance ≥ 95 %

(c) customers satisfied with network performance, reliability and availability ≥ 95 %

(d) customers satisfied with maintainability ≥ 95 %

(e) customers satisfied with offered supplementary services ≥ 90 %

(f) customers satisfied with help services including customer grievance redressal ≥ 90 %

(g) customers satisfied with overall service quality ≥ 90 %

5.5 The results of the survey on customer perception of service may be made public by the Authority for the information of the customers to generate

healthy competition amongst service providers to improve QoS and QoE for the consumers.

6. Record keeping and reporting:

6.1 As per current practice, reporting of performance against QoS benchmarks is done through quarterly Performance Monitoring Reports (PMR) and monthly POI congestion reports. However, the Authority is of the view that quarterly reporting of PMRs needs review to enable effective use of PMRs for tracking of QoS and to drive continuous improvement in QoS by service providers.

6.2 The automation of process for capturing of primary data for benchmarks is critical to ensure integrity of derived benchmarks through underlying primary data. For example, the Authority has observed a number of issues relating to quality and integrity of primary data relating to drop call rates i.e. $Q_{(S,D)}$ and $Q_{(T,D)}$. The observations of the Authority were communicated to service providers for remedial actions in March,2023. Further, with the expansion of existing PLMN network and increasing numbers of cells required for rollout of 5G services, it is neither feasible nor scalable to continue with the current practice of generation of offline reports through excel sheets and uploading to TRAI portal.

6.3 Therefore, the Authority is of the view that service providers need to upgrade or implement the automation for the process of collection of primary data from relevant sources (EMS/OSS/BSS/CRM etc.) required for generation of performance reports. This is also required for timely reporting of PMRs while ensuring the integrity of underlying primary data. The performance reports and supporting primary data shall be available to the Authority online for the period of one year or as per directions of the Authority in this regard.

6.4 As regards to uniform record keeping procedures, the Authority will prescribe the same including formats to be followed by all the service

providers for automation of process of collection of primary data, generation of PMR reports, download of primary data for granular analysis and audit etc. The Authority, at present, is not prescribing the internal audit mechanism. However, the Authority may audit/ inspect, either directly or through an agency appointed by it, the primary data and relevant records/ measurement relating to each quality-of-service parameter. The Authority may also require the service provider to get the report submitted to the Authority audited at its own cost through an independent and qualified agency.

7. Framework for Online Reporting of Performance of Quality-of-Service Parameters

7.1 There have been phenomenal technological developments in Information Technology (IT) systems, tools and processes which have enabled high level of automation in area of network monitoring, performance management and live monitoring of Quality-of-Service Parameters. 4G and 5G standards have adopted advanced analytics and machine learning methods to manage and deliver desired level of QoS and QoE to the end user of the application.

7.2 Telecom Service Providers have also achieved a significantly high level of process and workflow automation in network and QoS management. Almost all the access service providers have their central or distributed Network Operations Center (NOC), Operations Support System (OSS), Business Support System (BSS) etc. which enable live performance monitoring and management of telecom networks.

7.3 During analysis of QoS Performance Monitoring Reports (PMRs) related primary data for drop call rates for the quarter ending December 2022, the Authority has observed certain discrepancies in the data mainly arising out of manual compilation of QoS benchmarks from different systems.

7.4 To minimize the burden on access service providers related to QoS compliance, the Authority proposes that the service providers should upgrade their IT systems to provide online reporting of QoS performance and associated primary data as per the specified

periodicity. This will eliminate manual interventions in compilation of reports at the end of service provider and ensure integrity of QoS data while saving the manual efforts and associated cost.

7.5 The service providers shall provide secure access to the Authority to enable online reporting of QoS being delivered by the service providers across States/Union Territories or districts. The IT tool architecture shall ensure check and balance for ensuring integrity and completeness of primary data for various QoS parameters and benchmarks specified under relevant section of the regulation. The IT system shall provide a comprehensive regulatory dashboard to the Authority through which the Authority will be able to *inter-alia*.

(i) view and download primary data related to selected or all QoS parameters and benchmarks for access service (wireless or wireline) and broadband service (wireless or wireline) for any state/ UT or district for any given duration for a period of 1 year prior to current month.

(ii) view and download the PMRs generated by the service provider through the system.

(iii) view drive test report results conducted by service providers.

(iv) view or download results/ reports of the parameters to be measured by service provider.

(v) view and download static data related to wireless and wireline network including LSA, State/UT, district name, unique cell ID, technology, latitude, longitude etc.

7.6 The service provider shall also provide APIs (Application Programming Interface) to enable seamless exchange of data with TRAI's central platform, as and when rolled out, which shall include but not limited to: -

(i) APIs for pushing/ pulling of updated network related static data like cell or node ID, LSA, State/UT, district, technology (2G/ 3G/ 4G/ 5G etc.), latitude, longitude, backhaul media (Fiber/

Wireless <Frequency band>), Core Network ID etc.

(ii) Similarly, APIs for pushing/ pulling of updated network-related static data for access service.

(iii) API for pushing PMRs as per specified frequency.

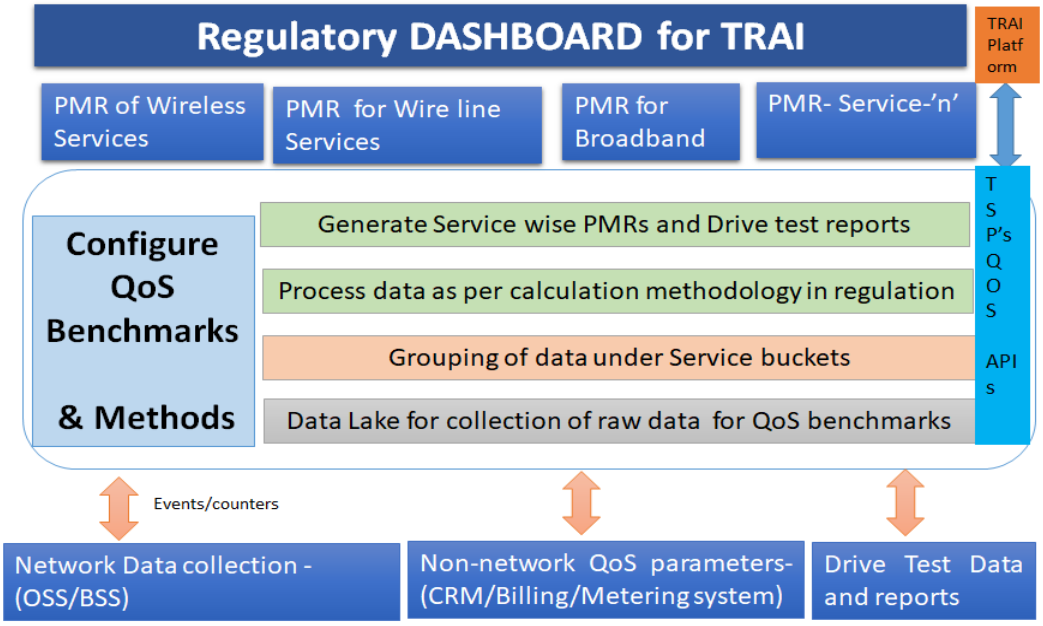
(iv) API for pushing/ pulling of primary data corresponding to the specified QoS parameters.

(v) API for pushing/ pulling of result of drive test conducted by service provider and other parameters which are to be measured by service provider.

(vi) API(s) for any other data within the purview the regulation

7.7 The above features are indicative and may be amended to meet requirements under the regulation. A high-level indicative framework for the IT system for online QoS performance reporting is given below:

Figure-3: IT framework for online reporting of QoS performance



8. Publication of QoS

The Authority has been publishing a summary of Quarterly Performance Monitoring reports, the results of audit and customer satisfaction survey undertaken by the Authority through agencies appointed by it on its website.

The Authority may continue to publish such information for the information of stakeholders. In addition, the Authority may also publish, State/UTs, district or even cell level performance including comparative performance of service providers against quality-of-service benchmarks for key parameters at the frequency and manner which the Authority may decide.

9. Financial Disincentives (FD):

9.1 Non-compliance with the Quality-of-Service standards laid down by TRAI amounts to violation of the Quality-of-Service Regulations of TRAI. For such violation, one of the options for the Authority is to take penal action against the service provider under the provisions of the TRAI Act, 1997. These provisions in the TRAI Act are available in Section 29, 30 and 34 of the TRAI Act, 1997. Since as per the license conditions the service providers must meet the QoS standards laid down by TRAI or the licensor, any failure to meet the benchmarks laid down by TRAI for the various QoS parameters amounts to violation of license conditions and the Department of Telecommunications has powers to impose penalty. The Authority could recommend to the Department of Telecommunications for imposition of penalty for such violation of license conditions.

9.2 The discharge of statutory mandate, to enforce standard of QoS and protect the interest of consumers, necessitates making appropriate provisions of financial disincentives in the regulation.

9.3 Accordingly, the provision of FD was introduced in year 2012 vide amendments in respective regulation. The summary of existing provisions of FD under present regulations is given below: -

(i) **Basic Services (Access Service-Wireline**): If a basic telephone service provider fails to meet the Quality-of-Service benchmarks, it will be liable to pay an amount, by way of financial disincentive, not exceeding rupees fifty thousand per parameter.

(ii) **Cellular Mobile Telephone Services (Access Service-Wireless):** For wireless services, present regulation provides two categories i.e. (a)

Drop Call Rate (DCR) related parameters and (b) other than DCR related parameters as under.

a. FD provision for other than DCR related parameters:

If a cellular mobile telephone service provider fails to meet the benchmark of parameter, it shall be liable to pay an amount, by way of financial disincentive, not exceeding rupees one lakh per parameter for the **first** contravention reported by the service provider in its quarterly report; provided that if the service provider fails to meet the benchmark of the same parameter consecutively in two or more subsequent quarters, it shall be liable to pay, by way of financial disincentives, an amount not exceeding rupees one lakh fifty thousand for the **second** consecutive contravention and not exceeding rupees two lakhs for **each consecutive** contravention occurring thereafter. However, for any failure to meet the benchmark of a parameter, *after the service provider has reported compliance of the said parameter in the previous quarter*, it shall be liable to pay the financial disincentive for such failure as applicable for the *first contravention.* There is no cap on FD amount which can be levied by the Authority for non-compliance of benchmarks for parameters under this category.

b. FD provision for DCR related parameters: The FD for non-compliance of two DCR related parameters i.e. Network_Q_{SD} (90,90) and Network_Q_{TD} (97,90) is in graded form as per the following tables. Further, total amount payable as financial disincentives, for breach of DCR related benchmarks shall not exceed rupees ten lakhs in a quarter.

Value of Network_Q_{SD} (90,90) in quarterly report	**Amount of Financial Disincentives in rupees**
More than 2% but not exceeding 4%	not exceeding One lakh
More than 4% but not exceeding 6%	not exceeding Two lakhs
More than 6% but not exceeding 8%	not exceeding Three lakhs
More than 8% but not exceeding 10%	not exceeding Four lakhs
More than 10%	not exceeding Five lakhs

Value of Network_Q_{TD} (97,90) in quarterly report	**Amount of Financial Disincentives in rupees**
More than 3% but not exceeding 5%	not exceeding One lakh
More than 5% but not exceeding 7%	not exceeding Two lakhs
More than 7% but not exceeding 9%	not exceeding Three lakhs
More than 9% but not exceeding 11%	not exceeding Four lakhs
More than 11%	not exceeding Five lakhs

(iii) **Broadband Services**: If a service provider providing broadband service fails to meet the benchmark of QoS parameter specified in the regulation, it shall be liable to pay an amount, by way of financial disincentive, *not exceeding rupees fifty thousand* per parameter and in case of second or subsequent such contravention, to pay an amount *not exceeding rupees one lakh per parameter* for each contravention. In this case, the FD amount of rupees one lakh per parameter become effective for all subsequent non-compliances after first non-compliance unlike in case of FD provisions for Access Service (Wireless) where it reverts to the level of that applicable for first contravention once the service provider has reported compliance of the said parameter in the previous quarter.

(iv) **Wireless Data Services:** At present, the provision of FD is not applicable for wireless data services. However, in the present scenario, the share of wireless broadband services is more than 97% in terms of subscriber base. Therefore, the provision of FD is equally relevant for contravention of benchmarks against specified parameters for wireless data services.

In addition to above provisions, if a service provider fails to submit reports within the timelines as specified in respective regulations, it shall be liable to pay an amount, by way of financial disincentive, not exceeding rupees **five thousand for every day** during which the default continues. Further as per present provisions, if the compliance report furnished by service provider is

false and which such service provider knows or believes to be false or does not believe to be true, it shall be liable to pay an amount, by way of financial disincentive, not exceeding **rupees ten lakh per parameter** for which such false report has been furnished.

9.4 The Authority is of the considered view that the provision of FD is essential. The provision of FD and the applicable amount was introduced in year 2012 which has not been revised since then except the provisions for two parameters of Cellular Mobile Telephone Services i.e. Network_Q_{SD} (90,90) and Network_Q_{TD} (97,90) introduced in August, 2017.

9.5 Accordingly, it is proposed to introduce simplified and graded FD provisions applicable for all services as specified in draft regulation. The FD provisions propose to reduce peak FD rates from rupees five lakh per parameter to rupees three lakh per parameter. Further, higher amount in graded FD is applicable only for contravention of the benchmark of same parameter consecutively in two or more subsequent months in place of application of higher rate after first contravention as is the case in existing provision of FD for Broadband services. With above referred considerations, the Authority propose to revise the present FD provisions as summarized below:

(i) financial disincentive of not exceeding rupees one lakh per benchmark against specified parameter for the first contravention. This is same as applicable for Cellular Mobile Telephone Service(CMTS) under present regulations.

(ii) if the service provider fails to meet the benchmark of the same parameter consecutively in two or more subsequent months, it shall be liable to pay, by way of financial disincentives, an amount not exceeding rupees one lakh fifty thousand for the second consecutive contravention (same as applicable currently from CMTS) and not exceeding rupees three lakhs for each consecutive contravention occurring thereafter.

(iii) **False Reporting of compliance of benchmarks**: If the compliance report furnished by the service provider under relevant regulation is false and which the service provider knows or believes to be false or does not believe to be true, it shall be liable to pay an amount, by way of financial disincentive, not exceeding rupees ten lakh per benchmark for which such false report has been furnished. No change in FD is proposed in this case.

(iv) **Failure of service provider to submit compliance report:** If a service provider fails to submit compliance report as per specified timelines, it shall be liable to pay an amount, by way of financial disincentive, not exceeding rupees twenty-five thousand per report for every day during which the default continues, subject to maximum amount of rupees seven lakh fifty thousand. Non-reporting of compliance is a serious violation of regulation. Therefore, the FD amount is proposed to be increased in this case to not exceeding rupees twenty-five thousand per report for every day subject to specified ceiling without prejudice to application of other remedial actions under TRAI Act.

9.6. **Consequence for failure of the service providers to pay FD within the stipulated time**: It has been observed that many a times, the FD amount is not paid in time and the issue of FD payment is kept alive on frivolous grounds. Further, unrecovered FD amount also attracts adverse audit observations and the same requires remedial action. Accordingly, any delay in payment of FD beyond the stipulated period shall attract interest on FD amount. The rate of interest shall be at a rate which will be 2% above the one-year Marginal Cost of Lending Rate (MCLR) of State Bank of India existing as on the beginning of the Financial Year (namely 1st April) in which last day of the stipulated period for payment falls. The interest shall be compounded annually.

Chapter 6: Emerging Trends -Shift from QoS to QoE

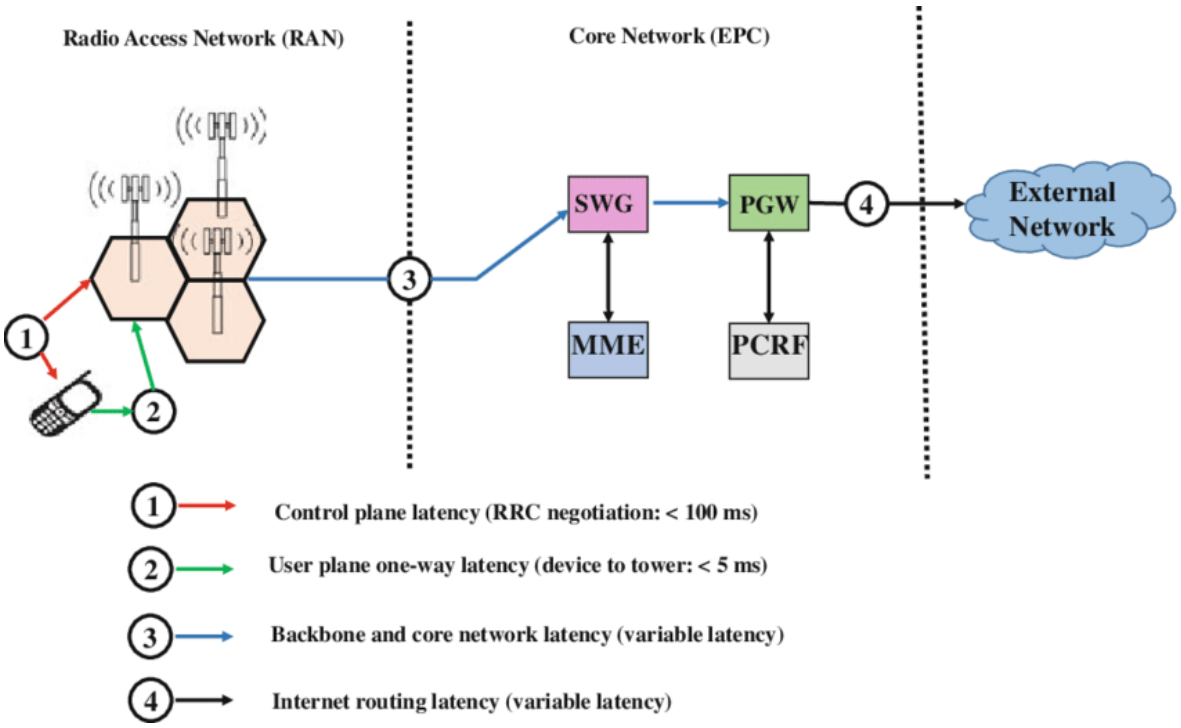
1. ITU-T Recommendation P.10 defines QoS as "*The totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service*". Further, QoE is defined as "*The degree of delight or annoyance of the user of an application or service".* QoE is different from QoS as it is based on customer perception of the given service. QoE includes the complete end-to-end system elements (client, terminal, network, services infrastructure, etc.) and may be influenced by user expectations and context.

2. QoE depends on the end-user perception in addition to features of services that may result in quite different ways of specifying the value. It is clear, however, that QoE is impacted by QoS and network performance.

3. Network performance is outcome of network provider's planning, network development, operations, and maintenance. The functions of a service depend on the performance of the network elements and the performance of user terminal equipment. QoS is always end-to-end, i.e. user-to-user or user-to-content. Therefore, QoS measurements are to be carried out end-to-end. End-to-end QoS depends on the contributions made by the components including user, user equipment, access network, IP transport, core network, and the rest of the path end-to-end (e.g. through the Internet).

   To illustrate, the Figure-4 explains the contribution of different network segments towards QoS parameter of latency of an LTE network in uplink scenario. In this scenario, latency includes control plane latency, user plane latency, backbone or core network latency and transport network latency up to the external network at traffic exchange point.

Figure-4: Breakup of Latency in uplink of LTE network



[Source: https://hpbn.co/mobile-networks/#wireless-history]

Thus, the QoE experienced by the end user will be affected negatively even if any of the network segments have degraded performance and contribute more latency than tolerable limit.

4. The fourth generation of mobile networks (LTE) has made it possible to generalize the consumption of video content in mobile. These services are mostly provided over-the-top, using the same internet connection as other applications in the mobile device, since they target end users (individual consumers) with a global outreach.

5. In fifth generation of mobile technology (5G), wireless networks are increasing their capabilities in terms of achieved throughput (enhanced Mobile Broadband (eMBB)), latency (ultra-reliable low latency communication (uRLLC)), and device density (massive machine type communications (mMTC)). Therefore, QoS requirements and QoE parameters for uRLLC and mMTC will be different from those applicable for eMBB. Further, QoS of these services will need to balance the network

resource allocation (spectrum, backhaul, core and transport) so that the allocation of common resources to one high priority service does not impact the QoS of other service.

6. 5G technology provides improved flexibility to apply these new capabilities to a specific subset of devices, using approaches such as network slicing or non-public networks (NPNs). This opens a new set of video-related services for professional users and vertical industries which, in previous technological generations, were only possible using wired networks, legacy non-IP based wireless links, or were even completely impossible to provide. Examples of those services are tele-operated driving (ToD), wireless content production (WCP), and cloud-enabled augmented and/or virtual reality (more generally, mixed reality (MR)).

7. The architecture for the 5G systems [3GPP TS 23.501] defines the QoS model used by 5G. The 5G QoS model is based on QoS Flows. The 5G QoS model supports both QoS Flows that require guaranteed flow bit rate (GBR flows) and QoS Flows that do not require guaranteed flow bit rate (Non-GBR QoS Flows). The QoS Flow is the finest granularity of QoS differentiation in the PDU (Packet Data Unit) Session. A QoS Flow ID (QFI) is used to identify a QoS Flow in the 5G System. User Plane traffic with the same QFI within a PDU Session receives the same traffic forwarding treatment (e.g. scheduling, admission threshold).

8. The QoS requirement of emerging applications is quite different from the present-day applications. Applications like gaming, Augmented Reality etc. require symmetric bandwidth as they send the information as much as they receive. Similarly, mobile networks need to support concurrency and should provide consistent QoS and experience regardless of the number of consumers using the network at any given point of time. Thus, mobile networks need to be designed for such agility to meet these dynamic requirements. Further, the integration of terrestrial and

upcoming non-terrestrial networks will also enforce the need for delivery end to end QoS to ensure seamless user experience.

9. **Approach for objective assessment of QoE**: As discussed in previous sections of this chapter, QoS is dependent upon the performance of each individual underlying network segments. Degradation of performance in any single network segment, the QoE may get severely impacted even though all other network segments might be delivering excellent QoS performance. For example, degradation in performance due to congestion in IP transport network between any two LSA will affect the QoE for voice calls between these two LSAs though the LTE networks of both the LSAs will show no such degradation in QoS. Therefore, to get end to end measure of QoS, performance of each network segment is required to be correlated and monitored to deliver QoE to the consumers.

10. **Identifying the relevant QoE Indicators**- There are different approaches for assessment of QoE. Most ITU-T Recommendations involving auditory, visual, or audiovisual quality aim at modelling or predicting the quality of experience perceived by the user. Another model may involve analysing the audiovisual signal involved, either as perceived by the user or in its encoded form (bitstream), or solely analysing the interaction of the audiovisual communication with the network QoS. ITU-T Technical Report-GSTR-5GQoE[5] on "*Quality of experience (QoE) requirements for real-time multimedia services over 5G networks"* was released in June 2022. This report provides following two models for identifying relevant QoE indicators.

    (i) **Planning models**. These models allow the dimensioning of the network, by estimating the expected QoE that can be achieved given generic characteristics of the content (e.g., resolution, codec, compression bit rate) and the network (e.g., throughput, loss rate). Examples are ITU-T P.107 and the P.1070–1072 series.

[5] https://www.itu.int/dms_pub/itu-t/opb/tut/T-TUT-QOS-2022-1-PDF-E.pdf

(ii) **Monitoring models**. These models allow the prediction of the subjective quality as perceived by a user from the actual bitstream that would be received by the user device, either in compressed or in decoded format. Examples are the ITU-T P.1201–1204 series recommendations.

The above-referred models are built using a set of technical factors which influence the QoE indicator. Those factors are related to:

(a) Implementation of the system (e.g., image resolution, codec).

(b) Restrictions on the communication channel (i.e., communication QoS indicators: throughput, loss rate, latency).

(c) A mathematical model which relates variations in the technical factors (causes) with variations in the QoE indicator (effect).

However, when analysing other types of services, especially the ones related to professional usage and vertical use cases, additional considerations are needed. Therefore, understanding the system implementation is also key for a proper analysis of the QoE. For example, vertical use cases may have very different setups, involving non-conventional streams (e.g., control signals) and devices (e.g., vehicles) unlike traditional voice and video streams.

11. While there is paradigm shift in standardization of telecom system and architecture to support required QoS and QoE for different use cases, it is equally important to plan, implement and maintain such networks with 'QoS by Design' approach. There is a wide gap in the QoS supported by the 4G and 5G networks and that experienced by the consumers which can be bridged through QoS by design approach to a large extent.

12. **Use of Artificial Intelligence (AI) for managing QoE**: The segmented approach for QoS management is the biggest bottleneck in unpredictable user experience which results in wide gap between the QoS measured by the service provider and actual QoS perceived by the consumer. The latest network standards support QoS and QoE management features albeit at equipment and segment level. However, user experience is the aggregate

outcome of QoS performance of each network segment i.e., access, backhaul, core and transport networks. Degradation of QoS performance of any of network will affect the QoE of these services. Near real-time, rather than monthly, QoS performance monitoring may be achieved by collection, processing, and correlation of performance data. The AI can play an important role in effectively managing end-to-end QoE in near real-time.

Issues for Consultation

Question-1: What are the possible reasons for increasing gaps between the QoS reported by the service providers and the QoS experienced by the consumers? How this gap can be bridged?

Question-2: To support emerging applications and use cases please suggest a transparent framework for measurement and reporting of QoS and QoE especially in 4G and 5G networks considering relevant standards and global best practices.

Question-3: What should be the QoS parameters and corresponding benchmarks for ultra-reliable low latency communication (uRLLC)), and massive machine type communications (mMTC)?

Question-4: Will there be any likely adverse impact on existing consumer voice(VoLTE/VoNR) and data services (eMBB) upon rollout of enterprise use cases of uRLLC or mMTC?

Question-5: If answer to Question-4 is 'No' then please explain how and if the answer is 'Yes' please suggest measures to ensure minimum guaranteed QoS for voice and data service for consumers.

Question-6: To achieve QoS and QoE end-to-end, it is essential that all network segments deliver the minimum level of QoS required by

respective service, application or use case. In this context, please suggest QoS parameters and corresponding benchmarks for National Long Distance (NLD) and International Long Distance (ILD) segments of the network with supporting global benchmarks.

Question-7: What should be the approach for adoption of 'QoS by Design' framework by the service providers to ensure that new generation wireless networks are planned, implemented and maintained to deliver required level of measurable QoS and QoE ?

Question-8: What measures are required to accelerate the adoption of AI for management of QoE to reduce consumer complaints protectively and to enable near real time reporting of QoS performance to consumers?

Chapter 7: Issues for Consultation

1. The Chapter-3 provides the draft of the proposed regulation i.e., '*THE STANDARDS OF QUALITY OF SERVICE OF ACCESS SERVICE (WIRELINE AND WIRELESS) AND BROADBAND SERVICE (WIRELINE and WIRELESS) REGULATIONS, 2023'*. The detailed measurement methodology for the parameters and corresponding benchmarks has been provided in Chapter-5. The present measurement methodology for percentile-based drop call rate is available at Annexure-I for reference.

2. The comments are invited from stakeholders on the Draft Regulation in Chapter-3 and Measurement Methodology in Chapter-5. The inputs/comments in this regard should be provided in the following template:

Sl. No.	Chapter No.	Regulation No/Clause No.	Proposed provision in consultation paper	Suggested modification	Justification/ Global references with supporting data points if any

3. The response is also invited on following questions for consultation provided in Chapter-6.

Question-1: What are the possible reasons for increasing gaps between the QoS reported by the service providers and the QoS experienced by the consumers? How this gap can be bridged?

Question-2: To support emerging applications and use cases please suggest a transparent framework for measurement and reporting of QoS and QoE especially in 4G and 5G networks considering relevant standards and global best practices.

Question-3: What should be the QoS parameters and corresponding benchmarks for ultra-reliable low latency communication (uRLLC)), and massive machine type communications (mMTC)?

Question-4: Will there be any likely adverse impact on existing consumer voice(VoLTE/VoNR) and data services (eMBB) upon rollout of enterprise use cases of uRLLC or mMTC?

Question-5: If answer to Question-4 is 'No' then please explain how and if the answer is 'Yes' please suggest measures to ensure minimum guaranteed QoS for voice and data service for consumers.

Question-6: To achieve QoS and QoE end-to-end, it is essential that all network segments deliver the minimum level of QoS required by respective service, application or use case. In this context, please suggest QoS parameters and corresponding benchmarks for National Long Distance (NLD) and International Long Distance (ILD) segments of the network with supporting global benchmarks.

Question-7: What should be the approach for adoption of 'QoS by Design' framework by the service providers to ensure that new generation wireless networks are planned, implemented and maintained to deliver required level of measurable QoS and QoE ?

Question-8: What measures are required to accelerate the adoption of AI for management of QoE to reduce consumer complaints protectively and to enable near real time reporting of QoS performance to consumers?

Annexure-I

1 FRAMEWORK FOR CURRENT BENCHMARKS, PARAMETERS AND METHODOLOGY FOR DCR ASSESSMENT

1.1 As noted earlier, the main goal of redefining the QoS parameter is to highlight the problem areas so that coordinated actions may be taken to ensure effective QoS. From the characterization of DCR Data in Spatial and Temporal Distribution, the problem areas, if any, are easily identifiable using the methodology described below.

1.2 The Spatial and Temporal Distribution methods portray the performance of the network in different parts of the service area and on different days. However, this is being achieved without involving any averaging process for the purpose of assessment of a cell or the assessment of a network as a whole.

1.3 DCR-Matrix arrangements with Spatial Distribution identifies the cells which have performed worse than the set benchmark beyond a certain % of days in the period of assessment. Some of these identified cells with poor performance for up to a certain number of days may be excluded from the overall assessment in view of practical difficulties and factors which may be beyond control of TSPs. But beyond these exclusions, which are clearly identified, every cell is considered for assessment of the overall network performance.

1.4 DCR-Matrix arrangements with Temporal Distribution identifies the days on which a significant number of cells of the network observed relatively poorer performance allowing them to be excluded while assessing the network's overall performance. Beyond these exclusions, which are clearly identified, each day during the assessment period is considered for assessment of the overall network performance.

1.5 Q-cross-points partitions of DCR-Matrix arrangements with Temporal and Spatial Distribution are very meaningful for the purpose of enabling consumers to make an informed choice. These distributions set out a clear assessment of what percentage of the total service area and for what percentage of days can a particular network be assumed to be performing better than the benchmarks set by the Authority. By knowing the position of Q-cross-point, subscribers will be in a position to assess the minimum confidence level with which they can be assured of a certain level of QoS.

1.6 The Q-value cross-points in the DCR Matrix, both in case of Spatial Distribution and Temporal Distribution, are based on percentile values, and can therefore be defined in an objective, measurable and verifiable manner. Based on the above, the Q-values cross-points methodology had

been adopted by Authority for ascertaining the level of QoS being offered by a service provider in relation to call drops which is currently in force.

2 SETTING THE BENCHMARKS (BMS) FOR DCR ASSESSMENT

2.1 While setting the benchmark values in year 2017, the objective was to arrive at Q-values which are achievable and force a service provider to invest in infrastructure and improve its services. At the same time, the benchmarks should be such that they satisfy the overarching concerns of user experience of QoS.

2.2 With these objectives in mind, the Authority decided to introduce the following benchmarks and criteria related terminologies and redefined DCR framework in 2017:

a. Percentile-t value of DCR out of DCR data for a particular cell which will be considered as representative DCR value for the performance of that particular cell for the entire period of assessment i.e.Cell_Q(t).

b. Percentile-s value of Cell_Q(t) values which is to be considered for representative DCR value for network DCR Spatial Distribution performance in the assessment period. i.e. Network_Q_{SD}(s, t).

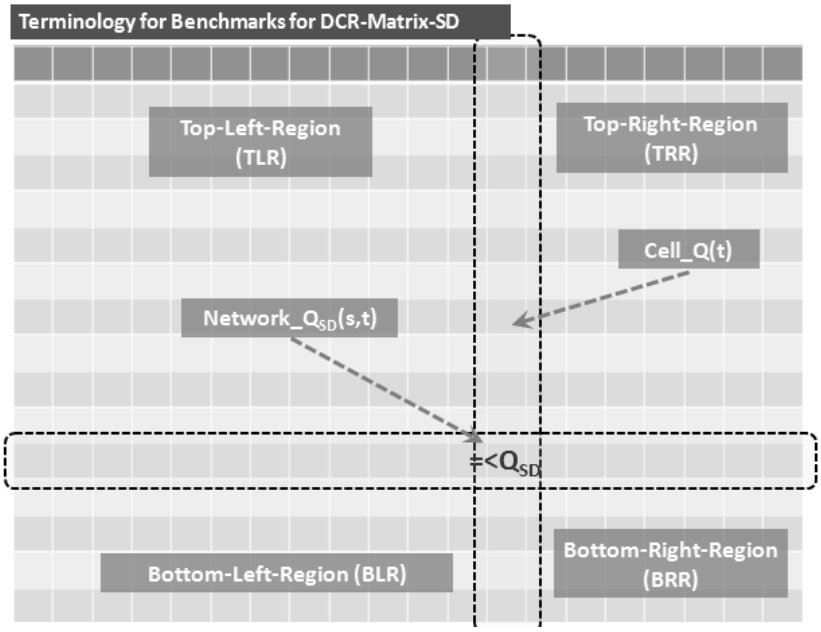


Figure 5: Terminology for DCR-Matrix-SD related benchmarks

c. DCR benchmark value, QSD which is to be set as a maximum DCR for Network_QSD(s, t) i.e. for network DCR Spatial Distribution performance in a LSA and will be considered as meeting the benchmark when value at Network_QSD(s,t) ≤Benchmark QSD.

d. Percentile-s value of DCR out of DCR data for all cells operating in a

network on a day which will be considered as representative DCR value for the performance of the network on that day i.e.Day_Q(s).

e. Percentile-t value of Day_Q(s) which is to be considered for representative DCR value for network DCR Temporal Distribution performance in the assessment period i.e. Network_Q_{TD}(s, t)

f. DCR benchmark value, QTD which is to be set as a maximum DCR for Network_Q_{TD}(s, t) i.e. for network DCR Temporal Distribution performance in a LSA and will be considered as meeting the benchmark when value at Network_Q_{TD}(s,t) ≤Benchmark Q_{TD}.

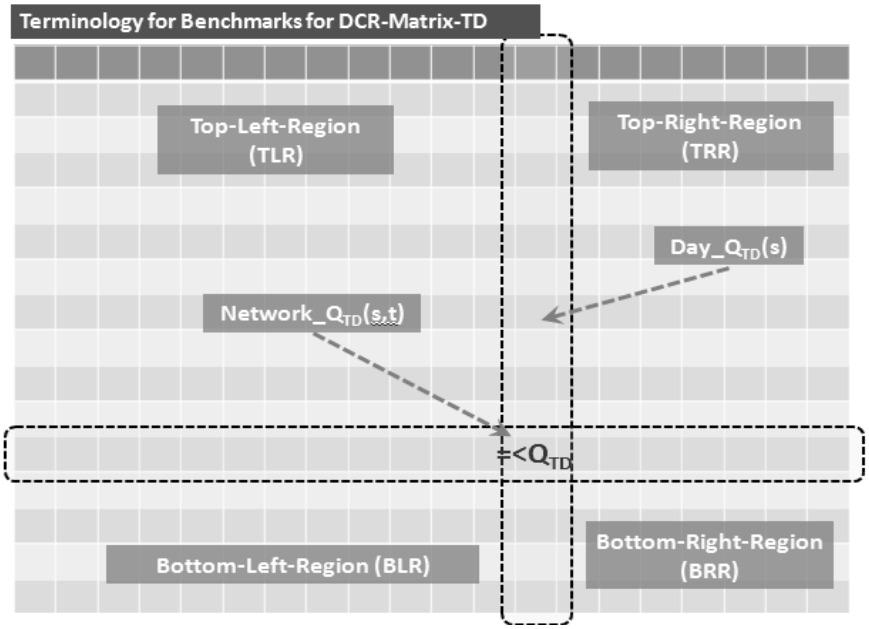


Figure 6: Terminology for DCR-Matrix-TD related benchmarks

2.3 The revised DCR assessment methodology was intended to remove averaging effect and also to improves confidence level by making it more representative of the actual network performance (e.g. at-least 90% of cells, at-least 90% of days have to achieve DCRs equal to or better than 2% DCR value); and as DCR is to be measured for individual cell, busy hour for that cell need to be taken, it means that DCR to be measured during CBBH. Similarly, worst-affected BTS parameter has been revised to adopt a cell-level parameter and ensure that on at-least 90% of days, at-least 97% of the cells, have to achieve DCR equal to or better than 3% DCR value. DCR is to be measured during CBBH.

2.4 In case 90% of total number of days or 97% of total number of cells is not an integer and includes fractional value then the DCR value corresponding to its rounded nearest integer value is to be considered for computation of the network's performance assessment.

2.5 There may, however, be situations when DCR data for a few cells may

not be available for all the days of a quarter. For example, this could happen in a case when the BS was installed and commissioned in the middle of that quarter; or if a particular BS went an operational shutdown for certain legitimate reasons; or if there was a genuine technical difficulty in acquiring data for a few days. There may also be cases where the net voice traffic handled by a cell on a particular day was zero or a value which makes DCR value on that day non-determinable or irrelevant.

a. For the treatment of special cases, 'DCR Codes' shall be used when a special observation is made corresponding to a Cell on a particular day as listed in the table below:

b. Authority may add, modify, or delete the list of DCR Codes, through directions issued from time to time.

c. All DCR values for the assessment period shall be considered for Percentile value computation for the parameter DCR spatial measurement and DCR temporal measurement excluding the cases enumerated in above the table.

d. DCR values of individual Cells for the computation of parameter DCR spatial measurement and DCR temporal measurement shall be computed during Cell Bouncing Busy Hour and only up to two decimal places.

Annexure-II

International references on key QoS standards

A. Mobile Voice and Broadband Services

1. **USA:** Measuring Mobile Broadband:

   (i) Measuring Broadband America programme is a nationwide study of broadband performance received by the consumers and it was expanded in 2012 to include information on mobile broadband. The testing is done using a mobile app called FCC Speed Test.

   (ii) The test suite of the app collects information on following parameters to measure the performance of mobile broadband service:

   a. Download Speed: Incoming throughput in megabits per second (Mbps) utilizing three concurrent Transmission Control Protocol (TCP) connections

   b. Upload Speed: Outgoing throughput in megabits per second (Mbps) utilizing three concurrent Transmission Control Protocol (TCP) connections

   c. UDP Latency: Average round trip time of a series of randomly transmitted User Datagram Protocol (UDP) packets distributed over a long timeframe

   d. UDP Packet Loss: Fraction of UDP packets lost during UDP latency test

   e. UDP Jitter: Mean round trip time (RTT) of UDP echo requests in microseconds from the app to a target test node

2. **United Kingdom:** The consumer mobile experience report: The report summarises data collected from a panel of consumers who have downloaded an app onto their Android smartphone, which measures the performance of their voice and data connections, collects information about how they use their device and asks the user about their perception

of the quality of the connection. The report was published, and the following metrics are analysed:

a) **Data network share**: This parameter records the type of network that Android users connect to when actively using apps and transferring data, and it provides an overall picture of the types of networks that they connect to most often. The data network share metric establishes the ratio of seconds per network technology across all used apps, and hence expresses the time share on 2G, 3G, 4G and Wi-Fi while actively using apps and transferring data.

b) **Data service availability**: It provides a view on the success or failure to connect to the internet using a 2G, 3G or 4G mobile data network connectivity. Every 15 minutes, the research app runs a background test which attempts to download a small file and logs whether this can be completed successfully. This metric defines the percentage of cases when the user can both connect to the network and download data.

c) **Data performance** – download speeds: Performance for Chrome, Facebook, YouTube, Google Play Store, Gmail, Instagram, Twitter, and WhatsApp was looked at in terms of the average DR that users would get when downloading data.

d) **Response time**: Response time (referred to technically as latency) is the delay between a consumer making a request to their mobile network for information and the network providing this information to the device. Latency is measured as part of the connection test.

e) **Voice performance**: This parameter measures whether people can successfully maintain voice calls by detecting cases where the call is interrupted due to a loss of service.

f) **App use**: Two metrics were analysed for app use in this report. The first was the average length of time, in minutes, that users spent within the application when it was actively being used in the

foreground. The second metric looked at the average (mean) number of times that an app was opened in a day.

g) **Satisfaction with network performance**: From time to time (based on predefined trigger frequencies), the app asks users to rate their satisfaction with voice calls and apps used.

3. <u>Australia:</u>

(i) The Communications Alliance, which is the unified voice for the Australian communications industry, has published standards for QoS parameters regarding IP networks and their classification in different classes. The important QoS parameters and the classification into classes is provided below:

a) **IP packet Transfer Delay (IPTD)/Delay**: This parameter is defined as the one-way time interval between the moment the first bit of an IP packet crosses an entry point of a network and the moment the last bit of the same packet crosses an exit point of the network.

b) **IP packet Delay Variation (IPDV)/Jitter**: This parameter is defined as the difference between the actual IPTD of a packet and a reference IPTD for a packet population of interest. The reference IPTD of a population of packets is the minimum IPTD for the packets within the population of interest.

c) **IP packet Loss Ratio (IPLR):** This parameter is defined the ratio of total lost IP packets to total transmitted packets in a population of interest. Total lost packets include any delivered with errors or IPTD greater than 3 seconds.

(ii) The Communications Alliance has defined IP Network QoS Class as a combination of bounds on the performance objectives for IP network parameters between a source User-to-Network Interface and destination User-to-Network Interface.

IP Network	Description	Performance Objectives		
		Mean IPTD	IPDV	IPLR

QoS Class				
0	Jitter-sensitive	≤100ms	≤50ms	$\leq 10^{-3}$
2	Highly interactive, transaction data	≤100ms	-	$\leq 10^{-3}$
5	Best Efforts	-	-	-
6	Ultra-low loss, high capacity	≤100ms	≤50ms @.001%	$\leq 10^{-5}$

4. <u>European Union</u>:

In its goal to be the most connected continent by 2030, EU has introduced the European electronic communications code, which sets clear rules applicable across all of Europe regarding telecommunications. This code also includes some of the QoS parameters for access to a public electronic communications network. The Body of European Regulators for Electronic Communications (BEREC) has also released guidelines detailing QoS Parameters. Some of the important QoS parameters are as given below:

(i) Supply time for initial connection: The duration from the instant of a valid service order being received by a direct service provider to the instant a working service is made available for use. This should exclude cancelled orders.

(ii) Call set up time: The call set up time is the period starting when the address information required for setting up a call is received by the network and finishing when the called party busy tone or ringing tone or answer signal is received by the calling party.

(iii) Bill correctness complaints: The proportion of bills resulting in a customer complaint about the correctness of a given bill per service.

(iv) Voice connection quality: Evaluation of speech quality per call or the end-user perceived voice quality.

(v) Dropped call ratio: The proportion of incoming and outgoing calls which, once they have been correctly established and therefore have an assigned traffic channel, are dropped or interrupted prior to their normal completion by the user, the cause of the early termination being within the operator's network.

(vi) Unsuccessful call ratio: Unsuccessful call ratio is defined as the ratio of unsuccessful calls to the total number of call attempts in a specified time period.

(vii) Call Setup Failure probability: The ratio of total call setup attempts that result in call setup failure to the total call setup attempts in a population of interest.

(viii) Call signalling delays: This parameter involves three different scenarios: call setup, call answer and call release. The call set up signalling delay is the time between the calling terminal providing sufficient address information to set up the call, and the calling party receiving a confirmation from the called terminal that the called party is being alerted.

(ix) Latency (delay): Latency is the time between the first bit entering the network and the first bit arriving at the user across the network. It includes three factors: transmission delay, propagation delay and node processing delay (including queuing delay).

(x) Jitter: Jitter is the variation between the maximum delay and minimum delay within a specific time window.

(xi) Packet loss ratio: Packet loss ratio (PLR) is the total number of packets failing to deliver through the network divided by the total number of transmitted packets within a specific time window.

(xii) Response time for operator services (Customer Care Services – Help Desk): Time elapsed between the end of dialling to the instant the human operator answers the calling user to provide the service requested.

(xiii) Frequency of customer complaints: The number of complaints logged per customer per data collection period.

(xiv) Customer complaints resolution time: The duration from the instant a customer complaint is notified to the published point of contact of a service provider and is not found to be invalid to the instant the cause for the complaint has been resolved.

5. <u>European Telecommunications Standards Institute (ETSI)</u>:

(i) In the ETSI Guide series ETSI EG 202 057, the organisation has provided information about user related QoS parameter definitions and measurements. The important QoS parameters that are measured are as follows:

a. Login time: This parameter signifies the number of successful log-ins.

b. Data transmission speed achieved: The data transmission speed is defined as the data transmission rate that is achieved separately for downloading and uploading specified test files between a remote web site and a user's computer.

c. Unsuccessful data transmissions ratio: This parameter is defined as the ratio of unsuccessful data transmissions to the total number of data transmissions over a period of time.

d. Successful log-in ratio: The successful log-in ratio is defined as the ratio of successful log-ins to access the Internet.

e. Delay (one way transmission time): The delay is half the time in milliseconds, that is needed for an ICMP Echo Request/Reply (Ping) to a valid IP address.

f. Unsuccessful call ratio: This parameter is defined as the ratio of unsuccessful calls to the total number of call attempts in a specified time period.

g. Call set up time: The call set up time is the period starting when the address information required for setting up a call is received by the network and finishing when the called party busy tone or ringing tone or answer signal is received by the calling party.

(ii) Parameters for VoLTE and CSFB:

a) CSFB Call Setup Failure Ratio [%]: This parameter is defined as the probability that the CSFB terminal cannot setup a call.

b) CSFB Call Setup Time: This parameter is the time period between initiation and establishment of a CSFB call

c) CSFB Failure Ratio (%): This parameter measures the probability that the CSFB procedure is not executed successfully by either the calling party or the called party.

d) CSFB Time: This parameter measures the duration of a CSFB procedure successfully executed on either the calling or called party.

e) VoLTE Session Setup Failure Ratio: This parameter is the probability that the VoLTE terminal cannot setup a session.

f) VoLTE Session Setup Time: This parameter is the time needed to initialize a VoLTE session.

g) VoLTE Session Cut-off Ratio: This parameter is the probability that a successfully started call is ended by a cause other than intentional termination by either the calling or called party.

h) IMS Registration Success Ratio: This parameter is the probability that UE successfully registers to IMS

i) IMS Registration Time: This parameter is defined as the time needed for successful registration to IMS.

j) SRVCC Success Ratio: This parameter is defined as the probability that UE successfully handover an IMS-anchored call to UMTS

k) SRVCC Time: This parameter is defined as the time taken to successfully handover an IMS-anchored call to UMTS.

6. OpenSignal:

OpenSignal publishes the Mobile Network Experience Report of different countries by comparing the mobile network performance that is experienced by the users of OpenSignal apps in these countries. The metrics used in the analysis are as follows:

(i) Video Experience: The Open signal Video Experience measurement directly streams sample video from typical content providers and measures a range of parameters that directly impact the user experience, such as loading time and video stalling ratio for different picture qualities or bit rates.

(ii) Games Experience: Open signal's Games Experience measures how mobile users experience real-time multiplayer mobile gaming on an operator's network.

(iii) Voice App Experience: Open signal's Voice App Experience measures the quality of experience for over-the-top (OTT) voice services — mobile voice apps such as WhatsApp, Skype and Facebook Messenger — using a model derived from the International Telecommunication Union (ITU) approach for quantifying overall voice call quality and a series of calibrated technical parameters.

(iv) Group Video Calling Experience: Group Video Calling Experience measures the proportion of video calls where all users on a call had at least an adequate or better video conference experience.

(v)Download and Upload Speed Experience: For the measurement of download and upload speed (DR) experience, OpenSignal uses a fixed time test as opposed to a fixed file size download/upload test.

(vi) Availability: OpenSignal measures the proportion of time for which the users have a network connection in frequent places.

(vii) 5G Reach: Open signal's reach metrics measure how mobile users experience the geographical extent of an operator's network. They analyse the average proportion of locations where users were connected to a network out of all the locations those users have visited

(viii) 4G Coverage Experience: 4G Coverage Experience measures how mobile subscribers experience 4G coverage on an operator's network.

(ix) Excellent and Core Consistent Quality: Consistent quality measurements provide information on how often users' experience on a network was sufficient to support common applications' requirements. It measures the regular set of metrics: download speed, upload speed, latency, jitter, packet loss, time to first byte and the percentage of tests attempted which failed due to a connectivity issue on either the download or server response component. Excellent Consistent Quality is the percentage of users' tests that met the minimum recommended performance thresholds to watch HD video, complete group video conference calls and play games. Core Consistent Quality is the percentage of users' tests that met the minimum recommended performance thresholds for lower performance applications including SD video, voice calls and web browsing.

7. GSMA:

GSMA has published the Official Document IR.42 which provides the definition and computation methods of general QoS parameters. Some of the prominent QoS parameters are as follows:

(i) Network Availability: This offers the probability that a service is offered to the user.

(ii) PDP Context Activation Success Ratio: A packet-switch data session will be considered set-up successfully if a PDP Context can be successfully activated.

(iii) PDP Context Activation Time: This parameter is the time between sending the PDP Context Activation request and receiving the notification of successful completion of that activation.

(iv) PDP context cut-off ratio: The PDP context cut-off ratio denotes the probability that a PDP context is deactivated without being deactivated intentionally by the user.

(v)Default EPS Bearer Context Activation Success Ratio: This parameter measures the success of the EPS attach procedure.

(vi) Default EPS Bearer Context Activation Time: The default EPS bearer context activation time is the time period needed to establish the initial default EPS bearer context for the default APN or any additional PDN connection.

(vii)Dedicated EPS Bearer Context Activation Success Ratio: The dedicated EPS bearer context activation success ratio measures the probability that a dedicated bearer can be activated. It is the proportion of successful dedicated bearer context activation attempts and the total number of dedicated bearer activation attempts.

(viii) Dedicated EPS Bearer Context Activation Time: The Dedicated EPS bearer context activation time is the time that is needed to establish a dedicated bearer for user data transfer.

(ix) EPS Bearer Context Cut-off Ratio: The default or dedicated EPS bearer context cut-off ratio measures whether a default or a dedicated EPS bearer context is deactivated without being initiated intentionally by the user.

(x)DNS Host Name Resolution Success Ratio: This parameter measures the probability for a host name to host address translation of a DNS resolver is successful.

(xi) DNS Host Name Resolution Time: This parameter is the time it takes a host name to host address translation.

(xii) Service Integrity - Throughput (Kbit/sec): This parameter describes the average data transfer rate at the network transport level

(xiii) Service Integrity - Goodput (Kbit/sec): This parameter describes the average data transfer rate at the User Application level

(xiv) Service Integrity - Roundtrip Time: Roundtrip Time (Roundtrip Delay) is the total time that it takes to transmit an IP packet from the source to the destination and receive the reply packet from the destination at the source.

(xv) Service Integrity – Packet Loss: Packet Loss is the ratio of dropped packets to all packets sent from the source to Destination over a given period of time.

(xvi) IMS Registration Success Ratio: This parameter denotes the probability that UE successfully registers to IMS.

(xvii) IMS Registration Time: This parameter denotes the time taken for the UE successfully registers to IMS.

(xviii) IMS Third-party Registration Success Ratio: This parameter denotes the probability for the 3rd-party IMS registrations to be successfully performed.

(xix) VoLTE / ViLTE service access success ratio: This parameter denotes the probability for the end-user to access the VoLTE / ViLTE service and initiate or receive a voice or video call.

(xx) VoLTE / ViLTE session setup time: Time needed to setup a call.

(xxi) SRVCC Success Ratio: This parameter denotes the probability that UE successfully handover a VoLTE call to UMTS or GSM.

(xxii) SRVCC Time: This parameter denotes the time taken to successfully handover a VoLTE call to UMTS or GSM.

B- Wireline Broadband Services

8. USA:

(i) The Measuring Broadband America (MBA) program is an ongoing nationwide performance study of broadband service in the United States that was developed out of a recommendation by the National Broadband Plan to improve the availability of information for consumers about their broadband service. The FCC partnered with SamKnows, an international statistic and analytics firm, to develop the software for MBA testing.

(ii) As part of the Measuring Broadband America (MBA) program, the Measuring Fixed Broadband studies began in 2011 with the release of annual reports based on data collected from fixed consumer broadband Internet service during a single month with few large-scale traffic events, such as major holidays, sports events, or other elections. The data analyzed in the reports thus reflect stable network conditions that provide the most accurate view of a provider's performance under controlled conditions. The measurements for DR (speed) are taken during peak usage periods (7 p.m. to 11 p.m. local time), and the ratio of median speed for each service tier to the advertised speed of the service tier was reported for a better understanding of the DR experienced by the users. For latency, the MBA program measures the round-trip time between the consumer's home and the closest measurement server. An active UDP-based packet loss measurement method is used for packet loss and the packet is considered lost if it is not returned within 3 seconds. The web browsing test accesses nine popular websites that include text and images.

(iii) The following QoS parameters are measured for the Measuring Fixed Broadband program:

a) Download speed - Utilizing three concurrent TCP connections.

b) Upload speed - Utilizing three concurrent TCP connections.

c) Lightweight download speed - utilizing a burst of UDP datagrams.

d) Lightweight upload speed - utilizing a burst of UDP datagrams.

e) Web browsing - Total page fetch time

f) UDP latency - Average round trip time of a series of randomly transmitted UDP packets distributed over a long timeframe.

g) UDP packet loss - The number of UDP packets lost (response packet is not received within three seconds of sending) out of

the total number of UDP packets sent for the UDP latency and packet loss test.

h) Voice over IP - Upstream packet loss, downstream packet loss, upstream jitter, downstream jitter, round trip latency

i) DNS resolution - The time taken for the ISP's recursive DNS resolver to return an 'A record' for a popular website domain name.

j) DNS failures

k) ICMP latency - round trip time of five evenly spaced ICMP packets

l) ICMP packet loss

m) UDP Latency underload - Average round trip time for a series of evenly spaced UDP packets sent during downstream/upstream sustained tests.

(iv) **Measurement Procedure:**

The measurement clients are white boxes (a consumer-grade device installed in the user's network between the router and devices) and the program focuses on performance during the peak usage period, which is defined as weeknights between 7:00 pm to 11:00 pm local time at the subscriber's location. The measurement of the following parameters is undertaken.

a) Download and Upload Speed (DR) test:

Download speed tests measure the download DR of each Whitebox over 10 seconds, once per hour during peak hours and once during each of the following periods: midnight to 6 am, 6 am to noon, and noon to 6 pm. The results from these measurements are averaged across the measurement month and median values of these averaged DRs are calculated for the entire set of

whiteboxes. Testing for upload DR is done similarly to download DR.

The payload that is hosted on a test web server is downloaded by the whitebox for 10 seconds using three concurrent TCP connections. Downloaded content is discarded as soon as it is received and is not written to the file system. Uploaded content is generated and streamed on the fly from a random source. The test is performed for both IPv4 and IPv6, where available, but only IPv4 results are reported.

b) Web Browsing time:

The Web Browsing test, which is performed once every hour, measures the total time it takes to request and receive webpages, including the text and images, from nine popular live websites instead test webpages.

The test records the averaged time taken to sequentially download the HTML and the referenced resources for the home page of each of the target websites, the number of bytes transferred, and the calculated rate per second.

The primary measure for this test is the total time taken to download the HTML front page for each website and all associated images, JavaScript, and stylesheet resources. The test uses up to eight concurrent TCP connections to fetch resources from targets. The test pools the TCP connections and utilizes persistent connections where the remote HTTP server supports them.

c) UDP Latency and Packet Loss:

For UDP latency and packet loss tests, the round-trip time of small UDP packets (8-byte sequence number and an 8-byte timestamp) between the Whitebox and a target test node is measured. The test records the number of packets sent each hour, the average round trip time, and the total number of

packets lost. This test starts when the Whitebox boots and runs permanently as a background test. The test is performed for both IPv4 and IPv6, where available, but only IPv4 results are reported.

9. France:

(i) France Très Haut Débit (France very high speed) program aimed to give all French people access to good, fixed broadband (minimum 8 Mbit/s) by the end of 2020, and to very high fixed speed (minimum 30 Mbit/s) by end of 2022.

(ii) In the less densely populated areas (45% of the area's premises), the program supports local authorities in charge of digital development in the design and deployment of public initiative networks (RIP). The France Very High-Speed Plan represents a state commitment of 3.3 billion euros.

(iii) The 2020 code of conduct on Internet QoS for stakeholders involved in QoS measurement, an update of the 2018 version of the same document was published by ARCEP to define a set of best practices for QoS measurements along with the required methodology. ARCEP measures the following QoS parameters for Internet QoS measurements:

a. Download and Upload Speed (Data Rate)
b. Latency
c. Web Browsing
d. Video Streaming

10. Canada:

(i) The Canadian Radio-television and Telecommunications Commission (CRTC) has commissioned SamKnows to conduct a study of the performance of broadband services sold to Canadian consumers in October 2019 in collaboration with SamKnows. The following internet performance metrics were investigated during the study:

a. Download and Upload speeds (DR)
b. Latency
c. Packet Loss
d. Webpage Loading Time

(ii) The speed (DR) tests (both Download and Upload) operate for either a fixed duration or a fixed volume where a portion of an infinitely sized binary payload is either downloaded from an HTTP server or uploaded to the test server. In the case of Latency and Packet Loss tests, the tests are continuously running in the background, randomly sending the echo requests over a fixed interval. For this parameter, 2000 samples are taken per hour, distributed throughout the hour, as long as the line is not busy.

(iii) Overall, Canadian ISPs have mostly met or exceeded the maximum advertised download and upload speeds across tiers and regions. This QoS is consistent across Canada. Average download performance is over 100% of the maximum advertised speed across all regions and technologies. Also, neither download nor upload performance was found to be affected by peak-hour network congestion to a degree that would be noticeable to users.

11. Italy:

(i) Autorità per le Garanzie nelle Comunicazion (Authority for Communications Guarantees, AGCOM), the Italian Telecom Regulator has started the project, QoS Internet broadband fixed access to address the issue of misleading Internet offers where ISPs provided only the theoretical maximum speed without providing any minimum guaranteed speed. AGCOM selected the following QoS parameters to measure Internet access performances:

a. Data transmission (DL/UL) throughput.
b. Data transmission (DL/UL) unsuccessful rate.
c. Web page download time (HTTP/HTTPS).
d. Packet delay.
e. Packet loss.
f. Jitter.

(ii) **Measurement Procedure:**

a) MisuraInternet is the project by AGCOM for monitoring the quality of Fixed Access Internet. MisuraInternet provides the free software Ne.Me.Sys., which enables the user to independently evaluate the quality of their Fixed Access Internet.

b) The project also compares the quality of the services offered by each operator through the data collected from MisuraInternet. MisuraInternet measures the quality of the line, making at least one measurement per hour throughout the day

c) The Measurements are taken from the user's location through a NAP (Neutral Access Point). AGCOM selected 'La Fondazione Ugo Bordoni' (FUB) to set up three NAPs as endpoints for the measurement.

d) The NAPs are connected to the users through the networks of the operators to which the users are subscribed. Hence, all the traffic exchanged between the NAP and the operator's probe transits exclusively on the network of the operator under test.

12. United Kingdom:

(i) The Office of Communications (Ofcom) published the Wholesale Fixed Telecom Market Review 2021-26 which describes how the regulator will regulate telecom fixed access services from 2021 to 2026. The consultation paper is available for public access:

(ii) The QoS testing for Home Broadband is given below:

a. Download Data Rate: Speed tests with multiple concurrent TCP connections, to assess the capacity of the user's broadband connection that run for 10 seconds. Files of different sizes are downloaded depending on the maximum Data Rate (DR) of the connection. Three files are usually downloaded parallelly to test the download DR.

b. Upload DR: Upload tests are performed similarly to that of Download DR tests

c. Web Page Loading Time: The test downloaded the HTML and media assets of a simple web page hosted on a SamKnows managed server. The time in milliseconds to receive the complete response from the web server is recorded, as well as any failed attempts

d. Latency: A bespoke application is used for the test intended to run continuously to get a statistically robust set of data using UDP.

e. Packet Loss: Same as Latency.

f. Jitter: Same as Latency and Packet Loss

g. Recursive DNS Resolver Responsiveness and Failures:

h. Netflix video streaming performance

(iii) Ofcom also tested the performance of Wi-Fi Routers. It is often observed that the wireless links between the router and the connected devices can become a bottleneck to the performance and consequently, despite the QoS delivered by Service Providers being sufficiently high, the QoS experienced by the users suffers. The key metrics which were tested for performance review of Wi-Fi routers are as given below:

a. RF Performance
b. Bandwidth
c. Stability
d. Interference
e. Capacity
f. Coverage

(iv) **Measurement Procedure:**

a. Ofcom periodically publishes reports for fixed-line residential broadband speeds. Ofcom collaborates with the broadband performance company SamKnows Limited and the testing methodology for the testing and measurements is developed by SamKnows.

b. The testing involved a hardware monitoring unit from SamKnows provided to the users participating in the testing. The unit is connected to the router using an Ethernet cable thereby allowing the unit to determine when the network is free to run the test.

c. SamKnows developed a customized OpenWRT firmware image which is installed on the units. At the point of delivery to the users, this is all that is present on the device; the physical unit contains no additional software, apart from a single script that checks for the availability of the software component at boot-up.

d. Download and Upload Speeds (DR):

   The speed tests for measuring download and upload DR run for a total duration of 10 seconds for broadband connections without a data cap. The testing is limited by the amount of data for broadband connections with a data cap to limit data use.

   For download tests, on connections slower than 30Mbit/s, units download 3 x 2MB files using separate TCP sessions (in parallel). Connections faster than 30 Mbit/s will transfer an increased amount during the downstream throughput test. This amount is up to 12MB (3 x 4MB files) or 10 seconds (whichever is reached first). Connections of 50 Mbit/s or faster are all without data caps and therefore employ the full 10-second speed test.

   The tests that are conducted exclude the period of the speed ramp-up. Multi-thread tests are run nine times per day, once every six hours in off-peak periods and once every hour at peak times.

e. Upload tests are performed for a fixed duration of 10 seconds for connections without data caps or those with an upload speed of 20 Mbit/s or faster. On connections slower than 30Mbit/s, upload tests were performed using 3 x 1MB files with a similar initial lead-in period to that used for download tests. Connections with upload speeds faster than 10 Mbit/s will transfer an

increased amount during the upstream throughput test. This amount is up to 6MB.

f. Webpage Loading Time:

   For webpage loading times, the test downloads the HTML and media assets of a simple web page hosted on a SamKnows managed server. This makes use of up to eight concurrent TCP connections to fetch the assets. The time in milliseconds to receive the complete response from the web server is recorded, as well as any failed attempts. A failed attempt is deemed to be one where the web server cannot be reached, or where an HTTP status code of something other than 213 is encountered. Tests were run every hour.

g. Latency, Packet Loss, and Jitter: For latency, packet loss, and jitter, a bespoke application was used. The application was designed to run continuously to get a statistically robust set of data. The test used UDP rather than ICMP and sent approximately 2000 packets every hour.

Annexure-III

F. No. 5-1/2022-AS-TF
Government of India
Ministry of Communications
Department of Telecommunications
(Quality of Services)
#6th Floor, MTNL Building, Minto Road, New Delhi
*****

Dated: 14.02.2023

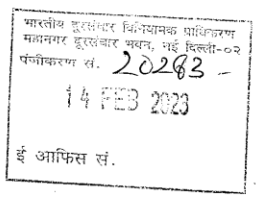
To,
Secretary,
Telecom Regulatory Authority of India,
MTNL Building,
J.L.N. Marg, Minto Road
New Delhi - 110002

Subject: Request for improvement in the present Quality of Service (QoS) through more stringent parameters -regarding

Ensuring QoS is very important for customers' satisfaction and protection of their interest. There is a need to have QoS regulations reviewed periodically to update the QoS parameters and benchmarks. Customer satisfaction should be the major determining factor for the emergence of new services, setting standards and designing of network. Therefore, the customer's requirement and expectations are of paramount importance in reviewing QoS standards.

2. Further, any review of QoS regulations should streamline monitoring, measurement and frameworks of QoS parameters according to the regulatory environment. While framing QoS norms, the parameters and benchmarks should be meaningful to the customer for enabling oneself to take an informed decision on the level of quality one is getting. The QoS standards that are objective, measurable and verifiable, are important to ascertain the quality of service being maintained by the service provider. In a competitive scenario, the need for the service providers is to provide best of the services to attract and retain the customer. This should serve as an incentive to maintain high QoS.

3. For effective competition, promotion of customer awareness and protection of customer interest, access to accurate and meaningful information about service quality can have an effect on customer's choice. This will lead to evolving suitable measures to develop Quality of Experience (QoE) for the customer so that it takes care of QoS and the perception of the customer.



4. In this regard, Department of Telecommunication (DoT) broadly studied various QoS practices which are being followed in other countries across the globe like USA, France, Canada, Singapore, UK, Kenya etc. During analysis, it is observed that a few KPIs with suitable benchmarks (as per Annexure-I) may be considered by TRAI, for further improvement in QoS.

5. In view of above, TRAI may consider to review the existing QoS Regulations and incorporate more stringent parameters / benchmarks to improve the present QoS significantly. While reviewing QoS Regulations, new technologies like 5G, which tends to have ultra-low latency, ultra-reliable communication, high data rates, may also be considered.

6. This is issued with the approval of competent authority.

Encl.: As above

Vivek khare 14/02/2023

(Vivek Khare)
DDG(QoS)
Phone: 011-23210182

Copy for kind information to:

i. PS to Hon'ble MOC
ii. PS to Hon'ble MOS (Comm.)
iii. PSO to Secretary(T)
iv. Sr. PPS to Member(T), DoT

Annexure-I

Sl. No.	Key Performance Indicators (KPIs)	Global QoS Standards	Remarks
1	Latency	For Kenya : Latency = 100 ms For Singapore : Local Latency <= 30 ms and International Latency <= 300 ms	Present benchmark fix by TRAI is 250 ms which seems to be on the higher side keeping in view of Global QoS standards
2	Inclusion of following Parameters in the Benchmarks for wireless data service. • Jitter : • Web: rate of web pages loaded in less than 10 seconds and less than 5 seconds • Streaming: rate of videos viewed in correct quality (light colors) and perfect quality (dark colors) • Downstream rate: (average downstream rate, in Mbit/s) • Upstream rate: (average upstream rate, in Mbit/s) • Rate of SMS received in less than 10 seconds	France	
3	**Drive Tests (DT)/ Virtual Drive Tests** should cover all networks of TSPs covering major areas of heavy usage, residential areas, office areas (indoor & outdoor), tourist attractions, major roads and highways, hospitals, airports, railways stations, bus-stands, schools, Metros (within and underground), commercial areas, business centers, areas from where network coverage/ call drop complaints are commonly received and other major hot spots. DTs should cover both voice and data tests including download/ upload speed, video streaming quality.		Virtual drive tests using AI/ML based tools give real time actual performance.

Sl. No.	Key Performance Indicators (KPIs)	Global QoS Standards	Remarks
4	• QoS monitoring mechanism through PMRs may be reviewed. Fetching of Data should be directly from the NOCs of the TSPs and further processing of this data for preparing PMRs should be at the end of TRAI.		PMR is collected quarterly and issued by a further delay of 2-3 months
	• Alternatively, Quartertly PMR reports submitted by the operators should be tallied with that prepared based on sample data obtained from the NOC/OSS of the TSPs.		
5	TRAI may consider conducting independent measurements of mobile service coverage on monthly basis.		
6	TRAI may consider to fix stringent KPIs with benchmarks for inside the building coverage related issues.		

Annexure-IV

List of Acronyms

Sl. No.	Acronym	Description
1	AGCOM	Authority for Communications Guarantees
2	AI	Artificial Intelligence
3	BEREC	Body of European Regulators for Electronic Communications
4	BMs	Benchmarks
5	CDMA	Code Division Multiple Access
6	CGI	Cell Global Identity
7	CI	Cell Identity
8	CMTS	Cellular Mobile Telephone Service
9	CPE	Customer Premises Equipment
10	CRTC	The Canadian Radio-television and Telecommunications Commission
11	CSSR	Call Set-up Success Rate
12	DCR	Drop Call Rate
13	DL	Down Link
14	DL-PDR	Packet Drop Rate
15	DNS	Domain Name System
16	DRB	Data Radio Bearer
17	eMBB	Enhanced Mobile Broadband
18	ETSI	European Telecommunications Standards Institute

19	E-UTRAN	Evolved Universal Terrestrial Radio Access Network
20	FD	Financial Disincentives
21	FQDN	Fully Qualified Domain Name
22	FTTH	Fibre to the Home
23	FUB	La Fondazione Ugo Bordoni
24	GSM	Global System for Mobile Communications
25	IAS	Internet Access Services
26	ILD	International Long Distance
27	IMS	IP Multimedia Subsystem
28	IP	Internet Protocol
29	IPDV	IP Packet Delay Variation
30	IPLC	International Private Leased Circuit
31	IPLR	IP Packet Loss Ratio
32	IPTD	IP Packet Transfer Delay
33	ISP	Internet Service Provider
34	ITU	International Telecommunication Union
35	IXP	Internet Exchange Point
36	KPIs	Key Performance Indicators
37	LA	Location Area
38	LAC	Location Area Code
39	LAC	Location Area Code
40	LSA	License Service Area
41	LTE	Long Term Evolution

42	MBA	Measuring Broadband America
43	Mbps	Megabits per second
44	MCC	Mobile Country Code
45	MCLR	Marginal Cost of Lending Rate
46	MME	Mobile Management Entity
47	mMTC	massive Machine Type Communications
48	MNC	Mobile Network Code
49	MRTG	Multi Router Traffic Grapher
50	MS	Mobile Station
51	MS-PDP	Mobile Station Packet Data Protocol
52	MTTR	Mean Time To Repair
53	NLD	National Long Distance
54	NSA	Non-Stand Alone
55	Ofcom	Office of Communications
56	OMC	Oeration and Maintenance Centre
57	OTT	Over-the-Top
58	PDCP	Packet Data Convergence Protocol
59	PDP	Packet Data Protocol
60	PLR	Packet Loss Ratio
61	PMRs	Performance Monitoring Reports
62	POI	Point of Interconnection
63	PoP	Point of Presence
64	QDN	Qualified Domain Name
65	QoE	Quality of Experience

66	QoS	Quality of Service
67	RAB	Radio Access Bearer
68	RAN	Radio Access Network
69	RoW	Right of Way
70	RRC	Radio Resource Control
71	RTT	Round Trip Time
72	SDCCH	Standalone Dedicated Control Channel
73	SDU	Service Data Units
74	SGW	Serving Gateway
75	TA	Tracking Area
76	TAC	Tracking Area Code
77	TAX	Trunk Automatic Exchange
78	TCBH	Time Consistent Busy Hours
79	TCH	Traffic Channel
80	TCP	Transmission Control Protocol
81	UDP	User Datagram Protocol
82	UE	User Equipment
83	uRLLC	Ultra-Reliable Low Latency Communication
84	UTRAN	Universal Terrestrial Radio Access Network
85	UTs	Union Territories
86	VoLTE	Voice over LTE
87	VoNR	Voice over New Radio

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