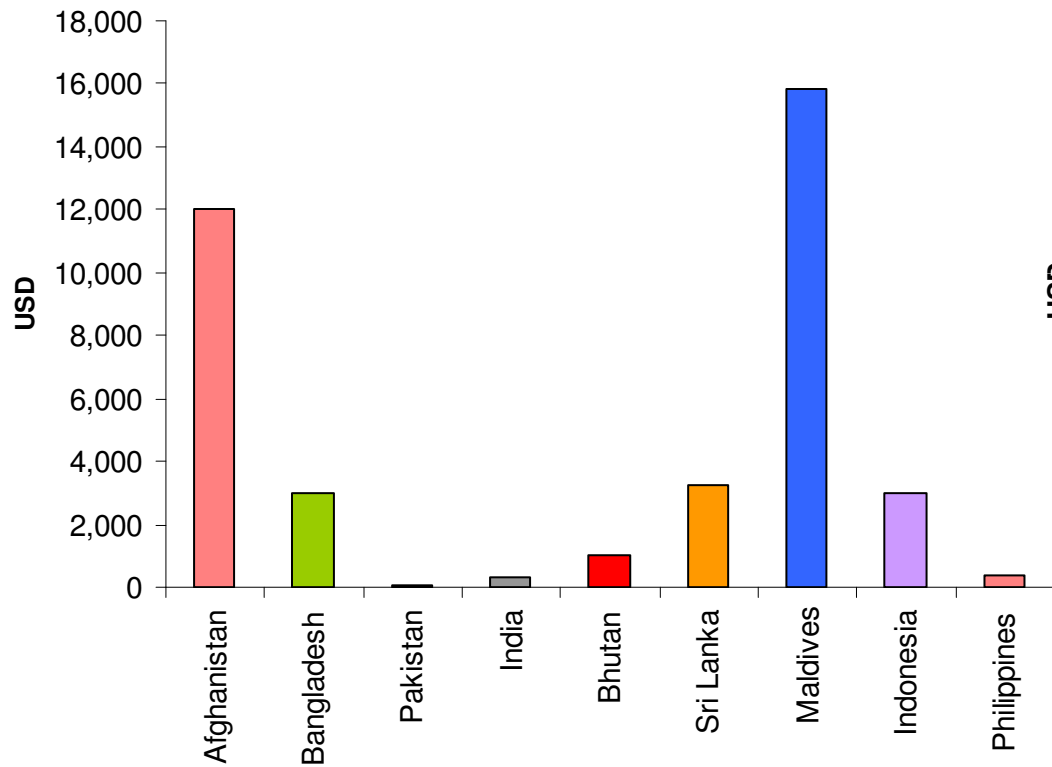


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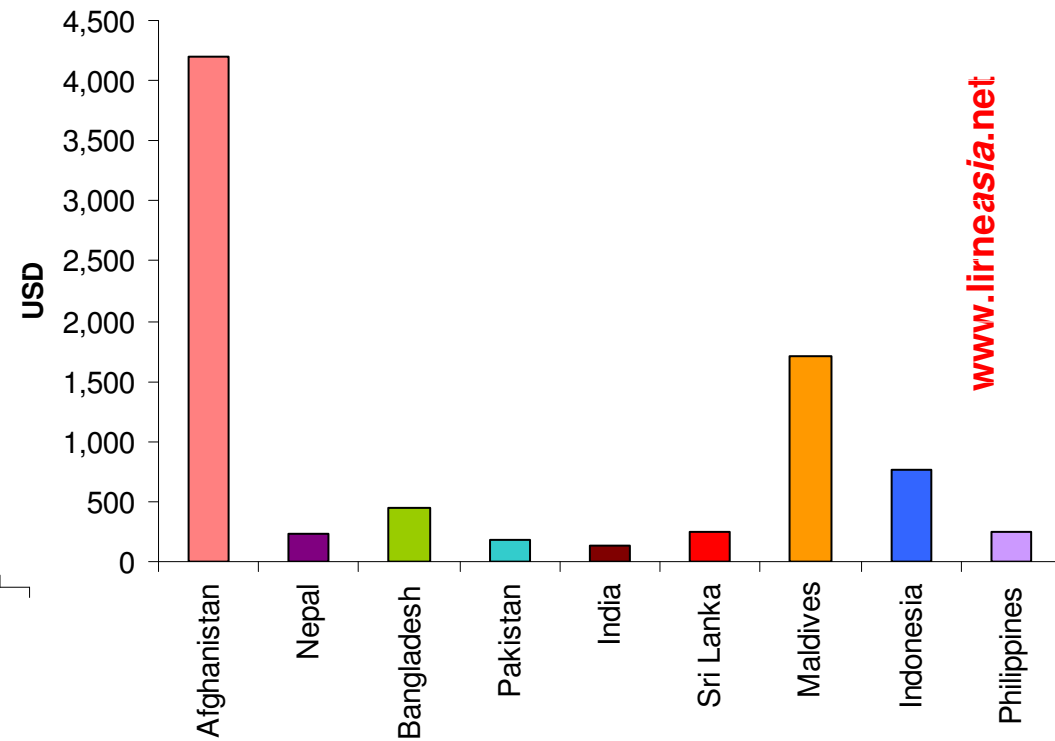
Annual Price 2Mbps, 2km leased line connection

Figure 1



Annual price 256kpbs Business Broadband connection

Figure 2



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Table 1- Broadband Prices in Emerging Asia in USD¹

Country ²	Annual cost, 2Mbps, 2km DPLC (tail cost)	Annual cost, 2Mbps, 100km DPLC ³	Annual cost, 2Mbps Broadband business connection ⁴ (unlimited download)	Annual cost, 256kbps Broadband business connection ⁴ (unlimited download)	Annual cost, 256kbps Broadband residential connection ⁴ (unlimited download)	Price per GB, for 2Mbps, 5-10 GB data limit (Business)	Price per GB, for 256kbps, 5-10 GB data limit (Business)	Price per GB, for 256kbps, 1-4 GB data limit (Residential)	Price per GB, 1Mbps speed, 1GB data limit mobile internet
South Asia									
Afghanistan	12,000 ⁵	- ⁶	11,700 ⁷	4,200 ⁸	4,200 ⁸	-	-	-	-
Nepal	- ⁹	- ¹⁰	1,567 ¹¹	238 ¹²	238 ¹²	-	-	-	-
Bangladesh	3,000 ¹³	- ⁶	-	444 ¹⁴	267 ¹⁵	-	- ¹⁶	-	-
Pakistan	38 ¹⁷	1,924 ¹⁸	761 ¹⁹	187 ²⁰	187 ²⁰	-	2.70 ²¹	2.14 ²²	2.24 ²³
India	330 ²⁴	3,423 ²⁵	3,491 ²⁶	139 ²⁷	145 ²⁸	3.05 ²⁹	-	5.08 ³⁰	- ³¹
Bhutan	986 ³²	7,392 ³³	-	-	-	4.21 ³⁴	4.33 ³⁵	4.03 ³⁶	17.54 ³⁷
Sri Lanka	3,249 ³⁸	6,350 ³⁹	557 ⁴⁰	251 ⁴¹	251 ⁴¹	-	-	9.10 ⁴²	9.10 ⁴³
Maldives	15,865 ⁴⁴	41,422 ⁴⁴	3,789 ⁴⁵	1,709 ⁴⁶	379 ⁴⁷	22.9 ⁴⁸	10.29 ⁴⁹	9.50 ⁵⁰	-
South East Asia									
Indonesia	2,958 ⁵¹	8,330 ⁵²	-	765 ⁵³	765 ⁵³	21 ⁵⁴	17 ⁵⁵	17 ⁵⁵	26.16 ⁵⁶
Philippines	392 ⁵⁷	- ⁶	495 ⁵⁸	256 ⁵⁹	256 ⁶⁰	- ⁶¹	-	- ⁶²	- ⁶³

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Broadband Quality of Service Experience (QoSE) Indicators⁶⁴

Price is not the only dimension that is of interest to customers and regulators. Quality of Service Experience (QoSE) 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 QOSE indicators for South Asia.

Throughput (kbps) Referred to as the “actual amount of useful data sent on a transmission”⁶⁵. **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”⁶⁶. 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

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as the Transmission Control Protocol (TCP).

The ITU definition states that “Latency means transmission delay for FEC (Forwarding Equivalence Class) encoding, decoding, interleaving and de-interleaving” (ITU-T G.972 (04), 3025).

Jitter (ms)

“Jitter is uneven latency and packet loss”⁶⁷. 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.⁶⁸

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).**

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Results of QoSE testing⁶⁹

Fixed Broadband - Download Speed⁷⁰

Figure 3

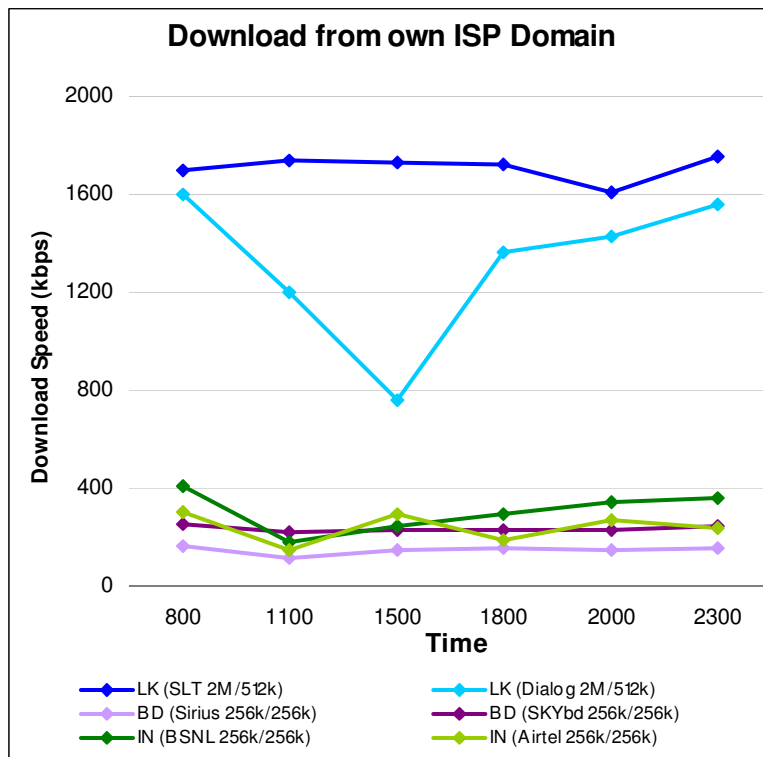
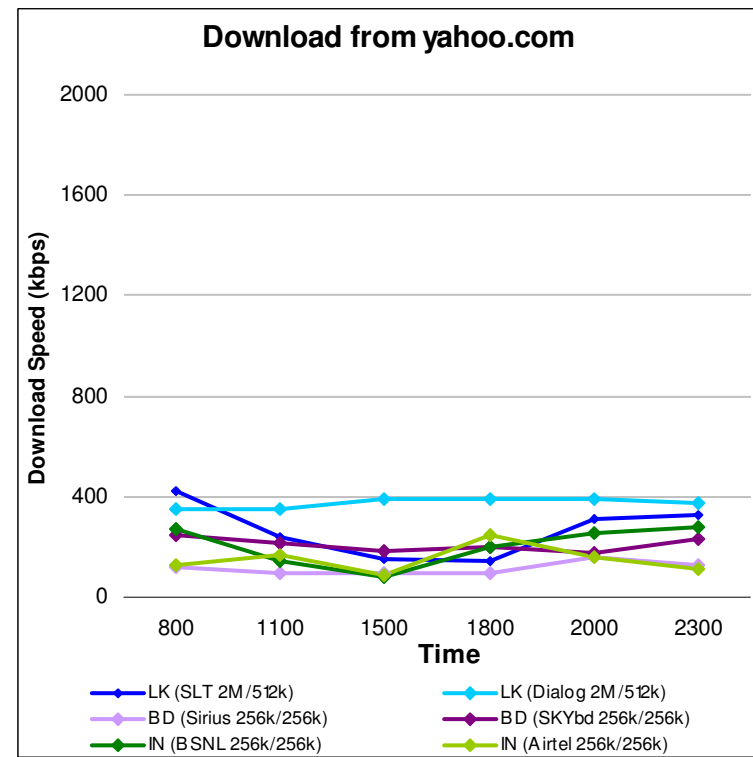


Figure 4



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Figure 5

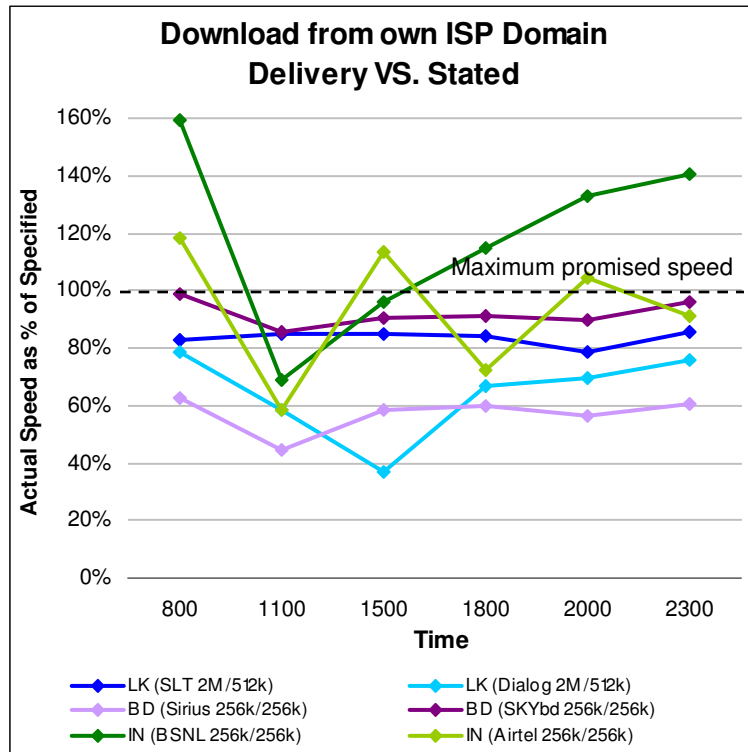
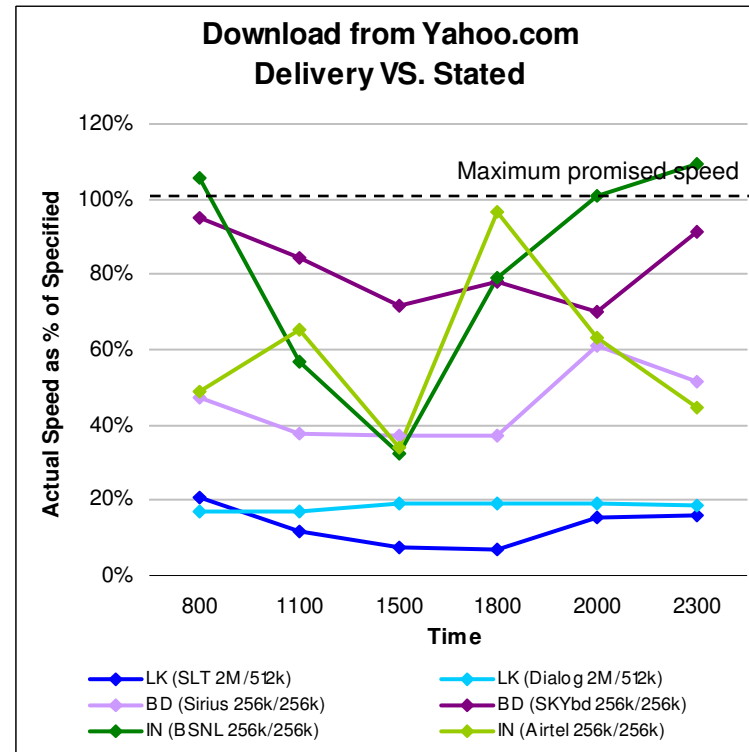


Figure 6



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Fixed Broadband - Jitter⁷¹ and Packet Loss⁷²

Figure 7⁷³

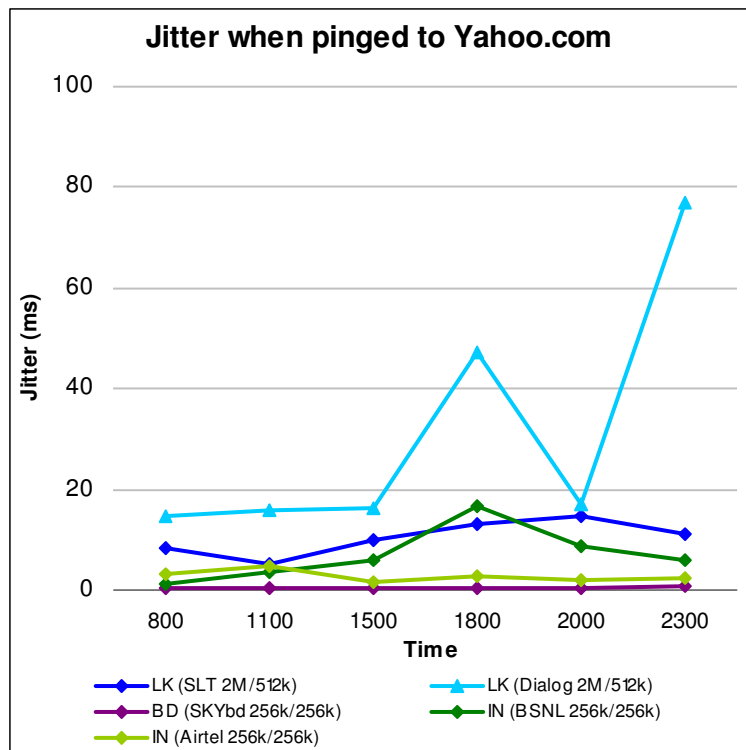
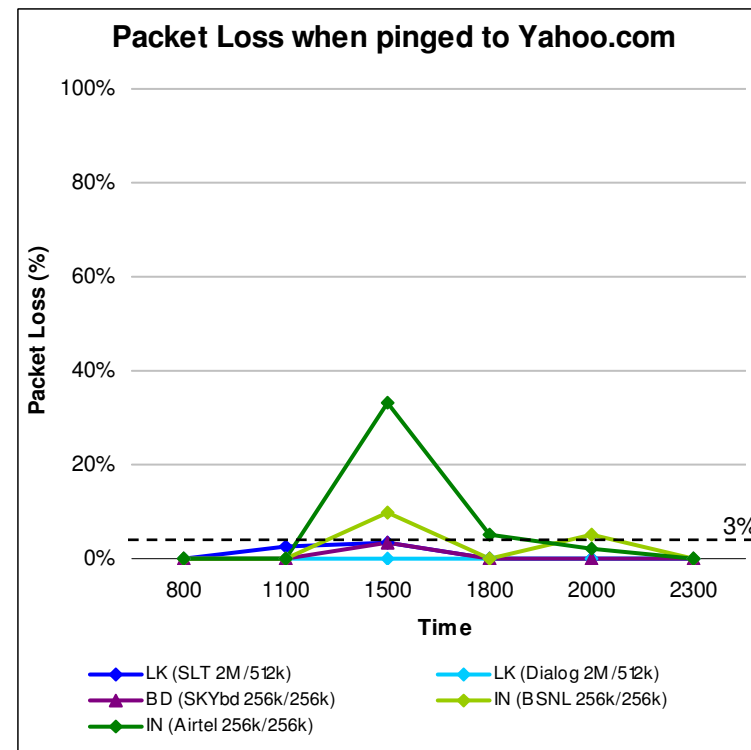


Figure 8⁷³



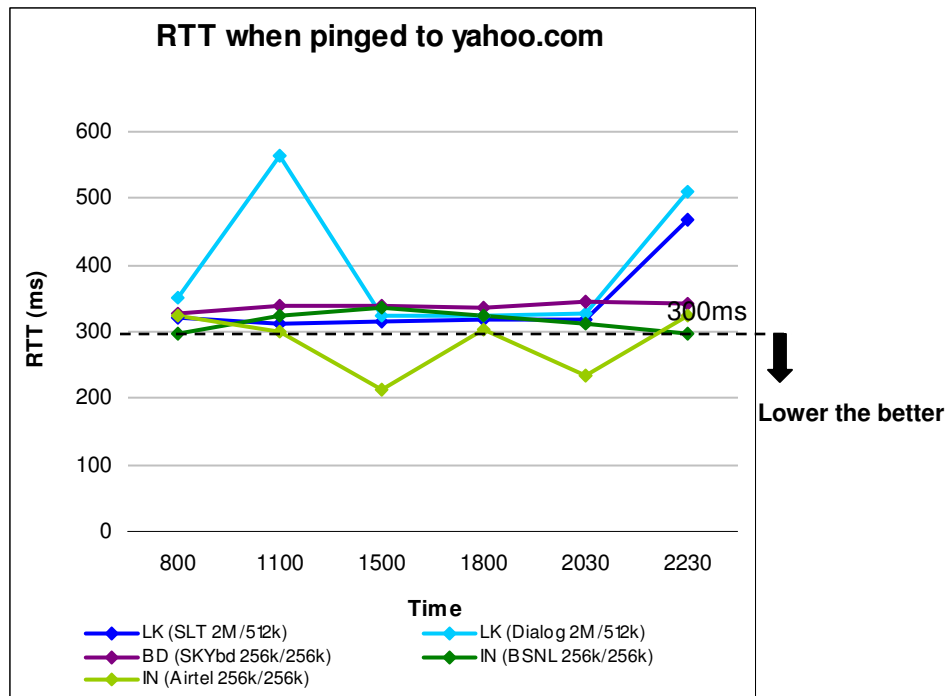
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Fixed Broadband - Latency⁷⁴

Figure 9⁷³



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Mobile Broadband – Download Speed

Figure 10⁷⁵

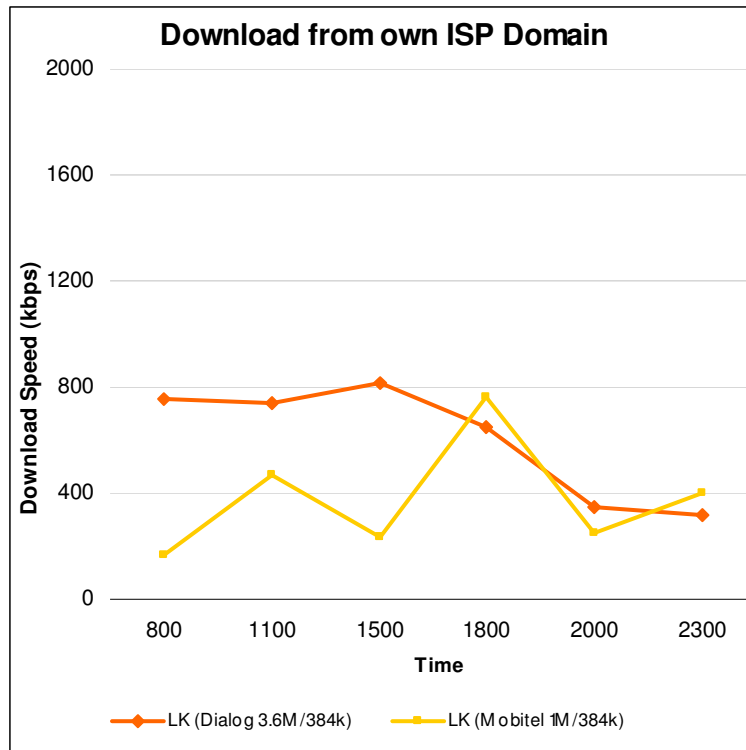
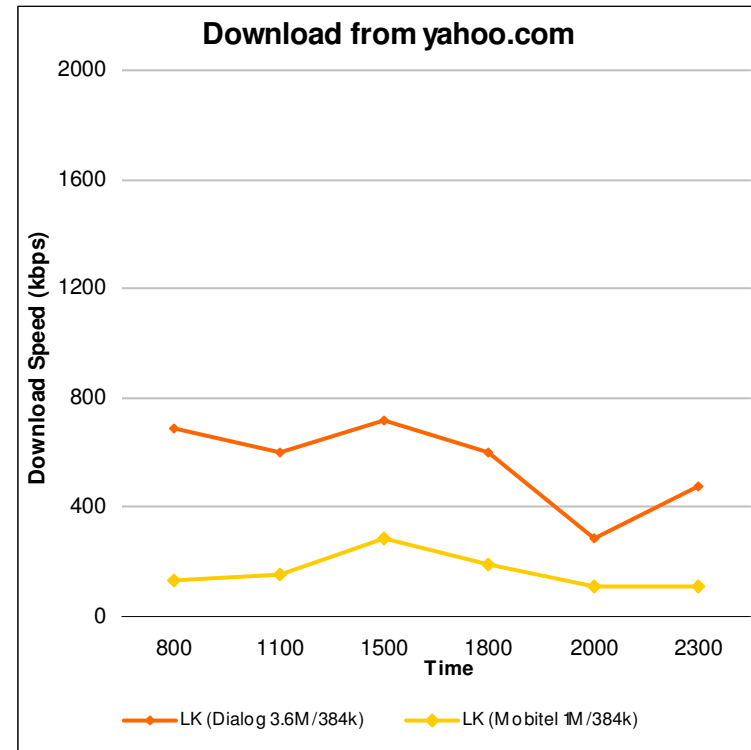


Figure 11



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Figure 12

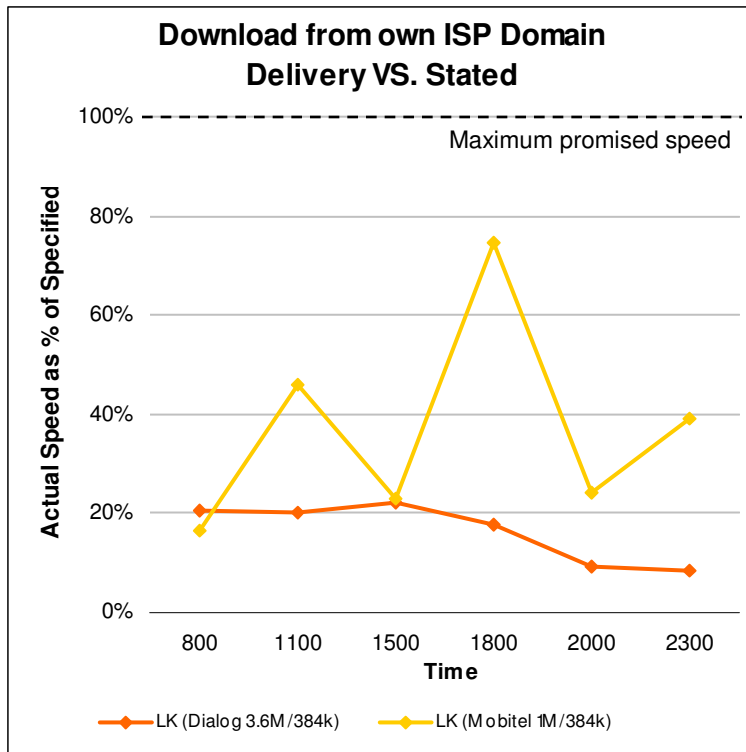
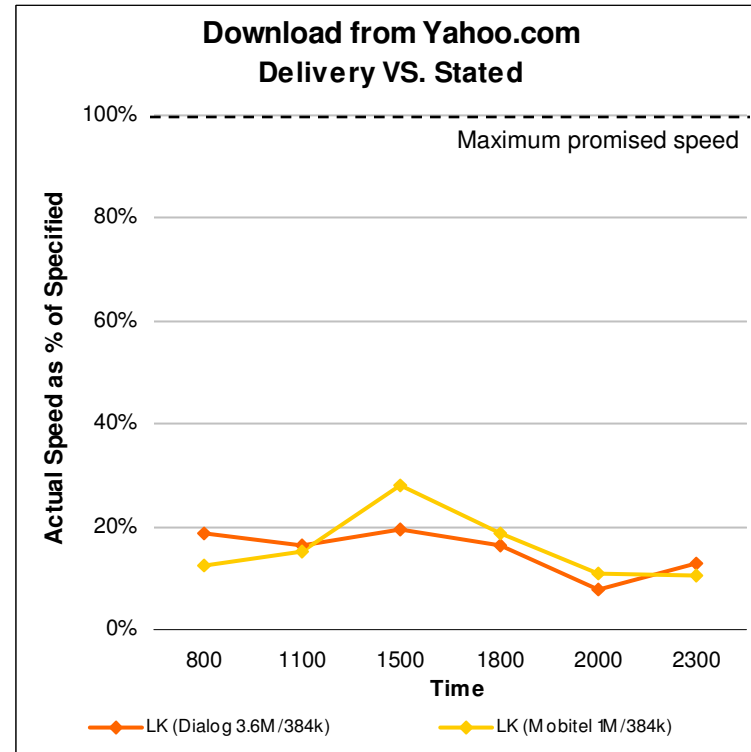


Figure 13



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Mobile Broadband - Jitter⁷¹ and Packet Loss⁷²

Figure 14

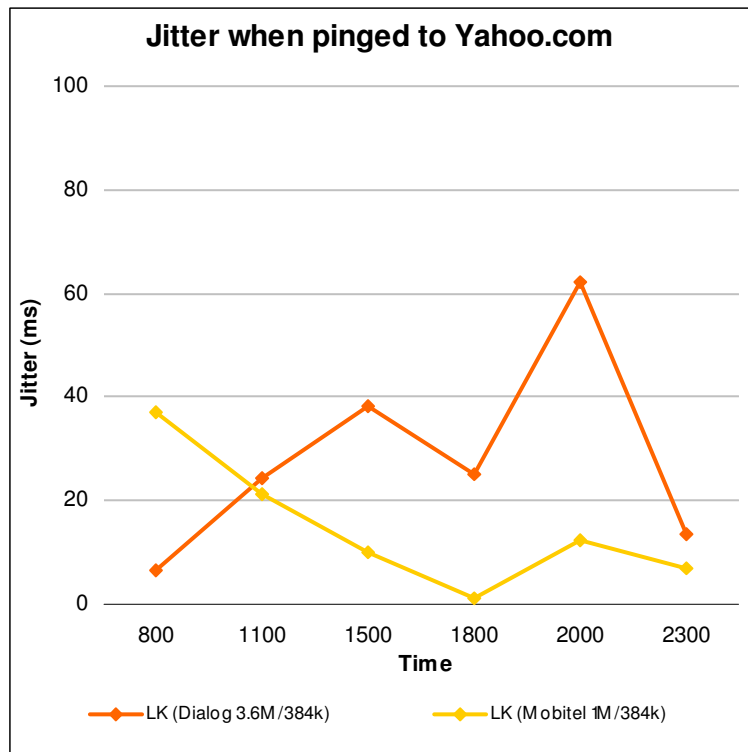
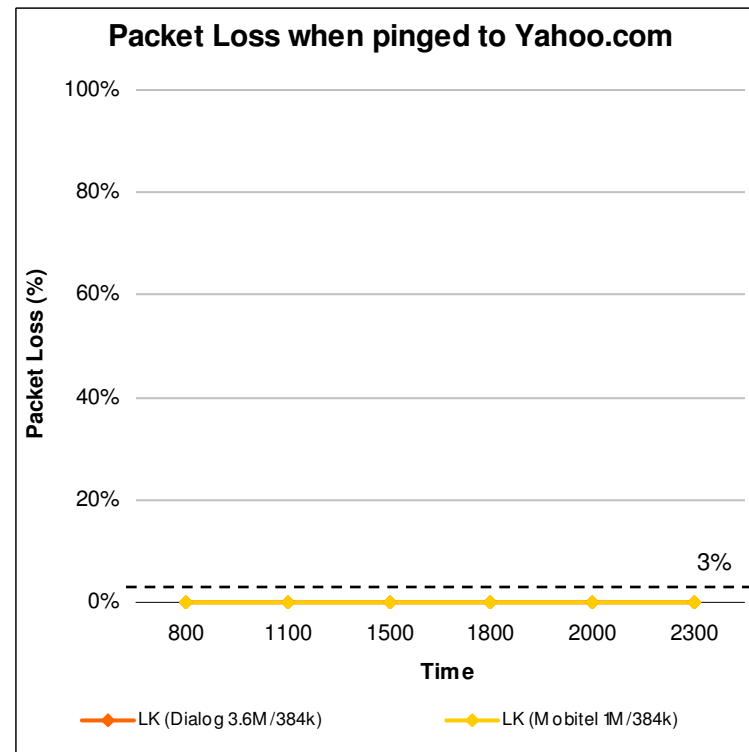


Figure 15



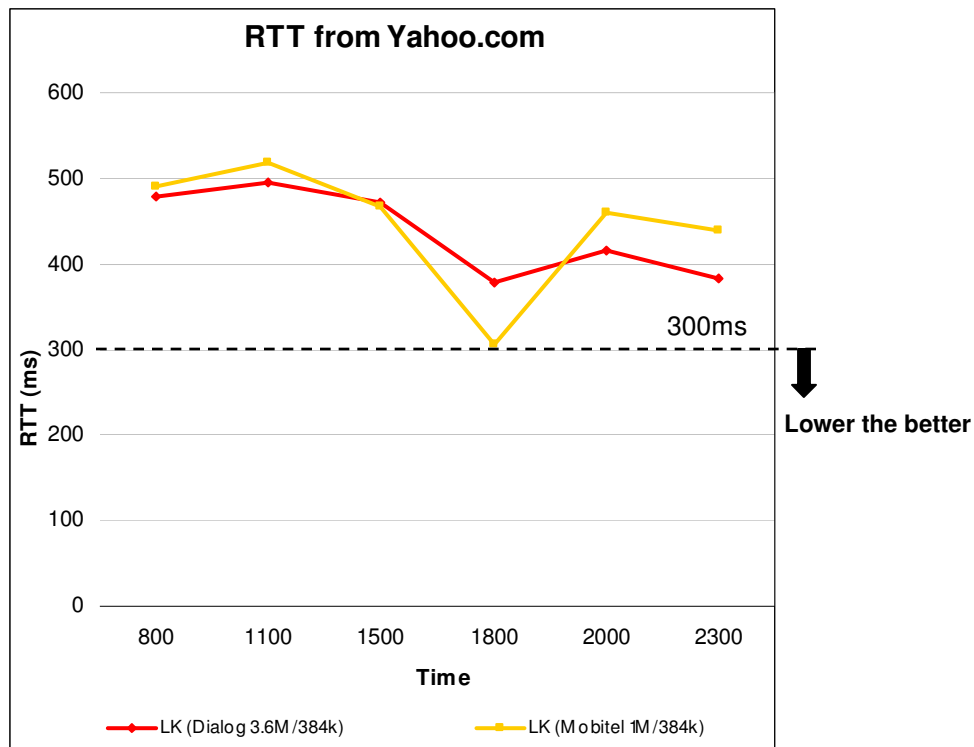
www.lirneasia.net

↓ Lower the better

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Mobile Broadband - Latency⁷⁴

Figure 16



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- ¹ Prices quoted in local currencies have been converted to USD on the 23/10/08 using exchange rates quoted from <http://www.domainit.com/currencyresults.html>
- ² Countries are ranked according to the GDP per capita obtained from the World Economic Outlook database, Oct 2007.
- ³ Cost of two tail charges + 96km link charge
- ⁴ In the event this specific package was not found the closest available package (at the next/fastest bandwidth or next download/upload limit) is reported.
- ⁵ Rates obtained from Afghanistan Telecom Regulatory Agency in October of 2007 quoted. More recent data not available at time of publication.
- ⁶ '-' indicates that information was not available at time of research or package to closely fit the category could not be found.
- ⁷ TS2, <http://www.ts2.pl/en/NSS-6>
- ⁸ TS2, <http://www.ts2.pl/en/NSS-6>
- ⁹ No Offering at this speed is available. Nepal Telecom offers 'Local point to point high speed data leased service' at a lower speed of 64kbps. A 10km link is USD 514. See http://www.ntc.net.np/tariff/pstn_leased_charge.php
- ¹⁰ No Offering at this speed is available. However Nepal Telecom offers 'National point to point high speed data leased service' at the lower speed of 64kbps. A 100km link is priced at USD 1,296.86. See http://www.ntc.net.np/tariff/pstn_leased_charge.php
- ¹¹ Nepal Telecom, *ADSL offerings*, http://www.ntc.net.np/adsl/adsl_tariffPlans.php2
- ¹² Nepal Telecom, *ADSL offerings*, there is no distinction between business and residential packages, http://www.ntc.net.np/adsl/adsl_tariffPlans.php
- ¹³ Office of the Bangladesh Telecom Regulatory Commission, *Approval for Leasing or Sharing of Transmission Capacity (E1 etc)*, BTRC/SS/GP-Tariff/Part-1/2005-325, for a 30km link.
- ¹⁴ Sirius Broadband, *Premium Package*, 96-256Kbps. Information received from Sirius Broadband customer service.
- ¹⁵ Sirius Broadband, *Xpress package*, <http://www.siriusbroadband.com/rate.php>
- ¹⁶ Packages are based on time of use (off- peak, peak)
- ¹⁷ Pakistan Telecom Company Limited, 0- 200Km rate x 2, <http://www.ptcl.com.pk/contentb.php?NID=43>
- ¹⁸ Pakistan Telecom Company Limited, 0-200km rate x 100, <http://www.ptcl.com.pk/contentb.php?NID=43>
- ¹⁹ Pakistan Telecom Company Limited, *DSL 2MB unlimited*, <http://www.ptcl.com.pk/contentp.php?NID=47>
- ²⁰ Pakistan Telecom Company Limited, *DSL 512 Kbps Unlimited*, There is no distinction between business and residential packages, <http://www.ptcl.com.pk/contentp.php?NID=47>
- ²¹ Micronet Broadband, *DSL connect 9, 9GB*, <http://www.dsl.net.pk/VolumePackages.php>
- ²² Micronet Broadband, *7GB, DSL@Home-7*, <http://www.dsl.net.pk/HomePackage.php>
- ²³ Mobilink, *Infinity package*, 5GB, <http://www.mobilinkinfinity.com/tariff/>
- ²⁴ BSNL, 5km, http://www.bsnl.co.in/service/leased_tariff1.htm
- ²⁵ BSNL, 100km rate, http://www.bsnl.co.in/service/leased_tariff.htm#high
- ²⁶ MTNL, *TriBand Broadband, Unlimited Plan -4*, <http://mumbai.mtnl.net.in/triband/htm/tariff.htm>
- ²⁷ MTNL, *TriB Unlimited, UL data – 256*, http://mtnldelhi.in/broadband/triband_tariff.htm
- ²⁸ BSNL, *Home UL 750 package*, http://www.bsnl.co.in/service/dataone_tariff.htm
- ²⁹ BSNL, *Business 1200, 256kbps-2MB, 8 GB data limit*, http://www.bsnl.co.in/service/dataone_tariff.htm#business1
- ³⁰ BSNL, *Home 250, 1GB Plan*, http://www.bsnl.co.in/service/dataone_tariff.htm#business1

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- ³¹ No Offering at this speed is available, However, TATA Indicom, *Millennium Edition Plans (ME)*, 150kbps, 1GB Data Limit, is priced at USD 11.35, <http://www.tataindicom.com/t-personal-internet-internetmobile.aspx>
<http://www.tataindicom.com/t-personal-internet-internetmobile.aspx>
- ³² Bhutan Telecom Ltd, 10km, http://www.druknet.bt/btelecom/index.php?option=com_content&task=view&id=35&Itemid=62
- ³³ Bhutan Telecom Ltd, 100km, http://www.druknet.bt/btelecom/index.php?option=com_content&task=view&id=35&Itemid=62
- ³⁴ Bhutan Telecom, *Enterprise 2Mbps*, 15GB, http://www.druknet.bt/btelecom/index.php?option=com_content&task=view&id=64&Itemid=112
- ³⁵ Bhutan Telecom, *Office – 256*, 7GB, http://www.druknet.bt/btelecom/index.php?option=com_content&task=view&id=64&Itemid=112
http://www.druknet.bt/btelecom/index.php?option=com_content&task=view&id=64&Itemid=112
- ³⁶ Bhutan Telecom Ltd, *Home Package*, 256kbps, http://www.druknet.bt/btelecom/index.php?option=com_content&task=view&id=64&Itemid=112
- ³⁷ B-Mobile, *Supreme*, 1.2GB, 1Mbps, Call from customer service
- ³⁸ Sri Lanka Telecom Rates for a 0-33km link. Price as quoted in Feb 2008
- ³⁹ Sri Lanka Telecom Rates for a 33-99km link. Price as quoted in Feb 2008
- ⁴⁰ Dialog, *Office Net Package*, 2Mbps/512kbps, <http://www.dialog.lk/en/broadband/products/officenet.html>
- ⁴¹ SLT, *ADSL Home Express Package*, 512/128kbps, <http://www.slt.lk/data/forbusiness/115adsl.htm>
- ⁴² SLT, *Broadband entrée package*, 512/128kps, <http://www.slt.lk/data/forbusiness/115adsl.html>
http://www.websurfer.com.np/cable_internet_service.php
- ⁴³ Mobitel, *Zoom 1024*, 1.5GB, <http://www.mobitellanka.com/broadband/tariff.html>
- ⁴⁴ Dhiraagu, <http://www.dhiraagu.com.mv/tariffs/dhivehinet.php#dedicatedaccess>
- ⁴⁵ ROL, *Biz Broadband 2M*, <http://www.rol.net.mv/small-medium-biz/Biz-Broadband-2M.html>
- ⁴⁶ Dhiraagu, *Biz unlimited*, 512/128kbps, http://www.dhiraagu.com.mv/beta/business/small_medium/b_internet/biz_unlimited.php
- ⁴⁷ ROL, *Broadband 256k Value*, <http://www.rol.net.mv/home-user/ROL-Broadband-256k-Value.html>
- ⁴⁸ Dhiraagu, *Biz Premier 4M*, 4MB/512kbps, 10 GB data limit, http://www.dhiraagu.com.mv/beta/business/small_medium/b_internet/biz_premier.php
- ⁴⁹ Dhiraagu, *Biz Starter Package*, 512/128kbps, 5GB, RF 0.25/MB, http://www.dhiraagu.com.mv/beta/business/small_medium/b_internet/biz_starter.php
- ⁵⁰ Dhiraagu, *Home Starter*, Up to 512kbps, 1GB data limit, RF 0.25/MB, <http://www.dhiraagu.com.mv/beta/internet/starter.php>
- ⁵¹ Telkom, 5km, Siaran Pers No. 32/DJPT.1/KOMINFO/4/2008
- ⁵² Telkom, 100km, Siaran Pers No. 32/DJPT.1/KOMINFO/4/2008
- ⁵³ ABLTECH, *Soho package*, <http://abltech.com/price.html>
- ⁵⁴ Indosat, <http://www.indosatm2.com/popup.php/promo/Bizz>
- ⁵⁵ PT Indosat, 3.6Mbps, 5GB, <http://www.indosatm2.com/popup.php/promo/Bizz>
- ⁵⁶ PT Indosat, *You!*, 3.6Mbps, 1.2GB, <http://www.indosatm2.com/popup.php/promo/prime>
- ⁵⁷ PLDT, <http://www.pldt.com.ph/prod-serv/business/diginet.htm>, information from Aug 2007.
- ⁵⁸ PLDT, *SmallBiz Micro*, <http://www.pldt.com.ph/prod-serv/business/bizdsl.htm>
- ⁵⁹ Globe Telecom, *Trader lite*, 384Kbps, <http://www.sme.globe.com.ph/GlobeCSME/View/Content.aspx?eFtJH3VkGkZ1MHH9FHehQ%3d%3d>
- ⁶⁰ Globe Telecom, wireless access, 384Kbps, http://www.globelines.com.ph/DataServices_HomeUse.php

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⁶¹ No Offering available. Available packages are based on (limited by) hours of use and not downloadable capacity.

⁶² No Offering to match this package is available. However Globe Telecom, 256Kbps, 30 hours of usage is priced at USD 12.20. See http://www.globelines.com.ph/DataServices_BusinessUse.php

⁶³ No Offering to match this package is available. However Globe Telecom, Plan 799, 1.8Mbps, 40 free hours of usage is priced at USD 16.38, http://www.globelines.com.ph/DataServices_BusinessUse.php

⁶⁴ <http://www.lirneasia.net/projects/current-projects/2241/>.

⁶⁵ Dodd, A. (2005), "The Essential Guide to Telecommunication" Fourth Edition, Pearson Education, p. 14

⁶⁶ Dodd, A. (2005), "The Essential Guide to Telecommunication" Fourth Edition, Pearson Education, p. 60

⁶⁷ Dodd, A. (2005), "The Essential Guide to Telecommunication" Fourth Edition, Pearson Education, p. 60

⁶⁸ Connection Magazine, <http://www.connectionsmagazine.com/articles/5/049.html>, CISCO Press Article

⁶⁹ The connections were tested on:

SLT tested on	: 21 Oct, 2008 & 22 Oct, 2008
Dialog tested on	: 21 Oct, 2008 & 22 Oct, 2008
BSNL tested on	: 22 Oct, 2008 & 24 Oct, 2008
Airtel tested on	: 05 Nov, 2008 & 07 Nov, 2008
Sirius tested on	: 18 Sep, 2008
SKYbd tested on	: 24 Sep, 2008
Mobitel (HSPA)	: 29 Oct, 2008 & 30 Oct, 2008
Dialog (HSPA)	: 22 Oct, 2008

⁷⁰ The speed at which the subscriber can receive traffic from 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.

⁷¹ Jitter is the variation of end-to-end delay from one packet to the next within the same packet stream/ connection/ flow. Jitter experienced in packets, more relevant in Real-time traffic like VOIP. Ideally it should be zero.

⁷² 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.

⁷³ Information not available for Sirius Broadband package

⁷⁴ Time taken for traffic to reach a particular destination.

⁷⁵ Maximum download speed for Dialog is noted as 3.6Mbps as this is the maximum capacity of the modem provided by the operator.