

TELECOM REGULATORY AUTHORITY OF INDIA

NOTIFICATION

New Delhi, the 31st July, 2018

F. No. 305-03/2018-QoS.....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 further to amend the Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009 (7 of 2009), namely: -

**THE STANDARDS OF QUALITY OF SERVICE OF BASIC TELEPHONE SERVICE (WIRELINE) AND CELLULAR MOBILE TELEPHONE SERVICE (SIXTH AMENDMENT) REGULATIONS, 2018
(7 of 2018)**

1. (1) These regulations may be called the Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Sixth Amendment) Regulations, 2018 (7 of 2018);
(2) They shall come into force from the 1st day of October 2018.

2. In sub-regulation (1) of regulation 2 of the Standards of Quality of Service Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009 (7 of 2009) (hereinafter referred to as the principal regulations),
 - (a) after clause (hb), the following clauses shall be inserted, namely: -

“(hba) **“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 based radio access networks;”
 - (b) after clause (y), the following clause shall be inserted, namely: -

“(ya) **“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 Quality of Service (QoS) Class Identifier (QCI)=1 in LTE based radio access networks;”

3. In sub-regulation (1) of regulation 5 of the principal regulations, in the table, and,
 - (a) under the column “Name of Parameter”,
 - (i) in serial number (iii) after entry (c), the entry ‘(d) DL Packet Drop Rate’ shall be inserted;
 - (ii) in serial number (iii) after entry (d), the entry ‘(e) UL Packet Drop Rate’ shall be inserted;
 - (b) under the column “Benchmark”,

- (i) in serial number (iii) item (d), the entry ' $\leq 2\%$ ' shall be inserted;
- (ii) in serial number (iii) item (e), the entry ' $\leq 2\%$ ' shall be inserted;
- (c) under the column "Method and Assessment period",
 - (i) in serial number (iii) item (d), the entry 'On average basis over a period of one quarter' shall be inserted;
 - (ii) in serial number (iii) item (e), the entry 'On average basis over a period of one quarter' shall be inserted.

(Sunil Kumar Gupta)
Secretary

Note.1. —The principal regulations were published in the Gazette of India, Extraordinary, Part III, Section 4 dated the 20th March 2009 vide notification No. 305-25/2008-QoS dated the 20th March 2009.

Note.2. —The principal regulations were amended by issuing the Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Amendment) Regulations, 2012 (10 of 2012) dated the 7th May 2012.

Note.3. —The principal regulations were further amended by issuing the Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Second Amendment) Regulations, 2012 (24 of 2012) dated the 8th November 2012.

Note.4. —The principal regulations were further amended by issuing the Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Third Amendment) Regulations, 2014 (12 of 2014) dated the 21st August 2014.

Note.5. —The principal regulations were further amended by issuing the Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Fourth Amendment) Regulations, 2015 (8 of 2015) dated the 15th October 2015.

Note.6. —The principal regulations were further amended by issuing the Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Fifth Amendment) Regulations, 2017 (4 of 2017) dated the 18th August, 2017.

Note.7. —The Explanatory Memorandum explains the objects and reasons of the "Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Sixth Amendment) Regulations, 2018 (7 of 2018).

Explanatory Memorandum

1. Background

- 1.1.** Telecom Regulatory Authority of India (TRAI) has been given the mandate under the TRAI Act, 1997 to lay down the Quality of Service (QoS), to ensure the QoS and to conduct the periodical survey of such service provided by the service providers so as to protect the interests of the consumers. In exercise of aforementioned functions under the TRAI Act, 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 objectives of these regulations were to create conditions for customer satisfaction by making known the Quality of Service which the service provider is required to provide, and the user has a right to expect; measure the Quality of Service provided by the service providers from time to time and to compare them with the benchmarks so as to assess the level of performance; and to generally protect the interests of consumers of telecommunication services.
- 1.2.** These regulations were subsequently reviewed and TRAI issued the revised QoS standards for these services in the year 2009 as The Standards of Quality of Service of Basic Telephone Service (Wireline) And Cellular Mobile Telephone Service Regulations, 2009 (7 of 2009). First four amendments to the main regulations were made keeping in view the 2G networks and 3G networks deployed by the service providers. Subsequently, due to growing concerns by consumers regarding poor QoS and increasing call drops and introduction of 4G network deployment by service providers, last amendment i.e. the fifth amendment to the regulations was issued on 18th August 2017 which redefined QoS framework for Drop Call Rate (DCR) assessment. After this amendment, the consolidated data of all the cells of the TSP is to be assessed as part of a single network, irrespective of the technology being used i.e. whether cells belong to GSM, CDMA, WCDMA or LTE.
- 1.3.** Similarly, parameters other than DCR like Accessibility (Call Setup Success Rate and Session Establishment Success Rate, Channel/ Bearer Congestion), Retainability parameter of Connection with good voice quality are also computed in a technology agnostic manner and these parameters includes LTE radio access bearers, Voice over LTE (VoLTE) in addition to voice and network performance for 2G and 3G networks. While computation of QoS parameters for all RATs may be consolidated as a single data set, there may be technology specific terms and thresholds for considering samples as good or bad. Corresponding values of parameters for different technologies may be computed in a technology specific manner but once computed they may become part of single data set. For DCR assessment, VoLTE was also included in the revised QoS regulations and Explanatory Memorandum (EM) to fifth amendment referred to ITU-T Recommendation G.1028 which defines end-to-end quality of service for voice over 4G mobile network. However, detailed deliberations on various issues of QoS specific to voice services for LTE users were not done during earlier consultation.
- 1.4.** LTE networks are IP based and it is common protocol for delivering voice and data. Voice and data have quite different characteristics, data in nature is asymmetric and comes in bursts while voice is symmetric and almost regular in periods. Therefore, providing voice services through LTE network may be a bit challenging as compared to the 2G and 3G networks. 2G and 3G based radio technologies and devices came in market with voice capabilities from day one and voice services to users are provided by the same network on which they were camped on. For purpose of voice calls, if LTE network is not supporting voice i.e. VoLTE then user may be required to be pushed to other radio access technologies i.e. fall back to Circuit Switched technologies (CSFB) which may affect QoS experience of user. LTE network penetration in India

has increased significantly in last one year. Many operators providing LTE coverage have yet to offer VoLTE. VoLTE may be launched in a phased manner across the country. Almost all other operators having LTE networks in India have plans to launch VoLTE services soon. In such scenarios, there may be many 4G users who are suffering due to long time required to set up the voice calls.

- 1.5. In view of this, the Authority undertook a public consultation in the matter by releasing a consultation paper on “Voice Services to LTE users (including VoLTE and CS Fallback)” on 26th February 2018 seeking comments of stakeholders by 16th March 2018. In response to the Consultation Paper, the Authority received comments from 12 stakeholders. An Open House Discussion (OHD) was also held with the stakeholders at New Delhi on 23rd April 2018. This consultation was focused and limited to QoS issues related to voice services to LTE users e.g. silence or voice mute for VoLTE users and voice call related issues experienced by users served via CSFB and capture them appropriately in the DCR statistics available from the networks or during drive tests. All comments received from stakeholders during the consultation process have been considered by the Authority while finalizing these regulations.

2. Key issues raised in the Consultation Paper (CP) were:

- 2.1. **Issue of silence/voice mute and requirement of new Quality of Service parameters specific to voice services for LTE users:** It is noticed that requirements of Quality of Service (QoS) specific to voice services for LTE users may be different from 2G and 3G users. Therefore, there are possibilities that network parameters and benchmarks as per existing regulations are not sufficient for effectively monitoring QoS for VoLTE/CSFB calls. Various situations were discussed in consultation paper which could result in poor QoS experience for VoLTE users. It is observed that, in LTE, some of the constants and timers are used whose values may impact QoS but improve DCR statistics or call set up success rate etc. Inappropriate value configuration of such timers and constants in the network may lead to situations like; frequent call drops, longer call set up delay, silence periods or voice muting. Such instances may result into silence period or voice mute observed by the users. In order to resolve such issues, it is important to define instance of silence/voice mute and how many such instances may be accepted during voice call. It was sought from stakeholders to identify the KPI which could be used to measure report and evaluate network or service from perspective of silence/voice mute problem.
- 2.2. **Parameters to measure performance of users being served voice via CSFB:** What parameters like Post Dialing Delay (PDD) may be introduced to measure performance of users being served voice via CSFB. For CSFB scenarios, measurements for time taken to set up the call and report the measured values may be required to be specified.

3. Comments of Stakeholders

- 3.1. **Issue of silence/voice mute and requirement of new Quality of Service parameters specific to voice services for LTE users:**
 - (a) Majority of stakeholders suggested that measurement of Mean Opinion Score (MOS) score provides an easy way to measure and quantify the device speech quality. However, few stakeholders mentioned that they cannot identify the source of the problem i.e. if the Mute or silence is due to device or network. Apart, these equipment's being expensive, do not scale out for a mass testing in live Service provider network. However, few stakeholders including service provider suggested that quality of VoLTE calls needs additional support from factors like IP Packet Loss (uplink and downlink), Block Error Rate (uplink & downlink), Garbled Voice Packets, Jitter, Mute calls, Mean Opinion Score (MOS), Dropped call, Call setup success rate, Call setup time, Post dial delay, Registration success rate, Registration

delay, S-CSCF identification success rate, S-CSCF identification delay etc.

- (b) Some stakeholders suggested that the existing parameters like packet loss, jitter, latency, end-to-end delay are sufficient to identify or measure silence/voice mute while others suggested some additional parameters may be used for measurement. One more suggestion received from stakeholders, which was related to tapping data with probes from VoLTE forwarding plane for the measurement of silence/voice mute instances and duration of silence impacting customer experience as it has a lot of subjectivity in it. These kinds of measurements and KPIs/ KQIs (Key Quality Index) are derived based on customized algorithms devised by individual “probe vendors”. Also, these KQI measurements are done on dip stick basis to evaluate customer experience trends and detect issues in the network/devices. These are non-standard/customized algorithms that are subjected to continuous tuning based on customer research surveys of experience and show variance of measurement output across probes from different vendors. Thus, introducing such KPIs/KQIs as part of the regulation will not be advisable. Other stakeholder suggested that a mechanism of measuring mute calls can be through conducting drive tests on sample basis during TRAI IDTs.
- (c) One service provider suggested that the measurement of PDCP SDU Loss Rate for VoLTE provides the fraction of IP packets (PDCP SDUs) which are lost (not successfully received) on the uplink and downlink. Packets lost in any of the lower layers such as Physical, MAC and RLC layers can be recovered through retransmission, however, Packets lost in PDCP SDU Layer cannot be recovered and hence can be considered for muting. The Benchmark for VoLTE Voice Quality KPI (100-PDCP SDU Loss Rate) is suggested to be of 95%. One consumer protection association furnished suggestions related to the average and the ideal quality values of the Packet Loss rate during Voice over LTE sessions and suggested values were <2% and <1% respectively.
- (d) Some stakeholders submitted that optimization of timers and constants, mentioned in 3GPP TS 36.331, is very essential from the users experience perspective. One stakeholder suggested that The Media Inactivity Timer (MIT) is the critical timer that influences the dropped call rate in VoLTE. One of the stakeholder suggested that PDCP discard timer could be used for optimization. However, majority of stakeholders suggested that the prescribed QoS parameters will be sufficient to take care of such constants/timers. While the ranges of timers/constants are as per the 3GPP standards, the actual values set are dependent on vendor implementations which may be different across all mobile operators (depending on which operator has deployed which vendor’s equipment in its network). Each OEM works on a certain range of values for the timers and constants as per the internal systems and network designs pertaining to applicable terrain, clutters etc. and uses them for the purpose of optimization.

3.2. Parameters to measure performance of users being served voice via CSFB: Few stakeholders suggested that ITU-T Recommendation G.1028 & GSMA recommendation IR.42 has defined parameters to measure performance of voice via CSFB such as Registration success rate (KPI related to IMS), Post-Dialing Delay (PDD), voice quality (MOS-LQ) and call drop rate, CSFB Return to LTE Success Ratio, Speech Quality on Call Basis (SpQ), Call Completion Ratio Circuit Switched Telephony etc. which may reflect the customer experience for voice service.

4. Analysis of inputs and conclusion

4.1. Issue of silence/voice mute and requirement of new Quality of Service parameters specific to voice services for LTE users: From the discussions and deliberations on the issues related to VoLTE, muting of

voice or silence during conversation seems to be a major concern. Any of the current parameters specified in the QoS regulations do not reflect poor quality of service on this part. Voice call over LTE might not be dropped while there may be a long pause of voice.

- (a) To capture instances of such pauses, percentage of Internet packet drops may be a network parameter which may reflect quality of service. To measure and assess high percentage of drops, there may be options to capture it while conducting drive tests but these tests in a particular area may not be very frequent. Other option may be to define a network level parameter which may be measured and reported periodically.
- (b) Mean Opinion Score (MOS) for measuring mute or silence during VoLTE calls at network level would require implementation of probes across the network. This may not be practical from regulatory perspective as probes are to be physically deployed across the networks and number of probes and locations are to be expanded along with the growth and expansion of the networks. MOS based methods or alternative ways to assess the quality of voice calls during conversations may be carried out by making sample test calls during drive tests. However, such tests would be limited to the period and locations of drive tests.
- (c) Network level parameter for measuring and assessing mute or silence period during VoLTE calls may be directly related to drop and loss rate of Internet packets (IP Packets). In LTE networks, to measure drop rate of packets, it may be appropriate to capture drop rate of Service Data Units (SDUs) at Packet Data Convergence Protocols (PDCP) layer as loss of packets at this layer cannot be recovered while loss of packets at lower layers than PDCP layer such as Physical, MAC and RLC layers have mechanism to recover packet loss through re-transmissions.
- (d) In view of this, **the Authority decided that new QoS network parameter for assessment of VoLTE mute may be assessed by packet drop rate in downlink and uplink. Such measurements may be made on average basis for entire network in the license service area and reported to TRAI on quarterly basis.** In general, Packet loss rate is defined as the ratio of lost packets to all packets sent from the Source to Destination in percents (measured over a given period of time) [GSMA document IR.34]. In LTE, following three scenarios for PDCP SDUs (Internet Protocol packets) drop and loss are possible which may be defined in accordance to the International Specifications 3GPP TS 36.314 and 3GPP TS 32.425: -
 - (i) PDCP SDUs (Internet Protocol packets) may be dropped or discarded on the downlink. Where, a dropped packet is one whose context is removed from the eNodeB without any part of it having been transmitted on the air interface while packets discarded during handover are excluded from the count. For such measurement, only user plane traffic (Dedicated Traffic Channel DTCH) is to be considered.
 - (ii) PDCP SDUs (Internet Protocol packets) may be lost (not successfully transmitted) on the downlink. Where, a lost packet is one whose context is removed from the eNodeB/ RN after an attempt has been made to transmit part or all of the packet on the air interface but the whole packet has not been successfully transmitted (not positively acknowledge). For such measurement, only user plane traffic (Dedicated Traffic Channel DTCH) is to be considered.
 - (iii) PDCP SDUs (Internet Protocol packets) may be lost (not successfully received) on the uplink. Where, a lost packet is a missing UL PDCP sequence number, representing packet that is not

delivered to higher layers, of a data radio bearer. For such measurement, only user plane traffic (Dedicated Traffic Channel DTCH) and only PDCP SDUs that have entered PDCP (and given a PDCP sequence number) are to be considered.

- (e) For the purpose of VoLTE, QCI will be equal to 1. In view of above, it is observed that new network parameters may be included, for QoS assessment, which will cover all the above mentioned three scenarios. Therefore, **Authority considered the views of stakeholders and decided to introduce two new network parameters for QoS regulations “Down Link (DL) Packet Drop Rate or DL-PDR” and “Up Link (UL) Packet Drop Rate or UL-PDR”, to measure overall packet loss or drop in both downlink and uplink at PDCP layer.** Here, DL-PDR will include both the packets dropped due to congestion, traffic management etc, and packets lost in the downlink transmission between the eNodeB and UE and between the eNodeB and Relay Nodes (RNs), as defined in sub-para(d) (i) and (d) (ii) respectively. However, UL-PDR will only include packets lost in the uplink transmission between the eNodeB and UE and between the eNodeB and RNs, as defined in sub-para(d) (iii) above. Regarding benchmark, one service provider suggested 5% benchmark for PDCP packet loss rate, however, one consumers’ association suggested that packet loss rate in case of voice over LTE session i.e. in ideal <1% and in average <2%. According to the ITU-R M.2135-1 report on ‘Guidelines for evaluation of radio interface technologies for IMT Advance’, *a user is defined to have experienced a voice outage if less than 98% of the packets have been delivered successfully.* In view of above, **Authority decided to prescribe benchmarks as less than or equal to 2% for both the parameters.**
- (f) 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 the eNodeB and is recorded 24 hours a day, every day of the years. However, for reporting the performance the measurements have to be taken during TCBH. The formula for calculating the percentage of DL Packet Drop Rate and UL Packet Drop Rate are:

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

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 and UE and between the eNodeB 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 and UE and between the eNodeB and RNs.

4.2. Voice Services for LTE Users via CS Fall Back: Circuit Switch (CS) Fall Back (CSFB) scenarios lead to long call set up time and user may not be aware about the requirements of the network for such longer times to set up the voice calls as network is not in a position to announce or send a tone because of non-availability of radio resources between user and network for the interim period. To address the concerns related to longer call set up time in cases of Circuit Switch (CS) Fall Back (CSFB) scenarios, the Authority acknowledged the technical reasons which may be beyond control of service providers to reduce the time gap when user initiates the call in LTE networks and calls are established over other types of access networks. In this regard, the Authority decided that field measurements are required to be collected on periodic basis from different locations before setting any particular parameter and benchmarks in this regard. In view of this, **the Authority decided to issue directions to service providers to conduct such field measurements and submit report to TRAI on quarterly basis.**