

South Asian Broadband (BB) Service Quality: Diagnosing bottlenecks

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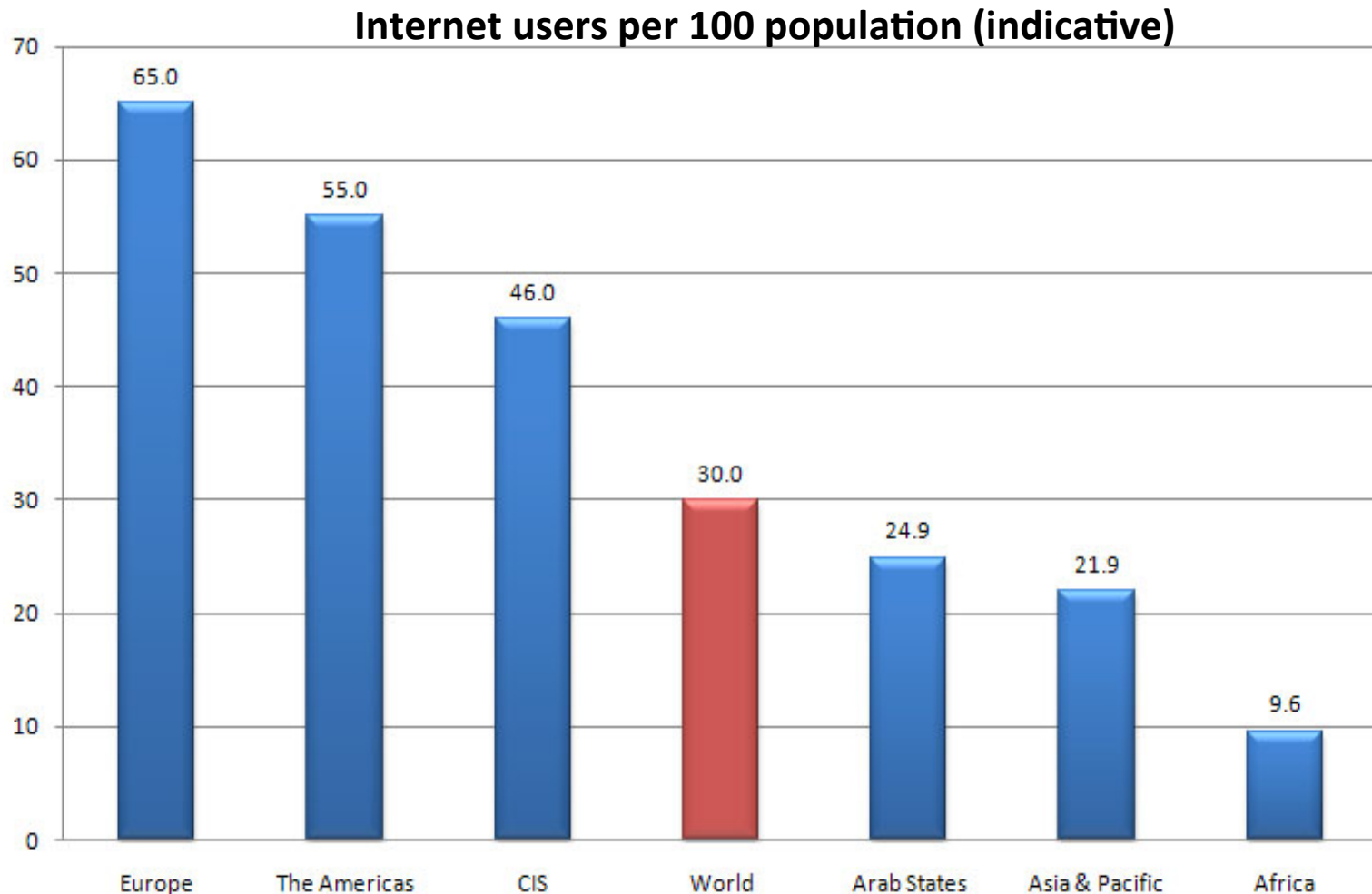
CPRafrica, Nairobi, Kenya

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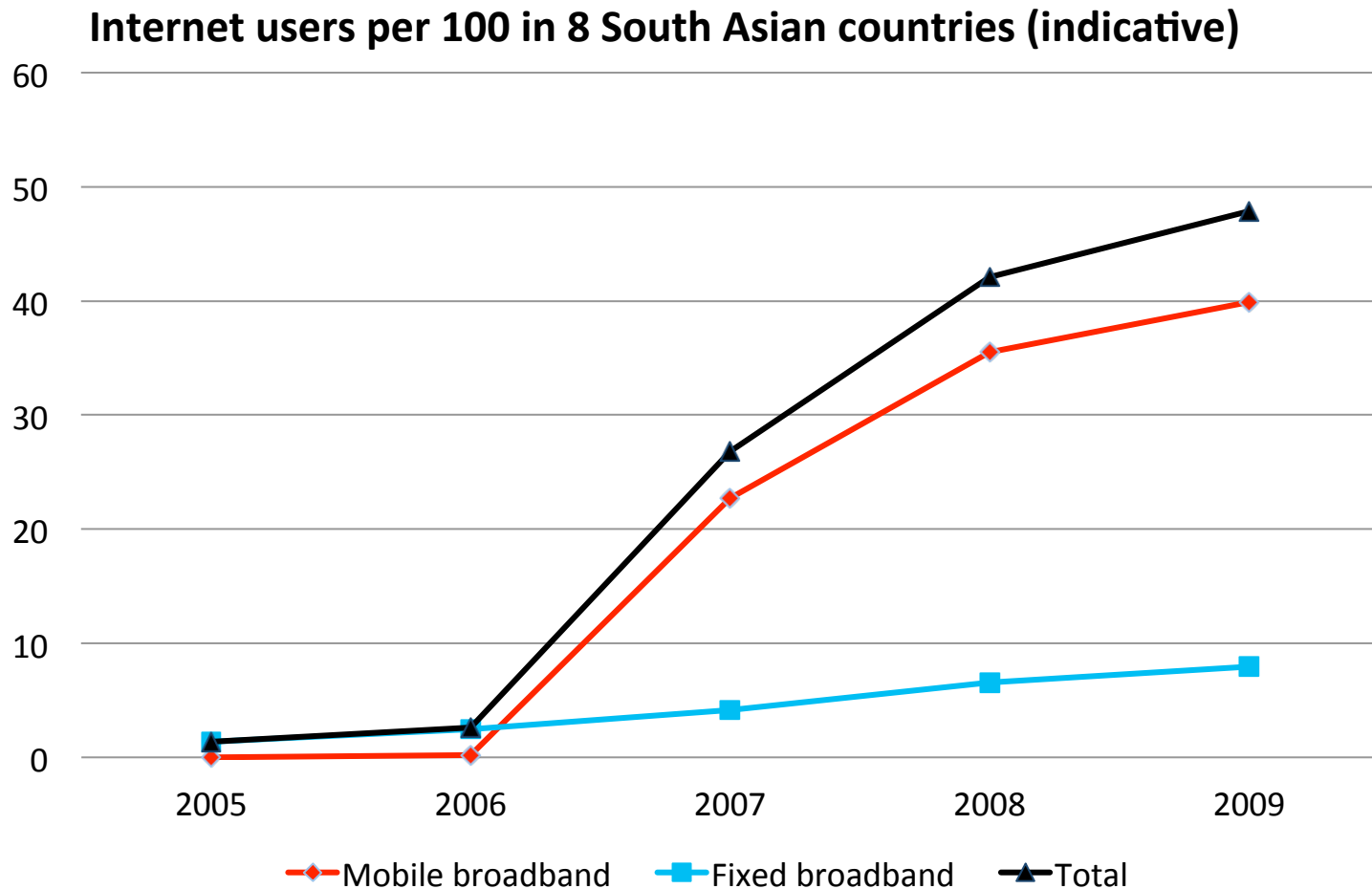
BB penetration in Asia still lags behind developed world



Source: ITU

Note: problems with counting users vs. subscriptions and problems with counting mobile BB subscriptions and other issues mean exact data is impossible. Estimation is possible. ITU relies on methodologies used by individual countries.

But South Asian BB use is growing, thanks to internet access through mobiles



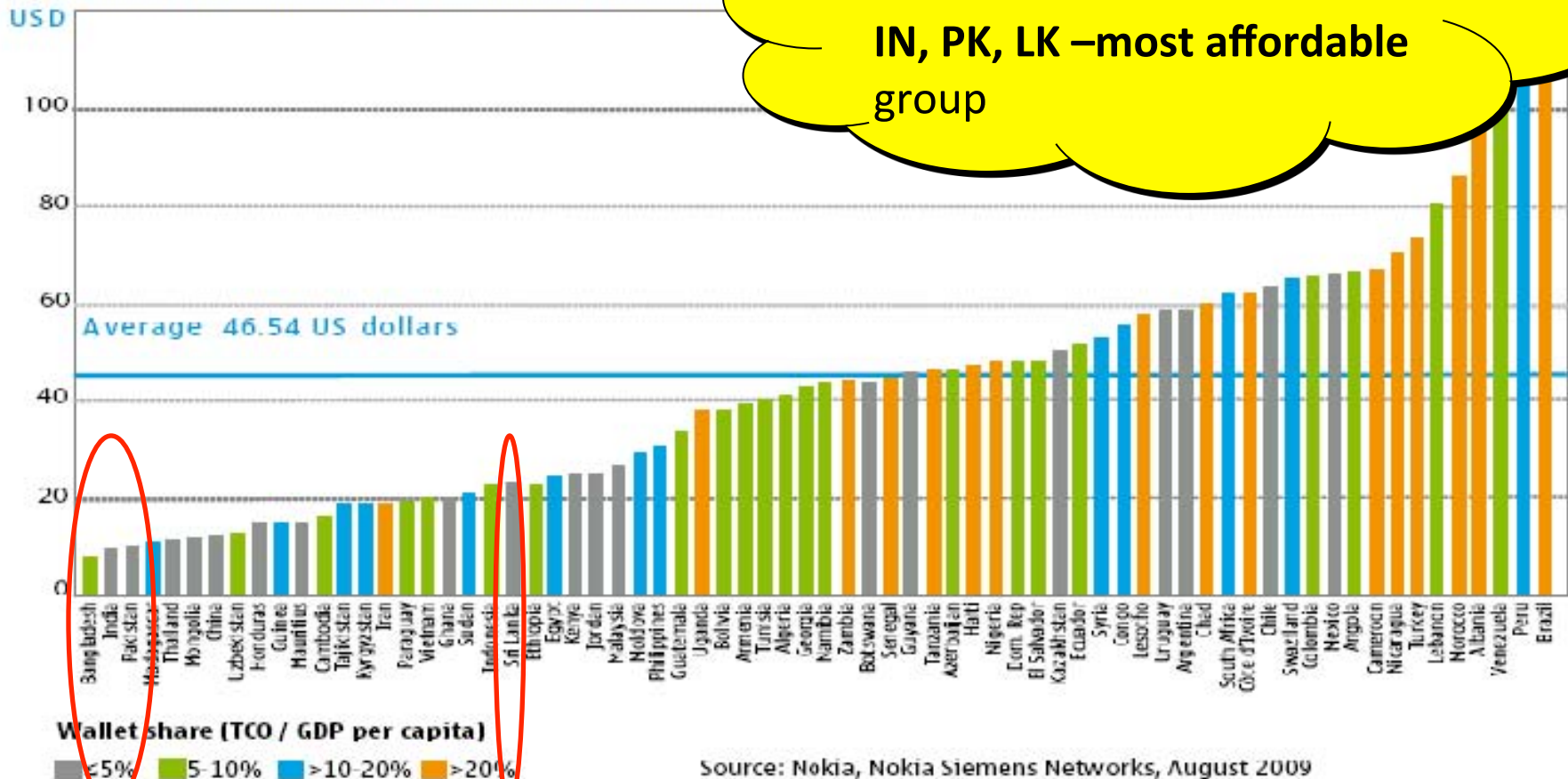
Source: ITU

Note: 1) South Asian countries are India, Bangladesh, Pakistan, Afghanistan, Sri Lanka, Nepal, Bhutan, Maldives.

2) Problems of counting users as acknowledged in previous slide

S. Asian mobile data and voice services are cheap and affordable

Monthly mobile data TCO by country



BD, IN, PK – Cheapest among all countries
IN, PK, LK – most affordable group

Source: Nokia, Nokia Siemens Networks, August 2009

In voice markets, high connectivity & low prices have come at a price: lower quality

- Lowering of network and other OpEx
 - Infrastructure sharing
 - Electronic top-ups
 - Outsourced network management
 - Pre-paid (no bills, no credit risk)
- Stimulation of demand
 - pre-paid (vs. post-paid): for people with variable income
 - Small re-charge values: for people on low income
- Result
 - Low per min. price + many users → EXTREMELY loaded networks → lower call quality
 - “double up” on each channel/frequency

Hypothesis: this (low quality problem) exists in BB data markets also

Reasonable hypothesis to form..

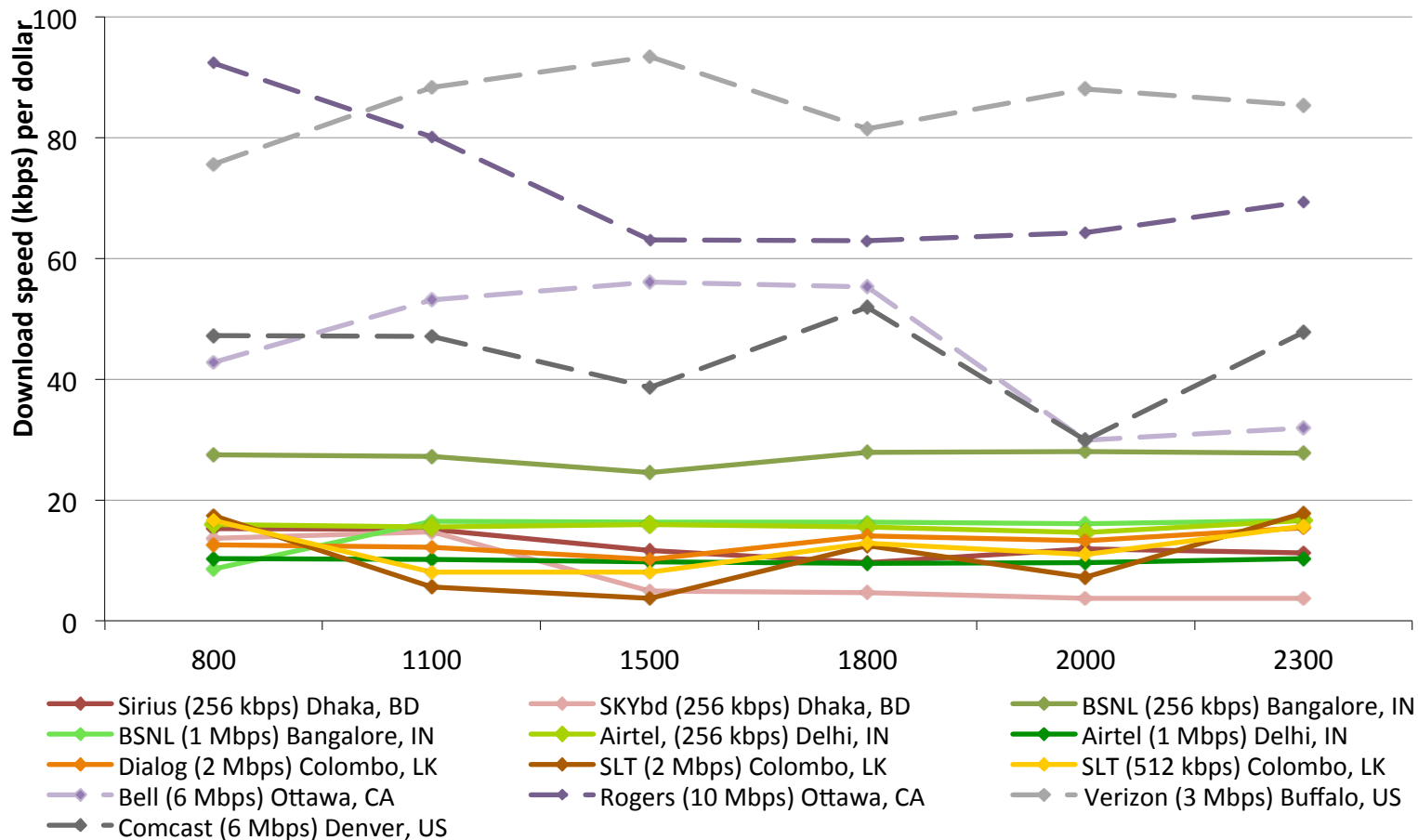
- Personal experience, Small sample group/peer group experience (on fixed and mobile BB)
- “Noise” in media (about fixed and mobile BB)
- Reasoning: if problem exists with mobile voice business model, it would exist in mobile data (same networks, same operators, same business model for increasing adoption and lowering prices)

Developing Methodology for testing hypothesis (measuring QoSE)

- Indicators that measure BB QoSE
 - Upload speed, download speed, round trip time, packet loss, jitter
- Measured multiple times a day (peak, off-peak)
- Measured multiple times (to leave out outliers)
- Measured in multiple locations in a city and country
- Averages reported on www.broadbandasia.info (software also available for free)
- [Details in Gonsalves, T. A. (2009)]

Results: S. Asian users get lower value for money than North American users

Download speeds (kbps) per dollar from International Server

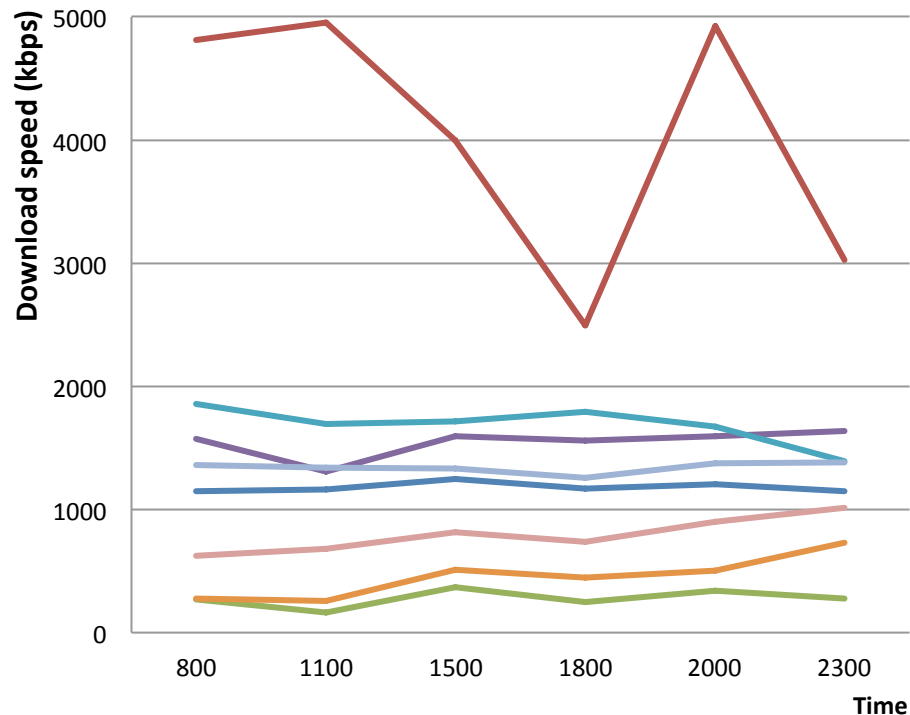


Where are the bottlenecks (i.e. where does QoS deteriorate most)?

- Methodology (and software) enables testing performance in different parts of the network
 - ISP domain (uploading/downloading data hosted on users own ISP)
 - National domain (data hosted in-country, but on a different ISP from that of user)
 - International domain (in another country – the USA in our testing)

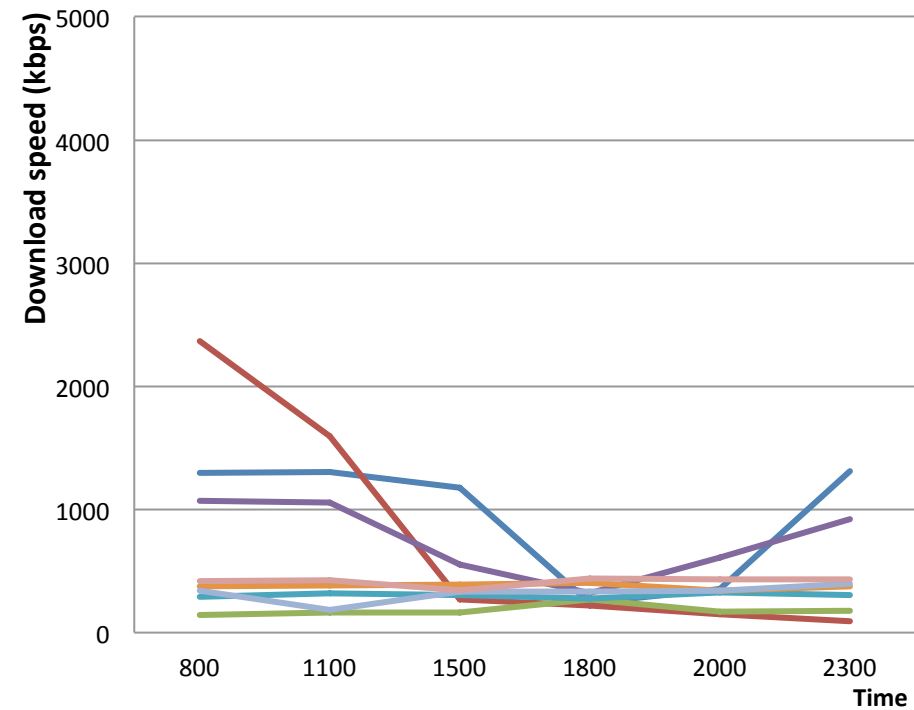
Results: Indian users get lower speeds when downloading international content

India - Download from ISP server



- Airtel (512 kbps) Bangalore, IN
- Airtel (512 kbps) Chennai, IN
- Airtel (2 Mbps) Mumbai, IN
- Airtel (512 kbps) New Delhi, IN
- BSNL (512 kbps) Bangalore, IN
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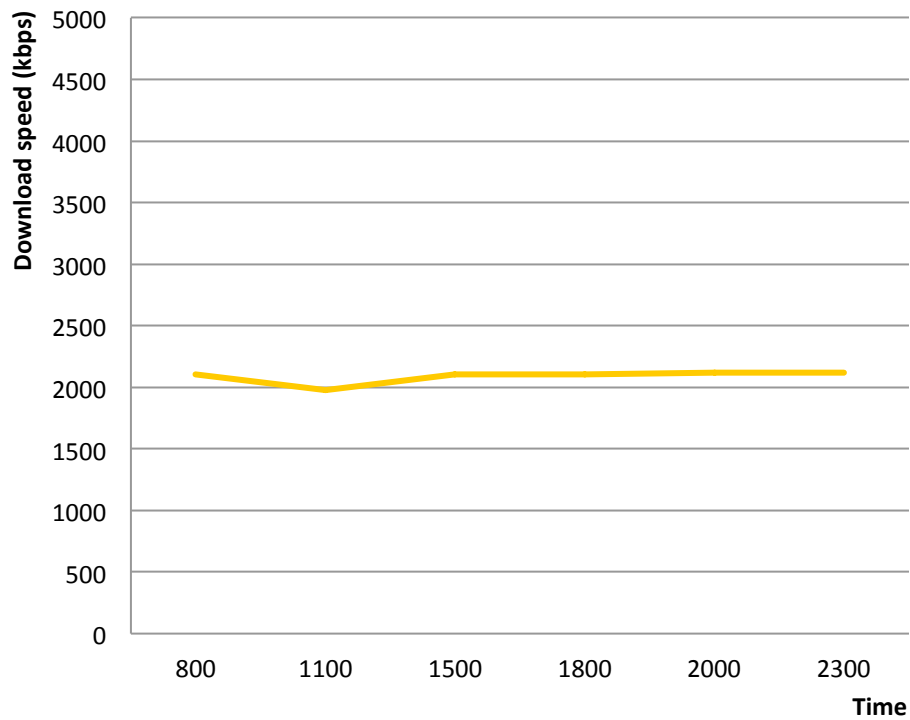
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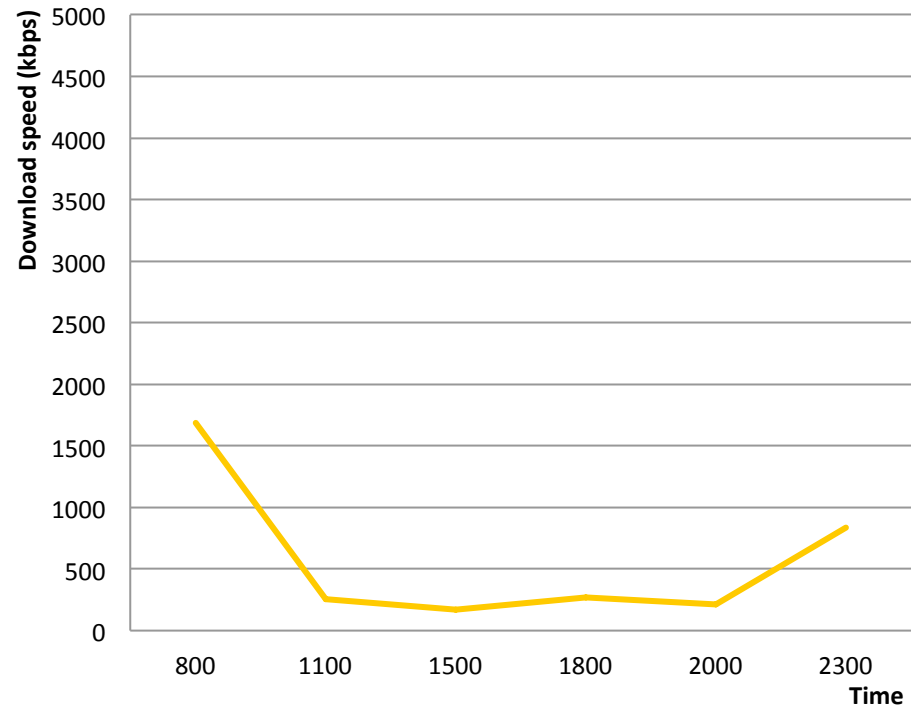
...as do Sri Lankan users

Sri Lanka - Download from ISP server



— SLT (2 Mbps) Colombo, LK

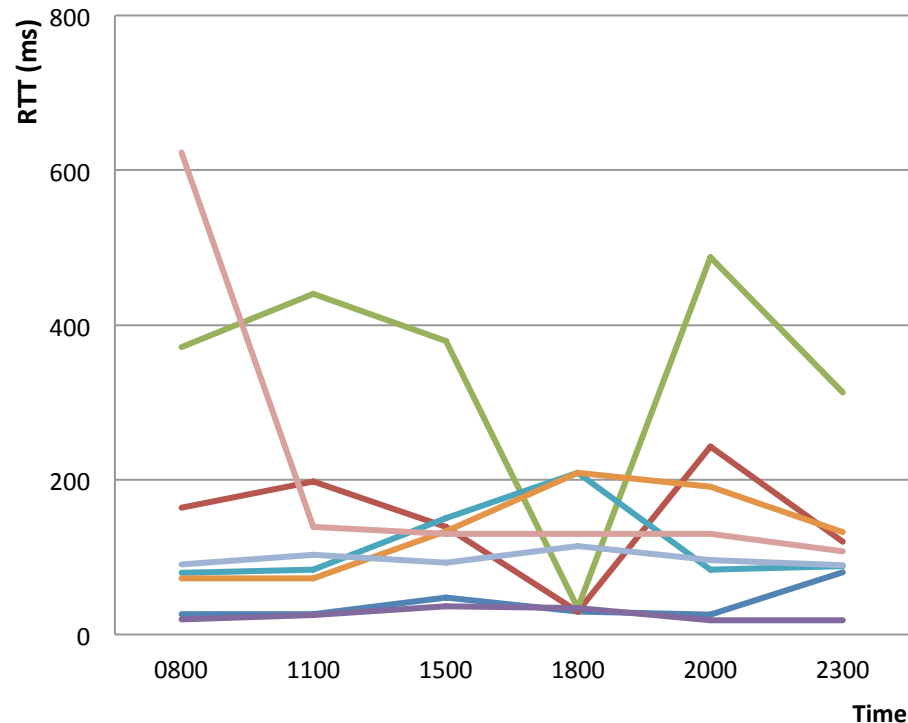
Sri Lanka - Download from International server



— SLT (2 Mbps) Colombo, LK

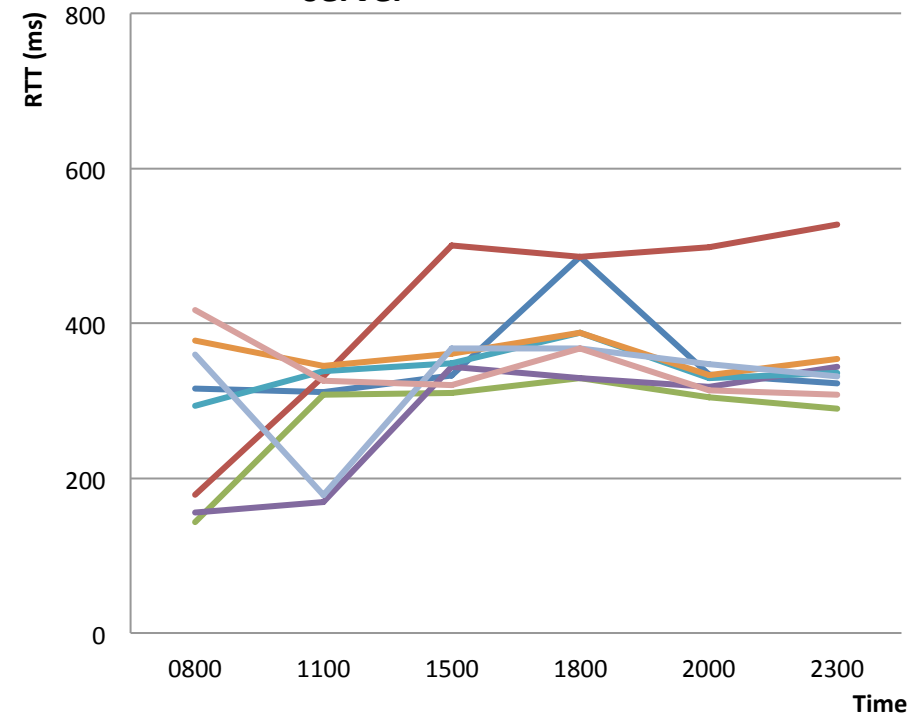
Round trip time deteriorates (increases) also when going international from India ..

India - RTT when pinged to ISP server



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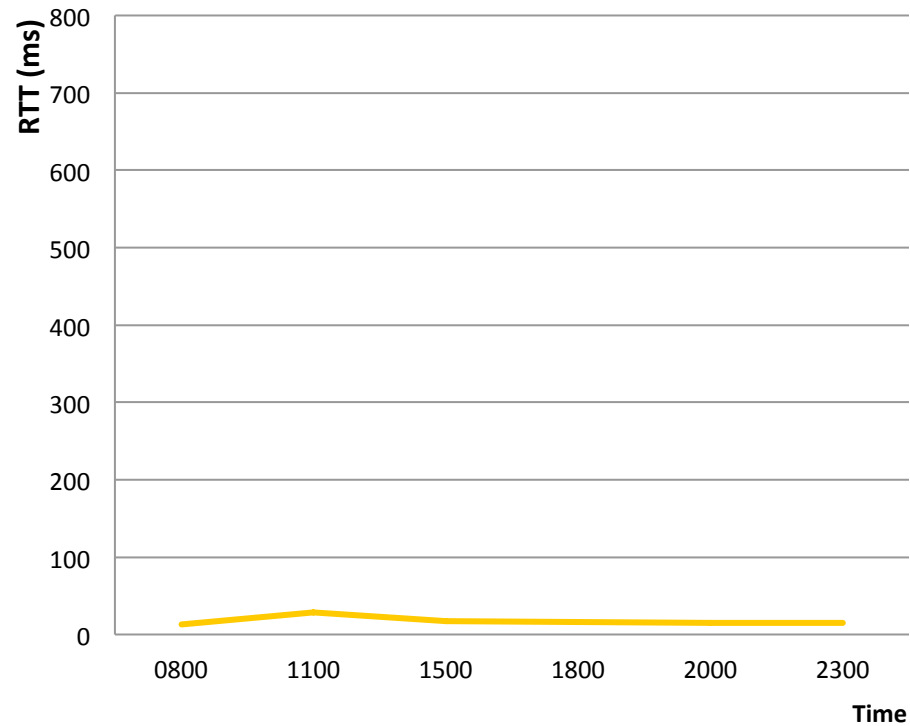
India - RTT when pinged to International server



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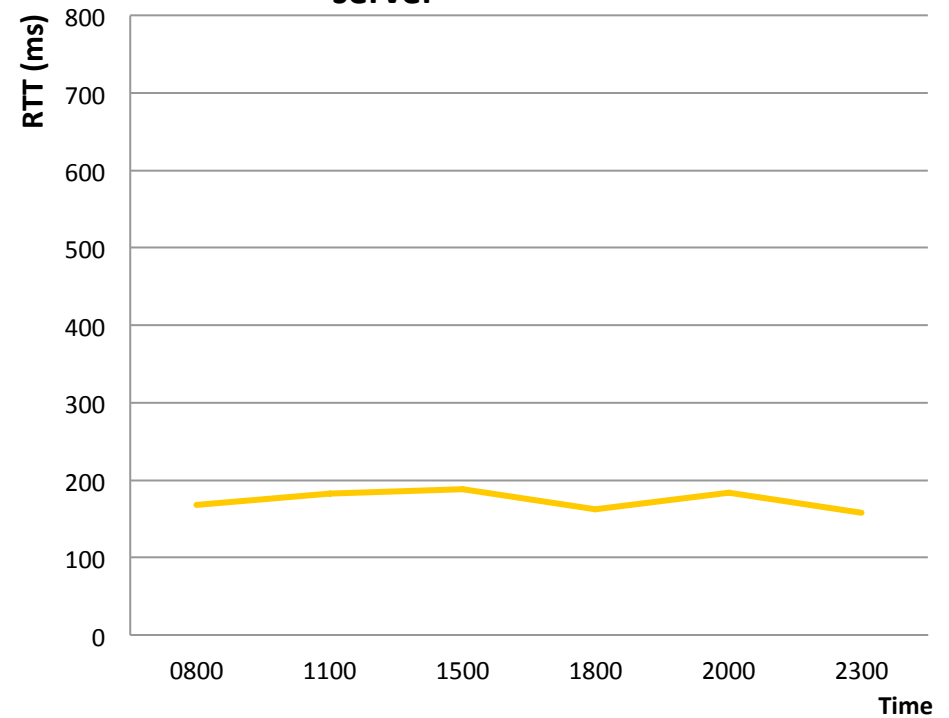
....and from Sri Lanka

Sri Lanka - RTT when pinged to ISP server



— SLT (2 Mbps) Colombo, LK

Sri Lanka - RTT when pinged to International server



— SLT (2 Mbps) Colombo, LK

**Why is international
bandwidth a bottleneck?**

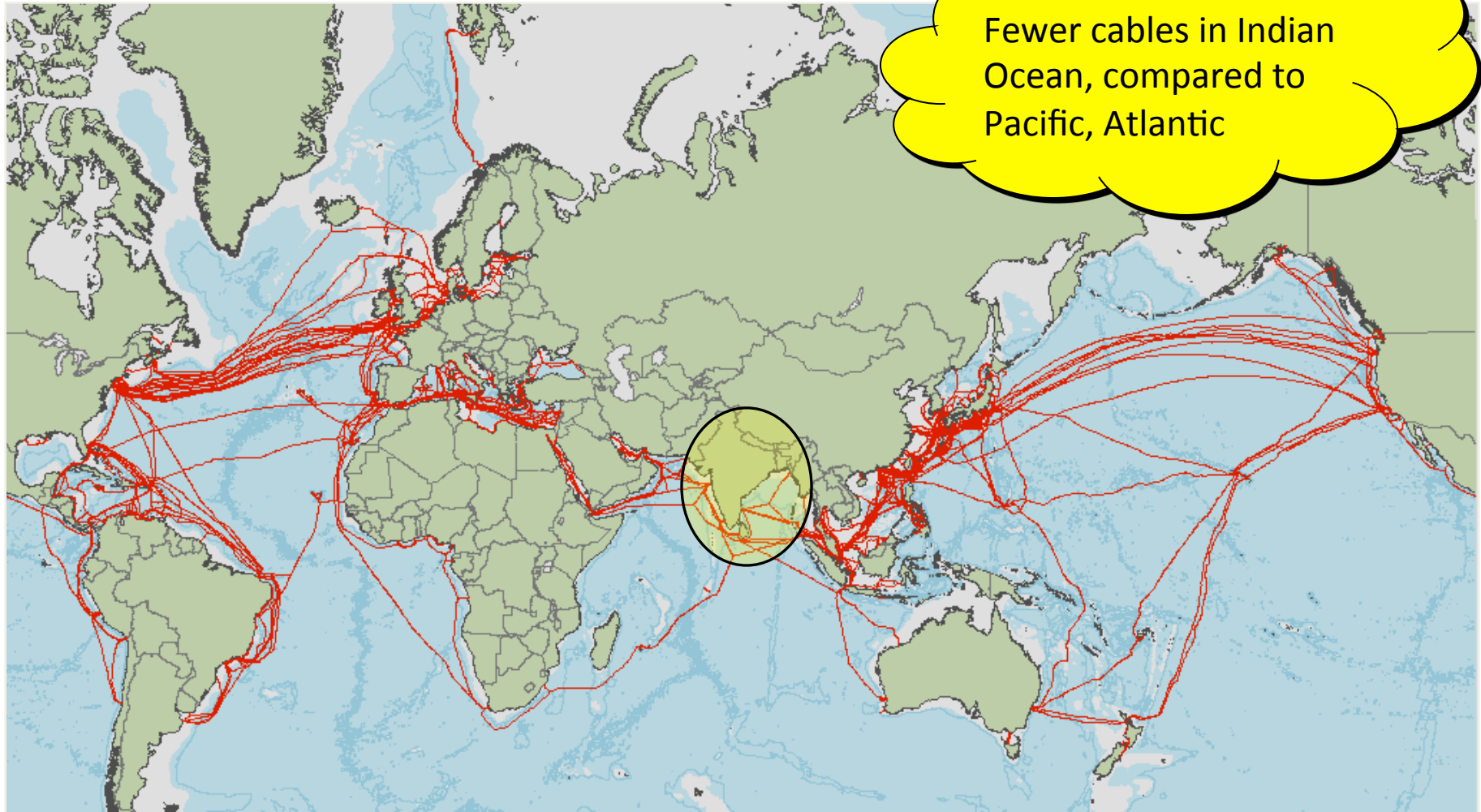
High demand for international bandwidth from the region....

- Demand increase (business/wholesale) – booming BPO business
 - Indian IT/BPO hubs (Hyderabad, Bangalore)
 - Sri Lanka
 - Offshoring by American, British firms
- Demand increase (retail) – many new users coming online, mostly via mobile devices (already shown).
- Demand increase (retail) due to majority of accessed content being hosted internationally

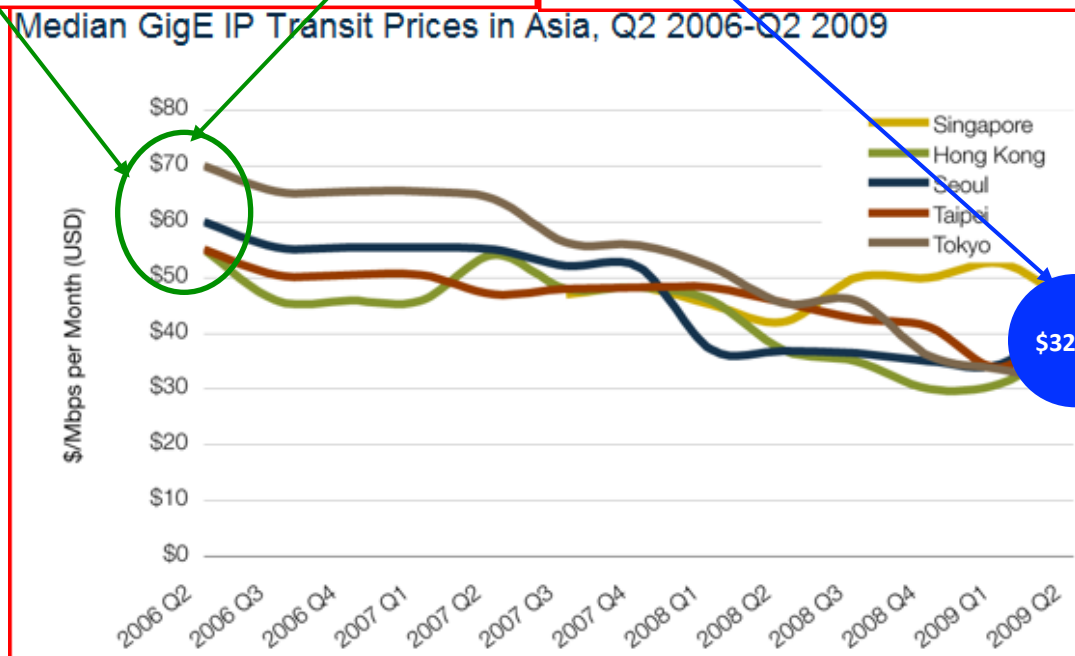
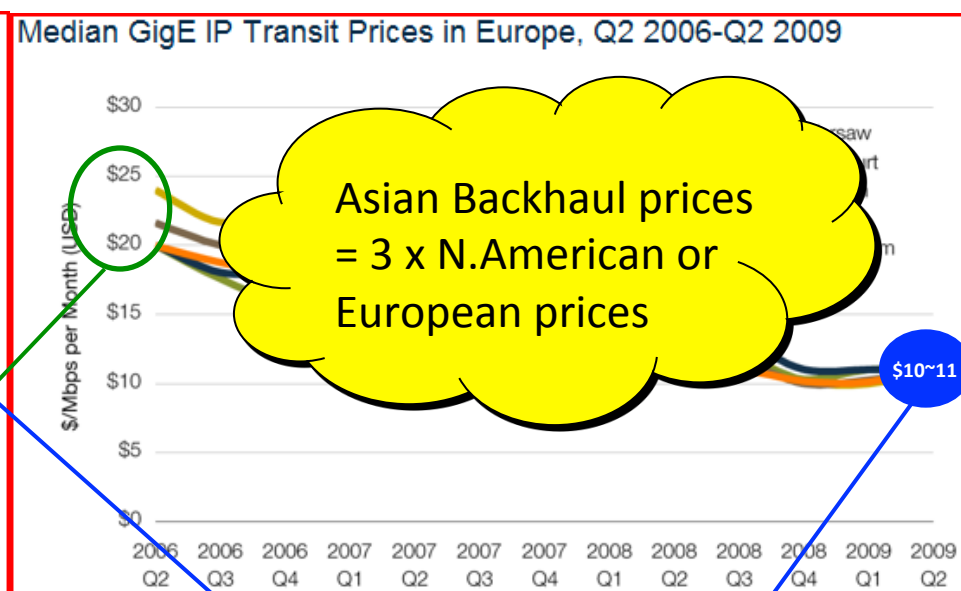
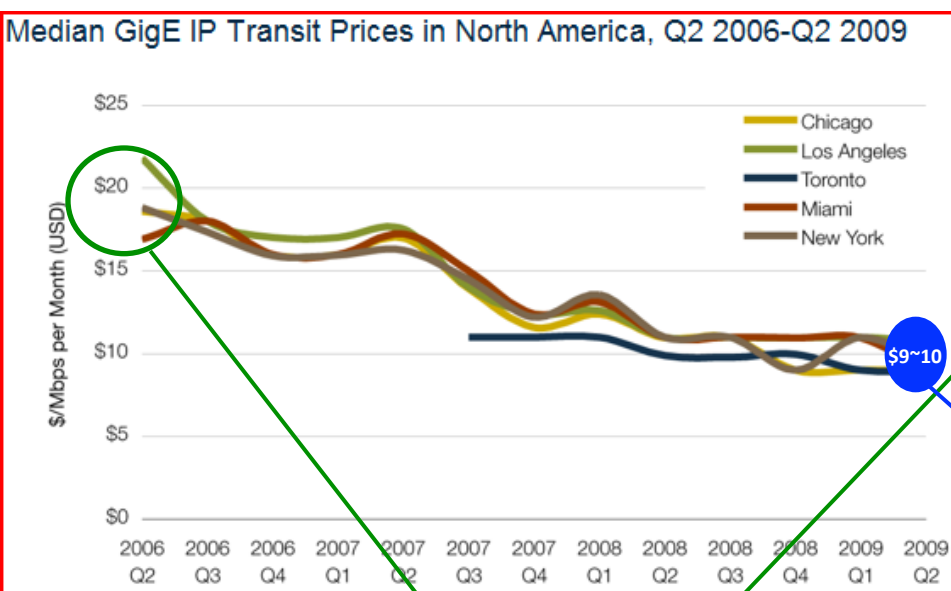
Top 10 sites accessed by users in April 2011 by country (Source: www.alexa.com).

Rank	Sri Lanka	India	Pakistan	Bangladesh
1	Google (google.lk)	Google India (google.co.in)	Google (google.com.pk)	Google (google.com)
2	Facebook (facebook.com)	Google (google.com)	Google (google.com)	Facebook (facebook.com)
3	Google (google.com)	Facebook (facebook.com)	Facebook (facebook.com)	Yahoo! (yahoo.com)
4	YouTube (youtube.com)	Yahoo! (yahoo.com)	YouTube (youtube.com)	B l o g g e r . c o m (blogspot.com)
5	Yahoo! (yahoo.com)	YouTube (youtube.com)	Yahoo! (yahoo.com)	YouTube (youtube.com)
6	B l o g g e r . c o m (blogspot.com)	B l o g g e r . c o m (blogspot.com)	B l o g g e r . c o m (blogspot.com)	Google (google.com.bd)
7	Espncricinfo.com	Wikipedia (Wikipedia.org)	Windows Live (live.com)	Espncricinfo.com
8	W i k i p e d i a (Wikipedia.com)	Twitter (twitter.com)	Wikipedia (Wikipedia.com)	oDesk (odesk.com)
9	Gossip Lanka News (gossiplankanews.com)	Rediff.com India Ltd. (rediff.com)	Twitter (twitter.com)	Prothom Alo (prothom- alo.com)
10	ElaKiri.com	Orkut.co.in	Espncricinfo.com	W i k i p e d i a (Wikipedia.com)

**...combined with low supply of int'l
bandwidth to the region**



Resulting in prices that are higher than others



Source: TeleGeography

Solution: increase supply of int'l bandwidth. But this is NOT simple nor quick

- Coordination costs of getting int'l undersea cable
 - Many partners involved/needed
 - Different incentives
 - Long lead-times

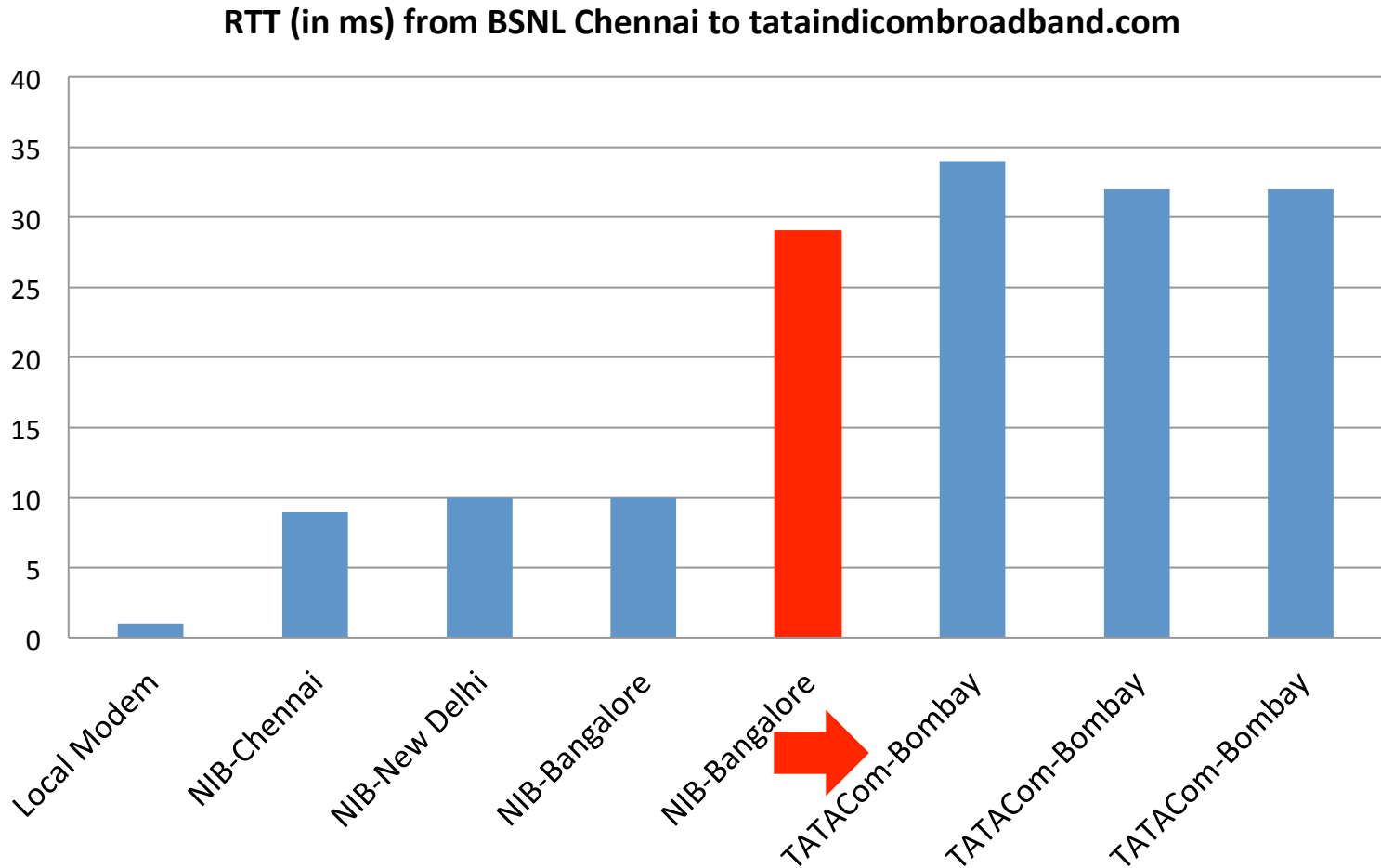
Interim solution: Limit demand for international bandwidth?

- Increasing locally hosted content
 - Takes time
 - Local hosting costs have to drop, quality/reliability has to increase
 - May not be possible in politically charged environments
- Local mirroring of foreign content/servers
- Local peering: keep local traffic local

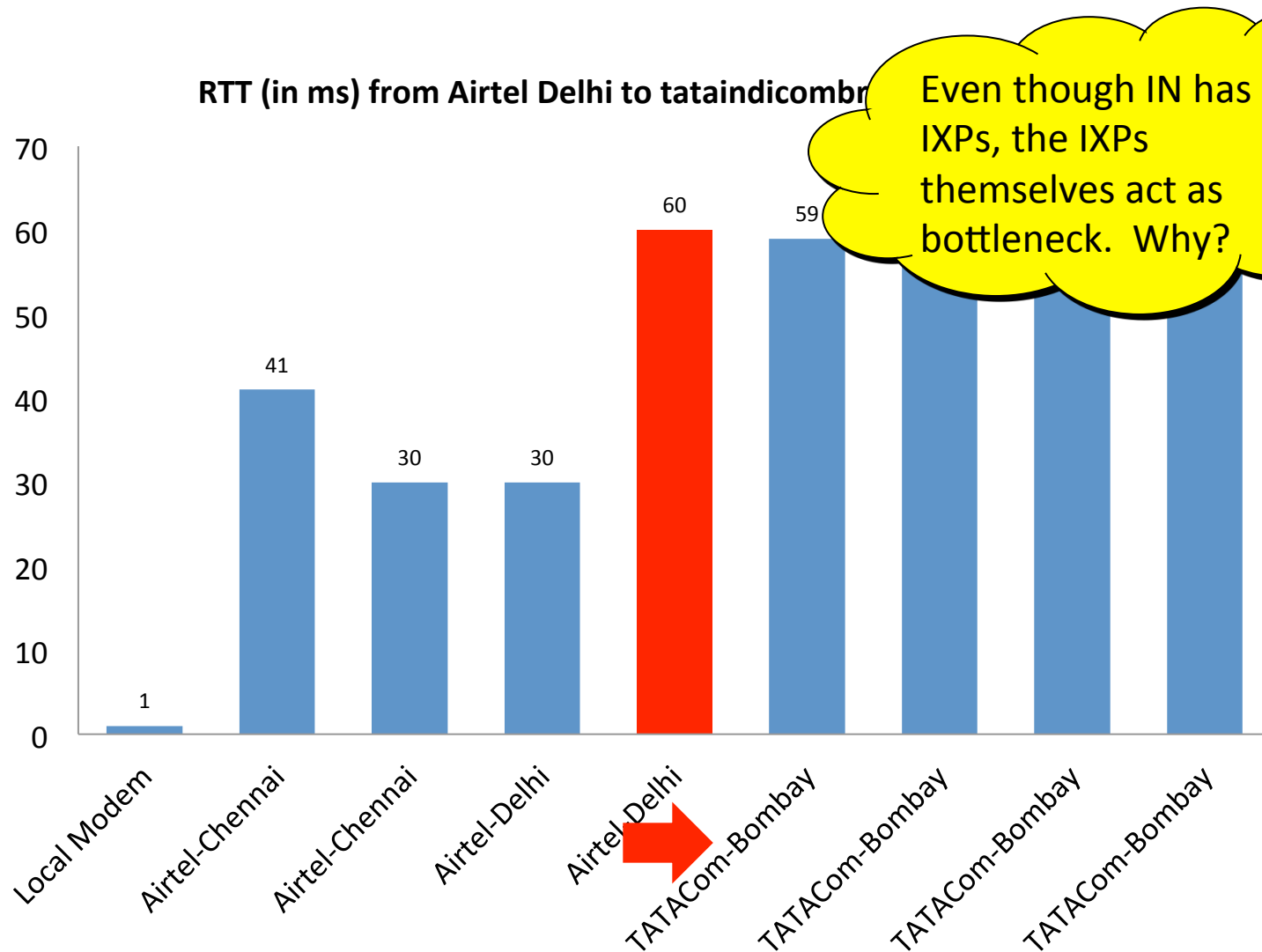
Country-level IXPs/NAPs keep local traffic local

- NAP/IXPs: where 2 or more networks exchange traffic
- Successful IXPs work as non-for-profit entities, established by operators
 - Perverse incentives (sp. Incumbent)
- Feb 2011: 80 countries have an IXP; 158 don't
 - IN, PK, BD had; others didn't
- IXP will keep in-country traffic in country
 - Reduce demand for int'l bandwidth

But IXPs can act as a bottleneck, according to our test results from Chennai, India



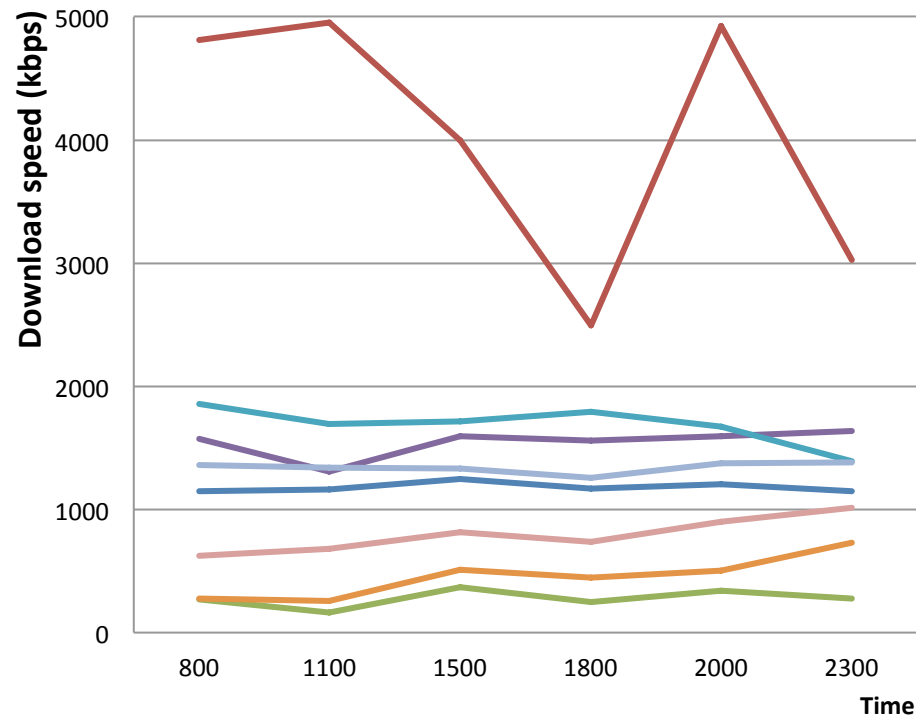
...and Delhi, India



Even though IN has 7+ IXPs, the IXPs themselves act as bottleneck. Why?

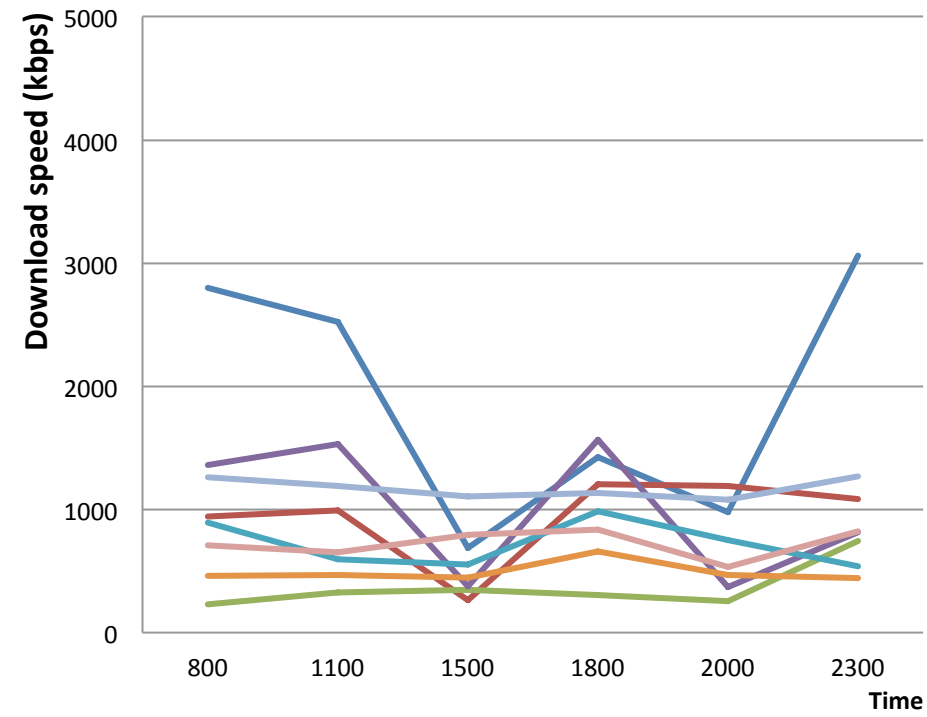
Download Speed also shows same trend in India..

India - Download from ISP server



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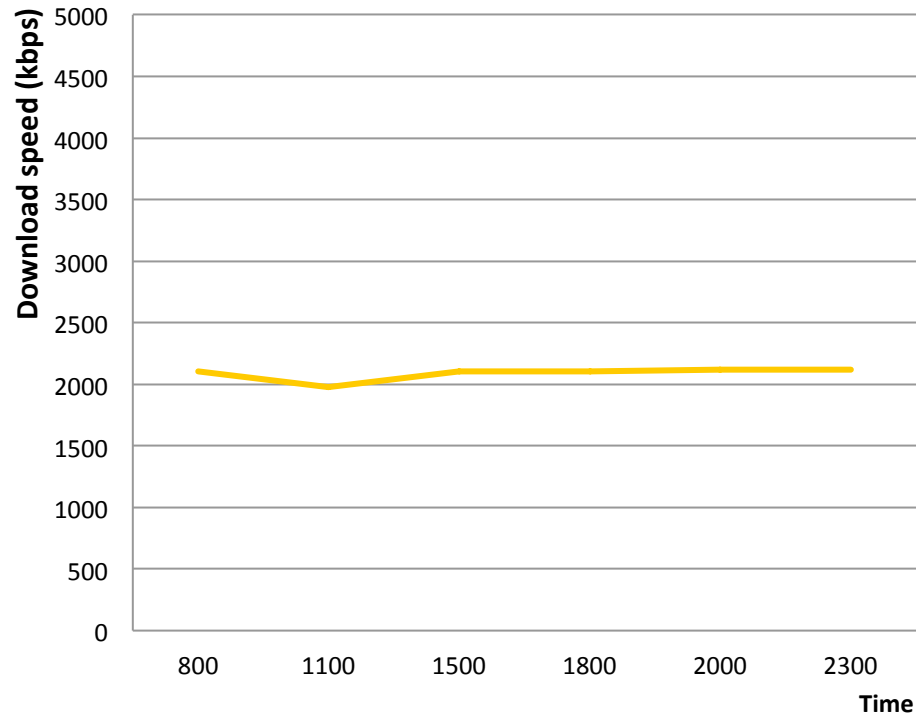
India - Download from National server



- Airtel (512 kbps) Bangalore, IN
- Airtel (512 kbps) Chennai, IN
- Airtel (2 Mbps) Mumbai, IN
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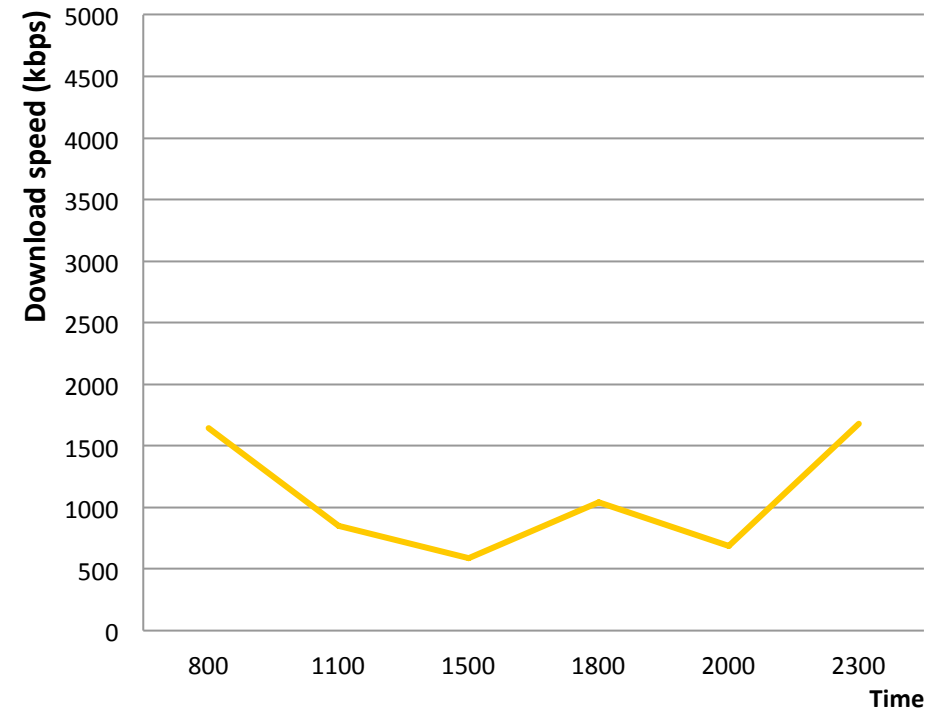
...and in Sri Lanka

Sri Lanka - Download from ISP server



— SLT (2 Mbps) Colombo, LK

Sri Lanka - Download from National server



— SLT (2 Mbps) Colombo, LK

Summary: 2 bottlenecks identified

- International bandwidth is a real bottleneck in South Asian consumers experiencing good broadband performance
- But supply side solutions are long term
 - Coordination costs, long lead time
- Demand Side solutions: mirroring, local hosting
 - Not always possible (democracy? Other reasons)
- IXPs can help limit demand for int'l bandwidth
 - But IXPs or NAPs can act as a bottleneck also (for reasons as yet undiagnosed)

Future work and questions.

- Question: Hang this WHICH literature?
 - Basic economics of regulation?
 - “Exit, Voice & Loyalty” (Hirschman, 1970) etc.
- Future: Why is IXP a bottleneck?
 - Technical reasons?
 - Incentives (dominant operator dis-incentives, etc)
 - Institutional design issues (IXP is non-profit? Vs. third party provider? Vs. Regulator operated?)

Without local peering, all traffic gets peered outside. Consumes valuable resources

- User user1@networkA.xy emailing user2@networkB.xy (same country)
- No Internet Exchange → A's email leaves country, until it meets peering point and comes back onto Network B
- IXP in country would just move email from network A to B, locally.