

Ascertaining the Reality of Network Neutrality Violation in Backbone ISPs

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Net neutrality debate

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Atypical Allies Tout Net Neutrality to Congress

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Newmark: Keep the Internet neutral, fair and free

POSTED: 11:06 a.m. EDT, October 20, 2006

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Comcast, Verizon in the hot seat at FCC debate

The public discussion at Harvard University will consider the principle of "network neutrality," or the idea that all Internet traffic should be treated equally.

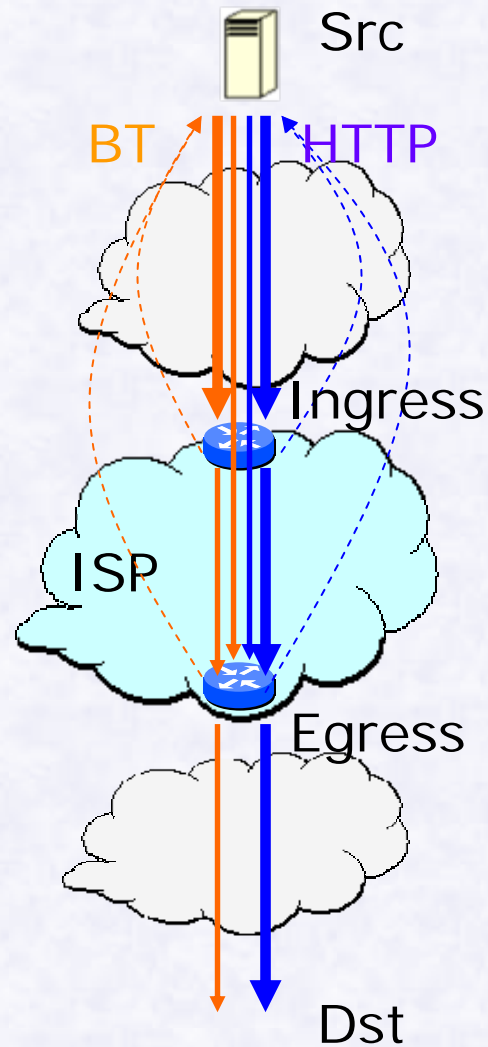
Why is there debate? (from wikipedia)

- Internet content companies: Microsoft, Google, Yahoo, eBay, Amazon
 - Protecting control of data
 - Protecting small providers and consumers
 - Level playing field
- ISPs & network equipment manufactures: AT&T, Verizon, Comcast, Cisco, Alcatel
 - Counterweight to server-side non-neutrality
 - Encouraging investment
 - Skepticism of government regulation

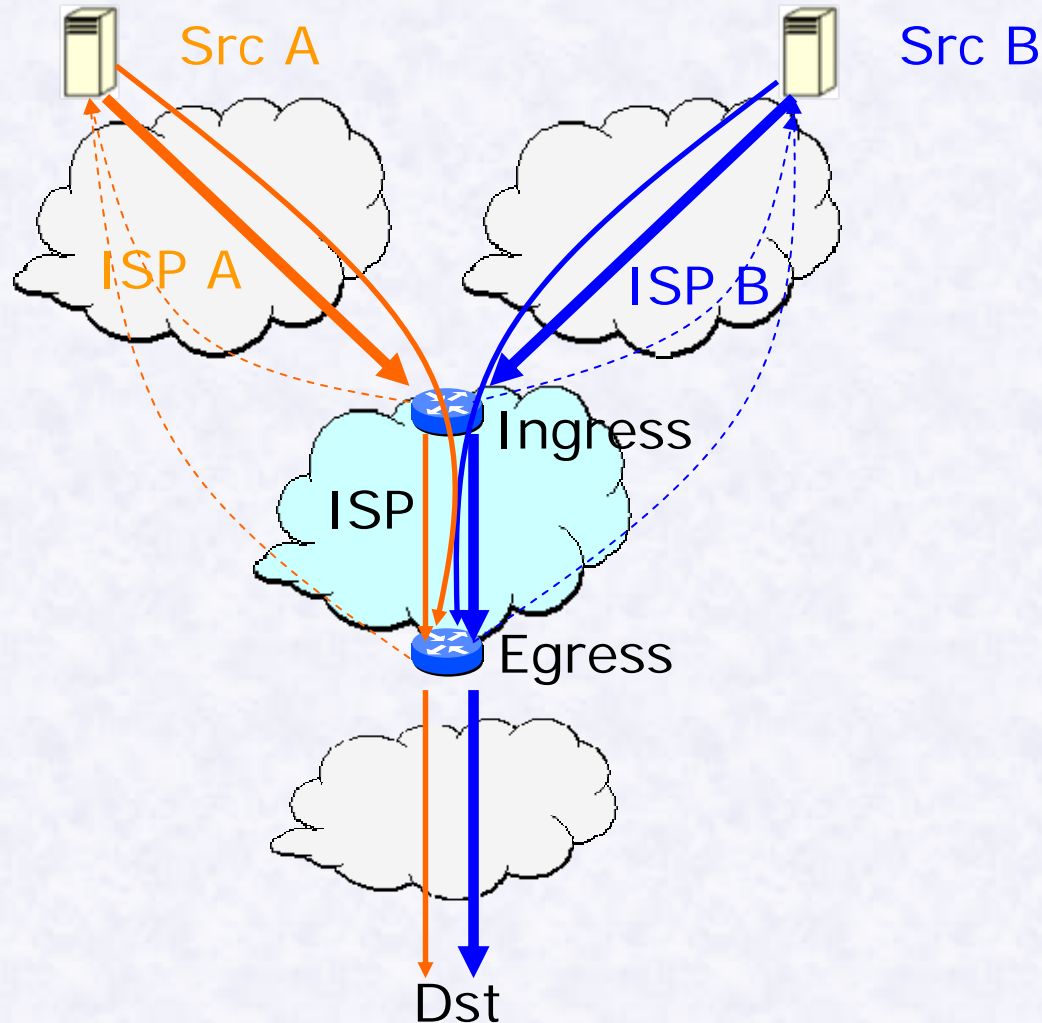
Goals of NVLens

- Known cases in broadband networks
 - Comcast severely delayed BitTorrent
- Few evidence in backbone networks
 - Potentially wider impact
- First system that detects traffic differentiation in backbone networks
 - Protect customers
 - Deter undesirable “differentiation”

Content based differentiation



Previous-hop AS based differentiation



Measurement methodology

- At large time scale, map ISP topology
 - Probe all the IP prefixes
 - Track topological changes
- At small time scale, measure loss rate and latency of ISP internal paths
 - Probe ingress/egress with traceroute-like packets
 - Packets extracted from application traces

Which applications do we measure?

- Five representative applications with distinct traffic characteristics
 - HTTP
 - UDP
 - BitTorrent
 - Skype
 - World of Warcraft
- Use HTTP as baseline for comparison

How to detect differentiation?

- Given two sets of data samples:
 - Same ingress and destination, different previous-hop AS,
 - Same source and egress, different next-hop AS
 - Same source and destination, different applications
- Apply hypothesis tests to compute statistical significance of difference
 - Wilcoxon test and permutation test
 - No assumption on properties of data distribution

Current status of NVlens

- Running on 750 PlanetLab nodes across 300 sites
- Monitoring 19 backbone ISPs
 - AT&T, Sprint, British Telecom, Tiscali...
- Results based on five weeks of data

Detected traffic differentiation

ISP	BT	Previous hop	Next hop	Same AS
UUNet	20 0.9%	633 3.6%	38 0.2%	92 0.5%
Tiscali	221 8%	184 3%	6 0.1%	0 0%

Correlation with TOS value

Traceroute planetlab1.arizona-gigapop.net → 193.58.13.1

➤	Tonto.telcom.arizona.edu	0
➤	Tuco.telcom.arizona.edu	0
➤	Morgan.telcom.arizona.edu	0
➤	216-64-190-5.static.twtelecom.net	0
➤	*	0
➤	So-1-0-0.was11.ip.tiscali.net	128
➤	So-3-0-0-0.lon12.ip.tiscali.net	128
➤	Xe-2-0-0.lon10.ip.tiscali.net	128
➤	Xe-0-0-0.bru20.ip.tiscali.net	128
➤	Ge-1-0-0.bru21.ip.tiscali.net	128

More results

- Quantifying the impact of noise and errors
 - Equal cost multi-paths
 - Overloaded prober
 - ICMP rate limiting
 - Packet loss on reverse path
- Detailed analysis of differentiation
 - What information is used?
 - Where and when is it enforced?

Discussion

- How to deal with differentiation?
 - Modify content
 - Change routing
- May miss certain types of differentiation based on
 - Traffic timing behavior
 - Source

Conclusion

- NVlens is the first system that can detect traffic differentiation in backbone networks
 - Protect customers, deter undesirable “differentiation”
- ISPs do differentiate traffic based on content and routing policy
 - Result in different loss rates
- More research needs to be done this area
 - Understand differentiation policies and scope