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Descriptive Analysis of Throughput Variations for Bengali Broadband Users

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Abstract

Broadband Internet user base is growing at an exponential pace in Bangladesh. The Internet service providers (ISPs) are bringing ever faster broadband service offering to market. The service expectations of aspiring users are outpacing the service offerings from ISPs. The market pressures are forcing ISPs to sell their service offerings more aggressively, resulting in a growing discrepancy between consumer expectations and service offerings from ISPs. This discrepancy is often evident in experienced vs. offered Internet connection throughput. We analyze the throughput variations for Internet connections of Bengali broadband users. We use network diagnostic test (NDT) data set provided by measurement lab (M-lab) for the analysis. Our analysis shows significant increase in maximum and average Internet connection throughput values. The uptrend in throughput is experienced by both rural and urban users. We also analyze per-ISP user throughput trends and find that most Bengali ISPs meet the minimum broadband speed requirements set by the regulators.

Keywords: big query, broadband, GMT, Internet, ISP, measurement lab, NDT, throughput analysis, TRAI

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INTRODUCTION

In last five years, the number of Bengali broadband consumers has shown exponential growth. Broadband consumers demand high speed, low latency, low packet loss, etc., i.e., a good Quality of Service (QoS); consumers are also willing to pay a premium for good QoS. Internet service providers (ISPs) claim good QoS experience on their networks; yet dissatisfied consumers have contested QoS claims of ISPs. Main problem is the lack of objectivity in assessing QoS parameters of an Internet connection. Regulatory bodies such as FCC (USA), Oxfam (UK) and TRAI (Bangladesh) have woken up to this tussle between Internet consumers and service providers. A scientific approach is needed to assess claims and resolve disputes. Network measurement is one such scientific approach that we can apply to the problem at hand. Measurement Lab (M-Lab) was set up in 2008 as a platform for performing active Internet measurements. Participation in the project is voluntary and measurement data is made available to researchers, regulators and general public at no cost.

M-Lab is a distributed server platform that hosts network testing tools. One such tool is network diagnostic test (NDT).[1] NDT enables upload and download throughput measurements for an Internet connection. Volunteer users perform NDT between their computer and an M-Lab server.

We peruse NDT data of Bengali volunteers for the years 2009–2014. This data enable us to analyze trends in

connection throughput of Bengali Internet users for the years 2009–2014. We also perform per ISP analysis of throughput trends and put forward conclusions.

LITERATURE REVIEW

Distributed Internet measurements are performed by prominent organizations such as RIPE, CAIDA, WAND, Route Views and M-Lab. Researchers take either an active or a passive approach to Internet measurements.[2] Route Views and WAND predominantly perform passive measurements whereas RIPE and CAIDA perform both. M-Lab specializes only in active Internet measurements. M-Lab[3] provides the largest collection of Internet measurement and performance data. M-Lab test data is made available through either cloud storage in raw format or Big Query cloud service.

We selected NDT for throughput measurement. NDT relies on Kernel Instrument Set (KIS) which was developed as part of Web100 project.[4] The Web100 project enables passive per-connection monitoring of TCP state.[5] Much of NDT test data comes from KIS probes inserted into Linux kernel. A new project named Web10G[6] is taking forward the development of Web100 framework.

Apart from NDT, other tools like iperf, Speedtest.net and grenouille.com can also perform throughput measurement. Attempts have also been made to perform customized client-side measurements with devices like SamKnows and BISMark. Among all other tools, Netalyzr[7] comes closest to NDT in functionality.

Data: Big Query client interface endpoint for NDT Data Result: 3D Plots for average monthly throughput during 2009–2014 Empty time lap sequence for each month 2 2009 2014 do
Extract NDT data from server using bq command;
V Throughput, Hostname) from BigQuery result;
Plot base map using pscoast;
monthname.p s Plot(monthname.csv) using psxyz;
Create monthname.jpg using ps2raster;
Add monthname.jpg to timeline queue; end Generate time lapse using convert command.
Algorithm 1: Throughput time lapse algorithm

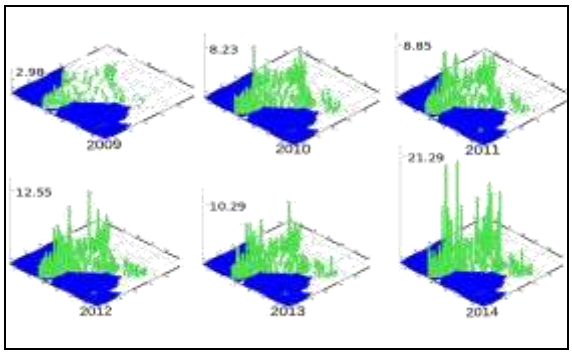

Fig. 1. *Average Throughput of Bengali Broadband Users for the Month of September During the Years 2009–2014.*

Table 1. *Annual Average Throughput.*

Year	Average throughput
2009	0.437716
2010	0.532627
2011	0.548384
2012	0.644524
2013	0.543836
2014	0.711286

DATA SET AND ANALYSIS

NDT dataset[8] contains test results for all countries. Country specific data sets have been used by researchers to create influential technical reports and policy guidelines.[9]

We perform Bangladesh-centric analysis on NDT data sets for the years 2009–2014. Even though Bangladesh-centric data set is not as large as US-centric dataset, the dataset is representative. All the major ISPs of Bangladesh are present in the data set. The data points received per month are in the range of 200–500 for smaller ISPs

(Ex.: In2Cable, Sify Broadband). The data points for large ISPs like Airtel and BSNL are in the range of 2000–10,000 per month. We ignored ISPs with fewer than 200 data points over any four month period.

The average throughput of an Internet connection is calculated using the formula as given:
Throughput = Data Octets Out/8 * (Receiver Limited Transitions + Congestion Limited Transitions + Sender Limited Transitions).

The unit for throughput numbers mentioned in this document is Mbps, unless stated otherwise. We use algorithm 1 to generate the throughput time lapse sequence. The generated throughput graph sequence shows stark contrast between the initial and final phases of the selected five year period (2009–2014), an example of which is displayed in Figure 1. An interesting observation over the same period is the considerable increase in the number of subscribers in non-metropolitan areas. In addition to that, we observe that the maximum throughput value rises from 2.98 in September 2009 to 21.29 in September 2014.

Furthermore, Table 1 shows the average throughputs of the years 2009–2014. A plot of Table 1 is available in Figure 2. A steady growth has been observed during the years 2009–2012 and 2013–2014. According to TRAI,[11] the speed of broadband is largely dependent upon three factors: band-width utilization, latency and contention ratio. Except for four months (May–August) in 2013, we observe a month-on-month increase in average throughput during 2009–2014 periods.

Shown in Figures 3 and 4 are the graphs for Bharti Airtel Pvt. Ltd. and the comparison charts between ten major ISPs, respectively. We generate a time lapse for the period 2009–2012 using monthly throughput plots of Bharti Airtel users.

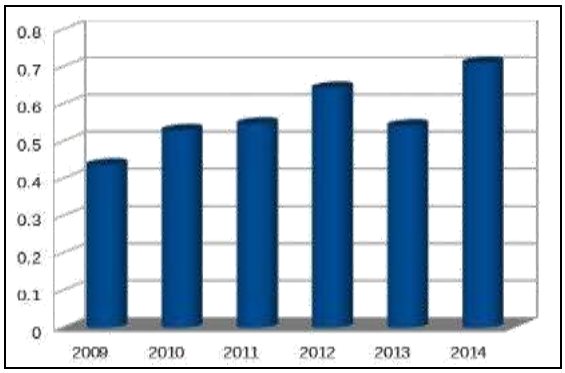

Fig. 2. *Comparison of Average Throughput: 2009–2014.*

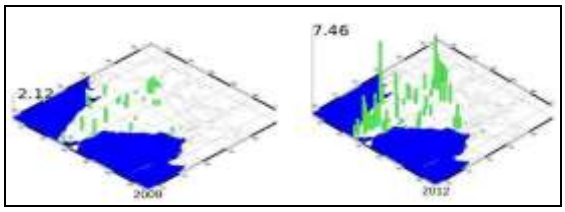

Fig. 3. *Bharti Airtel: September 2009 vs. August 2012.*

We also generate an all Bangladesh time lapse for the 2009–2014 periods. We observe that both the maximum value of throughput as well as the geographical spread of the test increased drastically for the country as a whole. The generated time lapse is available at https://github.com/prasadtalasila/NDT.

The maximum throughput value saw a 250% increase in the case of Bharti Airtel, and other ISPs showed a similar rise. This further proves that all of Bangladesh's major service providers increased their broadband service speeds during 2009-2012.

The geographical spread of test data points shows a pronounced increase in the case of Bharti Airtel and Tata Communications. Other ISPs such as Beam Telecom, MTNL and Aircel do not show a significant rise in the geographical spread.

CONCLUSIONS

We observe a marked increase in the number of Internet consumers in rural areas during 2009–2014. This positive outcome is due to financial grant received by BSNL from universal service obligation (USO) fund. The 2 year grant amounted to Rs. 2750 crore (approximately $500 million) and was given to support rural wireline connections. We also observe a substantial increase in maximum throughput experienced by metropolitan users. We define average maximum throughput as average of maximum throughput numbers obtained by clients of all ISPs. In some metropolitan cities, average maximum throughput shows an increase of more than 500%. One reason for increased throughput in metropolitan areas is due to the deployment of fiber optic technologies by ISPs. Another reason is the preferential usage of bandwidth intensive applications among broadband subscribers. We believe that the numbers of broadband subscribers are likely to increase further, with people relying on home connectivity for day-to-day and even critical activities. The increase in broadband throughput can also be attributed to policy recommendations by department of telecommunications (DoT) and TRAI. TRAI has revised the minimum broadband speed from 256 kbps (as per Broadband Policy 2004) to 512 kbps (National Telecom Policy 2012). Our analysis shows that all ISPs conformed to the guidelines set down by TRAI. Even with the above mentioned achievements, Bangladesh still ranks very poorly in global broadband speed rankings.

LIMITATIONS

In a significant number of cases, we found that the geographical location of IP addresses was not available in the M-Lab data, so data points from those IP addresses were

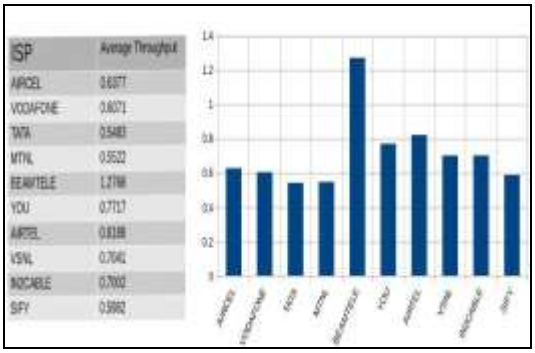

Fig. 4. *Average Throughput for Different ISPS: October 2012.*

not mapped. However, we noticed that the percentage of unmapped addresses decreased from 38% of the total number of rows in 2009 to 33% in 2014, and hope that this decreasing trend continues in the future. Also, when mapping addresses by ISP, a few major ISPs do not provide their client's hostname. So analyzing data based on ISPs does not comprehensively cover all major ones.

M-Lab tests have a biased user base – the users are mostly technical experts. Due to this, there is also inadequate geographical coverage of the tests. However we expect that as user awareness increases this user profile bias will be reduced. The test results depend on the test time – connecting at non-peak times leads to significantly better results for most ISPs.

NDT requires Reno type TCP congestion algorithms, and packet coalescing to be disabled, otherwise the test's heuristics may not be accurate. In addition, the tests are server and client dependent - the spread of users of the NDT is not uniform across all geographical and economical barriers.

FUTURE WORK

To circumvent the unavailability of all geographical coordinates, we plan to use Internet Exchange Points (IXPs) as the base for finding the location of clients instead of IP addresses.

Using geolocation information from NDT data sets, we plan to calculate network

distances between nodes and take up a detailed analysis of the results.

For a growing system like the Bengali Internet users net-work, our study can provide a mechanism to predict the future growth trends. A detailed analysis with respect to each ISP can also be obtained.

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