

**Response to TRAI consultation paper no. 6 / 2017
Data Speed Under Wireless Broadband Plans**

Response by:

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Q1: Is the information on wireless broadband speeds currently being made available to consumers is transparent enough for making informed choices?

There is significant transparency on data usage and billing, but not on QoS parameters as also discovered by us in this survey [1]. The data usage and billing aspects are hard to understand though, and actions like keeping users regularly informed about their data usage and unit costs can help improve consumer awareness. Information on QoS however tends to be quite misleading and incomplete, as has been outlined well in this consultation paper.

[1] CUTS International and IIT Delhi, *Mobile Internet Services in India - Quality of Service*, 2016.

http://www.iitd.ac.in/research/IITD/1615_QoS_Report_CUTS_IIT.pdf

Q2: If it is difficult to commit a minimum download speed, then could average speed be specified by the service providers? What should be the parameters for calculating average speed?

It is true that given the physical characteristics of the wireless medium and the design of 2G/3G standards, a minimum download speed for a subscriber at any given instance of time may be hard to commit. However, committing to an average speed in aggregate across subscribers and across time should indeed be feasible. The providers would be doing these calculations in any case to provision both adequate backhaul capacity as well as RAN capacity to be able to provide a certain average speed to subscribers based on the statistical multiplexing of connections.

Two sets of measurements can be used which can potentially serve as upper and lower bounds to assess the speeds being provided.

- Providers can conduct their own measurements by downloading data on a long-lived TCP connection as specified in the measurement methodology prescribed by TRAI as part of the 2012 wireless data service regulations. These speeds observed through multiple tests across multiple locations will give an upper bound to the speeds provided because the controlled test environment will guarantee that the server or the user device were not

bottlenecks, and the speeds attained were entirely dependent on the backhaul and RAN network capacity combined.

- Providers can measure the speeds obtained by different subscribers by instrumenting the data downloaded during active times of the connection. This information should not be difficult to obtain because the providers would be collecting per-user data regardless for billing and traffic shaping purposes according to the plans purchased by the users. These speeds will give a lower bound to the speeds provided because the user device or the server bandwidth or the application requirements may not utilize the network entirely and hence will give an estimate lower than what the network can provide.

In both cases, the distribution should be considered in the form of deciles or quartiles, rather than just the average. The difference between the two distributions will give in some sense a measure of the unused capacity, and should ideally differ by more than a 50% ratio. With such a difference, a reasonable commitment by the providers can be made to intermediate values. Note that we are not suggesting that this commitment can be evaluated on per subscriber or per connection basis, but that across subscribers and across times, the commitment can be assessed. Outlined in the questions below is how this concept can be implemented as part of standard reporting given to TRAI, and also exposed to users in more accessible ways.

Q3: What changes can be brought about to the existing framework on wireless broadband tariff plans to encourage better transparency and comparison between plans offered by different service providers?

Standardized labels can ensure that providers start giving information about different plans in a uniform manner, using the same terminologies and parameters. This can make comparison easier, and also gradually improve consumer awareness to look at multiple parameters. These parameters can include QoS indicators, data usage and pricing slabs, and specific performance enhancing methods deployed by different providers such as data compression and transcoding proxies, content delivery network linkages, fast DNS servers, network capacity, backbone connectivity, etc.

The parameter values given in the labels should be based on the values reported by the providers to TRAI, so that there is no inconsistency in advertised Vs provided values.

Finally, the detailed QoS values on speeds, latency, jitter, etc should be made more easily understandable to users by reducing them to simple star ratings reflective of user experience. Researchers have shown standard forms to relate QoE with QoS for different kinds of applications including voice communication, video streaming, browsing, etc, and these equations can be applied to reduce complex QoS parameters to a small set of simple star ratings for general consumption [2, 3].

[2] M. Fiedler, et al, *A Generic Quantitative Relationship Between Quality of Experience and Quality of Service*, IEEE Network, 2010

[3] S. Aroussi, et al, *Survey on Machine Learning-based QoE-QoS Correlation Models*, IEEE, 2014

Q4: Is there a need to include/delete any of the QoS parameters and/or revise any of the benchmarks currently stipulated in the Regulations?

Studies by us [4, 5] and other researchers [6] have shown that due to improper configurations IRAT (Inter Radio Access Technologies) handovers occur extensively and impede performance by forcing devices to switch from 3G to 2G then back to 3G, etc. This should be included among the list of self-reported indicators to TRAI.

As described earlier, rather than just reporting the average speeds or latencies or other parameters, the quartiles or deciles should also be reported to give a better picture of the deviation in performance.

Finally, so far the regulations outline the QoS parameters to be reported based on specific tests conducted by the providers. There are a few gaps through.

- One, there is a lack of clarity in the test methodology in specifying the test device – is this an actual data connection via a phone or computer through which the tests are to be run, or can these be artificially induced at the BTSes. Our experiments indicate that it is probably the latter because some indicators like availability reported by providers to TRAI were very high in general for all providers, while our measurements through user devices deployed over a period of three months obtained much lower values. This therefore raises questions on how representative of actual user experience is this self-reported data.
- Two, providers should also submit the QoS parameters actually provided to the users. These can be obtained easily from network statistics measured at the GGSNs/SGSNs/PGSNs or deeper into the RAN by observing the traffic profile of different users. As described earlier, this will help contrast the best obtained performance in tests conducted by the providers, with performance actually provided or consumed by the users. This is likely to be much lower than the provider measured values because the users are unlikely to raise requests to utilize the full network capacity, for example, a 240p Youtube stream will consume only 400Kbps or a Skype voice call will consume only 32Kbps, and similarly cases where the user will try downloading large files to utilize the full network capacity will be few.

Therefore, the test methodology to get upper bound estimates on the QoS should be made more rigorous and representative of actual user experience, and providers should be asked to also submit actual QoS provided to users.

The spatial granularity for the reports should also be increased to allow for good comparisons. Currently the reports are made at a circle level, but potentially reports at the district level and categorically separated into rural/urban areas

should provide greater information to consumers specific to geographies in which they are most interested.

[4] A. Sharma, et al, *Revisiting the State of Cellular Data Connectivity in India*, ACM DEV 2015.

[5] Z. Koradia, et al, *First Impressions on the State of Cellular Data Connectivity in India*, ACM DEV-4 2013.

[6] Y. Li, et al, *Instability in Distributed Mobility Management: Revisiting Configuration Management in 3G/4G Mobile Networks*, ACM SIGMETRICS 2016.

Q5: Should disclosure of average network performance over a period of time or at peak times including through broadband facts/labels be made mandatory?

Yes, this will greatly help bring standardization in products to enable users to compare them more easily with each other, and also improve consumer awareness about performance parameters. Most of this data is anyway being reported to TRAI on a regular basis, but subscribers are often not aware of accessing the reports on the TRAI website. Therefore the only part to be added is that this data should be made available to users at the time of purchasing the plans as well, and additionally through standard applications and websites as discussed next.

Q6: Should standard application/ websites be identified for mandating comparable disclosures about network speeds?

Yes, this will make it much easier for consumers to come to know about new regulatory initiatives and changes, and also build trust in the information source. But this channel should not obviate the need to have providers proactively disclose the information at the time of sale as well, since being able to spread information about the standard application or website will require significant efforts on consumer awareness and therefore utilizing the retail points and advertising efforts of the providers will be advisable.

Q7: What are the products/technologies that can be used to measure actual end-user experience on mobile broadband networks? At what level should the measurements take place (e.g., on the device, network node)?

Different aspects related to QoS should be measured in different ways.

- As outlined in this study [7], crowd-sourced measurements for throughput and latency should be aggregated in large numbers given the variability that can arise due to short-term and long-term shadowing in wireless connections. The alternate to have providers report data aggregated across

all user sessions is a more viable alternative, and can be measured from inside the providers' networks.

- Metrics such as availability however, should be measured from an end-user perspective by capturing data from the user device. Doing it via crowd-sourced applications however requires root permissions on the phone to access radio layer protocol information, and hence the same metrics should be monitored and reported from the provider's network such as number of attempts made, failed attempts, etc.

Crowd-sourced measurements through tools like TRAI's MySpeed app should therefore serve a purpose to cross-check the values reported by providers if they can be obtained at very large scale, and their distribution should then tally with the self-reported data by the providers since the test methods are similar of downloading large files, measuring IP packet latency, etc. Crowd-sourced measurements should however not be the basis for labelling the performance of providers unless they can be obtained at very large scales.

An issue remains of how to audit the data being reported by the providers, and therefore standardized log collection formats, anonymization of data, making it openly available, and use of large scale analytics on this data by academic institutions, should be used to audit the data.

[7] A. Gember, et al, *Obtaining In-Context Measurements of Cellular Network Performance*, IMC 2012.

Q8: Are there any legal, security, privacy or data sensitivity issues with collecting device level data?

a) If so, how can these issues be addressed?

b) Do these issues create a challenge for the adoption of any measurement tools?

There are no security or privacy issues in reporting user performance in aggregate, measured through the network. Crowd-sourced information similarly has no liability attached as long as aggregate data is revealed for performance comparison, and data even at the backend is stored through anonymization.

Q9: What measures can be taken to increase awareness among consumers about wireless broadband speeds, availability of various technological tools to monitor them and any potential concerns that may arise in the process?

The providers are best placed to create this awareness because of their direct connect with the consumers. Incorporating labels at the point of sale, detailed information on their websites, regular alerts to users, etc are all pro-active mechanisms that can not only bring transparency but also help users build an understanding about different performance parameters, billing details, etc.

Q10: Any other issue related to the matter of Consultation

To summarize our overall proposal, following are the steps we have outlined above:

- Data through test measurements being reported by the providers should be enhanced to make it more spatially granular, include additional parameters like IRAT handovers, and give quartile or decile distributions in addition to averages.
- Providers should also report the actual QoS provided and consumed by the users through measurements collected from inside the providers' networks. The difference between this distribution and the test distribution will give in some sense a measure of the unused capacity on which norms can be designed.
- The test and measured data should form the basis for QoS disclosures made by the providers, to allow consumers to make better choices and create a more competitive environment based on performance rather than just on price.
- The QoS disclosures can be made more easily understandable for consumers by converting them to simpler star-ratings for QoE, based on standard relationships that have been discovered for different kinds of applications.
- Crowd-sourced mobile applications can be used to cross-check the test measurements reported by the providers if data can be obtained at a large scale. However, audit processes should be built to make provider logs available in standardized formats which can be analysed by academic institutions and other agencies to check the reported data.