

Broadband Quality Test Plan

Version 1.2

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1 Experiment Design

We define several metrics and destinations.

1.1 Metrics

To measure the Broadband connection metrics from the subscriber perspective, we use the following metrics for our Broadband valuation:

1. **Download speed (kbps/Mbps):** One of the key advertised metrics in broadband services is the download speed, which defines how much traffic a subscriber can receive to the maximum. Also the performance of many residential applications like Web-browsing, downloading content etc, depends on this metric. We will measure the actual download speed available to the subscriber.
2. **Upload Speed (kbps/Mbps):** Upstream speed for the Internet connection. This metrics define the speed in which the subscriber can send traffic to Internet. Plays a significant role in responsiveness and real-time applications like VoIP etc.
3. **RTT (milli-sec):** Round Trip Delay. Time taken for the traffic to reach a particular destination and return. Round-trip delay time is significant in systems that require two-way interactive communication, such as voice telephony, or ACK/NAK data systems where the round-trip time directly affects the throughput rate, such as the Transmission Control Protocol (TCP).
4. **Jitter (milli-sec):** jitter is the fluctuation/variation of end-to-end delay from one packet to the next packet within the same packet stream/connection/flow. Jitter experienced by the packets is more relevant for Real-time traffic like VoIP.

E.g. Radio quality voice requires less than 1 ms Jitter, toll-quality voice requires less than 20 ms jitter, normal VoIP requires jitter to be less than 30 ms. Beyond 30 ms, VoIP performance will degrade.

(Source:

Connection Magazine, <http://www.connectionsmagazine.com/articles/5/049.html>,
CISCO Press Article,

<http://www.ciscopress.com/articles/article.asp?p=357102&rl=1>)

5. **Packet-Loss (%):** Number of packets (in percentage) which doesn't reach the destination. Packet-loss can result in highly noticeable performance issues with Streaming Technologies, VOIP, Videoconferencing, etc, and will affect all other network applications to a degree.

6. **Availability (in %):** Broadband availability, indicates the number of times we are able to access the Broadband services. Network non-availability can happen due to various reasons like line failure, AAA failure, backhaul failure etc. This metrics indicates the reliability of the Broadband service. During our testing if T attempts are made to connect to the Internet, and if F times the attempt failed, then Availability = $(1-F/T) \times 100\%$. An attempt is declared as failure, if we are not able to connect to Internet within 30 seconds.

1.2 Destinations

This section explains the destinations used with respect to Broadband Evaluation from India. This destinations needs to be changed, when conducting the test in other countries.

The following destinations will be used in the evaluation (See Figure 1):

1. **ISP site:** the website of the service provider
2. **National site:** well-known sites within the country, preferably hosted by some other ISP (the one which we are not choosing for our tests)
3. **Global site:** well-known global sites such as Google, Yahoo, etc. hosted outside the country

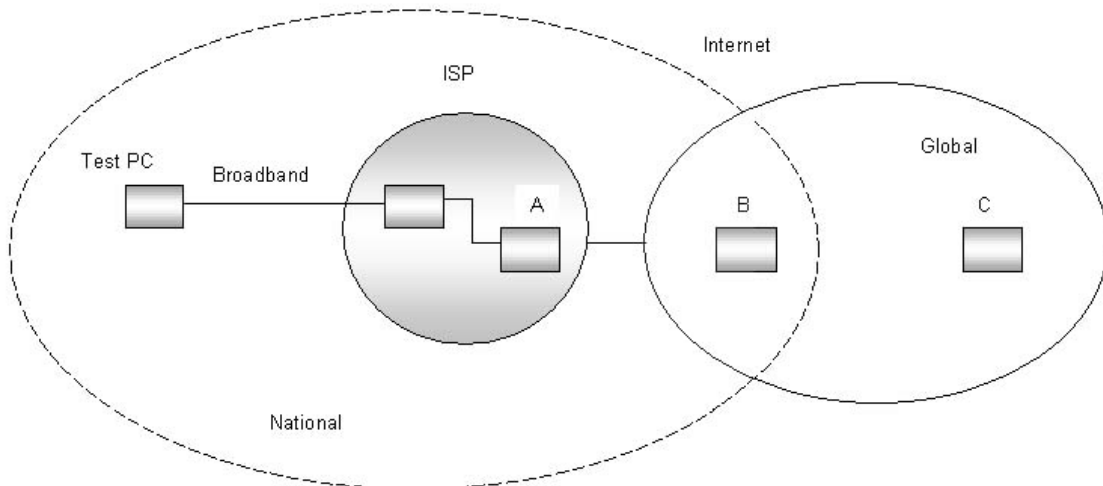


Figure 1: Test setup showing local and remote websites

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A = Broadband ISP's Website
 B = National Website
 C = Global Website

Since some host filters ICMP traffic (Ping), we use different locations for upload/download and Ping related tests (As much as possible, we try to reuse the same location for both the tests).

Table 1: Test Sites

		ISP Site	National Site	Global Site
BSNL	Upload/Download	http://www.dataone.in	http://www.zapak.com (or) http://www.indiatimes.com	http://Mail.yahoo.com
	Ping	www.Dataone.in	www.zapak.com	Mail.yahoo.com
Airtel (Bharti)	Upload/Download	http://mail.airtelbroadband.in	http://www.zapak.com (or) http://www.indiatimes.com	http://Mail.yahoo.com
	Ping	61.95.227.165	www.zapak.com	Mail.yahoo.com

The location of the above sites is verified using IP-Locator service available at the following site (www.geobytes.com/IPLocator.htm). Also the ISP of the host is checked with the APNIC/ARIN Database through WHOIS service, this can be accessed from the www.geobytes.com/IPLocator.htm web-page by invoking the URL encircled in Blue color in Figure 2 : Screenshot of www.geobytes.com.

folder for missing messages? Send your provider to our [CaseKeys](#) page.

Hint: Try searching this 'Chennai' search engine for your name, your friend's name, or on keywords like TV, Radio, News, Weather, Movies, Coupons, Fuel.

The following results were generated using **GeoSelect** version II.

IP Address to locate:

Country Code Country **Distance to Nearby Cities**
 Region Code Region km, mi, City, Region, Country
 City Code City 0 0 Chennai, TN, IN
 CityId Certainty
 Latitude Longitude
 Capital City Time Zone
 Nationality Singular Population
 Nationality Plural Is proxy
 CIA Map Reference Currency
 MapBytes Remaining Currency Code

Search WHOIS data at: [RIPE](#) [ARIN](#) [APNIC](#) [LACNIC](#) Flag

Check out Geobytes other products including: [GeoSelect](#), [GeoNetMap](#), [GeoReport](#), [GeoPhrase](#), [GeoLyzr](#), [GeoRemote](#), [GeoDirection](#), [MapBytes](#)

Click here to find out why our data can differ from the WHOIS data

Figure 2 : Screenshot of www.geobytes.com

As per the information from www.geobytes.com and WHOIS database from APNIC and ARIN, the location and ISP of our test sites are:

Table 2 : Test Sites and their Locations

Test Site	Location	ISP/Organization
61.95.227.165	Tamilnadu, India	Bharti Infotel Ltd.
Mail.airtelbroadband.in	New Delhi, India	Bharti Infotel Ltd.
www.zapak.com	Bangalore, India	Reliance Communications Ltd
Mail.yahoo.com	California, USA	Yahoo Inc.
www.dataone.in	Mumbai, India	BSNL
www.indiatimes.com (integra.indiatimes.com) ¹	Mumbai, India	VSNL

1.3 Measurement Techniques

For each of the destinations, some or all of the metrics are measured. These are shown in the Table 3.

Table 3 : List of Experiments

<i>S.No.</i>	<i>Destinations</i>	<i>ISP</i>	<i>National</i>	<i>Global</i>
1	Download	Yes	Yes	Yes
2	Upload	Yes	Yes	Yes
3	RTT	Yes	Yes	Yes
4	Jitter	Yes	Yes	Yes
5	Loss	Yes	Yes	Yes
6	Availability	Yes	Yes	Yes

¹ www.indiatimes.com redirect to integra.indiatimes.com for mail services. [Integra.indiatimes.com](http://integra.indiatimes.com) is in Mumbai, India.

2 Test Setup

2.1 ISPs and Packages

In our testing will benchmark with two ISPs who offers similar Connection Plan. With each ISP the metrics will be collected by Residential-Package and Business-Package.

Table 4: Broadband packages and operators (India)

	BSNL	Airtel
Business	TBD	TBD
Residential	256 Plan	256 Plan

2.2 Testing Methodology

The metrics mentioned above are measured using commonly available tools like Ping, Web-browsers and Network monitoring tools. Brief descriptions of these tools are mentioned in this section.

Bandwidth Monitor: Bandwidth Monitor tracks traffic of all network connections and displays real-time download and upload speeds in graphical and numerical forms (refer to screen shot below). The software logs traffic of all network connections and provides daily, weekly and monthly traffic reports. Bandwidth Monitor can also display download and upload speeds of multiple network connections on a computer at a time. For example, you can monitor bandwidth of mutiple network cards on your computer at the same time. This tool also offers useful built-in utilities: speeds stopwatch, transfer rates recorder, and bandwidth usage notification. Bandwidth Monitor works with the majority network connections including modem, ISDN, DSL, ADSL, cable modem, Ethernet cards, wireless, VPN, and more. It's compatible with Windows 98, Windows Me, Windows NT 4.0, Windows 2000, Windows XP, Windows 2003, and Windows Vista.

In our testing we use the Free Download Version of Bandwidth Monitor for this research project. The download is available at <http://www.bwmonitor.com/index.htm>. For extended research and commercial application, the commercial version is available.

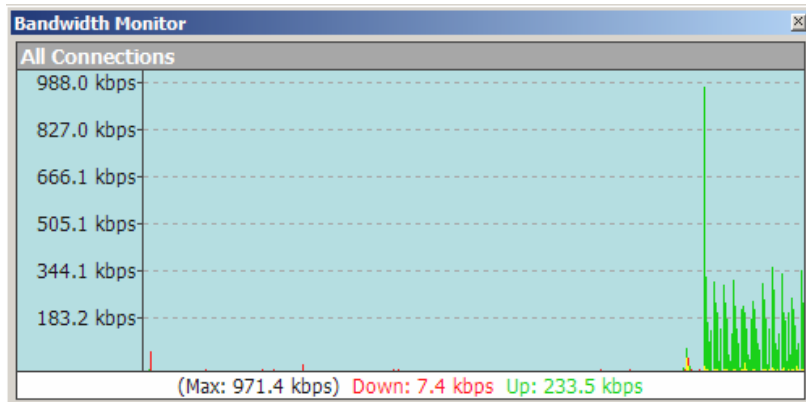


Figure 3: Screenshot of Bandwidth Monitor

Ping: Ping is a general tool available in Windows and most other OS to check the destination reachability.

Other Tools: Apart from the above-mentioned tools, we use the standard Web browser (Internet Explore 6.0 or FireFox) to browse the test site and upload or download files.

2.2.1 Download Speed

Prerequisites:

The respective E-Mail accounts in the ISP, National and Global sites are stored with a mail with 5 MB attachment file.

Test Procedure:

We measure the download speed by downloading a 5 MB file from the mail attachment using a standard Web browser, and calculate the average download bandwidth using a network measuring tools like *BandwidthMonitor*.

Normally the downloading software will show the download speed, but this doesn't include TCP/IP header and other overheads. Hence we use tools (*BandwidthMonitor*), which measures the bandwidth by snooping the raw packets that is getting transferred. (*Note:* The advertised download speed by the operator is a raw bandwidth).

2.2.2 Upload Speed

Prerequisites:

The respective E-Mail accounts in the ISP, National and Global sites are ensured to have free space to upload a 5 MB attachment file.

Test Procedure:

With stand-alone application, we measure the upload speed by uploading a 5-MB file to YAHOO Mail application and calculate the average upload bandwidth using standard measuring tools like *Bandwidth Monitor*.

We use standard tools (*BandwidthMonitor*), which measures the bandwidth by snooping packets for the same reason as stated for Download speed.

2.2.3 Round Trip Time (RTT)

Prerequisites:

Ensure that the Ping traffic to our test-sites is not blocked by the local firewall and the sites are reachable.

Test Procedure:

Among the stand-alone application, *ping* is a very common tool to measure the RTT. The Ping application generates an ICMP packet with a timestamp; RTT is calculated finding the difference between the current time and the received packet time-stamp. We need to generate around 100 ICMP packets, to get a good average (*ARTT*) on our measurement, with the interval of 1 second between packets.

Also initial Ping packet will take more RTT due to delay in ARP resolution etc. But considering the speed of the Internet and our sampling base, this error will be insignificant.

2.2.4 Jitter

Prerequisites:

Ensure that the Ping traffic to our test-sites is not blocked by the local firewall and the sites are reachable.

Test Procedure:

We use the same result as we got for the RTT using the Ping. The Result of the Ping output is saved in a file. $M = A_{RTT}$ is the average RTT, derived out of 100 samples, and $r_1, r_2 \dots r_{100}$ are the RTT for individual packets, then the Jitter is derived using the below formula.

$$\sum_{k=1}^{k=100} |M - r_k| / 100$$

In the above formula, r_k is extracted from the ping result stored in the file. Typically the output of the ping will be similar to the one shown in Figure 4 Using a script the RTT value marked in red color in Figure 4 is extracted for each packet (each line), this will be the values for $r_1, r_2 \dots r_{100}$.

```
>> ping 66.100.10.1
Reply from 66.100.10.1: bytes=32 time=220ms TTL=228
Reply from 66.100.10.1: bytes=32 time=211ms TTL=228
Reply from 66.100.10.1: bytes=32 time=210ms TTL=228
Reply from 66.100.10.1: bytes=32 time=210ms TTL=228

Ping statistics for 66.100.10.1:
Packets: Sent = 10, Received = 4, Lost = 6 (60% loss),
```

Figure 4 : Ping Result

2.2.5 Packet Loss

Prerequisites:

Ensure that the Ping traffic to our test-sites is not blocked by the local firewall and the sites are reachable.

Test Procedure:

Again we use *ping* to calculate the packet-loss. For the above two experiments we have been using Ping for calculating RTT and Jitter, at the end of the experiment, ping software summarizes the total number of packet transmitted, packet received and the packet loss in percentage (shown in Blue color in Figure 4 : Ping Result).

2.2.6 Availability

The network availability is measured by checking the accessibility to the Internet. As we discuss in this section, we will be running the experiment on each ISP/Packages for 6 times a day (If the net is not reachable, we may need to extend the experiment). Hence if *T* is the total number of times the experiment is done for a ISP/Package and *F* is the number of times internet is unreachable, then the Availability for that ISP/Package is calculated as follows.

$$(1-F/T) \times 100\%.$$

An attempt is declared as failed, if we are not able to connect to any of local, national or International site chosen within 30 seconds. On the contrary if any one of the site is reachable within 30 seconds, the attempt is declared success.

2.3 Experimental Method

This section explains the experimental method followed in our testing. Table 5 shows the test tools to be used for each experiment.

Table 5: Experiment Tools

<i>S.No.</i>	<i>Destinations Metrics</i>	<i>ISP</i>	<i>National</i>	<i>Global</i>
1	Download	BandwidthMonitor	BandwidthMonitor	BandwidthMonitor
2	Upload	BandwidthMonitor	BandwidthMonitor	BandwidthMonitor
3	RTT	Ping	Ping	Ping
4	Jitter	Ping	Ping	Ping
5	Loss	Ping	Ping	Ping
6	Availability	Ping	Ping	Ping

In our testing process, we follow the guidelines mentioned below:

Guideline 1. Run trace-route just before each experiment to record the route to the destination site. This will also ensure that the local DNS cache is primed with the IP address of the site, so that DNS lookup does not affect the subsequent measurements.

```
D:\>tracert mail.yahoo.com
Tracing route to inlogin.yahoo-ht2.akadns.net [202.86.7.110]
over a maximum of 30 hops:
  0  <1 ms    <1 ms    <1 ms    wify2.midascomm.com [192.168.14.1]
  1  3 ms     2 ms     2 ms     192.168.100.1
  2  2 ms     4 ms     2 ms     192.168.5.251
  3  2 ms     2 ms     3 ms     192.168.5.2
  4  1370 ms  1237 ms  1529 ms  dsl-TN-static-001.240.22.125.airtelbroadband.in
[125.22.240.11]
  5  1805 ms  1933 ms  2146 ms  ras-Chn-165.227.95.61.airtelbroadband.in [61.95.
227.165]
  6  2222 ms  2172 ms  1780 ms  61.95.240.129
  7  1817 ms  1555 ms  1751 ms  59.145.6.235
  8  1387 ms  1339 ms  1291 ms  59.145.0.133
  9  1153 ms  1507 ms  1380 ms  59.145.0.70
 10  1474 ms  1642 ms  1693 ms  ge-2-4.msrl.in.yahoo.com [203.84.220.217]
 11  1220 ms  1550 ms  1563 ms  ge-2-38.msrl.in2.yahoo.com [203.104.23.198]
 12  1399 ms  1023 ms  1189 ms  po1.bas-a2.in2.yahoo.com [203.104.23.234]
 13  *        1508 ms  1168 ms  11.member.vip.in2.yahoo.com [202.86.7.110]
 14
Trace complete.
```

Figure 5 : Traceroute Test Result

Guideline 2. Ensure that no other applications, background tasks or viruses are running in the PC during the measurements. These may generate network traffic. Linux is preferable as Windows is more susceptible to viruses (It's a suggestion and the experimenter can use any OS of his choice, provided the background tasks and viruses are controlled).

Guideline 3. The duration of each upload/download must be at least 100 seconds to minimize timing errors. For upload and download, minimum file size should be 2 MB (But 5 MB is recommended). The file size can be chosen based on the ISP package (e.g. for 64 Kbps link, 2 Mb would be sufficient, since the duration is longer).

Guideline 4. To have a proper recording of the test results for future references, we recommend saving all test results (screen shots) of all measurement programs including ping, traceroute, bwmonitor, etc. Use a structured file name of the format:

<ISP>-<Plan>-<DDMMYYHHmm>-<program>. <Ext>

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<i>ISP</i>	ISP name, e.g. BSNL, Bharti, VSNL, Yahoo etc.
<i>Plan</i>	ISP plan which is tested, e.g 256-Plan, 500-Plan etc.
<i>DDMMYY</i>	Date in Day (DD), Month (MM) and Year (YY)
<i>HHmm</i>	Time in Hour (HH) and Minute (mm)
<i>Program</i>	The program result which is stored, e.g. Ping, Tracert, Upload, Dnload etc)
<i>Ext</i>	Appropriate extension of the file (e.g. jpg, doc, txt etc).

E.g. a Ping result done on 6-Dec-07 at 9:30AM with BSNL, 256 Plan will be named as *BSNL-256Plan-0612070930-ping.txt*

Guideline 5. Each measurement must be repeated for three times.

3 Testing Period

The above-mentioned metrics are measured at different time of the day, as follows:

Table 6: Times for repetition of experiments

#	Measuring Time	Remarks
1	08:05 AM	Lean traffic time
2	11:13 AM	Peak business hour traffic
3	03:07 PM	Peak Business hour traffic
4	06:16 PM	Low business traffic and medium residential traffic
5	08:23 PM	Low business traffic and high residential traffic
6	10:26 PM	Medium-High Residential traffic

The timings are chosen in such a way to analyze the quality from low usage period to heavily used period. The readings are tabulated for at least 4 working days and weekend days or national holidays spread over a 15-day period.