MEASURING INTERNET CONGESTION AND ITS IMPACT ON QOE

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BACKGROUND

• Modern peering (interconnection) disputes manifest as congested links

• Disputes among access, content, and transit providers

• Some content is carried over inadequate links between access and transit networks

• congestion on transit links affects everybody, not just parties to the peering dispute
We are developing methods to measure the location and extent of interdomain congestion

Our goals (1) a system to monitor interdomain links and their congestion state, (2) a near real-time “congestion heat map” of the Internet, (3) increasing transparency, empirical grounding of debate

Part of a 3 year NSF-funded project on topology + congestion measurement
METHODOLOGY: TIME SERIES PING

Vantage Point

Border Routers on Interesting Link
METHOD: TIME SERIES PING

Vantage Point

Border Routers on Interesting Link

RTT #A

TTL: 2
METHOD: TIME SERIES PING

Vantage Point

Border Routers on Interesting Link

RTT #A

RTT #B

TTL: 2

TTL: 3
METHOD: TIME SERIES PING

Vantage Point

Border Routers on Interesting Link

TTL: 2

TTL: 3

(repeat to obtain a time series)
RTT measurements of border routers

Day of week in November 2013 (in New York)

Loss rate to far border router

Cogent (far)
Comcast (near)
IMPLICATIONS FOR QOE

• Application QoE is affected by a variety of network-level performance metrics - delay, delay jitter, loss rate, available bandwidth, stability of available-bandwidth..

• A congested peering link increases the delay for flows crossing that link (full buffer adds latency)

• A congested peering link has a non-negligible loss rate

• A congested peering link has low (almost zero?) available bandwidth. TCP flows starting across such a link must push other flows out of the way to get any throughput
Network A-Network B: Congestion persisted throughout April 2015, several hours daily
Network C-Network D: Only 4 days in May 2015, limited to ~1 hour daily
RECENT EXAMPLES

Network C-Network D: Only 4 days in May 2015, limited to ~1 hour daily
WHAT IS THE IMPACT ON USER QOE?

• The two examples are very different: One is long-lasting (two months) and persists for several hours every day. Other is short-lived (only 4 days) and is only seen for a short duration (~1 hour)

• How do these events affect user QoE?
MEASUREMENT SYSTEM

- AS relationships
- BGP
- IXP data

- VP topology data
- Link identification
- Alias resolution

- WHOIS
- Topology mapping

- VP topology data
- TSLP target selection
- Measurement notification system

- Probing logic
- Links DB
- Historical state
- VP capability
- Alerts DB

- TSLP samples
- Triggered meas scheduler
- Triggered meas data
- Time series analysis

- Alert system
- Frontend
- Visualization
- Longitudinal views

- Backend System
- Data processing
ON-DEMAND MEASUREMENTS

• Using the results of time series analysis to trigger additional measurements from the VP when we find evidence of congestion
  - high-frequency probing to measure loss rate
  - throughput/available bandwidth measurements
  - QoE measurements

• We would love to work with you to deploy new experiments on this platform
VP DEPLOYMENTS

• Deployments in various access networks (and other network types, see http://www.caida.org/projects/ark/)

• Currently 29 monitors running TSLP measurements

• We continue to deploy Ark nodes using Raspberry Pi hardware in homes of our friends (or friends of friends)

• Goal: deploy our experiments on other platforms: Bismark, FCC-Samknows (hundreds of vantage points)
THANKS!
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