

256 kbps commercial and residential connection prices compared

Figure 1

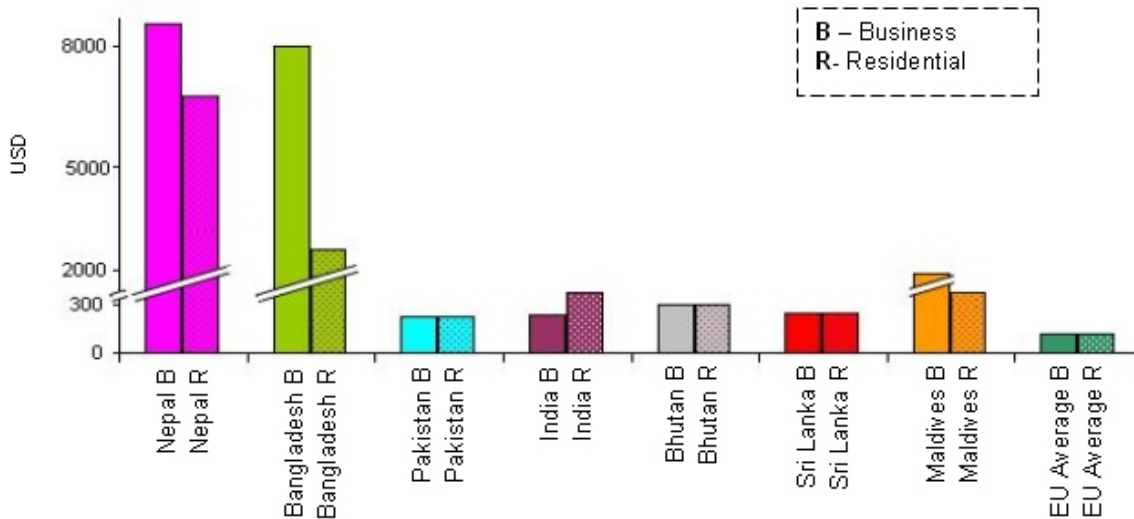


Table 1 - Broadband Prices¹

Country ²	2MB, 2km DPLC ³ (p.a) ⁴	2MB, 100km DPLC ⁵ (p.a)	2MB Broadband business connection ⁶ (p.a)	Minimum 256kbps Broadband business connection ⁶ (p.a)	Minimum 256kbps Broadband residential connection ⁶ (p.a)
Afghanistan	12,000 ⁷	N/O ⁸	N/O	N/O	N/O
Nepal	55,393 ⁹	2,760,290 ⁹	57,385 ¹⁰	8,608 ¹⁰	6,695 ¹⁰
Bangladesh	23,393 ¹¹	N/O	N/O	8,016 ¹²	2,680 ¹³
Pakistan	49 ¹⁴	2,437 ¹⁴	N/O	964 ¹⁵	964 ¹⁵
India	432 ¹⁶	4,447 ¹⁶	3,779 ¹⁷	241 ¹⁸	379 ¹⁷
Bhutan	2,438 ¹⁹	18,283 ¹⁹	4,540 ²⁰	303 ²¹	303 ²¹
Sri Lanka	3,249 ²²	6,350 ²³	556 ²⁴	250 ²⁵	250 ²⁵
Maldives	18,803 ²⁶	40,576 ²⁷	16619 ²⁸	2,091 ²⁹	379 ³⁰
EU Average	358 ³¹		164 ³¹	119 ³¹	119 ³¹

- Pakistan has the lowest domestic leased line connection prices in the South Asian region.
- Sri Lanka offers the lowest price for a 2MB Broadband business connection in the South Asian region.
- India offers the lowest price for a 256kbps Broadband business connection in the South Asian region.
- Sri Lanka offers the lowest price for a 256kbps Broadband residential connection in the South Asian region.

Feb 2008

Broadband Quality of Service Indicators³²

Price is not the only dimension that is of interest to customers and regulators. Quality of Service (QoS) is integrally connected to price: an increase in quality is an invisible decrease in price and vice versa.

Broadband quality can be evaluated through speed tests. Test sites provide a variety of information about the speed of a link. Careful design and implementation of tests can shed light on the exact segment where inadequate capacity constrains speed. Carefully implemented tests can also be the basis for Service Level Agreements (SLAs) between operators and users and for regulatory action.

In the present tests, the methodology has been developed in collaboration with a team headed by Professor Timothy Gonsalves of IIT Madras. The following dimensions of quality have been measured for two networks each in India (Chennai) and Sri Lanka (Colombo). Depending on the feedback that is received, the test methodology will be improved and extended to a larger number of locations, the objective being the development of Broadband QoS indicators for South Asia.

Throughput (kbps)

Referred to as the “actual amount of useful data sent on a transmission”³³. **Defined by the ITU as “an amount of user information transferred in a period of time” (ITU-T X.641 (97), 6.3.3.16)**, more commonly referred to as download or upload speeds. A key advertised metrics in broadband services is the download speed. It defines how much information a user can received from a local or international server. Upload speed defines the speed in which the user can send information to local or international servers. It plays a significant role in responsiveness and real-time applications like VOIP (Voice Over Internet Protocol).

Throughput, or download and upload speeds, varies depending on the location of the server that holds the content. If the location is local, such as an ISP server, the throughput may be higher than it would be if the location is international.

Therefore the testing has included throughput for both local (ISP) and international (yahoo.com) servers.

Latency (ms)

“Latency refers to delays when voice packets transverse the network”³⁴. It is measured in milliseconds by using the Round Trip Time (RTT). This is significant in systems that require two-way interactive communication, such as voice telephony, or ACK/NAK [acknowledge/not acknowledge] data systems where the round-trip time directly affects the throughput rate, such as the Transmission Control Protocol (TCP).

The ITU definition states that “Latency means transmission delay for FEC (Forwarding Equivalence Class) encoding, decoding,

Jitter (ms)

“Jitter is uneven latency and packet loss”³⁵. It is the variation of end-to-end delay from one packet to the next within the same packet stream/connection/flow. Jitter is more relevant for real-time traffic like VOIP. Ideally the figure should be low.

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.³⁶

Also defined by ITU as “Short-term non-cumulative variations of the significant instants of a digital signal from their ideal positions in time” (ITU-T G.701 (93), 2024).

Packet Loss (%)

Number of packets (as a percentage) that does not reach the destination. Degradation can result in noticeable performance loss with streaming technologies, VOIP and video conferencing. **ITU states that “In general, IP-based networks do not guarantee delivery of packets. Packets will be dropped under peak loads and during periods of congestion. NOTE In case of multimedia services, when a late packet finally arrives, it will be considered lost” (ITU-T H.360 (04), 5.3.2.2).**

Results of throughput tests are given in the tables below ³⁷:

Table 2 - Download Speed from own ISP (kbps)

Country	Plan (Promised Download / Promised Upload)	Time					
		0800	1130	1500	1800	2030	2230
Sri Lanka	SLT (2M/512k)	1750	1700	1666	1633	1650	1616
	Dialog (2M/512k)	1766	1666	1550	1708	1700	1458
India	BSNL (2M/256k)	1225	1710	1664	1448	1423	1458
	Airtel (512k/512k)	378	350	360	395	392	381

Table 3 - Download Speed from yahoo.com (kbps)

Country	Plan (Promised Download / Promised Upload)	Time					
		0800	1130	1500	1800	2030	2230
Sri Lanka	SLT (2M/512k)	447	119	95	405	391	444
	Dialog (2M/512k)	210	203	240	246	282	187
India	BSNL (2M/256k)	322	350	347	714	312	263
	Airtel (512k/512k)	210	205	178	201	204	247

Feb 2008

Table 4 - Upload Speed to own ISP (kbps)

Country	Plan (Promised Download / Promised Upload)	Time					
		0800	1130	1500	1800	2030	2230
Sri Lanka	SLT (2M/512k)	407	430	420	399	407	426
	Dialog (2M/512k)	348	407	447	239	306	341
India	BSNL (2M/256k)	209	211	212	207	206	207
	Airtel (512k/512k)	200	200	213	213	213	204

Table 5 - Upload Speed to yahoo.com (kbps)

Country	Plan (Promised Download / Promised Upload)	Time					
		0800	1130	1500	1800	2030	2230
Sri Lanka	SLT (2M/512k)	206	198	192	195	203	204
	Dialog (2M/512k)	133	125	125	120	121	109
India	BSNL (2M/256k)	119	100	90	110	108	105
	Airtel (512k/512k)	125	126	136	128	137	129

Download Speed ³⁸

Figure 2

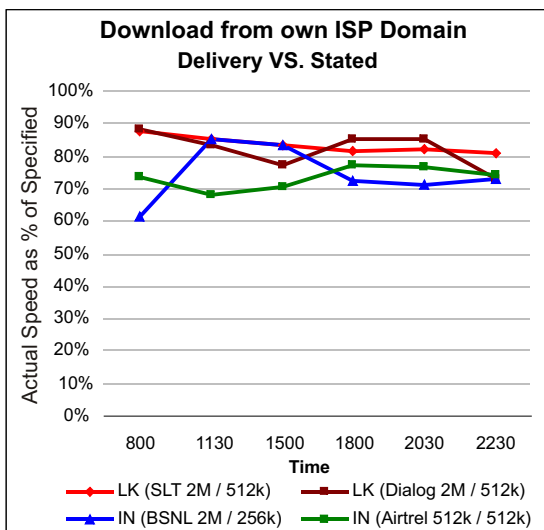
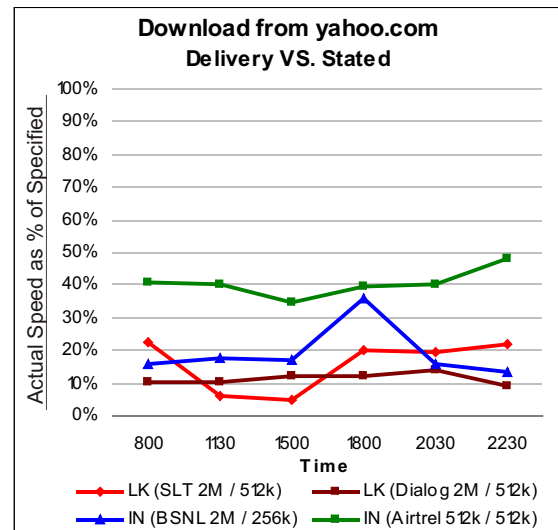


Figure 3



Upload Speed ³⁹

Figure 3

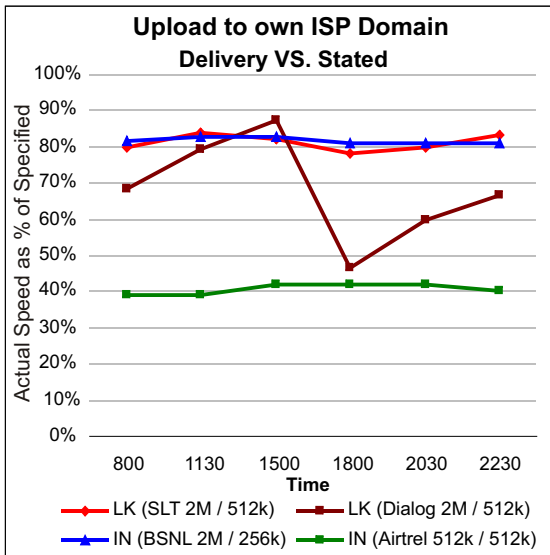
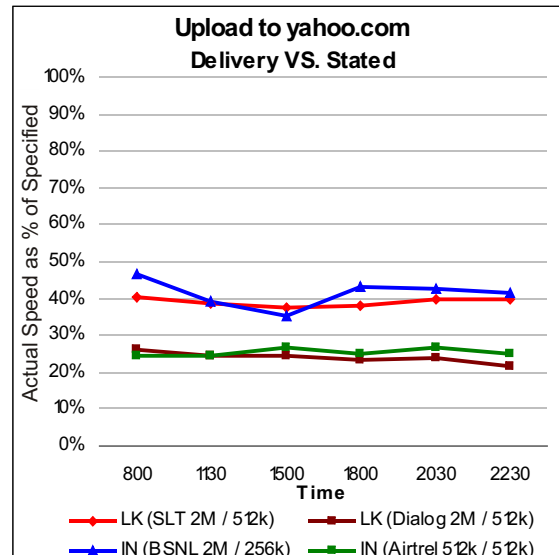
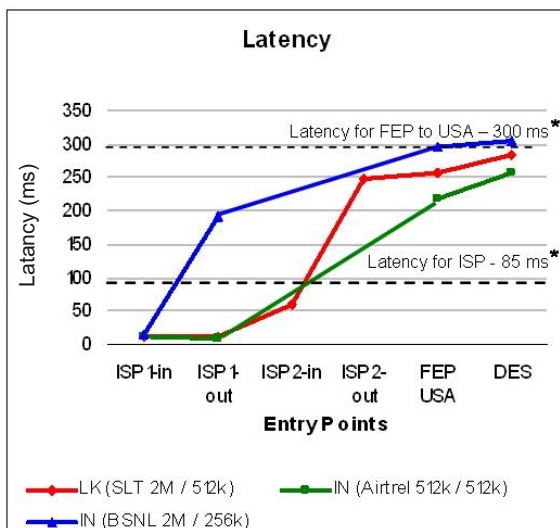


Figure 4



Latency ⁴⁰

Figure 5



* The latencies given in the graph above are those specified by the Singapore regulator to be followed by the Singapore Operators. The 85ms limit is within the local network domain and the 300ms limit is to reach the first entry point (FEP) to USA. Provided only for illustration purposes.⁴¹

The selected entry points are:

Entry Point	
ISP 1 in	Entry point to the Own ISP Domain ⁴²
ISP1 out	Exit point from Own ISP Domain
ISP 2 in	Entry point to non US International Gateway ⁴³
ISP 2	Exit point from non US International Gateway
FEP USA	First Entry Point to USA
DES	Destination (yahoo.com)

Jitter⁴⁴ and Availability⁴⁵

Figure 6

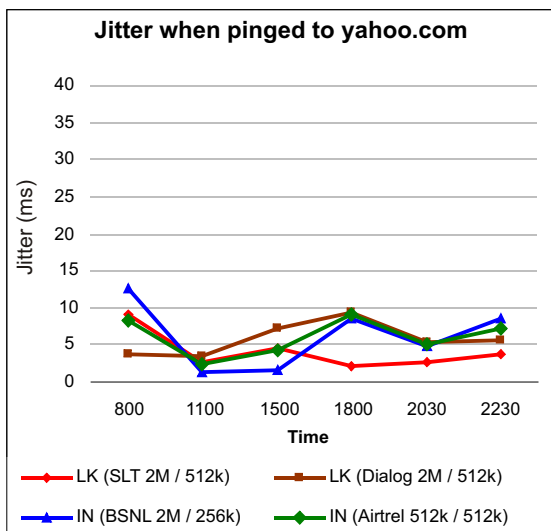
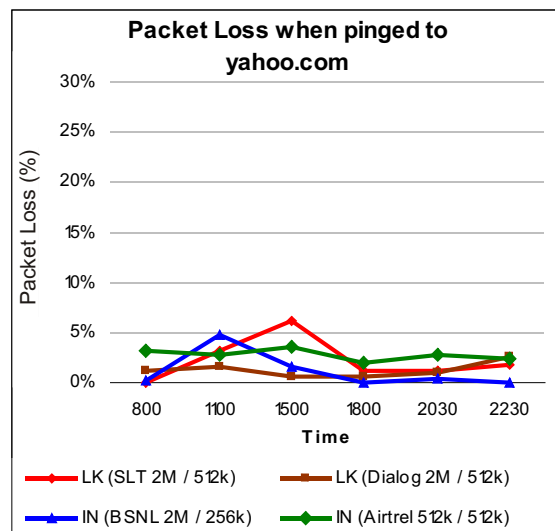


Figure 7



1 Prices quoted in local currencies converted to US Dollars based on rates from: <http://www.oanda.com/convert/classic.as.at> 10/02/2008. Annual prices for a Domestic Private Leased Circuit not inclusive of installation charges, modem/ router charges, any discounts, VAT or other taxes

2 Countries are ranked according to the GDP per capita obtained from the World Economic Outlook database, Oct 2007.

3 Also known as a tail cost;

4 p.a = per annum

5 Cost of two tail charges + 96km link charge

6 The packages chosen are those that have an unlimited download limit, in the event this package was not found the closest available offering was reported.

7 Rates obtained from ATRA, 2007 data as reported in the earlier document found at: <http://www.lirneasia.net/wp-content/uploads/2007/09/bbenchmarks-page1-v4.pdf>

8 N/O = No Offering of this capacity is available at time of publishing

9 Nepal Telecom, http://www.ntc.net.np/tariff/int_tariff_new.php

10 Radius Communications Pvt Ltd, <http://www.radiusnp.com/index.php>

11 BTTB, for a 5km link, <http://www.bttb.net.bd/rates.php#broadband>

12 Grameen Cybernet Ltd, Fibre-optic broadband connection, http://www.citechco.net/pro_int.php

- 13 Agni Systems Ltd, Premium package, Guaranteed minimum speed is 256kbps. <http://www.agni.com/products/fiber.php>
- 14 PTCL, <http://www.ptcl.com.pk/contentb.php?NID=43>
- 15 PTCL, DSL 1MB unlimited package, <http://www.ptcl.com.pk/contentp.php?NID=47>
- 16 BSNL, http://www.bsnl.co.in/service/leased_tariff.htm
- 17 BSNL, http://www.bsnl.co.in/service/dataone_tariff.htm
- 18 MTNL, TriB Unlimited, http://mtnlDelhi.in/broadband/triband_tariff.htm
- 19 Bhutan Telecom, http://www.druknet.bt/btelecom/index.php?option=com_content&task=view&id=35&Itemid=62
- 20 Bhutan Telecom, DSL 15000, Data limit of 12GB, http://www.druknet.bt/btelecom/index.php?option=com_content&task=view&id=64&Itemid=112
- 21 Bhutan Telecom, DSL 1000, Data limit of 500MB, Does not discriminate btw corporate and home users, http://www.druknet.bt/btelecom/index.php?option=com_content&task=view&id=64&Itemid=112
- 22 SLT, for a 0-33km link
- 23 SLT, for a 33-99km link
- 24 Dialog, WiMax, 2MB Corporate package, <http://www.dialog.lk/en/broadband/products/wimax.html>
- 25 SLT, ADSL Office/ Home Express, <http://www.slt.lk/data/forbusiness/115adsl.htm>
- 26 Dhiraagu, <http://www.dhiraagu.com.mv/tariffs/dhivehinet.php#dedicatedaccess>
- 27 As per the data from the previous document found at: <http://www.lirneasia.net/wp-content/uploads/2007/09/bbenchmarks-page1-v4.pdf>. Data was not available for this quarter.
- 28 <http://www.lirneasia.net/projects/benchmarks>
- 29 Focus Infocomm, ROL Corporate Access 2MB, <http://www.rol.net.mv/downloads/ROLTariffSheet.pdf>. Dhiraagu does not have a 2MB offering with an unlimited download capacity.
- 30 Dhiraagu, Biz Unlimited package, <http://www.dhiraagu.com.mv/tariffs/dhivehinet.php#broadband>
- 31 Focus Infocomm, ROL broadband 256 value for homes, <http://www.rol.net.mv/downloads/ROLTariffSheet.pdf>. The Dhiraagu package - Home Unlimited charges an annual rental of USD655 for a 256kbps broadband connection, <http://www.dhiraagu.com.mv/tariffs/dhivehinet.php#broadband>.
- 32 <http://www.lirneasia.net/projects/current-projects/2241/>
- 33 Dodd, A. (2005), "The Essential Guide to Telecommunication" Fourth Edition, Pearson Education, p. 14
- 34 Dodd, A. (2005), "The Essential Guide to Telecommunication" Fourth Edition, Pearson Education, p. 60
- 35 Dodd, A. (2005), "The Essential Guide to Telecommunication" Fourth Edition, Pearson Education, p. 60
- 36 Connection Magazine, <http://www.connectionsmagazine.com/articles/5/049.html>, CISCO Press Article
- 37 The connections were tested on:
 - SLT tested on : 19 Dec, 2007 & 20 Dec, 2007
 - Dialog tested on : 24 Dec, 2007 & 28 Dec, 2007
 - BSNL tested on : 12 Dec, 2007 & 19 Dec, 2007
 - Airtel tested on : 30 Dec, 2007 & 7 Jan, 2008
- 38 The speed at which the subscriber can receive traffic from the ISP server and a commonly used International Server (eg yahoo.com)
- 39 The speed in which the subscriber can send traffic to the ISP server and a commonly used International Server (eg yahoo.com). It plays a significant role in responsiveness and real-time applications like VOIP.
- 40 Time taken for the traffic to reach a particular destination. Only 3 broadband packages were tested for latency as Dialog (LK) does not allow for the traceroute application to be run on their broadband links.
- 41 http://www.ida.gov.sg/doc/Policies%20and%20Regulation/Policies_and_Regulation_Level2/QoS_webpage_-_BB.pdf, Accessed on 25th January, 2008.
- 42 The SLT (LK), BSNL (IN) & Airtel (IN) servers
- 43 For SLT (LK), this is Singtel, Singapore. BSNL & Airtel enter US after exiting their respective ISP domains.
- 44 Jitter is the variation of end-to-end delay from one packet to the next within the same packet stream/connection/flow. Jitter experienced by the packets, more relevant for Real-time traffic like VOIP. Ideally it should be zero.
- 45 Number of packets (in %) that does not reach the destination. This can result in highly noticeable performance issues with Streaming Technologies, VOIP and Video conferencing.