

Measurement Lab

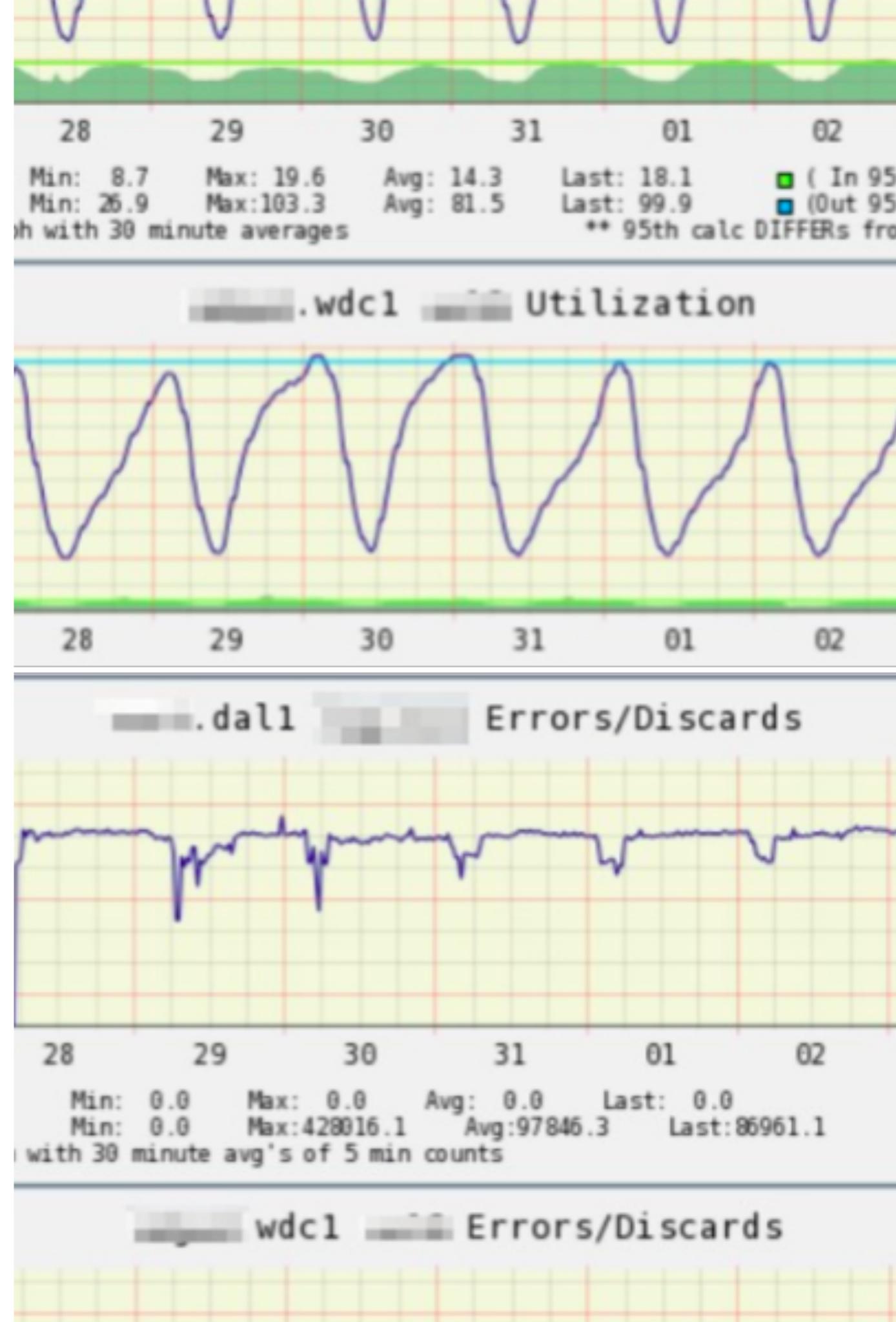
Internet Policy and Independent Network Performance Measurement

Collin Anderson

APRICOT 2015

The Regulator's Problem

- Utilization and Performance Data is Proprietary and Hidden from the Public.
- User Collected Information is Unreliable, Incomparable, Methodologically Unsound and Narrowly Scoped.
- Longitudinal Data is Rare, So Is Comparative Measurement.
- Independent Data is Expensive.





Posts: 2

Registered: 02-25-2014

✓ VPN speed issues

02-25-2014 01:07 PM

Opti

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 a Citrix server, and (2) comcast.net probably isn't the correct server to be pinging. Nevertheless, I think my questions are as follows:

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

Information Asymmetries
Create are Public Issues

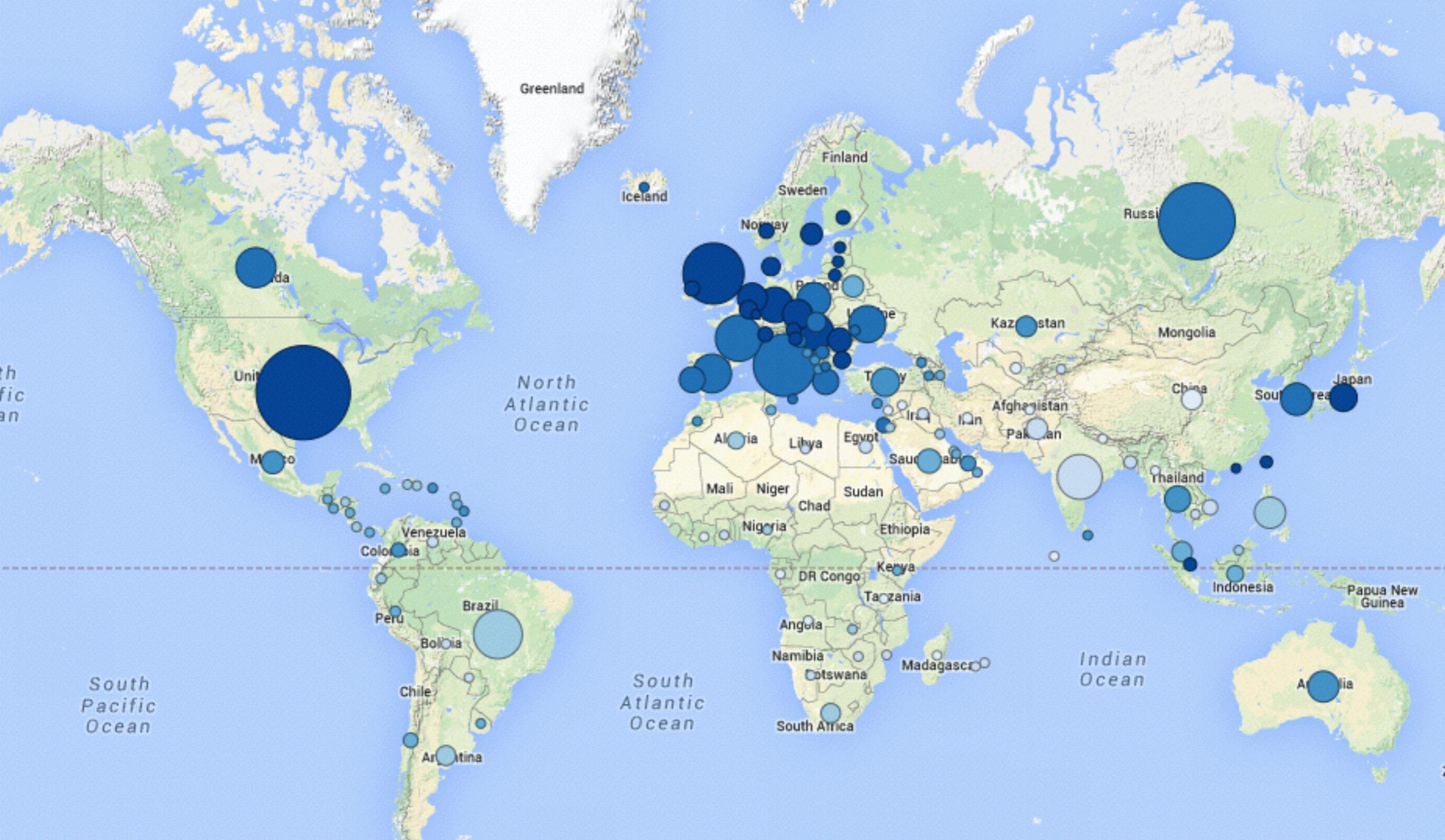
Service Providers Need Data

Overview of Measurement Lab



M-Lab's Global Footprint

Servers on Every Continent and Growing



M-Lab's Global Footprint

Tests from Every Country

Throughput Measurements

- M-Lab hosts two active throughput measurements:
 - Network Diagnostic Tool (NDT)
 - BISmark
- NDT is integrated with numerous applications and receives 200,000 tests from 100,000 clients per day.
- Nearly every country is well-covered.

YOUR TEST RESULTS

UPLOAD SPEED

15.68 mb/s

DOWNLOAD SPEED

12.53 mb/s

Network latency: 26 msec round trip time

Jitter: 40 msec

MLAB
More information about M-Lab

HOW NEUTRAL IS THE NET?

Select test All

Shaped tests in percent

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

SWITCH COLOR SCHEME

Transparency

- Three active tests:
 - Shaperprobe
 - Glasnost
 - Neubot
- Measure differential traffic performance and traffic classification regimes.



Path Information

- Measurement Lab collects paris-traceroutes for every attempt to connect to its sites.

| _traceroute_hop_src_ip | paris_traceroute |
|------------------------|------------------|
| 63.1.65 | 195.219.83.101 |
| 19.83.101 | 80.231.130.129 |
| 1.130.129 | 80.231.154.17 |
| 1.154.17 | 80.231.153.58 |
| 1.153.58 | 5.23.24.6 |
| 24.6 | 195.154.1.71 |
| 54.1.71 | 62.210.74.143 |
| 24.6 | 195.154.1.71 |
| 54.1.71 | 62.210.74.143 |
| 1.153.58 | 5.23.24.6 |
| 1.154.17 | 80.231.153.58 |
| 1.130.129 | 80.231.130.86 |
| 19.83.101 | 80.231.130.129 |

Censorship and Interference

- M-Lab Deployed the ‘Open Observatory of Network Interference’ (OONI) Test
- First deployment of a censorship measurement tool to OONI
- Initial test of HTTP middle boxes

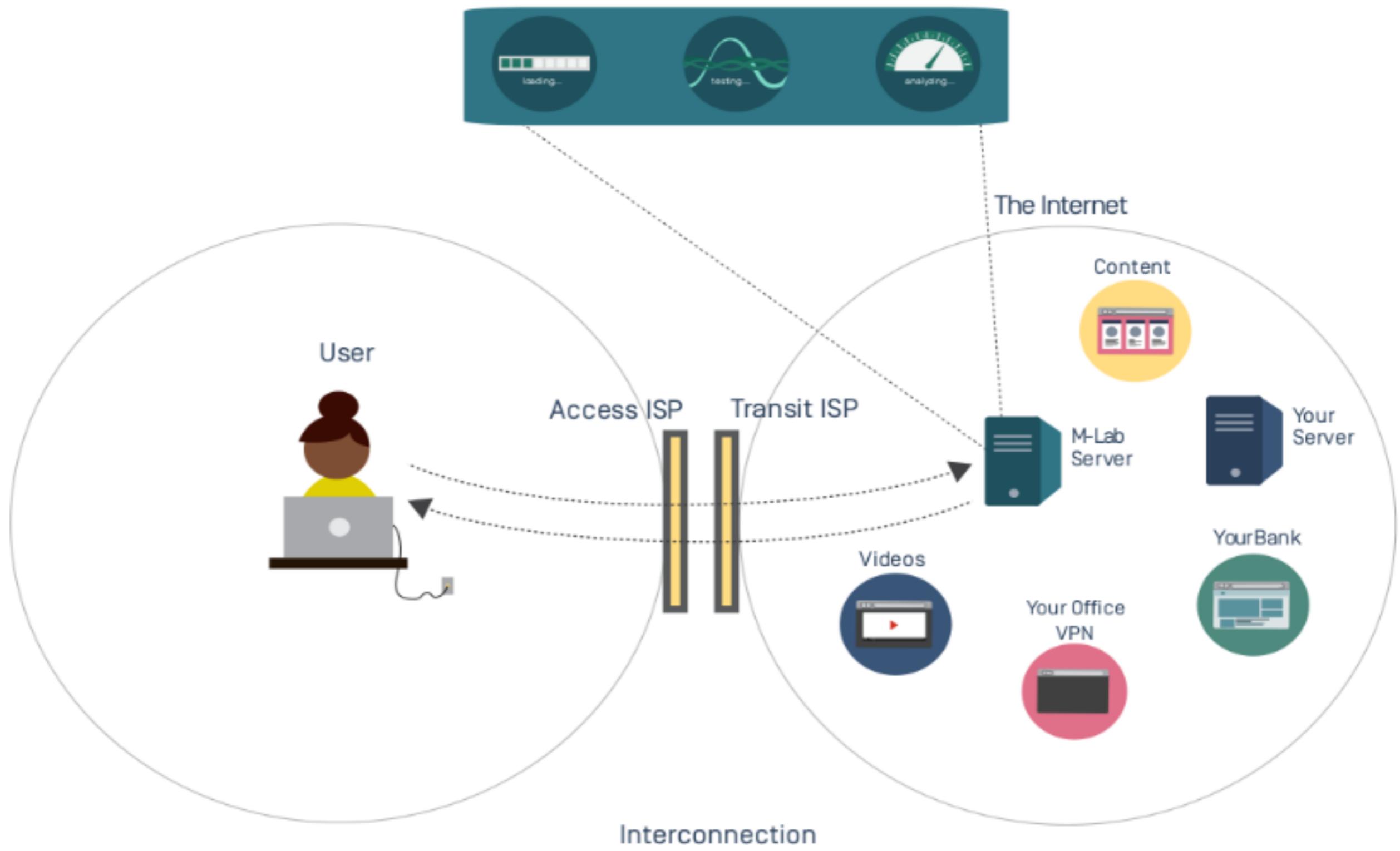


Open Observatory of Network Interference

ooni

Consumer Measurement and Policy

Methodologies from the Network Edge

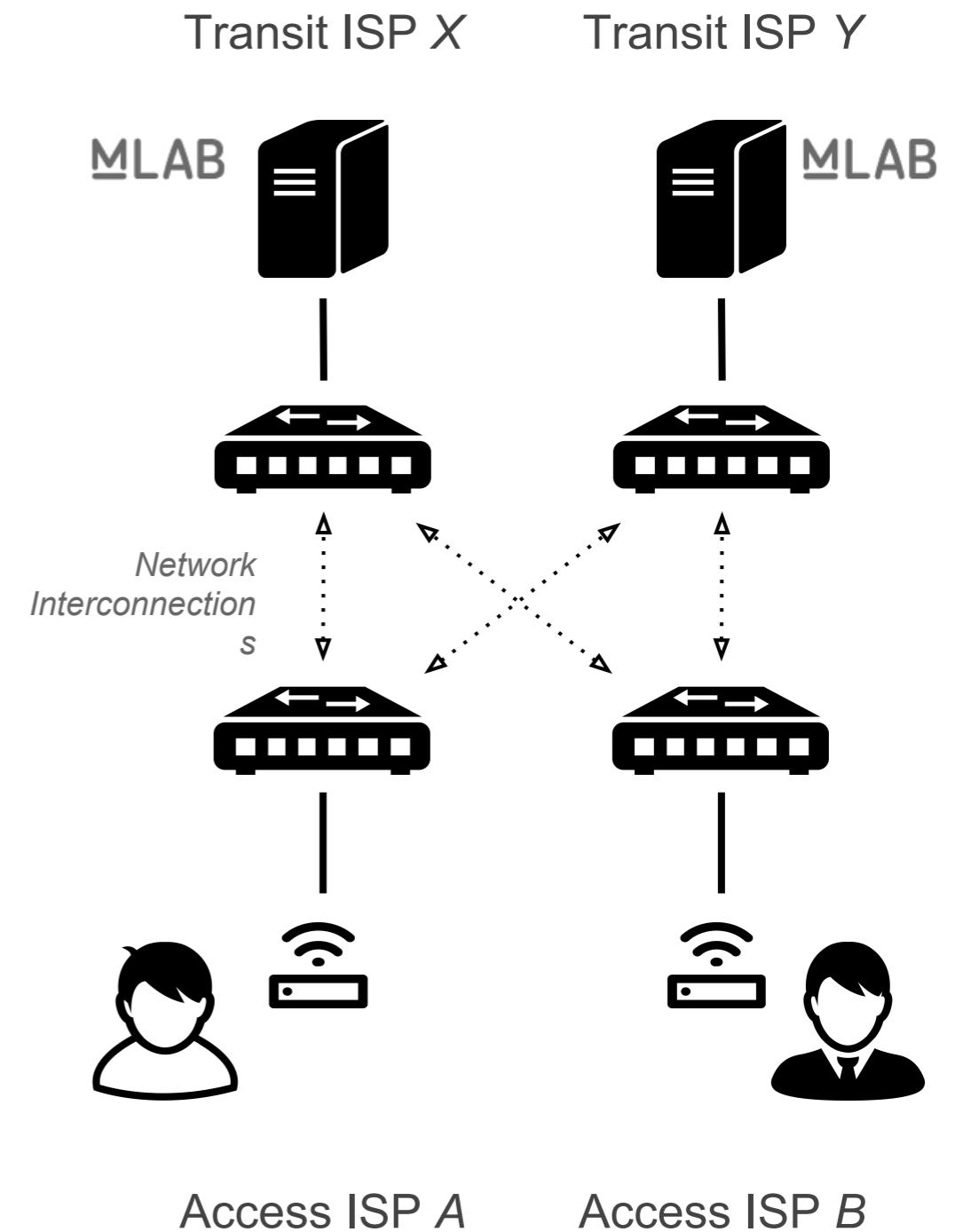


How Measurement Lab Collects Information

Measurements From Everyone

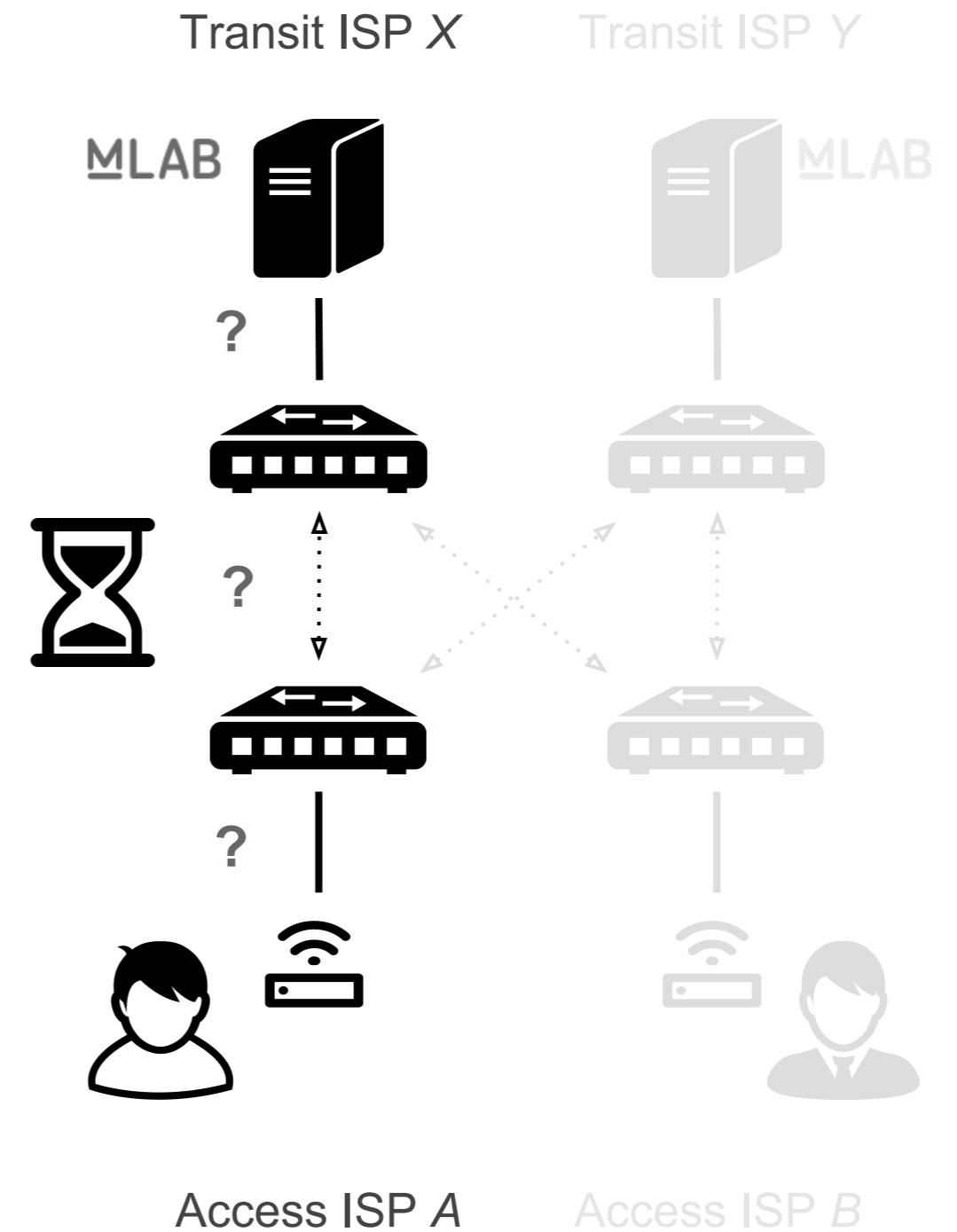
Methodology

Inferring the Source of Congestion



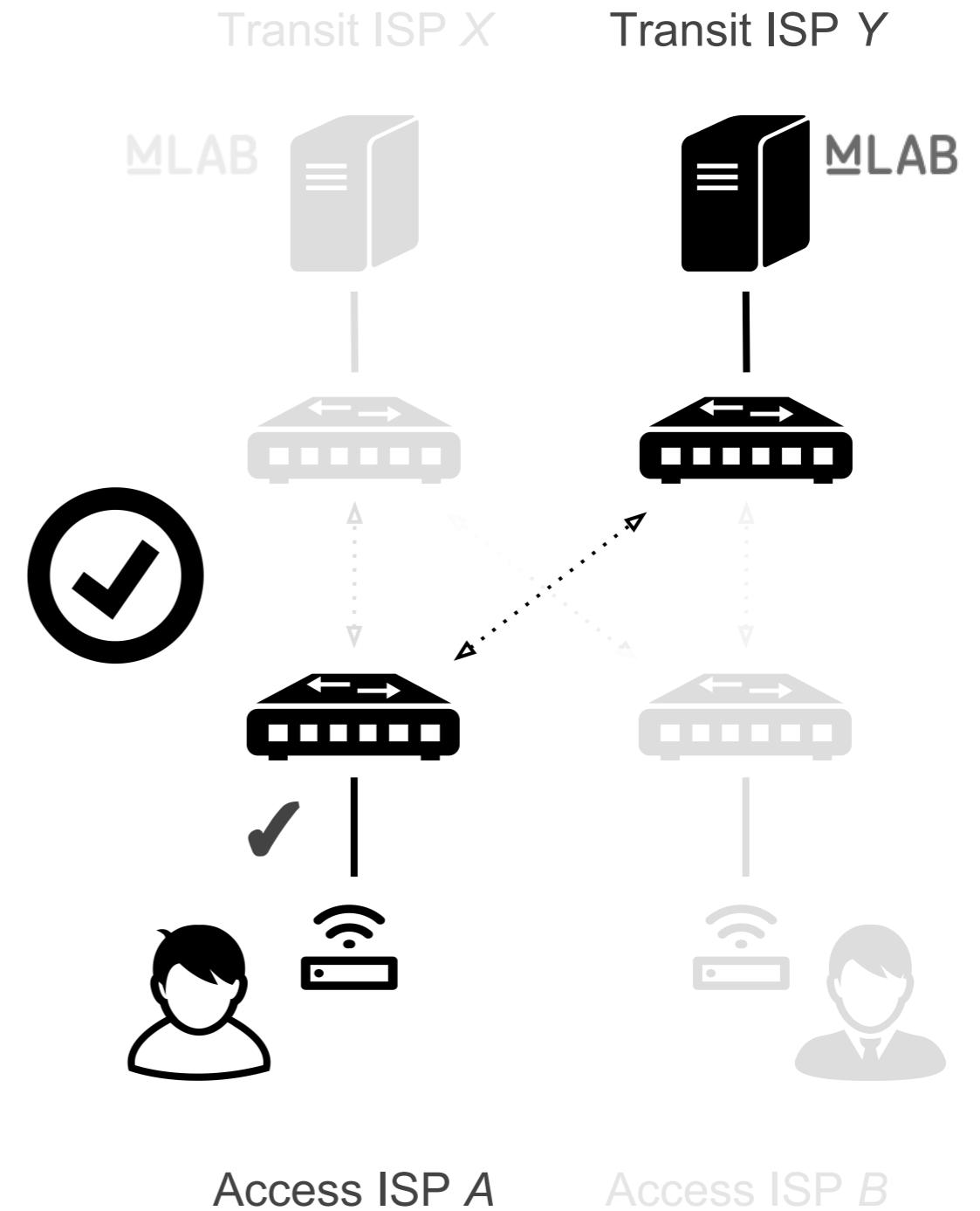
Methodology

Inferring the Source of Congestion



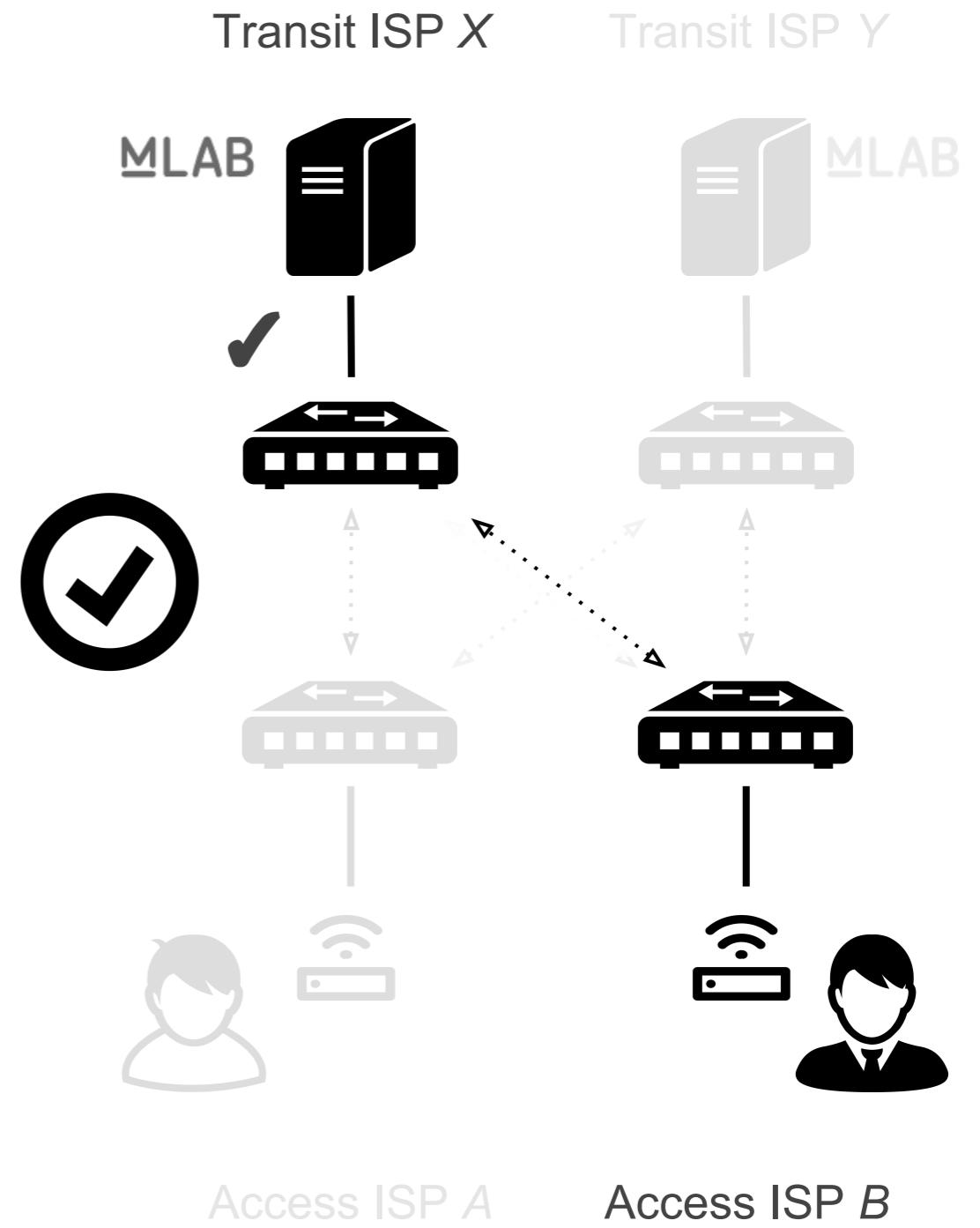
Methodology

Inferring the Source of Congestion



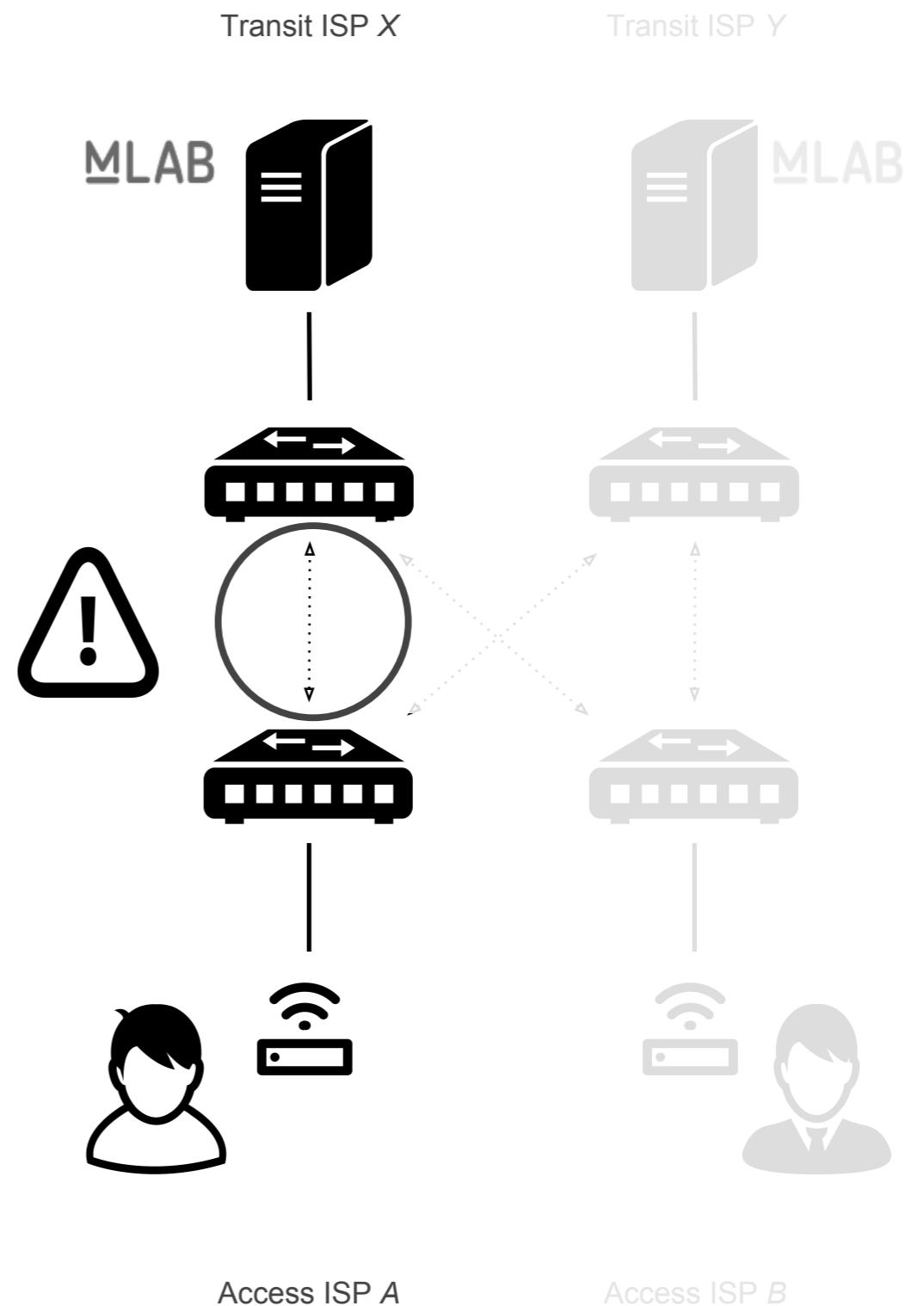
Methodology

Inferring the Source of Congestion



Methodology

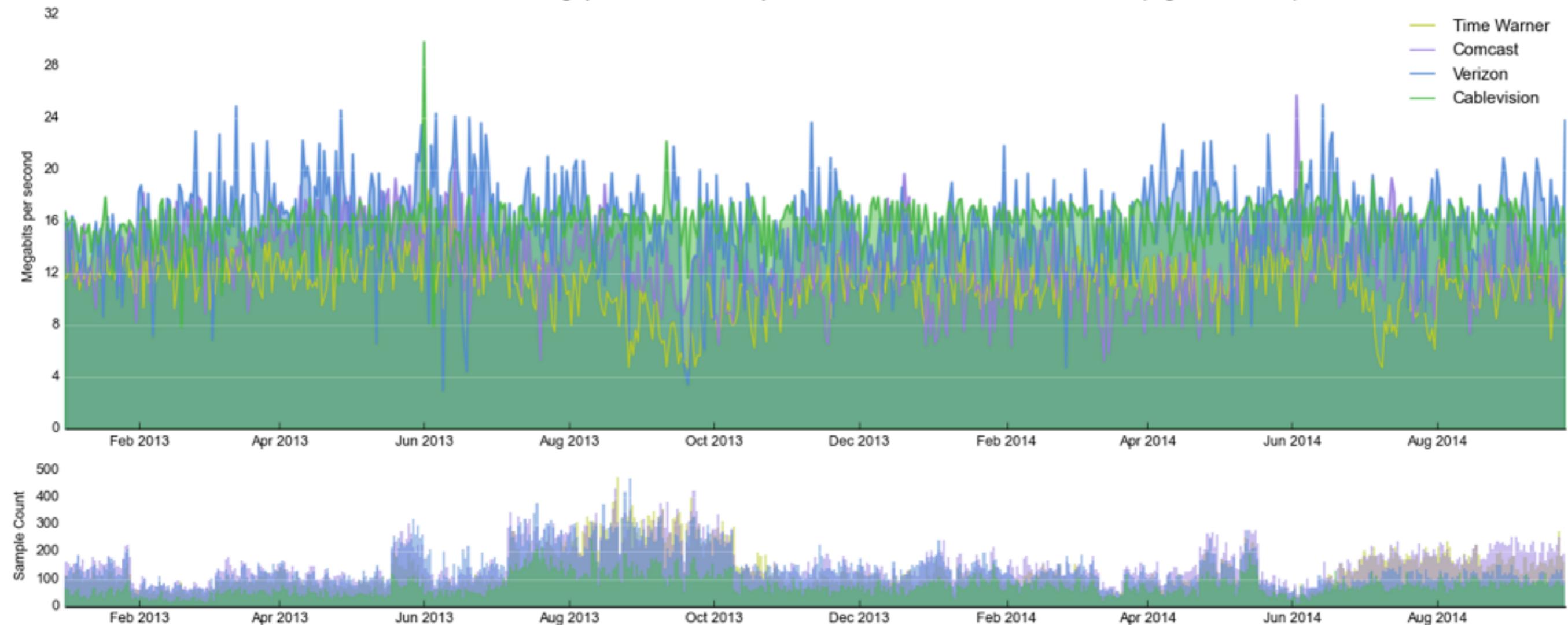
Inferring the Source of Congestion



Consumer Internet Measurement Case Study

Interconnection Disputes in the United States

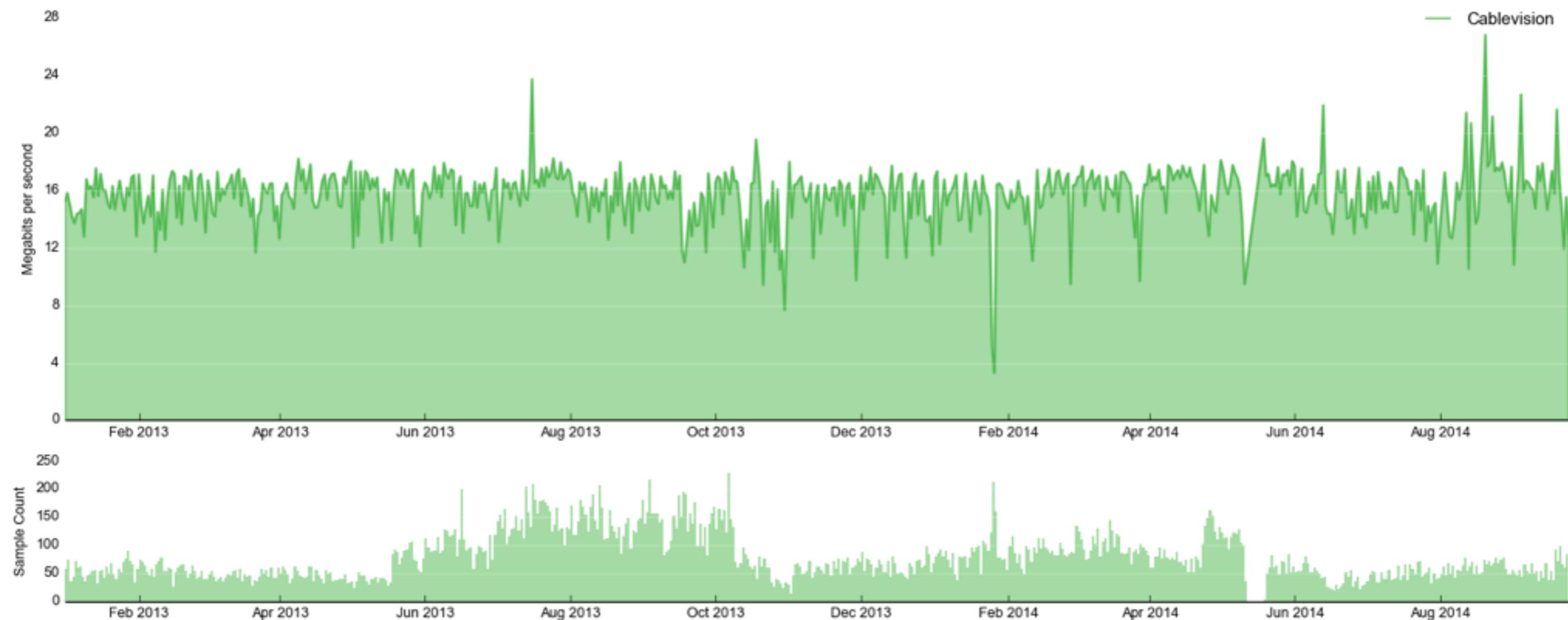
Median download throughput across Internap in NYC over time from different ISPs (higher is better)



Inferring Sources of
Congestion in Practice

US Access ISPs and Cogent (2013-2014)

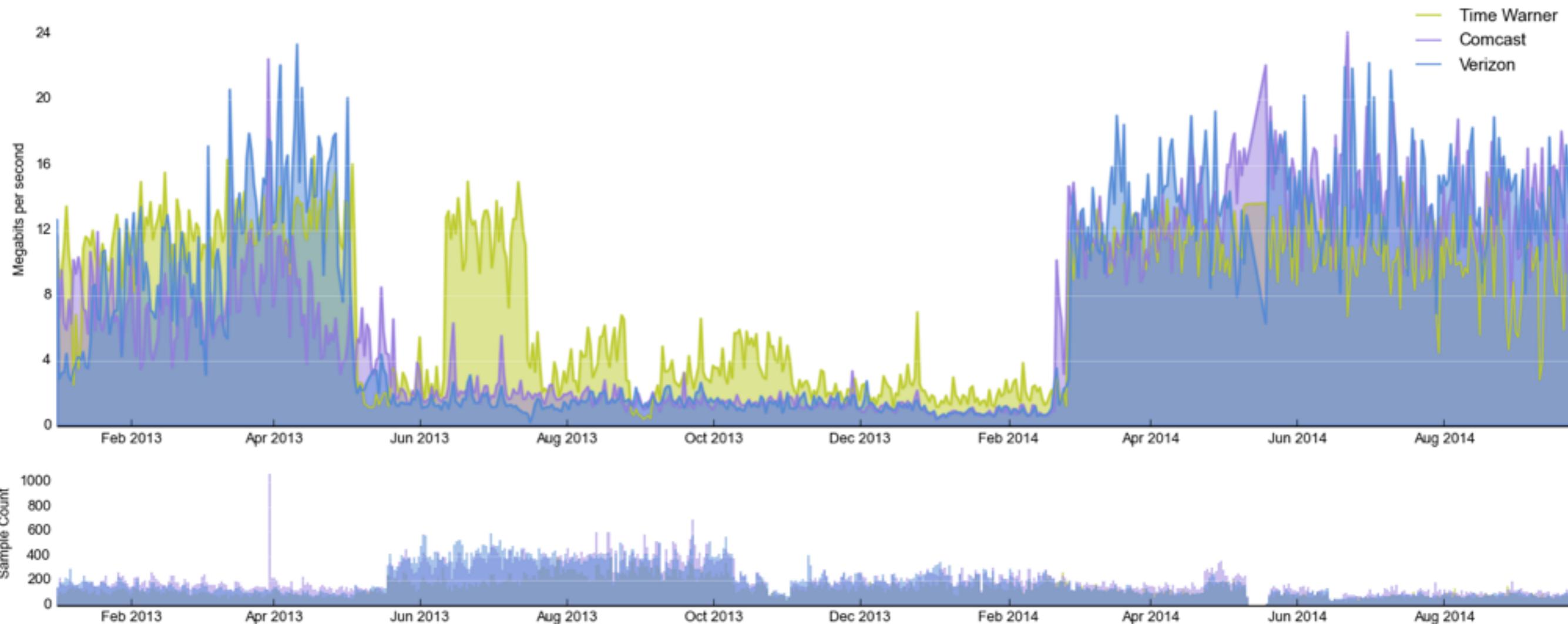
Median download throughput across Cogent to Cablevision in NYC over time (higher is better)



Inferring Sources of Congestion in Practice

US Access ISPs and Cogent (2013-2014)

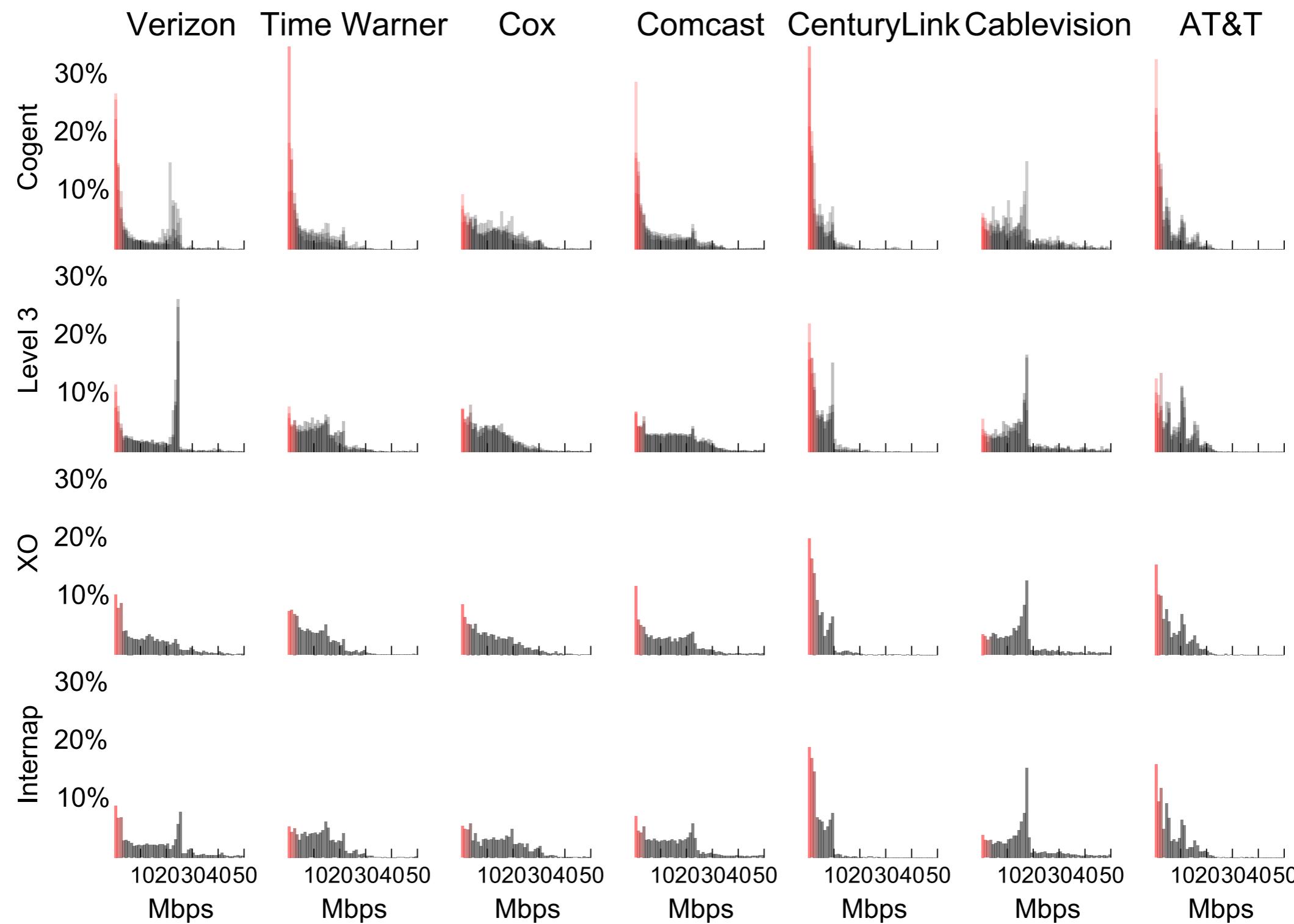
Median download throughput across Cogent in NYC over time from different ISPs (higher is better)



Inferring Sources of
Congestion in Practice

US Access ISPs and Cogent (2013-2014)

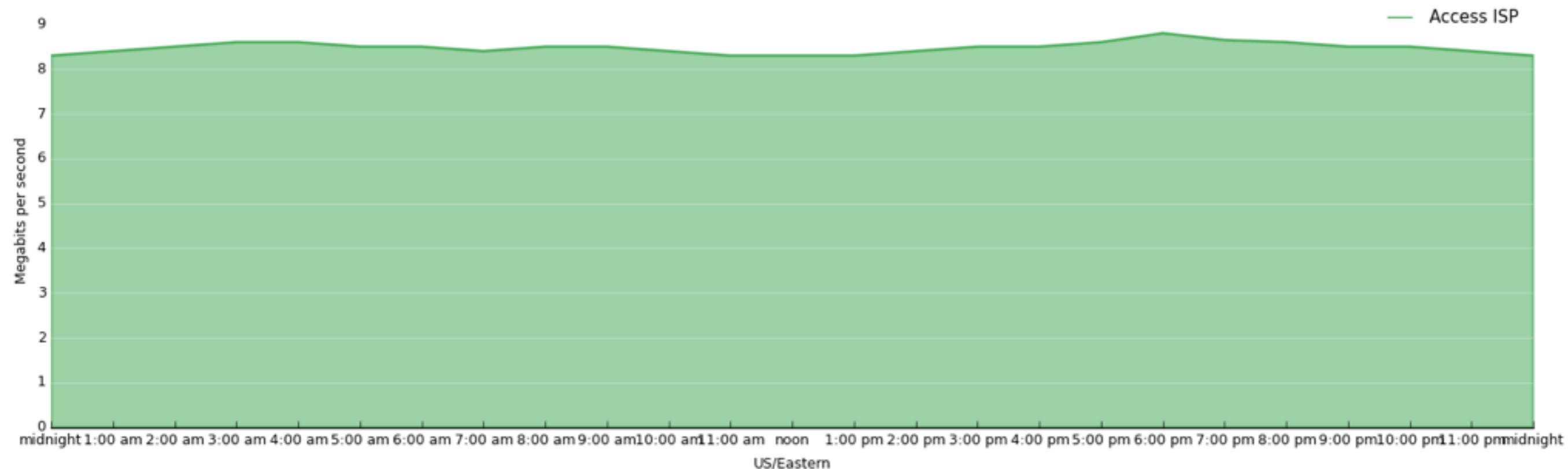
Access/Transit pair download throughput performance in Mbps in 2013



Comparative
Performance across ISPs

No Access ISPs or Transit ISPs Universally Underperforming

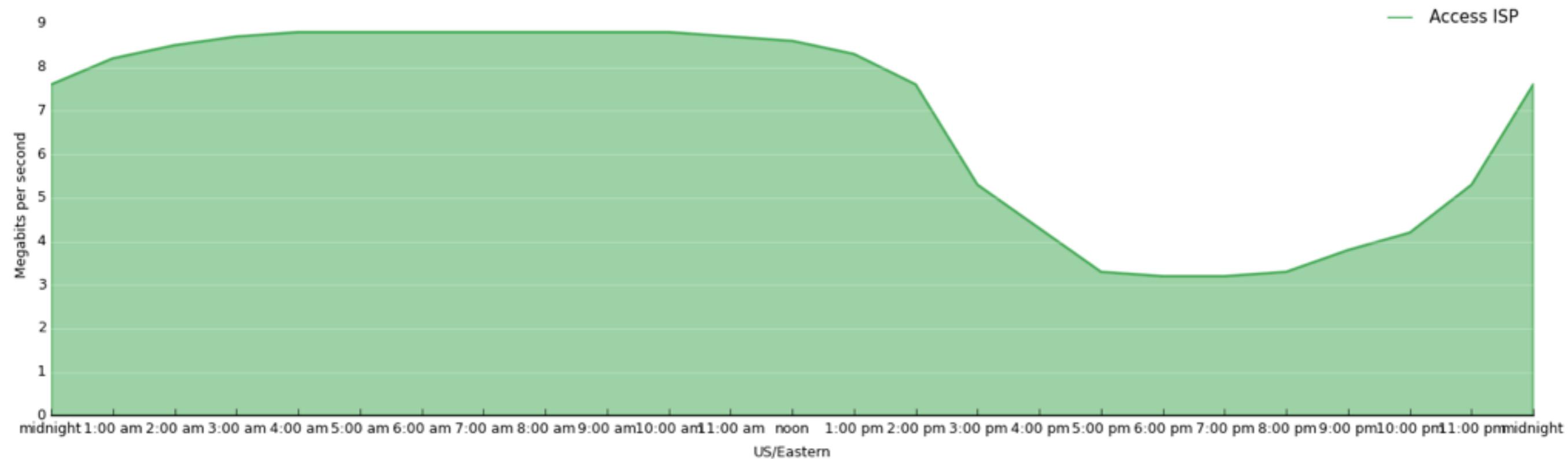
Median download throughput during the average day between access ISP and transit ISP (higher is better)



Diurnal Patterns Are
Instructive

Expectations of Normal Performance

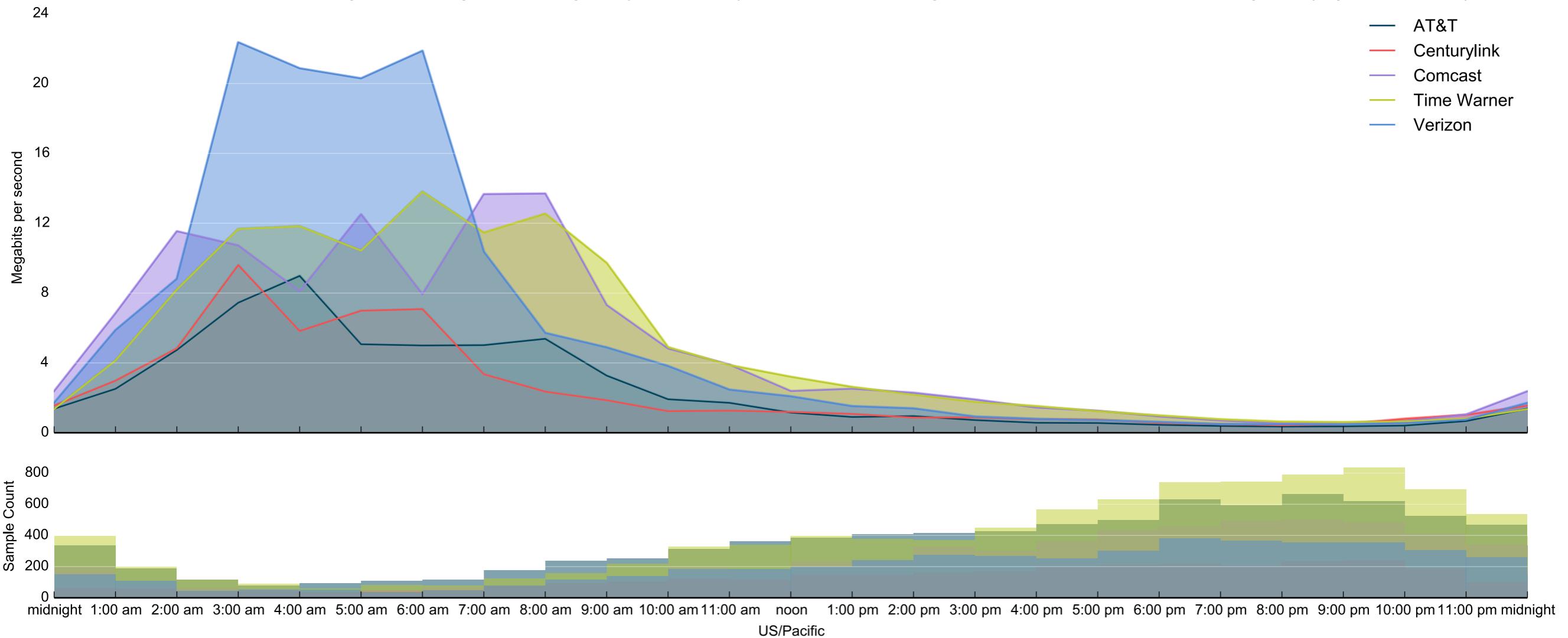
Median download throughput during the average day between access ISP and transit ISP (higher is better)



Diurnal Patterns Are Instructive

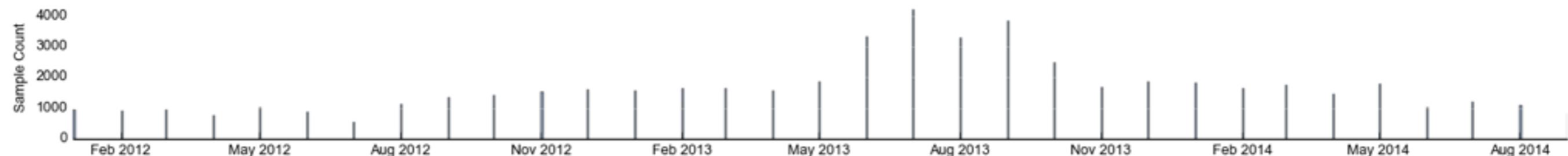
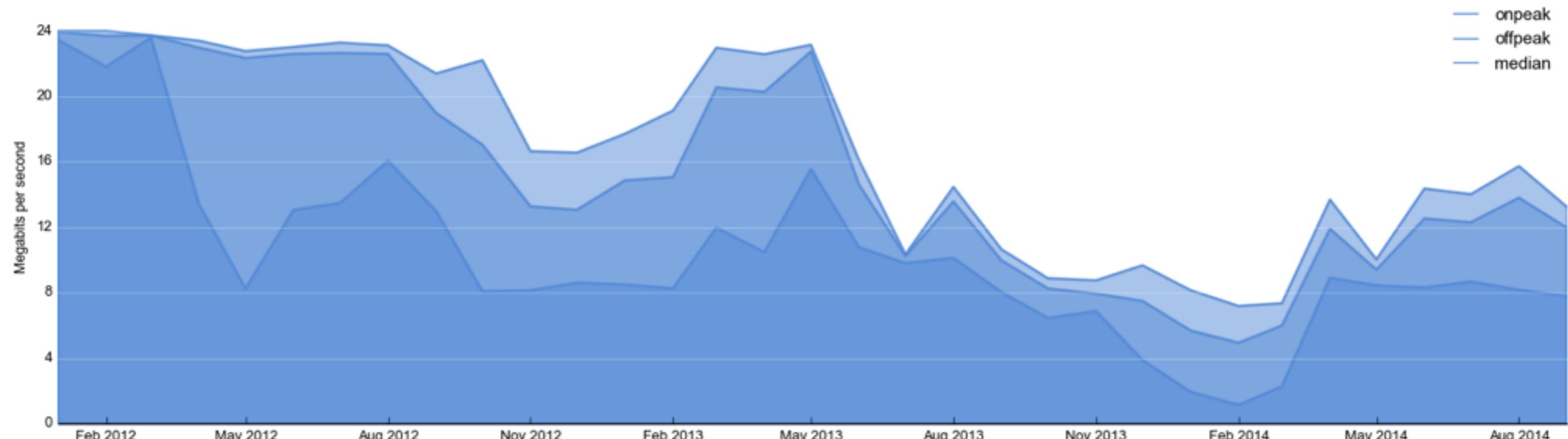
Expectations of Congested Performance

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)

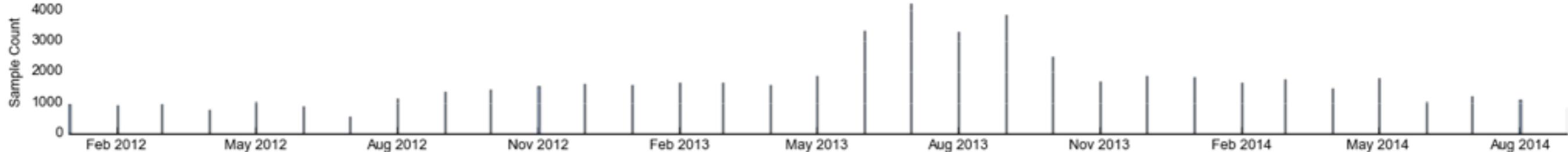
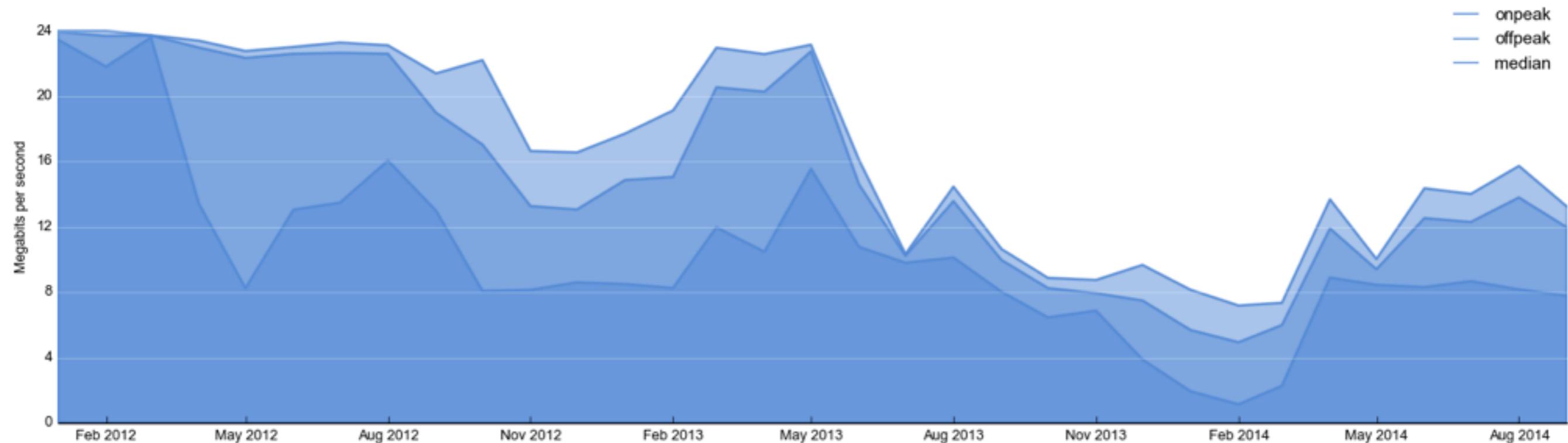


Diurnal Patterns Are Instructive

Peak Congestion Can Augur Future Degradation

Congestion affecting consumers has not been limited to interconnections with Cogent

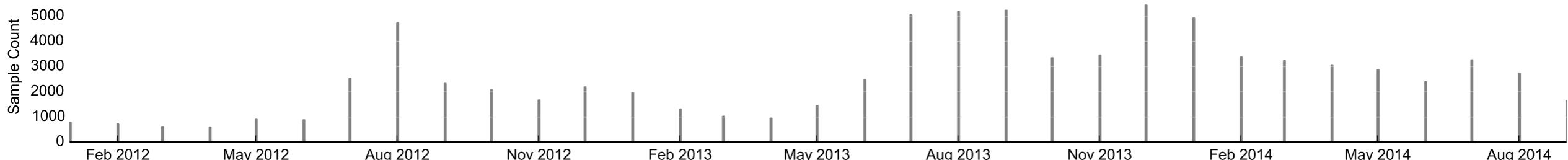
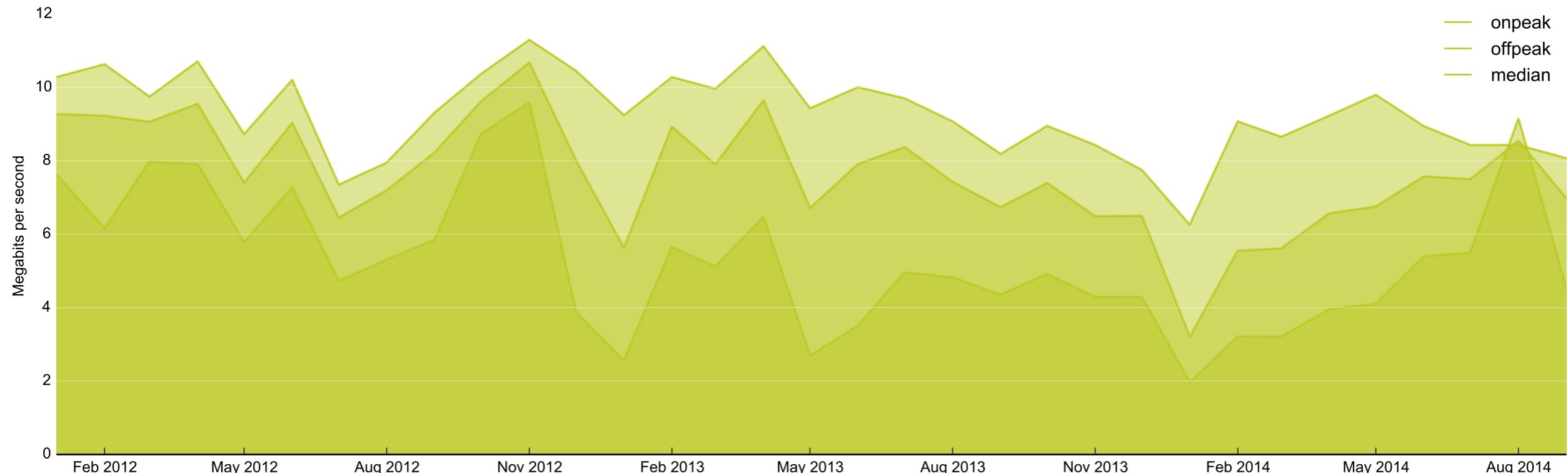
Median download throughput across Level 3 to Verizon in Chicago (higher is better)



Level 3 and Verizon

Ongoing

Median download throughput across XO to Time Warner in Washington D.C. over time during peak hours and off-peak hours (higher is better)



XO and Time Warner
Cable

Ongoing

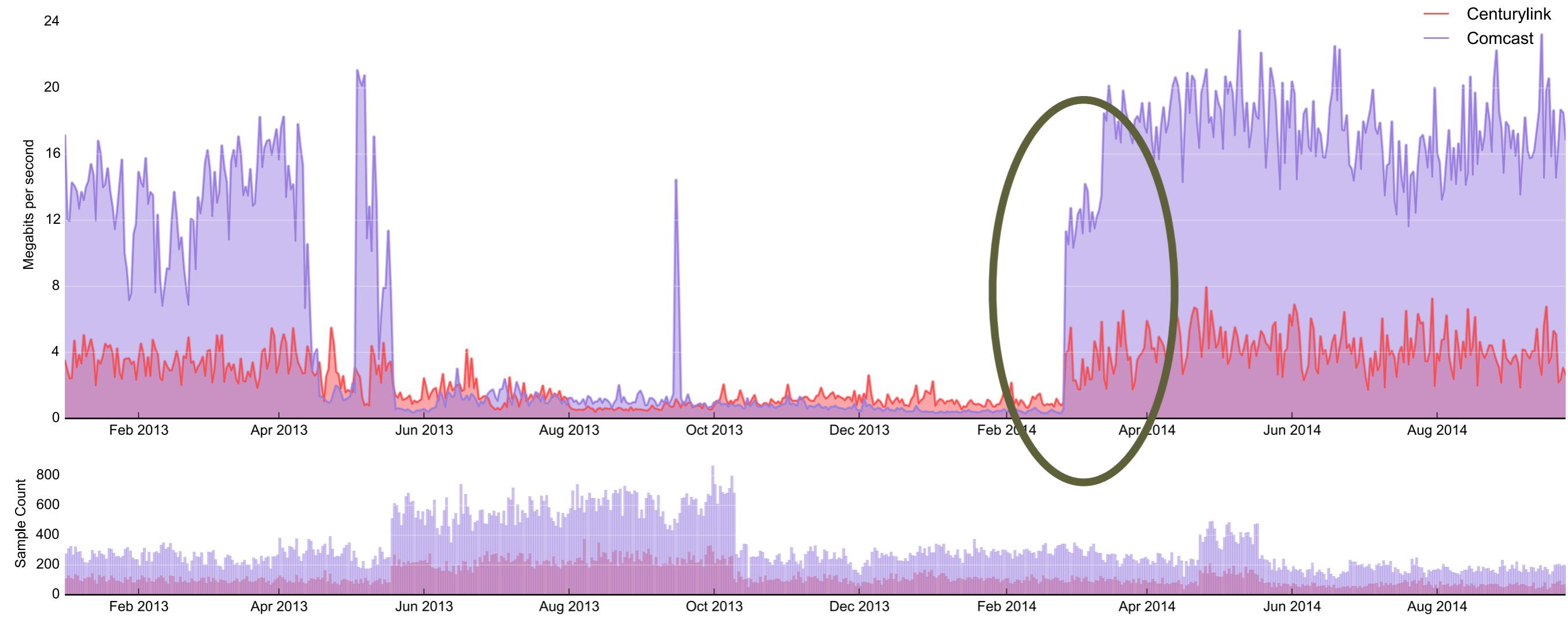
Our data shows that traffic from specific Access ISP customers across interconnections with specific Transit ISPs experienced degraded performance, and that this degradation forms a pattern wherever specific Access ISPs and Transit ISPs exchange traffic.

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]>

Assessment of Prioritization

Cross the Board Increases

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



Assessment of
Prioritization

Cross the Board Increases

Raw Data Access and Processed Data Extraction Tools



— 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

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

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

Metric ▾

View By ▾

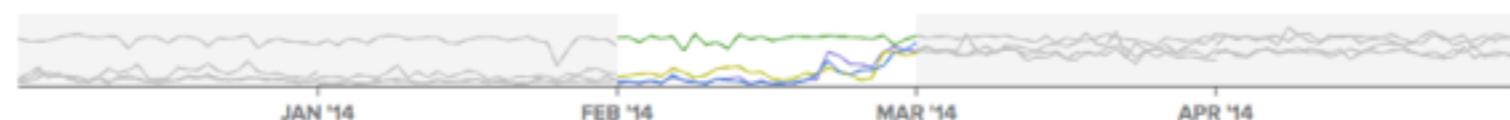
Metro Region ▾

Download Speed for New York

FEB 1 – 28, 2014

Share: [g+](#) [f](#) [t](#)

Click and drag left or right to adjust monthly date range



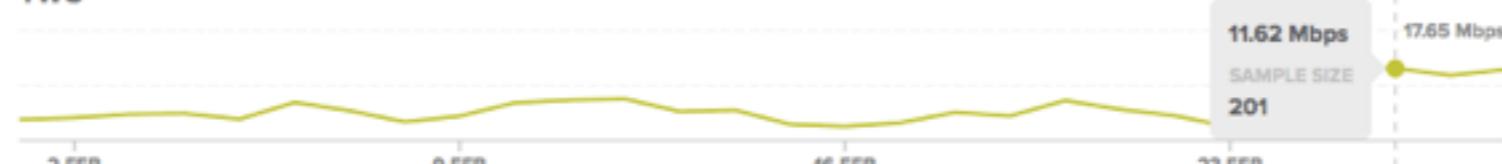
Cablevision



Comcast



TWC



Verizon



Measurement Lab Observatory

Currently US Only

Google BigQuery

https://bigquery.cloud.google.com/results/192795857953:job_J0r6rdFkFDRUF6_nkYAd8AQR50?pli=1

Search Images Mail Drive Calendar Sites Groups Admin More collin@averysmallbird.com

Google bigquery

COMPOSE QUERY ? X

New Query

```
1543 PARSE_IP(`web100_log_entry.connection_spec.remote_ip`) BETWEEN 3639693824 AND 3639694079 OR
1544 PARSE_IP(`web100_log_entry.connection_spec.remote_ip`) BETWEEN 3640184832 AND 3640188927 OR
1545 PARSE_IP(`web100_log_entry.connection_spec.remote_ip`) BETWEEN 3642532608 AND 3642532863 )
1546 ORDER BY
1547     day_timestamp, server_ip, client_ip;
1548
1549
```

RUN QUERY Save Query Save View Show Options Query complete (51.6s elapsed, 0 B processed) ✓

No datasets found in this project.
Please create a dataset or select a new project from the menu above.

publicdata:samples

github_nested
github_timeline
gsod
natality
shakespeare
trigrams
wikipedia

Query Results 9:21pm, 12 Jan 2015

Download as CSV Save as Table

| Row | day_timestamp | server_ip | client_ip | raw_download_rate | min_rtt |
|-----|---------------|---------------|-----------------|---------------------|---------|
| 1 | 1375320272 | 38.106.70.147 | 166.137.86.190 | 1.2128786828219895 | 92 |
| 2 | 1375320272 | 38.106.70.147 | 166.137.86.190 | 1.2128786828219895 | 92 |
| 3 | 1375323684 | 38.106.70.147 | 166.137.105.244 | 0.10470654031243713 | 500 |
| 4 | 1375323684 | 38.106.70.147 | 166.137.105.244 | 0.10470654031243713 | 500 |
| 5 | 1375357766 | 38.106.70.147 | 198.228.197.249 | 25.548208166465677 | 32 |
| 6 | 1375357766 | 38.106.70.147 | 198.228.197.249 | 25.548208166465677 | 32 |
| 7 | 1375361153 | 38.106.70.147 | 166.199.181.81 | 1.556854899614244 | 90 |

First < Prev Rows 1-7 of 345 Next > Last

Raw Data: BigQuery

Structured Database Access

Google Developers Console <https://console.developers.google.com/storage/browser/m-lab/>

Sign up for a free trial. +Collin 

Projects Buckets / m-lab

Billing [Upload files](#) [Upload folder](#) [New folder](#) [C](#) Delete Filter by prefix...

| <input type="checkbox"/> | NAME | SIZE | TYPE | LAST UPLOADED | SHARED PUBLICLY |
|--------------------------|-----------------------------|----------|--------------------|---------------|-------------------------------------------------------------------------------------|
| <input type="checkbox"/> | shaperprobe/ | — | Folder | — | |
| <input type="checkbox"/> | glasnost/ | — | Folder | — | |
| <input type="checkbox"/> | isp_to_asns_map.txt | 37.78 KB | application/x-gzip | 5 days ago |  |
| <input type="checkbox"/> | list/ | — | Folder | — | |
| <input type="checkbox"/> | ndt/ | — | Folder | — | |
| <input type="checkbox"/> | neubot/ | — | Folder | — | |
| <input type="checkbox"/> | npad/ | — | Folder | — | |
| <input type="checkbox"/> | paris-traceroute/ | — | Folder | — | |
| <input type="checkbox"/> | pathload2/ | — | Folder | — | |
| <input type="checkbox"/> | pde_charts_data/ | — | Folder | — | |
| <input type="checkbox"/> | interconnection-study-2014/ | — | Folder | — | |
| <input type="checkbox"/> | sidestream/ | — | Folder | — | |

« »

Raw Data: Cloud Storage

Raw Datafile Access

Growing the Network

- Infrastructure Update: Expansion of Server Coverage in Asia, North America and Africa.
- Deployment of M-Lab sites to locations in:
 - Canada (Calgary, Montreal, Toronto)
 - Africa (Tunisia)
 - Asia (Singapore, Thailand)
- Deployment to Transit ISPs:
 - Cogent
 - Level 3
 - NTT



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

measurementlab.net