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TELECOM REGULATORY AUTHORITY OF INDIA

NOTIFICATION

NEW DELHI, 18th AUGUST, 2017

THE STANDARDS OF QUALITY OF SERVICE OF BASIC TELEPHONE SERVICE (WIRELINE) AND CELLULAR MOBILE TELEPHONE SERVICE (FIFTH AMENDMENT) REGULATIONS, 2017 (4 of 2017)

F. No. 304-2/2016-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: -

1. (1) These regulations may be called the Standards of Quality of Service of Basic Telephone Service (wireline) and Cellular Mobile Telephone Service (Fifth Amendment) Regulations, 2017 (4 of 2017);

   (2) They shall come into force with effect from the 1st day of October 2017.

2. In sub-regulation (3) of regulation 1 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), after clause (iii), the following clause shall be inserted:-

   "(iv) Access Services authorized under Unified License (UL)";

3. In sub-regulation (1) of regulation 2 of the principal regulations,

   (a) after clause (a), the following clause shall be inserted:-

   "(aa) Access Services Authorization under Unified License (UL)

   (i) means collection, carriage, transmission and delivery of voice and/or non-voice messages over Licensee's network in the designated Service Area.

   (ii) The Licensee can also provide Internet Telephony, Internet Services including IPTV, Broadband Services and triple play i.e. voice, video and data.

   (iii) While providing Internet Telephony service, the Licensee may interconnect Internet Telephony network with PSTN/PLMN/GMPCS network. The Licensee may provide access service, which could be on wireline and / or wireless media with full mobility, limited mobility and fixed wireless access";

   (b) after clause (b), the following clause shall be inserted:-

   "(ba)**"Base Station" or "BS"** means a network element in a radio access network that is responsible for radio transmission and reception in one or more Cells to or from the user equipment and it includes BTS, Node B and eNode B;

   (bb) **"Base Transceiver Station" or "BTS"** means a Base Station in a GSM or CDMA based radio access network technology";

   (c) for clause (d), the following shall be substituted:-

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

   (d) after clause (e), the following clauses shall be inserted:-

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

   (eb) **"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)";

   (ec) **"Cell_Q(t)" or "Cell Quality of Service Performance Measure for DCR Parameter"** means the tth

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percentile value in the set of DCR values corresponding to a Cell observed during the assessment period";

(ed) **"Cell_Q(90)"** means Cell_Q(t) with t=90 and indicates the 90th 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 90th percentile DCR value for that Cell would point to 81st 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";

(e) sub-clause (iv) of clause (f) shall be substituted by the following:-

"(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 CMTS or UASL or UL";

(f) after clause (h), the following clauses shall be inserted:-

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

(hb) **"Day_Q(97)"** means Day_Q(s) with s=97 and indicates the 97th 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 97th percentile DCR value would point to the 9700th 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;

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

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

(g) after clause (j), the following clause shall be inserted:-

"(ja) **"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 GSM or CDMA or UTRAN Network;

(jb) **"Location Area Code" or "LAC"** means a number of fixed length identification number (of 2 octets) used for identifying a Location Area (LA) within a Public Land Mobile Network (PLMN)";

(h) clause (la) shall be substituted by the following:-

""**Node B"** means a Base Station that acts as a logical node in a Universal Terrestrial Access Network (UTRAN) based on Wideband CDMA (WCDMA) technology";

(i) after clause (la), the following clause shall be inserted:-

"(lb) **"Network_Q_{SD}(s,t)" or "Network Quality of Service (QoS) DCR Spatial Distribution Measure"** means the sth 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;

(lc)**"Network_Q_{SD}(90,90)"** means Network_Q_{SD}(s,t) with s=90 and t=90, and indicates 90th percentile value of Cell_Q(90) values of all cells in the network;

Explanation: Network_Q_{SD}(90,90) value is a representative DCR spatial distribution value for the entire network during the assessment period indicating that Cell_Q(90) value for at-least 90% of the Cells were equal

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to or lower than the Network_Q_{SD}(90,90) value. For example, if a network was operating with ten thousand cells on ninety days during the assessment period then Network_Q_{SD}(90,90) value will be the 90th percentile Cell_Q(90) value out of the available ten thousand Cell_Q(90) values;

(ld) **"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;

(le) **"Network_Q_{TD}(97,90)"** means Network_Q_{TD}(s,t) with s=97 and t=90, it indicates 90th percentile value of Day_Q(97) values of network on all days in the assessment period;

Explanation: Network_Q_{TD}(97,90) is a representative DCR temporal distribution value for the entire network during the assessment period indicating that the Day_Q(97) values of the network for at-least 90% of the days of the assessment periodwere equal to or lower than the Network_Q_{TD}(97,90) value. For example, if a network was operating with ten thousand cells for ninety days during the assessment period, then the Network_Q_{TD}(97,90) value will be the 90th percentile Day_Q(97) value out of available ninety Day_Q(97) values;

"(lf)" **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 90th 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 180th 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."

(j) after clause (m), the following clause shall be inserted:-

"(ma) **"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;"

(k) after sub-clause (rb), the following clause shall be inserted:-

"(rba)**"Radio Link Timeout" or "RLT"** means the Radio Link Timeout value broadcast by the GSM based radio access networks to initialize 'S' counter";

(l) after clause (u), the following clause shall be inserted:-

"(ua) **"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);

(ub) **"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 (PLMN)";

(m) after clause (y), the following clause shall be inserted:-

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

4. In sub-regulation (1) of regulation 5 of the principal regulations, in the table, the column headings and entries in Serial Number A, Network Service Quality Parameters shall be substituted by the following column headings and entries:-

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Serial Number	Name of Parameter	Benchmark	Method and Assessment period
A	**Network Service Quality Parameters:**		
(i)	Network Availability		
	(a) Base Station Accumulated downtime (not available for service)	≤ 2%	On average basis over a period of one quarter
	(b) Worst affected Base Station due to downtime	≤ 2%	On average basis over a period of one quarter
(ii)	Connection Establishment (Accessibility)		
	(a) Call Set-up Success Rate and Session Establishment Success Rate for Circuit Switched Voice or VoLTE as applicable (within licensee's own network)	≥ 95%	On average basis over a period of one quarter
	(b) SDCCH/ Paging Channel Congestion / RRC Congestion	≤ 1%	On average basis over a period of one quarter
	(c) TCH, RAB and E-RAB Congestion	≤ 2%	On average basis over a period of one quarter
(iii)	Connection Maintenance (Retainability)		
	(a) Network QoS DCR Spatial Distribution Measure [Network_Q_{SD}(90,90)]	≤ 2%	On percentile basis over a period of one quarter
	(b) Network QoS DCR Temporal Distribution Measure [Network_Q_{TD}(97,90)]	≤ 3%	On percentile basis over a period of one quarter
	(c) connections with good voice quality, Circuit Switched Voice Quality and Voice over LTE (VoLTE) quality	≥ 95%	On average basis over a period of one quarter
(iv)	Point of Interconnection (POI) Congestion (on individual POI)	≤ 0.5%	On average basis over a period of one quarter

5. In sub-regulation (1) of regulation 5 of the principal regulations, below the table, the following shall be inserted-

NOTE-1: The performance against benchmarks for the parameters listed under (i), (ii) and (iii) in the table shall be computed for all the cells, which are being used to provide Circuit Switched Voice or VoLTE service, in the License Service Area (LSA) in which a service provider is operating;

Explanation: In case, VoLTE service is provided by the service provider then DCR values for the cells of the eNodeBs will be included for the parameters listed under (iii) in the table and if only Circuit Switch based voice calls are provided then cells in the eNode Bs will not be included for the assessment purposes of parameter under (iii) in the table;

NOTE-2: All DCR values for the assessment period shall be considered for Percentile value computation for the parameter listed under (iii) (a) and (iii) (b) in the table except the cases enumerated in the table for list of 'DCR Codes (DC)' given in Note 5;

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NOTE-3: DCR values of each cells for the computation of parameter listed under (iii) (a) and (iii) (b) of the table shall be computed, up to two decimal places, during Cell Bouncing Busy Hour;

NOTE-4: Blank DCR entries or entries filled with any value other than computed DCR value or entries filled with any code or text other than DCR codes specified in Note 5, shall be considered as non-submission of compliance report;

NOTE-5: DCR codes as given below in the table shall be used for the reasons and circumstances corresponding to the codes:

DCR Code	Stands for	Reason or circumstances
DNE	Does Not Exist	The cell was either not commissioned or de-commissioned in the middle of the assessment period and was not part of the network to serve the users in the network.
NOP	Not Operational	The cell was not in operation either due to planned shut down or force majeure condition or technical problem and thus not able to serve the users in the network.
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, DCR values are indeterminate or computed value is irrelevant for the purpose of assessment

NOTE-6: Authority may further add, modify or delete the list of DCR Codes, through directions issued from time to time;

NOTE-7: Usage of DCR codes for reasons and circumstances other than that as specified in Note 5 shall be treated as violation in terms of sub-regulation (3) of Regulation 5 of the principal regulations.

6. In regulation 5A of the principal regulations,-----

(a) in sub regulation (1), after the words, characters and number "regulation (5)", the following shall be inserted:-

(i) ", other than the DCR related parameters i.e. Network_Q_{SD}(90,90) and Network_Q_{TD}(97,90);"

(b) after sub regulation (1), the following sub regulations shall be inserted:-

"(1a) If a cellular mobile telephone service provider fails to meet the benchmark for the parameter 'Network_Q_{SD}(90,90)', specified under sub-regulation (1) of regulation (5), 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, as given in the table below, for the contravention, reported by the service provider in its quarterly report:

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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

Provided that if the service provider fails to meet the benchmark consecutively in two or more subsequent quarters, he shall be liable to pay, by way of financial disincentive, an amount not exceeding one and half times of financial disincentive payable, for the consecutive contravention and not exceeding twice the financial disincentive liable to be paid as specified in the table above for each consecutive contravention occurring thereafter:

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

(1b) If a cellular mobile telephone service provider fails to meet the benchmark for the parameter 'Network_Q_{TD}(97,90)', specified under sub-regulation (1) of regulation (5), 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 there under, be liable to pay an amount, by way of financial disincentive, as given in the table below, for the first contravention, reported by the service provider in its quarterly report:

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

Provided that if the service provider fails to meet the benchmark consecutively in two or more subsequent quarters, he shall be liable to pay, by way of financial disincentive, an amount not exceeding one and half times of financial disincentive payable, for the consecutive contravention and not exceeding twice the financial disincentive, liable to be paid as specified in the table above, for each consecutive contravention occurring thereafter:

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

(1c) The total amount payable as financial disincentives, under sub-regulation (1a) and (1b), shall not exceed rupees ten lakhs, in a quarter.

(1d) The Authority may, impose a lower amount of financial disincentive than the amount of financial disincentive payable as per the provisions in sub-regulation (1a) or (1b) or (1c), as the case may be; where it finds merit in the

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reasons furnished by the service providers:

Provided that the decision of the Authority in such circumstances shall be final and binding on the service providers."

7. In sub-regulation (1) of regulation 6 of the principal regulations, -----

in the table, the following numbers, words, characters shall be inserted:-

Serial Number	Name of Parameter	Benchmark
2	Radio Link Timeout (RLT)	4 to 64

(a) after sub-regulation (6), the following sub-regulation shall be inserted:-

"(6a) The service provider shall keep records of those BTS with their locations, which were configured with Radio Link Timeout (RLT) values equal to or higher than 48 for a period of more than 3 consecutive days. Service provider shall maintain the records of valid reasons or justification for keeping RLT equal to or more than 48 for each Cell of BTS and provide it to the Authority or its authorized agency or representative, on demand, for verifications".

18/8/2017

(Sunil Kumar Gupta)
Secretary (In-charge)

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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 Explanatory Memorandum explains the objects and reasons of the "Standards of Quality of Service of Basic Telephone Service (wireline) and Cellular Mobile Telephone Service (Fifth Amendment) Regulations, 2017 (4 of 2017).

Explanatory Memorandum

1 Background

The rationale for regulations in the telecommunication sector is closely linked to the objectives of protecting the interests of telecom service providers, telecom consumers and maintaining an environment of orderly growth in the sector. One of the key responsibilities assigned to TRAI is to lay down the standards of quality of service to be provided by the service providers so that telecom subscribers should get a fair and satisfactory quality of service (QoS). The International Telecommunications Union (ITU) defines QoS to mean "*Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service*".

1.1 In general, markets are expected to function in a manner that consumers would gravitate towards providers that offer them the best service experience at the most competitive prices. But, in fact, subscribers come to know the quality of service provided by the service provider only after subscribing and using the services. And subscribers do not have the information to assess whether the services of a competing TSP are likely to be more or less satisfactory than those offered by their current provider.

1.2 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.

1.3 In exercise of its functions under the above provisions in 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

a. 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;

b. 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

c. to generally protect the interests of consumers of telecommunication services.

1.4 These regulations were subsequently reviewed and TRAI issued the revised QoS standards for these services in July 2005. The regulations issued in 2005 were further reviewed in 2008-09 and TRAI issued "The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations, 2009" in March, 2009.

1.5 The QoS regulations of 2009 were first amended in May, 2012 to provide for parameters for 3G services. In November, 2012 TRAI amended the regulations to include financial disincentives for delay in submission of compliance reports, non-compliance with the benchmarks for QoS parameters, and for wrong reporting of QoS performance. The introduction of these financial disincentives was based on the information collected by TRAI through various QoS audit analysis reports which revealed that some of the service providers were "*repeatedly not meeting the QoS benchmarks for some prescribed parameters and no consistent improvement is noticed in spite of the measures taken by TRAI. Therefore, there is a need to provide for financial disincentives for failure to meet the Quality of Service benchmarks*".[1] Accordingly, the Authority decided that there was a need to introduce financial disincentives in relation to the performance of service providers under the QoS benchmarks so as to strengthen the effectiveness and compliance of the said regulations.

1.6 Subsequently, a third amendment to the regulations was issued in August 2014, to address the practical difficulties expressed by the service providers in meeting the benchmarks. To create further deterrent against consecutive non-compliance with the benchmarks, TRAI again amended the regulations on 15th October 2015, providing for increased financial disincentives in cases of repetitive non-compliance.

1.7 Even with the regular monitoring of QoS parameters and financial disincentives in cases of non-compliance,

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1 Explanatory Memorandum to the Standards of Quality of Service of Basic Telephone Service (wireline) and Cellular Mobile Telephone Service (Second Amendment) Regulations, 2012.

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there have been growing concerns by consumers regarding poor QoS and increasing call drops, with a large number of consumers complaining about poor quality of experience (QoE), i.e. the level of quality that customers believe they have experienced. This was in contrast to observed QOS parameters where service providers were generally meeting the existing benchmarks for most of the QoS parameters.

1.8 In this background, with a view to compensate the customers for poor quality, the Authority undertook public consultation and issued the "Telecom Consumers Protection (Ninth Amendment) Regulations, 2015 (9 of 2015)" on October 16th, 2015. Through these regulations, TSPs were mandated to provide compensation of one Rupee for each dropped call to the calling consumers, limited to three dropped calls in a day. However, these regulations were struck down by the Hon'ble Supreme Court.

1.9 As it was being observed that there is a significant divide between the performance of TSPs against the current QoS benchmarks and the actual network performance as experienced by subscribers. This called for a need to reassess the current benchmarks and move towards adopting revised QoS norms and parameters that may be better equipped for achieving the desired goals. This is in line with the Authority's duty to lay down the QoS standards and ensure that such standards are met "*so as to protect interest of the consumers of telecommunication service*". Accordingly, the Authority decided to relook into the various other options for ensuring QoS, including redefining the various QoS parameters and benchmarks, measurement methodology etc. so as to improve the QoE of customers.

1.10 QoS network parameters, at present, are being evaluated for the service area as a whole and daily performances are averaged over a month for assessment of the performance of service providers at the level of the Licensed Service Area (LSA). But there could be many areas/ localities within the network where the performance on existing QoS parameters could be poorer in comparison to other parts of the LSA.

1.11 When the dropped call rate (DCR) is measured by averaging across the country, as mentioned in the consultation paper, more than 12% of the individual base transceiver stations (BTS) report a call drop rate of more than 2% and approximately 1% of the individual BTS report a call drop rate of more than 10%. In contrast, the overall call drop rate in the country - using the existing measure - was around 0.7%, which is well below the benchmark. TRAI has issued a Direction on 29th July, 2015 to the TSPs to provide the call drop rate in 63 cities across the country. It should be noted that in most of the cities, the TSPs are generally meeting the call drop rate of 2%, once again signaling a gap between the benchmark performance and end user experience.

1.12 The problems created as a result of this gap can be better explained by taking a closer look at the design and implementation of cellular networks. A cellular network consists of a large number of BTS, which is the infrastructure through which communication signals are transmitted between the subscriber's equipment (i.e. mobile phone) and the TSP's network. In general, each BTS consists of three cells each of which covers a certain number of subscribers within its coverage area. As the users of cellular networks move across several locations, the voice calls being made by them are handed over from one cell to another. This may lead one to assume that a subscriber's QoE is dependent on the performance of its TSP's network across the broad geographic area within which a subscriber would typically use its services. However, in reality, a large number of users typically use their mobile phones for making calls from one or two specific locations where they spend most of their time, in addition to a part of the time that may be spent in transit. For instance, subscribers who predominantly use their mobile phones at home or at their place of work would be most directly impacted by the performance of the TSP's cells that cover these specific areas. From the perspective of those users, degraded performance of these cells cannot be offset by better performance of the TSP's cells in some other location.

1.13 In view of this, the Authority undertook a public consultation in the matter by releasing a consultation paper on "*Review of network related Quality of Service standards for Cellular Mobile Telephone Service*" on 5th August, 2016 seeking comments of stakeholders by 16th September, 2016. In response to the Consultation Paper, the Authority received comments from 13 stakeholders. An Open House Discussion was also held with the stakeholders at Chennai on 21st December, 2016. All comments received from stakeholders during the consultation process have been considered by the Authority while finalizing these regulations.

1.14 Key issues in the Consultation Paper (CP) raised to review network related QoS standards for Cellular Mobile Telephone Service (CMTS) were:

a. Redefining existing network related QoS parameters

i. options to measure and benchmark QoS at Sub-service area level i.e. at LDCA (Long Distance Charging Area)/DHQ (District Headquarter)/City/Town/ BTS level

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ii. *options to benchmark call drop rate by calculating it at License Service Area (LSA) level during Time Consistent Busy Hour (TCBH) or by calculating it during Cell Busy Bouncing Hour (CBBH) at BTS level*

iii. *options to define parameters and benchmarks to make them technology agnostic*

b. Introducing additional Parameters to measure network related QoS parameters

i. *Criteria to set the RLT (Radio Link Timeout) parameters and values that need to be set*

ii. *Options to calculate call drop rate through CDR data analysis and benchmark for this purpose*

c. Defining Consumer satisfaction index for Quality of Experience (QoE) purpose and methodology of calculating such index. Also identifying latent variable and ways to calculate them.

d. Introducing a Graded Financial Disincentive based on performance and quantum of financial disincentives for various parameters.

1.15 Four issues raised in above sub-para 1.14 (a) namely, Sub-Service Area, TCBH vs. CBBH, options to define new parameters (including defining technology agnostic parameters) & setting new benchmarks are related with assessment methodology of Drop Call Rate (DCR) parameters. For the analysis of all these four issues and re-defining framework for DCR assessment methodology requires re-look into assessment area, assessment period, statistical measures to be used for the assessment, defining new parameter(s) and benchmark(s), if need. All these issues need to be deliberated together and therefore, this set of four issues have been deliberated in a combined manner in Para 2 to Para 7.

1.16 Rest of the four issue mentioned in sub-para 1.14 (b) and 1.14(c) namely, Graded Financial Disincentives, criteria to set RLT parameter, CDR data analysis for Call Drop Rate assessment and Customer Satisfaction Index have been deliberated subsequently in the Para 8 to Para 11 respectively.

2 Present Methodology of Drop Call Rate (DCR) Assessment and related issues

2.1 One of the main issues highlighted in the consultation paper was regarding the present methodology of assessment of the performance of service providers by averaging QoS parameter over the service provider network. CP emphasized the adverse impact of averaging out the 'Call Drop Rate 'parameter over a service area as a whole and also averaging out over a month. The averaging method for assessment of 'call drop rate' parameter could not identify local variations in many areas/ localities within the network where the performance on these QoS parameters could be poor.

2.2 One of the options to address the issues related to averaging may be to apply averaging on a smaller geographical area or for a shorter time period. For example, averaging on sub-service area instead of complete service area may contain the averaging effect within that sub-service area. Monitoring of benchmarks for various parameters on a sub-service area level may help in identifying the problem areas, taking measures to address the problem, and consequently ensuring better QoS. Other options to address the averaging effect may be to explore and define new parameters for the QoS standards.

2.3 The main issues raised in the consultation paper related to DCR assessment methodology were

a. Whether Measurement of QoS should be at sub service area level (LDCA/ DHQ/ City/ Town / BTS Wise) or a combination?

b. Whether call drop should be measured at TCBH or at CBBH?

c. How should the benchmark for the parameters be revised? What should be the benchmarks and how should they be measured?

2.4 TSPs' views

a. During the consultation process, service providers and industry associations had supported the present system of QoS measurement at LSA level.

b. The reasons advocated by them in support of their suggestions are that

i. *maintaining uniform QoS in all parts of the LSA is not possible due to various factors which are beyond their control,*

ii. *no international reference of sub-service area level benchmarking in geography comparable to India is found,*

iii. *the problem areas are well identified through the raw data network counters submitted to the Authority and also through regular drive tests,*

iv. *the networks are architected for a Service Area and not designed and built on LDCA or District basis, lack of availability of digital maps with clearly defined towns, varying size of sub-service area and quantum of BTSs etc.*

c. There was a suggestion from one service provider that the benchmarking of QoS parameters should be at a combination of LSA and BTS level.

d. The service providers have also suggested to change the measurement methodology for the parameter "Worst affected cells having more than 3% call drop rate".

e. With respect to measurement of call drops, the service providers and industry associations have supported measurement of QoS parameters at Time Consistent Busy Hour (TCBH) only at service area level as Cell Bouncing Busy Hour (CBBH) may vary drastically with various factors like sudden movement of subscribers, any outage etc. whereas, TCBH accounts for the network performance as a whole and not just for a particular cell.

f. The overall view of the service providers is that the existing regulation of measuring QoS of telecom networks at LSA level should continue.

2.5 Suggestions from stakeholders other than TSPs

a. Suggestions from other stakeholders included monitoring QoS at BTS level as this would eliminate "averaging-out", measurement of QoS across all of India, and focusing on 'hot spots' or poor service areas.

b. One consumer organization registered with TRAI suggested tightening the benchmark for the call drop parameters and the parameters relating to voice quality and POI congestion.

2.6 Suggestions were also made in favour of continuous measurement so that seasonal changes, metro, urban and suburban development can be factored into. The consumer organization referred to above also suggested that QoS measurement should take place at the BTS level during Cell Bouncing Busy Hour (CBBH).

2.7 Before proceeding further, it would be useful to gain a deeper insight into the DCR data and have a better understanding of the character, shapes and patterns of the typical distribution of DCR data. This is followed by an evaluation of the options of redefining the DCR parameters; the revisiting the measurement methodology; or tightening of the current benchmarks. Accordingly, the following section provides some illustrations to explain:

a. the typical distribution pattern of DCR values at the BTS level and the consequences of (i) averaging the DCR values of all the cells in a BTS; and (ii) further averaging the DCR values of a BTS over a period of time; and

b. the extent to which the poor performance of some BTS can be compensated by the better performance of others while averaging the performance of a provider's BTS at a LSA level.

2.8 Typical Distribution Pattern of Count of BTS vs. DCR

a. Distribution pattern of the number (count) of BTS with DCR meeting current benchmarks is illustrated in the graph below. DCR for a BTS is an average of three DCR values belonging to each sector or cell of this BTS. Consequently, very few BTS may report DCR value close to zero as it is highly unlikely for all three cells to have zero DCR values and average DCR value of zero for all days in the assessment period.

b. Similarly, very few BTS may be seen to have higher DCR values, which may be due to the effect of averaging DCRs for a BTS over a period of time. If a BTS had high DCR values on a few days, then it likely that it may also have had relatively lower (i.e. better) DCR values on some other days. Accordingly, for a network that meets the current benchmark of 2% DCR, the peak of the distribution of the number of BTS will most likely fall between DCR values of 0 to 2.

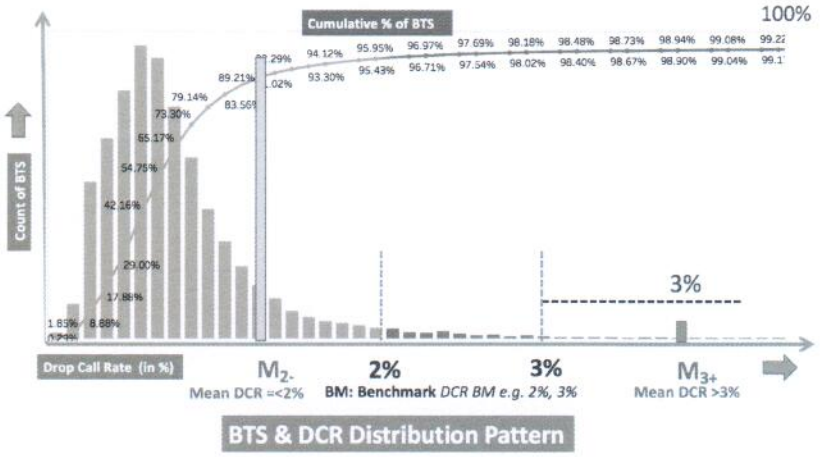

Figure 1: Illustration of distribution pattern of count of BTS vs. DCR

c. The range of continuous DCR values, along with the count of the BTS, may also be presented in a point-mass form. For instance, all BTS having DCR values less than or equal to 2% can be clubbed together and represented at their mean DCR value M_{2-} with height of the bar being equivalent to % of total count of BTS in the 0-2 DCR value region. Similarly, M_{3+} may represent mean DCR value of BTS having DCR value beyond 3%. Percentage of BTS counts exceeding 3% DCR value is represented as a point-mass value at M_{3+} with % of BTS counts shown at a bar height of 3%.

2.9 Impact on Network Performance Assessment due to DCR averaging

a. Presently, the QoS for network parameters is measured for the service area as whole. Because of averaging, bad performance in some of the areas within the LSA is compensated by good performance in other areas, allowing the service provider to meet the benchmark. However, this method of computation of QoS performance does not give a true picture about the extent of non-compliance in specific pockets and the problem areas. For example, the figure below illustrates the DCR performance of all the BTS of a provider in a particular LSA:

- M_{2-} indicates the mean DCR value of all DCR values lying between zero and 2%;
- M_{2-3} indicates the mean DCR value of DCR values lying between 2% and 3%; and
- M_{3+} indicates the DCR values lying beyond 3% and M_{ALL} is overall average value.

b. From the illustration, it can be seen that average DCR value meets the 2% benchmark even though there are a good number of BTS lying between 2% and 3% DCR and a few BTS also have DCRs greater than 3%.

c. The following is a hypothetical example that illustrates the extent to which the DCR values of badly

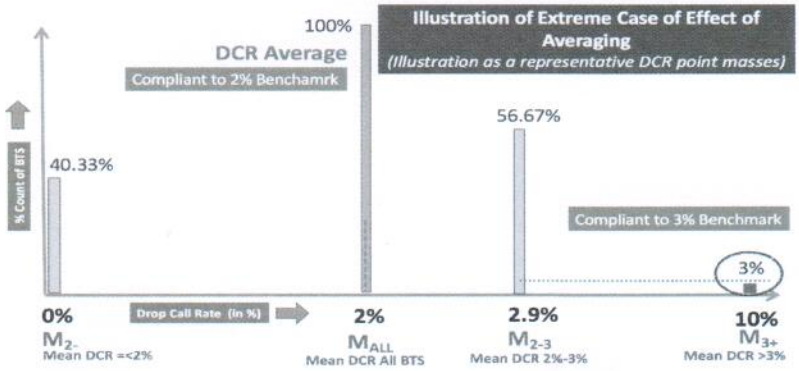

Figure 2: Illustration of effect of averaging in extreme case

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performing BTS could potentially be offset by the DCR values of value of well performing BTS. If we assume that 40.33% of the total BTS of a provider in a LSA are performing ideally with zero percent DCR value, that would be sufficient to compensate for 56.67% of its total BTS with DCR value at 2.9% (almost 3%) and 3% of BTS with DCRs values as high as 10%.

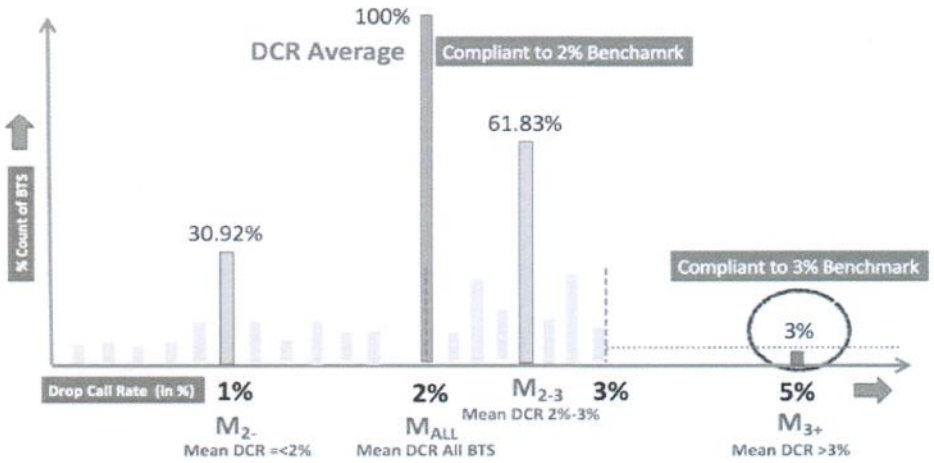

Figure 3: Illustration of effect of averaging

d. The effect of averaging may be better visualized by comparing the averaging process with a see-saw (as illustrated in the diagram below) having planks of unequal lengths. The benchmark point i.e. 2% DCR can be considered to be the fulcrum point of the see-saw with the left-side plank of the fulcrum being a length of 2mm (0 to 2% DCR) and the right-side plank going up-to the length of 98mm (2% to 100% DCR) to be the of the see-saw. The circles on either side represent the point mass for DCR value ranges while the size of the circles represents their weight, equivalent to the % count of BTS in that range. The position of the circles represents mean DCR values within the DCR sub-range which the circle represents. Typically, as seen in the BTS & DCR distribution patterns discussed earlier, weights on the left-side plank are likely to be heavier than weights on right-side plank. Further, on the right-side plank, the distances of circles from the fulcrum are relatively much larger than the distances of circles on the left-side of the plank. If the see-saw is balanced or inclined towards the left, then performance of the network would be considered to be compliant with the existing benchmark. As is obvious from the illustration, that averaging may easily balance out the far placed smaller size circles on the right part of plank using the weight of the bigger sized circles on the left part of the plank.

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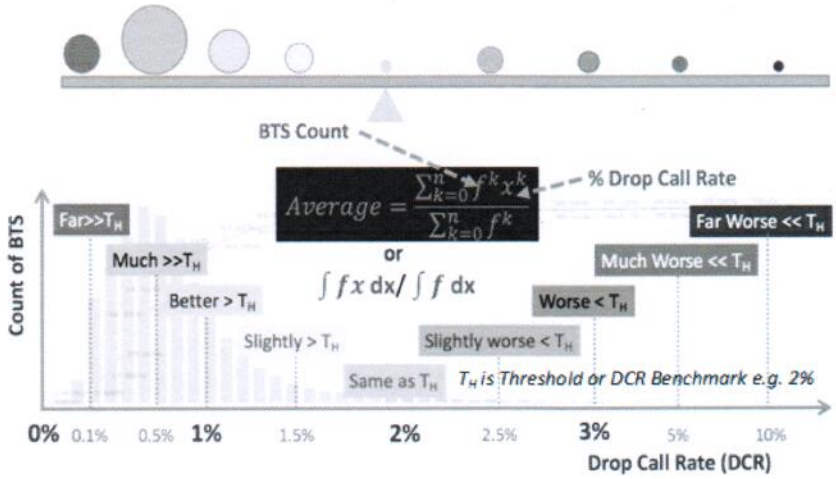

Figure 4: Illustration of effect of averaging (See-Saw)

2.10 In view of above, the Authority felt the need to devise a QoS framework for DCR assessment that measures and reflects a more realistic and granular picture of the network's performance while addressing the concerns of customers; and keeping in mind the practical constraints faced by TSPs, along with factors beyond their control.

2.11 The Authority accordingly decided to carry out a detailed study of the DCR data of some of the service areas submitted to TRAI by telecom service providers in order to gain a deeper insight and characterize the distribution behavior which would help to define new DCR parameters, revisit the existing methodology; or tighten the existing benchmarks. In summary, the framework is to be revised in such a manner that it identifies problem areas and represents a more realistic picture of the performance of the network.

3 Organizing the DCR data

3.1 Arranging the DCR Data (DCR-Matrix-Spatial-Distribution)

a. The first step is to organize the DCR data in matrix form where each row represents the DCR values for individual cells over the days in chronological order as columns i.e. the daily DCR values for the assessment period. DCR data points with values greater than the set benchmark for each individual cell are highlighted as illustrated in figure 5. e.g. 2% DCR are shown in light grey and DCR data points breaching the benchmark are in dark grey.

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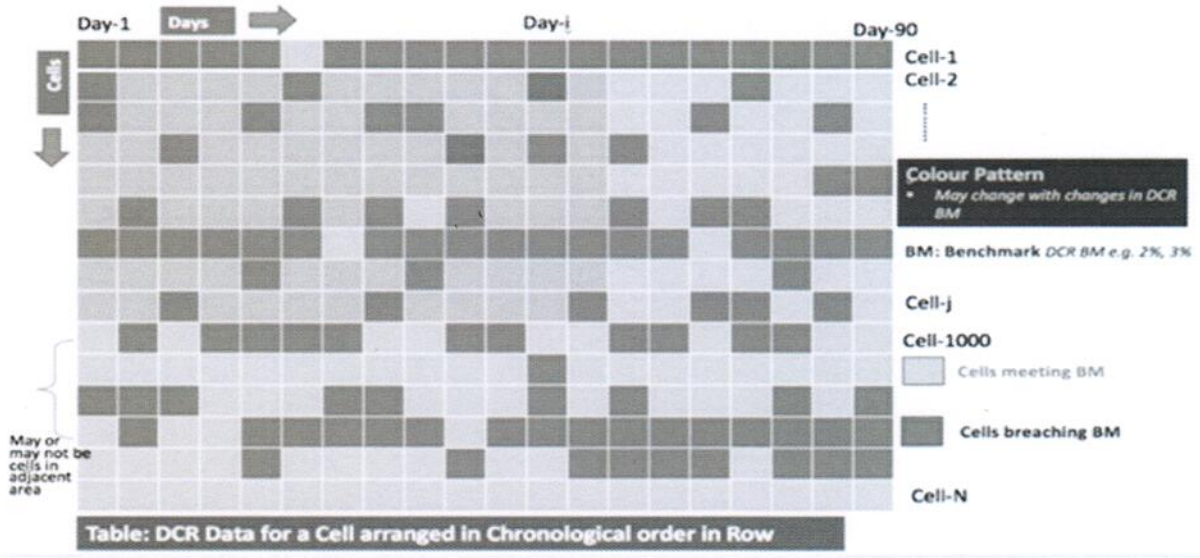

Figure 5: illustration of DCR data for different cells on different days

(grid size shown in the illustration is not to scale)

b. Suppose if DCR values for each individual cell be arranged in ascending order for all days in the assessment period, then the worst DCR values of a cell irrespective of date will slide to the rightmost part as illustrated in figure(6).

c. Certain days for a cell - let's say 10% of total days - may exhibit poor performance due to uncertainty and factors beyond the control of the TSP, for e.g. uncertainties in the behavior of mobile traffic and Radio Frequency (RF) signal propagation. Given this backdrop, 90 percentile (say) DCR value of the daily time-series of DCR values of each cell, may be considered as representative DCR for that cell during the period of assessment. This representative DCR value of each cell may be called Cell-Q factor, and in the context of spatial distribution matrix, the corresponding value for a cell may be called Cell_Q(90).

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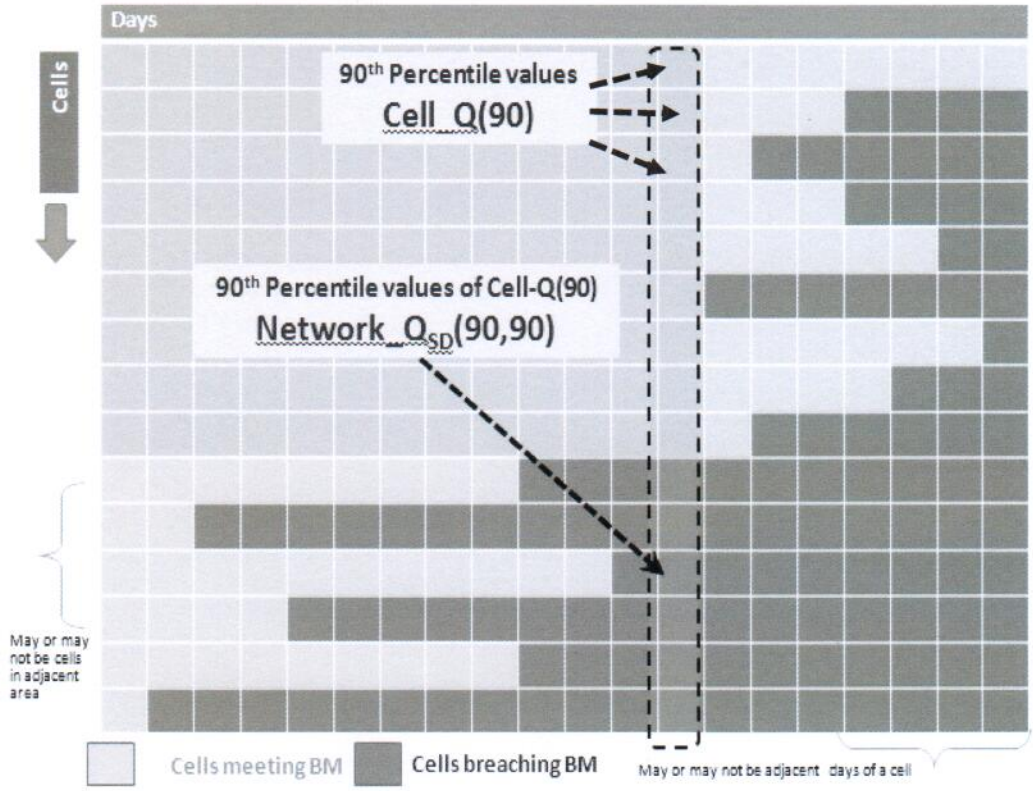

Figure 6: Illustration of DCR data after sorting of DCR values within a row and then sorting rows on the basis of 90th percentile DCR value of row
(grid size and column indicating Cell_Q(90) shown in the illustration is not to scale)

d. The rows, previously ordered over time, are next sorted in ascending order of their representative 90th percentile DCR values identified in the previous step. The 90th percentile DCR value is extracted from the resulting vector of ordered, representative 90 percentile values of each cell. Unlike the previous step, we obtain a single value for the cross-sectional 90th percentile cut which we refer to as Cell_Q(90).

e. Bottom region of the matrix after arranging of rows, will have all cells (complete row with DCR data belonging to that cell) with Cell_Q(90) relatively higher (i.e. poorer performance) in comparison to Cell_Q(90) of cells in upper part of the matrix.

f. The complete DCR value dataset arranged in a row and columns may be called the DCR-Matrix-Spatial-Distribution (DCR-Matrix-SD).

3.2 Partitioning of DCR Matrix Spatial Distribution

a. The Cell_Q(90) for each cell represents the worst performance (highest DCR) attained by the cell after removing 10% of its worst performing days. Next, in order to account for cells which might exhibit consistently poor performance e.g. border cells, we extract the 90th percentile DCR value from the vector of Cell_Q(90) for each cell. We obtain a single value for the cross-sectional 90th percentile cut which represents the DCR value achieved by a network 90% of the time, in 90% of geographic locations (cells). This value is the representative value for the performance of a network as a whole, across time and location and we term this value as Network_Q_{SD}(90,90). Essentially Network_Q_{SD}(90,90) is the 90th percentile of Cell_Q(90) of all cells in a network.

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b. Considering that data for all cells, for all days in the period of assessment is available, Network_Q_{SD}(90,90) will be a cross-point of a column having Cell_Q(90) values and a row having DCR values corresponding to a cell having Cell_Q(90) and represents 90th percentiles value among all Cell_Q(90) values.

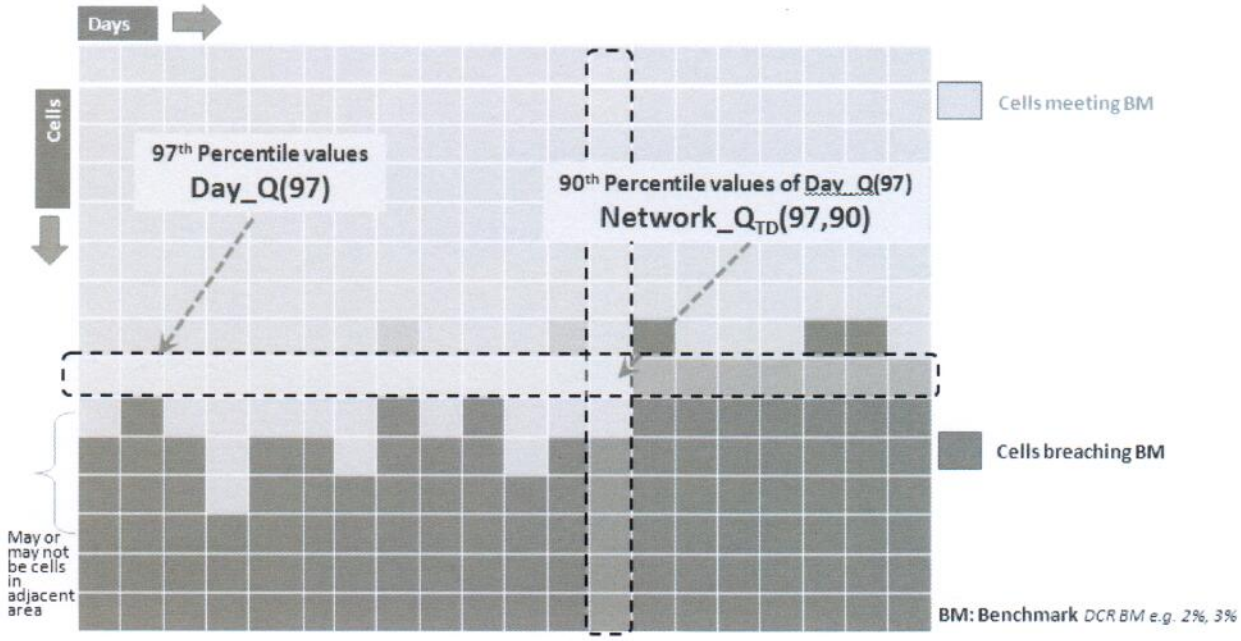

Figure 7: Illustration of DCR data to show Network_Q_{TD}(97,90) as 90th percentile DCR value Day_Q(97)

3.3 Arranging the DCR Data (DCR-Matrix-Temporal-Distribution)

a. Similarly, DCR Data can be arranged in ascending order in each column first for performances of various cells on a particular day.

b. 97th percentile DCR value in a column may be representative DCR value for that day with 97% of cells having better DCR values than this. This may be called as Day_Q(97).

c. Similar to Spatial Distribution Performance DCR Matrix, all columns can be rearranged in a ascending order of Day_Q(97) values and 90th Percentile of the Day_Q(97) will be Network_Q_{TD}(97,90).

d. The complete DCR value dataset arranged first spatially, and then temporally may be called DCR-Matrix-Temporal-Distribution (DCR-Matrix-TD).

3.4 Regions of DCR Matrix

a. The column and row associated with any Data-point in the DCR Matrix (apart from matrix borders) divide the matrix into four regions. From benchmark perspective, concern will be specific to some key points in the matrix such as Network_Q_{SD}(90,90) in the spatial distribution and Network_Q_{TD}(97,90) in the temporal distribution. This single Q-point may give good insight into thenetwork performance and may be a key data-point for defining benchmark.

b. Column and rows containing Network-Q_{SD}(90,90) in a completely filled array of DCR values matrix i.e. DCR-Matrix for Spatial or Network-Q_{TD}(97,90) for Temporal Distribution partitions the data in four regions namely, Top-Left Region (TLR) , Top-Right Region (TRR), Bottom-Left Region(BLR), Bottom-Right Region(BRR).

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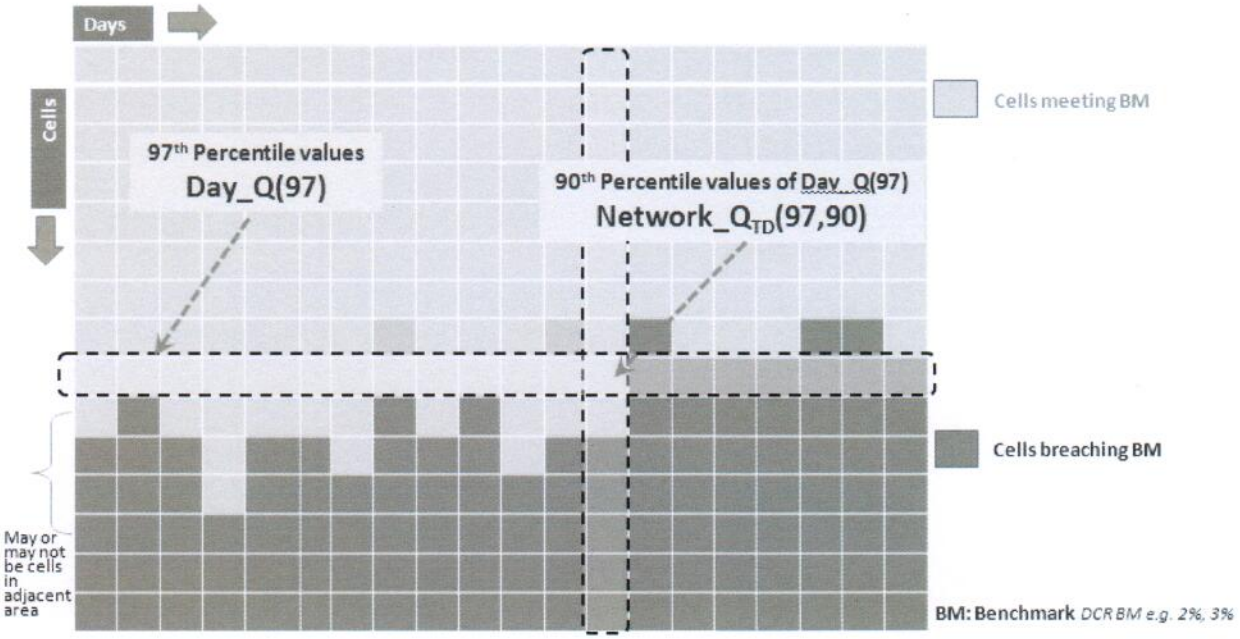

Figure 8: Illustration of DCR data to show Network_Q_{TD}(97,90) as 90th percentile DCR value Day_Q(97)

4 Characteristics of the data in different partition

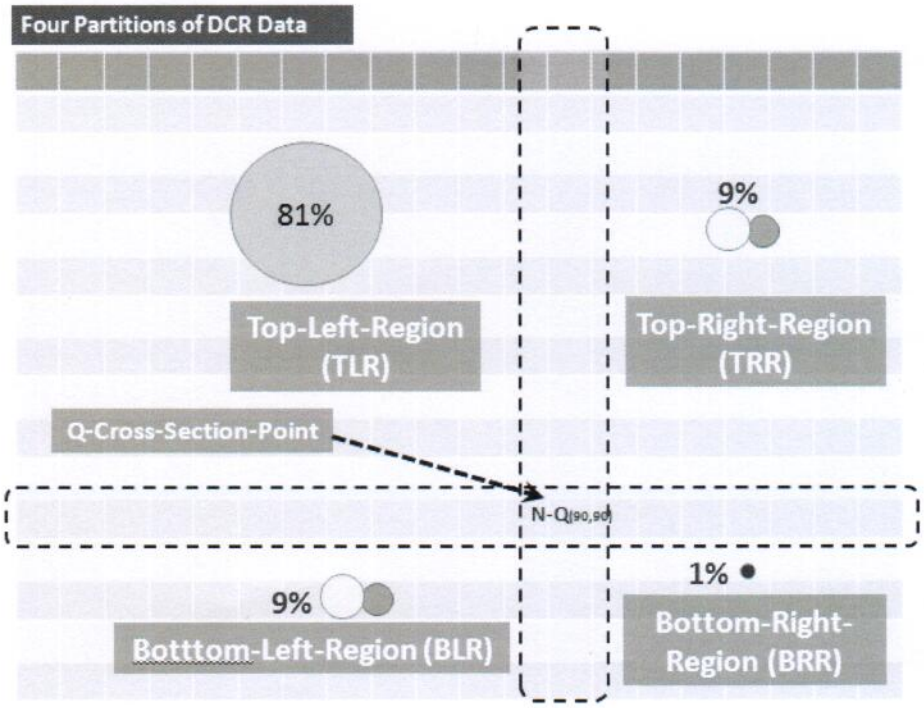

Figure 9: Illustration for partitioning of DCR Data

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4.1 Characteristics of the data in Top-Left Region (TLR) in DCR-Matrix-SD

a. Column containing Network_Q_{SD}(90,90) has representative DCR values for all cells and every DCR value of this column is a upper bound value for all DCR values in the left part of the same row. This DCR value is also a lower bound value for all DCR values in right part of the same row.

b. TLR part contains DCR values which are smaller than Network_Q_{SD}(90,90) i.e. Network_Q_{SD}(90,90)) is an upper bound value for complete Top-Left Region (TLR).

c. If the network performance of a TSP computed as per the Network_Q_{SD}(90,90) methodology meets the DCR

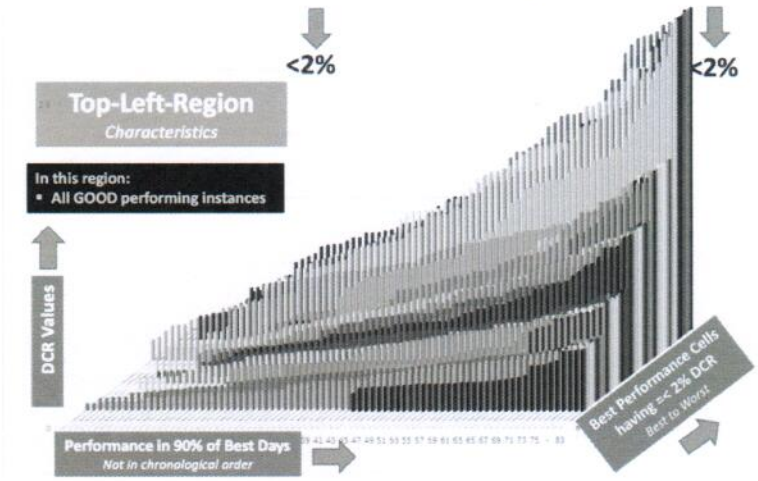

Figure 10: Top Left Region

benchmark specified by the Authority (say, 2%) then all data points in the TLR are better than benchmark value.

d. TLR contains 81% of the total data-points in the DCR-Matrix and Network_Q_{SD}(90,90) value meeting the DCR benchmark indicates that at least 81% data-points are better than the benchmark value.

e. If DCR values in TLR are not meeting the DCR benchmark value set for an individual cell, then there is a cell which has performed worse than the set DCR benchmark for more number of days than the set benchmark of 10% of total days (say).

4.2 Characteristics of the data in Top-Right Region (TRR) in DCR-Matrix-SD

a. This region of the Network_Q_{SD}(90,90) partition represents 9% data-points. It has row-wise DCR values which are greater than Cell_Q(90) values for the cell representing that row.

b. In this region, Cell_Q(90) values are smaller than the Network_Q_{SD}(90,90) values and there may be a wide range of DCR values in this region, some of which meet the specified benchmark value while others do not.

c. In this region, if two rows are considered then it may happen that DCR values in a row which is on downside

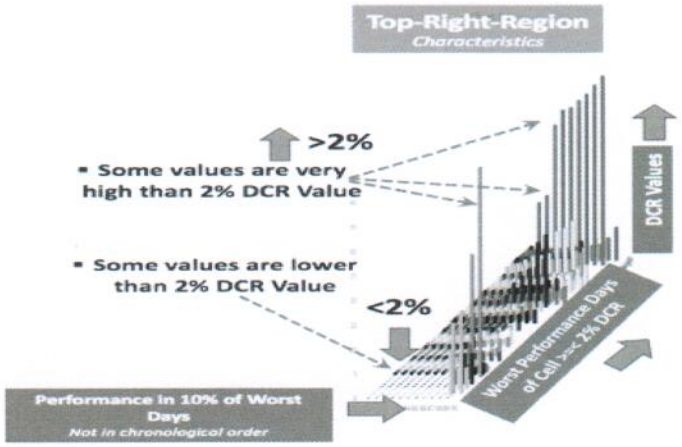

Figure 11: Top Right Region

may be having DCR values smaller than DCR values in the row on the upper side. It may depend upon DCR value rising pattern of row beyond a Cell_Q(90) point. Different rows having different Cell_Q(90) starting point may have rising curves competing with each other and one curve may be rising at a slower pace while other curve may be rising at a faster pace and cross each-other.

4.3 Characteristics of the data in Bottom-Left Region (BLR) in DCR-Matrix-SD

a. This region of the Network_Q_{SD}(90,90) partition symmetrically represents 9% data-points of DCR-Matrix.The DCR values in a row in BLR are smaller than Cell_Q(90) values for that cell.

b. In this region, if two rows are considered then DCR values of a row will be rising from left to right side and reaching to their respective Cell_Q(90) values. Cell_Q(90) of a row on downside may be equal or higher than Cell_Q(90) value of a row on upper side. But it may happen that DCR values in a row on downside may be having DCR values smaller than DCR values in the row on the upper side. It may depend upon DCR value rising pattern of row before reaching to a Cell_Q(90) point. Different rows having different Cell_Q(90) final points and DCR rising curve may compete with each other and one curve may be rising at a slower pace while other may be rising at a faster pace and cross each-other.

c. If one DCR value in a row in this region is not meeting the benchmark, then all right DCR points will not be meeting the benchmark value as they are arranged in non-decreasing order.

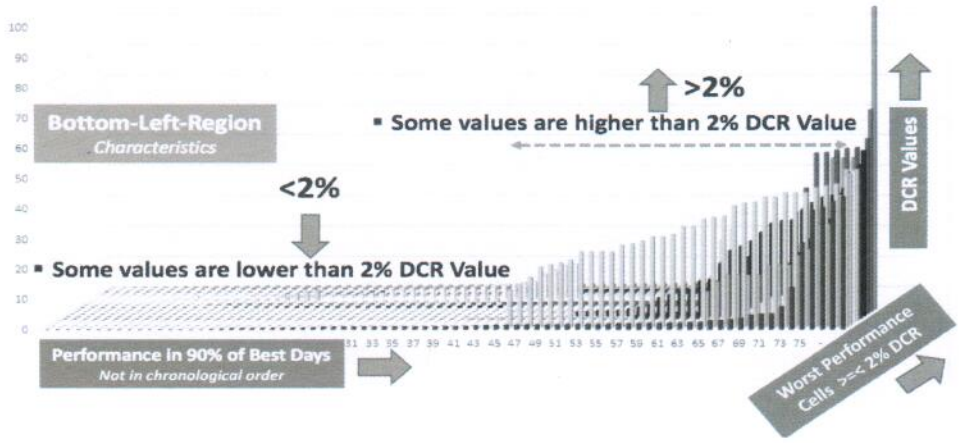

Figure 12: Bottom Left Region

4.4 Characteristics of the data in Bottom-Right Region (BRR) in DCR-Matrix-SD

a. This region of the Network_Q_{SD}(90,90) partition represents 1% data-points of DCR-Matrix.

b. This region represents all DCR values worse than benchmark values.

c. However, all DCR values may or may not be as bad as observed in TRR. This means that worst DCR values may either be in TRR or BRR.

d. Cell_Q(90) of a row is a lower bound value for all DCR values in the BRR.

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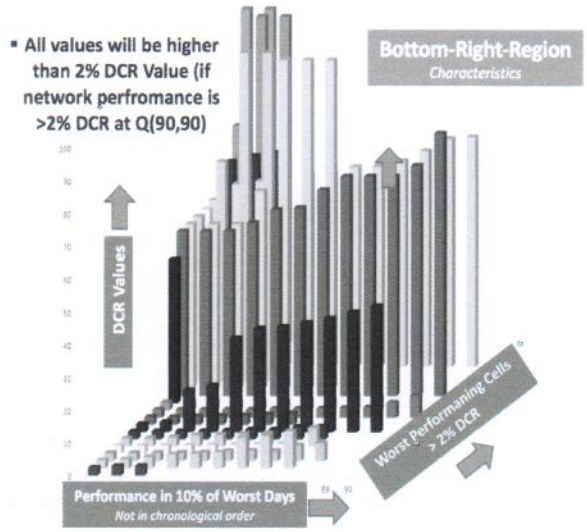

Figure 13: Bottom Right Region

4.5 Characteristics of the data in DCR-Matrix-TD

a. The DCR-matrix for Temporal Distribution similarly, has four regions divided by the point Network_Q_{TD}(97,90) with similar characteristics.

b. The key difference to be noted between the spatial and temporal matrices is that the former focuses on cells which are consistently performing poorly, for many days, while the latter addresses the days on which the performance of cells is relatively poorer than other days.

5 Main objectives for redefining existing network related quality of service parameters for cellular mobile telephone service.

5.1 DCR data organized in Spatial distribution and Temporal distribution will provide insight into area-to-area variations of DCR and day-to-day variations of DCR. Appropriate points in this distributions which may be representatives of performance of network on most of the days and for most of the cells in the network and may be used as new parameters for measure of DCR assessment and accordingly new benchmarks may be set for these parameters.

5.2 Before finalizing the new parameters for DCR assessment in context of DCR Spatial and Temporal Distribution, there is need to consider the main objectives which should be met by the new parameters and benchmarks. And also to consider the assessment area, radio access technologies and assessment period for which DCR matrix need to be populated. New parameters and benchmarks also take into account the factors which are beyond control of TSP and practical challenges faced by them. Some of these points like objectives and stakeholders' views related to DCR assessment are deliberated under this Para while other points are dealt in Para 6 and Para 7.

5.3 The benchmarks for QoS should be designed in a way that makes them meaningful to consumers - enabling them to make an informed choice between TSPs based on the level of quality of service they can expect, irrespective of the technology provided by the TSPs. Accordingly, it is important to adopt measures that are objective, measurable, and verifiable so as to ascertain the QoS being maintained by the service providers.

5.4 While designing the benchmarks, it was kept in mind that the benchmark parameters should be achievable - while at the same they should force a service provider to invest resources in improving QoS. Also the QoS parameters and benchmark should be technology agnostic (2G/ 3G/ 4G/ BWA) and should be capable of being measured and reported irrespective of the technology deployed.

5.5 For exploring the options of new parameters and benchmarks, or revising the measurement methodology - key objectives should be set ex-ante, which can be used to ascertain the appropriateness of the new approach and

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ensuring that the concerns with the present methodology or parameters are addressed.

5.6 After analyzing the issues raised earlier with the averaging process, following key objectives were set out for devising a new framework or approach for DCR assessment:

a. Main goal of the new framework should be to highlight the problem areas so that coordinated actions may be taken to ensure effective QoS.

b. New approach should consider DCR of individual cells of a Base Station (BS) for each day without involving any averaging process for the assessment of a cell during the period of assessment.

c. The new approach should also consider representative DCR value of all individual cells without involving any averaging process for assessment of the representative DCR value of the network.

d. The new methodology should be able to identify the cells which have performed worse than the set benchmark beyond a certain % of days in the period of assessment. Such identified cells with poor performance for many days should be appropriately considered in the performance assessment of the network.

e. The new methodology should also identify the days on which a significant number of cells (e.g. certain % of the total cells in the network) of the network observed relatively poorer performance. Such identified days should be considered while assessing the network performance.

5.7 After analyzing the stakeholders' views, the Authority felt that the following key points should be given due consideration while devising a new framework or approach for assessment:

a. Licenses are issued on service area basis and infrastructure is created to provide the service at a service area level.

b. Operators are facing problems in establishing infrastructure because of false EMF radiation rumours, scarcity of spectrum, Right of Way (RoW), infrastructure related issues, administrative issues, natural calamities etc.

c. TSPs face practical challenges in meeting the benchmarks at each individual cell level for every day, which are beyond their control e.g. various factors like sudden movement of subscribers, any outage etc.

d. Radio Frequency (RF) propagation characteristics introducing uncertainties in the coverage to any user with variations in location and time.

e. Performance assessment of a network should be done after excluding certain cells or certain days but assessment should be representative of most of the part of the network for most of the days.

5.8 New benchmark or methodology which achieves the above objectives and addresses the gaps in the existing benchmarks is deliberated in following Para(s).

6 Redefining framework for new benchmarks, parameters and methodology for DCR assessment

6.1 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, it is clear that the problem areas, if any, are easily identifiable using the methodology described above.

6.2 One of the options brought up in the consultation was to tighten the benchmark for the parameters so that the effect of averaging a TSP's performance over the LSA may be lessened. However, based on a detailed analysis of averaging process, it is obvious that mere tightening of benchmarks while retaining the process of averaging will not address the concerns of identifying the problem area. Any average DCR value arrived at through this process may not be representative of most of the parts of the networks and most of the days.

6.3 These concerns are being addressed by the being new methodology of carrying out the DCR-Matrix analysis using the Q-factor cross-section, as described in the previous sections.

6.4 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.

6.5 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

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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.

6.6 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.

6.7 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.

6.8 To meet the objective of assessment of network irrespective of the technology provided by the TSPs, the DCR Data matrix may be a single data matrix for all technologies being used for providing voice services. In case of a voice call, a user may not be concerned about the specific technology being used to serve him/her. Therefore, aggregating data of all cells of a TSP, irrespective of technology, will be appropriate. Accordingly, the Authority has decided that QoS parameter like DCR should be technology agnostic (2G/ 3G/ 4G/ BWA) as these can be measured and reported irrespective of the technology being deployed.

6.9 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. Accordingly, the Authority has come to the conclusion that the Q-values cross-points methodology shall be used for ascertaining the level of QoS being offered by a service provider in relation to call drops.

7 Setting the Benchmarks (BMs) for DCR Assessment

7.1 One of the objectives to be kept in mind while setting the benchmark value is to arrive at Q-values which are achievable and also 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.

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

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).

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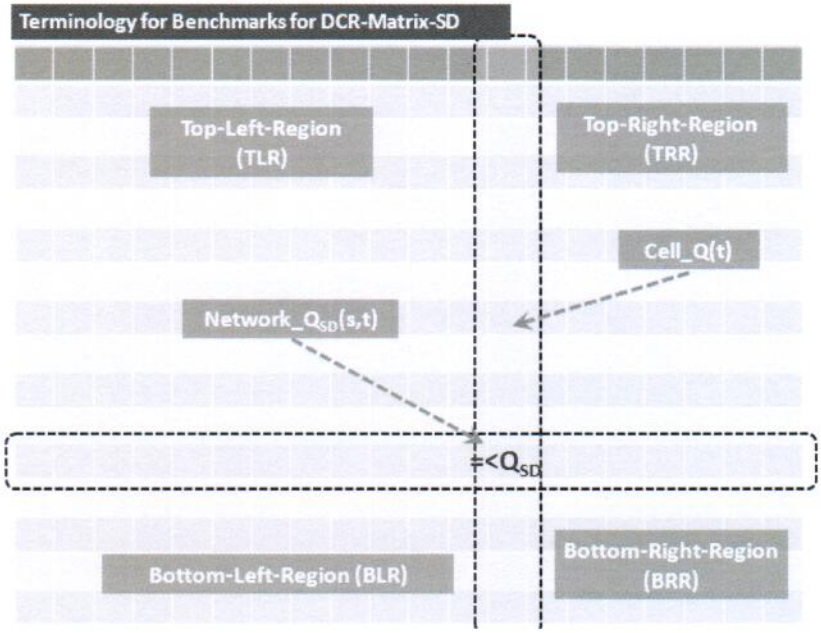

Figure 14: Terminology for DCR-Matrix-SD related

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_QTD(s, t)

f. DCR benchmark value, QTD which is to be set as a maximum DCR for Network_QTD(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}.

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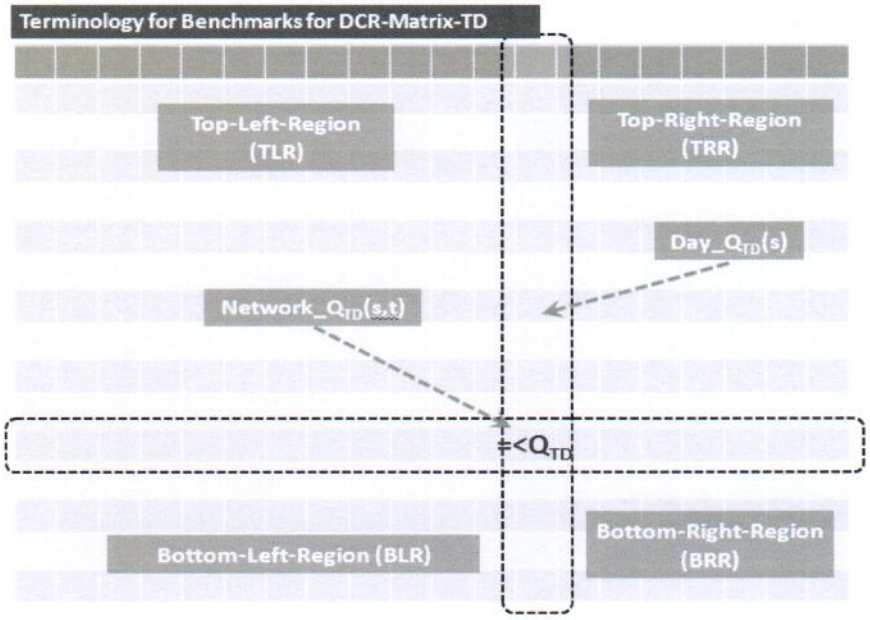

Figure 15: Terminology for DCR-Matrix-TD related

7.3 One of the main issues in the consultation paper was that averaging of DCR over the entire service area and over a period of three months was not reflective of a large number of local variations in the DCR value. The 2% DCR benchmark, as such, was not an issue although tightening of DCR benchmark was considered as an option for the specific purpose of lessening the impact of averaging. In the DCR-Matrix, DCR data is not averaged with DCR values of any other cells, not even with the values of other cells belonging to same BTS. In present assessment methodology of worst affected BTS, counts of good performing days of one BTS was compensating counts of bad performing days of other BTS which is not the case in revised approach. So, if averaging effect is nullified then, it will be a relatively stringent requirement. However, considering practical difficulties faced by the TSPs and the many factors that may be beyond the control of a TSP, certain percentage of days are allowed to be excluded for each cell and also certain percentage of cells are allowed to be excluded from the assessment of the network performance by appropriately choosing values of Percentile s and t values. Once that is done, if network is meeting the Q-Cross-point benchmark then DCR value for each cell on all days lying in the TLR would be better than 2% in case of spatial distribution and better than 3% for temporal distribution.

7.4 Sample analysis was carried out for a few LSAs using the current DCR data for 2G networks to have an idea about the network performance of different service providers with reference to Q-cross points Network_Q_{SD}(90,90) and Network_Q_{TD}(97,90) in case of metro type LSA e.g. Delhi, in case of Cat-A LSA e.g. Tamil Nadu, incase of cat-B LSA e.g. Punjab and in case of Cat-C LSA e.g. Himachal Pradesh.

7.5 Network_Q_{SD}(90,90)-values for Spatial Distribution were observed as

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TSP	Metro One LSA	Cat-A One LSA	Cat-C One LSA	Cat-B One LSA
TSP-1	3.12%	3.12%	4.84%	2.17%
TSP-2	1.58%	2.24%	0.92%	1.28%
TSP-3	2.46%	1.62%	2.78%	1.18%
TSP-4	2.05%	.....	.....	.....
TSP-5	0.67%	0.91%	1.39%	0.63%
TSP-6	1.47%	0.91%	0.00%	1.69%
TSP-7	3.25%	2.44%	2.65%	3.10%
TSP-8	.....	2.87%	10.97%	.....

7.6 Network_Q_{TD}(97,90) values for Temporal Distribution were observed as

TSP	Metro One LSA	Cat-A One LSA	Cat-C One LSA	Cat-B One LSA
TSP-1	3.70%	3.71%	5.92%	2.74%
TSP-2	1.97%	2.75%	1.21%	1.62%
TSP-3	2.99%	1.92%	2.94%	1.51%
TSP-4	3.11%	.....	.....	.....
TSP-5	0.96%	1.14%	2.50%	0.95%
TSP-6	2.17%	1.96%	0.00%	2.16%
TSP-7	3.65%	3.00%	2.90%	11.36%
TSP-8	.....	3.15%	14.49%	.....

7.7 LSA average DCR values for 2% benchmark, calculated as per the existing methodology are

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TSP	Metro One LSA	Cat-A One LSA	Cat-C One LSA	Cat-B One LSA
TSP-1	0.72%	0.79%	0.97%	0.62%
TSP-2	0.69%	0.69%	0.48%	0.45%
TSP-3	0.77%	0.24%	1.28%	0.30%
TSP-4	0.29%	.....	.....	.....
TSP-5	0.17%	0.14%	0.41%	0.08%
TSP-6	0.25%	0.27%	0.09%	0.36%
TSP-7	1.13%	0.61%	0.70%	0.64%
TSP-8	.....	0.86%	1.98%	0.76%

7.8 LSA average DCR values for 3% benchmark, calculated as per the existing methodology are

TSP	Metro One LSA	Cat-A One LSA	Cat-C One LSA	Cat-B One LSA
TSP-1	4.13%	4.05%	8.58%	2.01%
TSP-2	1.12%	2.05%	0.33%	0.89%
TSP-3	2.65%	1.25%	2.21%	0.47%
TSP-4	1.51%	.....	.....	.....
TSP-5	0.35%	0.34%	1.76%	0.41%
TSP-6	1.24%	1.27%	0.53%	1.37%
TSP-7	2.61%	2.48%	2.27%	2.80%
TSP-8	.....	1.77%	2.60%	1.15%

7.9 These values clearly indicate that while the average DCR value of each TSP was substantially lower than the current DCR benchmark of 2% but Network_Q_{SD}(90,90) was greater than 2%. In case of Network_Q_{SD}(90,90) approach at-least 81% data-points are equal to or lower than the Q-value i.e. Q-value is a better representative of the network performance. Additionally, it can be seen from these tables that Q_{SD}= 2% is practically achievable if service provider makes appropriate efforts to address the issues of poor performing cells or days.The Q-cross-section view portrays a truer picture of the network performance.

7.10 From above DCR Data analysis, it is quite clear that Network_Q_{SD}(90,90) in spatial distribution presents a more real picture of the performance of the network and if network meets the benchmark then it indicates that

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DCR≤2% is achieved on at-least 90% of days, by at-least 90% of cells and similarly Network_Q_{TD}(97,90) in temporal distribution meets the benchmark then it indicates that DCR≤3% is achieved on at-least 90% of days by at-least 97% of cells.

7.11 In view of above, the Authority has decided to set Network_Q_{SD}(90,90) =2% as the benchmark for the spatial distribution of the DCR Matrix. As the DCR value is to be measured at the cell level, therefore, it has been decided that all DCR values need to be reported by TSPs during the CBBH.

7.12 Day_Q(97) parameter of DCR-Matrix-Temporal Distribution may be compared with the present "Worst Affected BTS Call Drop Parameter" and Benchmark in the existing QoS regulations. "Worst Affected BTS Call Drop Parameter" specifies that a TSP should not have more than 3% BTS with more than 3% Call Drop Rate. This parameter may also be interpreted as the requirement that 'at-least 97% of the BTS' should have a DCR of less than 3%. It may be noted that computation of the 3% DCR for this parameter is based on the averaging of data across cells of same Base Station. Accordingly, there may be instances where the DCR of a cell is much higher than 3% but after averaging, it's value comes down to below DCR 3% at the BTS level. But same time, it does not consider the situations or difficulties faced by service providers and factors which may be beyond the control of service provider. To take that into account, certain percentage of cells and certain percentage of days may be required to be considered.

7.13 In the redefined framework of QoS, which is percentile based, worst affected 3% cells will be identified using the DCR-Matrix-TD. Rest of the approach remains similar to the Spatial Distribution except that the value of percentile-s which assess day-wise performance of cells would be considered at 97% instead of 90%. This will reflect that on at-least 90% of the days for at-least 97% of cells in a network, the performance will be better than 3% DCR if network is meeting the benchmark. Value of percentile-t which assess % of days when more than 97% of cells observed DCR higher than benchmark may be considered same as in case of Spatial Distribution i.e. 90%. DCR Benchmark for Temporal Distribution may be set as 3%, same as mentioned in the present regulation for worst affected BTS.

7.14 Therefore, the Authority has decided to set the benchmark for TD i.e. .Network_Q_{TD}(97,90) as 3%. Networks meeting this benchmark will indicate that DCR≤3% is achieved on at-least 90% of days by at-least 97% of cells.

7.15 It may be noted that due to high mountainous terrain, remote areas and other factors, certain service areas may face difficulties and challenges in maintaining QoS on implementation & operational fronts. Network coverage in many parts of these areas, may be in the form of island of coverage and may not be contiguous which is likely to lead to more drop call instances for traffic moving in or out of these islands of coverage. In the stages of evolving from islands of coverage to carpet or contiguous coverage, these services areas are likely to observe higher DCR values. Such situation for difficult service areas may require special consideration to encourage Service Providers to provide coverage in remote and challenging areas without fear of high financial disincentive on account of relatively more number of instances of Drop Call Rate higher than 2% or 3%. Such special circumstances can always be addressed on case to case basis and it cannot be the basis for any blanket relaxation. The Authority is aware of these concerns and it shall be looked into on need basis.

7.16 In summary, revised DCR assessment methodology will remove averaging effect. This methodology also 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.

7.17 Further, the Authority has decided the assessment of the performance of the network for QoS parameters to be continued at LSA level and on quarterly basis. QoS parameters with consolidate values for corresponding parameters for all cells (inclusive of all technologies) will be assessed as a whole. Benchmarks for network quality and customer service quality will continue to be applicable in the same manner as in the present regulation, except DCR benchmarks which will be 2% for DCR Spatial Distribution Measure and 3% for DCR Temporal Distribution Measure, and assessment period for all cases will be on quarterly basis.

7.18 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

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of the network's performance assessment.

7.19 The Authority has also decided that DCR benchmark should be technology agnostic. Accordingly, from a DCR benchmark and measurement perspective, a network's performance on all technologies (e.g. 2G, 3G or 4G) deployed by the TSP in a LSA and used for providing voice services will be treated equally. Therefore, the consolidated data of all the cells of the TSP will be assessed as part of a single network, irrespective of the technology being used.

7.20 The performance against benchmarks for the parameters namely availability, accessibility and retainability in the Network Service Quality table, to be computed for all the cells in the License Service Area (LSA) in which a service provider is operating and which are being used to provide Circuit Switched Voice or VoLTE service. For example, In case, VoLTE service is being provided by the service provider then DCR values for the cells of the eNodeBs will also be included for the parameters and if only Circuit Switch based voice calls are being provided then cells in the eNodeBs will not be included for the assessment purposes of parameter;

7.21 Data pertaining to all other QoS parameters should continue to be reported technology-wise although the Authority may consider revisiting the question of their assessment as a single network at a later stage.

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.

7.22 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. If it is found that DCR codes detailed in Note 5 are used not consistent with the reasons and circumstances for which it has been specified mentioned, then it may be treated as per sub-regulation (3) of Regulation 5A of the principal regulation;

d. Blank DCR entries or entries filled with any value other than computed DCR value or entries filled with any code or text other than DCR codes specified in Note 5, shall be considered as non-submission of the compliance report;

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e. 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.

f. 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;

7.23 TSPs need to start re-assessing their systems and processes to ensure that complete and verifiable data is available. In view of this, the Authority has decided that the revised framework for network service quality and methodology will come into effect only after 1st October, 2017, allowing TSPs sufficient time to adapt to the new framework.

8 Graded Financial Disincentives for non-compliance with the benchmarks

8.1 The present structure of DCR financial disincentives is based on a determination of whether or not a TSP meets the specified DCR benchmarks. However, no consideration is given to the extent of poor performance by the TSP. In this context, the consultation paper sought to explore the possibility of a scheme of graded financial disincentives which would allow the Authority to take actions commensurate with the extent of poor performance.

8.2 Service providers and their associations were broadly not in favour of amending the financial disincentives structure. There were also suggestions that there should be no financial disincentives on marginal violations of key performance indicators (say less than 10 to 15%). In contrast, others have suggested that a policy of "financial incentives" would be in the best interest of the consumers and serve the purpose of motivating the TSPs for provisioning better services. With respect to graded financial disincentives, it was suggested that it should not be done due to various reasons such as new site restrictions, EMF issues, Fibre cut, theft cases, boundary and fringe cells, GSM spectrum non-availability, interference etc. They also suggested that financial disincentives for QoS should be removed as there is heightened competition in the market with comparable price structures, and quality of service has emerged as a major differentiator. The TSPs were also not in favour of imposing additional penalties for 2nd and 3rd consecutive default if improvement in performance over previous quarters is observed. They were in favour of imposing penalties if a TSP refuses to collaborate in a joint action plan. They were also of the opinion that there should not be any financial disincentives for the TSPs if the QoS benchmarks are breached as choices are available to consumer and market forces will ensure improved QoS. In general, they believe that financial disincentives have not contributed in either increasing investments or to improve QoS. However, others have suggestions supporting graded financial disincentives.

8.3 The suggestions of stakeholders were taken into account by the Authority. At the same time, the Authority also considered the improvements in QoS standards that have taken place in the recent months. These positive developments are attributable in part to the increase in awareness and transparency about the performance of networks and the existence of the financial disincentives framework in the QoS regulations. In light of this, the Authority has decided to continue with the existing framework on consequences for non-compliance with the benchmarks for the network related QoS parameters, except for the parameter on call drop.

8.4 Being an issue of grave public concern, and to improve the quality of experience of telecom consumers, the Authority has decided to prescribe a graded financial disincentive structure for the call drop parameter. The graded financial disincentive (FD) will be imposed on the basis of extent of deviation of a network's performance from the specified DCR benchmarks. For this purpose, the Authority has decided to continue the existing periodicity of assessment of Performance Monitoring Report (PMR) i.e. on quarterly basis. The imposition of FD will take place at the LSA level taking into account the data for all cells (2G, 3G and 4G) which are being used for voice calls.

8.5 The revised graded FD structure being adopted by the Authority is with due regard to the specific functions conferred upon the Authority under the TRAI Act. The TRAI Act gives the Authority the power to not only regulate QoS but also ensure the compliance of the provisions of the regulations. The Authority has accordingly adopted a number of measures in the past to ensure such compliance by TSPs. Firstly, information relating to the QoS performance of service providers is being disclosed regularly to the public in the form of the TRAI's performance reports, QoS audit reports and the TRAI Analytics Portal. Secondly, FDs are being imposed on service providers that fail to meet the specified QoS benchmarks and information relating to the imposition of such FDs is also shared publicly by the Authority. The Authority intends to continue following both these paths

in respect of the new DCR benchmarks also. Authority decided to keep the minimum amount of FD in case of DCR benchmark same as present value of Rs. 1 lakh for each instance of non-compliance. This is being accompanied by a graded mechanism for determining the FD based on the extent to which a TSP's performance deviates from the specified DCR benchmark. If network doesn't meet benchmark then for every 2% deviation from DCR Benchmark, financial disincentives may also be increased by rupees one lakh. However, there may be a capping of rupees five lakh for FD against one DCR parameter if it is a first contravention of benchmark in the consecutive quarters. If there is a case of contravention of benchmark in consecutive quarters, then the amount of FD may be increased by a factor of 1.5 while by a factor of 2 if it is in more than two consecutive quarters.

8.6 To illustrate the computation of FD, for instance if the performance of a service provider in the first quarter with respect to the parameter Network_Q_{SD} (90,90) is 3.5 percent, then the FD payable would be rupees one lakh.In case the performance in the second quarter is 5.5 percent then the FD payable would be 1.5 times of rupees 2 lakhs i.e. rupees 3 lakhs. Similarly, in case the performance in the third quarter is 7 percent then the FD payable would be twice the amount payable as per the table in the regulations i.e. rupees 6 lakhs. Further, if the performance of the same service provider in the first quarter with respect to the parameter Network_Q_{TD} (97,90) is 4.7 percent, then the FD payable would be rupees one lakh. In case the performance in the second quarter is 6 percent then the FD payable would be 1.5 times of rupees 2 lakhs i.e. rupees 3 lakhs. Similarly, in case the performance in the third quarter is 8 percent then the FD payable would be twice the amount payable as per the table in the regulations i.e. rupees 6 lakhs. However, since there is a capping of rupees 10 lakhs in a quarter for combined violation of both the parameters, the FD payable for the third quarter violation, combined for both the parameters will be capped at rupees 10 lakhs.

8.7 It was proposed in the consultation paper that QoS parameters and benchmarks should be technology agnostic (2G/ 3G/ 4G/ BWA) and could be measured and reported irrespective of the technology deployed. During public consultations, most of the service providers and their associations had suggested that parameters for Network Availability, Accessibility (CSSR), Retainability (Call Drop Rate) should be technology agnostic as long as they provide voice services in the country. Presently, the 3G networks have similar network related parameters and benchmarks as 2G, although nomenclature of the parameters may differ. ITU-T Recommendation G.1028 defines end-to-end quality of service for voice over 4G mobile networks. For voice over 4G, parameters similar to 2G and 3G have been discussed with the service providers and consequently, TRAI had proposed similar parameters for 4G services. Almost all service providers have agreed with these parameters and benchmarks. Accordingly, TRAI has prescribed the parameters and benchmarks for 4G services in these regulations.

8.8 Network and Customer Service Quality parameters, other than DCR, will remain same as in the previous regulation and existing FD will continue.

9 Radio Link Timeout (RLT)

9.1 Call Drop Rate at network level is assessed on the basis of information captured by the network. Call drop is forced release when quality of voice call degrades below a pre-specified level. There may be scenarios in real environment when degradation of voice quality may be for very short duration and cause of degradation is likely to be temporary in nature e.g. user moving in and out of elevator (lift), passing through tunnel etc. In such scenarios, users may experience degradation of quality but for a very short duration. Degradation of voice quality for very short duration may also happen during the handover process between cells. The duration of degradation may also be dependent upon radio network deployment scenarios e.g. wide area cells and micro-cells may observe variations of different levels in the network signal. Similarly, there may be variations in the duration for which degraded network signal quality is observed.

9.2 Mobile networks are designed to take care of such scenarios and provide flexibility in the system through configurable parameters to handle situations in different network deployment scenarios and traffic patterns in different pockets of the network. In GSM system, RADIO_LINK_TIMEOUT value can be maintained and broadcast by the network to the devices for initializing or re-initializing Counter 'S', as defined by GSM specifications. The counter 'S' is incremented or decremented according to good and poor quality on the Slow Associated Control Channel (SACCH) associated with a connection. When Counter 'S' value becomes zero, radio resources are released.

9.3 In a GSM system, a mobile station (MS) making a voice call tracks a radio link counter, which is used to ensure the quality of the radio link. The radio link counter is used to measure the quality on the Slow Associated Control Channel (SACCH) associated with a connection (which may be used to carry a voice call). At the start

of a call, after handover, and after re-assignment, the radio link counter "S" is initialized to a network-defined Radio Link Timeout (RLT) value. After every bad SACCH block, S is decreased by 1. After every good SACCH block, S is increased by 2 (to a maximum value of RLT). If the radio channel conditions are bad, many radio blocks will be lost, and eventually the radio link counter will expire when the value of S equals the expiry value (zero). This event is termed Radio Link Failure (RLF), and at that point the device stops using the traffic channel. The commonly-seen problems leading to radio link failure are (a) rapid radio channel degradation (e.g., due to sudden co-channel interference), (b) the network not sending a handover message in time to avoid RLF and uplink interference and/or limit-of-sensitivity (due to limited transmit power) issues.

9.4 For cells with obvious coverage holes or in areas where call drops occur during movement, a TSP can increase this parameter appropriately in order to increase the possibility to resume the conversation. This parameter is normally set depending upon the region – urban, semi-urban, rural areas. Though the RLT value is normally set up as per the network, setting up high values for the same could lead to customer dissatisfaction. Considering this, the views of stakeholders were sought as to whether RLT parameter should be mandated or not and what should be the RLT values.

9.5 During public consultations, most of the stakeholders had suggested that RLT is just a configuration parameter amongst thousands of other configuration parameters to counter various dynamic adverse conditions and thus in the best interest of the TSPs being able to optimize their networks for delivering good quality services, it should be kept out of the ambit of any regulatory framework. However, there were suggestions to mandate optimal value for RLT.

9.6 Normally the RLT value is defined, to be between 36 to 48 for areas of light traffic and large coverage (rural areas); between 20 to 32 for areas of heavy traffic (urban areas); and between 4 to 16 for semi-urban areas and in areas with heavy traffic (with microcells). TRAI had obtained the details of cells with RLT values in the range of 0 to 16, 16 to 32, 32 to 48 and 48 to 64 from the service providers. On analysis of this data it was seen that in most of the cases the RLT value is within the range of 32 to 48. However, there were few cases where the RLT value was in the range of 48 to 64.

9.7 Inappropriately high RLT value configuration in the network may lead to a call not getting dropped even in case of prolonged degraded quality of voice call. In such cases, users are likely to disconnect the call because of poor quality of voice call and it may not be registered as call drop, though in real sense it was a call drop. Hypothetically, RLT parameter can be misused to moderate call drop rate in the network but no service provider is likely to adopt such practice as it will also deteriorate network performance. In view of this, the Authority feels that there is no need for mandating any specific value of RLT as such but there is a need to have mechanism to check inappropriate high RLT value configuration in the network. Since such high values could lead to poor customer experience the Authority has decided to monitor such cells through reporting by service providers for RLT values equal to or higher than 48 for more than three consecutive days.

10 Use of Call Detail Records (CDR) meta data for call drop rate calculation

10.1 CDRs (Call Detail Records) which provide usage related information for a particular customer, may be an additional source of information for the assessment of call drop rates. CDR captures cell id and duration of the call. The analysis of CDRs with small duration and repetitive calls to same called party within stipulated duration may give indication that the calls were probably getting dropped by the network. Through data analytics of the CDR, it may be possible to identify probable call drop instances.

10.2 Stakeholders' views

a. During the consultation process all the service providers had opined that identification or segregation of the Cause Codes whether they are due to network behavior or consumer behavior or device behavior is not possible with present information in the CDR. Hence, call drop rate using CDR meta data cannot be calculated.

b. One of the registered consumer organizations had suggested that CDR data method can be the secondary source for calculating call drops and worst of the two results should be counted for performance measurement.

10.3 The Authority, after considering the views of stakeholders and examining the issue found that cause codes captured as a part of CDRs are not detailing the specific reasons related to radio network conditions and mapping of radio network related events to the codes captured in CDR is many to one and this mapping has non-

uniform implementation among different telecom equipment vendors. It is also noted that analytics of CDR indicates the probability of call drop but it may not be concluded only on the basis of the CDR. This information may be helpful to identify likely problematic area and investigate further, if required. Further, as the CDR also reflects details of the source and destination numbers, any analysis of this data would also have to take into account the privacy of telecom subscribers. In view of these factors, the Authority has decided to undertake further analysis of this issue through engagements with expert agencies/organizations to consider the usefulness of CDR meta data analysis and feasibility of implementation.

11 Customer Satisfaction Index:

11.1 Measuring the QoE of consumers

a. One of the options for measuring the QoE of the consumer could be to calculate the QoE as perceived by the consumer. Perceived QoS could be assessed by customer surveys and from the service provider's network. Using the various network related parameters one can calculate the Network Service Quality Index (NSQI). Similarly, the Customer Service Quality Index (CSQI) could be calculated by focusing on the Customer Centric parameters like metering and billing credibility, for post-paid and pre-paid; resolution of billing/ charging complaints, etc. Similarly, the Customer Satisfaction Survey Quality Index (CSSQI) is calculated through consumer surveys.

b. These different indexes for could then be used to evaluate the performance of the cellular mobile service providers on each parameter based on a 10-point score and by giving equal weightage to each parameter. (Whenever a benchmark is achieved, a score of 10 points will be assigned to that parameter. In case the performance of parameter is below benchmark, the score will be reduced depending on level of performance). Accordingly, the total score for all parameters will be added. Using these the 'Customer Satisfaction Index' (CSI) could be calculated.

c. The CSI combines the user behavior and the actual performance of the network, Technical Quality perception and Service Quality Perception are included to distinguish network technologies and service quality from customer's perspective. While Technical specifications are also added for evaluating the real performance of the network. To calculate this, a number of latent variable needs to be defined - Customer Expectation; Value perception; Technical quality perception; Customer Satisfaction; Service quality perception; Customer Loyalty; and Technical Specifications.

d. The views of stakeholders were sought on the utility of customer satisfaction index, the methodology of calculation, the latent variables that need to be defined and how they are to be calculated.

11.2 Stakeholders' views

a. During consultation process the service providers and their associations had suggested that Quality of Experience(QoE) is subjective and varies with the expectation of the consumers and affected by various factors such as awareness, experience, media, perception etc. and hence, it should not be measured.

b. One of the consumer organization registered with TRAI suggested that the QoE can be calculated by giving weightage of 30% for NSQI, 40% to CSQI and 30% to CSSQI and CSSQI need to be refined based on experience of at least 2 years. There was also a suggestion that a SIM may be used by the TSPs to measure the QoE of customers as it will help the TSPs to invest wisely. Direct engagement with the customer to measure QoE is not suggested as their input to key performance indicator (KPI) is subjective.

c. The Authority considered the views of the stakeholders and has felt the need for using technological platforms, involving customers, to collect and assess feedback of QoE by the customers. In this regard, TRAI has recently launched the "TRAI MyCall App" through which the customers can rate their call quality experience. Also the App can capture the call quality and report to TRAI. The analytics of the data collected via App can be presented in a manner which enables consumers to understand the perceived quality of different service providers' network.

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