Lecture 15: Internet Measurement

CS 234 / NetSys 210: Advanced Computer Networks

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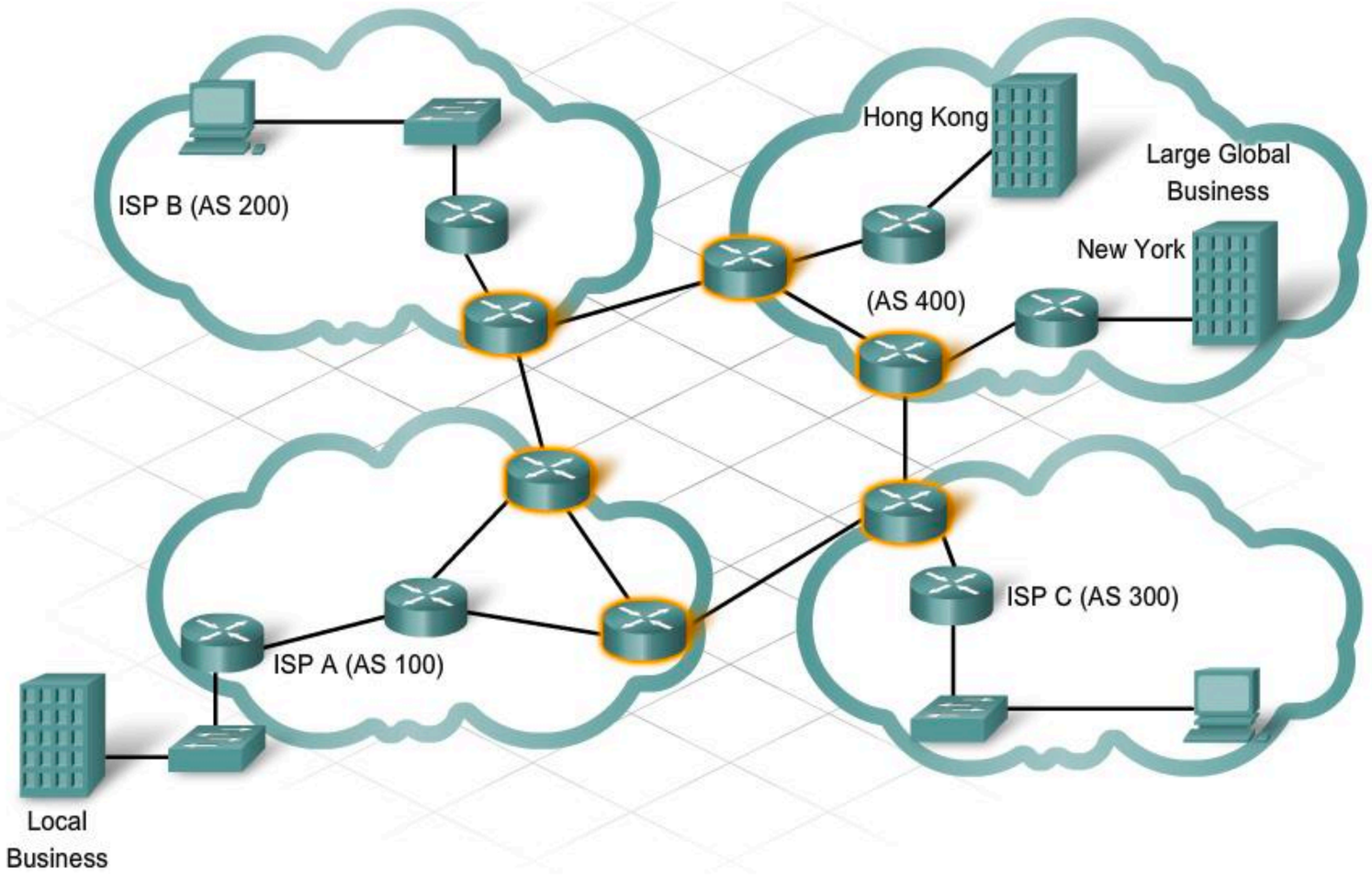
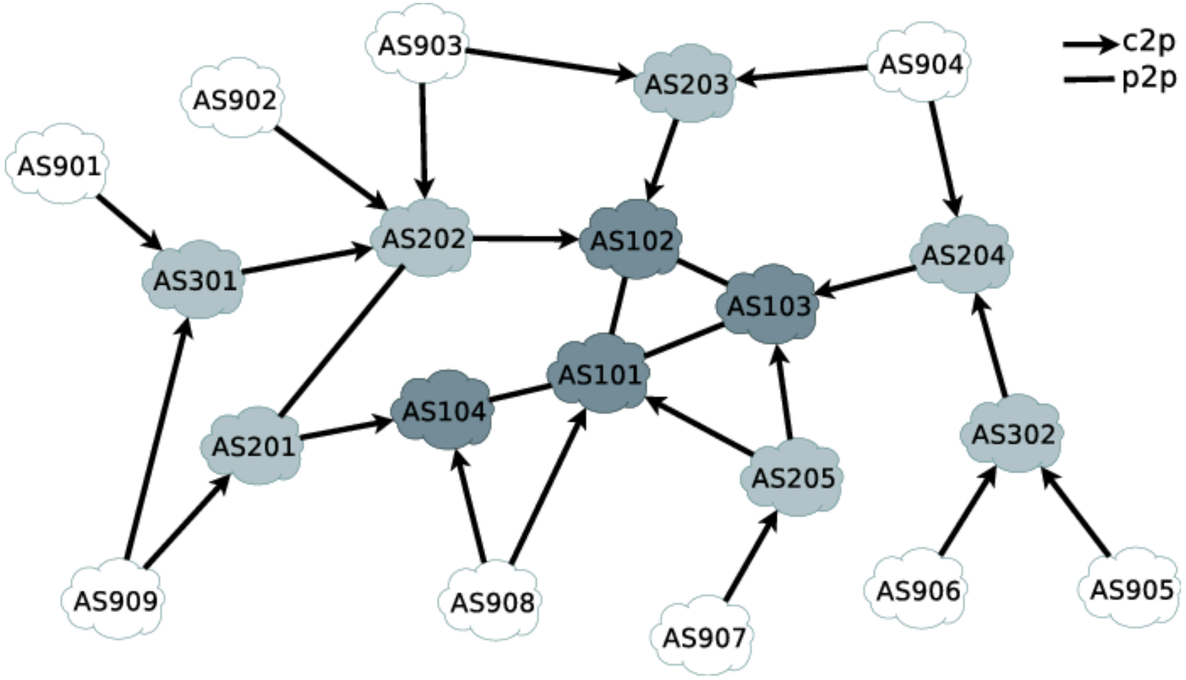
UCIRVINE

This lecture uses material from SIGCOMM'18 talk on inferring congestion paper and images from CAIDA

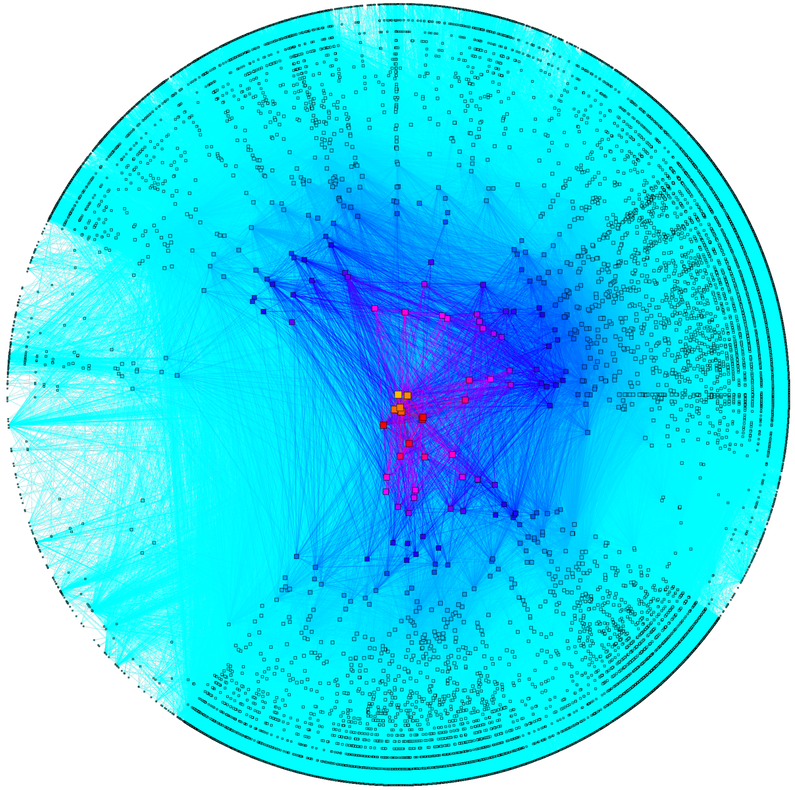
Internet Autonomous Systems



Internet Map



Autonomous System Relationships



Internet Disputes

France Telecom Accused Of Holding YouTube Videos Hostage Unless It Gets More Money

from the *more-peering-disputes* dept

Netflix packets being dropped every day because Verizon wants more money

Verizon wants to be paid by consumers and Cogent, but Cogent refuses to pay.

Peak Time Congestion Hits Hardest for Broadband ISP Plusnet

Monday, April 23rd, 2018 (3:12 pm) - Score 14,382

Level 3 and Comcast Issue Statement

Jul 16, 2013

el 3 and Comcast have resolved their prior interconnect
ails will not be released.

CenturyLink Pushed For Net Neutrality Repeal, Now Adorably Calls For FCC To Police Interconnection

from the *good-luck-with--that* dept

You'll probably recall that a few years ago, Netflix streams
users nationwide. Eventually, Netflix, Level3 and Cogent st
Netflix's end, but was occurring at peering points, where th
intentionally letting their networks congest by refusing to

Broadband
by Karl Bode
Thu, Dec 21st 2017
10:44am

Verizon denies using net neutrality victory to sabotage Netflix, Amazon

BY BRIAN FUNG February 5 at 1:59 pm

Cogent Gearing for Another Peering Battle

Confirmed: Comcast and Netflix have signed a paid peering agreement

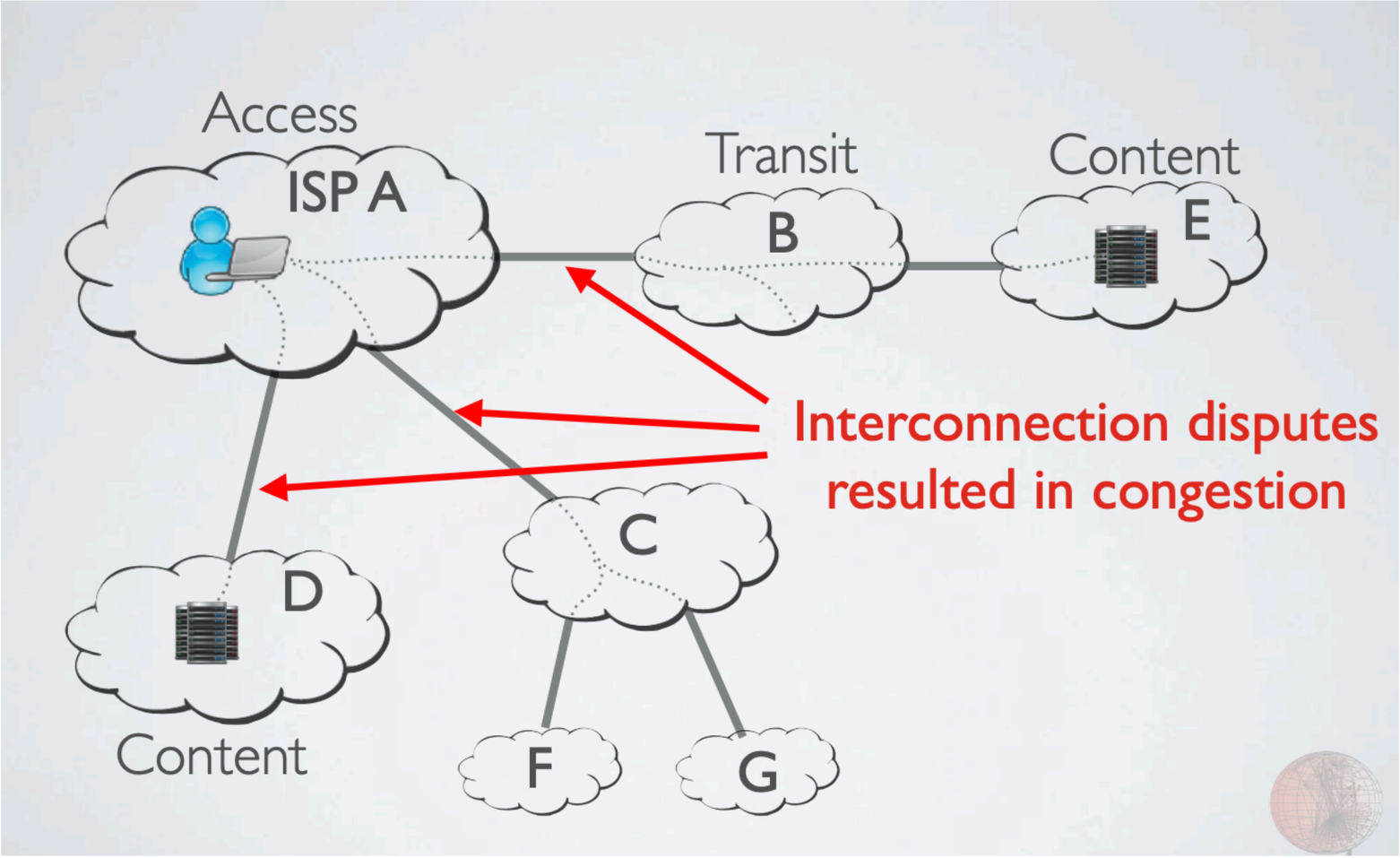
by Stacey Higginbotham FEB. 23, 2014 - 9:27 A

'Peering' Into AOL-MSN Outage

Netflix still sucks on AT&T, and now AT&T plans to offer Netflix clone

AT&T partners with an investment firm to buy and launch streaming services.

Manifestation: Interdomain Congestion



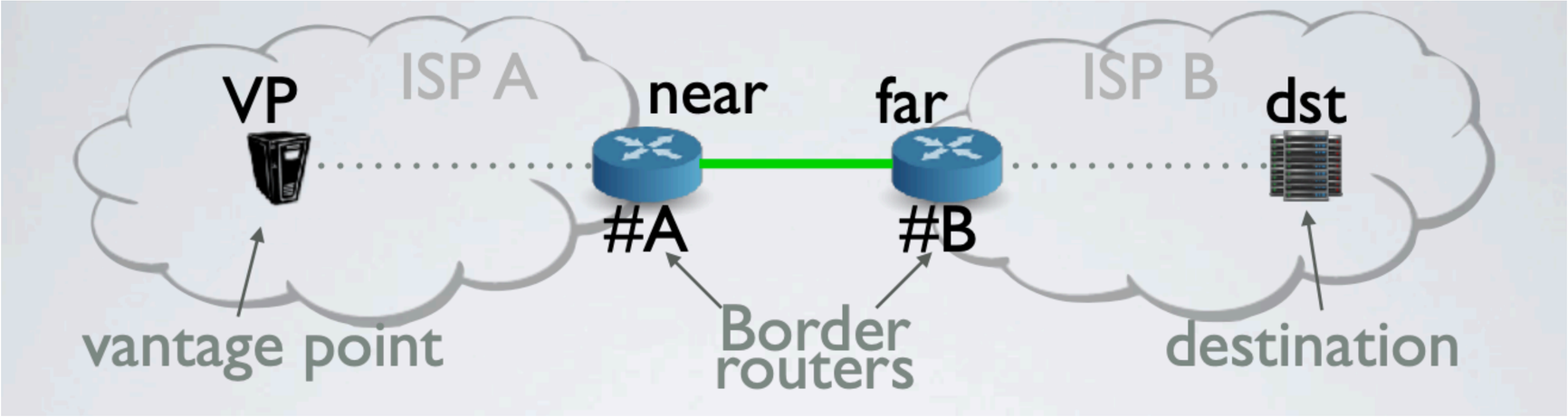
Consequences of the Problem

- Congestion on transit links affects parties other than those involved in the dispute
- Limited data available to regulators and researchers to increase transparency and empirical grounding of debate
- Goal of the paper: third-party inference of congestion at interdomain interconnections

Method: Time Series Latency Probes

- Observation:
  - Peak-hour congestion fills up router buffers, resulting in elevated latency across an interdomain link
- How do we measure latency across an interdomain link?

Time Series Latency Probes (TSLP)



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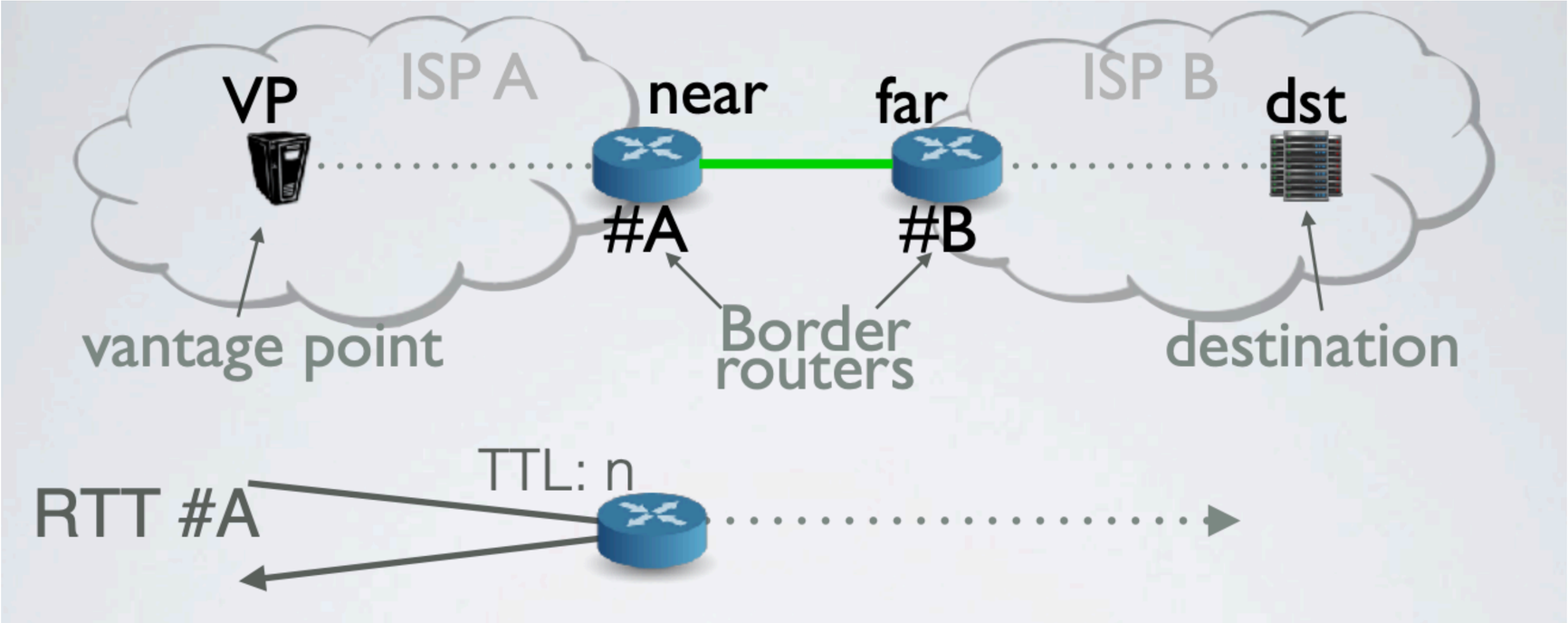
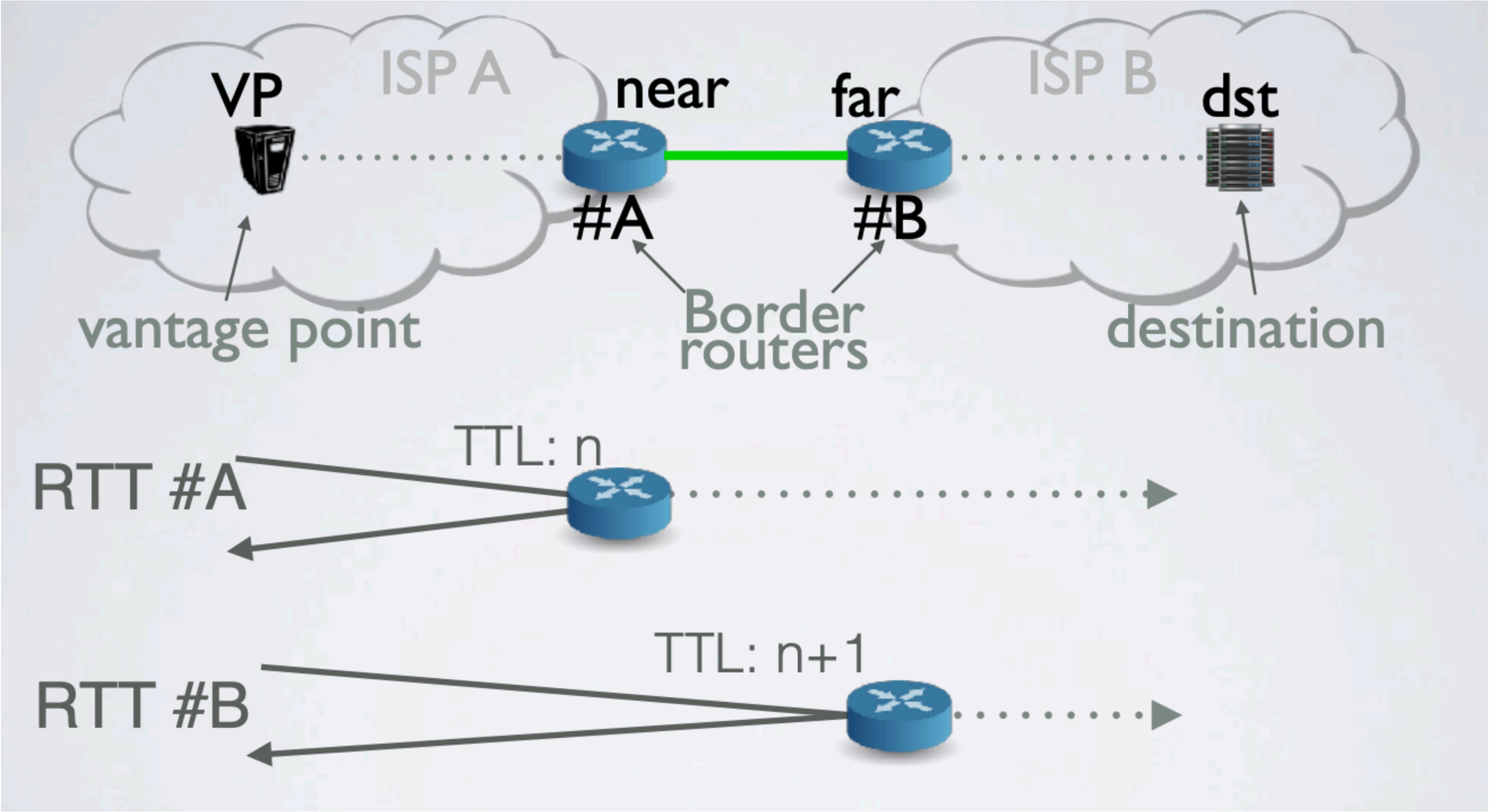


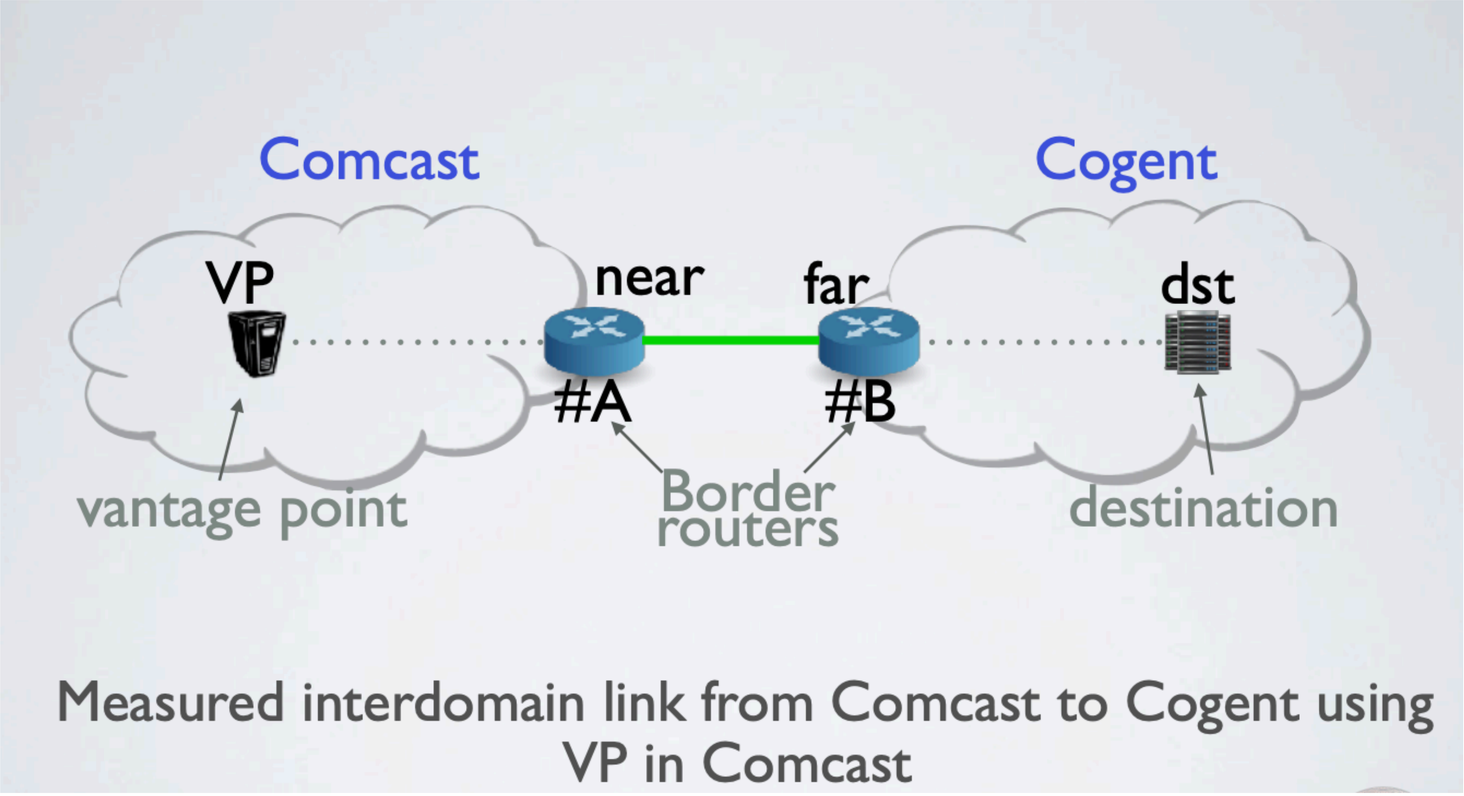
When discarding a packet with a TTL or Hop Limit of one or zero the router in question may (it's not mandatory) send an ICMP error message to the source as follows:

- IPv4: type 11: 'Time Exceeded', code 0: 'time to live exceeded in transit'

Time Series Latency Probes (TSLP)



An Experiment with TSLP



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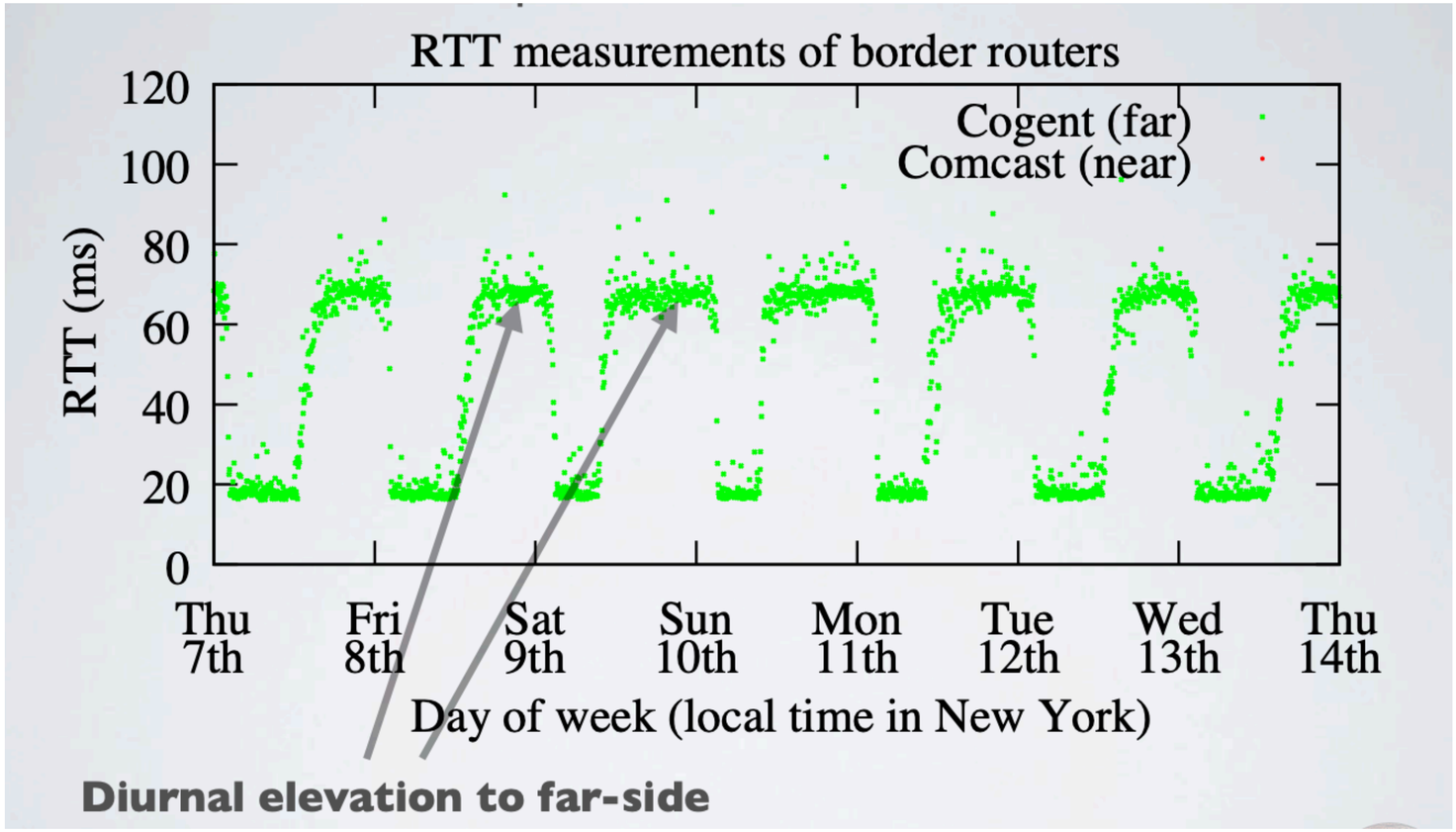
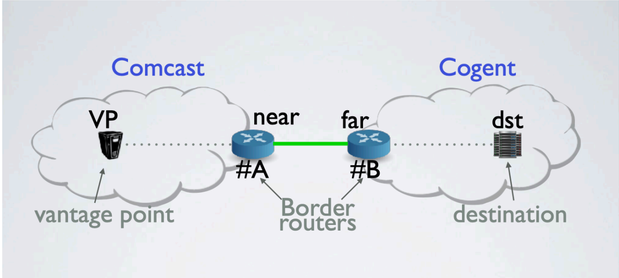
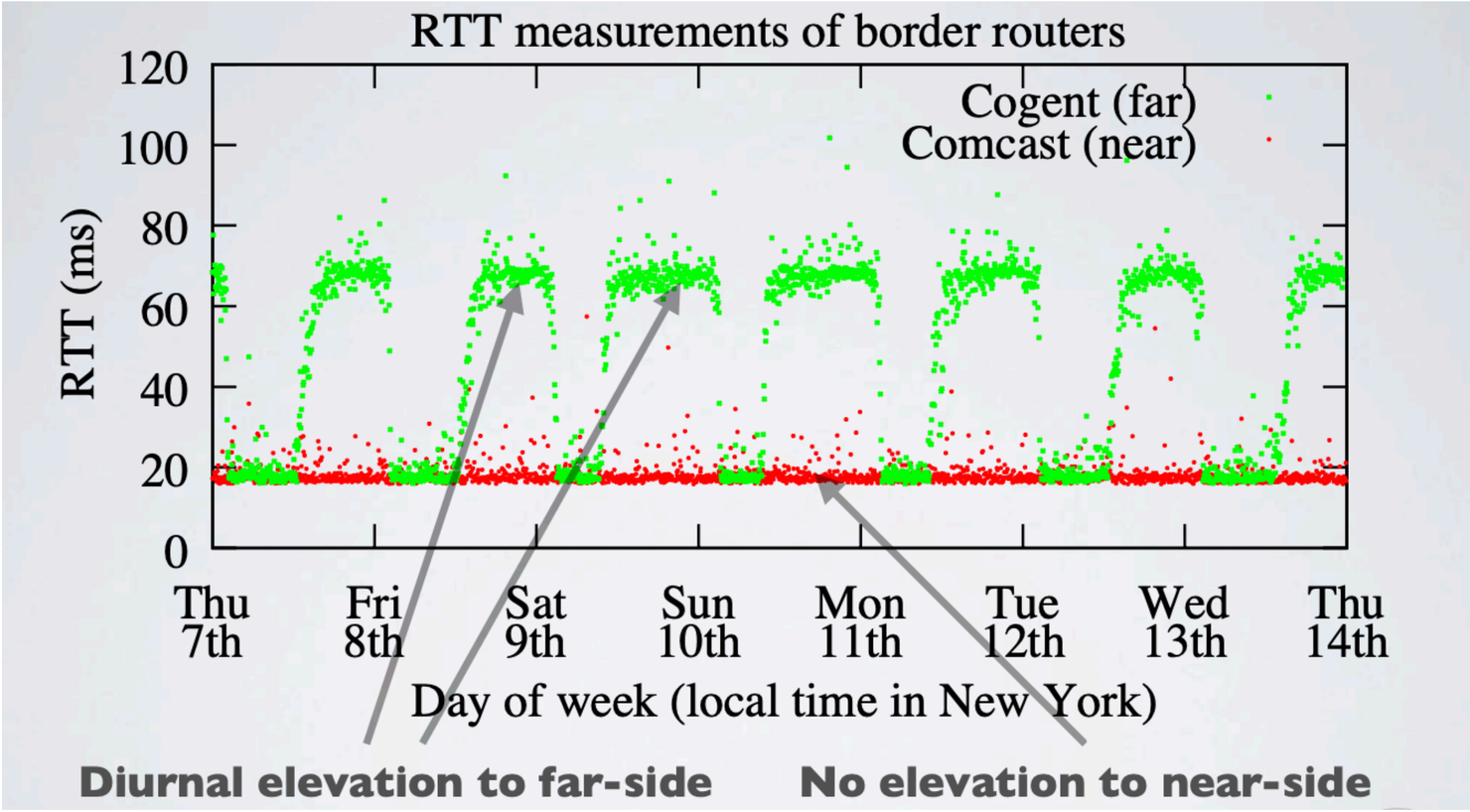
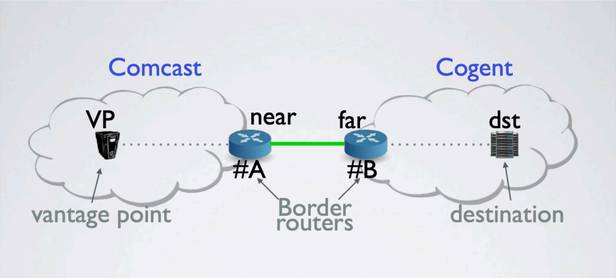




Measured interdomain link from Comcast to Cogent using VP in Comcast

An Experiment with TSLP



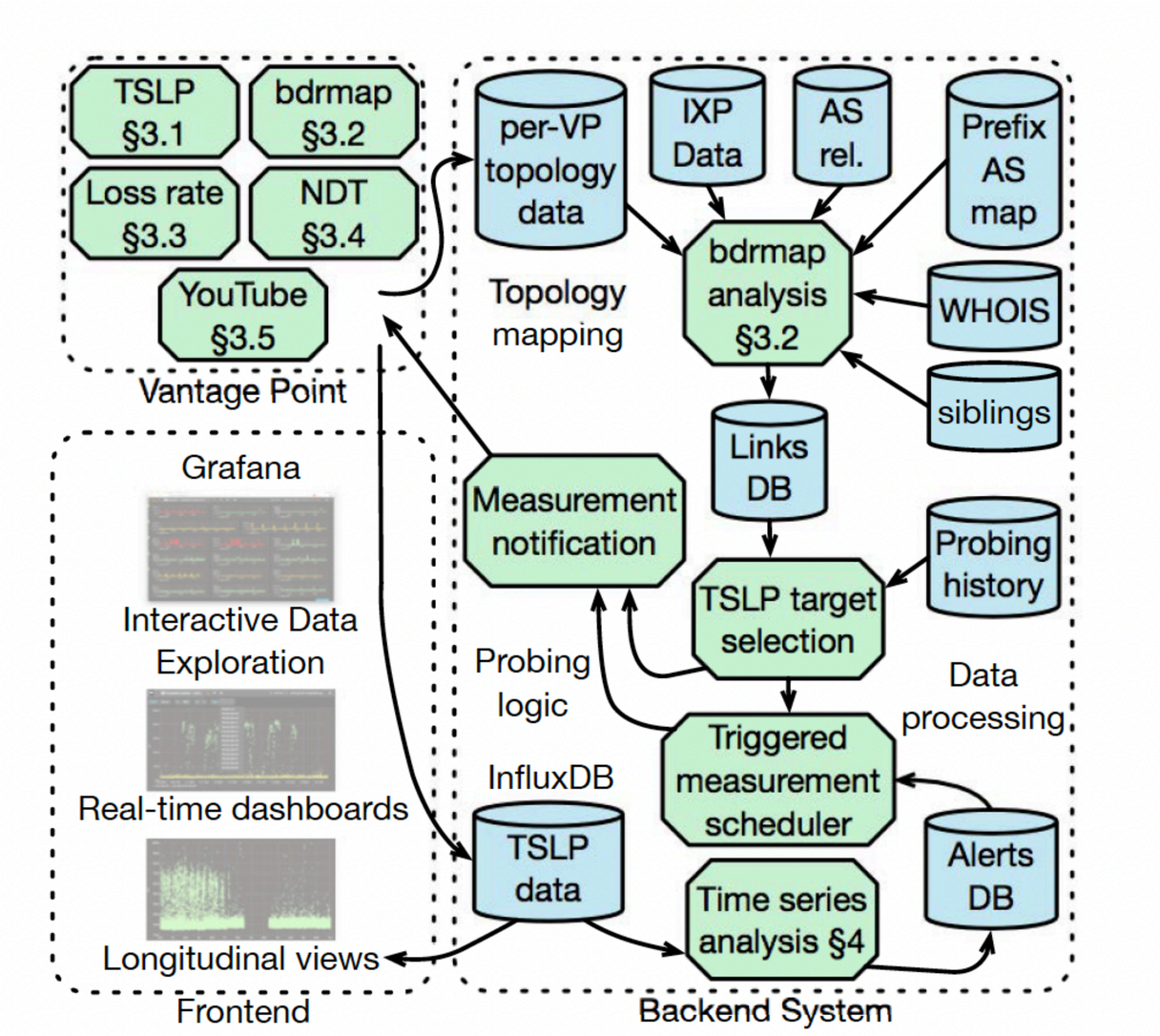


Measured interdomain link from Comcast to Cogent using VP in Comcast

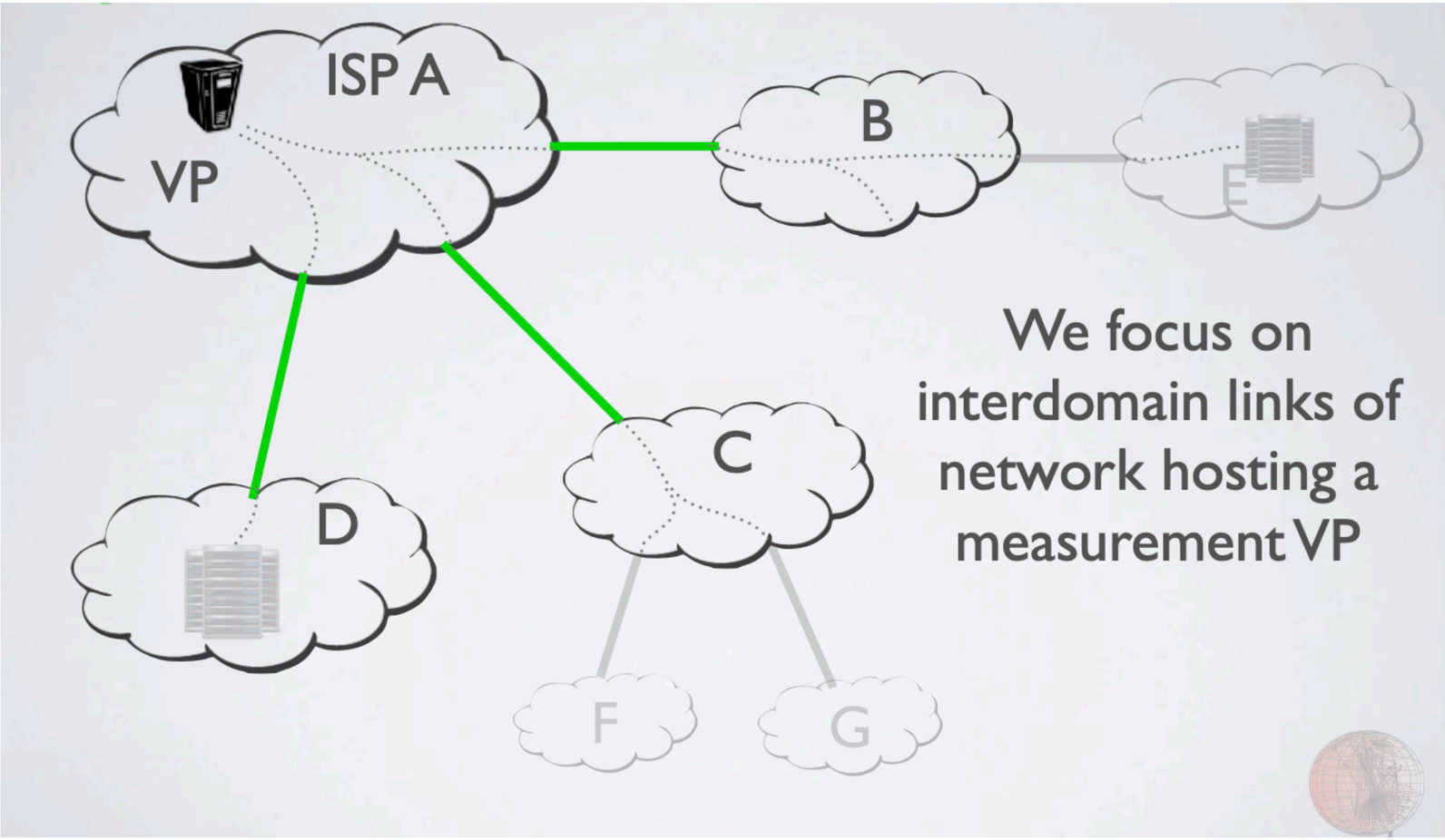
Challenges

- Interdomain link Identification: Need to identify interdomain links to be able to probe them
- Adaptive Probing: Need to be adaptive to changes in the underlying topology and routing
- Identifying Congested Links: Need time-series analysis techniques to find patterns in (noisy) data that indicate congestion
- Validation: Need to validate inferences. Most peering agreements are covered by NDAs

High-level System Design



Identifying Interdomain Links



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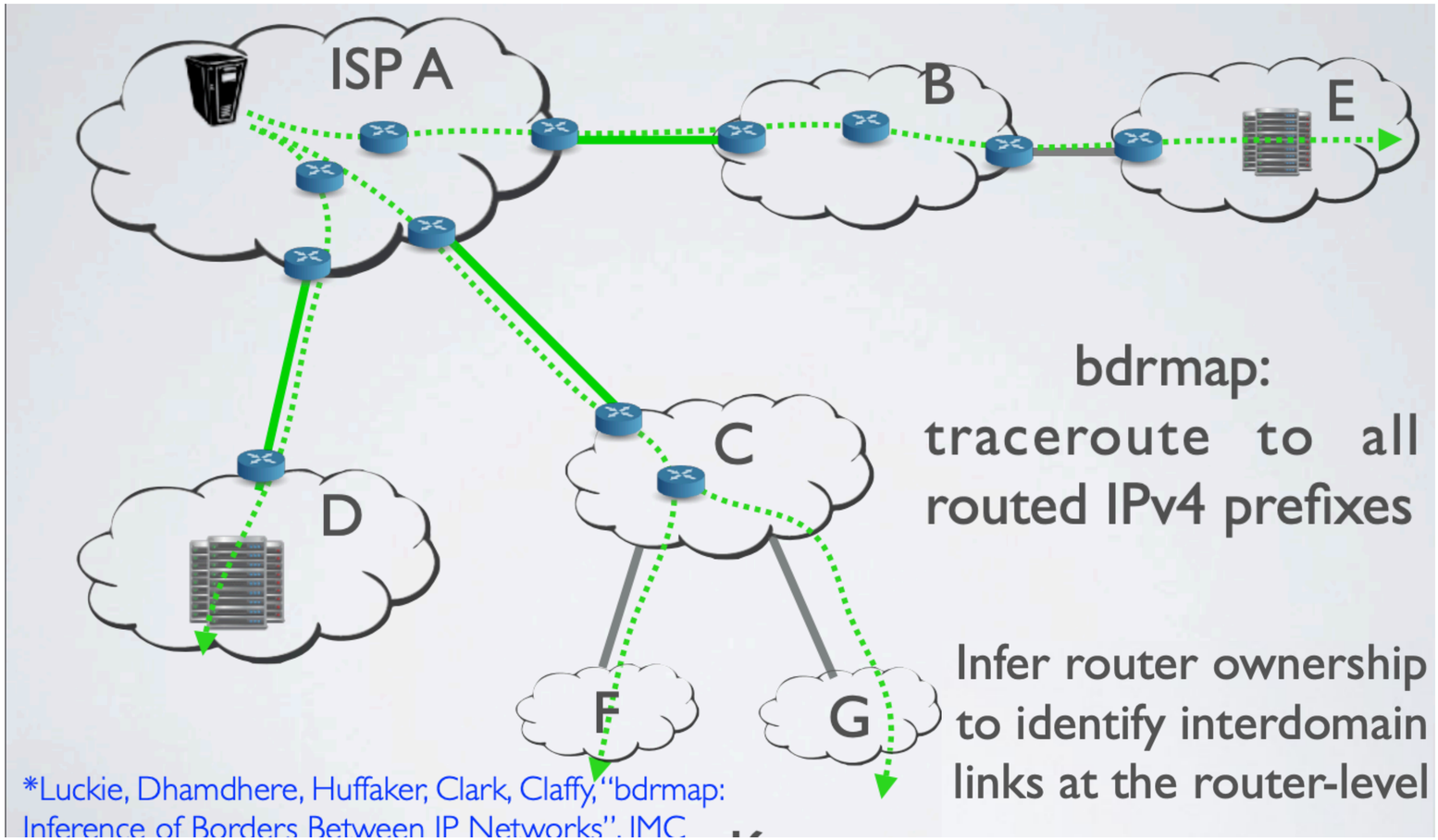
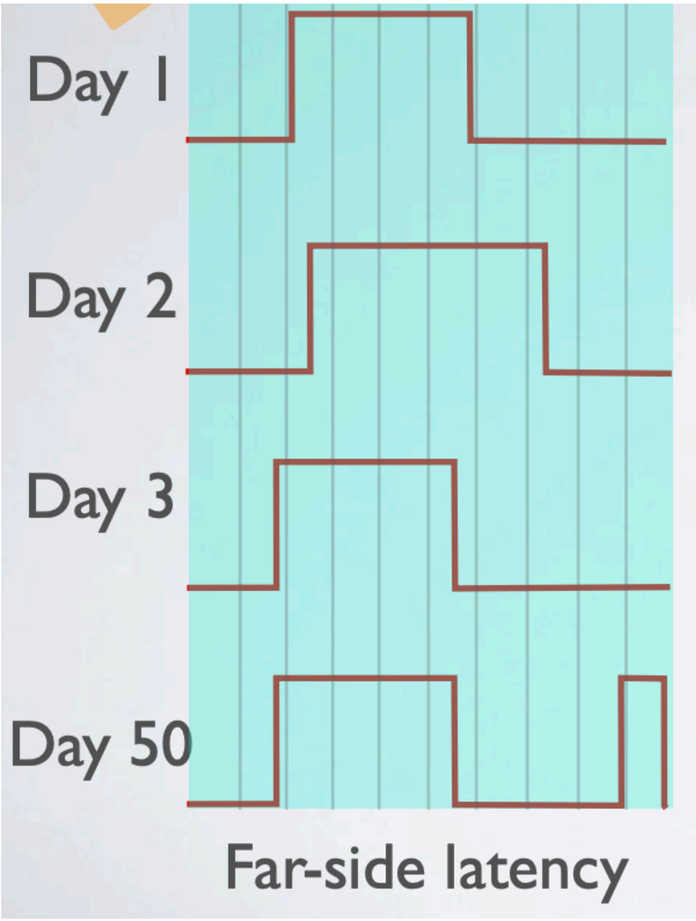


Identifying Congested Links

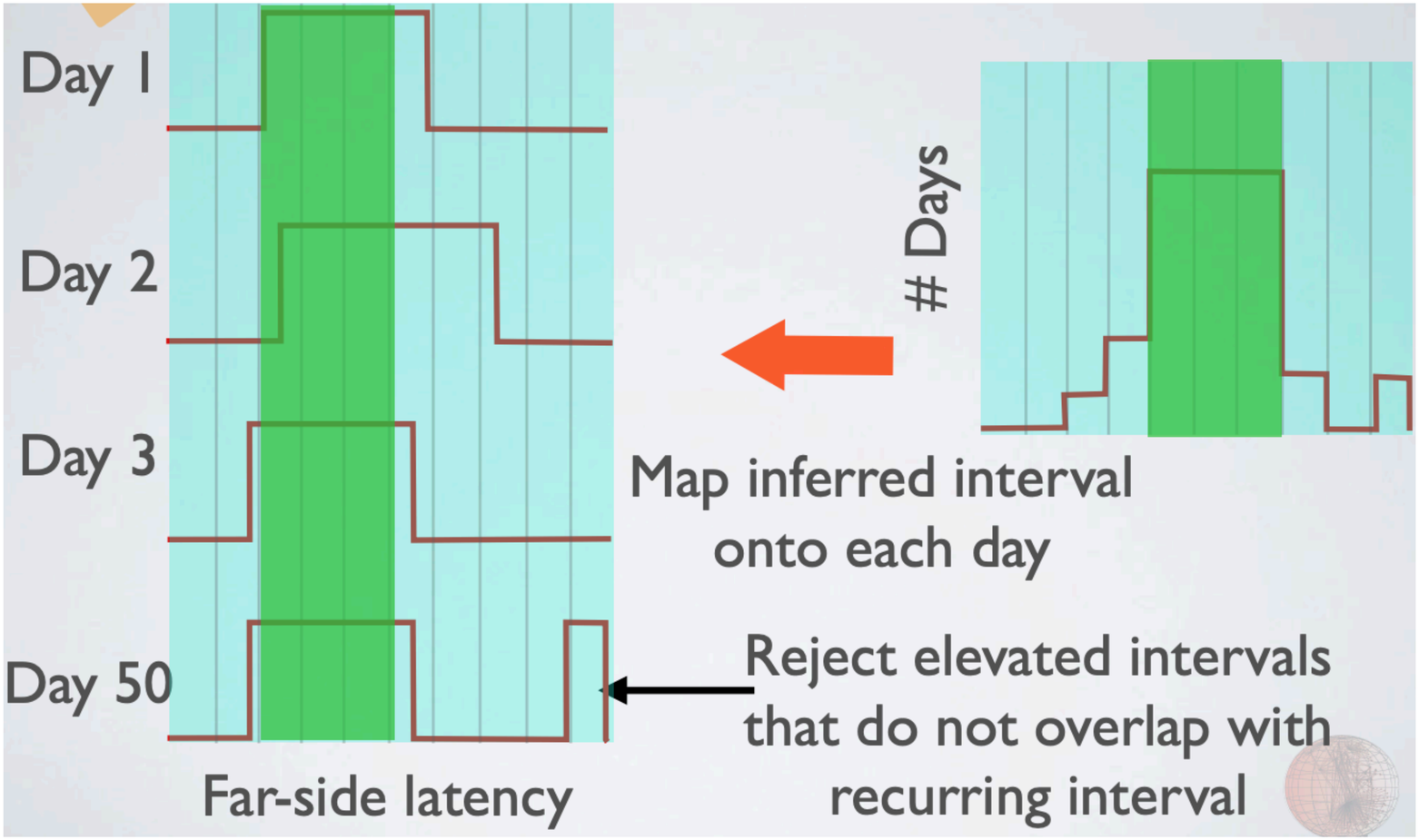
- Focus on persistently congested links

- Look for periods of elevated latency that correlate across days (autocorrelation method)

Autocorrelation method



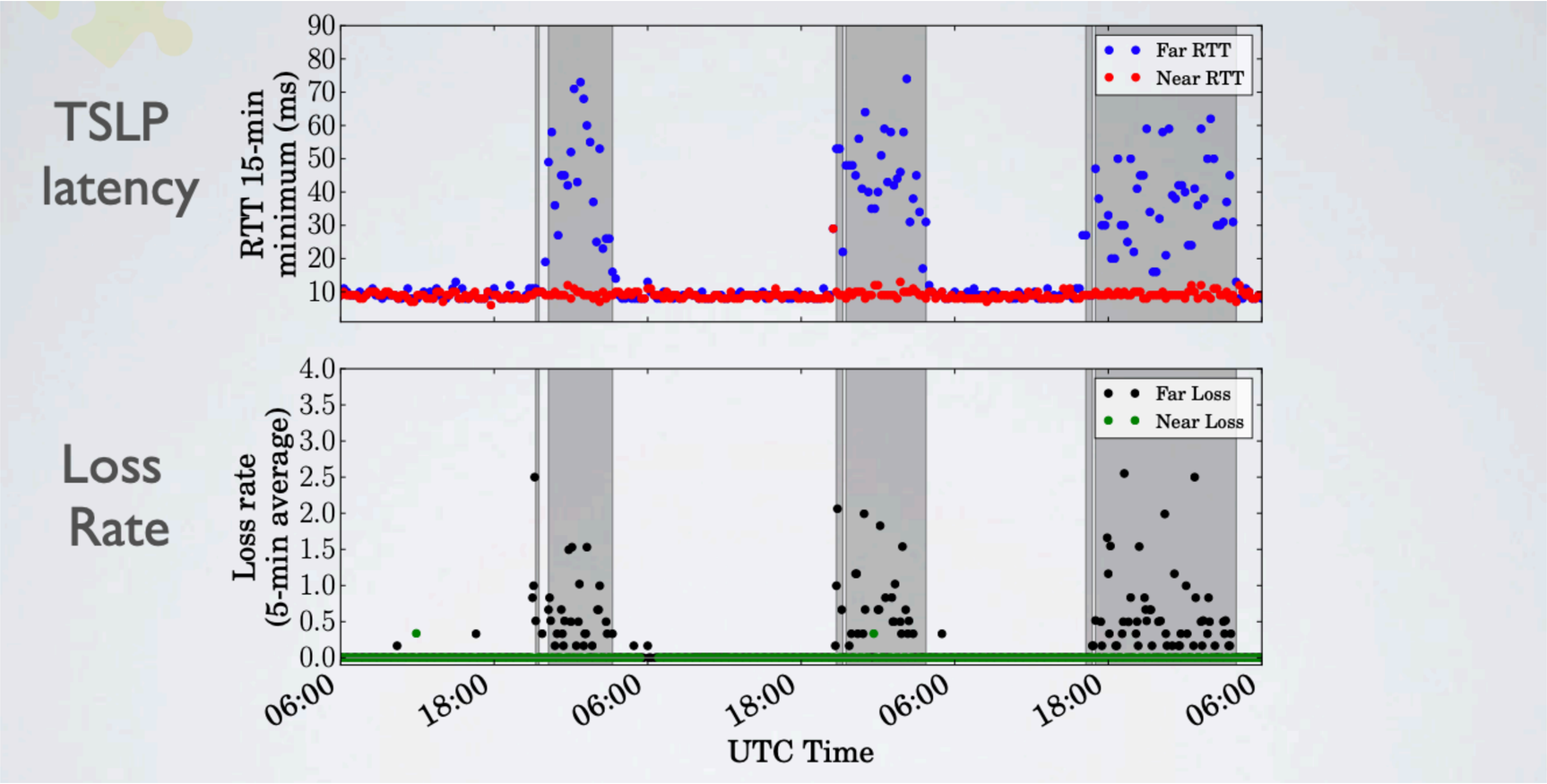
Autocorrelation method



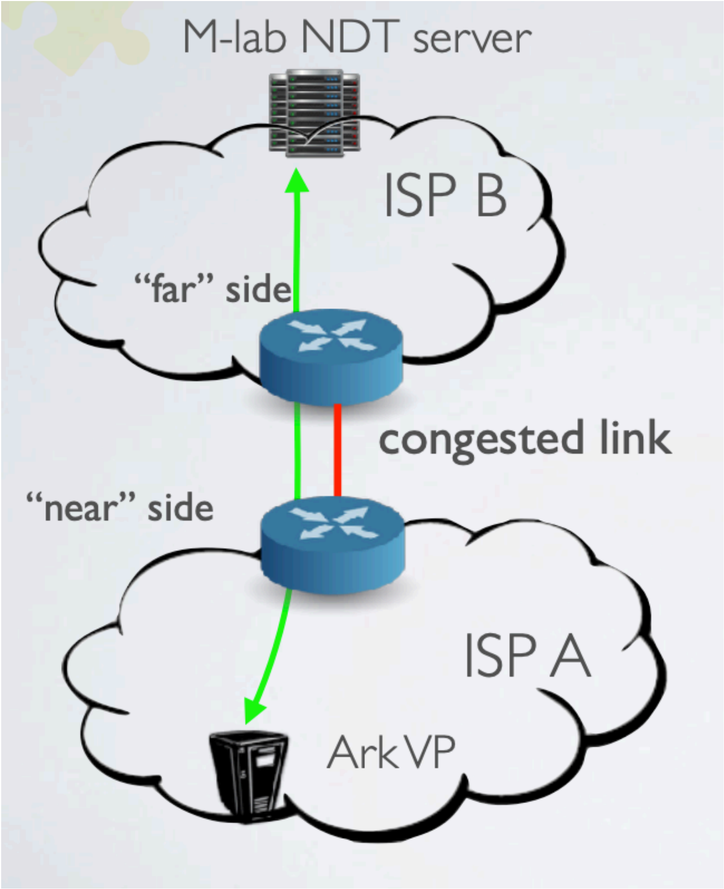
Heavy Emphasis on Validation

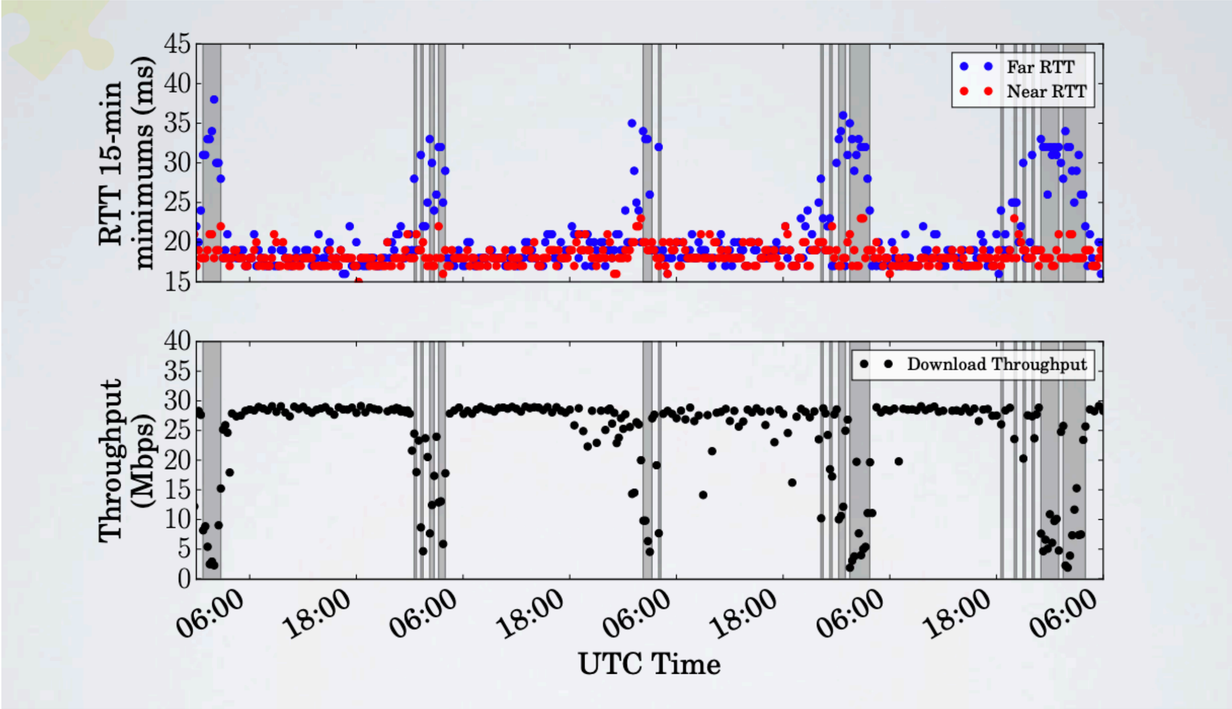
- Critical due to political nature of inferences
- Validation of inference method
    - Correlation with loss
    - Correlation with throughput
    - Correlation with YouTube streaming
- Validation of specific inferences
    - Ground truth from operators

TSLP inference correlates with loss

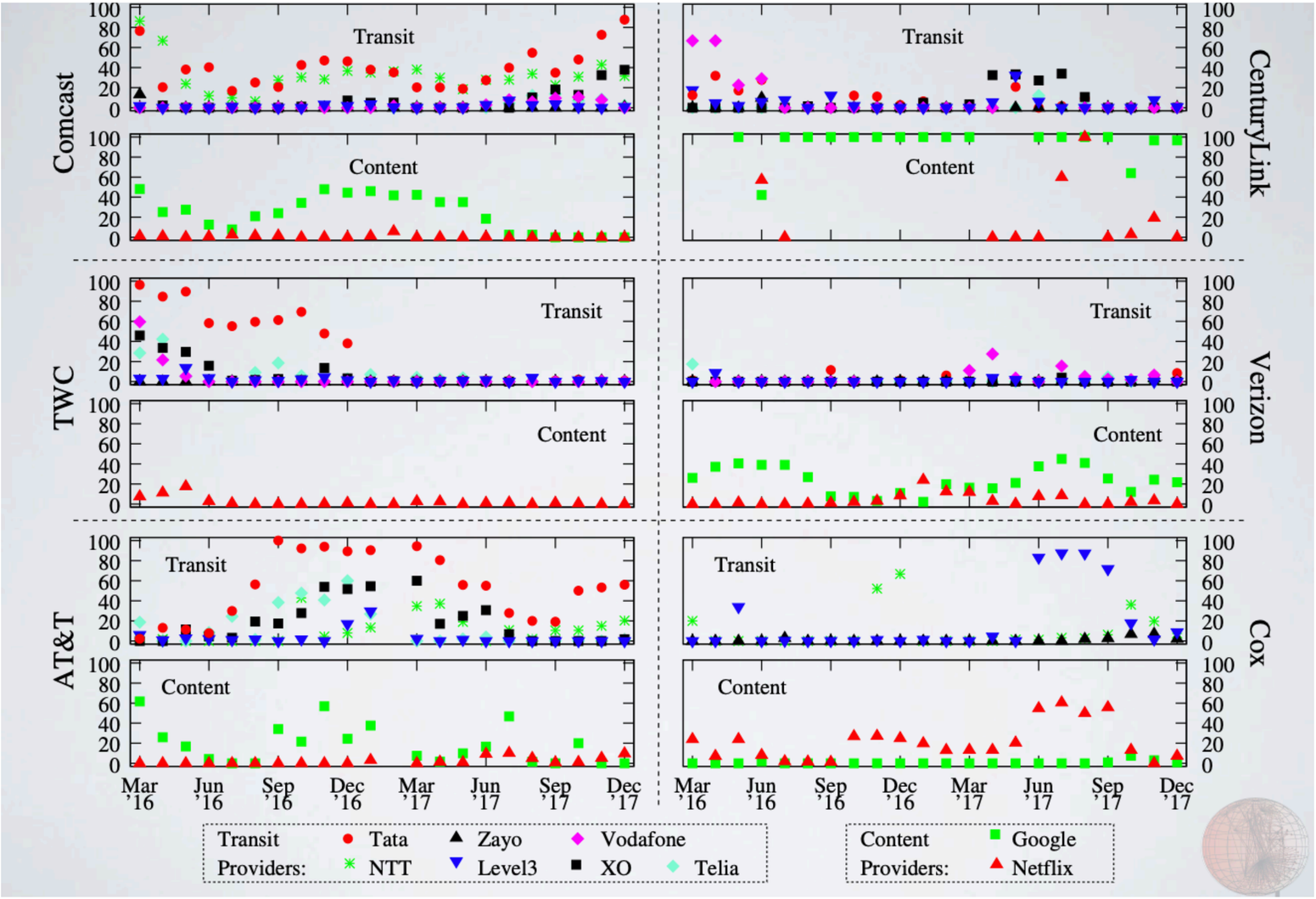


TSLP inference correlates with throughput





Percent of congested day-links over time



Other Measurement Infrastructure and Datasets

RIPE Atlas Probes

M-Lab Probes

CAIDA

RESOURCE CATALOG

Discover Internet Research Contributions made to the Scientific Community

Datasets

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CAIDA collects several types of data, and makes this data available to the research community while preserving the privacy of individuals and organizations who donate data or network access.

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Thanks!