

Open Internet and Interconnection Briefing

ISP Interconnection and its Impact on Consumer Internet Performance

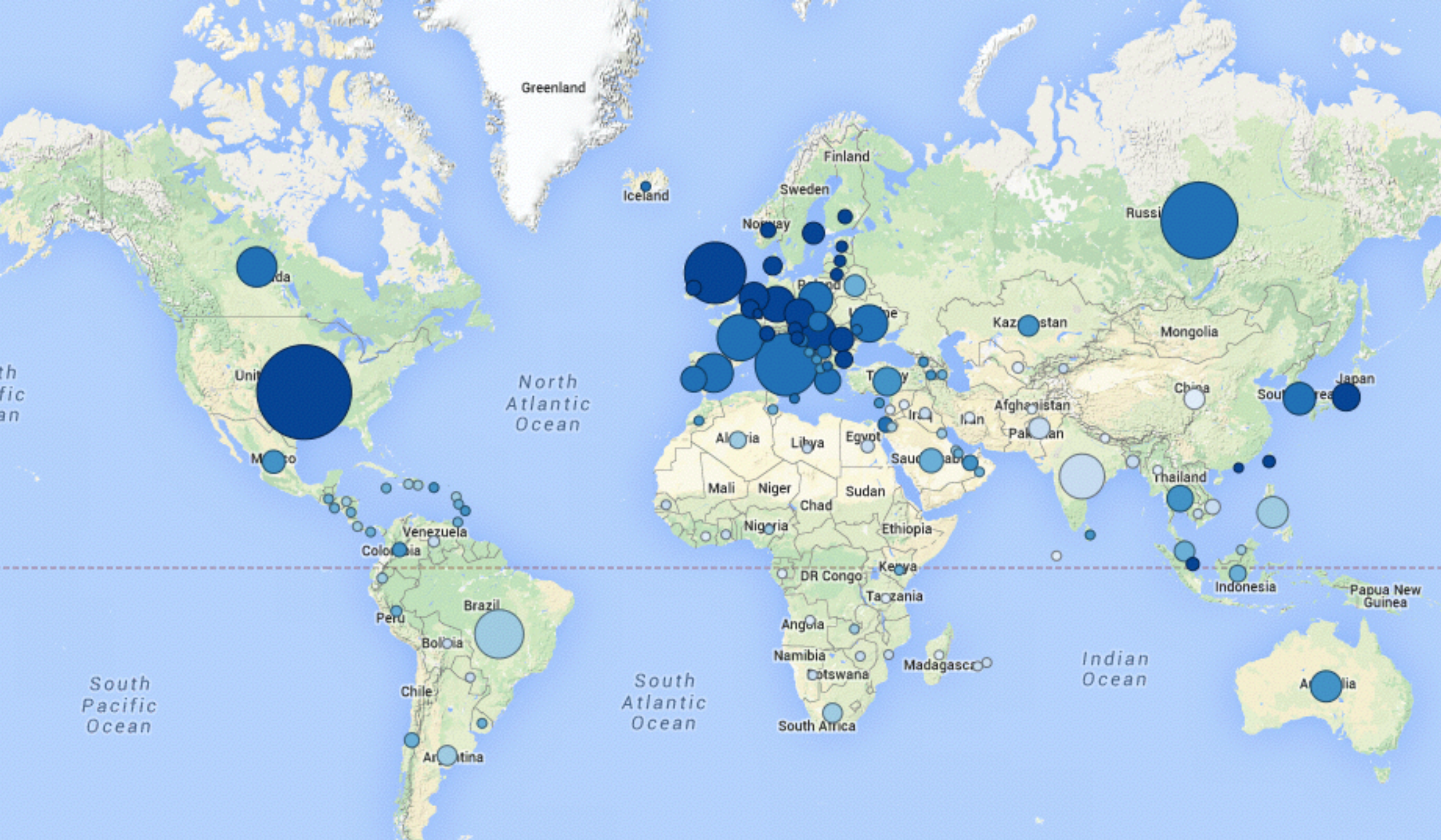
Collin Anderson
Measurement Lab

Measurement Lab (M-Lab) in Brief



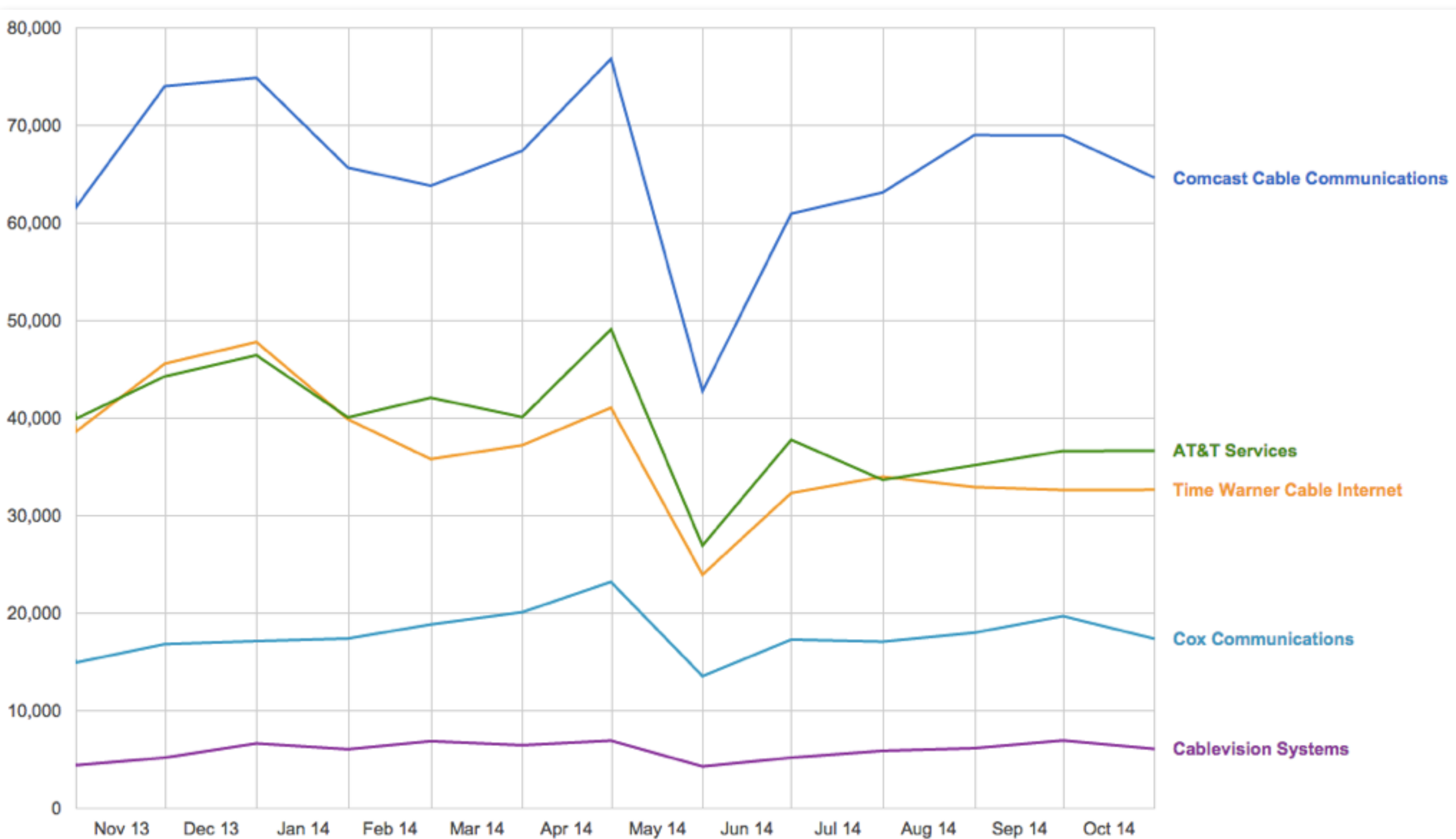
How Measurement Lab
Collects Information

One of the Largest Network
Performance Measurement
Initiatives



How Measurement Lab
Collects Information

One of the Largest Network
Performance Measurement
Initiatives



How Measurement Lab
Collects Information

The United States Constitutes
the Largest Source of this Data



Network Diagnostic Tool

Quantifying End User Performance

Open Research in Practice

- M-Lab's Founding Principle is Accessibility and Reproducibility in Research
- All Network Data is Publicly-Available in Multiple Formats
- The Software and Data Used in this Study is Open Source and Documented



m-lab-tools / telescope

Python framework designed to make extraction of raw measurement research <http://measurementlab.net> — Edit

23 commits

3 branches



branch: master

telescope / +

Merge pull request #19 from mtlynch/master ...



collina authored 5 days ago

dev

Adding pre-commit script

documentation

Updating selector file spec.

resources

Initial commit

telescope

Adding a unit test to make sure generated queries

.gitignore

Initial commit

LICENSE

Initial commit

NOTICE

Initial commit

README.md

Updating README to include information about s

client_secrets.json

Initial commit

main.py

Merge pull request #19 from mtlynch/master

requirements.txt

Initial commit

test-requirements.txt

Initial commit

Measurement for Internet Policy

- M-Lab performance data has been used by the FCC's Consumer Broadband Test
- Our measurement points are core to the SamKnows testing framework used by the FCC
- European regulators measure broadband access through M-Lab performance data
- Supports a community of researchers that study issues from broadband access to Internet censorship

Table 5: Number of Testing Servers Overall

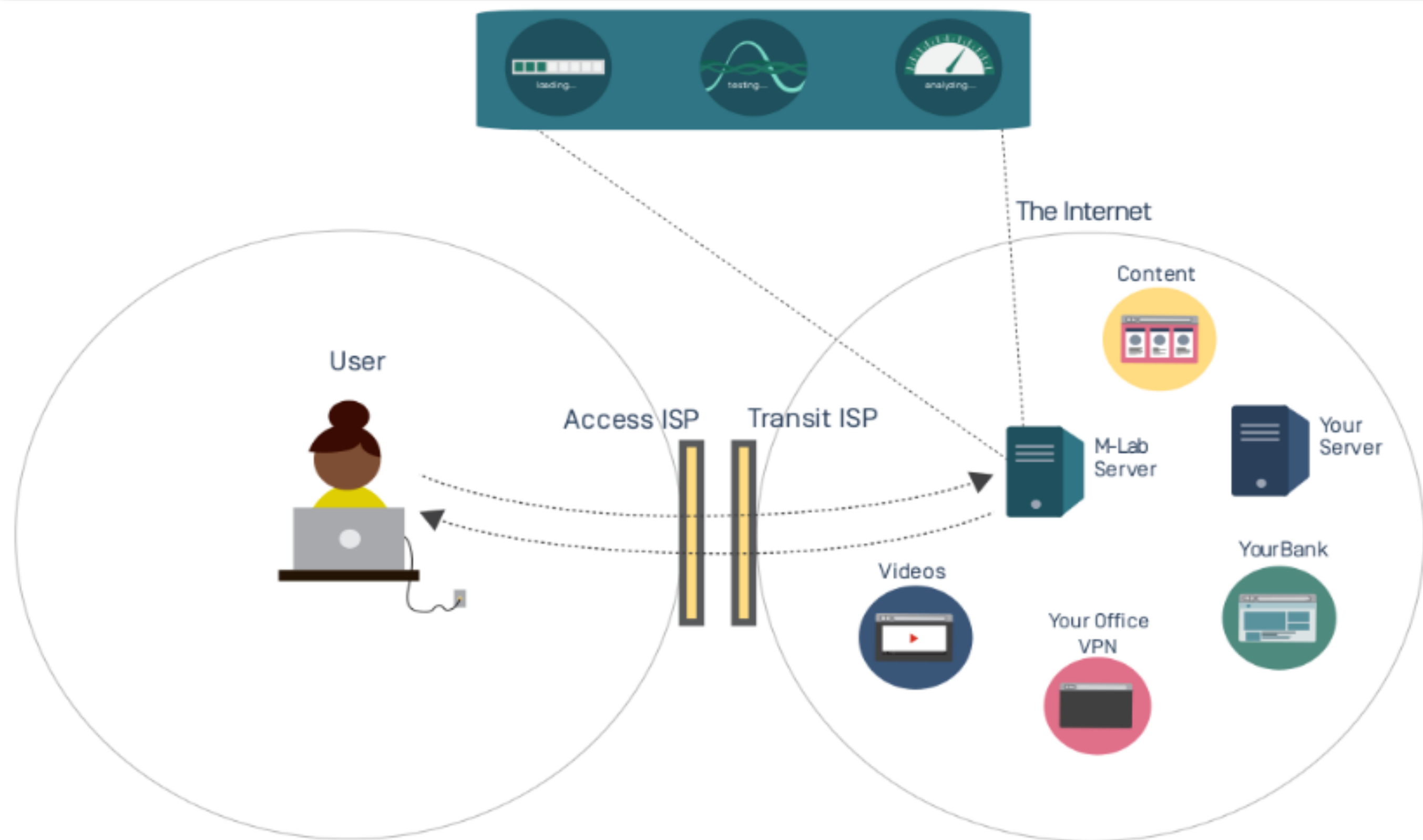
Server owner	#
AT&T	9
Cablevision	2
CenturyLink	14
Charter	5
Comcast	33
Cox	2
Frontier	5
Level 3	10
M-Lab	30
Mediacom	1
Qwest	4
Time Warner Cable	6
Verizon	5
Windstream	4

OFF-NET TEST NODES

The M-Lab infrastructure served as destinations for the ren were located in the following major U.S. Internet peering lo

- New York City, New York (2 locations)
- Chicago, Illinois
- Atlanta, Georgia
- Miami, Florida
- Washington, DC

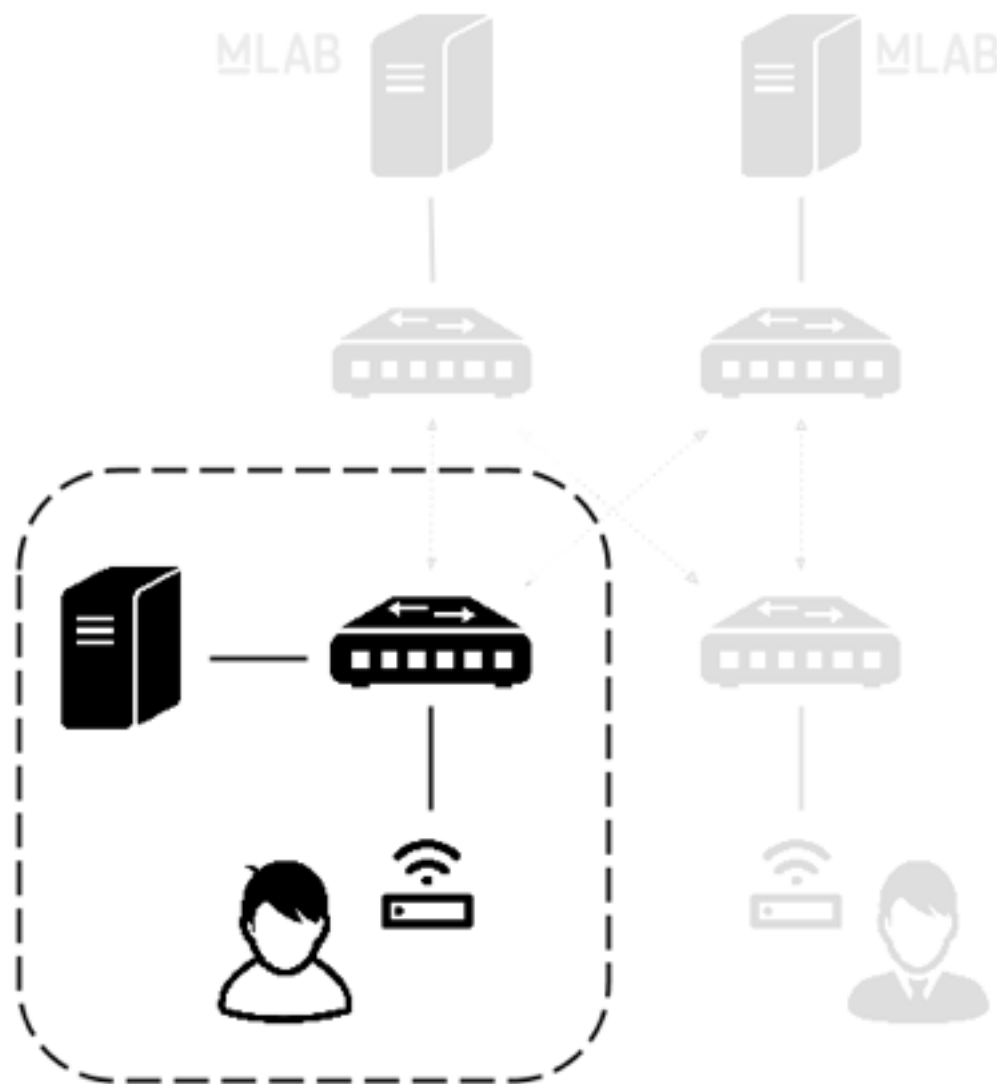
Measuring Interconnection from the Consumer's Perspective



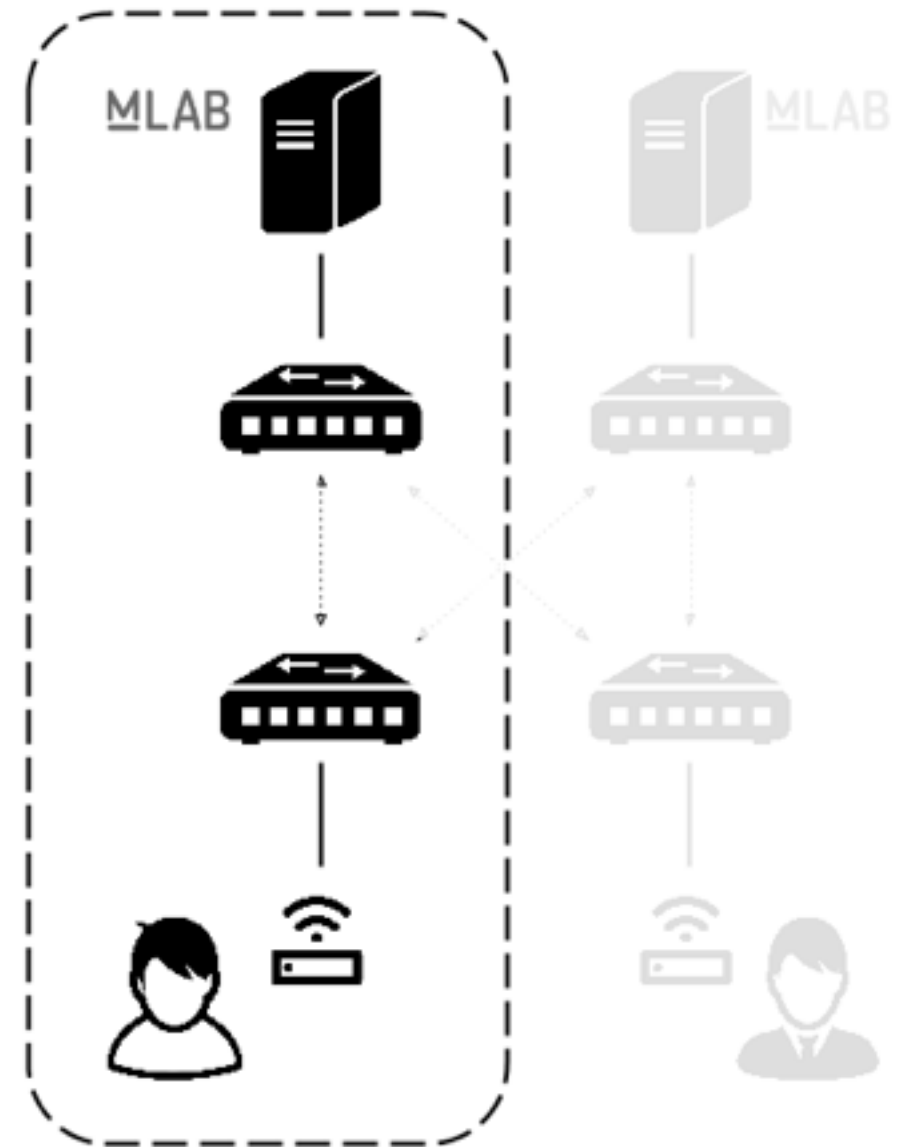
How Measurement Lab
Collects Information

Measurements From Everyone

On-Network Measurement



Full Measurement

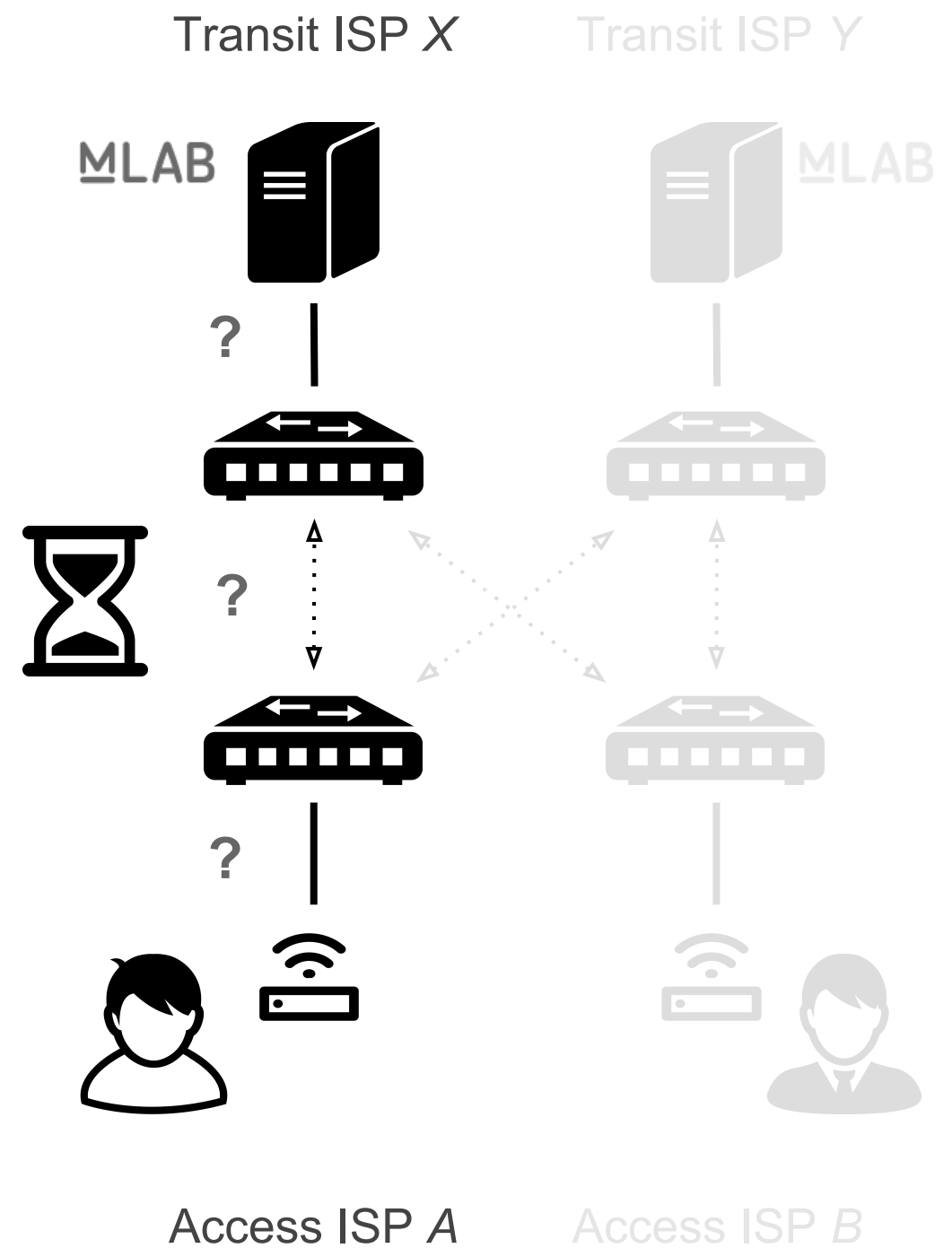


Methodology

Inferring the Source of Congestion

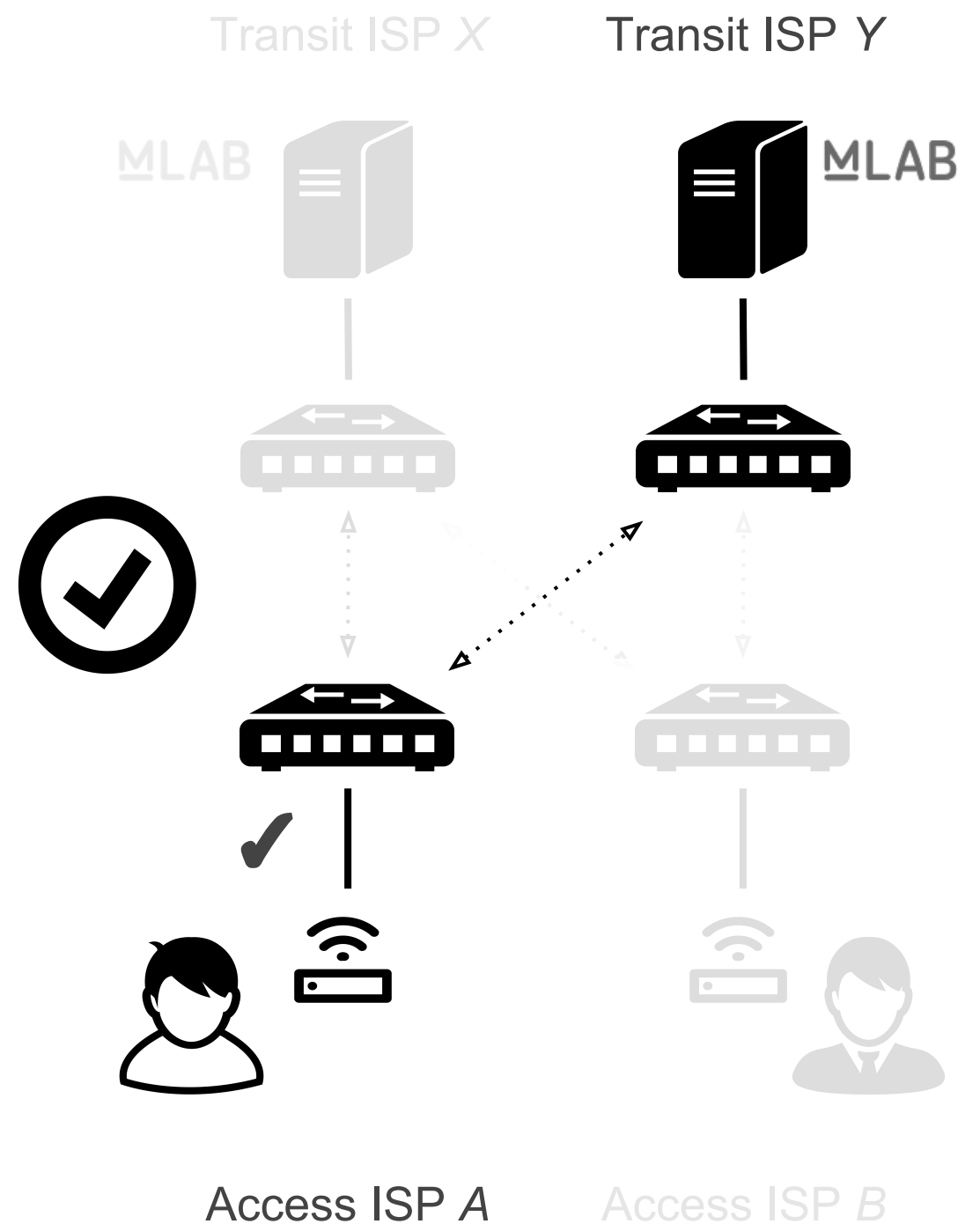
Methodology

Inferring the Source of Congestion



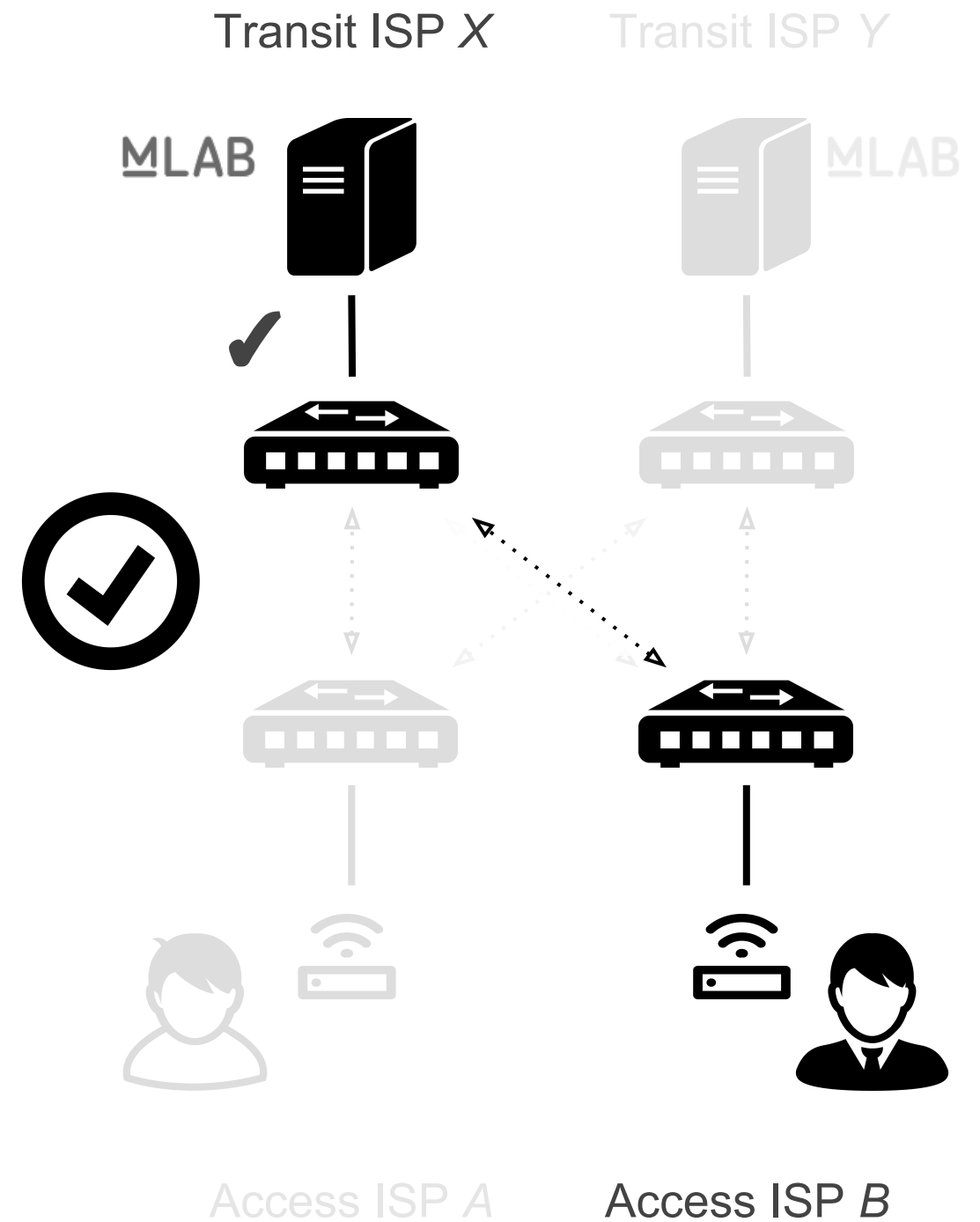
Methodology

Inferring the Source of Congestion



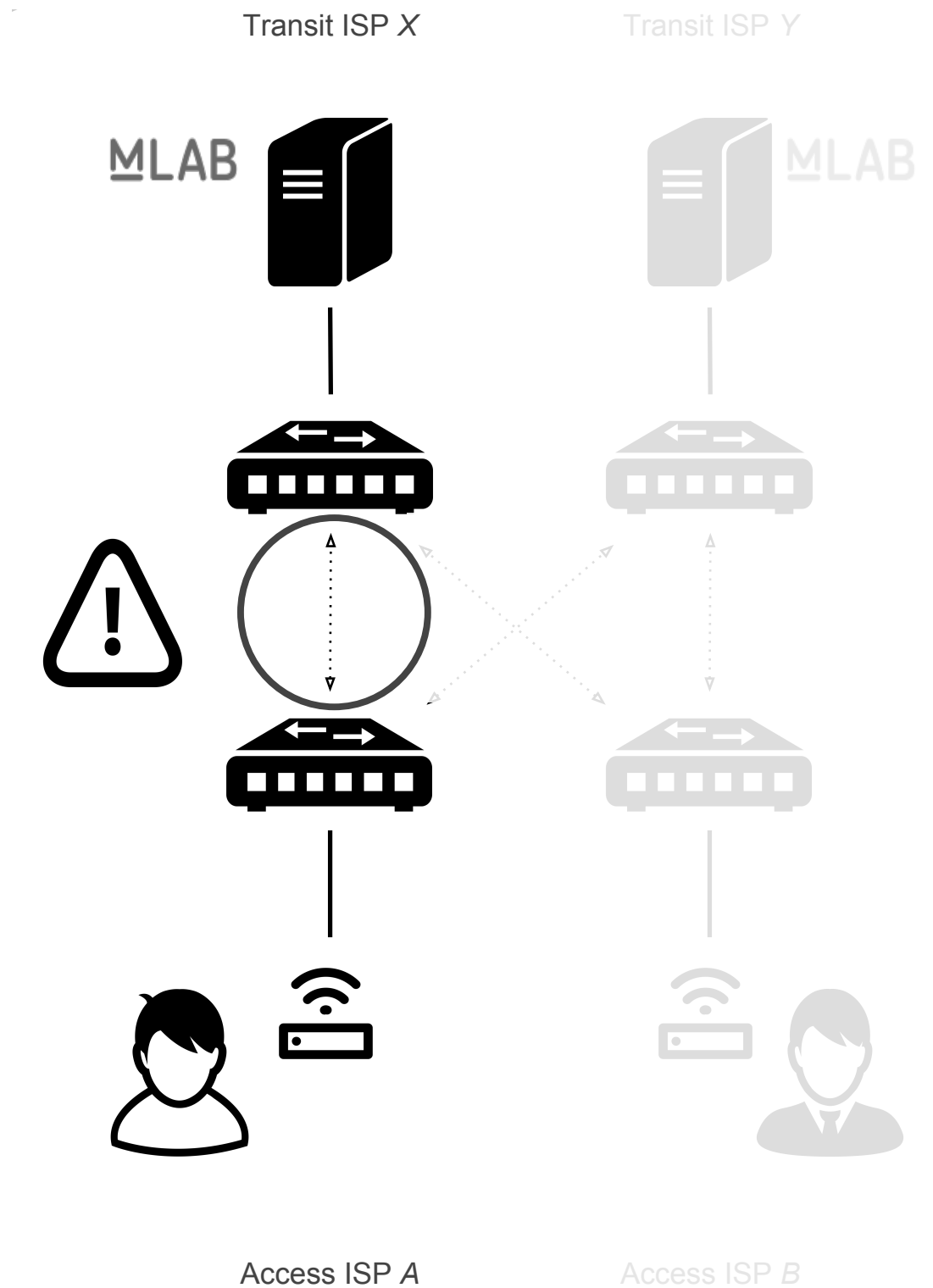
Methodology

Inferring the Source of Congestion



Methodology

Inferring the Source of Congestion



Shedding Light on the Daily Impact on Interconnection Performance



Posts: 2

Registered: 02-25-2014

✓ VPN speed issues

02-25-2014 01:07 PM

Hello,

I am a Comcast Business user with a 50/10 connection in Charlottesville, Virginia.

My needs are simple - I work in a local university hospital, and sometimes need to connect from home overnight or on weekends for urgent patient cases. So when I'm not using the connection as a home internet connection, I primarily connect to a VPN with a Citrix server, which hosts some proprietary software that displays certain patient data and relevant video. Video is vital to what I do, so I require reasonable speed.

At certain times of the day I've managed to get 15mbit/s down, and video runs at a decent speed. At peak times, however, I rarely see speeds upward of 700kbit/s down from the VPN, and the video is so slow as to be unusable, I might as well hop in my car and drive to work.

I don't know that I'm checking the appropriate servers, but I ran a tracert to comcast.net from my work computer. I see 9 hops within the intranet, and 6 hops through different Cogent servers, then finally multiple Comcast servers across the country. Granted, I'm aware that (1) my work computer is not connected to the Citrix server, and (2) comcast.net probably isn't the correct server to be pinging. Nevertheless, I think the questions are as follows:

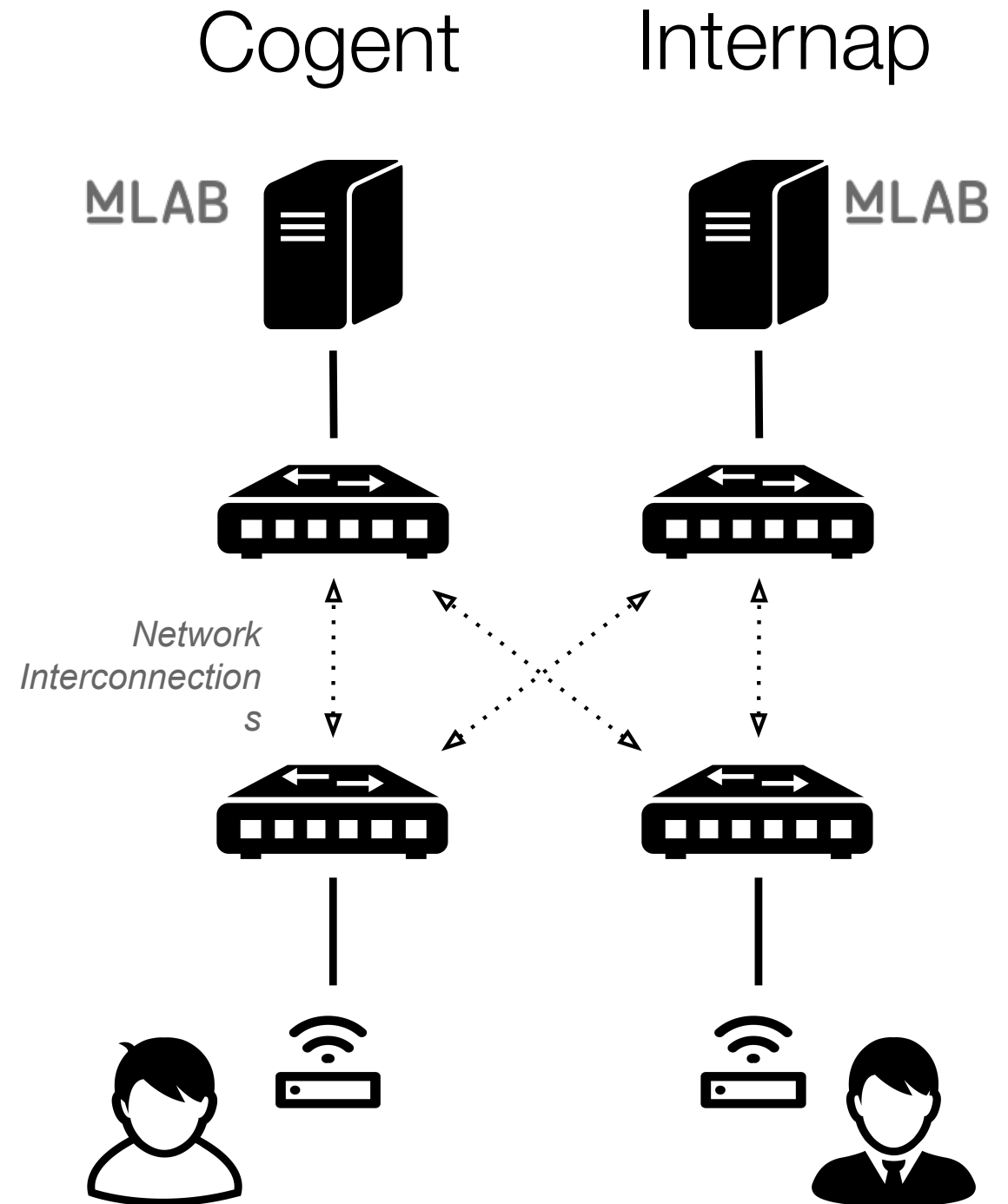
1. How can I fix this?
2. How can I fix this?
3. How can I fix this?

Inferring Sources of Congestion in Practice

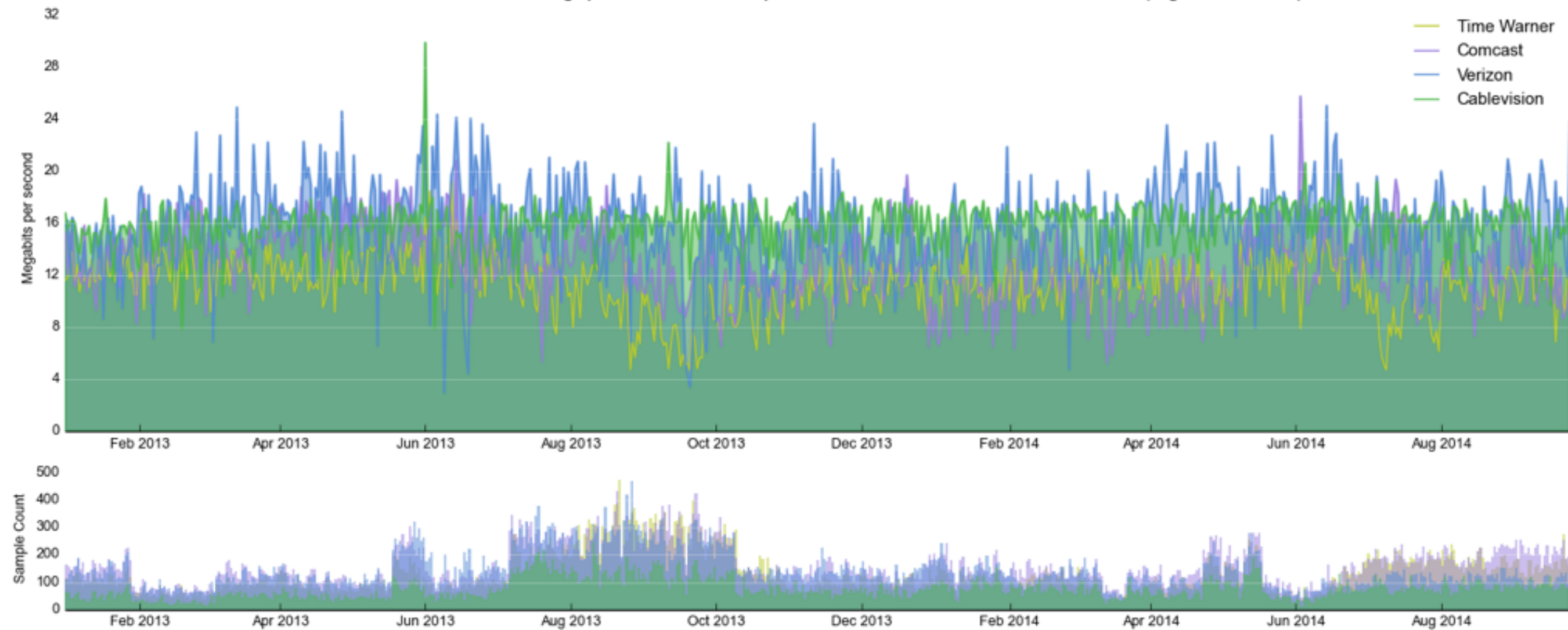
US Access ISPs and Cogent (2013-2014)

Applying our Methodology

M-Lab's New York Comparison



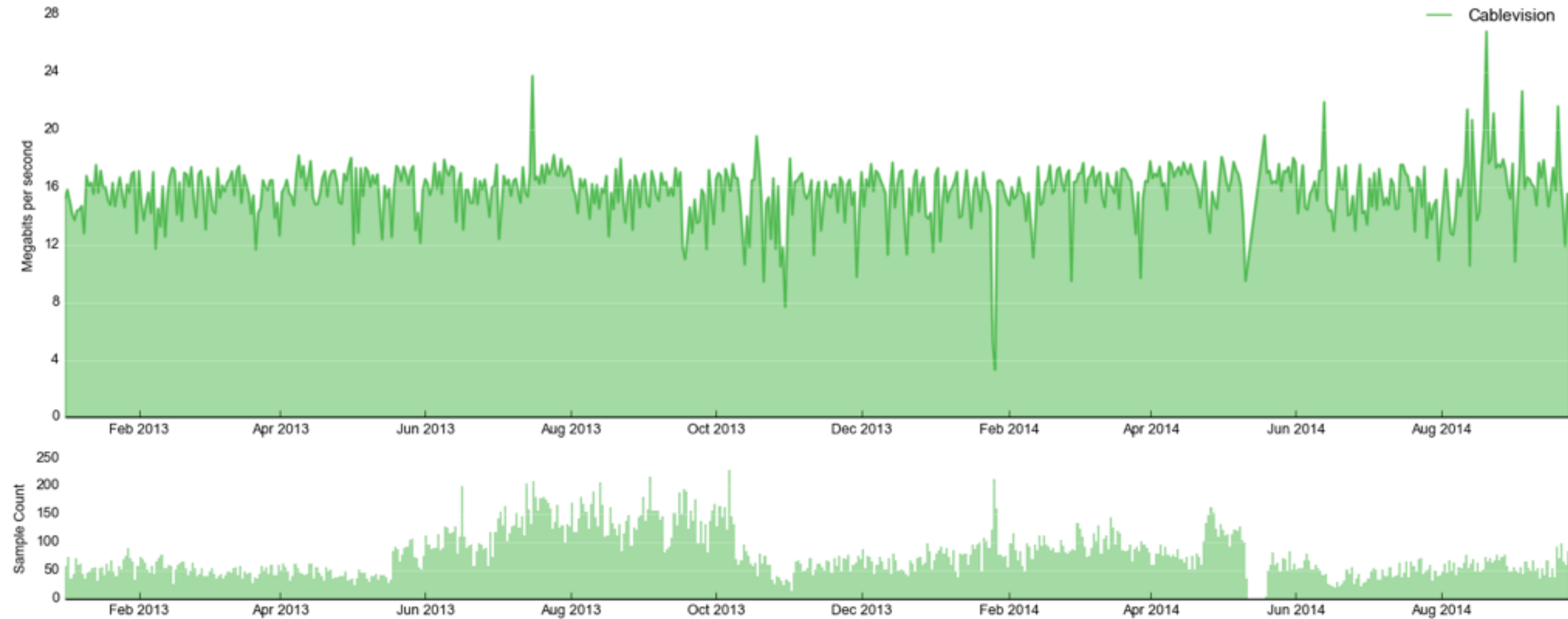
Median download throughput across Internap in NYC over time from different ISPs (higher is better)



Inferring Sources of
Congestion in Practice

Using New York's Comparison

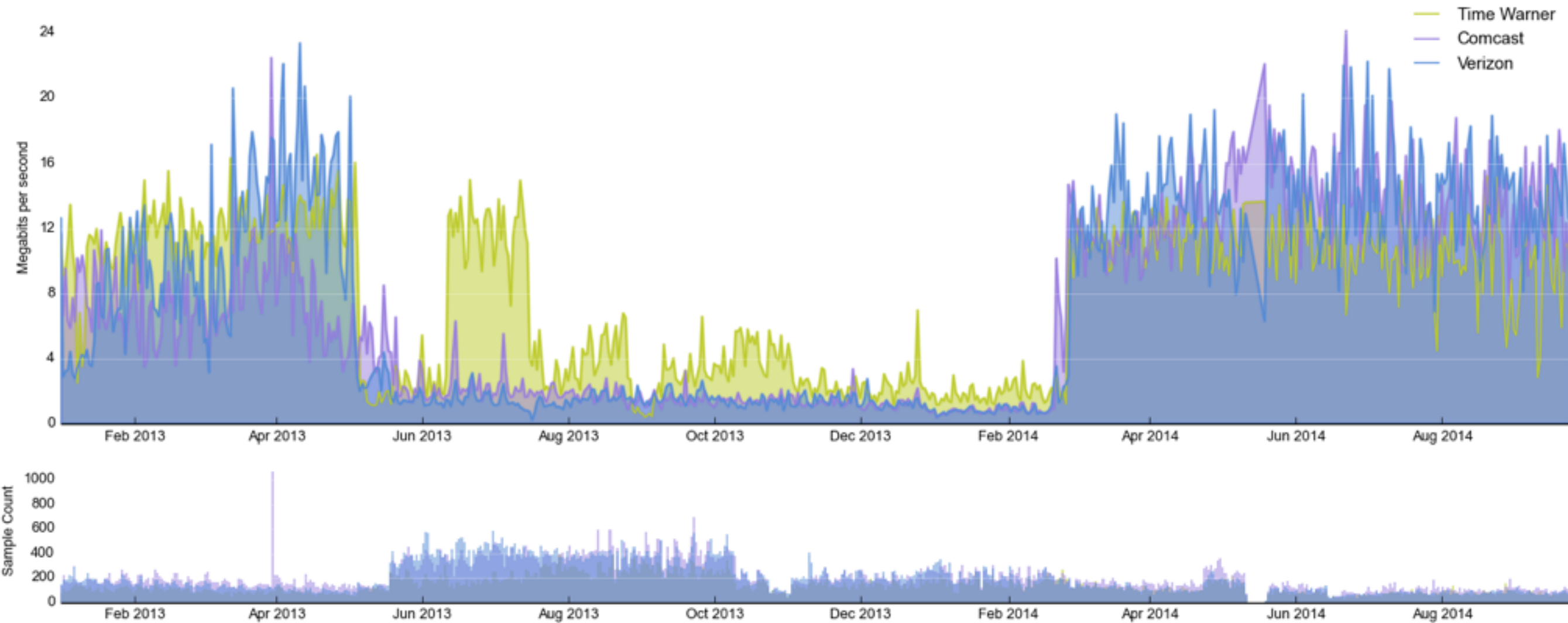
Median download throughput across Cogent to Cablevision in NYC over time (higher is better)



Inferring Sources of
Congestion in Practice

Using New York's Comparison

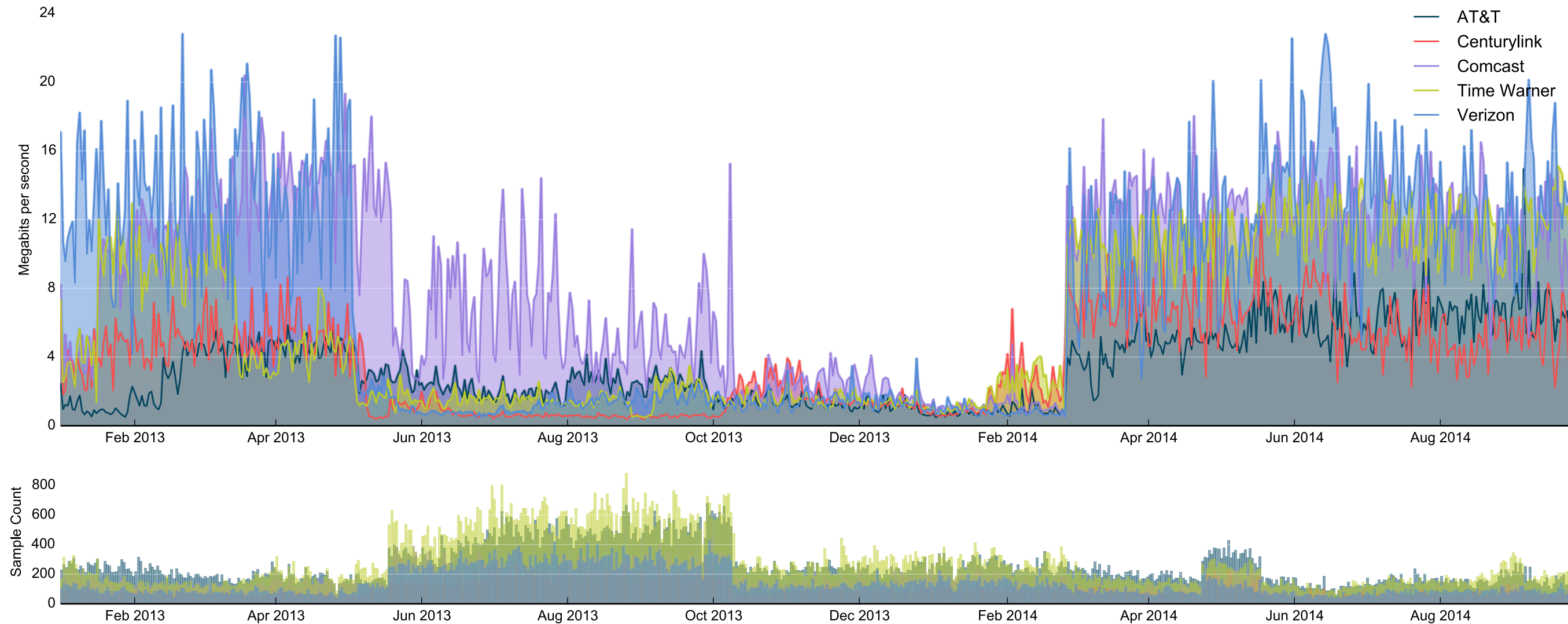
Median download throughput across Cogent in NYC over time from different ISPs (higher is better)



Inferring Sources of Congestion in Practice

US Access ISPs and Cogent (2013-2014)

Median download throughput across Cogent in LA over time from different ISPs (higher is better)

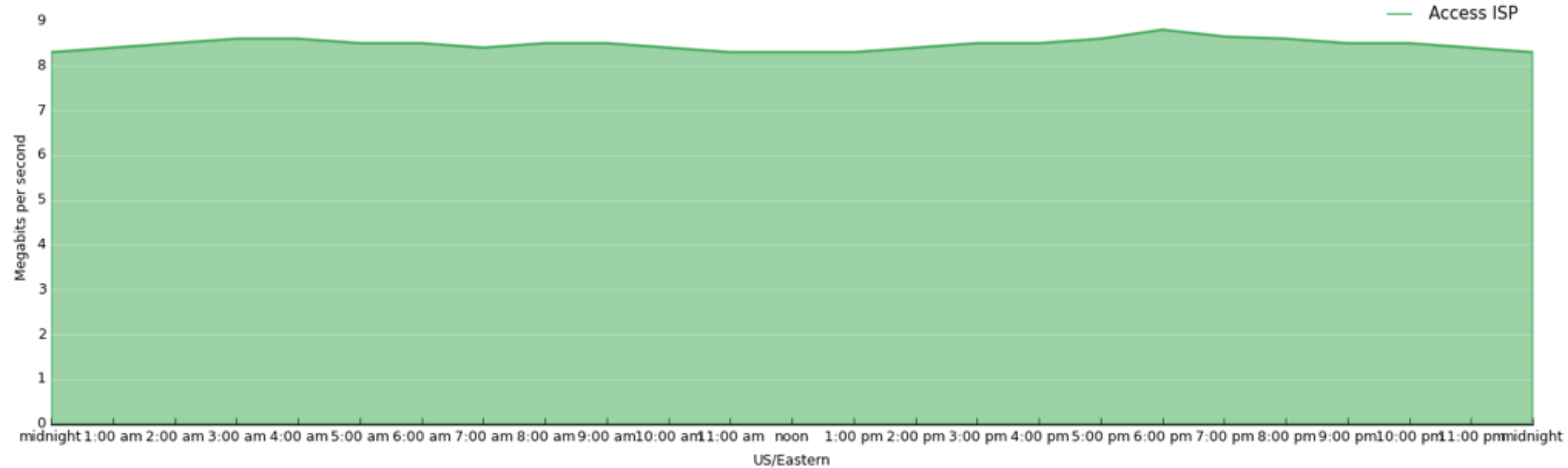


Inferring Sources of Congestion in Practice

US Access ISPs and Cogent (2013-2014)

Internet Performance Varies Significantly
Throughout the Day

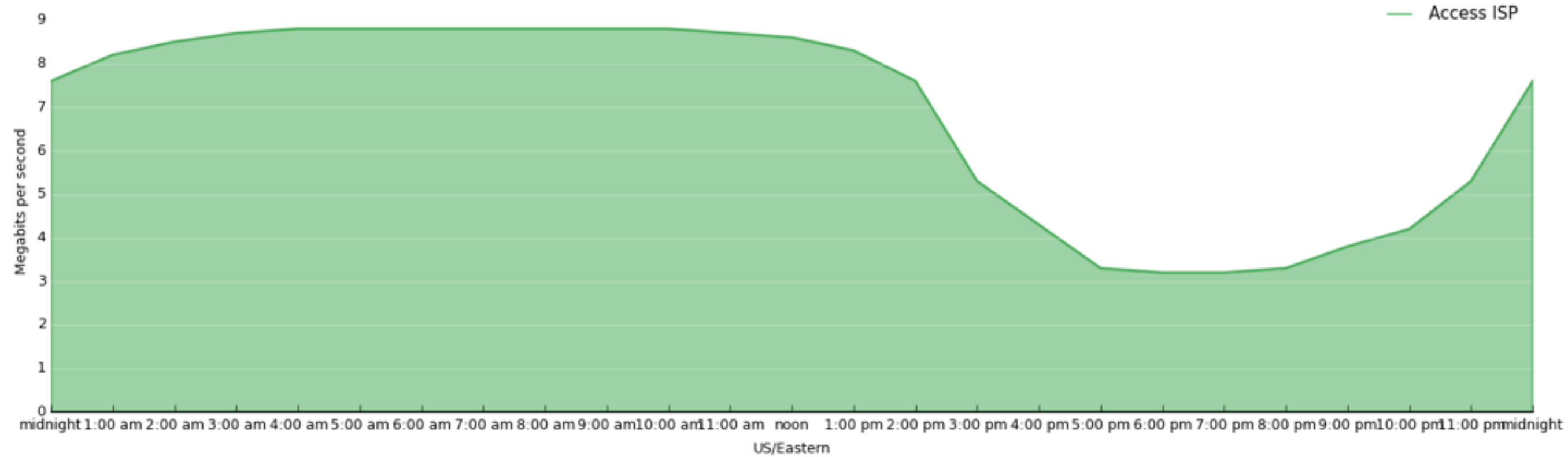
Median download throughput during the average day between access ISP and transit ISP (higher is better)



Diurnal Patterns Are
Instructive

Expectations of Normal Performance

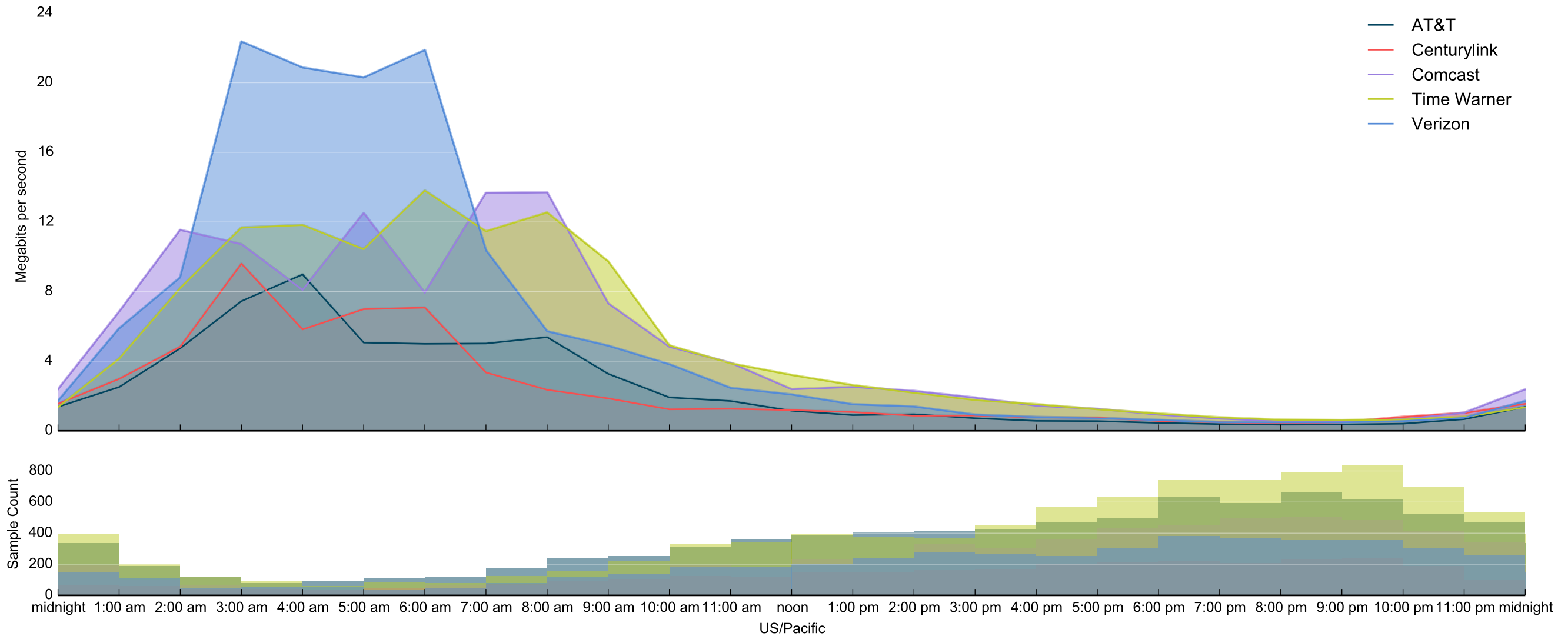
Median download throughput during the average day between access ISP and transit ISP (higher is better)



Diurnal Patterns Are
Instructive

Expectations of Congested Performance

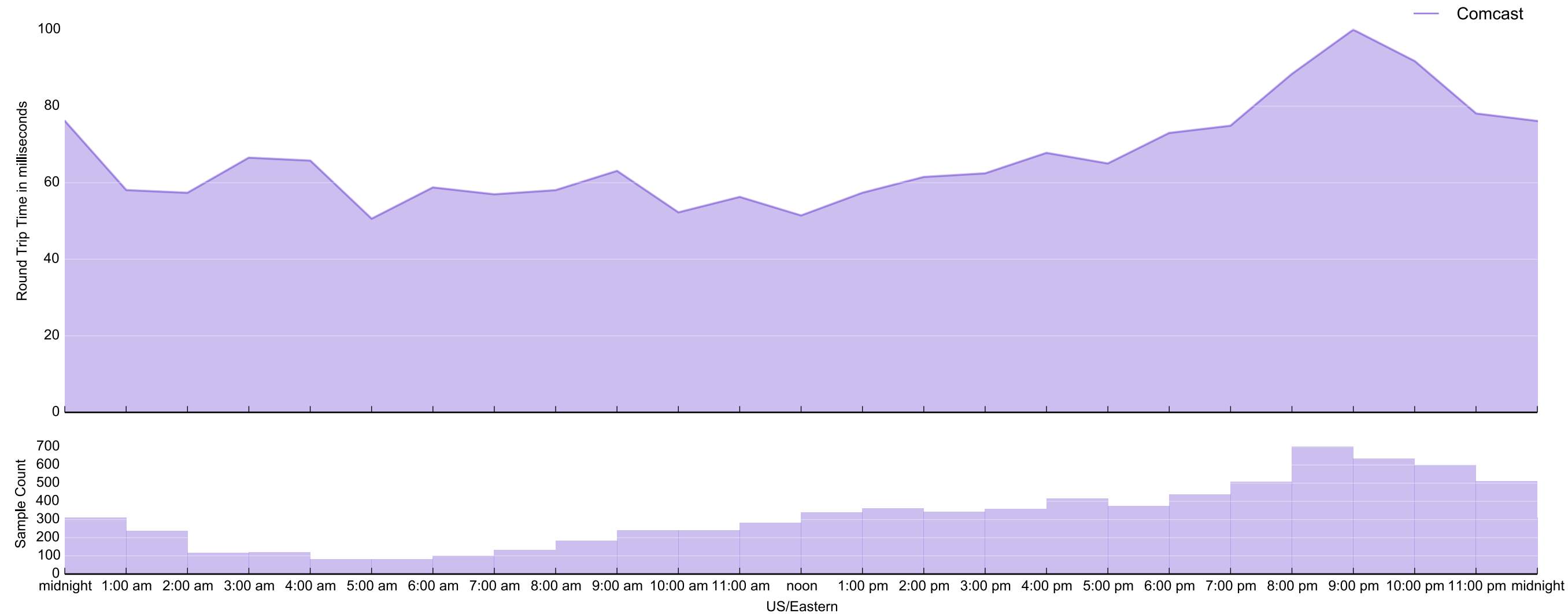
Median download throughput during the average day in January 2014 between Cogent and various ISPs in Los Angeles (higher is better)



Diurnal Cycles In Practice

Peak Hours, Peak Disruption

Median RTT during the average day in October 2013 between Level 3 and Comcast in Atlanta (lower is better)



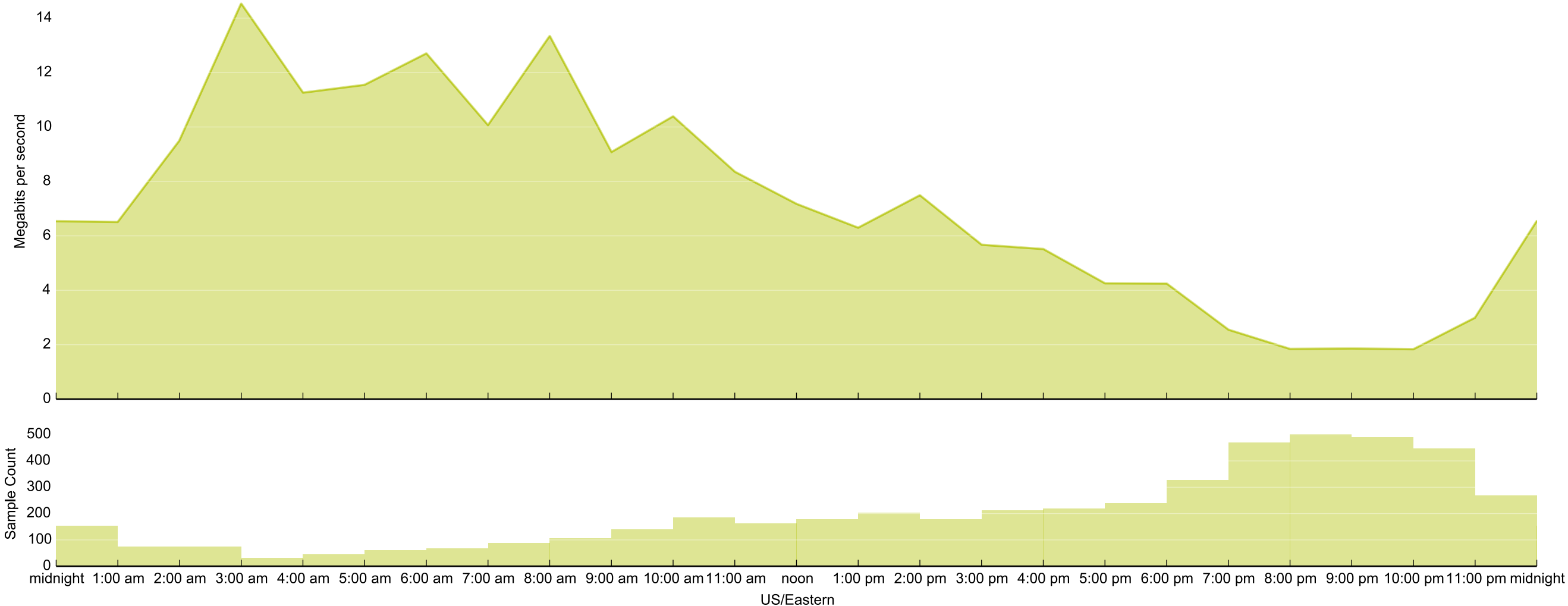
Not Limited to Download

Latency Sensitive Applications Affected

Congestion has not been Limited to
Interconnections with Cogent or Specific Services

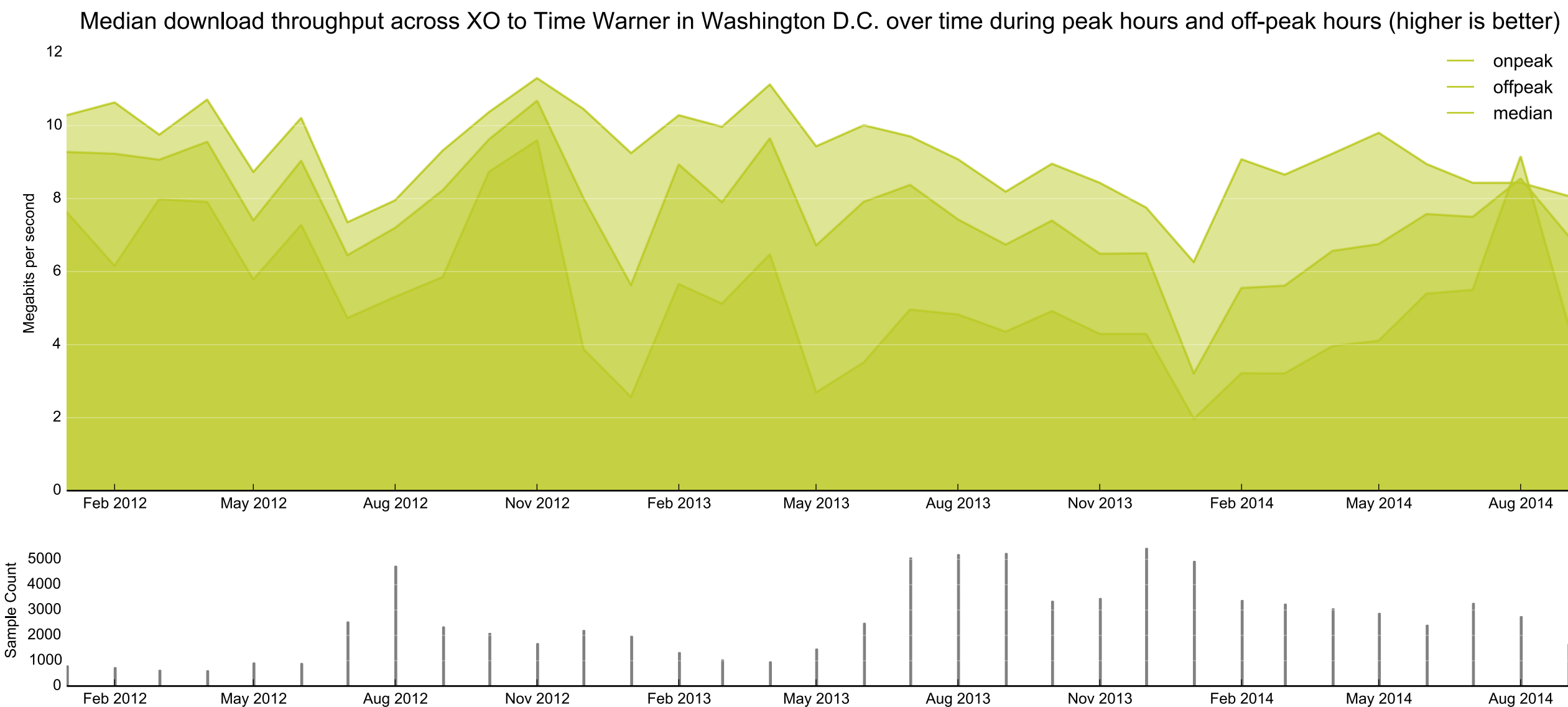
Median download throughput during the average day in January 2014 between XO and Time Warner in Washington D.C. (higher is better)

Time Warner



Level 3 and Verizon

Not Limited to Cogent

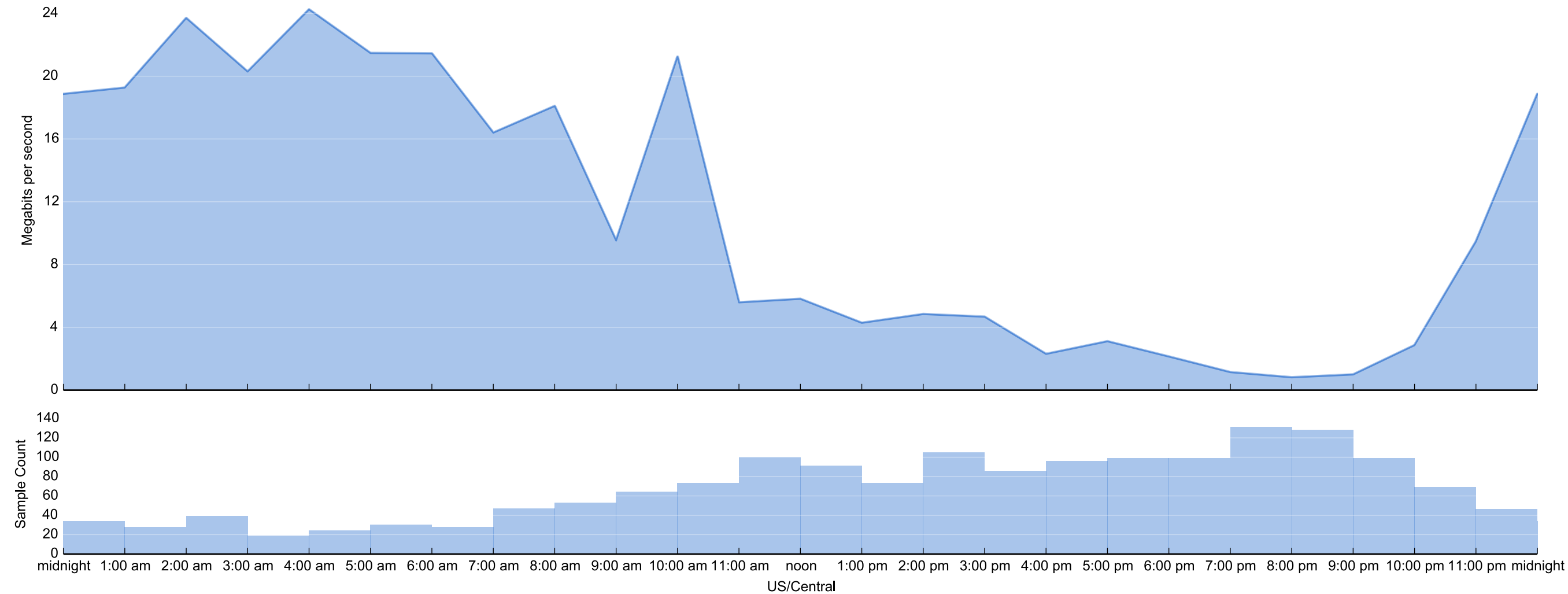


XO and Time Warner Cable

Not Limited to Cogent

Median download throughput during the average day in February 2014 between Level 3 and Verizon in Chicago (higher is better)

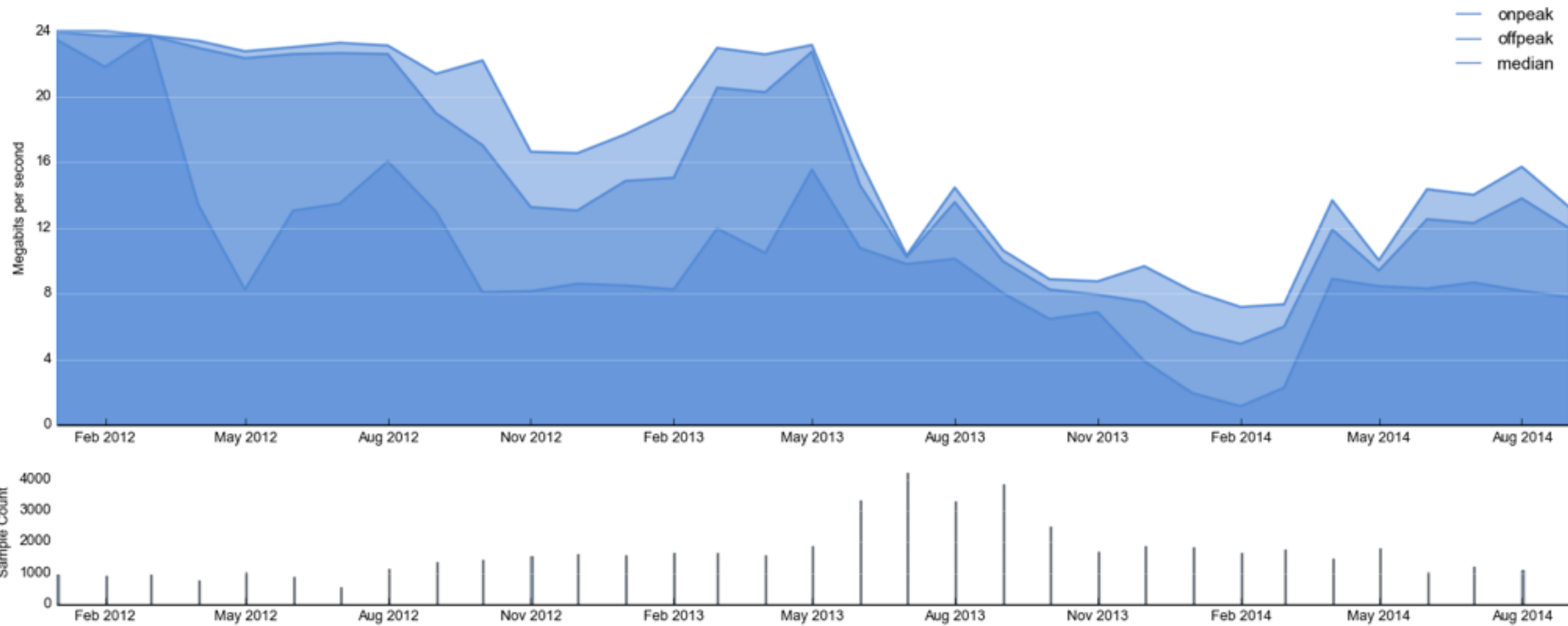
Verizon



XO and Time Warner Cable

Not Limited to Cogent

Median download throughput across Level 3 to Verizon in Chicago (higher is better)

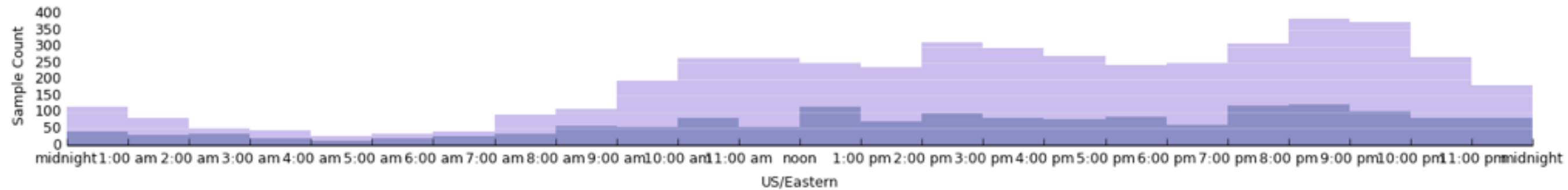
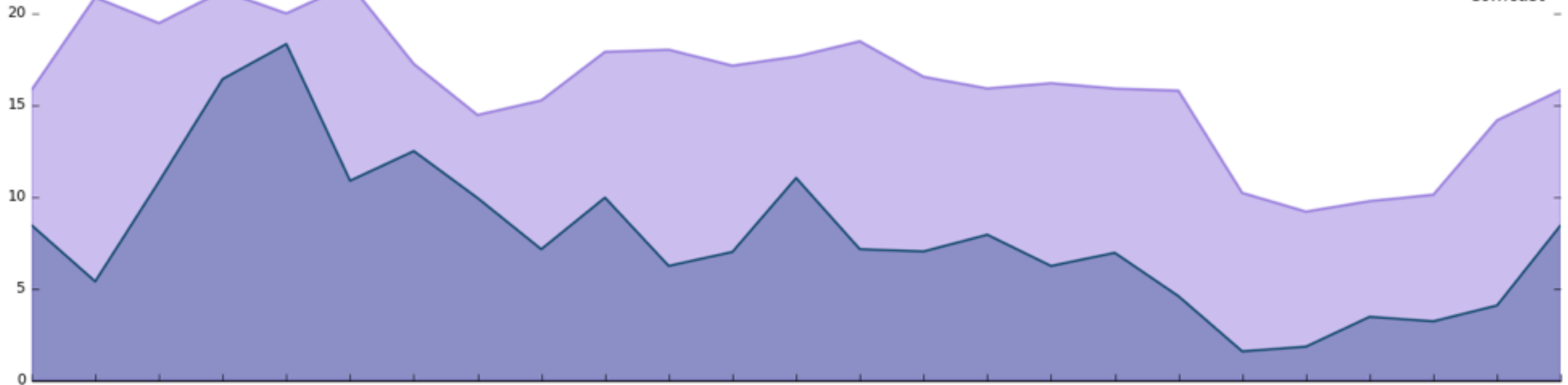


Level 3 and Verizon

Not Limited to Cogent

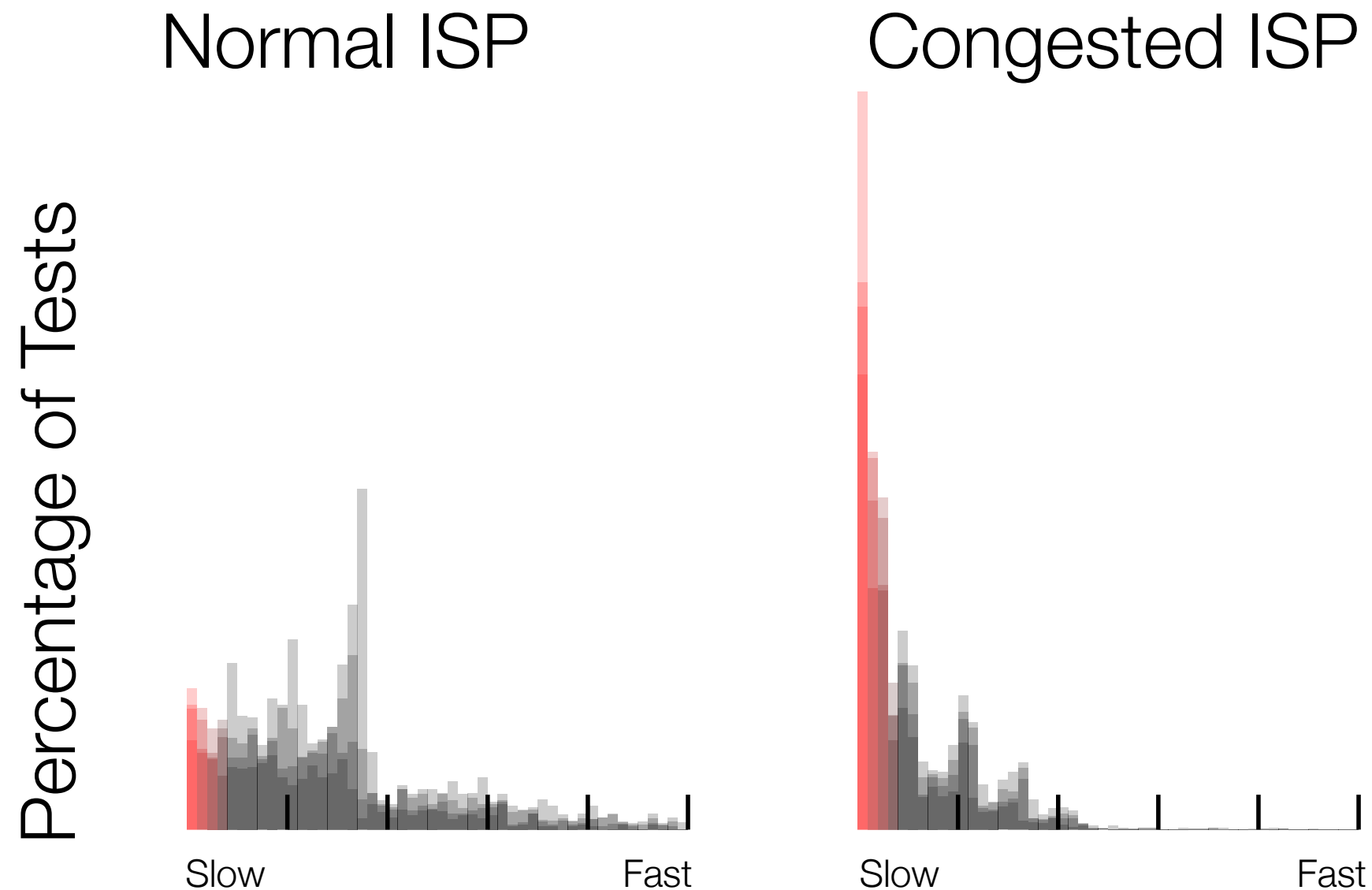
Median download throughput across XO in Washington D.C. for Fall 2014

AT&T
Comcast



Congestion is Continuing

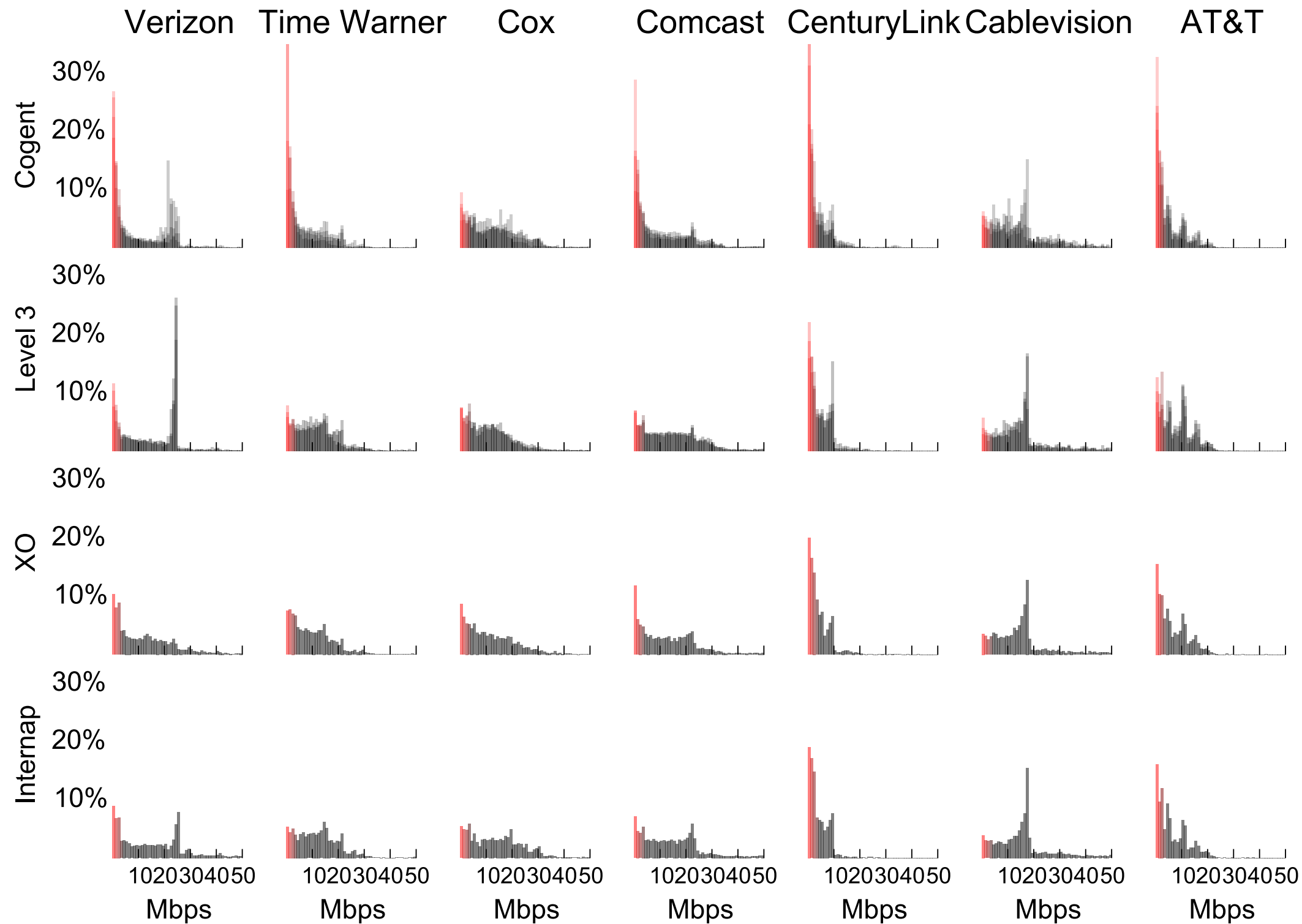
Congestion as of Fall 2014



Comparative
Performance across ISPs

No Access ISPs or Transit ISPs Universally Underperforming

Access/Transit pair download throughput performance in Mbps in 2013

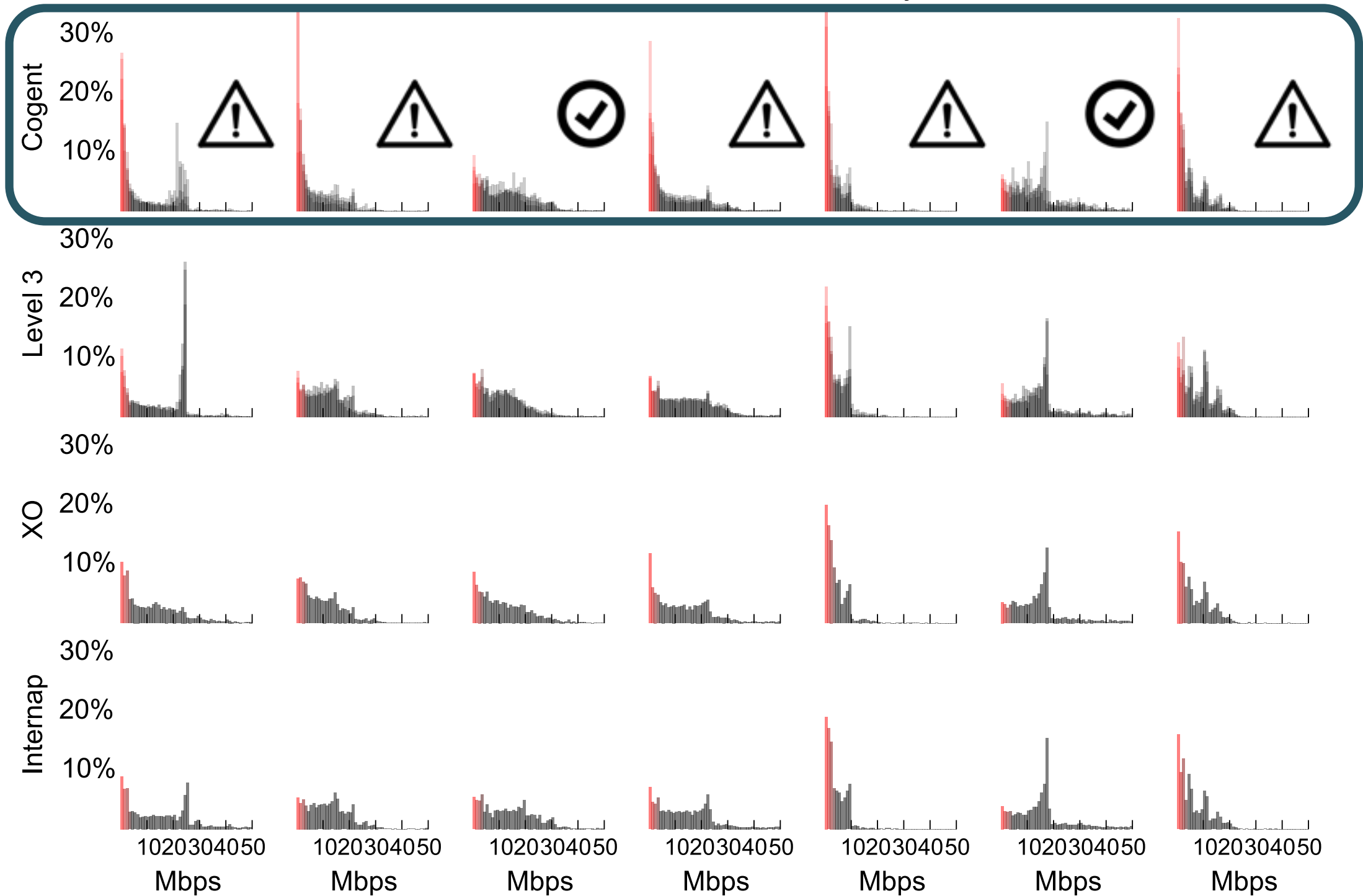


Comparative
Performance across ISPs

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Access/Transit pair download throughput performance in Mbps in 2013

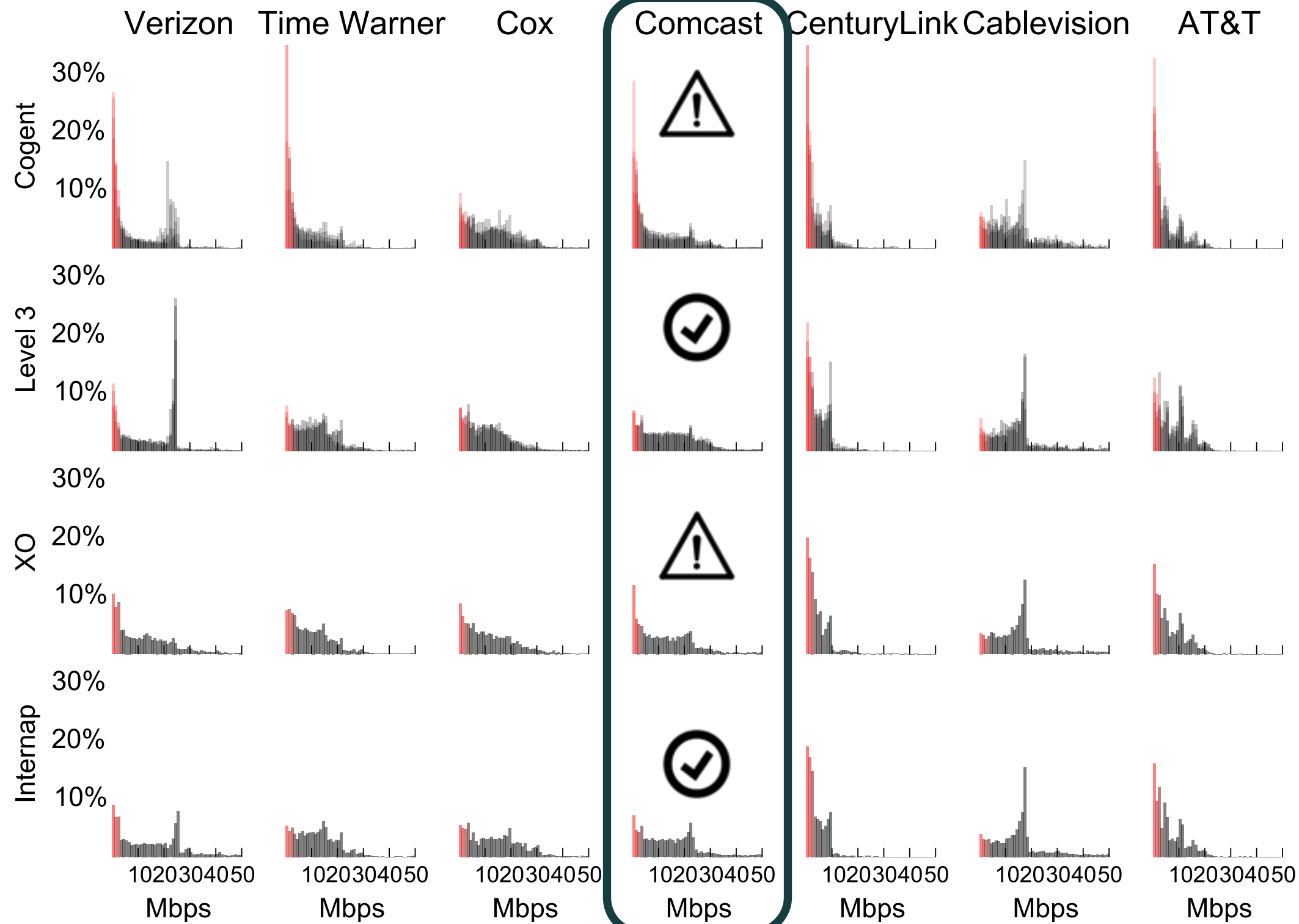
Verizon Time Warner Cox Comcast CenturyLink Cablevision AT&T



Comparative Performance across ISPs

No Access ISPs or Transit ISPs Universally Underperforming

Access/Transit pair download throughput performance in Mbps in 2013



Comparative
Performance across ISPs

No Access ISPs or Transit ISPs Universally Underperforming

Review and Conclusions

Our data shows that traffic from specific Access ISP customers across interconnections with specific Transit ISPs experienced degraded performance, and that this degradation forms a pattern wherever specific Access ISPs and Transit ISPs exchange traffic.

[Explore](#)[Compare](#)[How this works](#)

Metric ▾

View By ▾

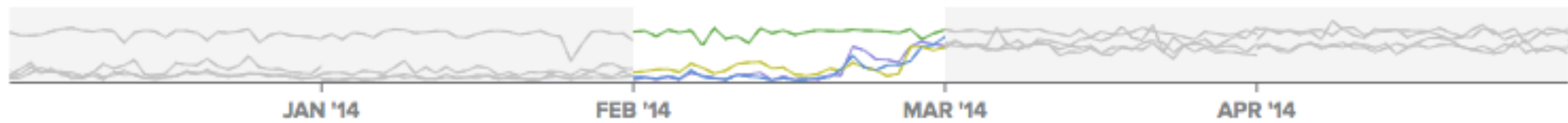
Metro Region ▾

Download Speed for New York

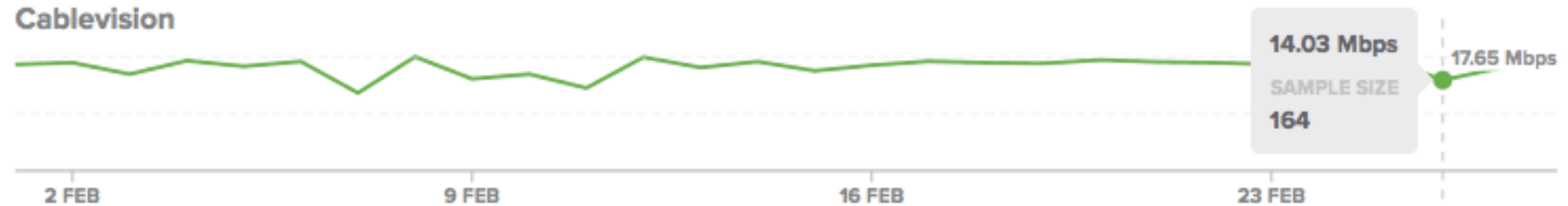
FEB 1 – 28, 2014

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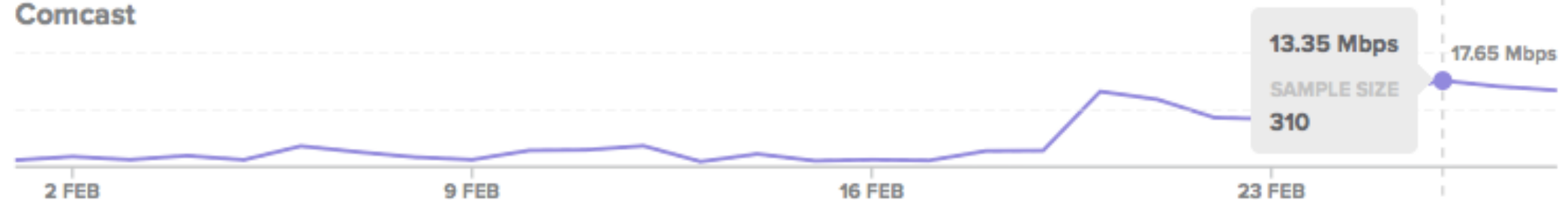
Click and drag left or right to adjust monthly date range



Cablevision



Comcast



Measurement Lab
Observatory

Extending the Interconnection Study

ISP Interconnection and its Impact on Consumer Internet Performance

Measurement Lab

measurementlab.net

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