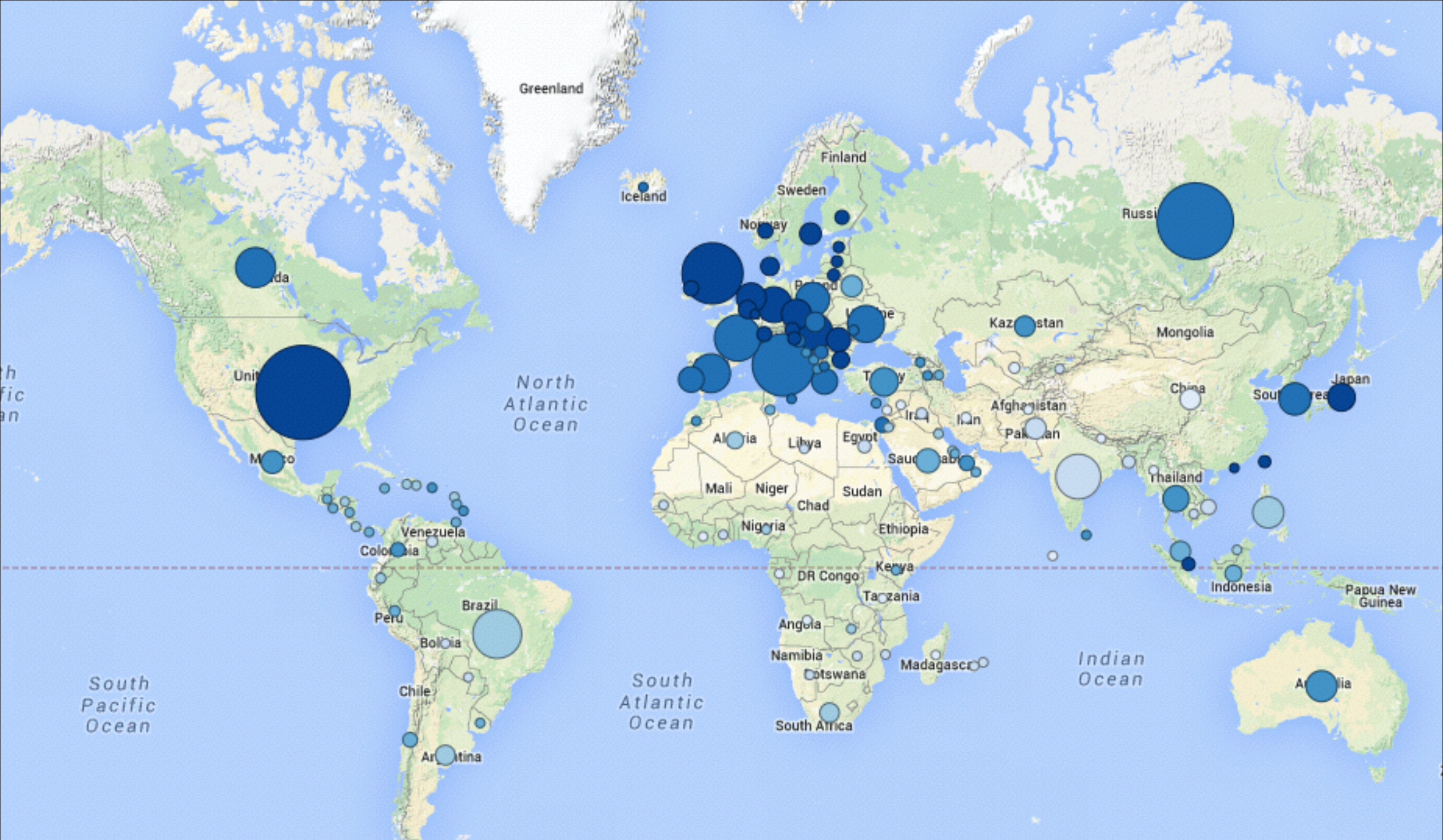


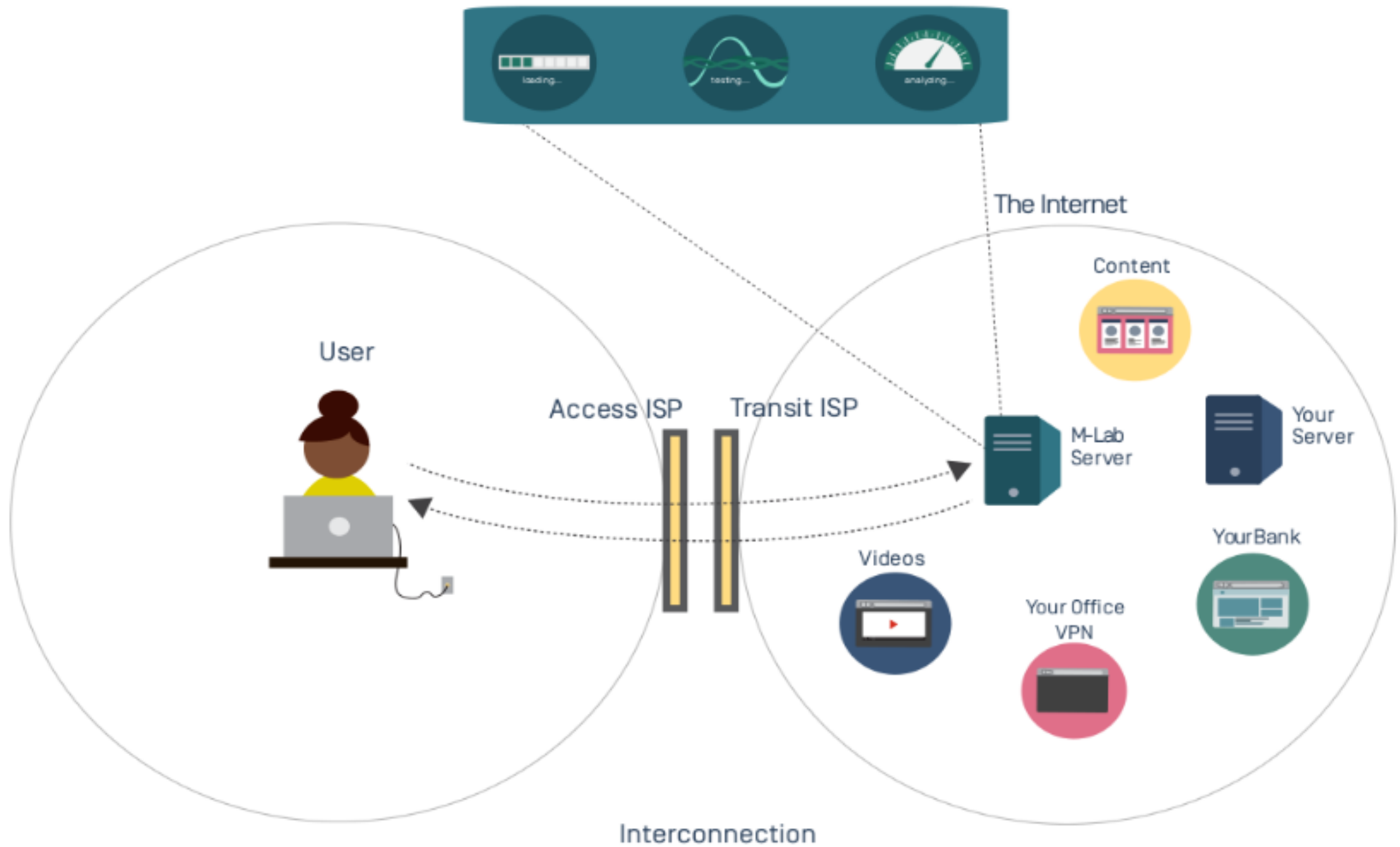
ISP Interconnection and its Impact on Consumer Internet Performance

Measurement Lab



How Measurement Lab
Collects Information

About 200,000 Test Per Day



How Measurement Lab
Collects Information

Measurements From Everyone

HOME | POLICY | TECHNOLOGY

FCC to probe interconnection deals between Internet providers, websites



11



10



5



5



COMMENTS 2

**SIGN UP FOR THE HILL'S
EMAILS AND ALERTS**

Enter Your Email Address

SIGNUP >**MORE TECHNOLOGY HEADLINES**

Tech donors nearly struck out in '14

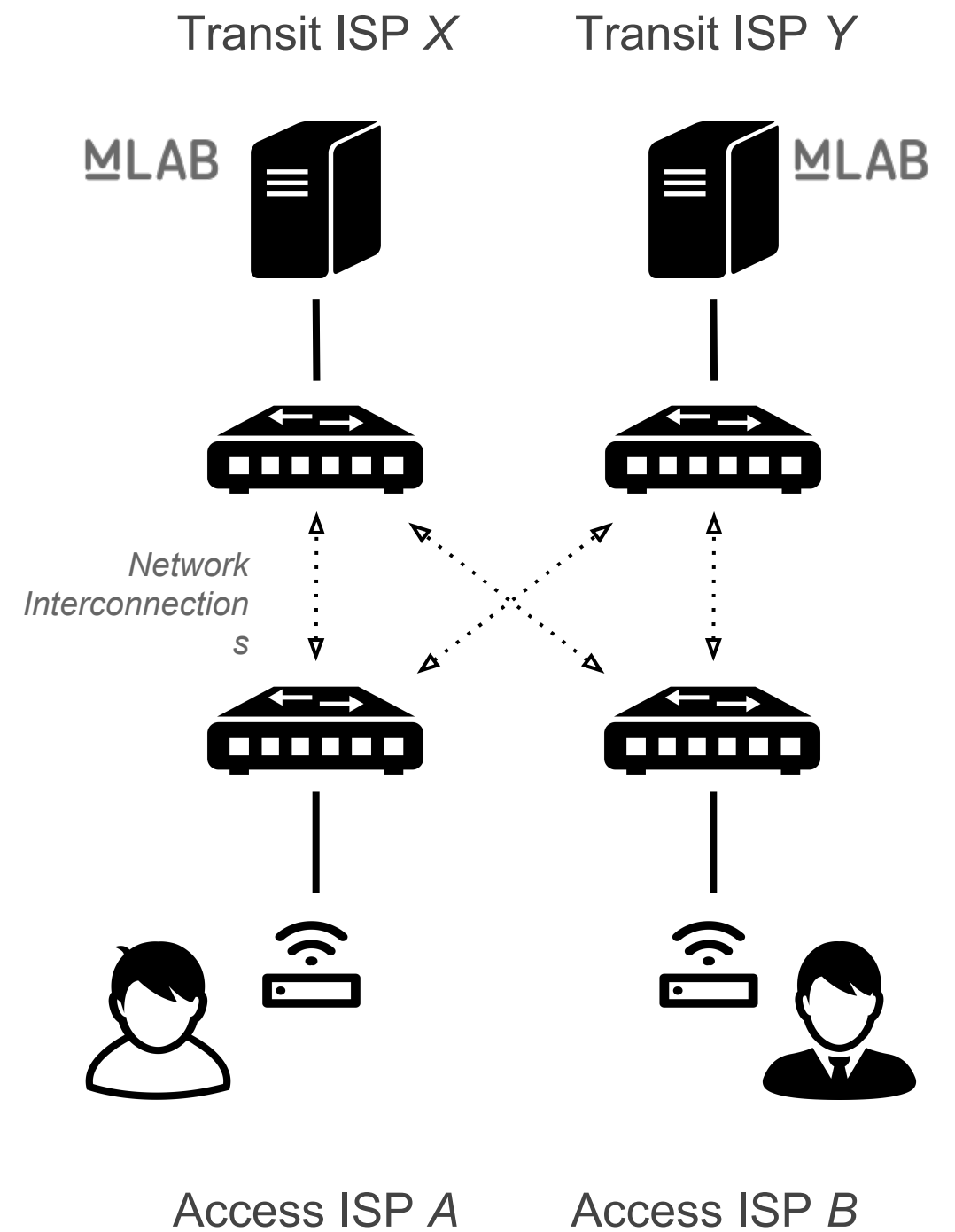
ACLU slams 'no-fly zone' over Ferguson

Measurement has a
Place in Policy

We can measure this!

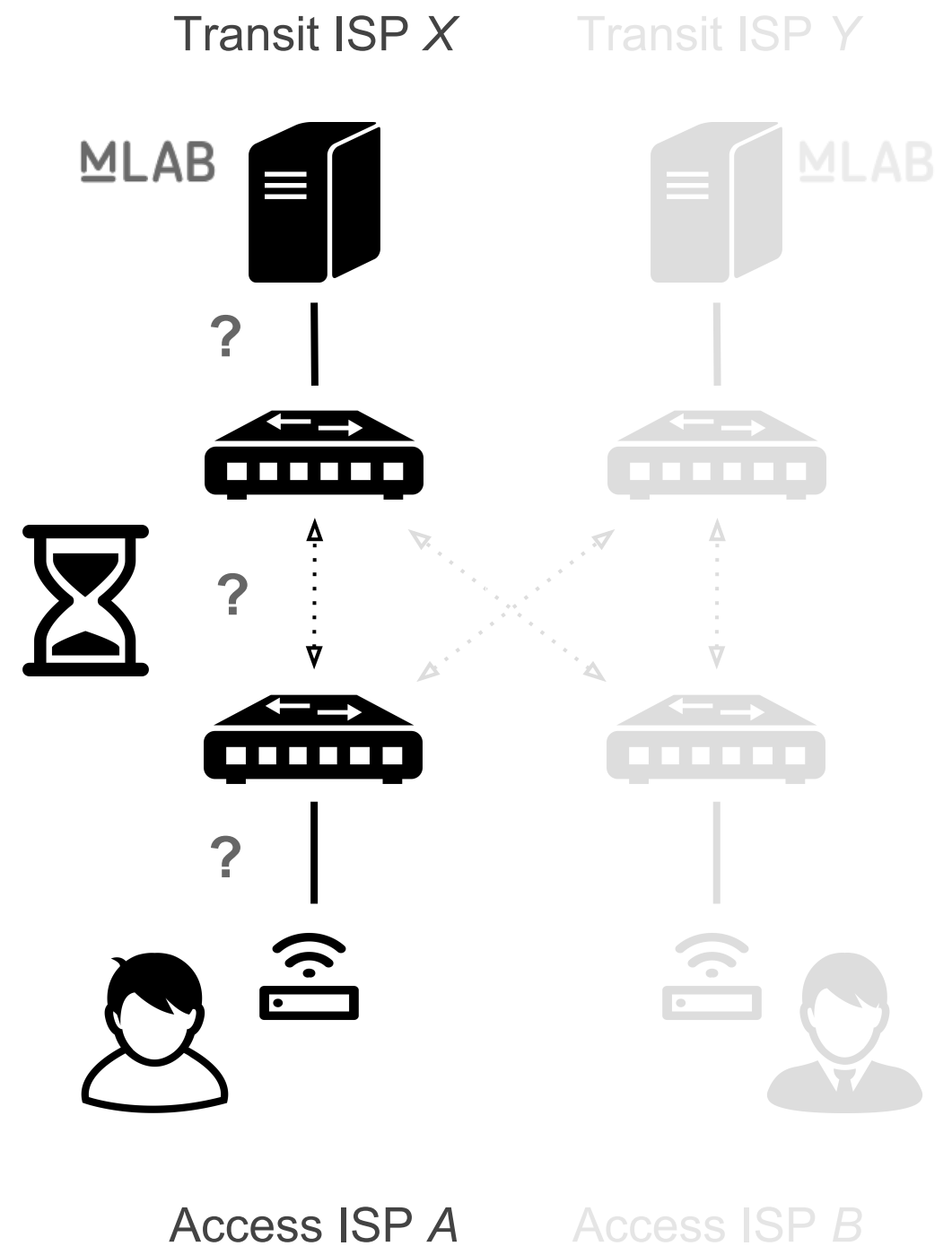
Methodology

Inferring the Source of Congestion



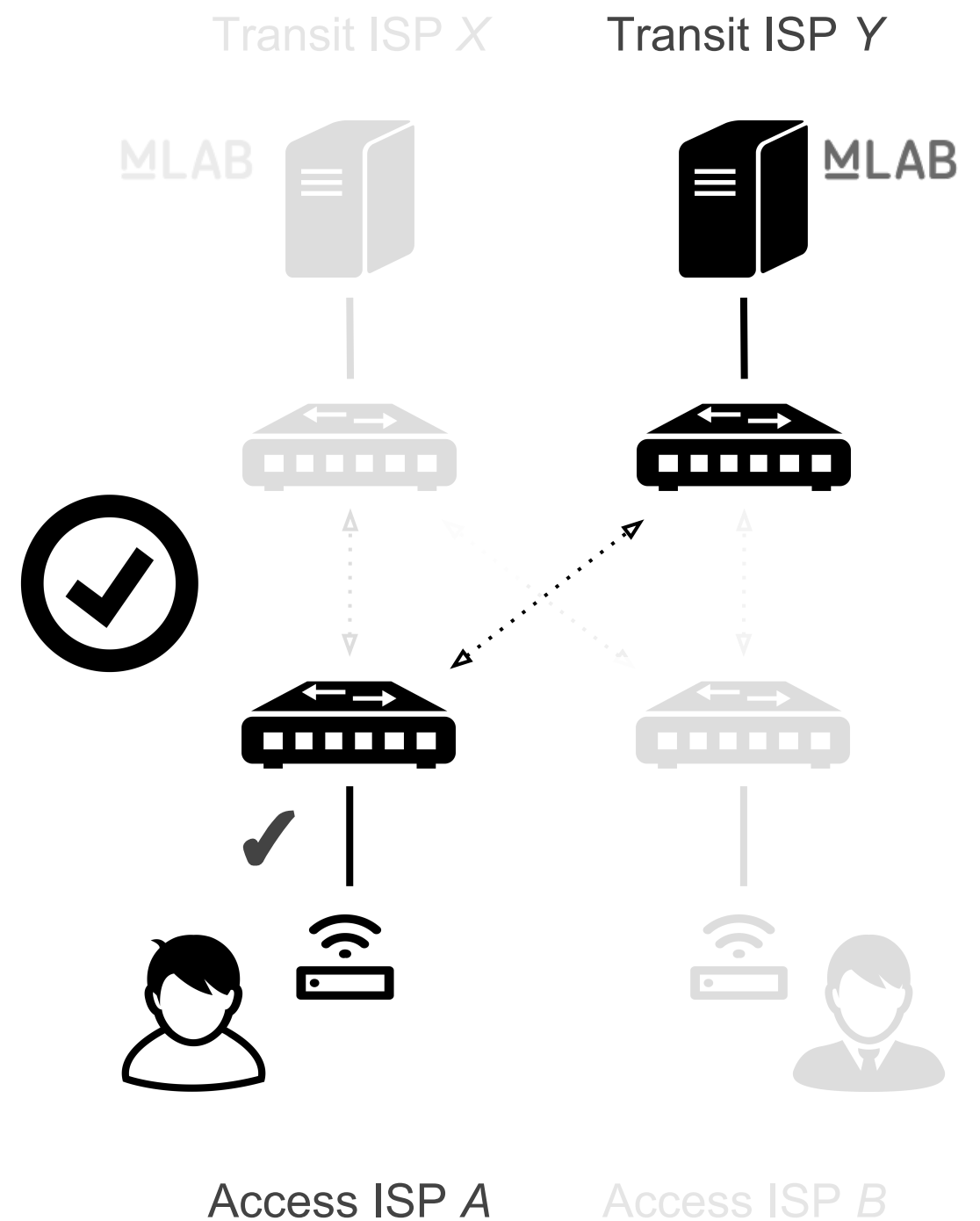
Methodology

Inferring the Source of Congestion



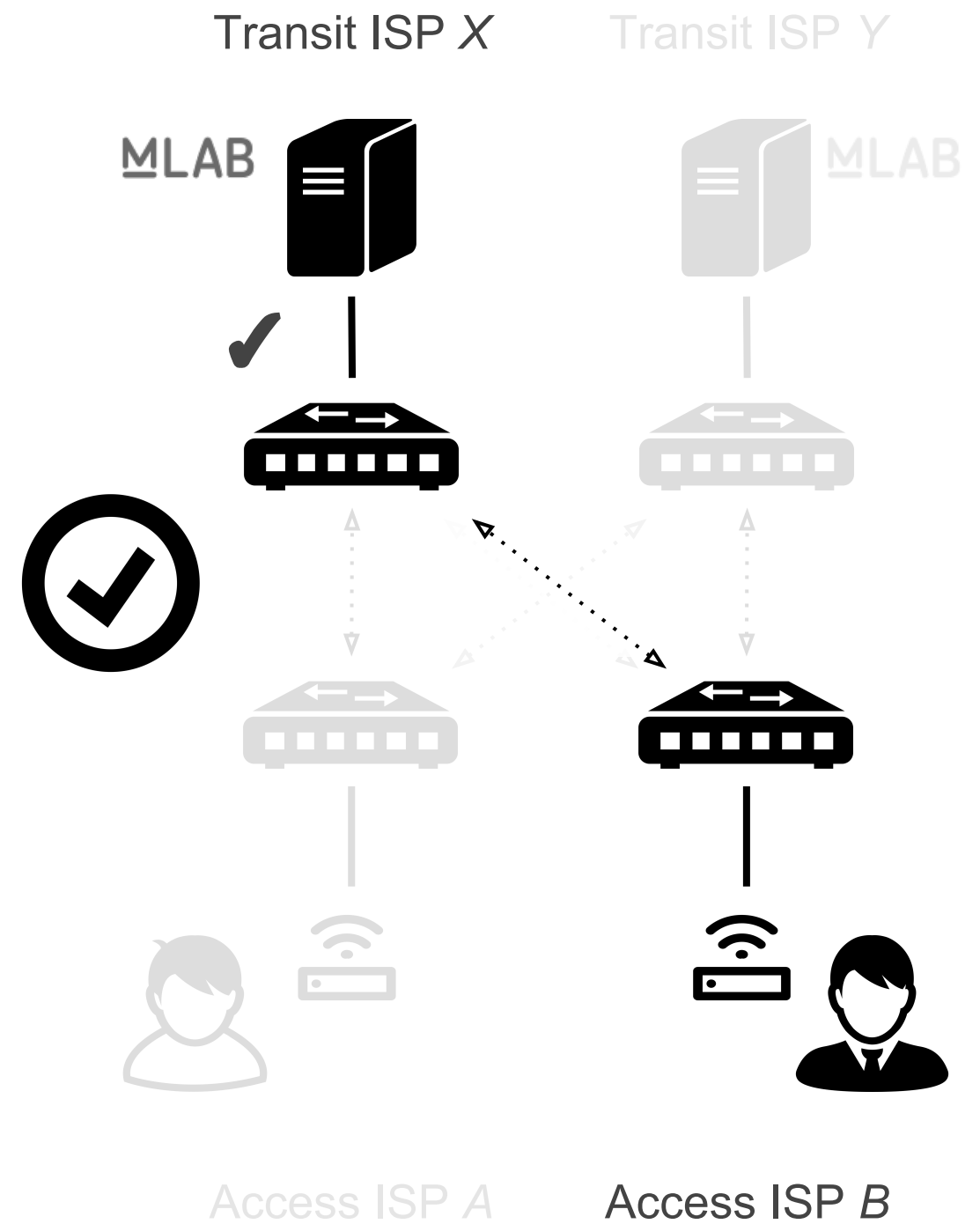
Methodology

Inferring the Source of Congestion



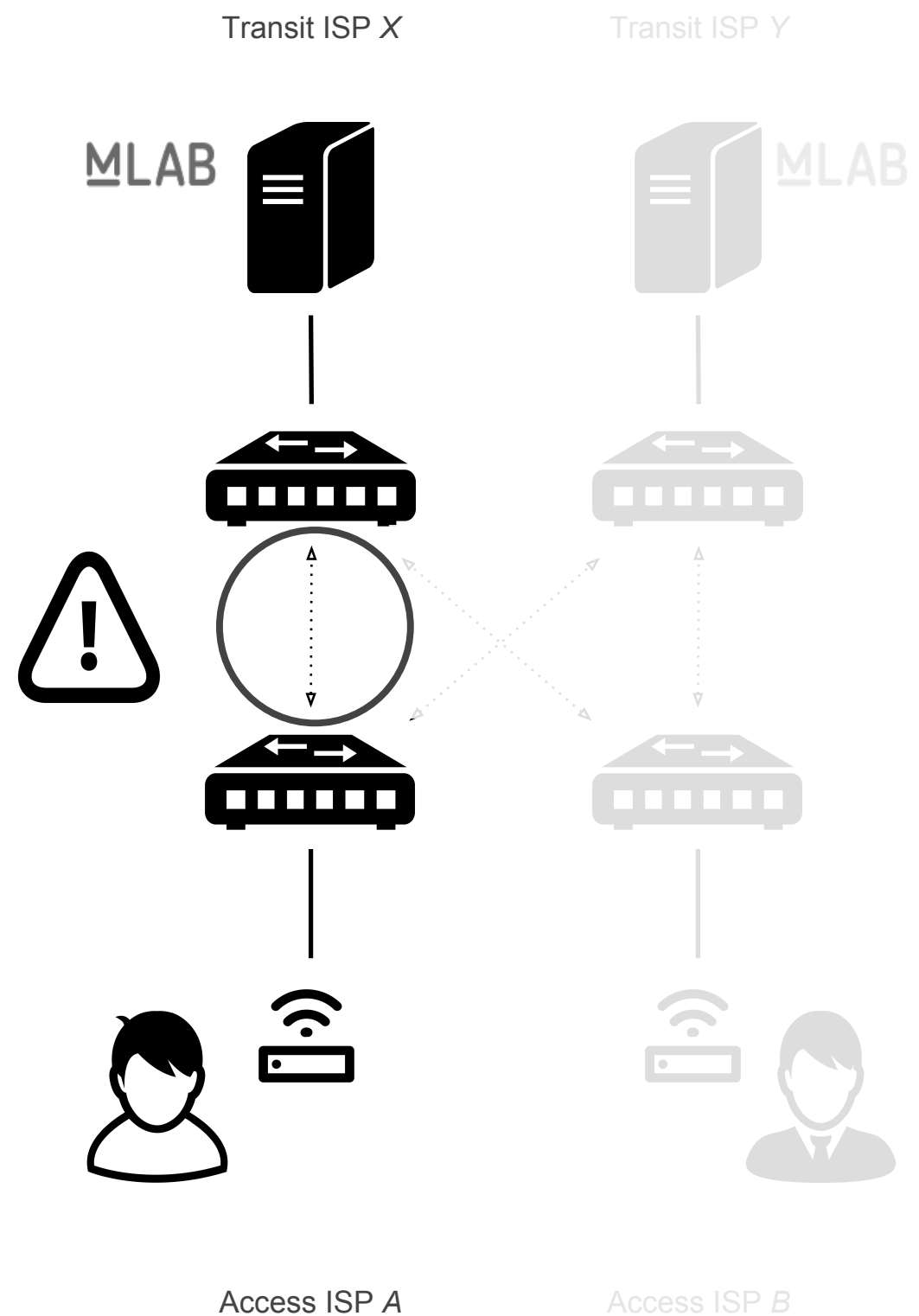
Methodology

Inferring the Source of Congestion



Methodology

Inferring the Source of Congestion





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 slow as to be unusable, I might as well hop in my car and drive to work.

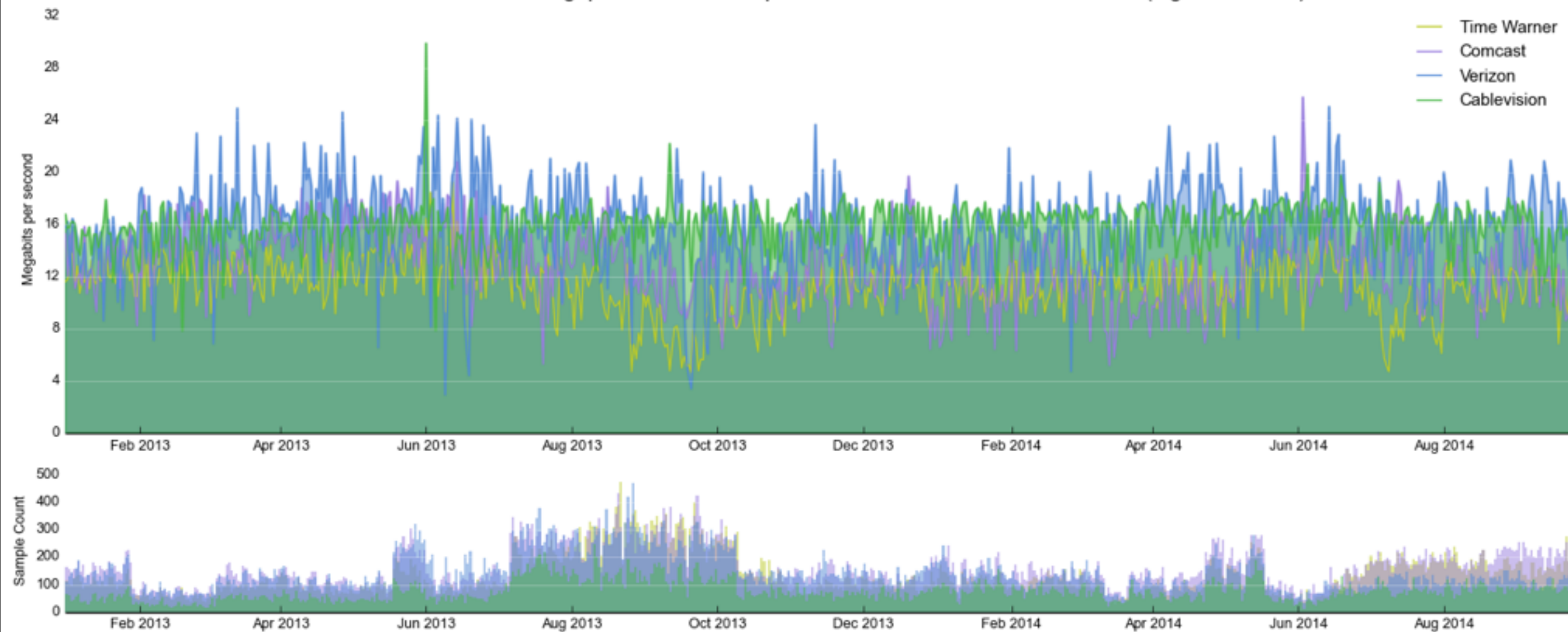
I don't know that I'm checking the appropriate servers, but I ran a tracert to comcast.net from my work computer. I see 9 hops within the intranet, and 6 hops through different Cogent servers, then finally multiple Comcast servers across the country. Granted, I'm aware that (1) my work computer is not 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)

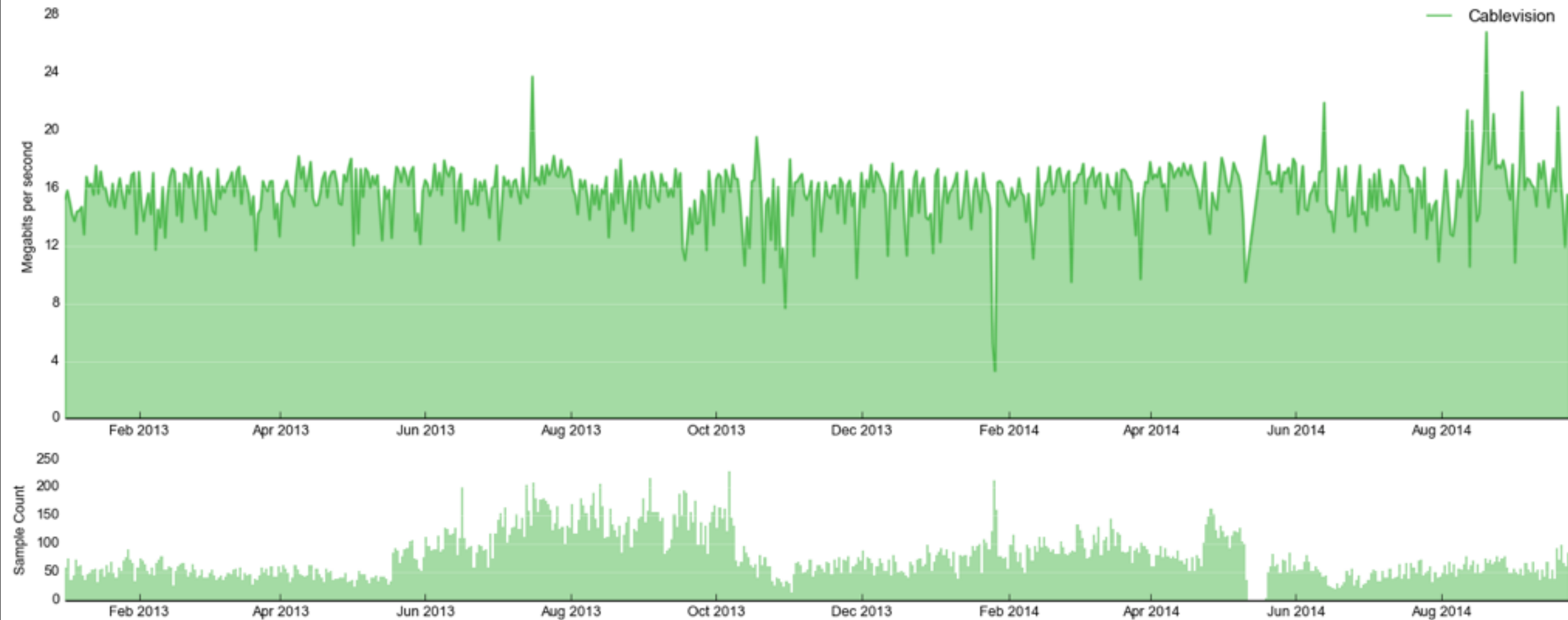
Median download throughput across Internap in NYC over time from different ISPs (higher is better)



Inferring Sources of Congestion in Practice

US Access ISPs and Cogent (2013-2014)

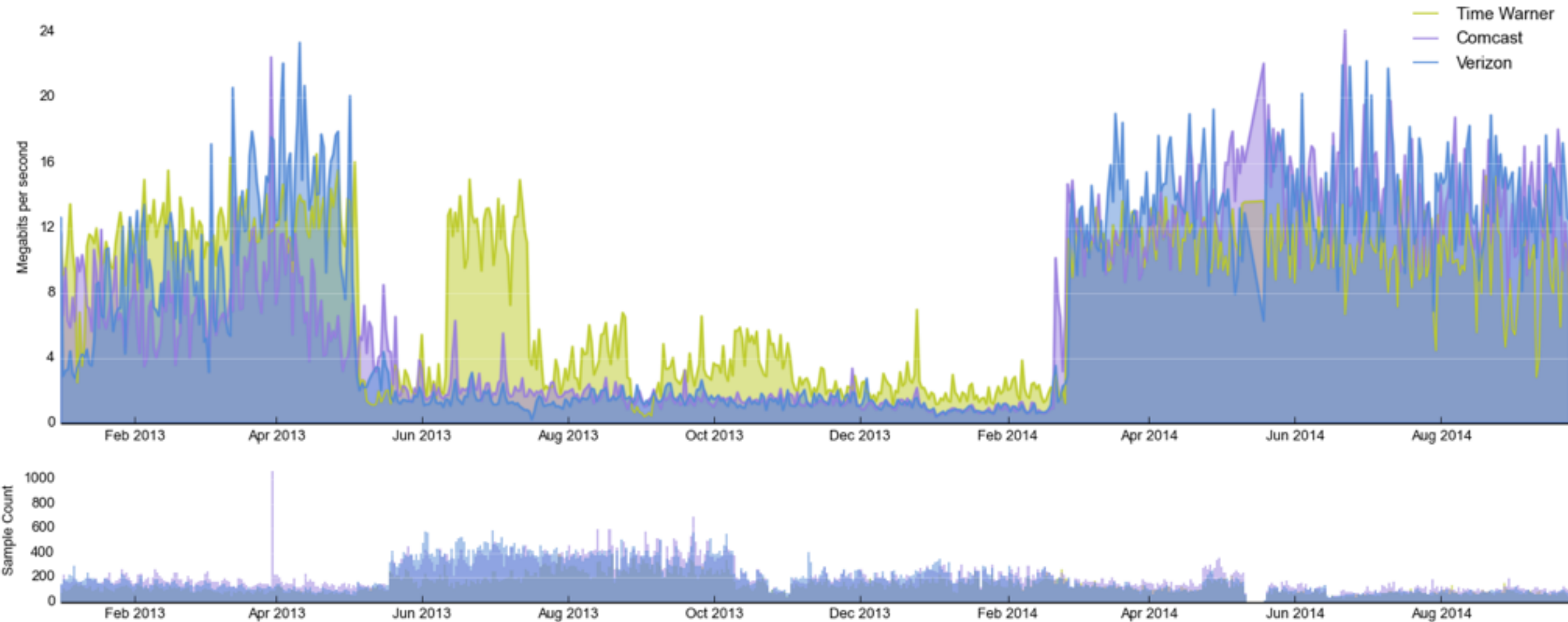
Median download throughput across Cogent to Cablevision in NYC over time (higher is better)



Inferring Sources of Congestion in Practice

US Access ISPs and Cogent (2013-2014)

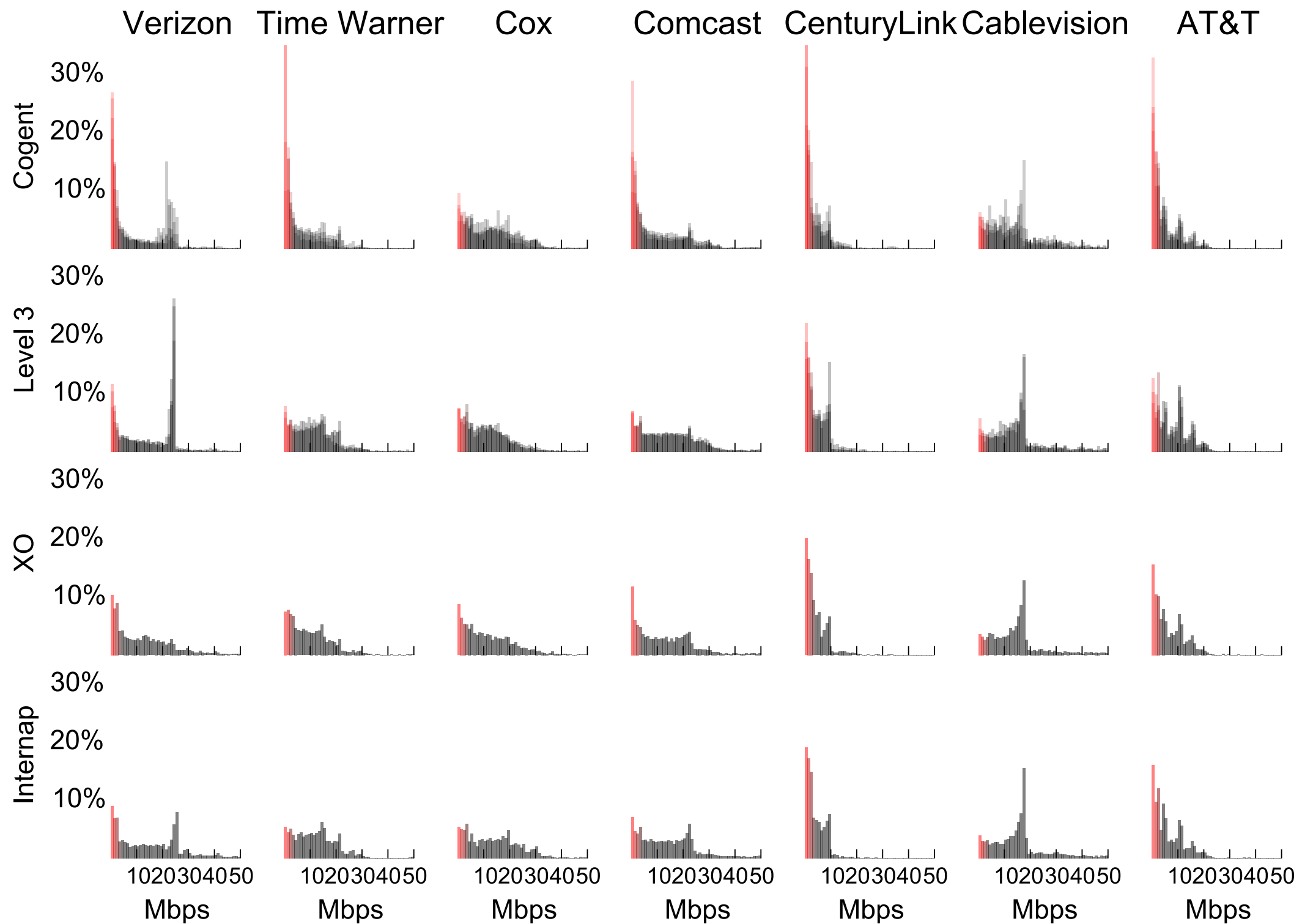
Median download throughput across Cogent in NYC over time from different ISPs (higher is better)



Inferring Sources of Congestion in Practice

US Access ISPs and Cogent (2013-2014)

Access/Transit pair download throughput performance in Mbps in 2013

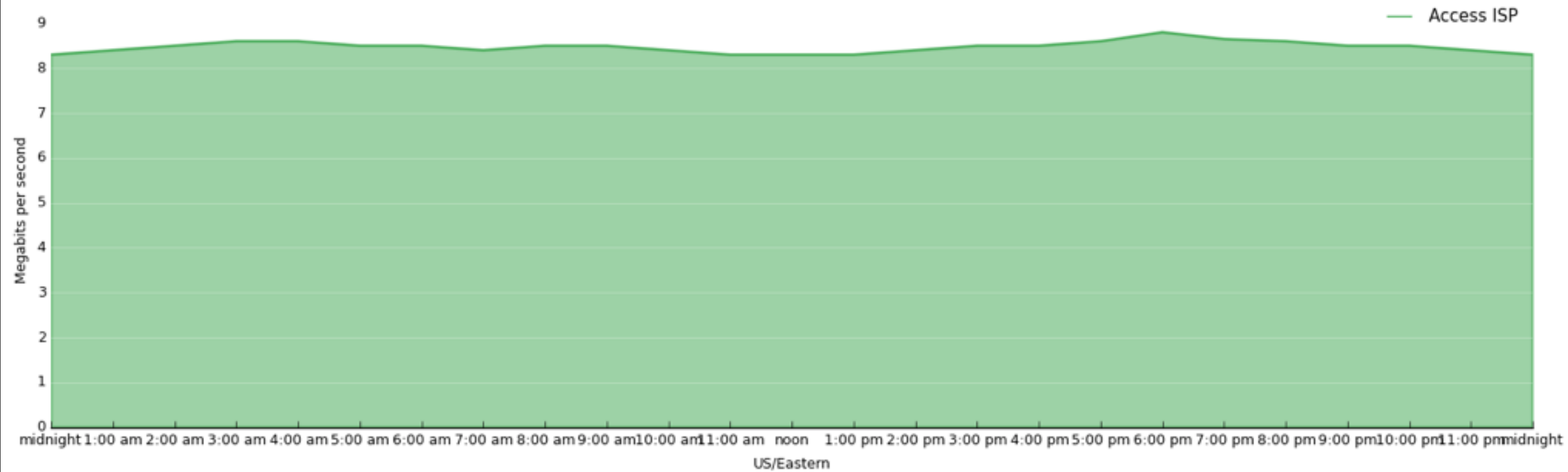


Comparative
Performance across ISPs

No Access ISPs or Transit ISPs Universally Underperforming

Diurnal Trends Matter

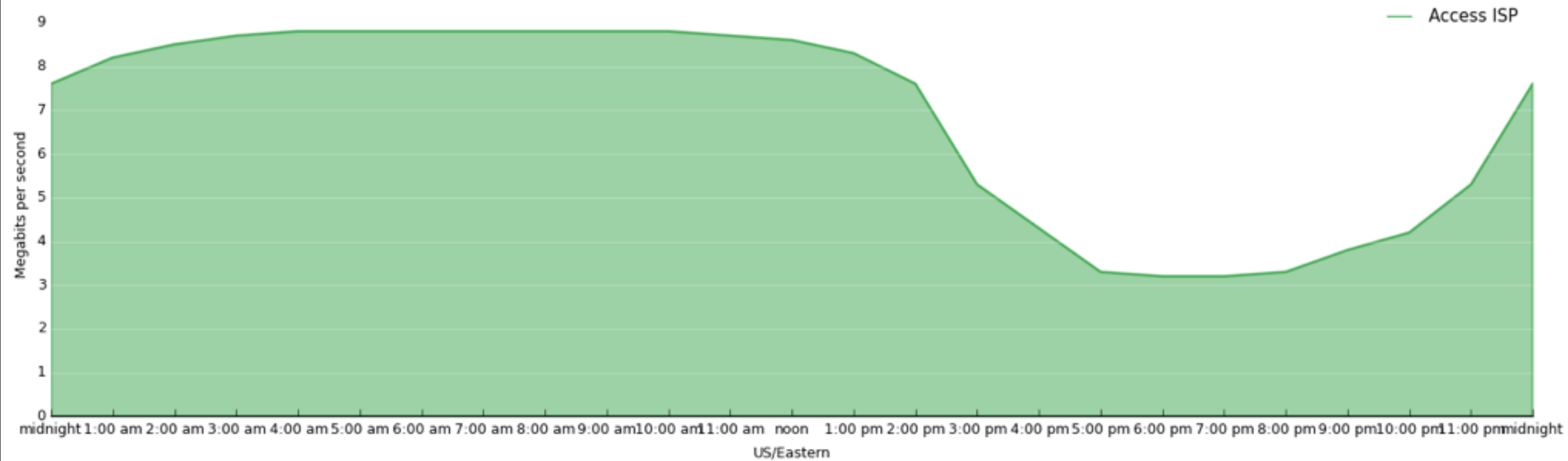
Median download throughput during the average day between access ISP and transit ISP (higher is better)



Diurnal Patterns Are
Instructive

Expectations of Normal Performance

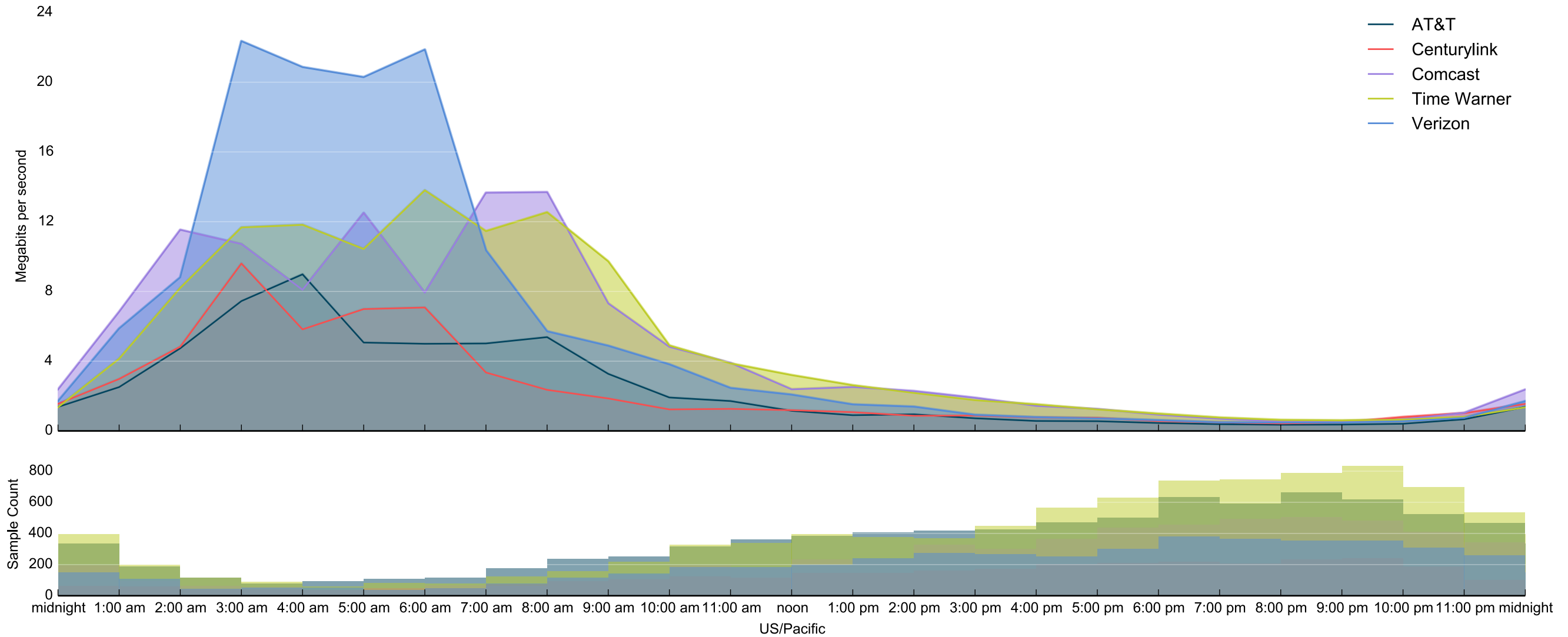
Median download throughput during the average day between access ISP and transit ISP (higher is better)



Diurnal Patterns Are
Instructive

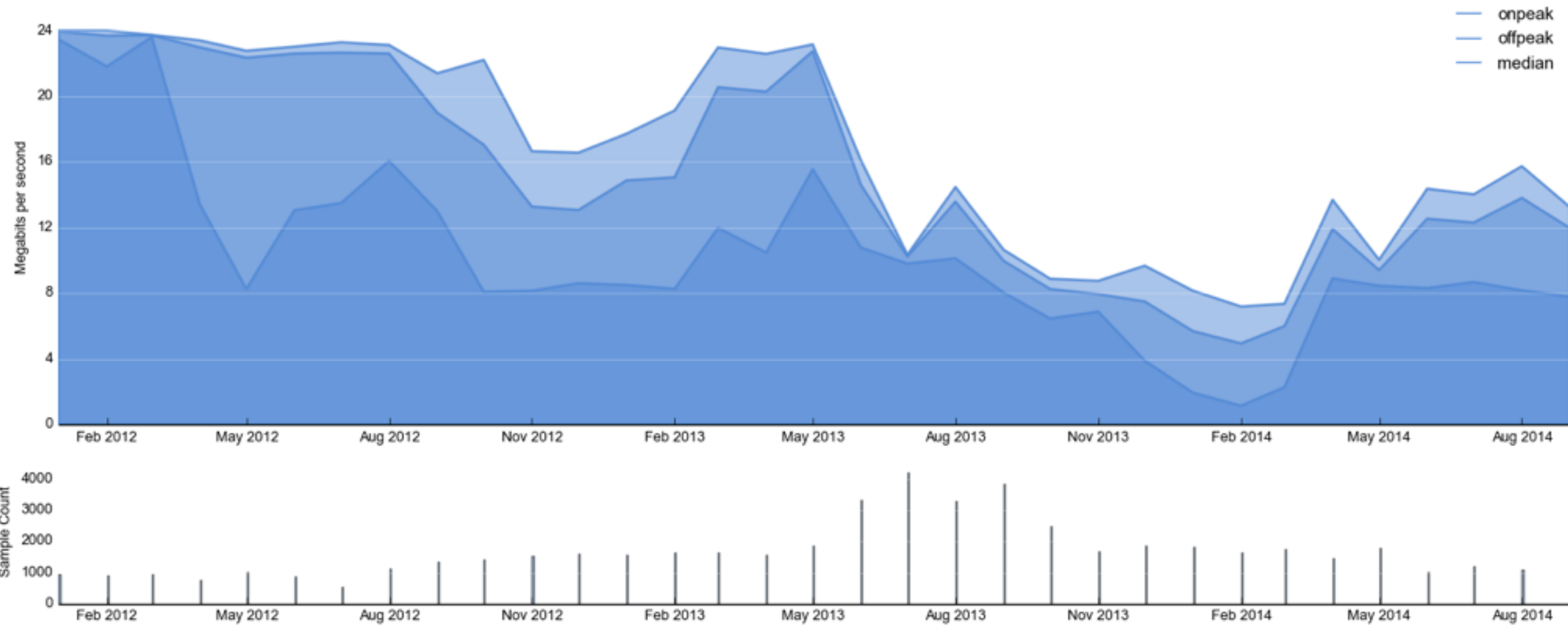
Expectations of Congested Performance

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

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

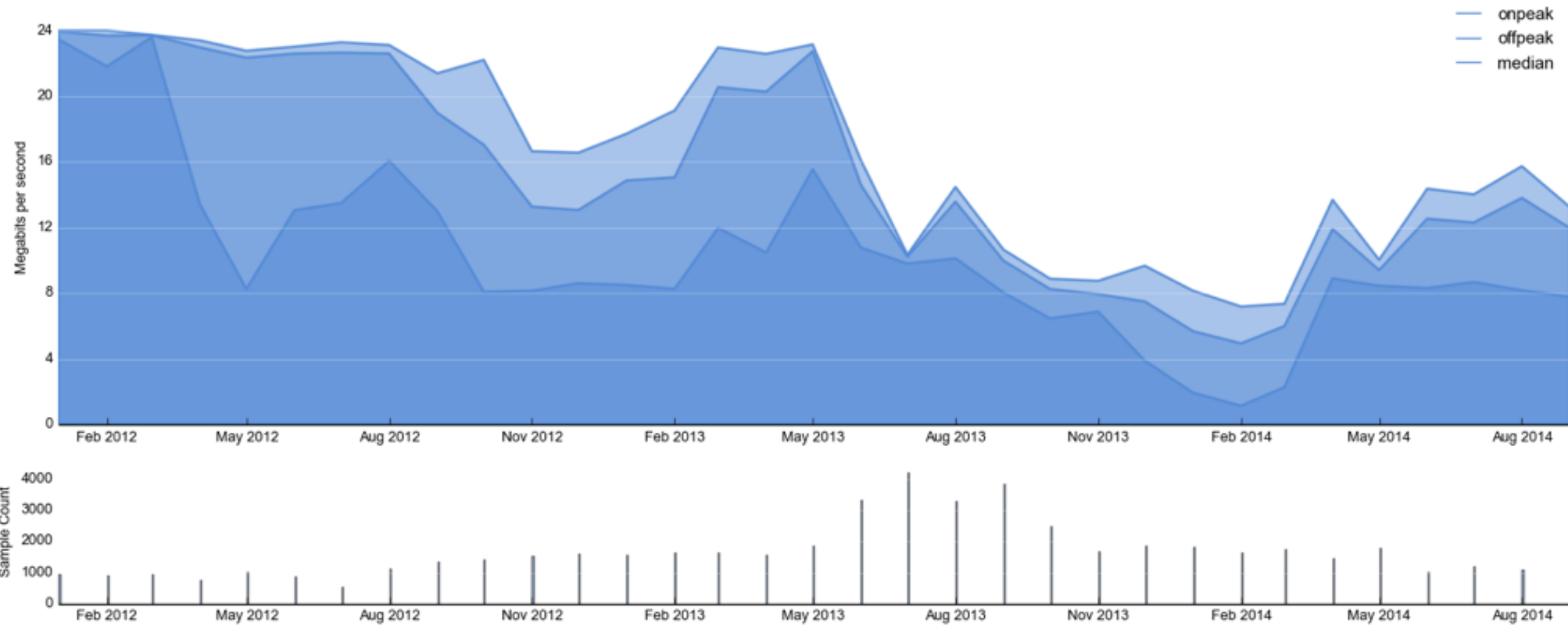


Diurnal Patterns Are
Instructive

Peak Congestion Can Augur Future Degradation

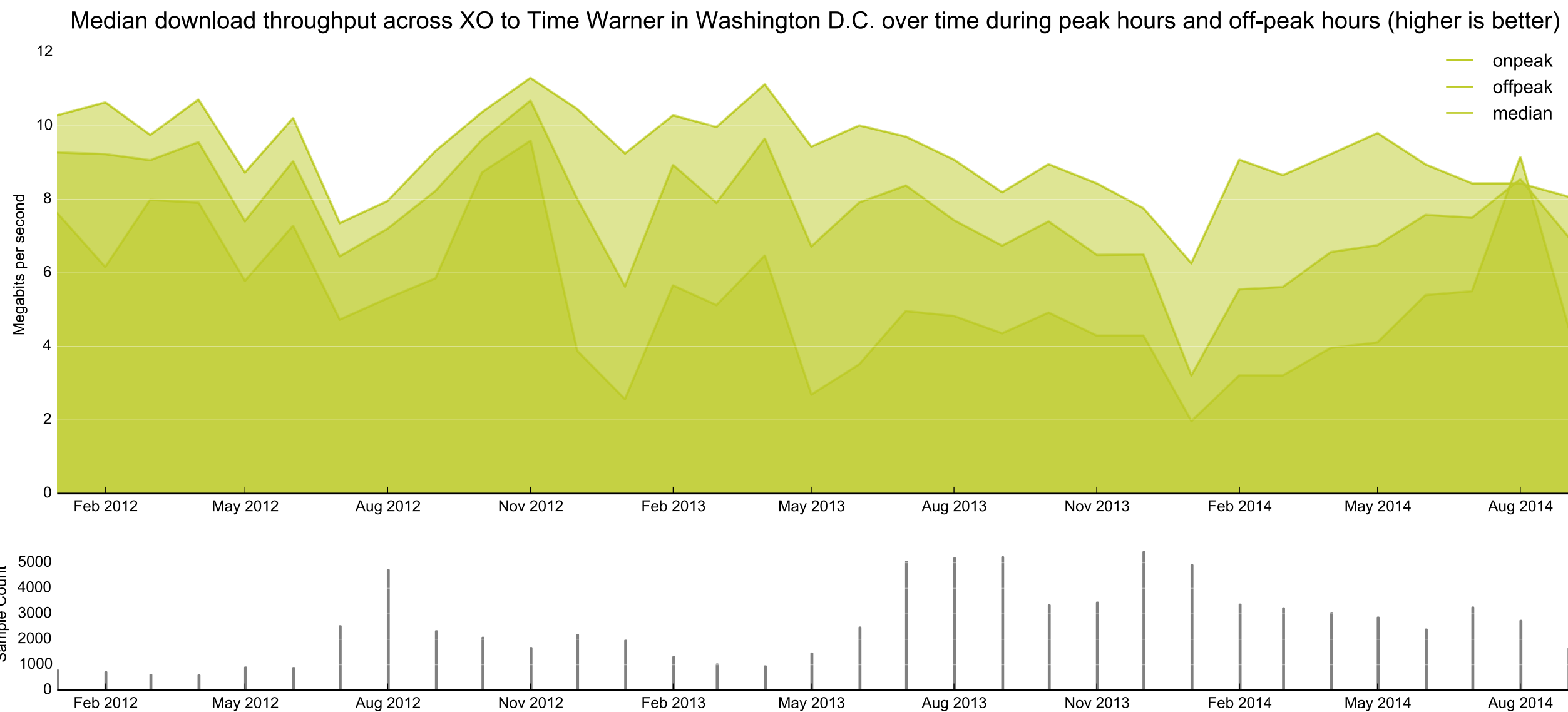
Congestion affecting consumers has not been limited to interconnections with Cogent

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



Level 3 and Verizon

Ongoing

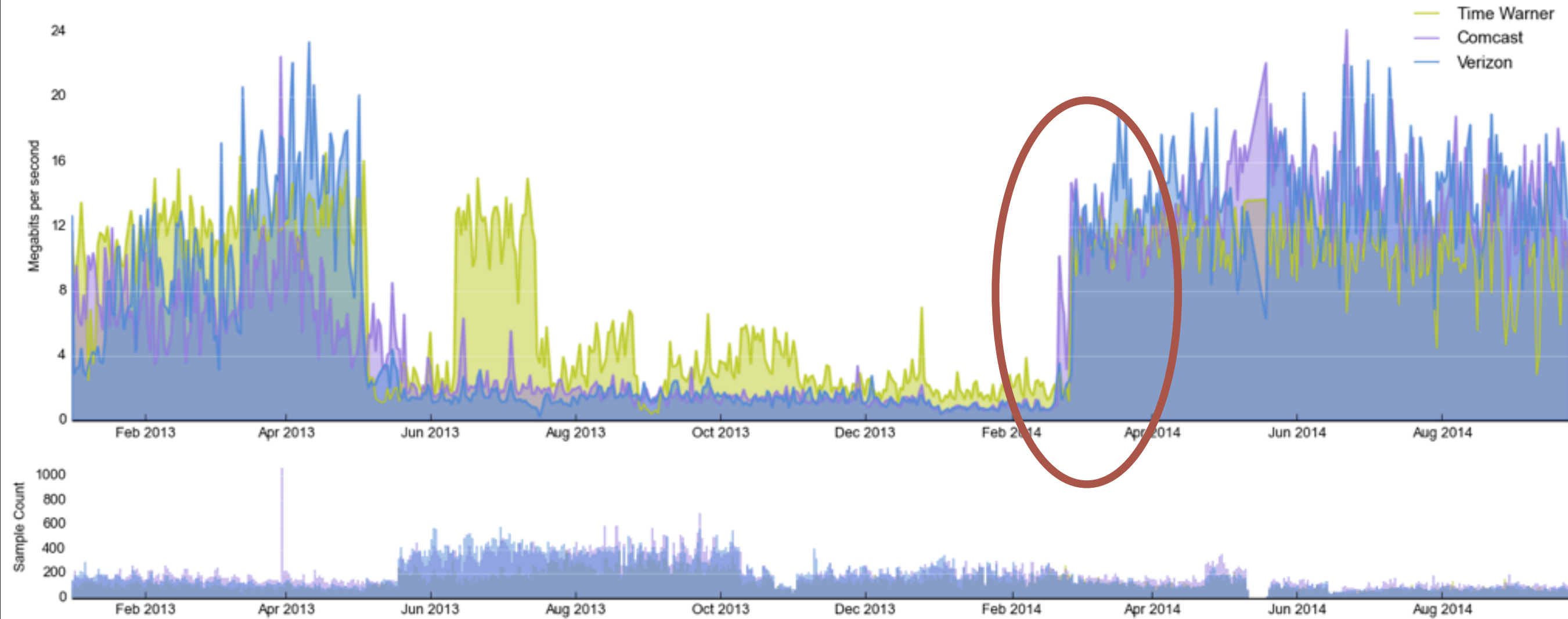


XO and Time Warner
Cable

Ongoing

Serendipitous Discovery

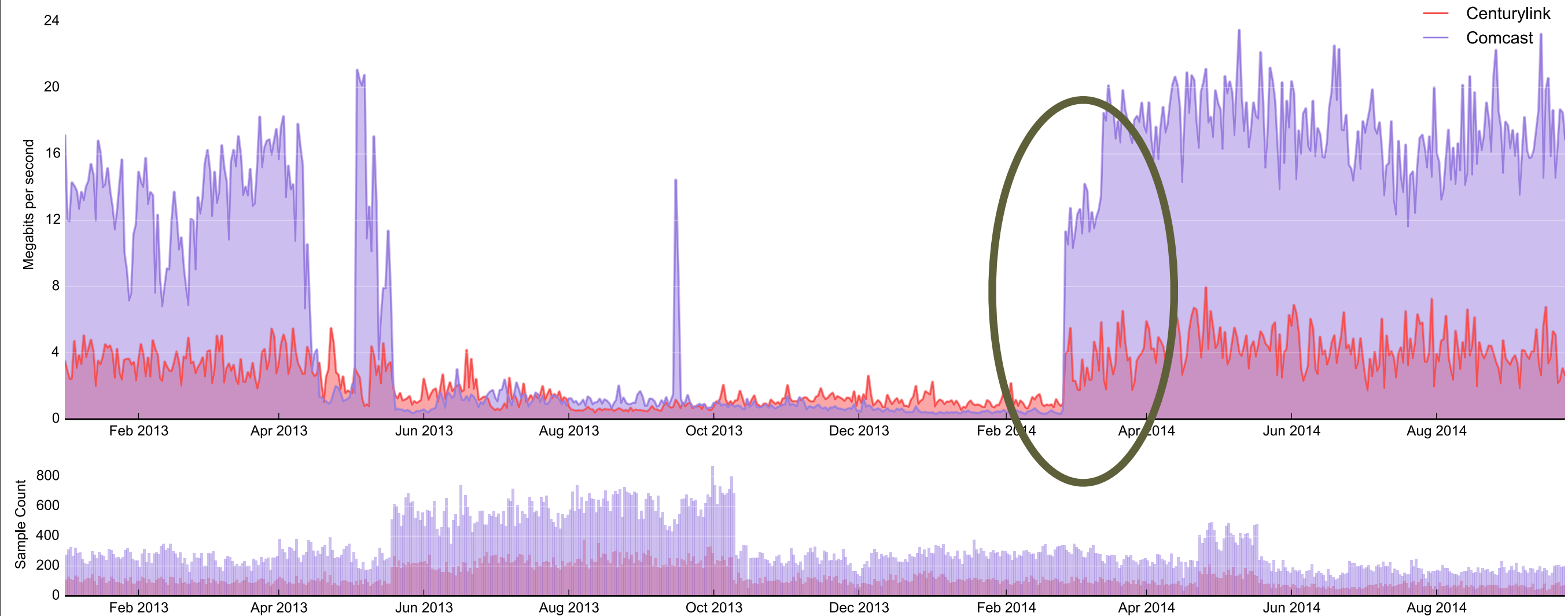
Median download throughput across Cogent in NYC over time from different ISPs (higher is better)



What Happened in Late
February?

Cross the Board Increases

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



What Happened in Late
February?

Cross the Board Increases


```

14:49:05.790333 IP (tos 0x0, ttl 64, id 996, offset 0, flags [DF], proto TCP (6), length 52)
    pool-108-41-239-212.nycmny.fios.verizon.net.49998 > 38.106.70.147.51494: Flags [.], seq 49358745:49360193,
in 8235, options [nop,nop,TS[|tcp]>
14:49:05.790410 IP (tos 0x0, ttl 64, id 996, offset 0, flags [DF], proto TCP (6), length 52)
    38.106.70.147.51494 > pool-108-41-239-212.nycmny.fios.verizon.net.49998: Flags [.], seq 0, ack 49361641, wi
options [nop,nop,TS[|tcp]>
14:49:05.790400 IP (tos 0x48, ttl 55, id 38409, offset 0, flags [DF], proto TCP (6), length 1500)
    pool-108-41-239-212.nycmny.fios.verizon.net.49998 > 38.106.70.147.51494: Flags [.], seq 49360193:49361641,
in 8235, options [nop,nop,TS[|tcp]>
14:49:05.790603 IP (tos 0x48, ttl 55, id 62276, offset 0, flags [DF], proto TCP (6), length 1500)
    pool-108-41-239-212.nycmny.fios.verizon.net.49998 > 38.106.70.147.51494: Flags [.], seq 49361641:49363089,
in 8235, options [nop,nop,TS[|tcp]>
14:49:05.790897 IP (tos 0x0, ttl 64, id 997, offset 0, flags [DF], proto TCP (6), length 52)
    38.106.70.147.51494 > pool-108-41-239-212.nycmny.fios.verizon.net.49998: Flags [.], seq 0, ack 49364537, wi
options [nop,nop,TS[|tcp]>
14:49:05.790886 IP (tos 0x48, ttl 55, id 3669, offset 0, flags [DF], proto TCP (6), length 1500)
    pool-108-41-239-212.nycmny.fios.verizon.net.49998 > 38.106.70.147.51494: Flags [.], seq 49363089:49364537,
in 8235, options [nop,nop,TS[|tcp]>
14:49:05.791255 IP (tos 0x48, ttl 55, id 35382, offset 0, flags [DF], proto TCP (6), length 1500)
    pool-108-41-239-212.nycmny.fios.verizon.net.49998 > 38.106.70.147.51494: Flags [.], seq 49364537:49365985,
in 8235, options [nop,nop,TS[|tcp]>
14:49:05.791508 IP (tos 0x0, ttl 64, id 998, offset 0, flags [DF], proto TCP (6), length 52)
    38.106.70.147.51494 > pool-108-41-239-212.nycmny.fios.verizon.net.49998: Flags [.], seq 0, ack 49367433, wi
options [nop,nop,TS[|tcp]>
14:49:05.791497 IP (tos 0x48, ttl 55, id 42646, offset 0, flags [DF], proto TCP (6), length 1500)
    pool-108-41-239-212.nycmny.fios.verizon.net.49998 > 38.106.70.147.51494: Flags [.], seq 49365985:49367433,
in 8235, options [nop,nop,TS[|tcp]>
14:49:05.791634 IP (tos 0x48, ttl 55, id 34115, offset 0, flags [DF], proto TCP (6), length 1500)
    pool-108-41-239-212.nycmny.fios.verizon.net.49998 > 38.106.70.147.51494: Flags [.], seq 49367433:49368881,
in 8235, options [nop,nop,TS[|tcp]>
^C14:49:05.791884 IP (tos 0x0, ttl 64, id 999, offset 0, flags [DF], proto TCP (6), length 52)
    38.106.70.147.51494 > pool-108-41-239-212.nycmny.fios.verizon.net.49998: Flags [.], seq 0, ack 49370329, wi
options [nop,nop,TS[|tcp]>

```

DSCP Changes!

Cross the Board Increases

Extending the Interconnection Study

github.com/m-lab-tools/telescope — m-lab-tools/telescope

This repository Search Explore Gist Blog Help collina

m-lab-tools / telescope Unwatch 13 Star 4 Fork 1

— Edit

6 commits 2 branches 1 release 1 contributor

branch: master telescope / +

Updating README to include information about selectors.

mtlynch authored 15 days ago latest commit f6384d8275

documentation	Updating selector file spec.	16 days ago
resources	Initial commit	17 days ago
telescope	Initial commit	17 days ago
.gitignore	Initial commit	17 days ago
LICENSE	Initial commit	17 days ago
NOTICE	Initial commit	17 days ago
README.md	Updating README to include information about selectors.	15 days ago
client_secrets.json	Initial commit	17 days ago
main.py	Adding more function documentation to main.py	16 days ago
requirements.txt	Initial commit	17 days ago
test-requirements.txt	Initial commit	17 days ago

README.md

Measurement Lab: Telescope

Dependencies

Code

Issues 7

Pull Requests 1

Wiki

Pulse

Graphs

Settings

SSH clone URL

git@github.com:m-lab-to

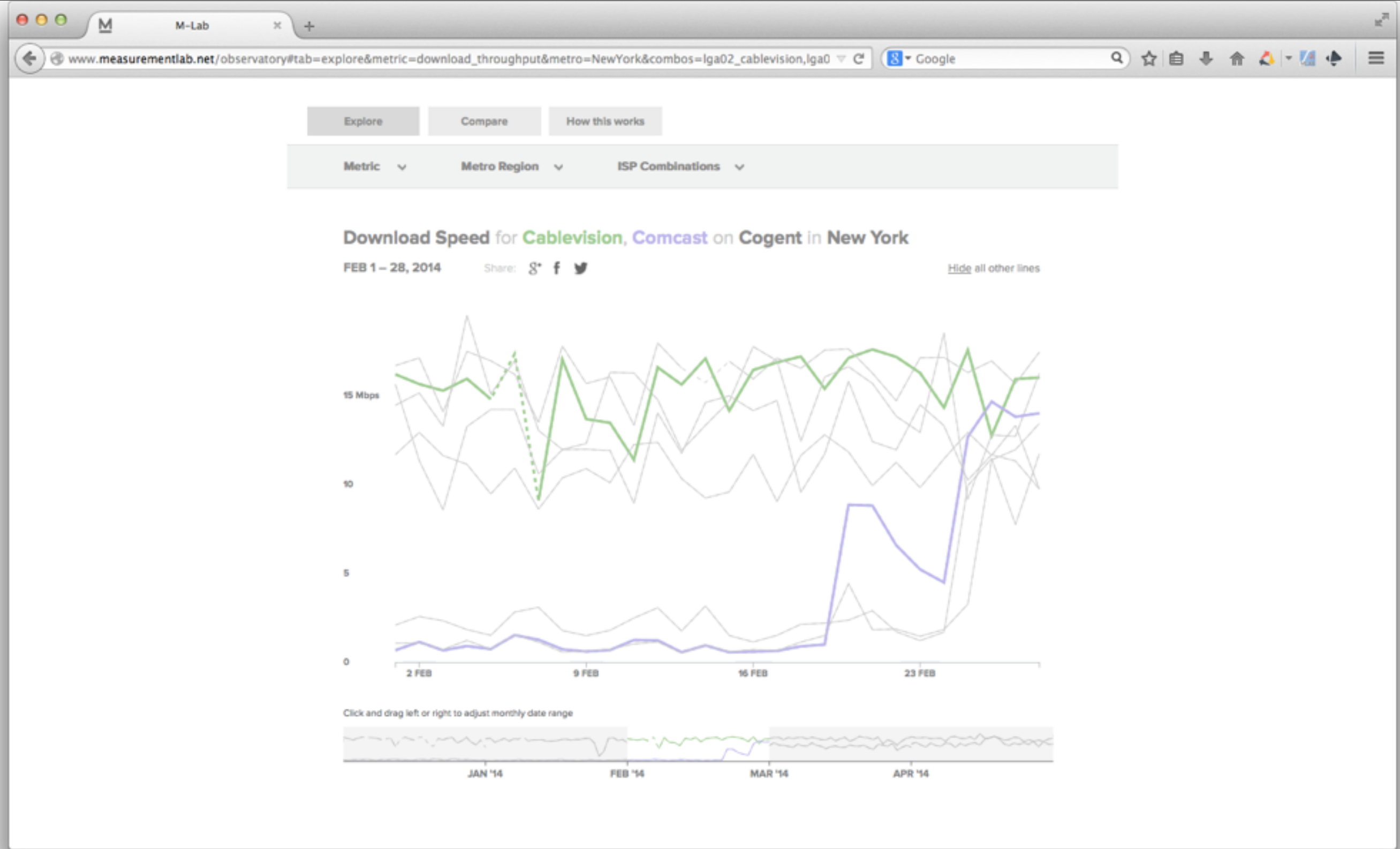
You can clone with HTTPS, SSH, or Subversion.

Clone in Desktop

Download ZIP

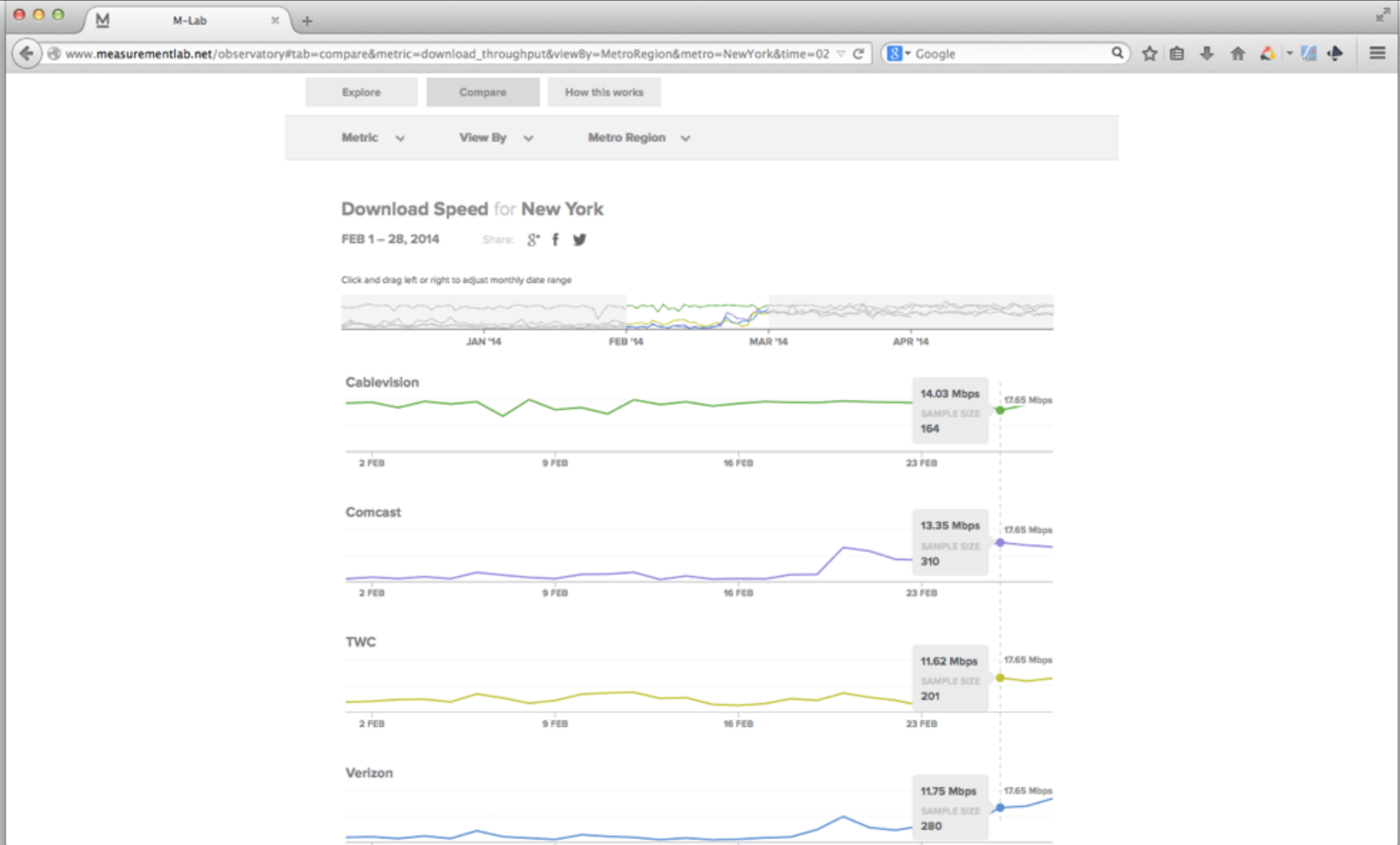
Measurement Lab Telescope

Python to extract M-Lab data



Measurement Lab
Observatory

Currently US Only



Measurement Lab
Observatory

Currently US Only

Review, Clarifications 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.

“This is a measurement study, not an answer study.”

–Randy Bush



TECHNOLOGY LAB / INFORMATION TECHNOLOGY

Study: Comcast and Verizon connections to Cogent dropped below 0.5Mbps

Measurements show how bad it got before Netflix money disputes were resolved.

by Jon Brodtkin - Oct 28 2014, 10:45pm GMT



Share



Tweet

112

Plenty of Comcast and Verizon customers know just how bad Internet service was on major ISPs during the **months-long battle** over who should pay to deliver Netflix traffic.

But now we have more numbers on the performance declines, thanks to a [new report](#) from the Measurement Lab Consortium (M-Lab). M-Lab hosts measuring equipment at Internet exchange points to analyze connections between network operators and has more than five years' worth of measurements. A report released today examines connections between consumer Internet service providers ("Access ISPs" in M-Lab parlance) and backbone operators ("Transit ISPs"), including the ones that sent traffic from Netflix to ISPs while the money fights were still going on.

Netflix eventually **agreed to pay** Comcast, Verizon, Time Warner Cable, and AT&T for direct connections to their networks, but until that happened there was severe degradation in links carrying traffic from Netflix and many other Web services to consumers. Connections were particularly bad between ISPs and Cogent, one of the backbone operators that Netflix paid to carry its traffic.

FURTHER READING



HOW COMCAST BECAME A POWERFUL—AND CONTROVERSIAL—PART OF THE INTERNET BACKBONE

Comcast tells Ars why it's not to blame in Netflix fight—it was only business.



CLICK HERE

Get your favorite magazines on your tablet!



LATEST FEATURE STORY ▾



FEATURE STORY (2 PAGES)

The other Ebola fear: Your civil liberties

The power to quarantine is as "American as apple pie."

Although, Measurement Matters to the Public

People Need Information

Research Limitations

- We cannot determine which actors or actions are “responsible” for observed degradation.
- Path data is not included in the scope of this report (but it is collected and consulted by M-Lab).
- We cannot identify the precise cause of performance problems (e.g. a broken router) in a path between a client.



Criticisms and Contributions

- Host a Measurement Lab site.
- Review *Telescope*, and extend it for your own purposes.
- Access our data and review our measurement methodology.
- Discuss this research on the discuss@measurementlab.net list.



There is still much more in Measurement Lab's dataset. Please explore.

measurementlab.net