

## Broadband Quality of Service Experience (QoSE) Indicators<sup>1</sup>

Price is not the only dimension that interests broadband users 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 packages of two operators in Bangladesh (Dhaka) four packages of two operators in India (Bangalore and New Delhi) and seven packages of four networks in Sri Lanka (Colombo). Also this report contains a comparison with two packages of two operators in Canada (Ottawa) and two packages of two networks in United States (Buffalo and Denver).

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<b>Throughput (kbps)</b>	<p>Referred to as the “actual amount of useful data sent on a transmission”<sup>ii</sup>. <b>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),</b> more commonly referred to as download or upload speeds.</p> <p>A key advertised metric in broadband services is the download speed. It defines how much information a user can receive from a local or international server. Upload speed defines the speed at 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).</p> <p>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.</p> <p>Therefore the testing has included throughput for both local (ISP) and international (yahoo.com) servers.</p>
<b>Latency (ms)</b>	<p>Referred to as “delays when voice packets transverse the network”<sup>iii</sup>. 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).</p> <p><b>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).</b></p>
<b>Jitter (ms)</b>	<p>Referred to as “uneven latency and packet loss”<sup>iv</sup>. 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.</p> <p>E.g. Radio quality voice requires less than 1 ms Jitter, toll-quality voice requires less than 20 ms jitter and normal VoIP requires jitter to be less than 30 ms. Beyond 30 ms, the performance of VoIP will degrade.<sup>v</sup></p> <p><b>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).</b></p>
<b>Packet Loss (%)</b>	<p>Referred to as the 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. <b>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).</b></p>

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 Results of QoSE testing<sup>vi</sup> (Bangalore, Chennai, New Delhi, Colombo, Dhaka, Buffalo, Denver and Ottawa)

Fixed Broadband Packages and colour keys

Package/Test Location/Country	Advertised Download speed
Sirius (256 kbps) Dhaka, Bangladesh	256 kbps
SKYbd (256 kbps) Dhaka, Bangladesh	256 kbps
BSNL (256 kbps) Bangalore, India	256 kbps
BSNL (1 Mbps) Bangalore, India	1 Mbps
Airtel (256 kbps) Delhi, India	256 kbps
Airtel (1 Mbps) Delhi, India	1 Mbps
Dialog (2 Mbps) Colombo, Sri Lanka	2 Mbps
SLT (2 Mbps) Colombo, Sri Lanka	2 Mbps
SLT (512 kbps) Colombo, Sri Lanka	512 kbps
Bell (6 Mbps) Ottawa, Canada	6 Mbps
Rogers (10 Mbps) Ottawa, Canada	10 Mbps
Verizon (3 Mbps) Buffalo, United States	3 Mbps
Comcast (6 Mbps) Denver, United States	6 Mbps

Fixed Broadband – Throughput (kbps)<sup>vii</sup>  
 Figure 1 - Download from ISP - kbps per dollar<sup>viii</sup>

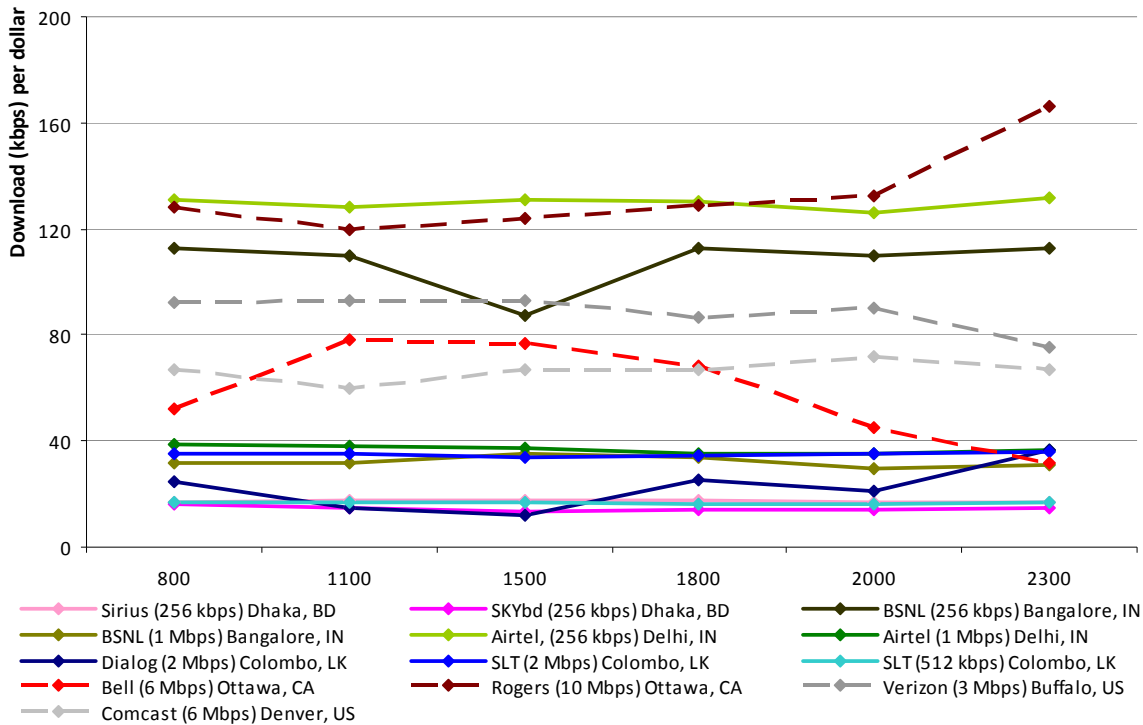


Figure 2 - Download from ISP - Fixed Broadband (Delivery vs. Stated)

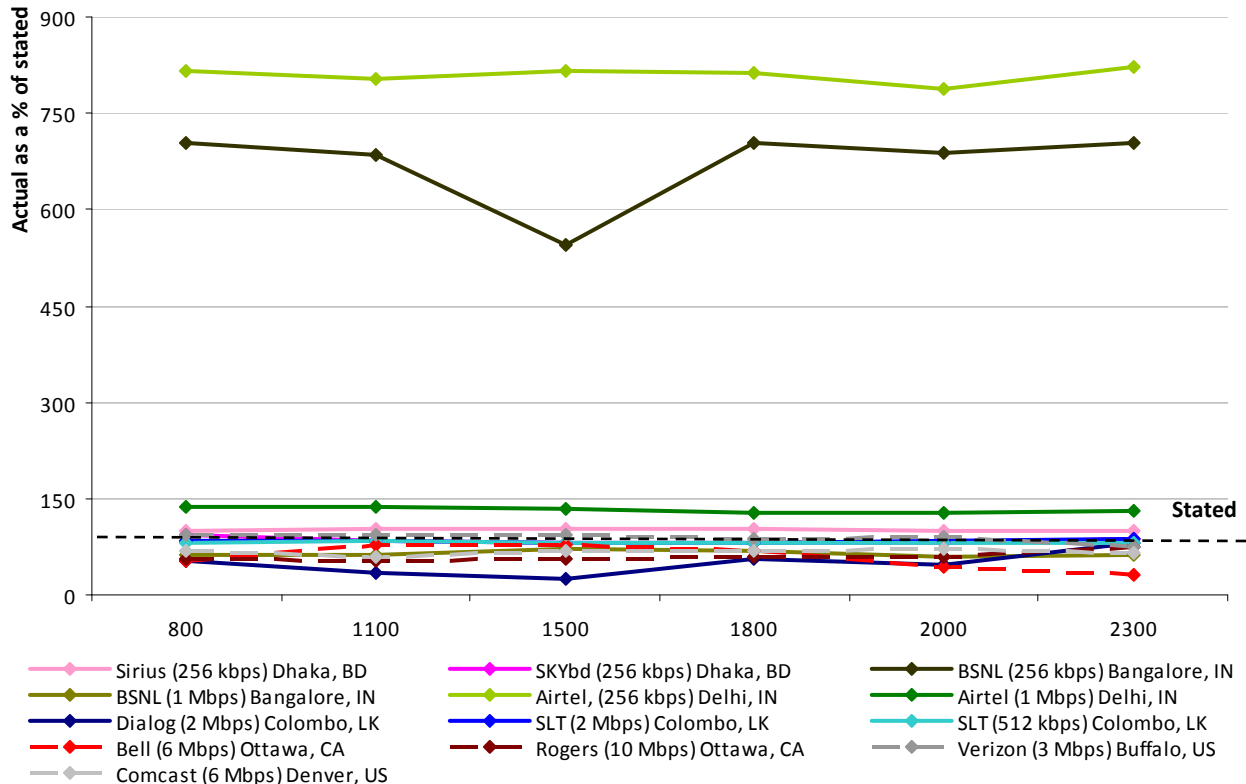


Figure 3 - Download from International - kbps per dollar

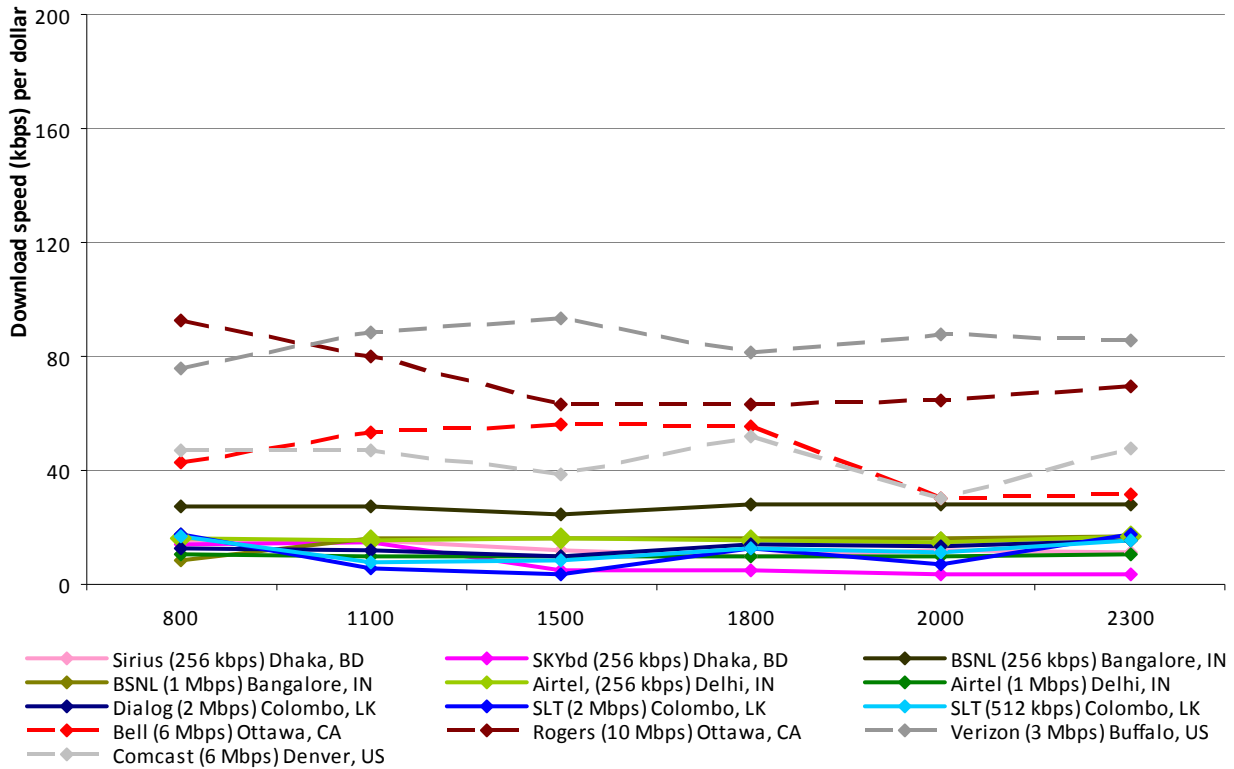
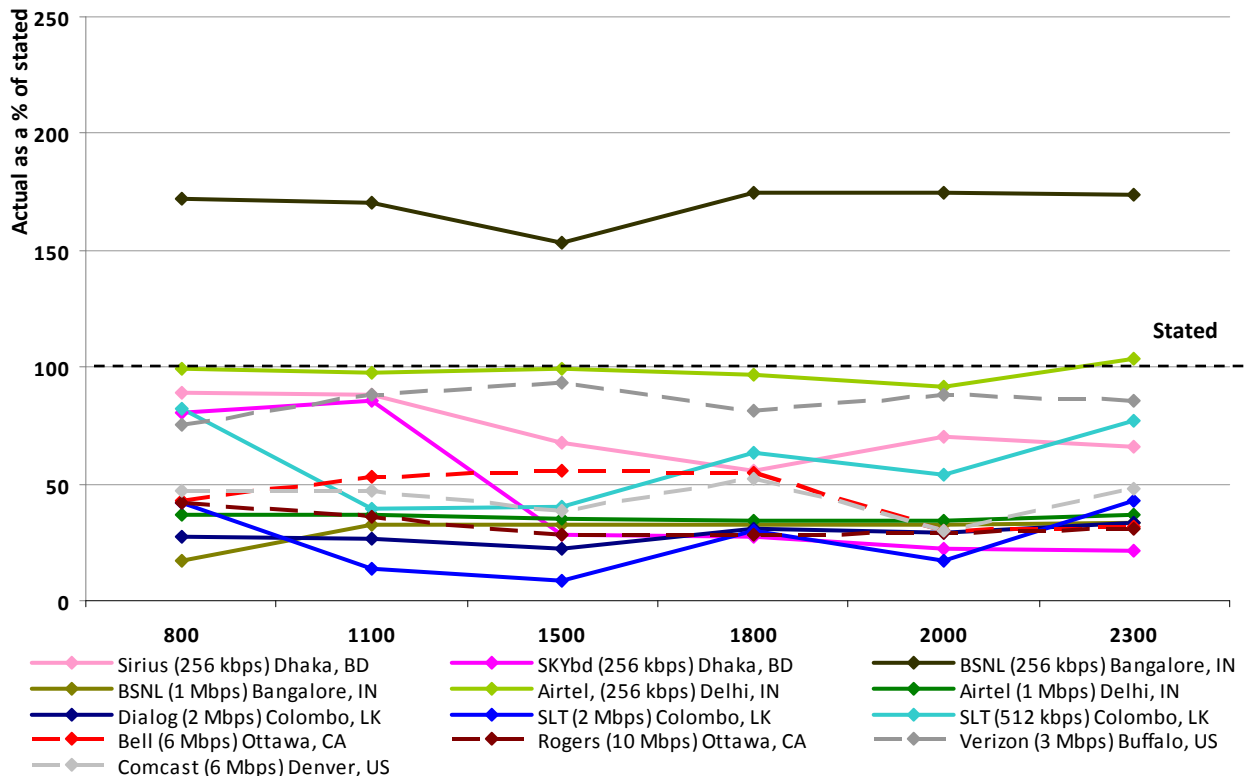


Figure 4 - Download from International (Delivery vs. Stated)



Fixed Broadband - Jitter<sup>ix</sup> and Packet Loss<sup>x</sup>  
Figure 5 - Jitter when pinged to International

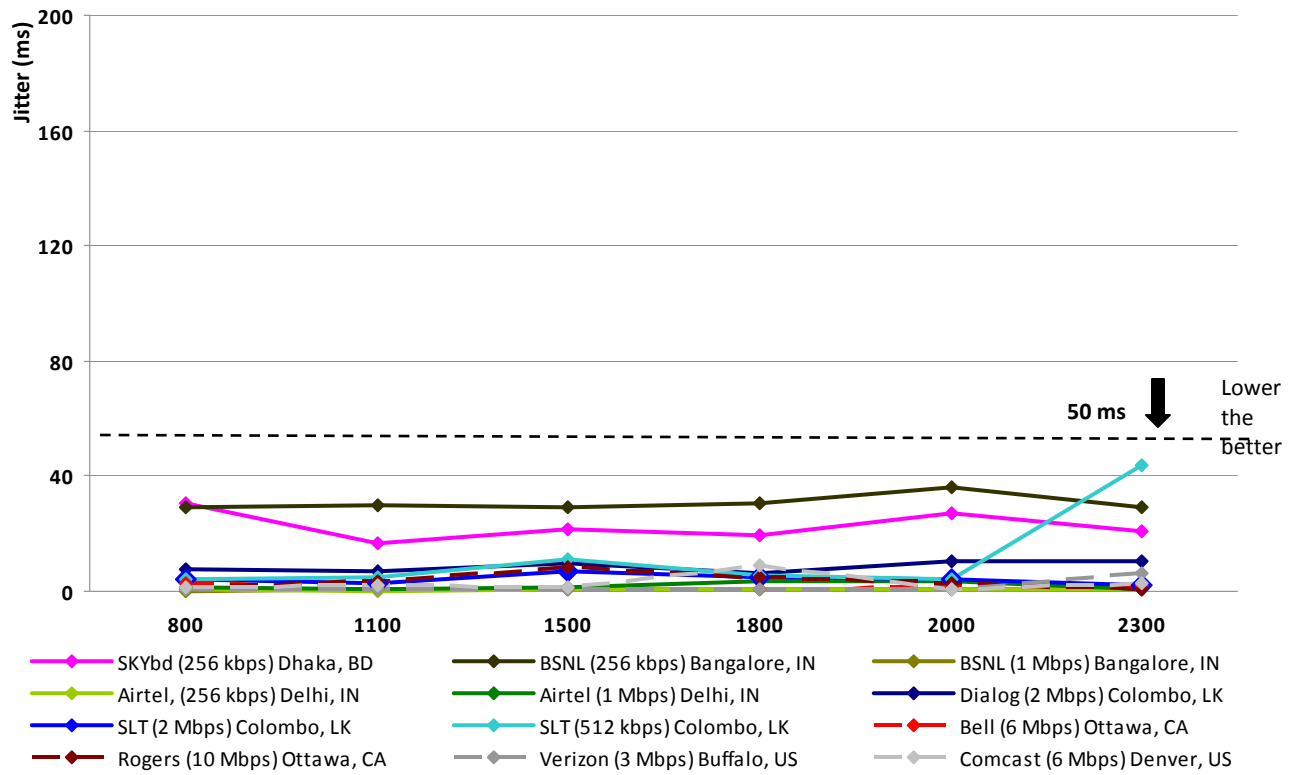
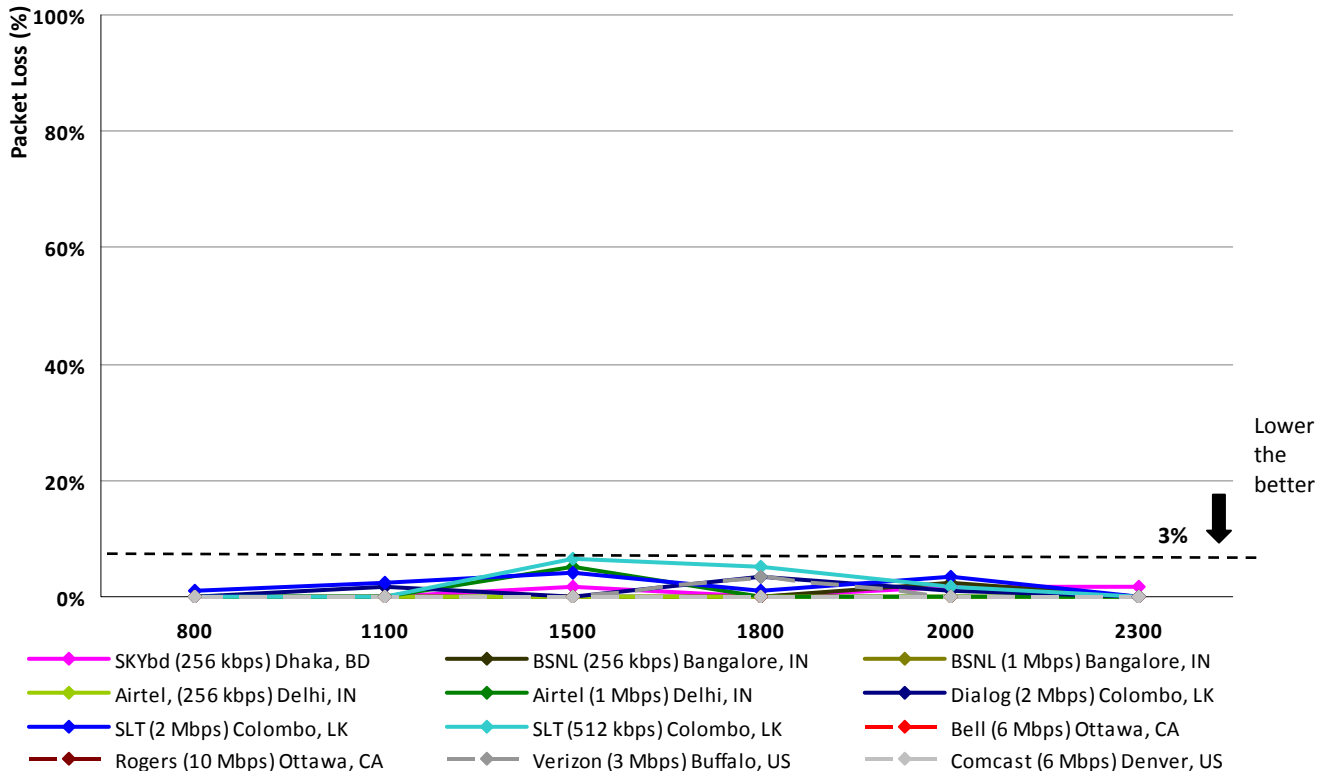
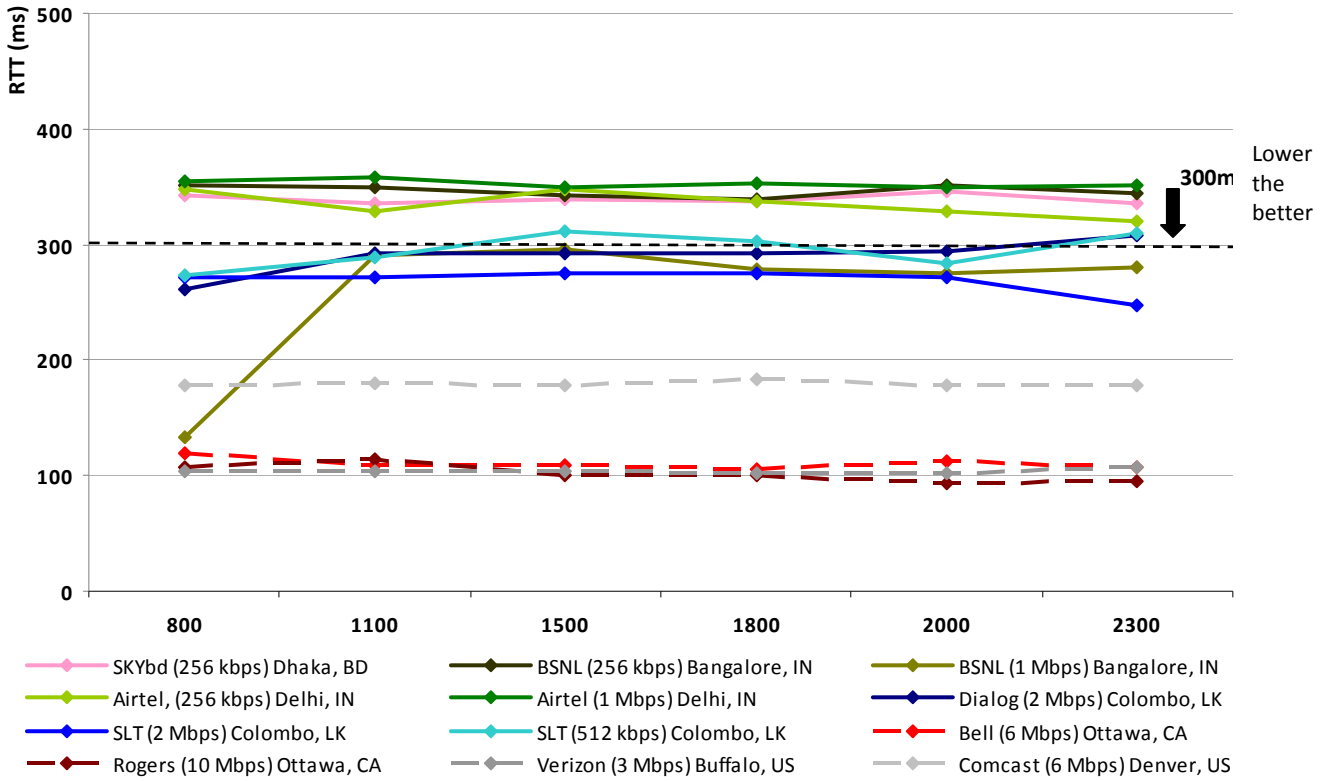


Figure 6 - Packet loss when pinged to International



## Fixed Broadband - Latency<sup>xi</sup>

Figure 7 - RTT when pinged to International



**Mobile Broadband Packages and colour keys**

Package/Test Location/Country	Advertised Download speed	Data Limit
Dialog (1 Mbps) Colombo, Sri Lanka - I	1 Mbps	1 GB
Dialog (1 Mbps) Colombo, Sri Lanka - II	1 Mbps	Unlimited
Mobitel (1 Mbps) Colombo, Sri Lanka	1 Mbps	2 GB
Mobitel (3.6 Mbps) Colombo, Sri Lanka	3.6 Mbps	7 GB

**NB:**

1. This comparison has ignored whether the package offers limited or unlimited download option. For example Dialog (1 Mbps) Colombo LK which seems to offer the best performance has a limit of 1 GB per month.
2. Speeds were taken using personal computers not mobile handsets. The speeds may vary when mobile handsets are used.

## Mobile Broadband (Simulated testing) – Throughput (kbps)

Figure 8 - Download from ISP - kbps per dollar

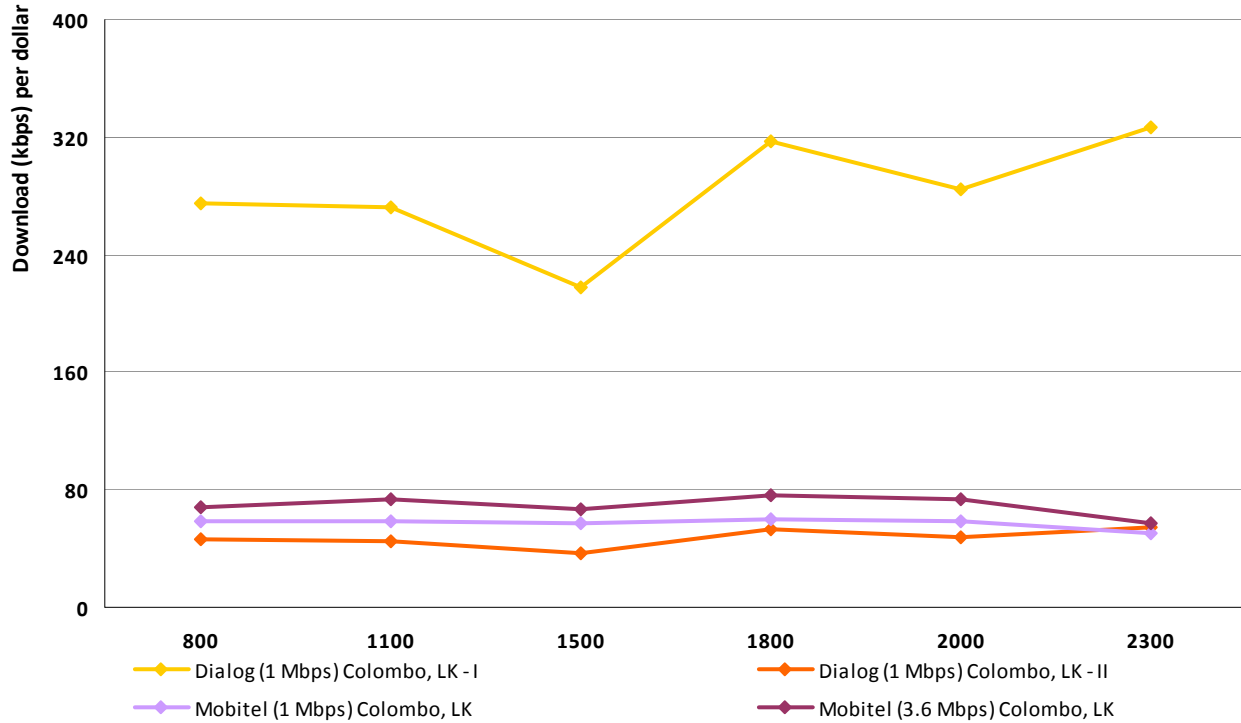


Figure 9 - Download from ISP - Fixed Broadband (Delivery vs. Stated)

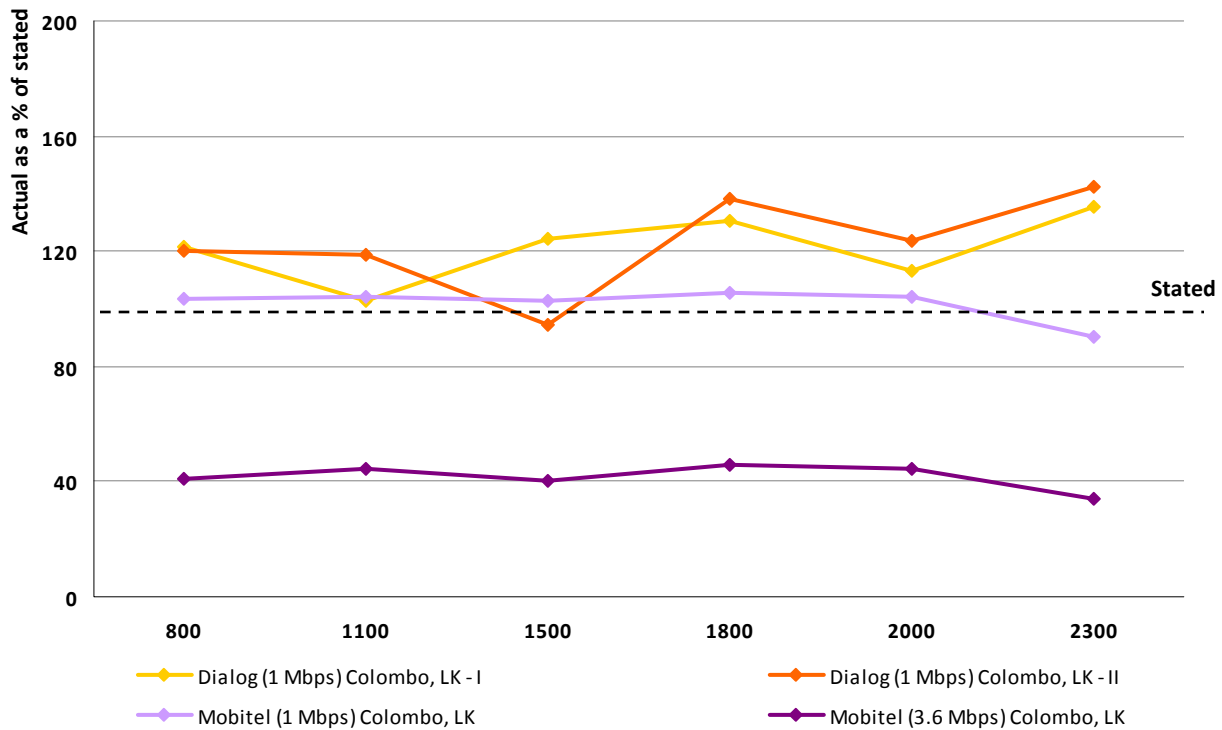


Figure 10 - Download from International - kbps per dollar

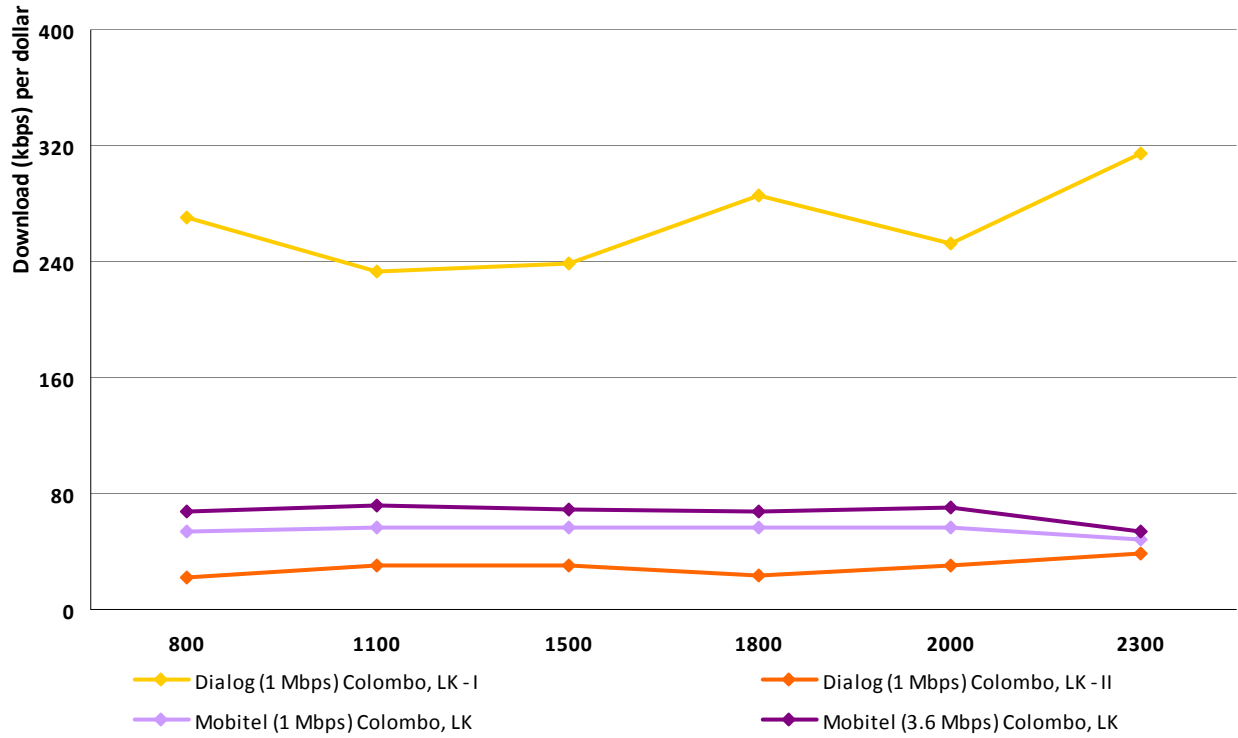
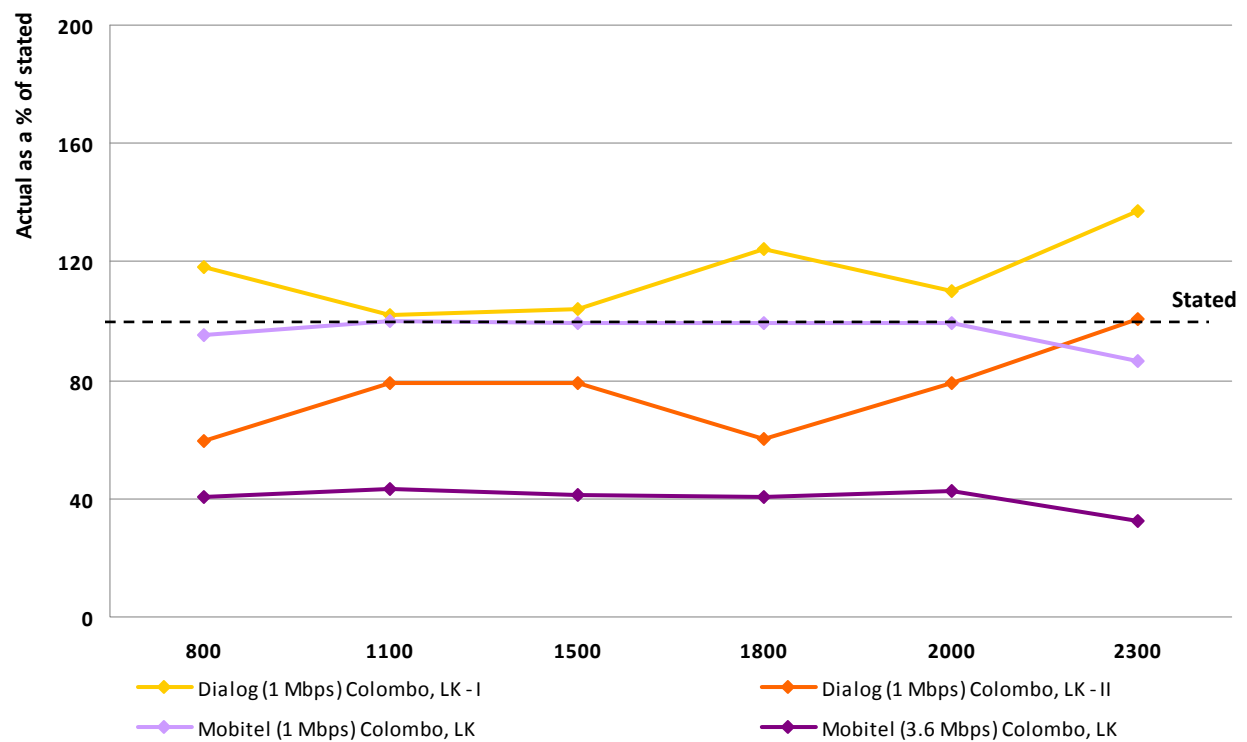


Figure 11 - Download from International (Delivery vs. Stated)



Mobile Broadband (Simulated testing) - Jitter<sup>xii</sup> and Packet Loss<sup>xiii</sup>  
 Figure 12 - Jitter when pinged to International

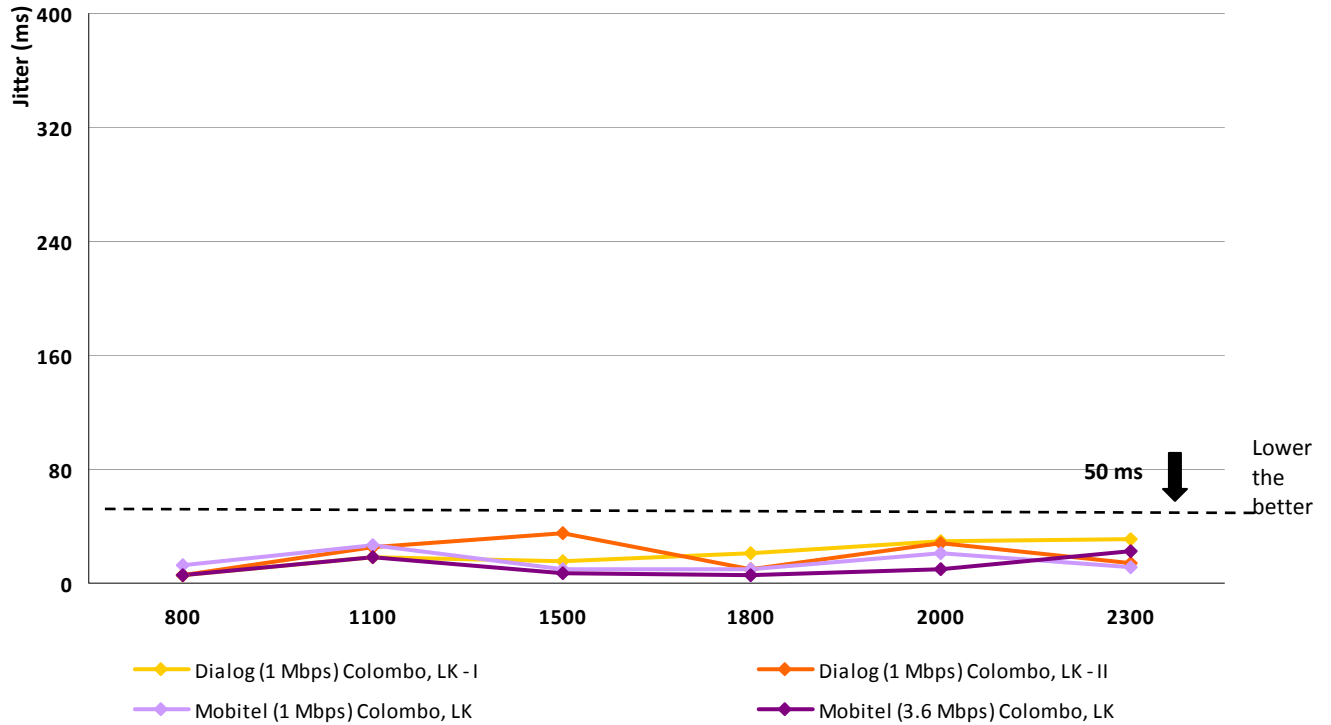
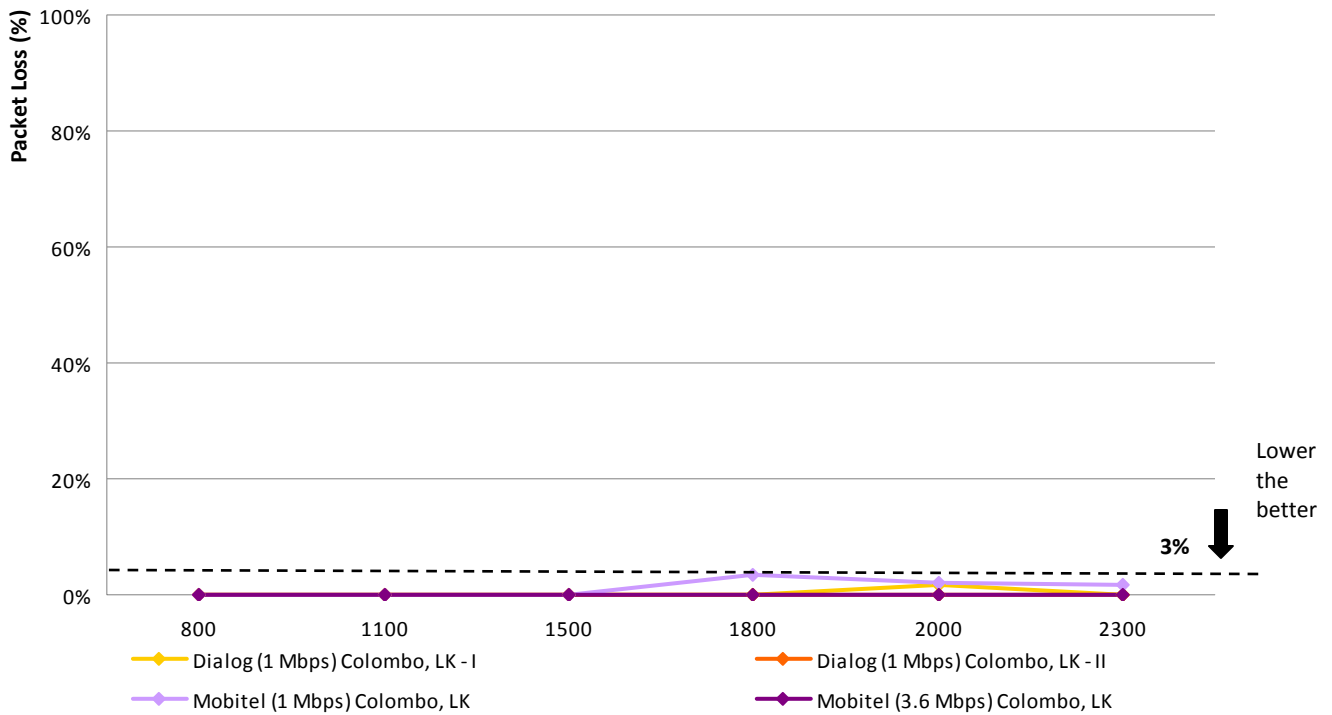
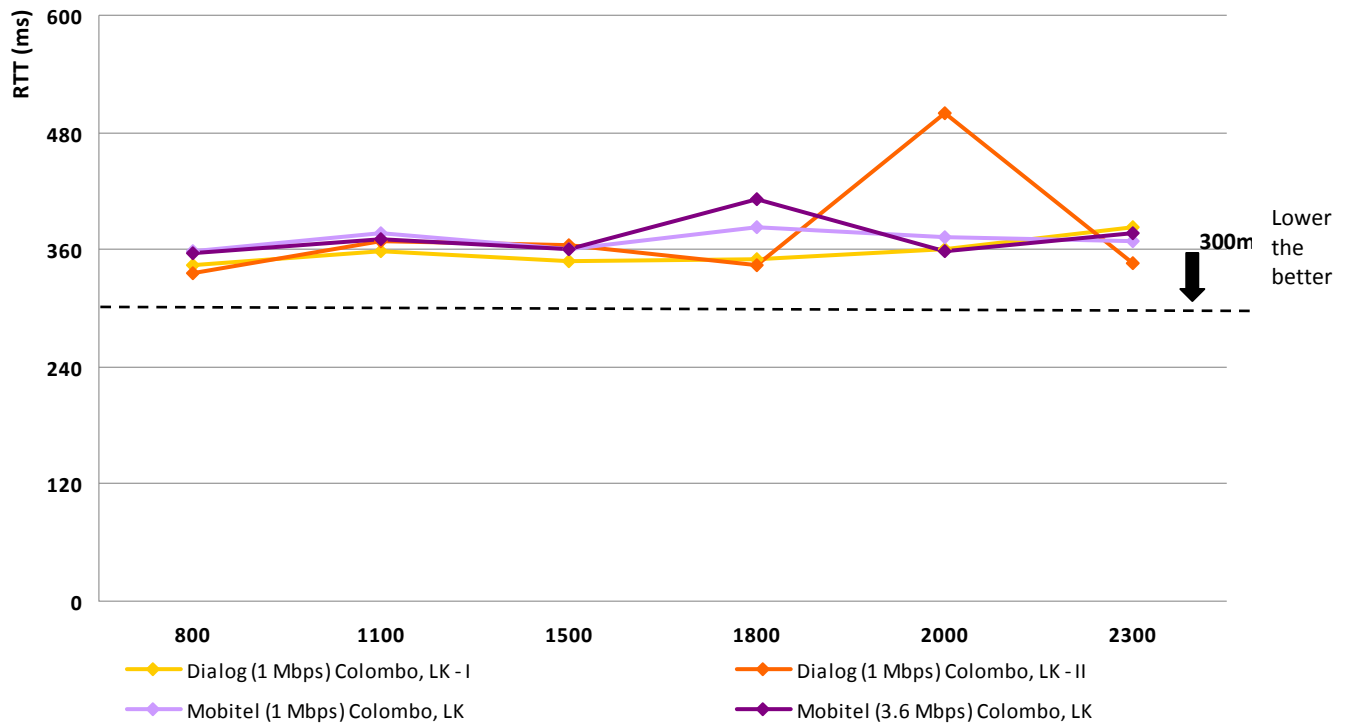


Figure 13 - Packet loss when pinged to International



Mobile Broadband (Simulated testing) - Latency<sup>xiv</sup>  
 Figure 14 - RTT when pinged to International



i <http://lireasia.net/projects/2008-2010/indicators-continued/benchmarks/>

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

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

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

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

vi The connections were tested on:

SLT 1Mbps (Colombo) tested on	: 08 Sep and 09 Sep 2009
SLT 2Mbps (Colombo) tested on	: 08 Sep, 09 Sep, 24 Sep and 25 Sep 2009
Dialog 2 Mbps (Colombo) tested on	: 08 Sep, 09 Sep, 24 Sep and 25 Sep 2009
BSNL 256 kbps (Bangalore) tested on	: 08 Sep and 09 Sep 2009
BSNL 1 Mbps (Bangalore) tested on	: 09 Sep and 10 Sep 2009
Airtel (256 kbps) Delhi, tested on	: 08 Sep and 09 Sep 2009
Airtel (1 Mbps) Delhi, tested on	: 09 Sep and 12 Sep 2009
Sirius 256 kbps (Dhaka) tested on	: 15 Sep and 18 Sep 2009
SKYbd 256 kbps (Dhaka) tested on	: 16Sep and 18 Sep 2009
Rogers 10 Mbps (Ottawa) tested on	: 07 Oct, 08 Oct, 09 Oct and 10 Oct
Bell 6 Mbprs (Ottawa) tested on	: 22 Sep to 25 Sep 2009
Comcast 6 Mbps (Denver) tested on	: 09 Aug and 10 Aug 2009
Verizon 3 Mbps (Buffalo) tested on	: 20 Jul and 21 Jul 09
Dialog 3G – 1 GB Limited (Colombo) tested on	: 09 Sep and 11 Sep 2009
Dialog 3G – Unlimted (Colombo) tested on	: 10 Sep and 11 Sep 2009
Mobitel 3G – 2GB Limit (Colombo) tested on	: 08 Sep and 09 Sep 2009
Mobitel 3.5G – 7GB Limit (Colombo) tested on	: 10 Sep and 11 Sep 2009

vii The speedsat which the subscriber can receive traffic from the ISP server and a commonly used International Server. (e.g. yahoo.com). It plays a significant role in responsiveness and real-time applications like VoIP.

viii Tariff of the packages are converted in to United State Dollars for comparison.

ix 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.

x 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.

xi Time taken for traffic to reach a particular destination.

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