

Mobile Internet Services in India

Quality of Service



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Consumer Unity & Trust Society
D-217, Bhaskar Marg, Bani Park
Jaipur 302016, India
Ph: 91.141.228 2821, Fx: 91.141.228 2485
Email: cuts@cuts.org
Web: www.cuts-international.org



Indian Institute of Technology Delhi
Hauz Khas, New Delhi-110 016, India
Phone: 011 2659 1291
E-mail: aseth@cse.iitd.ac.in
Web: act4d.iitd.ernet.in

Contributors:

Udai S. Mehta, Director CUTS International
Aaditeshwar Seth, Assistant Professor, IIT Delhi
Neha Tomar, Senior Research Associate, CUTS International
Rohit Singh, Policy Analyst, CUTS International

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Editing & Design Credits

Madhuri Vasnani
Mukesh Tyagi
Rajkumar Trivedi

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Finally, any error that may have remained is solely ours.

Abbreviations

AUTSPI	Association of Unified Telecom Service Providers of India
CSOs	Civil Society Organisations
CSPs	Cellular Mobile Service Providers
IIT	Indian Institute of Technology
ISoc	Internet Society
ISP	Internet Service Provider
NCR	National Capital Region
NGOs	Non-Governmental Organisations
NHSCE	National Centre for Human Settlements and Environment
QoE	Quality of Experience
QoS	Quality of Service
TRAI	Telecom Regulatory Authority of India
UAS	Unified Access Service
USPs	Unified Access Service Providers
USSD	Unstructured Supplementary Service Data
VOICE	Voluntary Organisation in Interest of Consumer Education

Foreword

Having started work related to exploiting ICT for India's socio-economic development, especially in the rural areas, almost 15 years ago I have been amazed at the remarkable progress India has made in bringing the benefits of ICT to its massive population. On the one hand, handheld devices of all kinds are not uncommon even in the hinterland, and on the other, they are not standalone devices; users find that they provide a conduit to the world at large. Nobody would have imagined that within a dozen or so years, things would have reached this happy state.

But, why is not everyone celebrating? Is not everything going right? Are some potential users being left behind, their needs not being met, or their desire for quality service not being handled, even though they are willing to pay for the services?

These questions have prompted the study described in this report prepared by a team of academic researchers, led by Aaditeshwar Seth (IIT Delhi) and Udai S. Mehta (CUTS International). This report comes at a very important juncture for Indian IT, with issues related to India's telecom services, such as net neutrality, providing an even playing field for all, affordability, etc. are on everyone's mind, with the common man at the centre of the evolving landscape.

Through a rigorous evaluation of the Quality of Service (QoS) provided to customers in a variety of geographies during the delivery of several different types of information, authors of this report have filled a major gap in the understanding of the current scenario. With providers claiming 100 percent uptime while the customers' experience leaves much to be desired, clearly, we need a study such as this to categorically reveal the reality as is so that the right steps are taken to fix the ills that prevail.

The two-pronged approach that authors have designed and executed is highly laudable. The first involves highly technical measurement-based assessments of parameters that are indicators of the performance of the innards of the system. The second is a user perception-based survey that complements and supplements the former. They combine academic rigour with practical import.

Perhaps the most important part of the report is the set of well thought out, actionable recommendations that are primarily intended for the Telecom Regulatory Authority of India (TRAI) to seriously consider and implement. This is essential for the benefits of ICT to reach every nook and corner of India. Otherwise, the current excitement will be short-lived.

I must mention that as an academic I am thrilled that Prof. Seth has made this study, part of his research programme. It is important for Indian researchers to pick up such practical real-world problems from our own backyard so that they can make a difference to our society. Hope this report will inspire others too.

Krithi Ramamritham

Professor, Department of Computer Science
IIT Bombay

Preface

In recent years, much importance has been given to issues pertaining to quality standards for voice calls and mobile internet. This report deals with the latter and discusses issues pertaining to the framework of regulations for quality of service (QoS) standards for mobile internet in India. The report is well timed, as TRAI has also been focusing on the issue and recently took the initiative to launch Myspeed App to measure real time mobile internet speed that is received by the consumers.

The Telecom Regulatory Authority of India (TRAI) had formulated standards for mobile internet under the *QoS for Wireless Data Services Regulations 2012* (hereafter referred to as Regulations 2012). The regulation enlists the benchmarks for mobile internet services, for service providers rendering Unified Access Service (UAS) as well as cellular mobile telephone service. On the basis of their performance against the benchmarks, service providers are required to submit monthly performance reports to TRAI. The regulator, based on monthly performance reports, releases a quarterly report for all operators, for all 22 service areas in India. However, there are no penalties provisioned in case of breach of those standards. Further, there are no incentives (from the regulator) for the operators to perform as well.

Against this backdrop, this study attempts to bring together secondary and primary data to sift issues and provide evidence-based policy recommendations towards better enforcement of the QoS for mobile internet services. The study was jointly undertaken by the Indian Institute of Technology (IIT), Delhi and Consumer Unity & Trust Society (CUTS International).

This report is a continuation of a study undertaken by IIT, "2G/3G Internet Measurements in India". The study focussed on collecting measurements from several rural and urban areas on the QoS consumers receive from various 2G/3G service providers in India. Data was collected from service providers, such as Idea, MTNL, Airtel and Reliance across rural and urban areas of Madhya Pradesh, Jharkhand and Delhi.

CUTS has over 30 years of experience in issues pertaining to consumer protection, competition and regulations. The *modus operandi* followed is evidence based advocacy, followed by capacity building and networking. CUTS was responsible for undertaking consumer surveys in West Bengal, Rajasthan and the survey for NCR was jointly undertaken with IIT, Delhi. On the basis of data collected and analysed, the recommendations have been framed.

In our view, it is important for service providers to provide complete set of information about their services to consumers, in order to enable them to make an informed choice. Information not only regarding the amount of data consumed, but also regarding the bandwidth and other parameters like latency should be provided to consumers in a

simplified manner. TRAI should also strengthen the network measurement methodologies prescribed by them for the service providers to report QoS performance, and measures should be taken to make this data available transparently for academic and consumer rights organisations to audit externally. It is also important to bring in place penalties, to ensure the QoS benchmarks are not breached. Further, the TRAI should also introduce a system of ranking whereby service providers are ranked on the QoS they provide. This would instil a spirit of competition amongst service providers and enhance transparency for consumers.

Our hope is that the report will stimulate public debate on issues pertaining to QoS and their effective implementation by the regulator.

Pradeep S Mehta
Secretary General, CUTS International

Executive Summary

Background

In the year 2015, global mobile data traffic grew by 75 percent.¹ In India specifically, mobile data traffic grew by 50 percent, while (year-on-year) 3G traffic increased by a significant 85 percent.² Evidently, there has been a surge in consumption of mobile data by consumers in India. With the recent launch of 4G enabled services, mobile data traffic is only expected to increase further. According to a recent study undertaken by Nokia, the introduction of 4G increases data usage by approximately four times.³

Factors such as the upcoming spectrum auction in July 2016, and increased smartphone penetration will boost mobile data traffic in the coming years in India. Moreover, the current government has focussed on digital inclusion as one of their key priorities.

With the on-going technological advancements and initiatives towards important issues such as digital inclusion and mobile internet penetration, one must not forget the importance of ensuring 'quality' mobile internet services. To ensure these, the Telecom Regulatory Authority of India (TRAI) has formulated specific parameters or the QoS standards. These standards have been enlisted in the Standards of Quality of Service for Wireless Data Services Regulations, 2012. Successful digital inclusion and/or mobile internet penetration would negate its purpose if the standards of QoS are weak at the consumer end.

Against this backdrop, our Consumer Unity & Trust Society (CUTS International) and Indian Institute of Technology Delhi, (IIT) report covers the following two key points – (i) evidence from select States on the quality of mobile internet services (based on data); and (ii) perception and awareness of consumers in select States regarding the quality of mobile internet services and relevant policies and regulations.

About the Project⁴

IIT recently implemented a project entitled '2G/3G Internet Measurements in India', which focussed on collecting measurements from several rural and urban areas in Madhya Pradesh, Jharkhand, and Delhi on the QoS consumers get from different 2G/3G service providers. Based on the findings of the study, CUTS partnered with IIT, to further understand the role of the Regulator & Civil Societies in implementing/enhancing quality standards, and conducted surveys in West Bengal, Rajasthan, and Delhi on the perception of consumers regarding their experience of using mobile internet services.

¹ <http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html>

² <http://company.nokia.com/en/news/press-releases/2016/03/08/nokia-study-shows-multimedia-and-expanding-device-ecosystem-will-fuel-mobile-data-traffic-growth-as-india-moves-towards-4g-lte>

³ *Ibid*

⁴ For more details regarding the project, please visit: <http://www.cuts-ccier.org/QOSII/index.html>

Accordingly, based on our findings, one is able to conclude that there is a need to further strengthen QoS regulations for mobile internet services in India. The data collected from the surveys underscores some of the key issues pertaining to the quality of mobile internet services.

Objectives

- Understand the current state of QoS for mobile internet services – policies and practices; and;
- Provide evidence-based policy recommendations to enhance QoS and promote better enforcement of the QoS Regulations.

Methodology

The methodology provided below encapsulates the *modus operandi* undertaken by IIT for network measurements and by CUTS for the consumer surveys.

i. Network measurements

During 2013 and 2014, mobile performance measurement data was collected for 2G and 3G services from 20 rural and urban locations in Madhya Pradesh, Jharkhand and Delhi. The measurement suite was written on Linux-based Netbooks that were placed at these sites and configured to run tests to measure the throughput, latency, availability, etc. of 2G and 3G connections provided by different telecom providers. On each Netbook, three Huawei USB modems were connected to enable probing three different telecom providers simultaneously.

Several social enterprises and NGOs were involved in the identification of sites where the testing equipment could be placed for a long stretch of time over several months, and also refer to local staff members working out of these locations to check or restart the Netbooks if required. The organisations involved in the study were *PRADAN*, *Vikas Samvad*, *Air Jaldi* and *Gram Vaani*.

ii. Consumer survey

To gauge consumer experiences and perception on QoS for mobile internet services, an extensive survey was implemented across West Bengal, Rajasthan and NCR. Based on a structured questionnaire, it was implemented using both web based surveys and personal interviews. The questionnaire consisted of 35 questions pertaining to:

- Awareness/knowledge on terms of usage and bandwidth provided by operators
- Awareness/knowledge on sector regulator and existing regulations for mobile internet services in India
- Opinion about the QoS for mobile Internet service, consumer service and complaint handling by operators

A total of 730 responses were collected, 300 from West Bengal, 300 from Rajasthan and 130 from NCR.

Key Findings

Through network measurements, which involved direct evaluation of mobile internet services at various rural and urban locations, mobile internet services were evaluated on technical parameters like throughput, latency, availability, etc. The network measurement study highlighted that the QoS experienced by users differs considerably from the advertised values provided by the various telecom providers, and to a certain extent also from the values reported by them to TRAI. It also seemed that in many cases, simply taking better care of the configurations of the cellular networks could lead to better performance.

On the other hand, the consumer surveys revealed that the respondents across the three States chose their service provider (for mobile internet) on the basis of QoS but were largely unsatisfied with the same. Further, they were unsatisfied with the cost incurred for the same. The table below provides a snapshot of the data obtained from the respondents.

Summary of Key Findings			
Parameter	West Bengal	Rajasthan	New Delhi & NCR
Respondents	300	300	130
QoS is the rationale for selecting service provider	42%	52%	64%
Level of Satisfaction with QoS is good	45%	24%	52%
Level of Satisfaction with tariff is good	28%	15%	26%
Awareness levels in respondents is good (regarding data plan)	63%	62%	82%
Service providers should regularly alert customers on data usage	83%	62%	58%
Service providers should mention the exact amount of data that is consumed per month by users	58%	73%	60%
Respondents do not know about bandwidth but want to know the same	92%	91%	89%
Respondents know about TRAI	40%	46%	85%
Respondents do not know about QoS parameters but want to know	65%	93%	81%
Penalties should be put in place for breach of QoS parameters	95%	99%	97%
Service providers should be ranked (quarterly) on the basis of their performance	91%	98%	97%

As the table above suggests, the respondents were well aware of their data plans but had little information regarding the exact quantity of data being used every month. The level of awareness was significantly low in case of bandwidth usage. Most of the respondents clearly expressed a desire to know more about these issues. Thus, information asymmetry needs to be dealt with by providing more information to consumers, so as to enable them to make informed decision. Similarly, most of the

respondents were unaware of the regulatory body, i.e. TRAI. Low awareness regarding the regulator implies that the information published by TRAI on QoS for mobile internet services does not trickle down to the consumers. It also indicated the need for active presence of the regulator at a State level, rather than just being confined to Delhi.

Further, when information regarding absence of penalty provisions for breach of QoS parameters was shared with the respondents, the majority of them felt it was crucial to introduce and effectively implement the penalties. Lastly, most of the respondents were of the opinion that it would be beneficial to develop a ranking mechanism whereby service providers could be ranked on the basis of their overall performance and the information be shared in public domain.

Key Recommendations

As per the data collected and analysed under the study, the following key recommendations have been suggested:

- TRAI needs to mandate more rigorous QoS measurement and reporting methodologies by the ISPs, to make the data reflective of actual end-user observed performance. Steps should be taken to make this data available in user-friendly ways to improve consumer awareness. Steps should also be taken to enable auditing of this data by non-state actors.
- Adoption of a nutrition label for the QoS can provide all the key information such as speed variations, service limits and conditions, pricing and other relevant information transparently to the consumers. The adoption of the label would empower consumers with information to compare broadband services in India and make an informed decision.
- Service providers need to provide complete information to the consumers on mobile internet services, at the time of sales as well as on their websites. Strict rules should be imposed against misleading advertisements by the ISPs, and the reported performance should be compared with the performance that was originally advertised to understand the differences arising between promised and achieved performance.
- A system of ranking on QoS performance should be introduced for mobile internet service providers to instil competition and enhance QoS efficiency and innovation.
- Penalties should be provisioned in case of breach of QoS parameter benchmarks by service providers.
- Consumers should be (a) made aware of their entitlements/actual terms of service, and (b) empowered to get necessary information through a speed test, for instance, which would allow them to test their services and compare them with the regulatory benchmarks. TRAI should, apart from drafting regulations, also focus on educating consumers of their rights and provisioning of complete set of information on the product i.e. mobile internet.
- Finally, TRAI needs to make its presence felt across India by establishing regional centres. Awareness workshops need to be undertaken by TRAI so as to inform consumers regarding the relevance of QoS parameters for mobile internet services.

Structure of the Report

The report is divided into four sections. The first section discusses the QoS regulatory scenario for mobile internet/wireless data services in India, describing the regulations and the regulator. This section apprises the reader on the QoS definition and the QoS regulations that exist in India.

The next section describes the network measurement exercise that was conducted by IIT to gauge the QoS for mobile internet that is being provided by different operators across select states. Its latter part showcases the outcomes of the survey that was conducted on consumer experiences on mobile internet QoS.

The third section talks about the possible role of the Civil Society Organisations (CSOs) in ensuring a high QoS is dispensed by the operators to consumers and also on keeping a check on possible degradation to the services. This section discusses the possibility of the CSO engaging with the regulator and providing them a platform to raise suggestions and complaints to the TRAI for mobile internet services.

The final section, based on evidence from the earlier sections, draws conclusions and provides recommendations for improved implementation and exercise of the QoS. It also provides a base to strengthen the existing policies and regulation, implementing which shall foster better QoS for mobile internet services.

Quality of Service for Mobile Internet Services in India: *Regulators and Regulations*

"Mobile data will log a compound annual growth rate of 18 percent between 2015 and 2020, increasing its revenue share from the current 18 percent to 31 percent"
– Citi Research Report

The statistics suggest that there is a tremendous upsurge in mobile data usage and this growth is expected to continue in foreseeable future. As far as wireless internet subscribers are concerned, India's internet users have risen considerably from 50 million in 2007 to 100 million in 2010 and more than 306 million at the end of December 2015.⁵ Of all the internet users in India, close to 60 percent of users, access internet services via mobiles.⁶

QoS becomes an important parameter to gauge the performance of mobile internet services

Data is the future for telecommunication services and will drive the sector's growth.⁷ To ensure that this dynamic growth is accompanied by competition, efficiency as well as consumer satisfaction, it is important that the same be supported by a framework of well-structured regulations and clear roles of stakeholders. QoS, thus, becomes an important parameter to gauge the performance of mobile internet services. The TRAI defines QoS as:

"Quality of Service" is the main indicator of the performance of a telecommunication network and of the degree to which such network conforms to the standards of such quality of service as specified in these regulations for specified parameters."⁸

QoS parameters ensure a competitive and transparent market but for that end consumers should be fully aware of the actual terms of services offered. For technical and intangible services like internet access, it is not possible for consumers to evaluate the QoS by themselves. Further, due to lack of technical know-how, consumers may not be able to determine the QoS being delivered as compared to that being advertised by the service providers.

QoS parameters ensure a competitive and transparent market but for that end consumers should be fully aware of the actual terms of services offered

⁵ "Mobile internet users in India to reach 371mn by June 2016", The Indian Express, accessed on May 09, 2016, <http://indianexpress.com/article/technology/tech-news-technology/mobile-internet-users-in-india-to-reach-371-mn-by-june-2016/>

⁶ Mobile Internet in India 2015, Internet & Mobile Association of India

⁷ "Mobile data is a part of future growth and we anticipate a larger ratio to our overall revenues in next two to three year timeframe," Naveen Chopra, Vodafone India Chief Operating Officer (<http://economictimes.indiatimes.com/industry/telecom/data-services-to-become-a-future-growth-driver-vodafone/articleshow/50993102.cms>)

⁸ Standards of Quality of Service for Mobile Data Services Regulations, TRAI, accessed on May 15, 2015

To ensure quality internet services, telecommunication regulators, globally, have enlisted QoS parameters with minimum threshold values in their regulations for the telecom operators to comply with, for services they render. Although for many countries, regulations are in place for fixed broadband and internet QoS, many countries are yet to frame the same for wireless/mobile data services. India does have regulation for wireless data services but there still have been questions on the quality of wireless internet services provided by the operators in India.

Mobile Internet: QoS Regulations in India

TRAI, in December, 2012 issued “Standards of Quality of Service for Mobile Data Services Regulations, 2012” to ensure quality Wireless Data services in India.⁹ It introduced a list of QoS parameters, with minimum benchmarked for operators to meet, on which the performance and QoS is being monitored in India.

Operators have to ensure that the minimum download speed specified in their advertisements, is delivered not less than 80 percent of the usage time

Following the 2012 Regulations, TRAI in July 2014, introduced a clause in the regulation that mandates operators to publish minimum download speed for the wireless data plans. Operators also have to ensure that the minimum download speed specified in their advertisements, is delivered not less than 80 percent¹⁰ of the usage time. This was introduced as the advertised speeds and actuals differed substantially. The complete set of QoS parameters, laid out by TRAI, are showcased in Table 1:

Table 1: QoS Standards as per TRAI	
Name of Parameter	Benchmark
Regulation 2012	
Service Activation/Provisioning	Within 4 hours with 95% success rate
Successful Data Transmission Download Attempts	> 80%
Successful Data Transmission Upload Attempts	> 75%
Minimum Download Speed	To be measured for each plan by the service provider and reported to TRAI
Average Throughput for Packet Data	> 75% of the subscribed speed
Latency	Data < 250 ms
PDP Context Activation Success Rate	≥ 95%
Drop Rate	≤ 5%
Amendment 2014	
Minimum Download Speed	≥ 80% of the usage time
<i>Source: TRAI Website (www.trai.gov.in/Content/Regulation/0_3_REGULATIONS.aspx)</i>	

⁹ *Ibid*

¹⁰ TRAI, accessed on May 05, 2015, www.trai.gov.in

Indian QoS regulations comprises of various technical parameters like data transmission attempts, minimum download speed, average throughput, latency, PDP context activation success and drop rate. These parameters are averaged over a month for reporting. More details on the QoS parameters may be found at TRAI's website.¹¹

Box 1: TRAI's Direction on Information Disclosure for Broadband Services (wired & wireless)

There exists a direction by TRAI to the service providers to provide adequate information to the consumers for the "broadband services". The rationale given by TRAI for the direction was that the Authority was receiving complaints from consumers and consumer organisations that there exists no transparency on information for broadband services by the service providers. The TRAI direction¹² dated July 27, 2012, mandates service providers to:

- 1) provide on their website and also in all advertisements published through any media, the following information in respect of all broadband tariff plans offered under Fair Usage Policy:
 - a) data usage limit with higher speed;
 - b) speed of connection up to data usage limit; and
 - c) speed of connection beyond data usage limit;
- 2) provide information specified in Para (a) in printed form to the new subscribers on their enrolment and to existing subscribers through email on their registered email address and through SMS on their mobile numbers registered with the service providers;
- 3) ensure that speed of broadband connection is not reduced, in all broadband tariff plans, below the minimum speed specified in Quality of Service of Broadband Service Regulations 2006;
- 4) provide alert to the customer at the time of login to the network of the service provider when his data usage reaches eighty percent of the data usage limit bundled with the plan and to ensure that such four alerts shall be provided at each login after data usage crosses the said limit of 80 percent; and send alert to the customer either through SMS on his mobile number registered with the service provider or to his registered email, each time when the data usage by the customer reaches eighty percent and hundred percent of the data usage limit bundled with plan opted by the customer, or through Unstructured Supplementary Service Data (USSD) at each login by the customer after the data usage reaches eighty percent of the data usage limit bundled with his plan.

Source: The TRAI

([www.trai.gov.in/WriteReadData/Direction/Document/Direction_final_vetted_160712\[1\].pdf](http://www.trai.gov.in/WriteReadData/Direction/Document/Direction_final_vetted_160712[1].pdf))

¹¹ TRAI QoS Regulations: http://www.trai.gov.in/Content/Regulation/0_3_REGULATIONS.aspx

¹² Direction under section 13 read with clause (b) of sub-section (1) of section 11 of the Telecom Regulatory Authority of India Act, 1997 (24 of 1997) to service providers for delivering broadband services in a transparent manner by providing adequate information to broadband consumers, dated July 27, 2012, accessed on October 12, 2015

2G mobile internet services do not fall under the category of broadband services like 3G and 4G, and for that there are no other directions for QoS provisioning by the operators

TRAI has separate QoS regulations for broadband services and wireless data services. It may be noted that 2G mobile internet services do not fall in the category of broadband services and there does not exist any separate direction on information provisioning by the operators for wireless data services. 3G and 4G data services can be categorised as broadband services. This makes it easier for the operators, to skip publishing of 'adequate' information to public, on wireless internet services. Given the fact that only 9 percent¹³ of the Indian

mobile consumers have a 3G connection, it is required for the regulator to focus on 2G services as well, till the time the users choose to upgrade to faster internet services. Thus, there is a requirement for similar direction for information disclosure for wireless internet services as well, and suggests that regulations for mobile/wireless internet services have a long way to go.

As a latest development, TRAI, on January 20, 2016, came out with a draft direction on delivering broadband services in a transparent manner.¹⁴ The final directions coming out after stakeholder feedbacks are expected to supersede the TRAI direction¹⁵ dated July 27, 2012. The draft directions are quoted in Box 2.

Given the fact that only 9 percent of the Indian mobile consumers have a 3G connection, the regulator should focus on 2G services as well, till the time users choose to upgrade to faster internet services

Box 2: Draft Direction on Delivering Broadband Services in a Transparent Manner

Now, therefore, in supersession of its earlier direction No. 4-1/2011 BB&PA dated the July 27, 2012, the Authority, in exercise of the powers conferred upon it under section 13, read with clause (b) of sub-section (1) of section 11, of the TRAI Act, 1997 (24 of 1997) and in order to ensure transparency in delivery of internet and broadband services and to protect interests of consumers of the telecom sector and to facilitate further growth of internet and broadband services in India, hereby directs all the telecom service providers providing broadband (wire-line or wireless) services to

a) provide on their website and also in all advertisements published through any media, the following information in respect of all broadband tariff plans offered under Fair Usage Policy: -

A. for Fixed broadband service:

- (i). data usage limit with specified speed;
- (ii). speed of broadband connection upto specified data usage limit; and
- (iii). speed of broadband connection beyond data usage limit;

B. for Mobile broadband service:

¹³ Article: www.thehindubusinessline.com/info-tech/only-9-of-mobile-users-have-3g-connection-clsa/article8000932.ece

¹⁴ The TRAI draft Direction, The TRAI, accessed on April 08, 2016, www.trai.gov.in/WriteReaddata/ConsultationPaper/Document/Draft%20Direction%2020.1.16.pdf

¹⁵ Supra Note 8

- (i). data usage limit with specified technology (3G/4G) for providing services;
- (ii). technology (3G/4G) offered for providing broadband services up to specified data usage limit; and
- (iii). technology (2G/3G/4G) offered for providing broadband services beyond data usage limit;

b) provide information specified in para (a) above to both new and existing subscribers on their registered email address and through SMS on their mobile number registered with the service providers;

c) ensure that download speed of broadband service provided to the fixed broadband subscriber is not reduced below 512 kbps in any broadband tariff plan;

d) provide alert to the subscriber when his data usage reaches 80 percent of the data usage limit under his plan and ensure that such alert is provided to the fixed broadband subscriber at each login after data usage crosses the said limit of 80 percent; and

e) send alert to the subscriber either through SMS or USSD on his mobile number, registered with the service provider or to his registered email address, each time when the data usage by the subscriber reaches eighty percent and hundred percent of the data usage limit under his plan and furnish compliance report by the (date).

Source: The TRAI

(www.trai.gov.in/WriteReaddata/ConsultationPaper/Document/Draft%20Direction%202020.1.16.pdf)

Considering the scenario, there are QoS regulations and certain direction in place by the regulator to ensure QoS, however the mobile internet services are still struggling in terms of quality. This highlights that there exists lapses in the framework. These may be attributed to factors such as weak infrastructure, policies and its implementation. The implementation of regulations is described below.

Implementation

TRAI directs the Unified Access Service Providers (USPs) and Cellular Mobile Service Providers (CSPs), providing wireless data services, to submit compliance reports every month in accordance to the QoS parameters specified in the regulation. TRAI, based on the data provided by operators in their monthly reports, issues a quarterly performance report, which is published on the regulator's website. These reports indicate operator's performance against the QoS benchmarks laid out in the regulations. Despite the QoS regulations and regulator's keenness on ensuring their implementation, in cases of non-compliance, TRAI does not have any provision of penalising operators.

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Other than this, TRAI publishes reports from independent agencies which engage on the assessment of QoS and customer satisfaction surveys of telecom services in various licence areas. TRAI has also developed an android application which can be used by the user to provide instant feedback on QoS provided by the operator. Consumers can now

respond to surveys through websites and applications. This comes in handy to assess the consumer satisfaction of telecom services in an area. However, questions specific to mobile internet services are either absent or scarce.

TRAI has also appointed three audit agencies, viz. M/s CS Datamation Research Services Pvt. Ltd., M/s TUV SUD South Asia/TUV SUD Group and M/s IMRB International to conduct audit and assessment of QoS measurements provided by various service providers in different zones and service areas in India.¹⁶

Challenges in India

Internationally, internet customers have fallen prey to practices, such as misleading advertising, unfair contract terms and unfair billing practices.¹⁷ The condition could not be different in India. Set out below are some of the challenges pertaining to internet services in India, which were reflected at the stakeholder consultation meeting, conducted as part of the study:¹⁸

1. *Misleading advertisements:* Use of terms like 'up to' for data speeds and non-compliance with the same is common occurrence. Non-disclosure of provisions of services like data speed, contract terms, latency, etc, are a matter of concern for consumers which influence consumer satisfaction.
2. *Non-compliance with Transparency Directions:* The Transparency Directions require service providers to provide on their website and also in all advertisements published through any media, information related to data usage limit, and speed of connection, in respect of all broadband tariff plans offered under fair usage policy. They also require service providers to intimate the customer upon 80 percent usage of the quota. Such conditions are rarely met.¹⁹
3. *No penalties on non-compliance with QoS regulations:* Currently, TRAI does not have any provision to penalise operators if they fail to achieve minimum threshold, for the QoS parameters, laid out in the regulations. This sets least incentives for the operators to comply with the regulations for 2G and 3G services.²⁰
4. *Data Collection:* There is no tool which collects information directly from the consumer's equipment (mobile and computers), which may help the regulator with genuine data on the performance of internet without a risk of any fudging.

There is no tool which collects information directly from the consumer's equipment (mobile and computers), which may help the regulator with genuine data on the performance of data services without risk of any fudging

¹⁶ Direction No. 301-1/2013-PMR-QoS (pt.) Oct 2013, Telecom Regulatory Authority of India

¹⁷ Consumers International, *Holding Broadband Providers to Account*, A Consumer Advocacy Manual, 2012

¹⁸ Stakeholder Consultation Meeting, June 17, 2015 at IIT Delhi Campus, New Delhi

¹⁹ Mhatre et al, *5 things all broadband users must know*, Tech2.in.com, March 2013

²⁰ Annexure 4.3 to the TRAI report on Indian Telecom Services Performance Indicators (January-March 2013) dated August 2013.

5. *Interrupted Services*: Weak telecom infrastructure in India causes drops in network on the move. India needs to strengthen its infrastructure by miles, which is suggested by the 3G coverage in India being only 30 percent.²¹ Power outages or power savings activities by operators cause shutdown of base stations, particularly in the rural area during nights, which results in interruption of internet services. 68 percent of mobile internet users experience session failures and lengthy loading times while outdoors and 63 percent face quality and reliability issues indoors.²²
6. *Principle parameter for QoS*: The QoS of mobile internet is mainly judged on the speeds experienced by the user. Speed/Throughput, thus, becomes the principal parameter to judge QoS of the services. It is required to base the QoS regulations on another parameter or a set of parameters which can represent the QoS more effectively.
7. *Performance Monitoring*: TRAI publishes State-wise quarterly performance reports for wireless data services. These reports list the performance of ISPs on the technical parameters listed in the QoS regulations but it is not easy for local people to comprehend such technical information, and the information can also not be audited externally to ensure that the self-reported values by the ISPs are indeed correct and measured in a methodically sound manner.

I. Cross Country Experiences in QoS

In this report, the quality monitoring and assessment framework has been reviewed for 3 countries namely – Brazil, Pakistan and Singapore. These countries have QoS parameters/guidelines for mobile internet as well. Brazil has been a great example of achieving high mobile coverage in the country, while Pakistan is a neighbouring country, sharing common issues like high population and low literacy levels. Singapore is one of the technologically advanced nations in Asia, which can provide learning lessons for India. Key statistics of the countries being reviewed are given in the table below:

²¹ Indian mobile data from 2G and 3G increased 87 percent in 2013, says NSN, Telecom Lead, accessed on May 05, 2015

www.telecomlead.com/3g/indian-mobile-data-2g-3g-increased-87-percent-2013-says-nsn-89749-49535

²² Ericsson Consumer Lab: The Changing Mobile Broadband Landscape, 2015, accessed on March 20, 2016, <http://www.ericsson.com/res/docs/2015/consumerlab/ericsson-consumerlab-the-changing-mobile-broadband-landscape-india.pdf>

Table 2: Key Statistics of Countries

	Brazil	Singapore	India	Pakistan
Population (million)²³	204.2	5.6	1251.6	199.1
Geographic Area (Km²)²⁴	8,514,209	683	3,287,240	770,880
Internet Launch Year	1988	1987	1995	1995
Internet Penetration (percent)	53.37	80.73	19.19	10.84
2G Coverage (percent)	99 ²⁵	99	90 ²⁶	90 ²⁷
3G Coverage (percent)	90	99	30	01 ²⁸
Regulator*	ANATEL	IDA	TRAI	PTA
Quality of Service (QoS) Parameters	Yes	Yes	Yes	Yes
Minimum QoS Values	Yes	Yes	Yes	Yes
Penalties on Non-compliance	Yes	Yes	No	Yes
Number of Mobile Operators	8	5	15	6

Sources: various websites

**ANATEL: Agência Nacional de Telecomunicações*
TRAI: Telecom Regulatory Authority of India
IDA: Infocomm Development Authority
PTA: Pakistan Telecommunication Authority

Brazil

Regulations: ANATEL has established QoS regulations which focus on minimum and median actual speed, service readiness and transparency of connection. In October 2011, through Resolution No. 575, ANATEL released Regulation on Quality Personal Mobile Service Delivery Management which sets QoS parameters for the operators to comply with.

In Brazil, operators have to ensure a minimum average connection speed; which will increase year-by-year, from 60 percent of the maximum speed in the first year to 70 in next and 80 in the subsequent year

Regulations set a key target of universal access to broadband with a minimum speed of 1 MBPS for approximately R\$35 Brazilian Real (US\$15.50).²⁹ Also, operators have to ensure minimum average connection speed; which will increase year-by-year, from 60 percent of the maximum speed in the first year to 70 in next and 80 in the subsequent year.

²³ United States Census Bureau, U.S. Department of Commerce, accessed May 07, 2015, <http://www.census.gov/en.html>

²⁴ Worldometer, accessed May 07, 2015, <http://www.worldometers.info/world-population/population-by-country/>

²⁵ Rossini C., Affordable Internet Access in Brazil, 2014, Alliance for Affordable Internet.

²⁶ Broadband in India: Realising the Vision (Oct 2014), Ericsson

²⁷ Patrick W. Nee, Key Facts on Pakistan: Essential Information on Pakistan, 2013,

²⁸ Digital inclusion and mobile sector taxation in Pakistan, 2015, Deloitte

²⁹ "Anatel Publica Regulamento com Padrões Mínimos de Qualidade para Internet Fixa", accessed May 05, 2015,

<http://www.anatel.gov.br/Portal/exibirPortalNoticias.do?acao=carregaNoticia&codigo=24110>

The QoS parameters in Brazil represent a number of factors ranging from consumer satisfaction to consumer centricity to technical measurement. The non-technical parameters include the number of complaints (quantum) and complaints handling (response time). The technical parameters comprise of factors like successful connections, drops, compliance to the contracted speed, latency to servers, jitter, packet losses and availability. The complete list of indicators may be found on ANATEL's website³⁰.

Implementation: The quality measurement is done by a private entity which is chosen through a bidding process, by a committee represented by the operators and ANATEL, but is contracted by the Operators. PricewaterhouseCoopers International, with technical help from SamKnows, is measuring quality by collecting samples for network indicators directly from the consumer equipment.

These measurements are submitted periodically to the regulator based on which a report comparing QoS of operators is prepared by ANATEL for each month. The operators are then rated and ranked in each of the 27 Brazilian States according to their QoS performance. These reports are published on ANATEL's website and other media for public reference.

In Brazil, the quality measurement is done by a private entity which is chosen through a bidding process, measuring quality by collecting samples for network indicators directly from the consumer equipment. The operators are then rated and ranked in each of the 27 Brazilian States on their QoS

As the government is actively participating in the infrastructure development for telecommunication under the PPP (Public-Private Partnership) model, the operators are investing more to improve the quality of networks.

Pakistan

Regulation: Pakistan Telecommunication Authority (PTA) in order to raise the quality of broadband services in Pakistan released the regulations on Broadband Quality of Service Regulation in 2014. The Authority has incorporated technical as well as non-technical KPIs (Key Performance Indicators) which are being used to measure the quality/performance of the internet.

The regulation is common for the wired as well as wireless BSP (Broadband Service Providers) like mobile internet. These KPIs include technical parameters like network availability, link speed, service availability, retainability, bandwidth specifications including speed, contention ratio, round trip time, packet loss and jitter while the non-technical parameters include tariffs, customer services, complaints, outages and billing issues. The complete list may be found on the PTA's website³¹.

Implementation: PTA ensures the QoS in two different ways. First, it conducts its own surveys and tests to ensure the quality standards for broadband internet. Second, the BSPs are required to test their services in accordance to the parameters prescribed by

³⁰ ANATEL QoS Regulation: <http://www.anatel.gov.br/legislacao/en/resolutions/806-resolution-575>

³¹ PTA's QoS Regulations: http://www.pta.gov.pk/bb_qos_regs_2014.pdf

PTA in their regulation. Outcomes of these tests have to be submitted to the regulator periodically i.e. every quarter.

In Pakistan, the data submitted by service providers is liable to be audited and inspected by the regulator, with or without prior notice

The BSPs have to ensure that the data is submitted within 30 days after the end of each quarter. The data submitted by BSPs is liable to be audited and inspected by the representatives of the PTA, with or without prior notice. PTA publishes survey results, service test results and ratings of BSPs for the information of general public.

QoS regulations for internet in Pakistan have a good mix of technical and non-technical parameters which also focus on network and service availability. It is yet to be seen how these regulations have actually helped Pakistan in improving the quality standards of internet in the country.

Singapore

Regulations: Telecom regulator of Singapore, Infocomm Development Authority (IDA), has a different approach for QoS management. Internet Service Providers (ISPs) are required to report quarterly on some select parameters on QoS to IDA as well as it is mandatory for them to publish accurate and complete information for the services they claim to provide or advertise. This ensures transparency on the services offered by the ISPs and also enhances the overall customer satisfaction.

Table 3: QoS: Singapore and India Compared

Parameter	Singapore	India
Network Availability	> 99 percent	> 98 percent
Latency (Local)	< 85 ms	< 120 ms
Latency (International)	< 300 ms (terrestrial) < 800 ms (satellite)	< 350 ms (terrestrial) < 800 ms (satellite)
Bandwidth Utilization	90 percent during peak hours	< 80 percent during peak hours
Broadband Connection Speed	Not Specified	> 80 percent of specified from user to ISP
Service Activation	Not Specified	100 percent in 15 working days
Customer Support (percentage calls answered by operator)	Not Specified	60 percent calls in 60 seconds 80 percent calls in 90 seconds

Source: LirneAsia³²

The entire framework is weaved around the speed of internet service to be experienced by the user. It mandates the ISPs to publish speed, plan and other details on ISPs'

³² Wattegama C., Broadband –Regulatory challenges in addressing QoS issues, LIRNEasia, http://lirneasia.net/wp-content/uploads/2008/06/2-cw_broadband-qos.pdf

websites, digital & press advertising materials, and any other publicity or marketing materials. Publications requirements in detail may be found on IDA's website³³.

Implementation: All ISPs providing fixed residential broadband and consumer mobile broadband services publish the typical broadband Internet access download speeds likely to be experienced by end users, in addition to the theoretical maximum speeds. All ISPs, as the regulations state, also publish such information in all advertising and publicity materials, as well as their websites.

In Singapore, in the case of non-compliance to the QoS guidelines by operators, the regulator has provision to penalise up to \$50,000 for each instance per standard on quarterly reporting, which increases on subsequent instances

The operators have to submit quarterly reports to IDA on their service quality. Surveys on mobile coverage are carried out by IDA to monitor mobile operator's performance. The methodology for data collection largely follows the requirement imposed on the mobile operators by IDA. The results of these surveys are published on the IDA's website. In case of non-compliance to the QoS guidelines by operators, IDA has provision to penalise up to \$50,000 for each instance per standard on quarterly reporting, which increases on subsequent instances.³⁴

Table 4: QoS Parameters: A Comparative Table for Countries reviewed

	Customer Service	Speed (Throughput Download / Upload)	Latency	Jitter	Availability	Connections	Drops in connections	Activation	Transmission Attempts	PDP	Min. Speed	Retainability	Contention Ratio	Tariff	Outages
Brazil	✓	✓	✓	✓	✓	✓	✓								
India	✓	✓	✓				✓	✓	✓	✓	✓				
Pakistan	✓	✓	✓		✓							✓	✓	✓	✓
Singapore		✓	✓		✓						✓				

³³ IDA's Guidelines:

https://www.ida.gov.sg/~media/Files/PCDG/Licensees/Information%20Papers/PR_ISP.pdf

³⁴ Quality of Service, Infocomm Development Authority of Singapore, accessed May 13, 2015, <http://www.ida.gov.sg/Policies-and-Regulations/Industry-and-Licensees/Standards-and-Quality-of-Service/Quality-of-Service>

Results and Findings

From the Network Measurements

The count of mobile Internet users in India has been growing at a rate of 27 percent annually and is expected to reach 300M by 2017. There is, however, limited understanding of whether this rapid growth is happening while also ensuring that good

It was found that the QoS provided differs considerably from the advertised values, and is widely different in different locations. Data reported by providers to TRAI showcased that some parameter values differ substantially and more realistic test environments should be mandated by TRAI to mimic the actual user experience with data services

QoS is provided to users. To find out, IIT, Delhi deployed a measurement framework in 20 rural, semi-urban, and urban sites in North India and probed four leading 2G and 3G telecom providers to measure performance metrics such as availability, throughput and latency. It was found that QoS provided differs considerably from advertised values, and is widely different in different locations. These measured values were then compared with data reported by the providers to TRAI, and showcased that some parameter values differ substantially and more realistic test environments should be mandated by TRAI to mimic the actual user experience with cellular data services.

It is also shown, through two examples, that a better infrastructure monitoring and more careful network configurations may help improve the QoS even with the existing infrastructure – providers who have configured smaller buffer sizes in their network elements would be able to provide better latency, and similarly providers who have configured less reactive switching between 2G and 3G would be able to avoid certain detrimental interactions with the higher layer TCP protocol that impacts the final throughput achieved. Overall, the study highlights the need for telecom providers to manage their networks more efficiently and provide better QoS to consumers, who currently do not seem to be getting the service to which they are entitled.

Providers who have configured smaller buffer sizes in their network elements are able to provide better latency, and similarly providers who have configured less reactive switching between 2G and 3G are able to avoid certain detrimental interactions with the higher layer TCP protocol that impacts the final throughput achieved

Network Measurements

During 2013 and 2014, 2G and 3G measurements were collected from 20 rural and urban locations and each location was probed for a period of at least three months. A measurement suite was written on Linux based Netbooks which were placed at these sites, and were configured to run tests to measure the throughput, latency, and availability of 2G and 3G connections provided by different telecom providers. On each Netbook, three Huawei USB modems were attached to be able to probe three different telecom providers simultaneously.

The existing relationship of IIT with several social enterprises and NGOs was leveraged to identify sites where the equipment could be safely placed for a long stretch of time over several months, and also referred to local staff members working out of these locations to check or restart the Netbooks if required. With help from the organisations PRADAN and *Vikas Samvad*, 11 sites were identified in the state of Madhya Pradesh, which were either local offices of these organisations or the homes of their staff members and volunteers. Similarly, with help from the social enterprises Air Jaldi and *Gram Vaani*, five sites were identified in the state of Jharkhand. Three sites were used in the state of Rajasthan which were homes of family members of some of the authors.

Finally, one site was in Delhi out of the IIT lab. For all sites, the SIM cards for the 2G and 3G connections were procured locally, and only those providers were probed which steadily gave high signal strength of at least 20 ASU at the sites. Wherever 3G services were available, both 3G and 2G performances were probed. Note that 3G services are however available only in urban and semi-urban areas, therefore 2G measurements prevail in the dataset. This is reflective of the adoption of 3G services in the country, which was approximately half of 2G adoption during the time we conducted the tests.

The choice of using Netbooks was primarily motivated because of the long battery life of commodity Netbooks, so that the deployments would not require any complex setup with UPSes or solar powered units to manage power failures. However, several other challenges were handled, which often required strong support from the local staff or friends and family at these locations.

One such challenge was that the 2G and 3G connections bought locally were prepaid connections and hence had to be recharged periodically. Watchdogs were built on the Netbooks which would use AT commands to query the remaining usage quota on the connections, and according send alert emails so that money could be added through APIs provided by prepaid recharge vendors. There however were several instances when the SIMs lost their validity and had to be replaced.

Another challenge was that the USB modems would sometimes hang. Despite watchdogs which would attempt to first re-mount that particular USB modem, failing which the Netbook would be rebooted automatically once tests on other connections had completed, the only failsafe was to unplug and plug the modem for which the local staff helped. Finally, due to disk failures or misconfigurations, and massive floods in one site in Madhya Pradesh, the Netbooks themselves had to be replaced at a few locations and required the team to travel to the sites with replacements. For these reasons the measurement entire data produced could not be used, and only those sites and providers for which long stretches of good quality data was available, were selected for the analysis.

Figure 1 shows the key components of the measurement architecture deployed. The Netbooks consult a control server to get a list of tests and test parameters to execute, and then run these tests such as upload and download iperfs to a different measurement server. Yet another data server is used to collect data from the Netbooks when they are not running the measurement tests. Virtual machines were used, hosted on Linode for the measurement and control servers, and a server at IIT Delhi as the data server.

Figure 1: Measurement Architecture

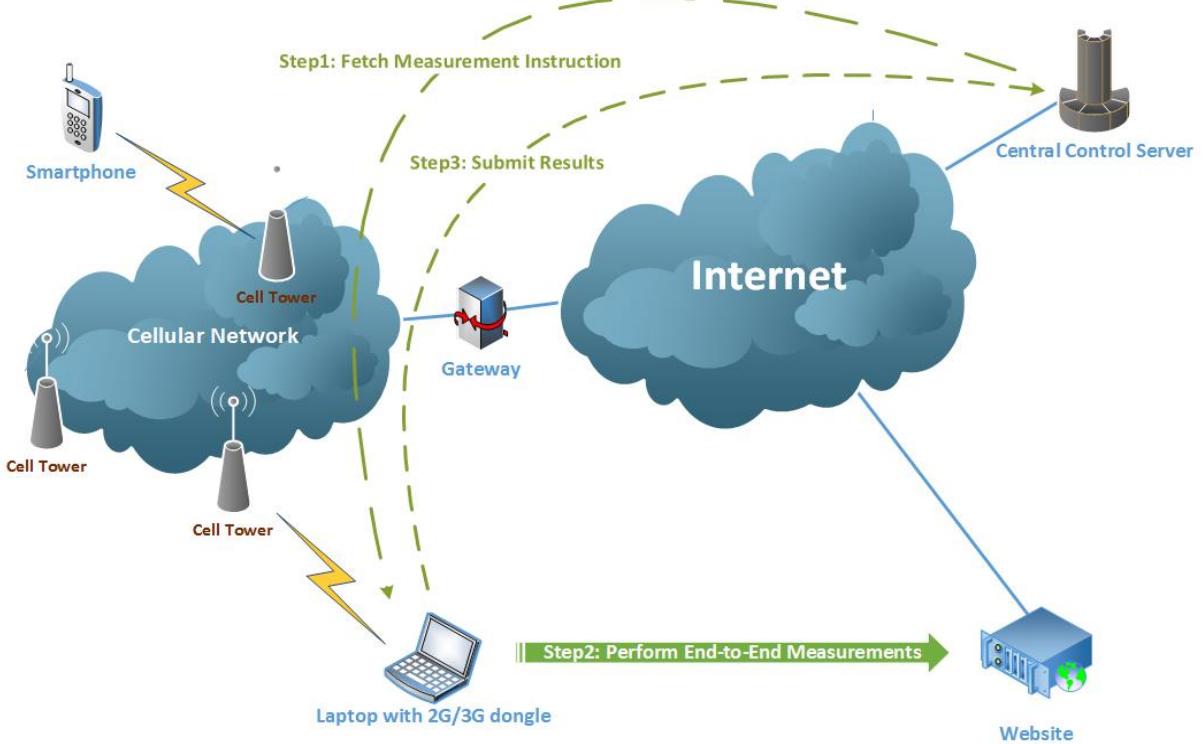


Table 1 summarises the providers and access technologies the exercise was able to probe successfully at the different locations. EDGE and UMTS are 2.5G and 3G technologies respectively belonging to the GSM family, and 1xRTT and EvDO are 2.5G and 3G technologies belonging to the CDMA family. For ease of exposition, EDGE and 1xRTT are referred as 2G, and UMTS and EvDO as 3G technologies. Among the GSM based providers, BSNL, Airtel and Idea were chosen, which are among the largest providers in the country, and refer to them as G_1 , G_2 and G_3 respectively with the G meant to denote GSM. Reliance was the only operator providing CDMA based services, and we referred to it as C_1 with the C meant to denote CDMA. Labels R_1 to R_{11} refer to rural locations, S_1 to S_4 are semi-urban locations, and U_1 to U_5 are urban locations.

Table 5: Measurement Locations/Service Providers

	<i>G₁</i> (BSNL)	<i>G₂</i> (Airtel)	<i>G₃</i> (Idea)	<i>C₁</i> (Reliance)
<i>R₁</i> (Lamta, MP)	EDGE	EDGE	-	1xRTT
<i>R₂</i> (Paraswada, MP)	EDGE	EDGE	EDGE	-
<i>R₃</i> (Ukwa, MP)	EDGE	EDGE	EDGE	-
<i>R₄</i> (Amarpur, MP)	EDGE	EDGE	EDGE	-
<i>R₅</i> (Samnapur, MP)	EDGE	-	-	1xRTT
<i>R₆</i> (Janakpur, MP)	EDGE	-	-	-
<i>R₇</i> (Manjha, MP)	-	EDGE	-	1xRTT
<i>R₈</i> (Hanumanpura, RJ)	EDGE	EDGE	EDGE	-
<i>R₉</i> (Kulhi, JH)	EDGE	UMTS	-	-
<i>R₁₀</i> (Gondlipokhar, JH)	EDGE	UMTS	-	-
<i>R₁₁</i> (Getalsud, JH)	UMTS	EDGE	-	1xRTT
<i>S₁</i> (Dindori, MP)	EDGE	-	-	-
<i>S₂</i> (Panna, MP)	EDGE	UMTS	UMTS	-
<i>S₃</i> (Jatadungari, MP)	-	-	EDGE	-
<i>S₄</i> (Ormanjhi, JH)	-	EDGE	UMTS	-
<i>U₁</i> (Pondi, MP)	EDGE	-	-	1xRTT
<i>U₂</i> (Jaipur, RJ)	UMTS	UMTS	EDGE	-
<i>U₃</i> (Sikar, RJ)	UMTS	UMTS	EDGE	-
<i>U₄</i> (Ranchi, JH)	EDGE	UMTS	-	-
<i>U₅</i> (Delhi)	UMTS	UMTS	UMTS	EVDO
	EDGE	EDGE	EDGE	

Availability Measurements

For each service provider at each location, the fraction of time for which connectivity was available was evaluated. To do so network connection were timestamped and disconnection events were reported by the USB modems during the time when the upload/download/latency experiments ran on the modems, and also noted any modem down times during this period when the modem was not responding and re-mounting attempts were being made by watchdog scripts. Using this, the availability was calculated as:

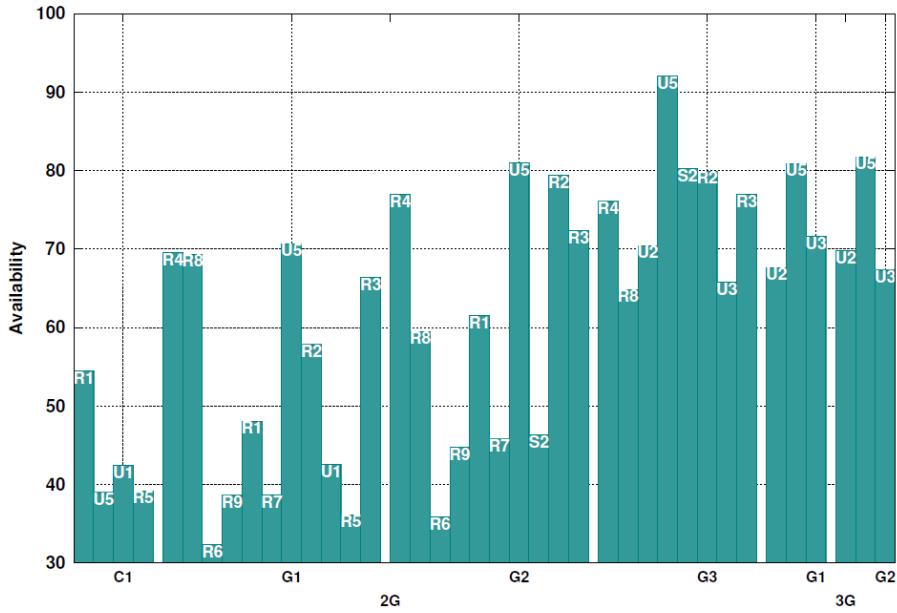
$$\text{availability} = \frac{\text{connected_time}}{(\text{measurement_duration} - \text{down_time})}$$

Where *connected_time* is the duration in seconds for which connectivity was available, *measurement_duration* is the time for which experiments ran on the modems, and *down_time* is the duration for which the USB modem may have been in a hung state. Figure 2 shows the availability of service providers across different locations.

It is alarming that in some cases the availability was as low as 35 percent, which means that the modem was able to successfully remain connected to a base station for only 35 percent of the time for which it tried

It is alarming that in some cases the availability was as low as 35 percent, which means that the modem was able to successfully remain connected to a base station for only 35 percent of the time for which it tried. Further, it was noticed that with the exception of *C₁*, availability was typically lower in rural and semi-urban locations than in urban locations. This was probably an artifact of misconfigurations or insufficient monitoring of rural cellular sites, some of which are to be brought to notice again in subsequent sections.

Figure 2: Availability Measurements



Throughput Measurements

Long duration single threaded TCP tests were used with iperf on the uplink and curl on the downlink to measure the throughput. Figure 3 shows the 2G and 3G uplink/downlink throughput values. The observations were similar to the availability data that some providers like *G3* provided consistent performance, but there was a high degree of variability with other providers. It was important to be brought to notice, the apparent evidence of misconfiguration in subsequent sections where it showed that TCP connections can actually get stalled for tens of seconds at times, thus affecting the throughput, which pointed towards the need for better monitoring and configuration of cellular sites.

What was also alarming was the extent to which the obtained throughput was often much lower than the values advertised by the service providers. Table 2 shows these advertised values. In fact, misleading advertising which promise speeds of 'up to 14.4 Mbps' are common sights on wall paintings and billboards all across India. TRAI needs to take note of misleading advertisements which not only presents trust issues but also hinder the awareness of the consumers in terms of knowing what QoS are they actually entitled.

What was also alarming was the extent to which the obtained throughput was often much lower than the values advertised by the service providers

Figure 3: Throughput Measurements

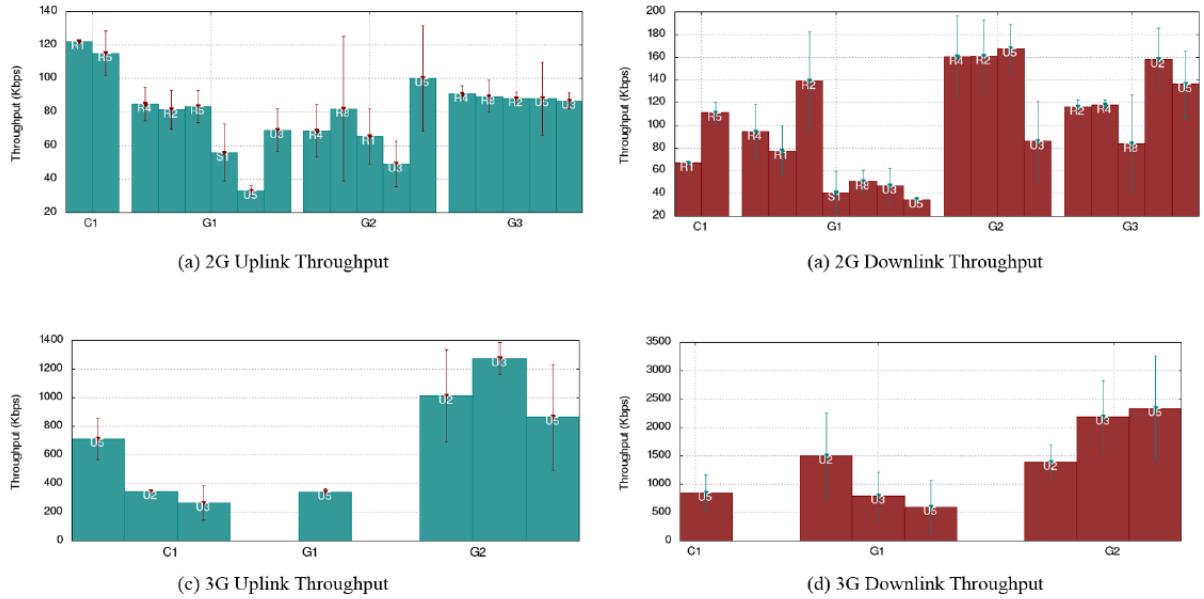


Table 6: Throughput Values Advertised by Service Providers

	2G Uplink	2G Downlink	3G Uplink	3G Downlink
C1	-	20 Kbps	-	256 Kbps
G1	144 Kbps	144 Kbps	14 Mbps	14 Mbps
G2	256 Kbps	256 Kbps	21.1 Mbps	21.1 Mbps
G3	236 Kbps	236 Kbps	5.7 Mbps	21 Mbps

Latency Measurements

Ping and traceroute measurements were used to find the latency values to the first IP hop in the network, arguably the GGSN or the PDSN gateway in the cellular network. This was also compared to the end to end latency to the Linode measurement server, to understand what proportion of the latency was spent in the radio access network.

Figure 4 shows the round trip latencies to the measurement server, and its sub-component to the gateway node in the network. It was interesting to note that providers like *G3* were able to provide almost 3G like latencies on 2G connections, but other providers had much higher latencies and also showed wide variations across different locations, again pointing towards different network configurations which probably caused these variations. This was confirmed by measuring the buffer sizes on the downlink and uplink by sending a train of UDP packets and spotting the first packet which was lost.

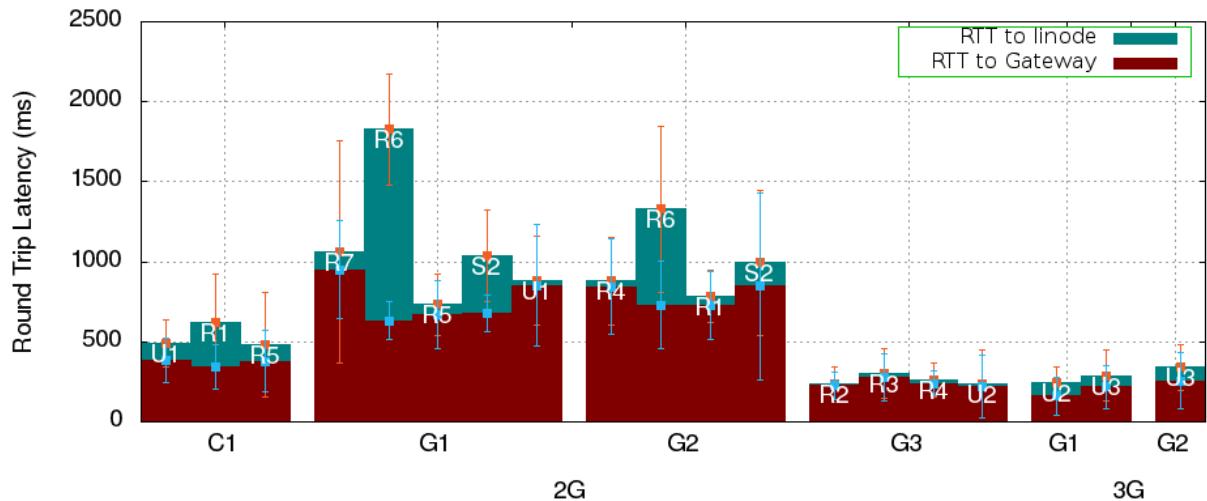
It was observed that the providers Idea and Reliance with the smallest buffers were also the ones with the smallest latencies. It may be argued that a more careful network configuration can alleviate several QoS problems, without any need to provision additional infrastructure

It was observed that the providers *G3* and *C1* with the smallest buffers were also the ones with the

smallest latencies. Large buffers are known to lead to high latencies and the bufferbloat problem, where interactive flows suffer when co-existing with long flows. Therefore, it may be argued that a more careful network configuration can alleviate several QoS problems, without any need to provision additional infrastructure.

Another observation from Figure 4 was that the latency beyond the gateway was also lower for $G3$ and $C1$, indicating that these ISPs were likely to have better connectivity with the rest of the Internet.

Figure 4: Latency Measurements



Comparison of QoS Measurements

TRAI releases a quarterly report on the QoS provided in different states for cellular data services. These are self-reported values by telecom providers, based on a test methodology specified by TRAI. On the surface the test methodology looks similar to the one used in this research, where TRAI specifies the file size and number of tries for upload and download to measure throughput, and the use of ping to find latencies. The tests however were actually conducted in a controlled environment, most likely from network elements located deeper inside the radio access network, which did not accurately mimic the real world environment that users actually experience.

Table 3 shows the data from the TRAI report for the service provider Airtel $G2$, and compared it with the parameters as measured by IIT during the same period. Broadly, the throughput values were of the same order, the latency values measured by us are quite higher, but the greatest difference was in the availability values where the provider actually reports 100 percent availability in most cases!

The takeaways therefore from a QoS regulation standpoint was for TRAI to mandate more realistic environments for providers to conduct network tests, or to depute third party agencies such as Sam Knows in the US to report measurements collected from actual user devices. These measures would bring more data to the public domain and thus draw attention to the

TRAI should mandate more realistic environments for providers to conduct network tests or to depute third parties (such as how Sam Knows works in the US) to report measurements collected from actual user devices

Proposals such as nutrition labels could help empower consumers by making them more aware of the QoS to expect and use the information to make better purchase decisions when buying data plans

widely different QoS provided in different locations by different providers.

Proposals, such as nutrition labels could also help empower consumers by making them more aware of the QoS to expect and then use the information to make better choices when buying data plans. However, unless TRAI does not mandate some minimum QoS standards to which providers can be

held accountable, or the published information is not made available to consumers easily to be able to exercise their choice in selecting providers, even these stronger regulatory measures may arguably not yield much benefit. Therefore it is believed that TRAI should continue to mount pressure on the providers to manage their networks better since our data indicates that just careful network configurations alone can help to a significant extent.

Table 7: Comparison of Performance Metrics Observed by us with TRAI Reported Values by Service Providers

Location	Observed Values			TRAI Values		
	Availability (%)	Throughput (kbps)	Latency (ms)	Availability (%)	Throughput (kbps)	Latency (ms)
RJ	2G 59.49	131.02	308.45	100	116.5	206.3
	3G 69.73 - 71.58	1394.03- 2187.13	128.84 - 256.89	100	2476.3	191.8
JH	2G 41.97 - 57.64		453.85 - 1040.75	100	199.7	244.8
	3G			100	3485.2	64
MP	2G 36.37 - 80.17	85.89 - 160.72	405.16 - 936.45	99.83	131.8	119
	3G 73.66	907.80	476.57			
Delhi	2G 81.44	167.82	310.58	100	130.2	173.3
	3G 91.69	2332.25	540.41		2369.4	80.4

Evidence of Network Mis-configuration Impacting Performance

There was observed an odd behaviour, that large file downloads on TCP sometimes stalled for long periods of time of up to tens of seconds. It was found that the occurrence of these stalls was quite frequent in some locations and detrimental for performance because it would cause the entire TCP connection to pause and later initiate a slow start. IIT discovered that the problem was to do with device and network configurations which caused the USB modems to search for other networks periodically, and thereby temporarily suspended data transfer – the signal strength dropped to zero and a new connection had to be initiated after the search procedure was over. Since this happened more in some sites than others, it again pointed towards configuration problems that led to such events.

Figure 5: Frequency of Switching and Switching Leading to Stalls

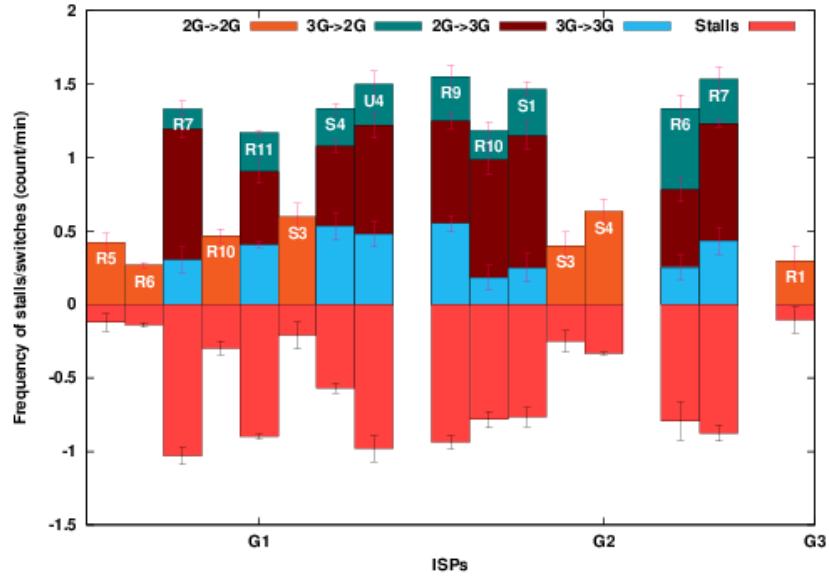
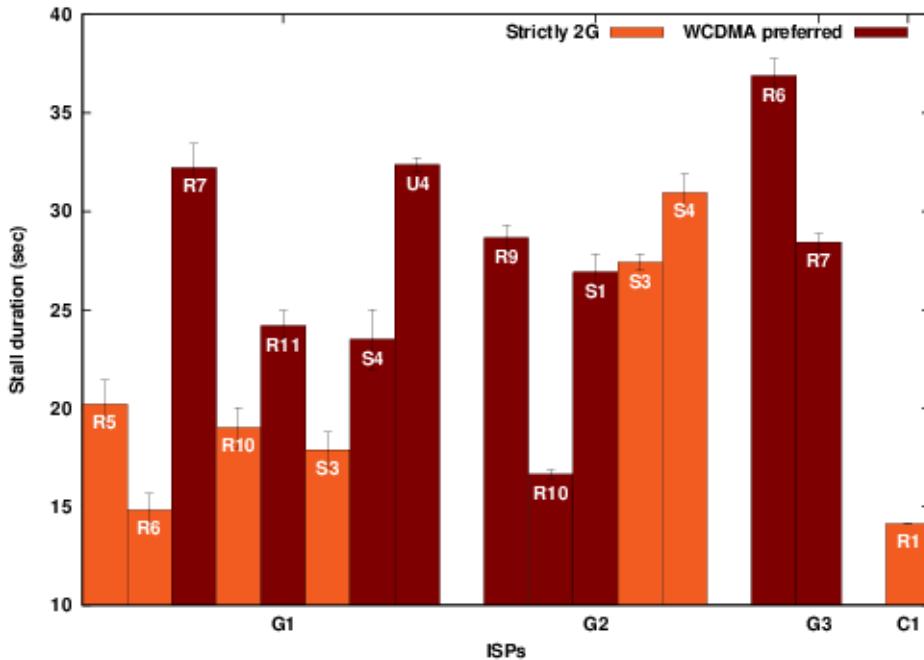


Figure 5 shows the frequency of switching, with many locations witnessed a switching event every 40 seconds on average. The negative axis on this figure shows how often these switches led to stall events where there was at least one timeout, and many locations had such stalls once every minute. There were however also combinations of providers and locations with low switching frequencies, but such cases of good configuration settings were seemingly rare.

Figure 6 plots the duration for these stall events. These stall durations ran into tens of seconds. The events were therefore detrimental in the case of any long transfers, since almost every minute some tens of seconds of connectivity went unutilised, and in the case of TCP this further sent the connection into timeouts.

Figure 6: Duration of Stalls



Overall, it was found that long duration downloads in most locations had stalls more than 40 percent of the time, and in some cases almost 90 percent of downloads had stalls. Downloads without stalls gave a throughput 25 percent higher than downloads with stalls and in the case of 2G, and 65 percent higher in the case of 3G connections. This seemed like it could be an avoidable penalty: In the case of sites with only 2G access, repeated searching could be disabled, or at least made less frequent. With sites having 3G and 2G access, a deeper analysis of the provider logs should be done to check if 3G access is being deliberately downgraded to 2G by the providers because their networks are under-provisioned, or the networks are just misconfigured and cause unnecessary switches.

When considered in perspective with the latency and throughput measurements in the earlier sections, it is clear that some providers were able to provide more consistent performance than others, and some sites were better configured than others. These observations therefore pointed towards the need for providers to be more careful in managing their networks, which can either be ensured through stronger and more appropriate regulations or through greater consumer awareness, so that the providers can be pushed to work harder at delivering better performance.

Putting together the diversity in latency and throughput measurements in different locations and by different providers, it is clear that some providers are able to provide more consistent performance than others, and some sites are better configured than others

Does QoS Perceptibly Affect QoE?

The study further wanted to check if the QoS delivered over different telco networks actually affected the quality of experience (QoE) perceived by the users. For this, a survey with 10 respondents was in a controlled lab setting, and the respondents were asked to rate between 1-5 their QoE while accessing a website or service over different networks. Websites were chosen based on different network requirements, such as on-demand video streaming which requires high throughput, and webpages with multiple embedded content objects that require low latencies to render within quick page load times. Table 4 shows the Kendall's rank correlation coefficient between the average respondent rating for accessing a specific website over a specific 3G telco network, and the QoS for throughput/latency/page load time for the access.

Table 8: Kendall's Rank Correlation Coefficient

	Idea	MTNL	Reliance	Kendall's coefficient
YouTube				
Mean rating given by respondents	2.9	1.7	1.6	
Measured throughput in KBps	59.4	7.9	4.8	1.0
Measured roundtrip latency in ms	37.6	14.6	55.9	-0.33
Facebook				
Mean rating given by respondents	2.8	1.6	2.0	
Measured throughput in KBps	16.6	8.5	8.0	0.33
Measured roundtrip latency in ms	15.7	81.1	30.7	-1.0
Measured page load time in ms	448.6	1518.7	549.6	-1.0
Google+				
Mean rating given by respondents	3.3	1.8	1.5	
Measured throughput in KBps	18.6	7.2	5.8	1.0
Measured roundtrip latency in ms	14.8	32.8	35.7	-1.0
Measured page load time in ms	418.4	591.5	1136.3	-1.0
Raaga				
Mean rating given by respondents	3.1	1.8	1.7	
Measured throughput in KBps	8.3	6.1	5.0	1.0
Measured roundtrip latency in ms	22.7	27.3	129.5	-1.0
Saavn				
Mean rating given by respondents	3.2	1.9	1.4	
Measured throughput in KBps	15.2	7.2	3.7	1.0
Measured roundtrip latency in ms	16.5	27.1	35.8	-1.0
ToI				
Mean rating given by respondents	2.9	1.8	1.4	
Measured throughput in KBps	14.2	4.5	5.1	0.33
Measured roundtrip latency in ms	12.3	16.7	18.5	1
Measured page load time in ms	2418.6	7604.4	4457.9	-0.67

It is clear from this table that the QoE for browsing websites such as Facebook or Times of India or Google+, is guided somewhat positively on throughput and strongly negatively on latency & page load times. This was expected because the websites serve heavy pages which open multiple TCP connections to download small objects, and therefore the page load times and latencies provide a better reflection of the QoE.

It may be deduced that the QoS provided by different networks directly affects the QoE of users, and in fact, users may perceive some networks to work better than others for a certain set of applications

Streaming websites such as YouTube or Raaga or Saavn, show a strong positive relationship with throughout and a strong negative relationship with latency, which again was expected because buffer underruns can be caused due to poor throughput or high latency. It may hence be deduced that the QoS provided by different networks directly affects the QoE of users, and in fact, users may perceive some networks to work better than others for a certain set of applications.

From the Consumer Survey

Introduction to the Survey Aims and Outcomes

The survey was envisaged to provide evidences to the anecdotal thoughts, bearing consumers dissatisfaction for the mobile internet services. The survey was framed in order to gauge consumer experiences and their awareness levels on the features of mobile internet, the regulatory authority and perception about various aspects of mobile internet services. For the respondent, who despite being consumers of mobile internet services, had limited knowledge about the same, were also educated by the surveyors on the concepts, the information that exists in public domain and their right to demand better services for the cost they were incurring for the services.

For this an extensive survey was conceptualised, and a detailed questionnaire was drafted (Annex). The questionnaire was designed to get feedback from mobile internet consumers on following three broad issues:

- 1) Awareness/knowledge on terms of usage and bandwidth provided by operators
- 2) Awareness/knowledge on sector regulator and existing regulations for mobile internet services in India
- 3) Opinion about the QoS for mobile Internet service, consumer service and complaint handling by operators

The survey envisaged to collect enough responses which could have been extrapolated in order to reflect the QoS for mobile internet services in India as a whole. However, due to time constraint associated with the study, the study could only manage to coverage, 3 regions. These were: Rajasthan, West Bengal and National Capital Region (NCR).

Respondents for the Survey

Rajasthan

A total of 300 respondents were surveyed from across 10 districts of Rajasthan. The respondents were randomly identified and their responses were collected through in depth interviews, based on structured questionnaires. While most of the questionnaires (270) were administered in person, others (30) were undertaken as online surveys.

The districts covered for the survey were – Banswara, Bhilwara, Bundi, Chittorgarh, Dungarpur, Jaipur, Kota, Pratapgarh, Rajsamand and Udaipur. From each district, 30 responses were collected across different age, occupation and education strata.

West Bengal

In West Bengal, a total of 300 respondents were surveyed from 10 districts, namely – Kolkata, Maldah, Purulia, Murshidabad, Hooghly, Howrah, Nadia, Midnapur, Parganas, Baharampur.

From each district, 30 respondents were selected on random basis. The data was collected through in depth interviews, based on structured questionnaires. All the questions in West Bengal were administered in person.

National Capital Region (NCR)

In New Delhi, 130 respondents were surveyed across rural, semi urban and urban areas. Some of the respondents represented the National Capital Region.

All respondents were selected on random basis. While some responses were gathered in person, others were gathered electronically.

Table 9 summarises some of the key findings across the three States:

Table 9: Summary of Key Findings Across Three States			
Parameter	West Bengal	Rajasthan	New Delhi & NCR
Respondents	300	300	130
QoS is the rationale for selecting service provider	42%	52%	64%
Level of Satisfaction with QoS is good	45%	24%	52%
Level of Satisfaction with tariff is good	28%	15%	26%
Awareness levels in respondents is good (regarding data plan)	63%	62%	82%
Service providers should regularly alert customers on data usage	83%	62%	58%
Service providers should mention the exact amount of data that is consumed per month by users	58%	73%	60%
Respondents do not know about bandwidth but want to know the same	92%	91%	89%
Respondents know about TRAI	40%	46%	85%
Respondents do not know about QoS parameters but want to know	65%	93%	81%
Penalties should be put in place for breach of QoS parameters	95%	99%	97%
Service providers should be ranked (quarterly) on the basis of their performance	91%	98%	97%

Rajasthan: Analysis

Respondent Characteristics

As mentioned above, the respondents were randomly identified from 10 districts of Rajasthan. An attempt was made to cover respondents from all economic and educational domains. The classification details are given below:

- Age: The survey made an attempt to cover mobile internet users belonging to different age brackets. 44 percent of respondents belonged to the age bracket of 15-25 years, closely followed by the age bracket of 25-35 years (38 percent). 13 percent of respondents were between the age of 35-50 years while the age bracket of 50 years and above contributed five percent of respondents.
- Economic & Educational Background: Considering the economic background of the respondents, 53 percent of respondents were urban dwellers while 44 percent were associated with rural areas. The remaining three percent corresponded to semi-urban locations. The reason for higher urban representation may be attributed to the higher internet penetration and wider coverage of services and network in urban areas as compared to rural and semi-urban locations.

The respondents were also graded on educational levels. 39 percent of respondents were graduates, while 34 percent were post graduates. 26 percent of respondents had studied up till Higher Secondary.

- Employment: In terms of employment, majority of respondents were involved in service-related jobs (33 percent), closely followed by business (26 percent) and students (22 percent). Some of the respondents surveyed were unemployed (10 percent), daily wage workers (seven percent) and homemakers (two percent).

Although the survey was based on random sampling, an effort was made to have a good mix of respondents from diverse strata. From the gathered information, it may be deciphered that the survey could manage responses from diverse sections of society.

Service Provider

It was seen that majority of respondents (40 percent) used Airtel for their mobile internet services. The next popular mobile internet service provider was Vodafone (31 percent) followed by Idea (13 percent) and BSNL (eight percent). The other notable service providers were Reliance (four percent) and Tata (one percent).

It is pertinent to mention that Tata Tele Services and MTS were not used by any of the respondents. This may be accredited to the fact that Airtel, Vodafone and Idea, being leaders in cellular industry, provide more coverage across country as compared to others, which contributes to the higher adoption of their services. Since, mobile internet is one of the services offered through a mobile connection; other services such as calling, value-added services, offers, etc. also influence the choice making for service provider by the user.

In terms of post-paid and pre-paid mobile services, it was found that most of the members had pre-paid connection (90 percent) while the remaining (10 percent) used post-paid. Post-paid connections are associated with fixed and recurring monthly charges and hassles of submitting bills, which is not the case with pre-paid services. The flexibility to choose between plans (in terms of tariff and requirement) and no minimum obligation to meet every month, contributes to the higher uptake of pre-paid services.

Rationale for Selection of Service Provider: When respondents were asked for the reasons behind selecting their respective mobile internet service provider, QoS³⁵ was the leading answer (52 percent) followed by tariff for services (28 percent). Some respondents (13 percent) mentioned that they did not have any other option to choose from and hence selected their mobile internet service provider. Only six percent of respondents accredited good customer services offered, as a reason for selecting their service provider.

Therefore, the quality and tariff for services were the propellants for selecting the mobile internet service provider. Indians have always been cost sensitive and considerate to after-sales service before opting for services and same is the case with mobile internet services as well.

Overall Level of Satisfaction with QoS and tariff

54 percent of the respondents, from all 10 districts combined, conceded that the level of satisfaction with the QoS for mobile internet services was average. It is important to note that while 52 percent of the respondents, in the above section, quoted QoS as the reason for selecting their service provider; they were not satisfied with the QoS for mobile internet delivered to them.

54 percent of respondents, from all 10 districts combined, conceded that the level of satisfaction with the QoS for mobile internet services was average

Only three percent of respondents felt that the overall QoS for their mobile internet services was very good and 24 percent thought it was good. 14 percent of the respondents felt the services were poor while five percent thought the same were very poor.

41 percent of respondents drew average satisfaction for their mobile internet services with respect to the tariffs incurred, while 37 percent claimed their satisfaction levels to be poor

Similar was the response on satisfaction with tariffs paid for mobile internet services. 41 percent of respondents drew average satisfaction for their mobile internet services with respect to the tariffs incurred, while 37 percent claimed their satisfaction levels to be poor. Only 15 percent of respondents felt services to be value for money or better while seven percent felt the tariffs they were paying were highly in excess for the QoS provided by the service provider. Importantly, as many as 73 percent of respondents felt that they were not being

³⁵ QoS here refers to the quality of service perceived by the consumers and is not based on industry or any other standards

charged appropriately (were being charged higher) for the mobile internet services while only 27 percent thought they were being charged appropriately.

Interestingly, considering the respondents from the rural areas (131), 60 percent considered their QoS for mobile internet services as average while for urban areas (159 respondents), it was 50 percent. While only 12 percent of rural respondents said the QoS was good and better, for urban respondents it was 36 percent. For the 'dis-satisfied' consumers, rural contributed 26 percent while urban accounted for 15 percent.

It can be deduced from the survey data that users were not satisfied on the QoS provided by operators for the mobile internet services with respect to the tariff borne by them. As a matter of fact, most respondents felt that the QoS provided by operators was average while the satisfaction with tariff was either average or poor. It was also assessed that the dissatisfaction was higher in the rural areas as compared to urban locations.

Awareness on subscribed mobile internet plans in terms of Usage

Most of the respondents (62 percent) reported that they were aware of the features offered by their respective subscribed internet plans. The features which were inquired were the knowledge of the data limit and the associated tariffs associated with mobile internet plans. The tariff accounted for applicable charges for usage within the subscribed data limit and post exhaustion of the data limit. When inquired about the source of information for mobile internet plan features, common responses were – service operator (49 percent), customer care centres (32 percent) and through other users/friends (18 percent).

Most of the respondents reported that they were aware of the features offered by their respective subscribed internet plans. The features which were inquired were the knowledge of the data limit and the associated tariffs associated with mobile internet plans

The survey also required respondents to mention their average mobile internet data consumption for one month. It was found that most of the respondents (56 percent) consumed 1GB to 4GB of mobile internet data each month followed by those who used less than 1GB of data (36 percent). This mobile internet data consumption information did not include the data incurred from accessing internet through other services such as Wi-Fi or broadband.

It may, therefore, be concluded that most of the consumers were well aware of their subscribed mobile internet plans, and the information was popularly procured from the service operator(s), customer care and other users and friends. Further, it may also be deduced that irrespective of the background, majority of the consumers (92 percent) consume less than 4 GB of mobile internet data.

Tracking Internet Usage against the Subscribed mobile internet plan

The respondents were inquired if it would be beneficial for them to track their mobile internet usage as against their subscribed mobile internet plan. Majority of the respondents (63 percent) mentioned that provision of such information would benefit them while others were sceptical about its utility.

Of the respondents who felt that the provision of usage information would benefit them, 73 percent claimed that it would help them to assess if they were correctly being charged for their mobile internet services. Similarly, 26 percent mentioned that such information would be useful in optimising their mobile internet usage.

The TRAI intends to bring in a regulation where service providers would be required to send regular usage alerts, i.e. after every 5MB usage of mobile internet data. This would enable consumers to keep a track of their internet usage and ration their mobile internet data as per their need. This is indeed a welcome step by the telecom regulator. Of the respondents, 62 percent wanted to receive regular alerts on mobile internet data usage while few respondents (six percent) mentioned that such information was not required by them.

Bandwidth on mobile internet services offered by Service providers

Interestingly, majority of respondents (93 percent) mentioned that they were unaware of the term bandwidth and its association with their mobile internet plan

Interestingly, majority of respondents (93 percent) mentioned that they were unaware of the term bandwidth and its association with their mobile internet plan. The respondents, who were aware, explained that they procured this information from customer care (45 percent), operator (36 percent) or existing users/friends (14 percent).

For the respondents who were unaware on the mobile internet bandwidth, the same was explained to them by the surveyors. Then the respondents were asked if they would like to know their mobile internet plan bandwidth. 91 percent responded affirmatively and only nine percent responded negatively. This highlights the lack of information provided by the operators to their customers. Since there is no disclosure or mention of bandwidth by operators in their advertisements or product information, the consumers scarcely get to know about such information and its implication on mobile internet QoS. Since bandwidth may be more closely linked to the speed of internet service, the operators should ideally include the download and upload speeds, offered by their internet plans, in their advertisements.

Then the respondents were asked if they would like to know their mobile internet plan bandwidth. 91 percent responded affirmatively and only nine percent responded negatively. This highlights the lack of information provided by the operators to their customers

The respondents also expressed interest in knowing the relationship between bandwidth and data usage. Most of them (56 percent) remarked that they did not know the relationship but wanted to understand the concept, while only a few (three percent) mentioned that they did not know and would not be interested in knowing either.

3G Users and Mobile Applications

The respondents were inquired about the internet-based applications that they used the most on their mobile phones. Most of the respondents used different types of such applications on their mobile phones. 78 percent respondents used mobile internet to access social media applications such as Facebook, LinkedIn and 71 percent used messaging apps such as Whatsapp/Viber/etc. Other applications used by respondents

were – video/audio streaming apps (40 percent), maps and directions (28 percent) and video chat apps (19 percent).

For the respondents who accessed YouTube through their mobile phones, 53 percent mentioned that they surf without switching over to Wi-Fi, while the remaining (47 percent) said they do prefer to switch to Wi-Fi. Since Wi-Fi is not available at all locations, and even for the places where it does, the costs associated may not suit all consumers. This is a possible reason why the users preferred to use their mobile internet services to watch YouTube.

The members who switched to Wi-Fi explained that they do so because buffering time (38 percent) and data cost (36 percent) associated with mobile internet services are too high. Of the total respondents, 26 percent claimed that they were not interested in surfing YouTube. Accordingly, it may be assumed that switching to Wi-Fi for YouTube surfing is not a major concern amongst the respondents. In cases where users switched to Wi-Fi, it was to attain better buffering speed or to save data cost.

It is interesting to note that majority of the respondents (94 percent) did not know how much mobile internet data is consumed in watching videos on YouTube and the associated data costs. When asked if they were willing to know about their YouTube usage and cost, 91 percent of the respondents showed interest to know about it and only nine percent declined. The respondents were informed that, on an average, watching a five-minute video on YouTube costs Rs. 3.20. 83 percent respondents also said that they would like to stay informed of the data cost incurred while watching videos on YouTube.

Telecom Regulatory Authority of India

Respondents were queried on their awareness about the telecom regulator, i.e. TRAI. The responses narrated that 46 percent of respondents were aware of TRAI and 54

The responses narrated that 46 percent of respondents were aware of TRAI and 54 percent were not

percent were not. Of those, who were aware of TRAI (46 percent), 58 percent were also aware of the fact that all service providers are required to submit quarterly performance reports to TRAI regarding mobile internet services. The limited awareness on existence of TRAI and its functions may be attributed to its Delhi-centred presence. TRAI has no regional representation and hence, there is limited awareness about the institution.

The reports submitted by service providers are collated by TRAI and made available on their official website in public interest. However, the same is not published by the operators on their official webpages. The respondents were asked if they would be interested in perusing the quarterly performance reports of mobile operators if they were easily available. Most of the respondents (88 percent) affirmed that the quarterly reports would be useful for them in choosing between service providers, while only a few (12 percent) said it would not be useful for them.

Most of the respondents (88 percent) affirmed that the quarterly reports would be useful for them in choosing between service providers, while only a few (12 percent) said it would not be useful for them

Only one percent said they were already aware of QoS benchmarks to be provided by the operators, while the majority (93 percent) did not know about the standards but were keen to know

Importantly, the respondents were queried if they were willing to know about the TRAI set QoS parameters, on which the QoS for mobile internet is judged. Only one percent said they were already aware of the same, while majority (93 percent) did not know about the standards but were keen to know. A handful of the respondents (five percent) felt neutral towards knowing the QoS parameters.

Hence, it may be concluded that almost half of the respondents were unaware of the regulatory authority and its functions. Almost none of the respondents were aware about the QoS parameters for mobile internet set by TRAI. However, when informed about the existence of QoS parameters, majority of the respondents expressed their interest in learning the QoS standards. Even though TRAI publishes quarterly reports on Mobile Operators performance, there is limited awareness on existence of such reports among consumers. Thus, there seems a need for TRAI to have a better regional visibility.

Customer Service

It was witnessed that most of the respondents (69 percent) did not have any previous experience in lodging a mobile internet service related complaint against their service provider. The complaints were, in most cases, lodged at the customer care centres, through call centres or operator's physical outlets. For the remaining 31 percent of respondents, those who did complain, only seven percent were satisfied with the manner in which their complaints were handled by the operator. 51 percent of the respondents felt that their complaint was handled unsatisfactorily and 41 percent thought the process was averagely handled.

Penalties

Although TRAI has published minimum benchmarks for mobile internet QoS which the operators are mandated to adhere to, there are no penalties levied for breach of these benchmarks. The respondents were questioned if there should exist penalty clauses for breach on QoS parameters by the operators. 99 percent of the respondents wanted penalties in place for such breaches while a mere one percent of respondents felt that penalties were not required.

When queries on what the penalties may be for the operators, 39 percent of the respondents felt that the penalty should only be monetary, while 34 percent said that the operator breaching the parameter(s) should be only named and shamed in public domain. It was interesting to find that 25 percent of the respondents wanted monetary as well as name and shame as punishment for breaches. It is assumed that the imposition of penalties may act as deterrent for the service providers and may force them to enhance their QoS levels, for mobile internet services they render.

Ranking system

Lastly, the respondents were asked if a quarterly ranking system, which would grade the operators based on their performance in a quarter, should be provisioned by the regulator. Since TRAI already publishes quarterly performance reports of operators, it may go a step further by ranking the operators based on their performances. As many

as 98 percent of the respondents felt that provision of a ranking system for operators may help consumers in choosing the best service provider and may as well enhance QoS levels and competition in the sector.

West Bengal: Analysis

Respondent Characteristics

As mentioned above, the respondents were randomly identified from 10 districts of West Bengal. An attempt was made to cover respondents from all economic and education groups.

- **Age:** Majority of the respondents surveyed (40 percent) belonged to the age bracket of 25-35 years, closely followed (37 percent) by the age group of 15-25. Only a few of the respondents (19 percent) belonged to the age bracket 35-50, followed by aged 50 or above (4 percent).

It is important to note here that the majority (77 percent) of the respondents represent the younger consumer voice from the range of 15-35 years.

- **Educational Background:** In terms of educational background, most of the respondents (39 percent) were graduates followed by Higher Secondary Education (34 percent). Some of the respondents (26 percent) were post graduates while only one percent had not been to school at all.
- **Employment:** In case of employment profile, it was found that most of the respondents belonged to the service class (38 percent) or were students (31 percent). Some of the respondents (18 percent) were in business, while some (seven percent) were homemakers. Only a few were unemployed (four percent) or daily wage workers (three percent).

Service Provider

Having understood the demographics, the respondents were asked about the service provider deployed for mobile internet services. A wide range of service providers are available in West Bengal for mobile internet services.

First, the respondents were asked which service provider they use for mobile internet services. It was found that most of the respondents (37 percent) used Vodafone, very closely trailed (34 percent) by Airtel. The other service providers used were - Idea (seven percent), Reliance (six percent), BSNL (six percent), MTS (four percent), Tata (three percent), Tata Tele (one percent) and others (two percent). Although, MTNL is also a service provider, none of the respondents mentioned using the same for mobile internet services.

The respondents were then asked whether they used post-paid or prepaid services. Most of the respondents said they used prepaid (93 percent) rather than post-paid (seven percent). Such choice may be accrued to the fact that prepaid services offer monetary flexibility as compared to post-paid services.

Rationale for Selection of Service Provider: To gather further information, respondents were then asked the primary reason behind selecting the service provider for their mobile internet services. Majority of the respondents said that the prime reason for selecting the service provider was QoS (42 percent). The other reasons cited for the selection were price (31 percent) and customer service (22 percent) and the fact that the service provider was the only option (seven percent).

It is important to note that QoS and price form the leading reasons for selecting the mobile internet provider (jointly 73 percent).

Majority of the respondents said that the prime reason for selecting the service provider was QoS (42 percent). The other reasons cited for the selection were price (31 percent) and customer service (22 percent) and the fact that the service provider was the only option (seven percent)

Amount Spent on Mobile Internet Services

In terms of the amount spent on mobile internet data (monthly), the respondents answered as – ₹51-200 (60 percent), ₹201-500 (24 percent) and lesser than ₹50 (14 percent). The respondents were also asked if they thought they were being charged correctly. While most (55 percent) of the respondents thought they were being charged correctly, a close (45 percent) thought they were not.

Overall Level of Satisfaction with QoS and tariff

The respondents were then questioned on the overall level of satisfaction with respect to their mobile internet QoS. Interestingly, most of the respondents answered the same was good (45 percent) or average (42 percent). Only a few (seven percent) agreed that the level of satisfaction was very good, while a few mentioned the same was poor (seven percent) or very poor (seven percent).

Further, the respondents were asked the level of satisfaction with the tariff. Again most of the respondents thought the same was average (50 percent). The remaining respondents responded as – good (28 percent), poor (14 percent), very good (five percent) and very poor (two percent).

On the overall, it can be summarised that the level of satisfaction with respect to the QoS was relatively high in West Bengal. The data collected reflected a good response as in general, most of the respondents (87 percent) thought the overall service of quality was above average or good. Similarly, the level of satisfaction keeping in mind the tariff paid was also rated as average.

Awareness of Plan in terms of Usage and Bandwidth

The respondents were enquired on the awareness levels with respect to the advertised data plan. Most of the respondents (63 percent) reported that they were aware of the features of the internet plan subscribed. The respondents were then asked how they received this information, to which the response was as: customer care (52 percent), operators/agents (35 percent), existing friends/users (15 percent) and other sources (six percent).

The survey also required respondents to mention the average amount of internet data that they consumed in a month. It was found that most of the members used lesser than

1GB data (44 percent) followed by 1GB-4GB (38 percent). It is important to note here this excludes data consumed through Wi-Fi.

Respondents (58 percent) mentioned that it was important to know how much data they were consuming as it would help them evaluate if they were being charged correctly or if they could use more data within the subscribed data plan (44 percent). Only a few (four percent) mentioned that the given information will not be helpful for them.

It may therefore be concluded that most of the consumers were well aware of their subscribed mobile internet plan (in terms of data limit and applicable charges), where the information is popularly obtained from the customer care or service operator(s).

Bandwidth and Data Usage

When the respondents were asked if they knew the bandwidth that came with their mobile internet plans, most (74 percent) mentioned that they had no idea, while a few (26 percent) said they were aware. Of these 26 percent of the respondents, most (47 percent) said that they obtained this information from their operator or agent, while the others obtained the same from customer care (38 percent), from friends/existing users (18 percent), from the bill (13 percent) and others (five percent). Moreover, from the 74 percent of the respondents who were unaware of the bandwidth, most (92 percent) said they would like to know their bandwidth.

Importantly, most of the respondents (48 percent) mentioned that they were not sure of the relationship between bandwidth and data usage, but wanted to understand.

It is important thereby for service providers to not only publish the data but also the bandwidth in order to provide complete information regarding mobile internet service. Further, as reflected from the data captured, users are interested in knowing the bandwidth.

3G Users and Mobile Applications

The respondents were asked to rank which applications they use the most on their mobile phones (when not connected to Wi-Fi). This was a multiple choice question and

the respondents chose more than one options. Majority of the respondents (75 percent) voted for social media applications, followed by messaging apps (35 percent) and streaming apps (23 percent). The remaining voted for maps and directions (18 percent) and video chat (13 percent).

Majority of the respondents (60 percent) said that they do not switch to Wi-Fi for data services. The 40 percent who do, said that they surf YouTube through Wi-Fi because of the high data cost (38 percent) and high buffering time (35 percent) on cellular networks

Further, the respondents were asked if they surf YouTube on their phones when not connected to Wi-Fi. Majority of them (60 percent) said that they don't while the remaining (40 percent) said that they do switch to Wi-Fi. The respondents who do not surf YouTube without Wi-Fi, said they do so because of the high data cost (38 percent), high buffering time (35 percent) or simply because they are not interested in YouTube (30 percent).

Moreover, when the respondents were asked if they knew what the cost of surfing YouTube was, most (90 percent) said that they were unaware and 83% of the respondents said that they would like to know to know the cost in order to keep a track of data usage.³⁶

When the respondents were asked if they knew what the cost of surfing YouTube was, most (90 percent) said that they were unaware

In fact, when the respondents were asked if they would like to receive regular updates on data usage, most of them (83 percent) said they would like to receive the information.

This is in line with the new regulation that the TRAI intends to bring in whereby regular alerts will be sent to users after every 5MB of data usage. This would help the users keep a track of their usage and ration mobile data as per their need.

Telecom Regulatory Authority of India

The respondents were questioned on the awareness level of the TRAI. Remarkably, most of the respondents (60 percent) were not aware of the TRAI. Only a few (40 percent) said that they were. Out of these 40 percent, most of the respondents (66 percent) were aware that the service provider has to submit a quarterly report regarding quality of mobile internet standards to the TRAI. While a consolidated report of all service providers is available on the TRAI website, it is not available on the individual service providers' webpage.

The respondents were then asked if it would be beneficial for them if the aforementioned quarterly reports were made available to public, most (79 percent) said the same would be beneficial. Further, the respondents were asked if they would like to know the QoS parameters framed by the TRAI, most (65 percent) said they would like to know, while some (17 percent) said they already knew and a few (10 percent) said they were neutral towards the standards. A few of the respondents (eight percent) said they would not want to know.

Most of the people are unaware of the TRAI but are interested to know about the institution and the quality of standards that it has set to ensure quality in mobile internet. It is thereby recommended that the TRAI undertakes workshops or such activities at the state level in order to create awareness about the Regulator

Therefore, as seen in Rajasthan, it is important to note that in West Bengal too, most of the people are unaware of the TRAI but are interested to knowing about the institution and the quality of standards that it has set to ensure quality in mobile internet. It is thereby recommended that the TRAI undertakes workshops or such activities at the state level in order to create awareness of the Regulator.

³⁶ It costs about ₹3.2 to watch a 5 minutes video on YouTube. The cost information was shared with the interested respondents.

Customer Service

Respondents were asked about their experience on lodging complaints against mobile internet services at customer care. It was found that only a few respondents (31 percent) had previously lodged a complaint against mobile internet services. Out of these, majority of them (60 percent) mentioned that they were unsatisfied with how their complaint was dealt, while only 26 percent mentioned their experience was average and 14 percent said it was satisfactory.

60 percent of the respondents were unsatisfied with how their complaint was dealt, while only 26 percent mentioned that their experience was average

This is an important finding as it shows that while most customers had not lodged any complaints regarding their mobile internet services, out of the ones which have only as few as 14 percent were satisfied with how the complaint was dealt.

Penalties

Although TRAI has enlisted specific benchmarks for mobile internet service providers to adhere to in order to ensure good quality of mobile internet services, there are no punishments assigned for breach of the same. So when the respondents were questioned on the awareness levels on the benchmarks, most (65 percent) said that they did not know but of the benchmarks but would like to know. A handful (17 percent) of the respondents said that they were already aware, while 10 percent said they were not aware and were neutral towards the quality standards.

Whether punishments for QoS violation need to be put in place by TRAI, most (95 percent) said it should be imposed

should be introduced.

Similarly, when the respondents were asked if punishments for such breach needed to be put in place by TRAI, most (95 percent) said it should while a mere (five percent) said that it should not. In terms of type of punishment, majority of the respondents (72 percent) felt that a monetary punishment should be imposed, while a few (23 percent) felt that the mode of name and shame

It is argued that the TRAI needs to put in place penalties in case of breach of quality of mobile internet services. However, it is important for TRAI to understand the implications of the punishment it brings. Imposing a monetary punishment may not as a corrective measure and may merely pass on the monetary burden on consumers.

Ranking system

Lastly, the respondents were asked if the service providers should be ranked on monthly basis on the ground of their overall performance. Most of the respondents (91 percent) said that such ranking should be introduced, while the remaining (nine percent) did not think so. Such ranking may instil competition amongst the service providers and enhance the overall quality of mobile internet services provided.

National Capital Region (NCR): Analysis

Respondent Characteristics

As mentioned above, the respondents were randomly identified from across New Delhi and the National Capital Region (NCR). An attempt was made to cover respondents from all economic and educational groups.

- **Age:** Majority of the respondents surveyed (52 percent) belonged to the age bracket of 15-25 years. Out of the remaining, 34 percent belonged to the age group, 12 percent belonged to the group 35-45 and three percent were of 50 years or above.
- **Educational Background:** In terms of educational background, most of the respondents (76 percent) were post graduates. The other respondents had obtained Higher Secondary Education (15 percent) or had studied till Higher Secondary or lesser (nine percent).
- **Employment:** In case of employment, most of the respondents were students (52 percent), closely followed by those who belonged to service class (44 percent). Regarding the remaining respondents, only a few (nine percent) were home-makers and business (one percent).

On the overall, it is important to note that the respondents in New Delhi and NCR were mostly younger than the respondents in West Bengal and Rajasthan. Further, most of the respondents here were post-graduates and students or belonged to the service class.

Service Provider

Once the demographics were captured, the respondents were asked which service provider they used for mobile internet services. Multiple service providers provide mobile internet facilities in New Delhi and NCR.

It was found that most of the respondents used (47 percent) or Vodafone (32 percent). The remaining maintained they use other service providers as: Idea (11 percent), Reliance (three percent), BSNL (two percent), Tata (two percent), MTNL (two percent) and others (two percent).

In terms of prepaid and post-paid services, most of the respondents used pre-paid (55 percent) while the remaining (45 percent) used post-paid.

Based on the evidence gathered, it is evident that most of the respondents in New Delhi and NCR used either Airtel or Vodafone. Further, in terms of post-paid and prepaid services, most of the respondents used prepaid services. This may be due to the fact that prepaid services are easier to maintain and offer monetary flexibility.

Rationale for Selection of Service Provider: The respondents were then asked the primary reason for selecting their service provider for mobile internet. Significantly, most of the respondents (64 percent) mentioned that they select their service provider

on the basis of QoS. The other reasons cited for the selection were customer service (eight percent), other reasons (eight percent) and price (four percent).

Overall Level of Satisfaction with QoS and tariff

When the respondents were asked about the overall level of satisfaction with QoS, most of the respondents (52 percent) thought the same was good. Some of the respondents (26 percent) felt the same was average, while the remaining felt it was poor (eight percent) or very poor (three percent). Only a few (11 percent) of the respondents felt the QoS were very good.

In terms of satisfaction with cost paid, however, majority of the respondents (43 percent) thought the same was only average. The remaining respondents mentioned the same was good (26 percent), poor (18 percent), very poor (seven percent), very good (six percent).

Accordingly, on the overall it can be said that regarding the QoS, most of the respondents think the same is good, however, comparing the satisfaction to the cost paid, most think the same is only average.

Awareness of Plan in terms of Usage and Bandwidth

The respondents were also enquired on the awareness levels with respect to the advertised data plan. As witnessed in the other states, most of the respondents (82 percent) said they were well aware of their plans. In terms of the source of this information, the respondents answered as operator/agent (49 percent), existing users/friends (21 percent), customer care (16 percent), others (nine percent) and through the information provided on the bill (eight percent).

Further, respondents were asked if they were aware of the amount of data they were actually using per month. Most of the respondents (45 percent) said they use lesser than 1GB, closely followed (43 percent) said they used 1GB-4GB. Only a few (four percent) said they were not aware of the same. When these few were asked if knowing the exact data consumption would be useful, majority of them (60 percent) said it would. They said such information would help them in evaluating if they were being charged correctly (62 percent), if they had more data to use (43 percent) or other reasons (two percent). Only a few (12 percent) said such information may not be useful.

Having gathered information on the amount of data used, the respondents were asked if they thought they were being charged correctly. Most of the respondents (51 percent) consented that they did not know if they were being charged correctly, while the remaining thought the opposite.

The respondents were then asked if receiving regular alerts for data usage would be useful for them. While most (58 percent) said it would be useful, a close (42 percent) said it would not.

This data gathered thereby reflects the fact most of the respondents are well aware of their data plans but would like to be more informed in terms of the exact usage.

Bandwidth and Data Usage

When the respondents were asked if they knew the bandwidth that came with their mobile internet plans, most (74 percent) mentioned that they had no idea, while a few (26 percent) said they were aware. Of these 26 percent of the respondents, most (47 percent) said that they obtained this information from their operator or agent, while the others obtained the same from customer care (38 percent), from friends/existing users (18 percent), from the bill (13 percent) and others (five percent). Moreover, from the 74 percent of the respondents who were unaware of the bandwidth, most (92 percent) said they would like to know their bandwidth.

Importantly, most of the respondents (48 percent) mentioned that they were not sure of the relationship between bandwidth and data usage, but wanted to understand.

It is important thereby for service providers to not only publish the data but also the bandwidth in order to provide complete information regarding mobile internet service. Further, as reflected from the data captured, users are interested in knowing the bandwidth.

3G Users and Mobile Applications

The respondents were asked to rank which applications they used the most on their mobile phones (when not connected to Wi-Fi). This was a multiple choice question and the respondents chose more than one options. Majority of the respondents (85 percent) said they used social media apps the most. This was closely followed by messaging apps (83 percent). The other applications frequently used were maps and directions (72 percent), streaming apps (60 percent) and video chat (35 percent).

Further, the respondents were asked if they used YouTube on their phones when not connected to Wi-Fi. Interestingly, most of the respondents (56 percent) said they do not, while the remaining 44 percent said they do not. Most of the respondents (79 percent) said they did not surf YouTube without Wi-Fi simply because of the high data cost. While the remaining respondents said they do not surf YouTube because of the high buffering time (49 percent) or simply because they are not interested in YouTube (five percent).

The respondents were then asked if they were aware of how much a video on YouTube cost, most of them (82 percent) said they were unaware. In fact, most of the respondents (91 percent) said they were interested in knowing the amount of data they spent on various applications in order to keep track of the data expenditure.

This is in line with the new regulation that the TRAI intends to bring in whereby regular alerts will be sent to users after every 5MB of data usage. This would help the users keep a track of their usage and ration mobile data as per their need.

Telecom Regulatory Authority of India

The respondents were asked if they were aware of the TRAI. Remarkably, most of the respondents (85 percent) said they were aware of TRAI. They were further asked if they were aware that the service providers were required to submit quarterly reports to the

TRAI on QoS. Again, most of the respondents (57 percent) said they were aware of the same.

As the aforementioned quarterly reports are submitted to the service providers and not available for public, the respondents were asked if it would be beneficial for them if the reports were made available. Majority of the respondents (78 percent) said it would be beneficial for them.

The respondents were then asked if they were aware of the QoS parameters which the TRAI had framed for mobile internet. Most of the respondents (81 percent) mentioned they were not aware of the parameters but would like to know about them. A few of them (12 percent) were neutral towards it while fewer (six percent) said they were aware of the parameters.

It is thereby pertinent to note that the respondents in New Delhi are relatively more aware of TRAI, compared to the respondents in West Bengal and Rajasthan. Further, the respondents are interested to know about the parameters set by the TRAI for QoS for mobile internet.

Customer Service

An attempt was made to gather information from the respondents on their experience with complaints regarding mobile internet services. Interestingly, most of the respondents (62 percent) said they had not lodged a complaint regarding mobile internet services yet. Of the remaining respondents (38 percent), most of them mentioned their experience was average (45 percent) or unsatisfactory (35 percent). Only a few (14 percent) felt their experience was satisfactory.

Penalties

While TRAI has enlisted the benchmark for QoS for mobile internet, it has not enlisted any penalties in case of breach of the same. When the respondents were asked if TRAI needs to set penalties, majority (97 percent) of the respondents affirmed that it should, while only a few (seven percent) said it need not.

In case of the type of punishment, most of the respondents (83 percent) felt that monetary punishment should be introduced, while some (46 percent) felt that the violators should be named and shamed.

Ranking system

Lastly, the respondents were asked if the service providers should be ranked on monthly basis on the ground of their overall performance. As many as 97 percent respondents said such ranking should be brought in place.

From the information gathered by the respondents, it is evident that merely setting standards is not enough. TRAI needs to bring in a mechanism whereby violators are punished. Furthermore, respondents think that ranking of service providers should be introduced. Such ranking will not only enhance QoS but also the competition among players.

Role of Civil Society Organisations on Mobile Internet QoS

Consumers are the *raison de' etre* of all economic activities in all economies. Production is usually driven by consumer demand – willingness to pay and ability to pay. The satisfaction of consumer interests provides the necessary stimulus for economic growth. Given that the economic interests of powerfully organised producers and inadequately organised consumer groups often clash at the level of the industry, there is a case for regulators which not only takes into account views and interests of all stakeholders but also ensures that the consumers have the opportunity as well as capacity to voice their opinions regarding the conduct of regulation and supply of the services.

This study highlights to the fact that the mobile internet services are not sub-par and there is a lack of complete information disclosure by the operators to the consumers which impact their informed choice making. Even for TRAI and its quarterly performance reports, there are limited consumers who know about their existence and those who do, the technicality of these reports is difficult to comprehend. Against this background, it is crucial for CSOs to play an active role in bridging the gap between consumers, TRAI as well as the service providers. Not only should they reflect consumer concerns but also relay the challenges faced by service providers in implementing the QoS parameters. Furthermore, they should detect potential degradations in service quality over time and report the same to the regulator.

CSOs/Consumer Groups' Representation under TRAI

The TRAI Act, 1997 explicitly underscores the importance of consumer welfare for the services provided. In order to provide space for effective consumer representation, TRAI passed the Regulation on Guidelines for Registration of Consumer Organisations/Non-Governmental Organisations (NGOs) and their Interaction with TRAI, 2001. The regulations provide specific guidelines for registration of CSOs and NGOs with TRAI.³⁷ The registered organisations have the privilege of obtaining data from TRAI and attending special meetings with the regulatory board where they are given an opportunity to voice their opinions.³⁸

The said regulations were later revised and replaced by the Registration of Consumer Organisations Regulations in 2013 on the basis of stakeholder consultations (including consumer advocacy groups).³⁹ The core objective of reviewing the Regulation was to

³⁷ "Regulation on guidelines for registration of Consumer Organisations/ Non-government Organisations (NGOs) and their Interaction with TRAI, 2001", 2001, Telecom Regulatory Authority of India, accessed June 01, 2015, <http://www.dot.gov.in/sites/default/files/15jan2001.pdf>

³⁸ Organisations which are not registered with TRAI are invited for open house discussions but not given a speaking slot. They can only speak in the open floor discussion

³⁹ Press Release No. 11/2013, "Registration of Consumer Organisations Regulations, 2013", Telecom Regulatory Authority of India, 2013, accessed June 01, 2015

bring transparency with the registration process and enhance effective communication between the consumer groups and TRAI.

Currently, there are 42 consumer organisations (National and State level) registered with TRAI.⁴⁰ The Consumer Affairs (CA and QoS) Division, as the name suggests is responsible for the registration and interaction of consumer groups and framing and monitoring of QoS by service providers.⁴¹

Role and Scope

Although, many CSOs and consumer groups have played a significant role in general regulation making process and awareness segment of the telecommunications sector, their interventions in the mobile internet QoS segment has been limited. In case of QoS, there are two crucial areas where CSOs in India need to play an important role, these are – regulations and effective implementation.

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CSO on Regulations for QoS

In case of regulations pertaining to the quest, TRAI frames the same and releases the draft on its official website for public comments. The draft is available for a certain period for comments and an extended period for counter comments. In such cases, it is essential for CSOs and relevant stakeholders to provide comments/suggestions to TRAI. Furthermore, organisations registered with the TRAI should not only provide comments but also actively voice their opinion in special meetings and open floor discussions with TRAI as well as the media.

An example of an organisation that has played an active role in providing comments on the QoS is Voluntary Organisation in Interest of Consumer Education (VOICE), a consumer protection group set by teachers and students of the Delhi University in 1983. When the draft 'Amendment to the Standards of Quality of Service for Wireless Data Services Regulations, 2012', were laid out in the public domain, VOICE strongly advocated for prescribing benchmarks of minimum download speed.

<http://www.trai.gov.in/WriteReadData/WhatsNew/Documents/11-2013-Press%20Release%20on%20regulation%20on%20registration%20of%20CAGs.pdf>

⁴⁰ "List of Consumer Advocacy Groups registered with TRAI" Telecom Regulatory Authority of India, accessed June 1, 2015,

<http://www.trai.gov.in/WriteReadData/ConsumerGroup/Document/consumerref.pdf>

⁴¹ "Manual Under Section 4(1) (b) of the Right to Information Act, 2005" Telecom Regulatory Authority of India, accessed June 1, 2015, http://trai.gov.in/WriteReadData/userfiles/file/rti/RTI-Act_TRAI-Website-06.03.13.pdf

Box 3: Opinion of VOICE on Minimum Download Speed

"It is high time that all parameters related to QoS for Wireless Data Services are prescribed and monitored. This is probably one of the rare product/service where a buyer does not know what he is buying as the Internet Service Provider (ISP) will keep on changing the specification of the service on offer at his whims and fancies even overlooking the basic trade norms. Unless the buyer is told of the specifications of the service being offered how the consumer can demand performance. And the Licensor as well as the regulator have overlooked this basic fact and have not provided a proper definition to all aspects of internet. Obviously, the ISPs do not believe in self-regulation as no ISP has defined his offerings clearly. Then there is a misleading sales pitch – 'Speed up toMbps....' which does not guarantee any performance.

Further, all ISPs should be mandated to specify minimum performance on not only download speed but upload speed as well for each plan.

Source: Inputs received from VOICE

Similarly, other groups, such as the Internet Society (ISoc), Consumer Protection Association, National Centre for Human Settlements and Environment (NHSCE), Association of Unified Telecom Service Providers of India (AUTSPI) and Haryana Technical Association, have also played an active role in providing comments to TRAI on QoS regulations. However, on comparing the dynamism of stakeholders in providing comments on TRAI's draft regulations, it is noted that service providers have been much more active in voicing their opinions as compared to CSOs.⁴² It is, therefore, argued that to ensure that inputs of all stakeholders is relayed to TRAI, more CSOs need to participate in providing substantial inputs.

Implementation of QoS

In case of implementation of the QoS, the role of CSOs has been rather latent. In fact, based on secondary research, it has been found that no such organisation essentially works on the issues of implementation (which extends to include monitoring and evaluation) of the QoS in mobile internet. A couple of implications of limited interventions have been cited below:

To make the process of audit more transparent and authentic, it is crucial for CSOs to question and determine the complete process of auditing itself

Auditing and Accountability

One may commend TRAI's agility in compiling and publishing the quarterly reports based on monthly reports submitted by service providers regarding their performance on the QoS Standards.⁴³ The authority has also been proactive in auditing the said reports and publishing the same, albeit the

⁴² Comments and counter comments submitted to TRAI can be viewed by public. On analysing the stakeholders who have been actively commenting on the QoS Regulations, it is noted that the service providers have been far more active than the CSOs.

⁴³ Quality of Service Consultation Papers, Telecom Regulatory Authority of India, accessed June 01, 2015, http://www.trai.gov.in/Content/CONSULTATION/23_CONSULTATIONS.aspx

Regulation 2012 provides that TRAI 'might' audit the reports (and not 'shall'). To make the process of audit more transparent and authentic, it is crucial for CSOs to question and determine the complete process of auditing itself.

Publication of Reports by Service Providers

Regulation, 2012, section 6 (2) *de jure* mandates that service providers should 'publish, for the information of consumers' its performance with respect to the QoS. However, *de facto* no such information is available on the official website of any of the service providers in India. If the reports are to be published (as per the Regulation 2012), TRAI needs to specify where and how the information should be published while the CSOs should ensure the same is accordingly published and made easily available to consumers.

It is, therefore, argued that the CSOs need to build their capacity to be able to monitor the implementation of the regulations pertaining to the QoS. The objective here is dual pronged. Firstly, this will help TRAI in monitoring the QoS transparently and efficiently. Secondly, this would help in bridging the gap between framing and implementing the QoS. Interaction with the consumers will reflect the ground results of regulations while interaction with service providers will help them assess challenges faced while implementing the QoS parameters. Subsequently, they will be able to provide TRAI with strong evidence-based inputs for improved QoS regulation.

Possible Engagement of CSOs

CSOs engagement in QoS regulation has increased in the past few years. However, to realise the regulation, it is important for CSOs to intervene at the implementation level as well. While active intervention of CSOs is strongly argued, one must not overlook the hurdles which limit the participation of the CSOs. Often CSOs suffer from financial limitations, poor regulatory response, information asymmetry and lack of training and capacity building. Some of the recommendations put forth through this paper, keeping in mind the limitations are as follows:

- **Collaboration of CSOs:** CSOs must collaborate their strengths to effectively tackle the issues pertaining to QoS, especially the CSOs registered with TRAI. Such CSOs might meet periodically to channelise their inputs and subsequently relay the same to TRAI in the special meetings and open floor discussions. Further, Indian CSOs might also collaborate with international experts or international groups like the International Governance Forum and the International Telecommunication Union to keep abreast of the developments in the QoS which take place at the international-level.
- **Good practices of CSOs abroad:** CSOs in India should learn from the good practices of CSOs abroad working in this field. One such international organisation is LIRNEasia, a regional Information and Communication Technology policy and regulation think tank active across Asia Pacific. The organisation has been active in research and advocating for effective QoS standards across Asia.

- **Outsourcing Internet Measurement:** It is important for CSOs to advocate for more institutions to partake such evaluation. Internationally, various internet measurement platforms have emerged in the past few years. Further, such platforms are being deployed by Regulators, Consumers and ISPs. For example, SamKnows, a private organisation has become popular in collecting internet data for quality measurement amongst Regulators across (including US, UK, Singapore, Brazil and Canada). Another example is Broadband Internet Service mark (BISmark), an initiative by Georgia Tech for (broadband) internet measurement. Civil society and consumer groups in India could advocate for deployment of such organisations. This would save time and efforts in data collection and provide space for efficient data for QoS analysis.
- **Collaboration with the Universities:** For technical assistance in monitoring and/or evaluating the QoS, CSOs could collaborate with Universities having technical expertise. For instance, Indian Institute of Technology (IIT) has collected internet data from four service providers across rural as well as urban locations. At the international-level, some of the Universities which have developed a model to evaluate QoS performance of service providers are: Aalto University (Netradar model) and University of Pisa (Portolan model).⁴⁴ Hence, the CSOs might urge Indian Universities to develop a framework for QoS evaluation and collaborate with them to conduct third party assessments.
- **Creation of complaint redressal mechanisms:** Advocate setting up of complaint redressal mechanisms for consumer complaints related to Internet connectivity. Merely assessing QoS parameters and asking ISPs to submit is not sufficient. A consumer redressal mechanism which is transparent and swift needs to be put in place.
- **Privileges given to registered CSO/NGOs:** The CSOs/NGOs registered with TRAI is an opportunity for close focussed interaction which has not been capitalised. TRAI should use this platform to build the capacity and involvement of the registered organisations. For instance, CSOs should advocate for biannual meetings with TRAI to have focussed discussions on the issues pertaining to QoS. Further, (as done earlier) a fund could be allocated to the registered CSOs to enable them to carry out related functions and awareness programmes.

Merely assessing QoS parameters and asking ISPs to submit the data is not sufficient. A consumer redressal mechanism which is transparent and swift needs to be put in place

⁴⁴ Bajpai V. and Schönwälde J., "A Survey on Internet Performance Measurement Platforms and Related Standardization Efforts", University of Bremen, accessed June 1, 2015
<http://vaibhavbajpai.com/documents/papers/proceedings/lsmp-comst-2015.pdf>

Observations & Recommendations

The study tries to assess the QoS for mobile internet services in two ways. One is through a network measurement process, which involves direct collection of measurement data on QoS for mobile internet services at various locations, rural and urban. This evaluates the mobile internet services on technical parameters like throughput, latency, and availability.

The network measurement study highlights that the QoS obtained by users differs considerably from advertised values by the telecom providers, and several measured values even differ from values reported by them to the TRAI - pointing to the urgency of imposing more rigorous measurement methodologies. It also seems that in many cases, simply a more careful configuration of the cellular networks could lead to better performance.

Considering the evidence the network measurements could provide, the second assessment involves identifying consumer perception to assess consumer experience of the mobile internet services they were using. A survey led to gathering of important information on QoS for mobile internet, which has been analysed further. The information from the survey pertains to the awareness levels among consumers regarding their data plans, overall satisfaction, TRAI and its regulations on QoS, etc. Some of the key overarching observations are highlighted in the section below.

Observations

- Most people choose the service provider for mobile internet based on factors such as speed and coverage which pertain to QoS. However, most consumers are not satisfied with the QoS provided by their service provider, and network measurements strongly point towards unsatisfactory QoS being provided. In fact, most consumers feel that their satisfaction on cost paid by them for the services provided is just average.
- Consumers are well aware of their data plan usage limit and they are informed about it by the provider itself. Consumers also keep track of their data usage, and agree that greater information will help them plan their usage better.
- Contrastingly, clarity on bandwidth is absent. People don't know how much to expect, and advertisements such as speeds of 'up to' are in fact misleading. Some of the consumers know that bandwidth is different from data usage but more awareness on the concept is needed. The data gathered reflects that the consumers are not informed on the bandwidth by the providers as this information is rarely published. Hence there is a need for greater consumer awareness through methods such as nutrition labels or notifications on bandwidth provided.

- There is a good spread of apps and websites that consumers access using mobile internet. Websites like YouTube are not accessed actively (when not connected to Wi-Fi). More than cost as a reason for this, it is because of poor QoS, i.e. high buffering time. Therefore, an argument can be made that if QoS is improved, it will lead to more consumption of data and hence higher revenues for providers.
- Most people are unaware of the TRAI. Further, there is no information on the QoS parameters and regulations set by TRAI to ensure quality of mobile internet. Since there is low awareness about the regulator, there is associated low awareness of reports which are published on the TRAI website. Hence, TRAI needs to publicise QoS reports to consumers, and providers should be mandated to publish nutrition labels or performance reports for the QoS rendered by them. Further, the methodology prescribed by TRAI to measure QoS being provided to consumers should be strengthened to make it more robust and reflective of actual end-user experience. Third party information platforms can also be created, which present the TRAI-reported information in user friendly ways.
- In line with the QoS set by TRAI, currently there are no penalties in case of breach of the minimum benchmark mandated. Most consumers feel that some kind of penalty should be imposed for such breaches. Furthermore, as of now there are also no incentives for the service providers to perform better other than just expanding the consumer base. It is therefore recommended that a ranking system be put in place, which could act as an incentive to boost competition and improve quality.
- A number of consumers who lodged complaints about slow internet felt that their complaints were not handled properly. Consumers, in general, are not happy and want stronger regulations, fines, etc. for customer support. Thus customer support should also be a part of QoS benchmarking.
- Lastly, the data gathered shows that consumers are capable of enforcing accountability if (a) they are aware of their entitlements/actual terms of service, and (b) they are empowered to test and compare their services with regulatory benchmarks e.g. speed test. TRAI should, apart from drafting regulations, also focus on educating consumers of their rights and provisioning of complete set of information on the product i.e. mobile internet.

It is important for the TRAI to address these issues and pave the way for improved and accountable quality of mobile internet. Some recommendations may be drawn from the evidence gathered by the study.

Recommendations

- It is evident from the report that, while consumers are unaware of certain attributes of mobile internet services, such as the bandwidth provided and the QoS mandates set by TRAI, consumers are eager to know about the same. Importantly, most of the consumers are not even aware of the institution TRAI. Accordingly, awareness workshops need to be undertaken, not only at the central level but also at the regional level. TRAI needs to make its presence felt

across India through regional centres. Even the process for submitting complaints to the TRAI need to be eased out for the consumers.

- The system of quarterly audit reports (based on monthly reporting by service providers on QoS to TRAI) should be made more transparent. One may think of bringing in a nutrition label,⁴⁵ so consumers get to know what QoS they are being provided against their entitlement. The methodology for the providers to measure and report QoS should also be strengthened and made more reflective of actual end-consumer experience.
- In terms of service providers, they need to provide more information to the consumers while selling data packs. For instance, bandwidth provided should also be explained apart from data limit and various associated charges, and misleading advertising should be avoided. There is evidence to suggest that even though consumers are keen to have fuller information about their data packs, they are being offered incomplete information.
- Service providers should also publish the above mentioned reports on their websites. This would provide another means of facilitating information to consumers and enable them to differentiate between services rendered by various operators. This would then enable them to make an informed choice. Misleading advertisements by service providers should not be allowed, and the achieved performance should be compared with the advertised performance to spot any differences between what was committed and what was provided.
- TRAI should mandate regular data usage alerts. It is already recommended that service providers should provide data usage notifications to users based on set intervals of usage such as after 50 percent consumption of the data pack limit, after 80 percent, etc. This will help users optimise their internet pack usage.
- A system of ranking should be introduced. Under the system, service providers should be ranked on their relative performance on QoS parameters. Such a system would not only instil competition amongst the service providers but also improve efficiency and innovation. This would act as an incentive for service providers to perform better.
- Similarly, while there are QoS regulations already laid out by the regulator, no penalties have been provisioned in case of breach of the mandates in regulations. Therefore, to make the service providers efficient and accountable, it is crucial to insert penalty clauses for the breaches. One of the modes of penalising recommended under this report is – name and shame, where the name of the service provider breaching mandates shall be reported on public forums and mediums. This mode of punishment is suggested in lieu of or in combination with monetary penalty. Merely provisioning penalties could lead to the cost being ultimately transferred to the consumers.

⁴⁵ A nutrition label for internet services would be similar to nutrition label for packaged food products, which shall have complete set of information on the product/services. While in case of food products it has the protein, fat, mineral, energy, etc. content, the nutrition label for internet services shall have information, such as download/upload speeds, latency, bandwidth, etc.

Survey Questionnaire on QoS for Mobile Internet in India

Section 1 – Basic Information

Name: _____ Age: _____ Gender: _____

Location: _____

Education:	1. Not been to school	2. Up to Standard 8 or less	3. Up to Standard 12 or less	4. Graduate or higher
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Employment:	1. Student	2. Housewife	3. Job	4. Daily Wage Worker	5. Unemployed
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Section 2 – Servicer Provider

1. What service provider are you using for mobile Internet?

1. MTNL	2. Airtel	3. Idea	4. Reliance	5. BSNL
6. Tata	7. Vodafone	8. Tata Tele	9. MTS	10. BSNL

2. Do you use a pre-paid or post-paid connection?

1. Postpaid	2. Prepaid
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3. Why have you chosen the select service provider for your mobile internet service?

Quality of service implies the overall performance of the consumer's service provider as observed by the consumer.

1. Quality of Service	2. Price	3. Same provider as for voice calling	4. Customer service	5. Other reason (Please specify) -
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4. How would you rate the quality of service of your mobile internet?

1. Very Good	2. Good	3. Average	4. Poor	5. Very Poor
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5. How satisfied are you with the cost you pay for your mobile internet services?

1. Very satisfied	2. Satisfied	3. OK	4. Dissatisfied	5. Very dissatisfied
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Section 3 – Awareness of Plan in terms of usage and bandwidth

Do you know your advertised plan for data usage?

1. Yes	2. No	3. Somewhat
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6. If yes, how did you get to know about the details of the plan bought by you?

1. Service Provider at the time of purchase	2. Subsequent inquiry or info present on bill	3. Other, please specify:
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7. How was this information provided to you?

1. Verbally	2. On paper – booklet, pamphlet, bill etc.	3. Through website
4. Do not remember	5. Other, please specify:	

8. Do you know how much data you end up consuming each month or with each data pack you buy?

1. < 1 GB	2. 1 GB – 4 GB	3. 4 GB – 6 GB	4. >6 GB	5. Don't know
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9. If no, would it be beneficial for you to know how much data you actually consume?

1. Yes	2. No
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10. If you know or come to know about your data usage, how do you think it can be useful for you?

1. Know whether I am being charged correctly.	2. Know if I can use the internet more than I want to	3. May not use the information	4. Other, specify :
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11. Do you think you are being charged appropriately for your internet data consumption?

1. Yes	2. No
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12. Would it be beneficial if the service provider sent you regular alerts on data usage?

1. Yes	2. Already get alerts	3. No
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14. Do you know how much you paid for internet access last month?

1. < ₹50	2. ₹50 – 200	3. ₹200 – 500	4. ₹500 – 1000	5. > ₹1000
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15. Do you know what bandwidth your plan comes with?

1. Yes	2. No	3. Somewhat
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16. If yes, how did you get to know of bandwidth your plan comes with?

1. Service Provider at the time of purchase	2. Subsequent inquiry or info present on bill	3. Other, please specify:
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17. How was this information about the bandwidth provided to you?

1. Verbally	2. On paper – booklet, pamphlet, bill etc.	3. Through website
4. Do not remember	5. Other, please specify:	

18. If no, would you like to know your service provider's advertised bandwidth?

1. Yes	2. No
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19. Do you know the relationship between data usage and bandwidth?

1. Same thing, just different units	2. Bandwidth affects the speed of data transfer, data usage is the amount of data used	3. Not sure what bandwidth means, data usage is the amount of data
4. Not sure and don't want to understand, just wanted to buy a simple data plan	5. Not sure but would like to understand	6. Other comments:

Section 4 – For 3G users

20. In what order of usage do you use apps on your cell phone? List as 1 to 5 with 1 being the most used:

a. Social Media Apps (Facebook, Twitter etc.)	b. Music/Video Streaming Apps (YouTube, SoundCloud etc.)	c. Video Chat (Skype, Google hangout etc.)	d. Maps and directions (Google maps, Waze)	e. Messaging Apps (Viber, whatsapp)
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21. Do you watch YouTube on your phone without Wi-Fi? If not, is it because:

1. High data cost	2. High buffering time	3. Not interested in YouTube
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22. Do you know how much each YouTube video costs to watch?

1. Yes	2. No
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23. If you don't know, would you like to stay informed to keep track of your data usage because watching 5 minute of YouTube actually costs you ₹3.2 on average across different providers?

1. Yes	2. No
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24. Would you like to know the costs of some of the other commonly used websites/apps?

1. Yes	2. No
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Section 5 – TRAI related information

25. Are you aware of TRAI?

1. Yes	2. No
The TRAI is the independent regulator of the telecommunications business in India. One of its main objectives is to provide a fair and transparent environment that promotes a level playing field and facilitates fair competition in the market. For example, it directed the Indian telecom market's evolution from a government owned monopoly to a multi-operator, multi-service open competitive market.	

26. Are you aware that your service provider has to report its performance statistics to TRAI?

1. Yes	2. No
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27. If reports provided by your service provider to TRAI were made available, would the same be useful for you?

1. Yes	2. No
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28. As per TRAI, service providers are supposed to meet minimum 'quality of service' standards. Would you like to know what these standards are?

1. Already know	2. Would like to know	3. Neutral towards it	4. Do not want to know
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Section 6 – Penalties and Ranking of Service Providers

29. Currently, there are no provisions for penalties in case of breach of Quality of Service regulations in mobile Internet. Do you think there is a need to bring such a regulation in place?

1. Yes	2. No
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30. According to you what kind of penalties should be imposed?

1. Monetary	2. Name and shame	3. Other, specify :
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31. Would it be beneficial if on the basis of certain parameters, service providers are ranked on monthly basis?

1. Yes	2. No
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Section 7 - Consumer Action

This section requires user consent to download and run speed test on their phone.

32. Have you ever tried Speed test to measure your mobile internet speed?

1. Yes	2. No
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33. If yes, please mention your remarks:

34. If no, would you allow us to run a speed test using speedtest.net on your phone?

1. Yes	2. No
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35. The bandwidth you are getting is 28a._____ while your service provider advertises 28b._____.

36. What would you like to do with this information?

1. Complain to demand better bandwidth	2. Get a clarification from the provider about what their advertisement means.
3. Do nothing, but would like to do this test again a few times.	4. Do nothing, happy with the service.

37. Have you had previous experience with lodging a service related complaint to your service provider?

1. Yes	2. No
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38. If yes, can you share with us what the complaint was about?

39. Did you feel that the customer service provided by your service provider was:

1. Satisfactory	2. Average	3. Unsatisfactory	4. Other comments:
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40. Please explain why:



Consumer Unity & Trust Society

D-217, Bhaskar Marg, Bani Park, Jaipur 302016, India

Ph: 91.141.228 2821, Fx: 91.141.228 2485

Email: cuts@cuts.org, Web: www.cuts-international.org