Broadband Quality of Service

Prof. Timothy Gonsalves

Dept of Computer Science & Engg
TeNeT Group, IIT-Madras

tag@tenet.res.in

Overview

- The users
- The technologies
- The QoS metrics
- The evaluation methodology

The Next Billion

- Dense urban areas – 10,000 people/sq. km
- Sparse rural areas
  - Village every 3-10 km
  - Population 1,000-25,000
  - Within 25 km of fibre
  - 700 m in India
- ARPU today for 100m subscribers: Rs. 350 ($7)
- ARPU tomorrow for next billion: Rs. 100 ($2)

Broadband Defined

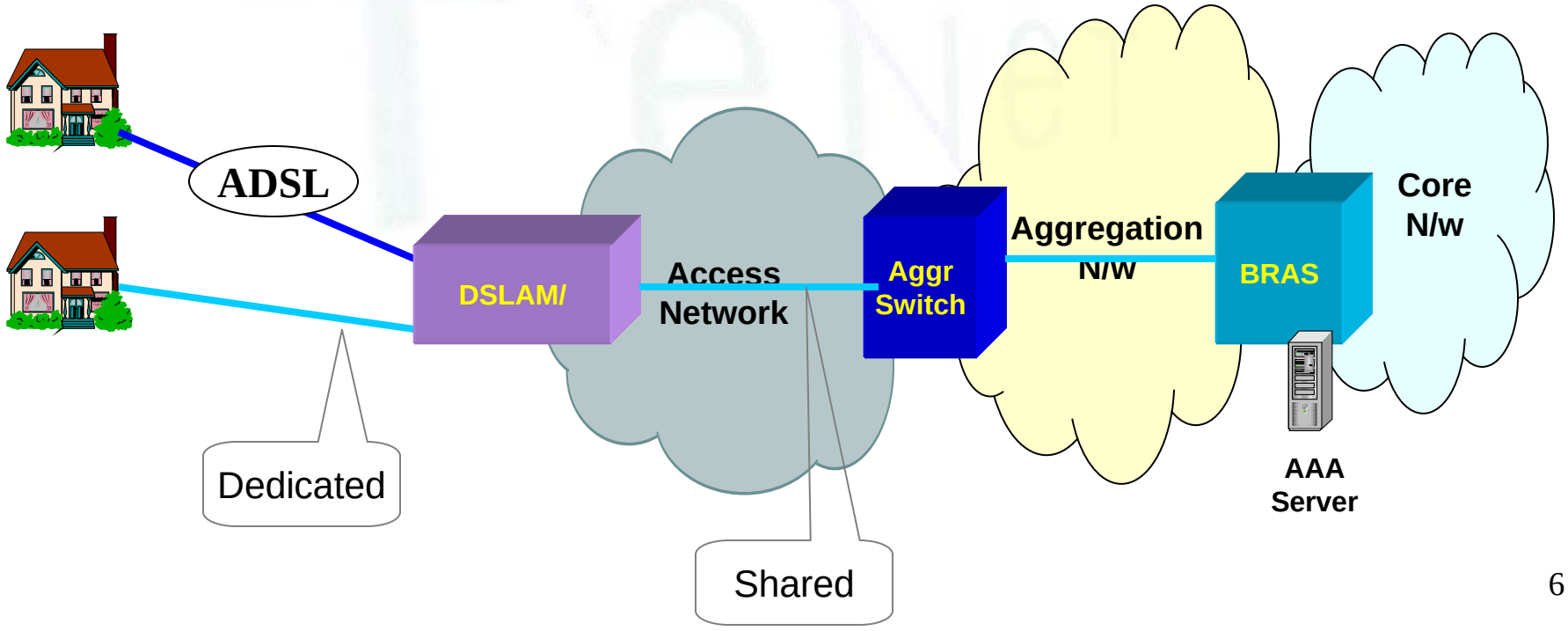
- ITU-T: 1.5 Mb/s
- TRAI: 256 kb/s
- Subscriber:
  Good experience with common services -- multi-media browsing, downloads, streaming media, VOIP, multi-player games
  Requires 256 kb/s - 1 Mb/s

Broadband Technologies

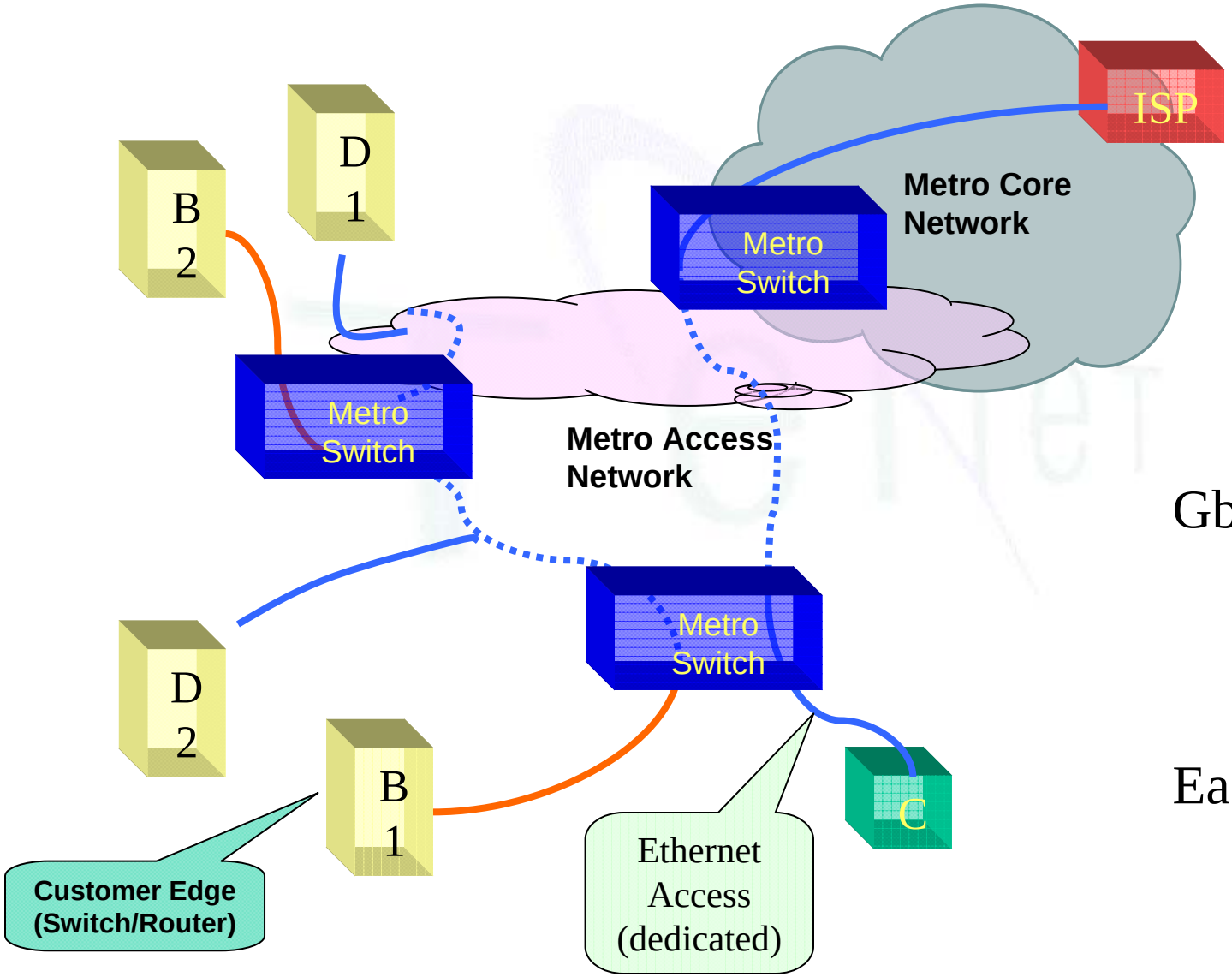
- ADSL over copper
- Metro-Ethernet
- Cable Internet
- Wireless: *urban or rural*
  - GSM
  - CDMA
  - DECT
  - WiMAX

ADSL

- Downstream 8-24 Mb/s, upstream 0.5-3.5 Mb/s max
- Bandwidth guaranteed only to DSLAM, thereafter depends on how operator configures the switches/BRAS/routers
- Good for incumbent operator with many wired subscribers



Metro Ethernet

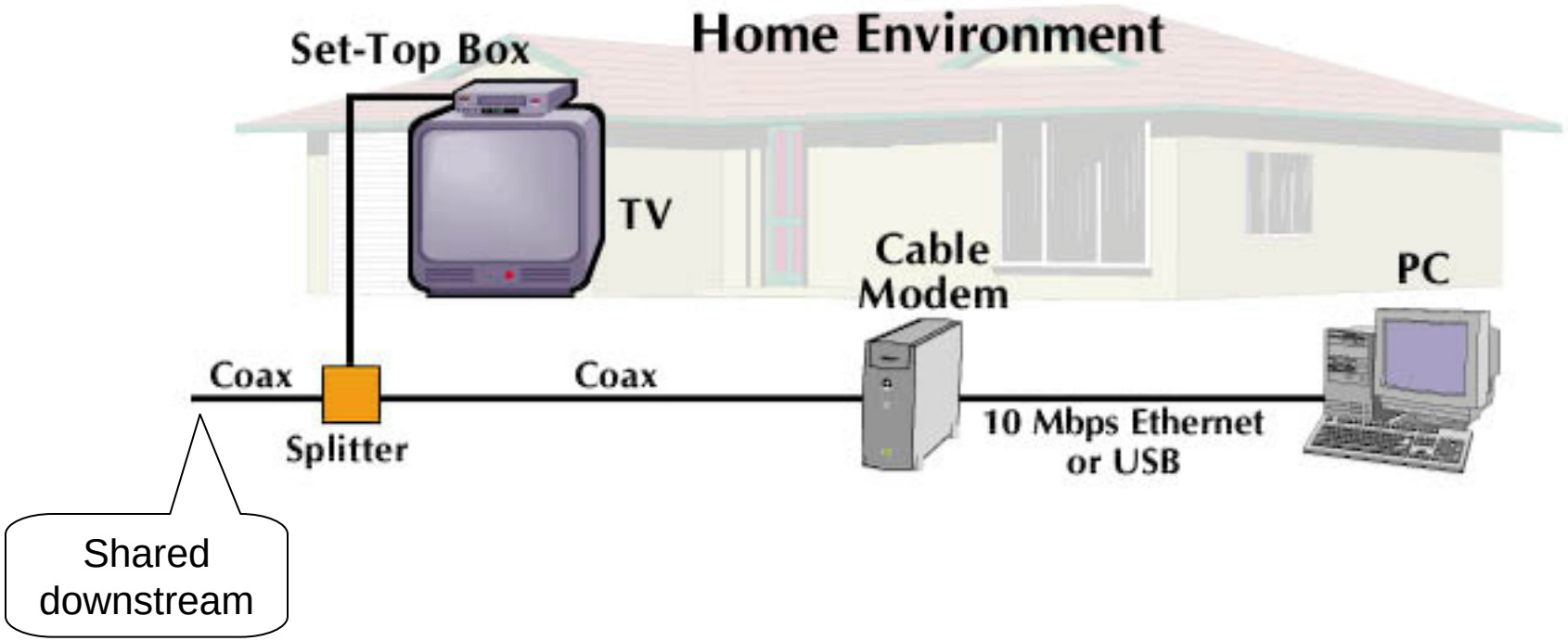


Gb/s fibre access with 100 Mb/s CAT-6 in the building

Easy provisioning of bandwidth limits

Cable Internet

- Downstream 40 Mb/s shared, upstream 384 kb/s
- Requires good quality cable infrastructure



… Cable Internet in India

- 60,000 CATV operators serving 60m homes
- $2-3/month
- Cable connection quality good for TV, not good enough for upstream digital

⇦Triple-play products from Midas provide 40 Mb/s downstream on poor quality coaxial plant:

- CITIUS: upstream on wireless corDECT – PC + TV
- CATIUS: upstream on Ethernet – PC + TV

Wireless

- GSM:
  - GPRS: 56-114 kb/s
  - EDGE: upto 236.8 kb/s
  - HSDPA: Theoretical downlink 14.4 Mb/s
    Deployed: 7.2 Mb/s
    Uplink 384 kb/s
- CDMA:
  - CDMA 1x: 144 kb/s
  - CDMA 3x: downlink 2.4-3.1 Mb/s, uplink 154 kb/s-1.8 Mb/s
    downlink minimum 38.4 kb/s

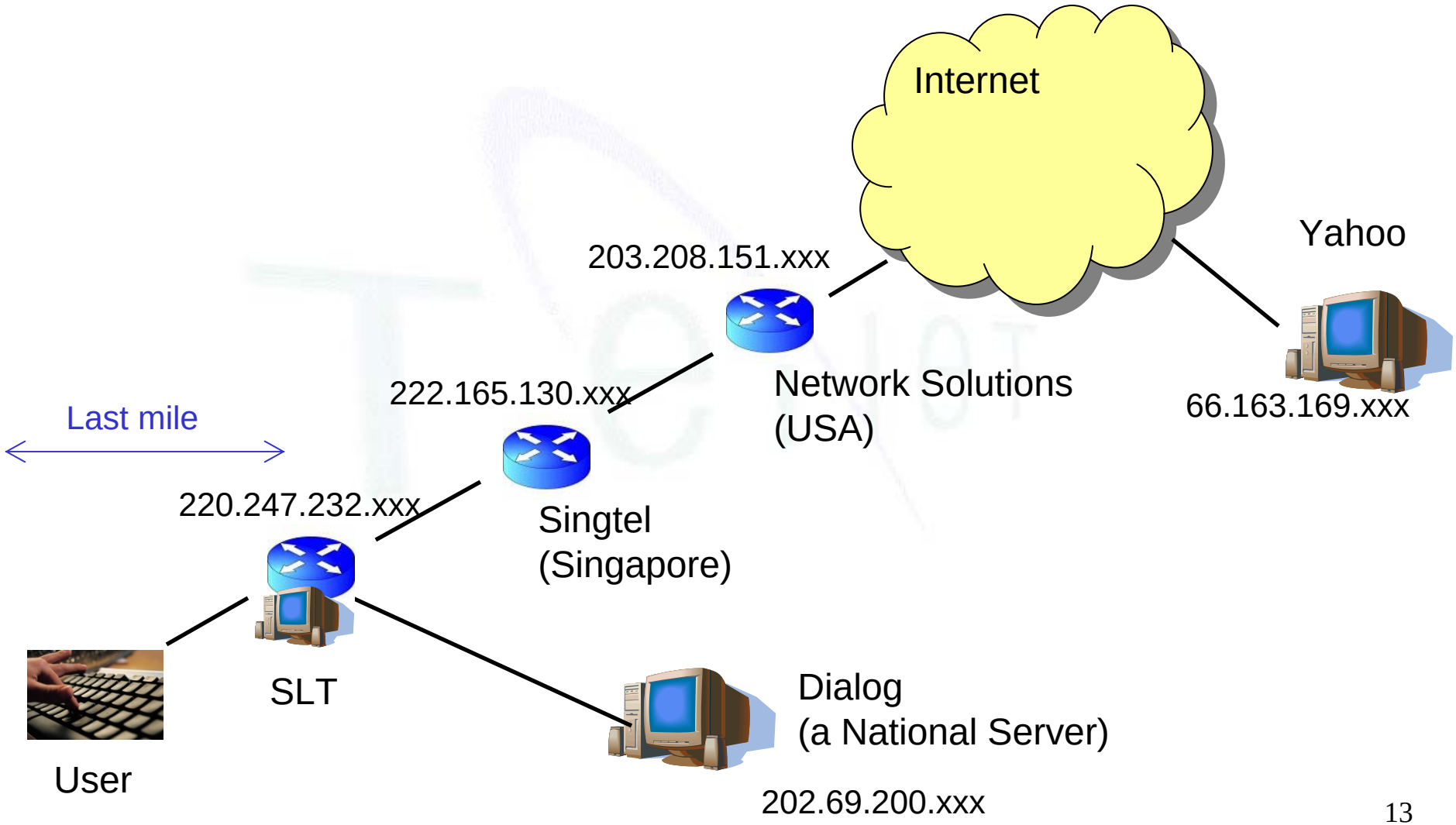
… Wireless

- DECT:
  - Broadband corDECT (Midas): 256-512 kb/s dedicated per subscriber plus toll-quality voice
- WiMAX:
  - 70 Mb/s shared downlink over short distances,
    10 Mb/s over 10 kms
    2 Mb/s over long distances

Test Methodology

- Uses multiple tools (BW monitor, ping, tracert)
- Measures 6 parameters
- Tests three servers (ISP, National, International)
- Repeated at different times of the day
- Repeated at weekdays and weekends
- Tests for long intervals to minimize effects of short term variations (eg. 100 pings, 100 sec download)
- Variations analysed and outliers removed

Network Diagram of a Test



Broadband QoS Metrics

1. Download throughput
2. Upload throughput
3. Round-trip delay (RTT)
4. Delay jitter
5. Packet loss
6. Availability of service

Jitter and Round Trip Time

- RTT: Time taken for a packet to reach the destination and return.
- Jitter: Variation in RTT

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

M = mean RTT, n=sample size , r_k = k^{th} RTT reading

- Measured by pinging n=100 packets to destination

Packet Loss and Availability

- Packet Loss = Number of packets (in %) which do not reach the destination (measured by pinging)
- Availability = 1 – Prob[Service unavailable for >30 sec]

Relevance of Metrics

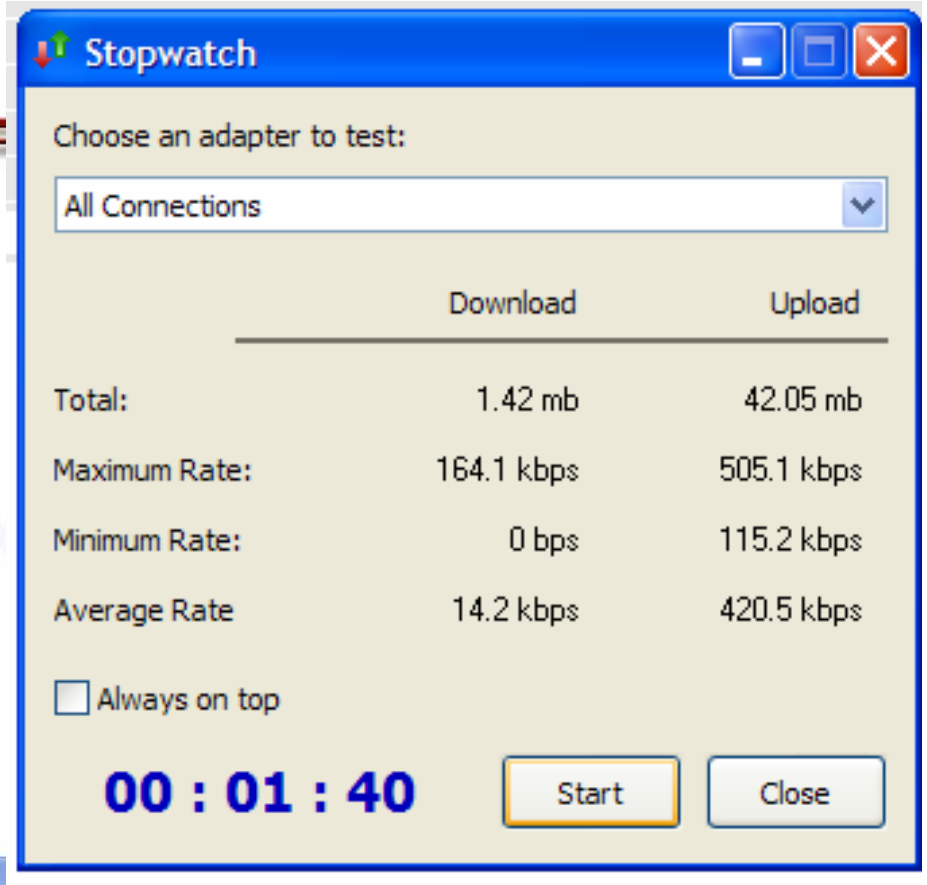
	Throughput		*Delay*		
Service	*Down*	*Up*	*RTT*	*Jitter*	*Loss*
Browse (text)	++	-	++	-	-
Browse (media)	+++	-	+	+	+
Download file	+++	-	-	-	-
Transactions	-	-	++	+	-
Streaming media	+++	-	+	++	++
VOIP	+	+	+++	+++	+++
Games	+	+	+++	++	++

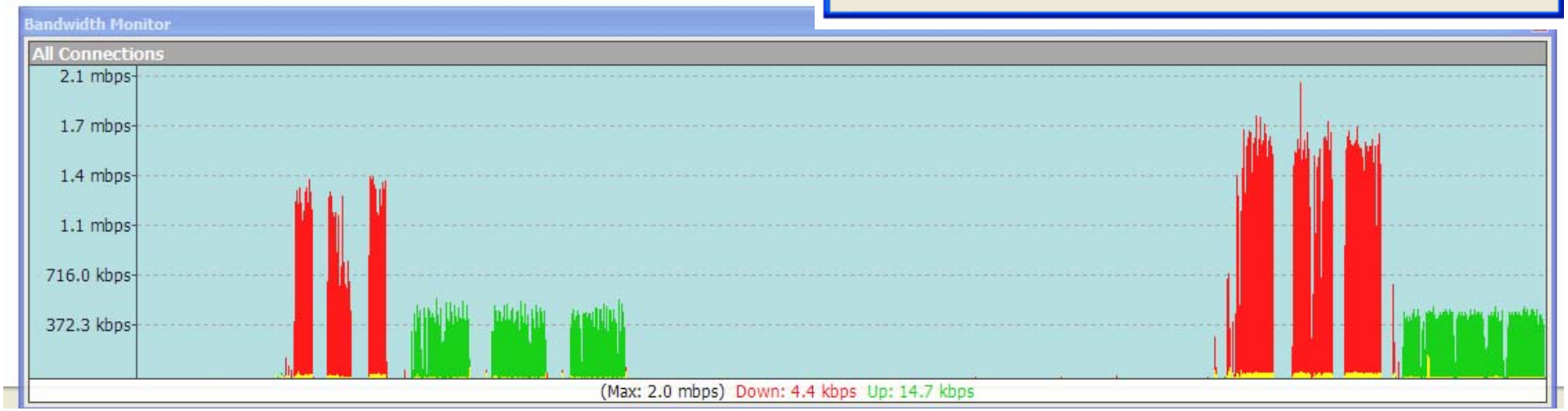
+++ highly relevant, ++ very relevant, + relevant, - not relevant

Test tools

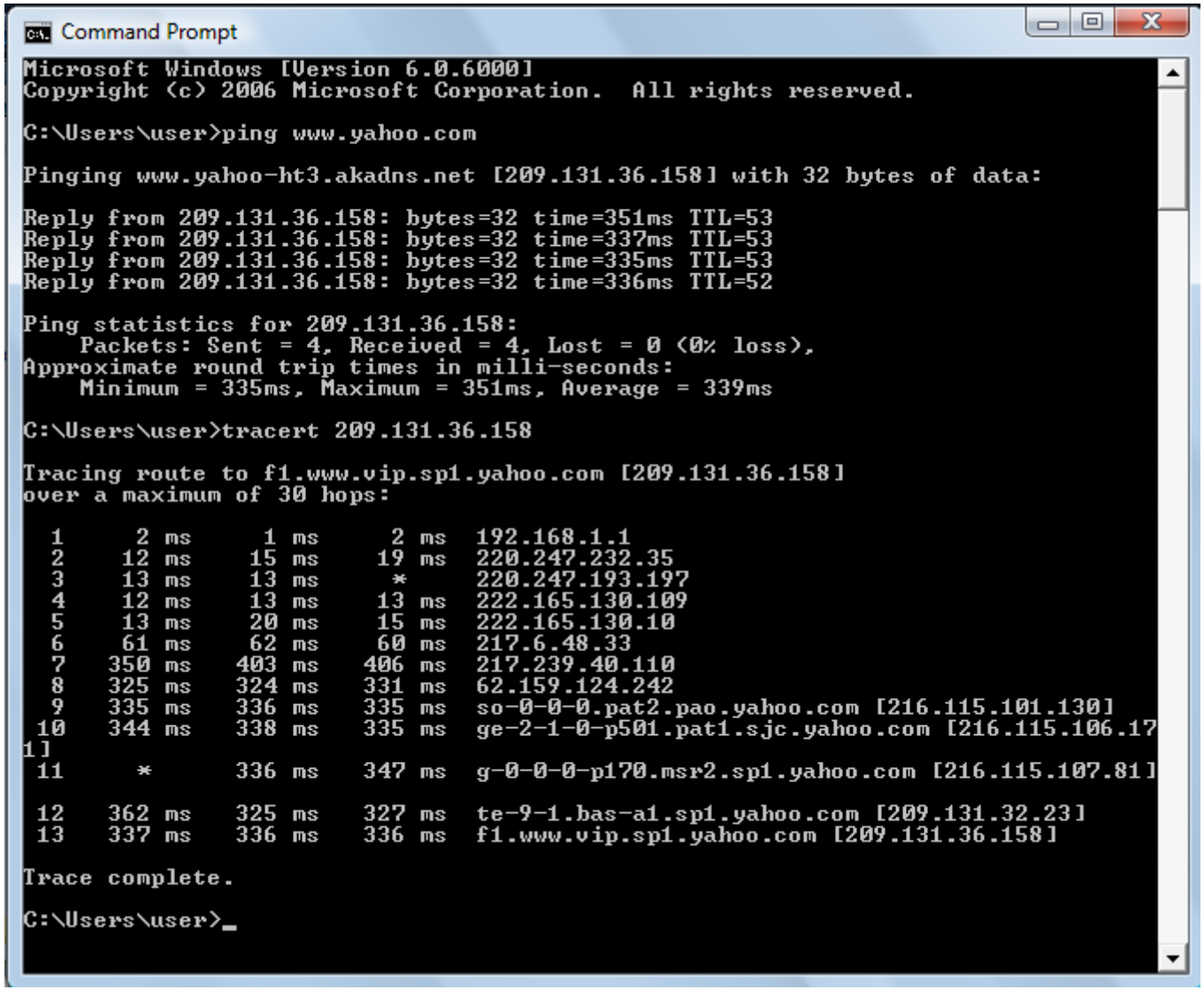
Download/upload speeds:

Measured using BWMonitor while downloading ~ 5 MB file (~100 secs)





Test tools: ping/tracert



Test Timings

- 08:00 hrs: Lean period
- 11:30 hrs: Peak Business hours
- 15:00 hrs: Peak business hours
- 18:00 hrs: Shift from business to residential usage
- 20:30 hrs: Early residential users
- 22:30 hrs: Late residential users

Conclusions

- Several broadband technologies for 256k-70m
  - Wired -- urban
  - Wireless -- urban and rural
- Tremendous potential for subscriber growth
  - Cost of service and QoS are key
- Six service-oriented objective measures for QoS
- Test methodology to minimize bias and error

Links

- TeNeT Group of IIT-M -- http://www.tenet.res.in
- Broadband corDECT, Cable Internet products -- http://www.midascomm.com
- Articles on various broadband technologies -- http://en.wikipedia.org
- Broadband QoS study -- http://www.lirneasia.net/projects/current-projects/2241/
- Broadband testing partner: Nilgiri Networks -- http://www.nilgirinetworks.in

Email: tag@tenet.res.in