

Measurement Lab

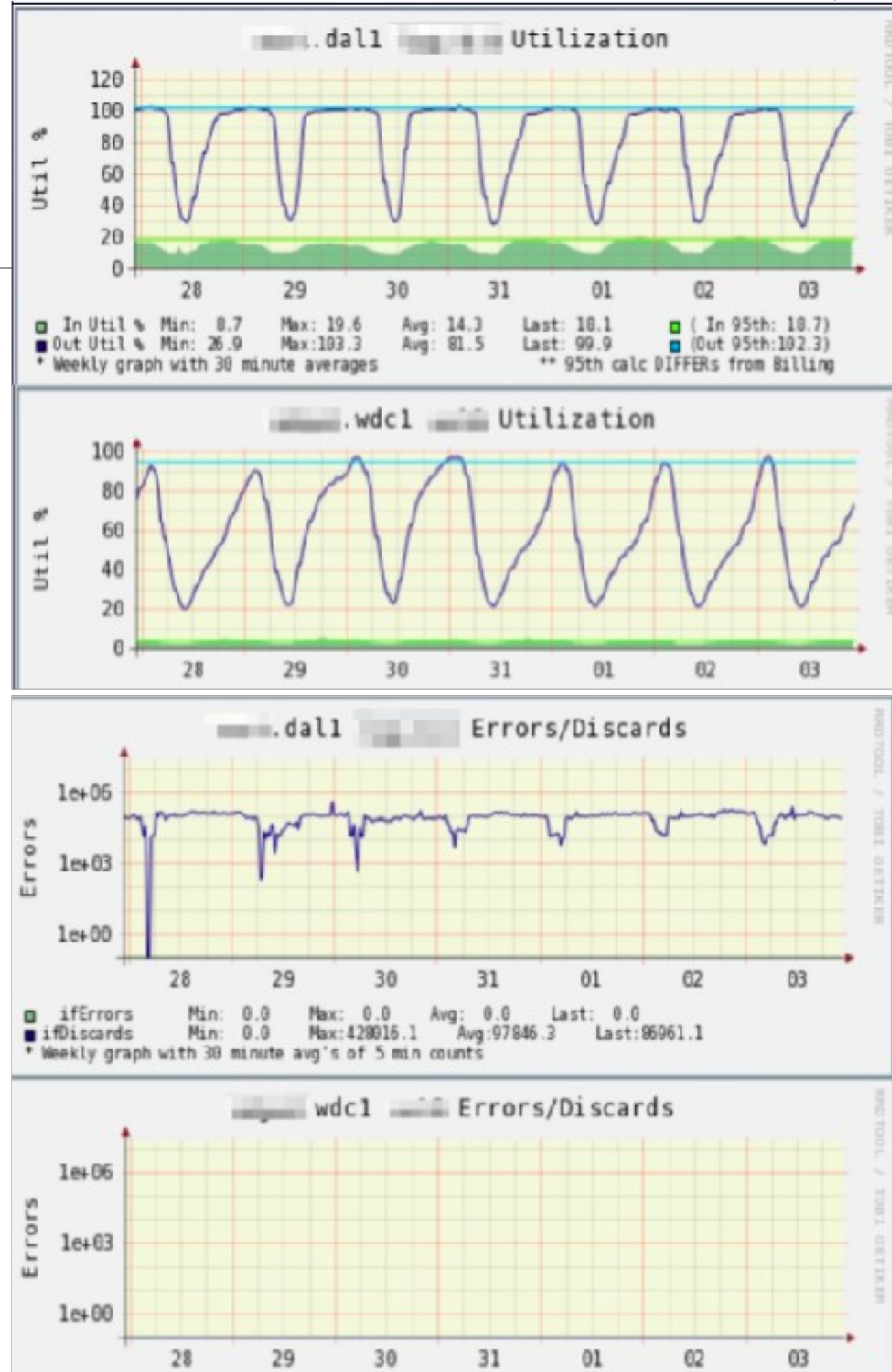
Internet Policy and Independent Network Performance Measurement

Chris Ritzo, Collin Anderson

LACNIC 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.



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 the 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?

Just kidding...

1. How can I locate the bottleneck? If I run speedtests on my comcast connection when the VPN connection is crazy slow, I'm still getting 50/10 down/up. The rest of the Internet seems to be working just fine, as well.
2. Supposing I can locate the bottleneck and it's distant from my Comcast connection, what are my options to fix the problem? What if it's at the university site? What if it's somewhere in between?

Any suggestions or information would be greatly appreciated. I have tried our local IT contacts, but they have been of limited assistance (of the "unplug and reboot your computer" variety).

Thanks!

Information
Asymmetries Create
are Public Issues

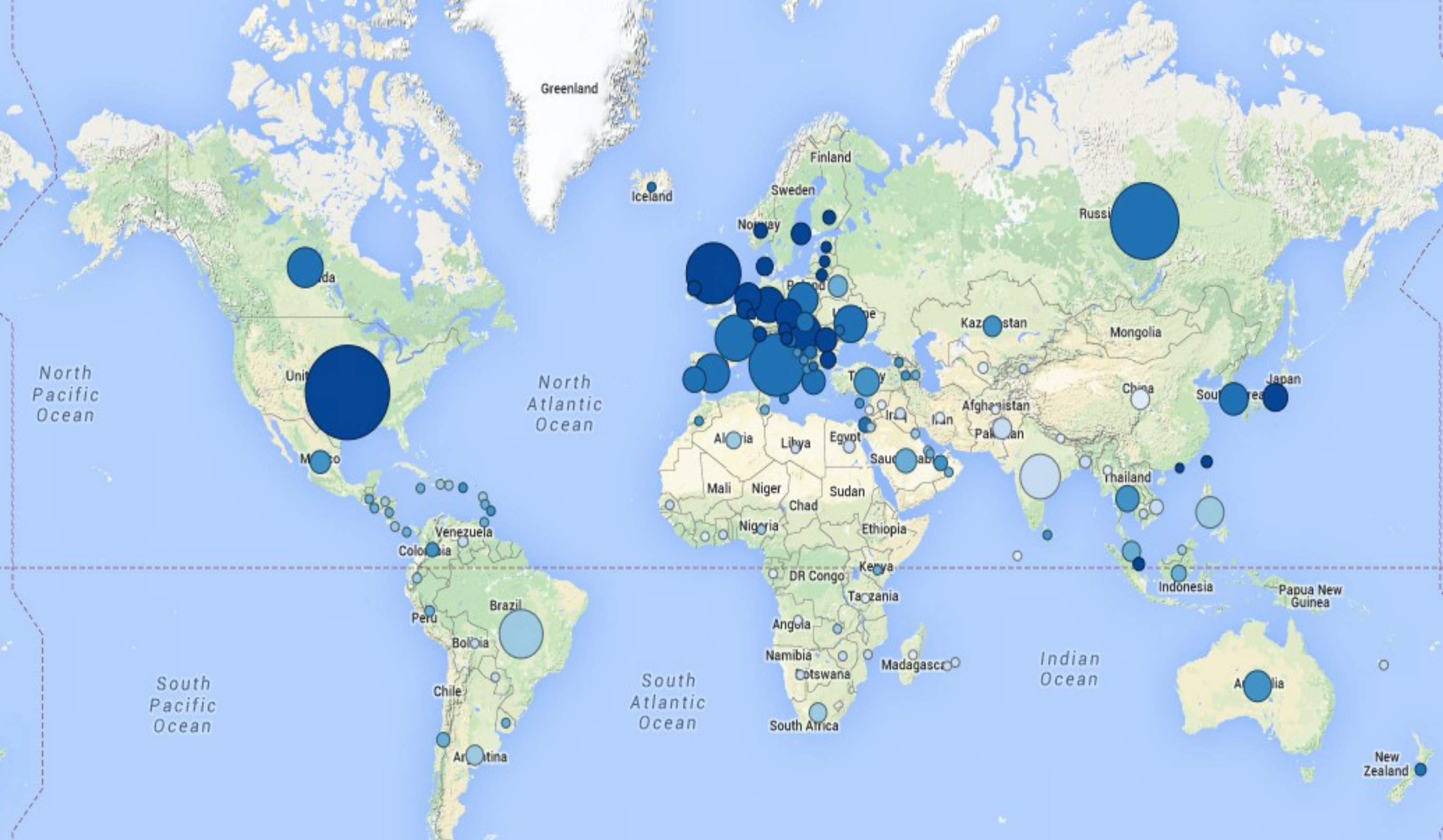
Service Providers Need Data

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.

NDT Mobile Client (beta 2)

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

Transparency

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

HOW NEUTRAL IS THE NET?



Path Information

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

connection_spec_server_ip	paris_traceroute_hop_src_ip	paris_traceroute_hop_dest_ip
217.163.1.89	217.163.1.85	195.219.83.101
217.163.1.89	195.219.83.101	80.231.130.129
217.163.1.89	80.231.130.129	80.231.154.17
217.163.1.89	80.231.154.17	80.231.153.58
217.163.1.89	80.231.153.58	5.23.24.6
217.163.1.89	5.23.24.6	195.154.1.71
217.163.1.89	195.154.1.71	62.210.74.143
217.163.1.102	5.23.24.6	195.154.1.71
217.163.1.102	195.154.1.71	62.210.74.143
217.163.1.102	80.231.153.58	5.23.24.6
217.163.1.102	80.231.154.17	80.231.153.58
217.163.1.102	80.231.130.129	80.231.130.86
217.163.1.102	195.219.83.101	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

STEP 1

A user, connected to the Internet by one or another access ISP, runs a test.

STEP 2

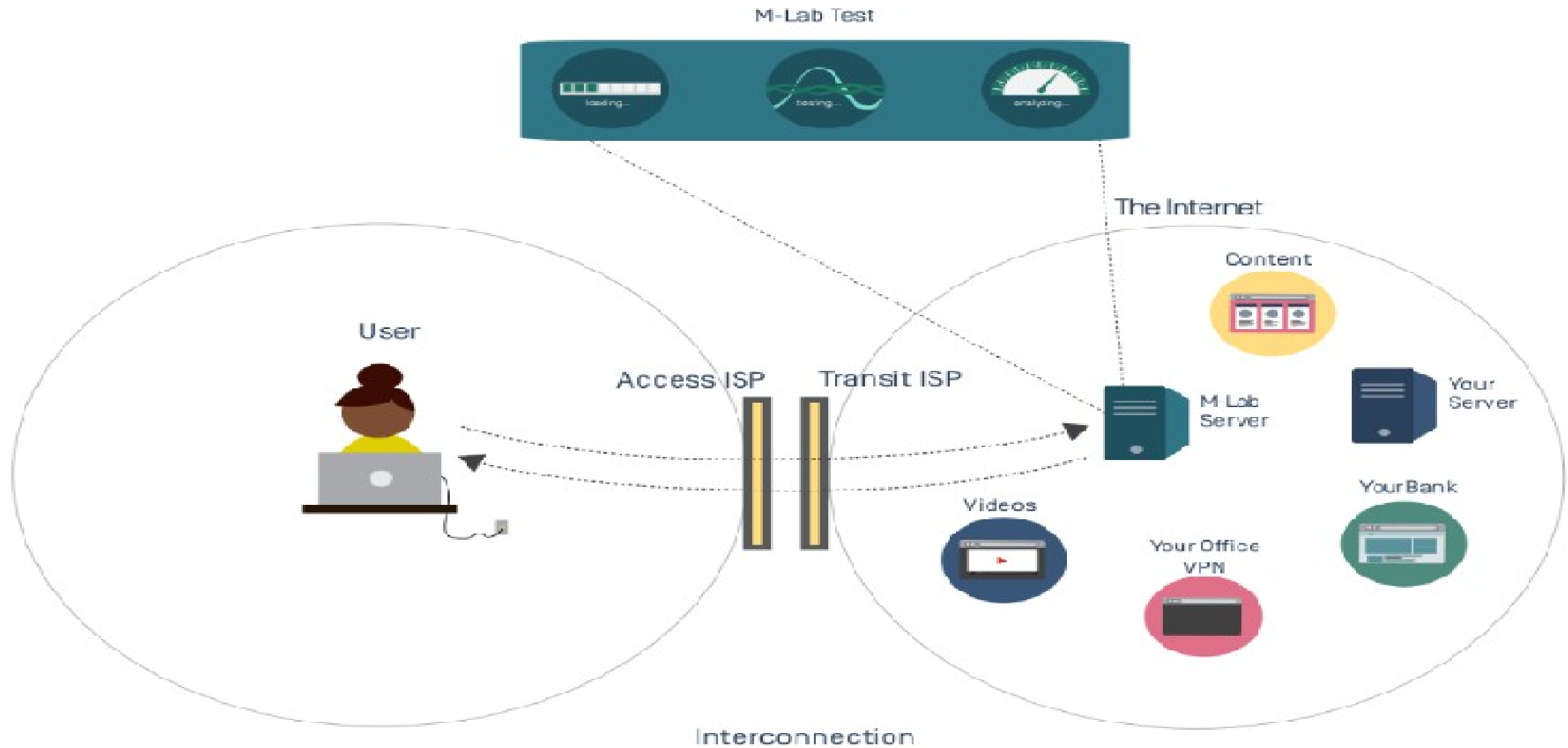
The test sends traffic from their device to the closest M-lab measurement point, and back.

STEP 3

This measures performance from the access ISP into the Internet (not just within the access ISP's network).

STEP 4

The measurements generated by a given test are shown to the user, and put into the public domain.



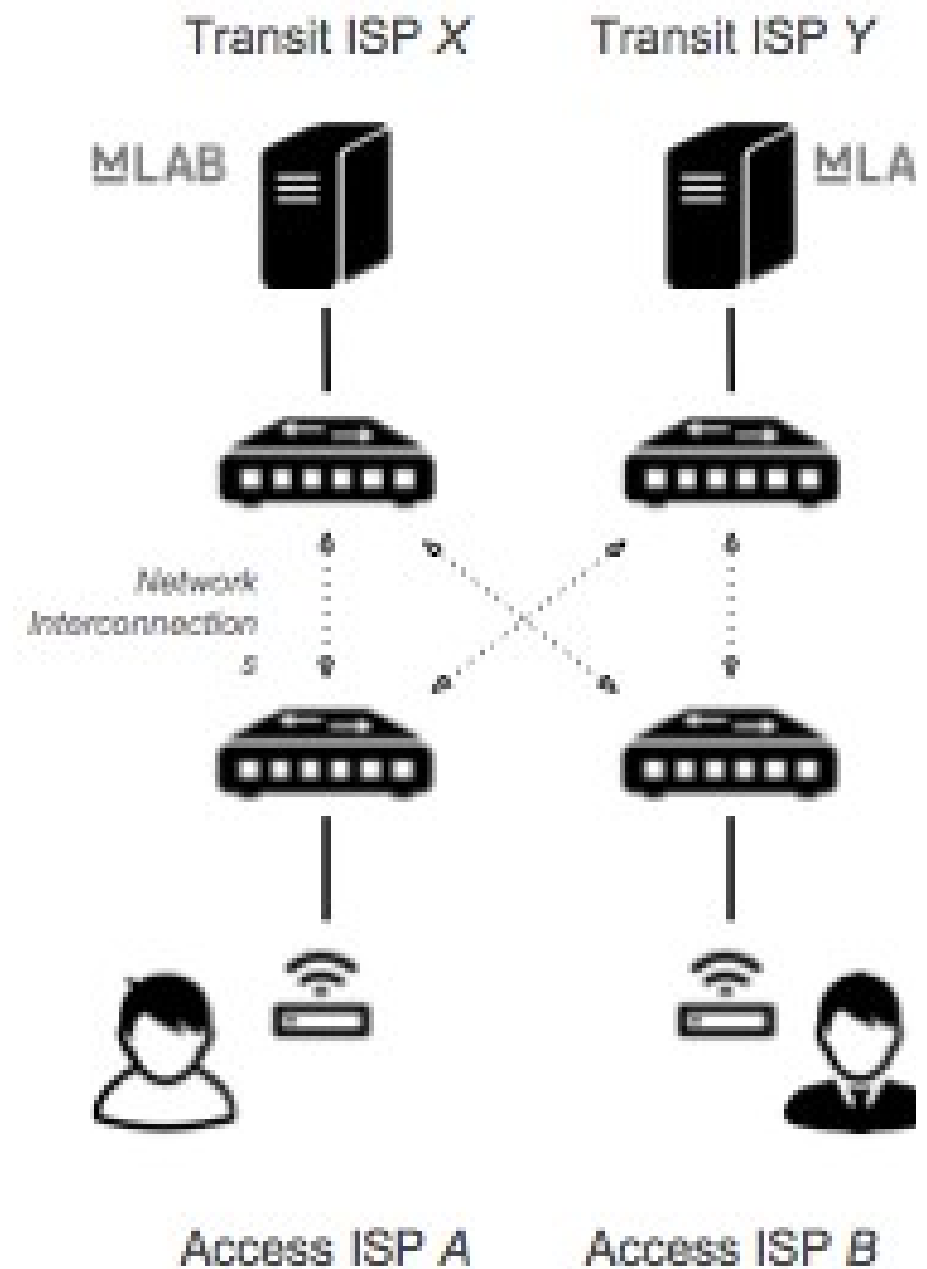
How Measurement Lab Collects Information

Measurements From
Everyone

Methodology

Inferring the Source of
Congestion

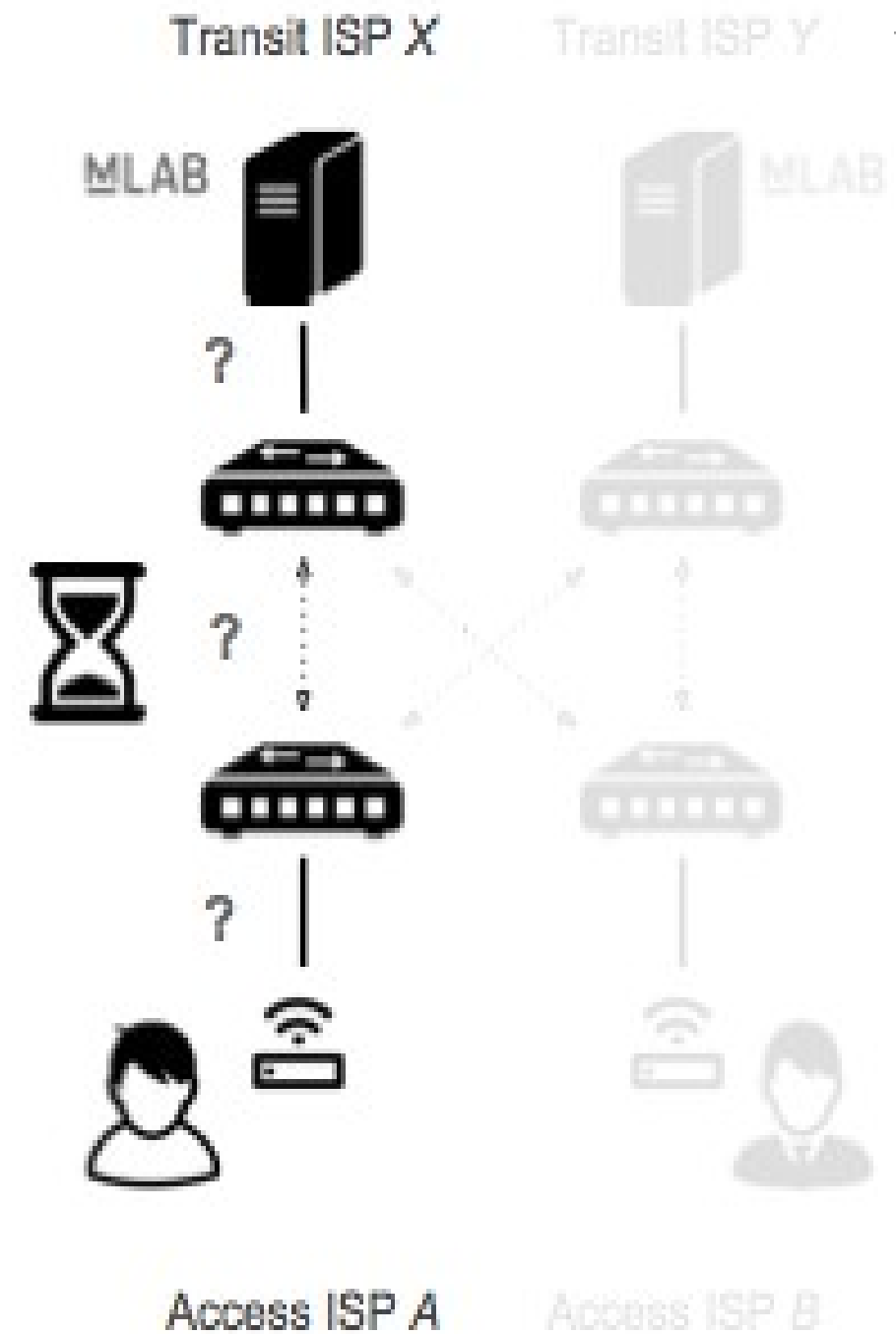
1



Methodology

Inferring the Source of
Congestion

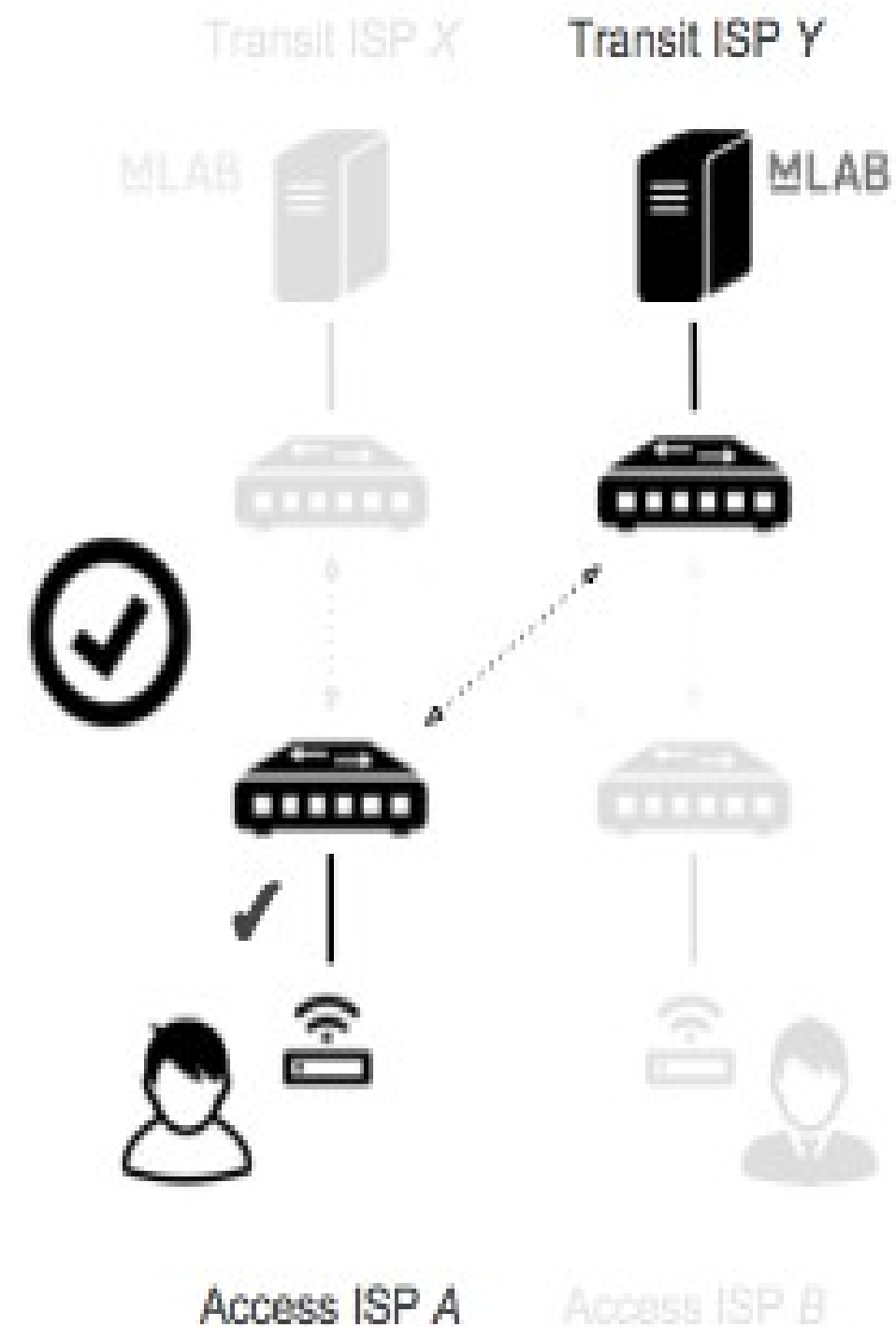
2



Methodology

Inferring the Source of
Congestion

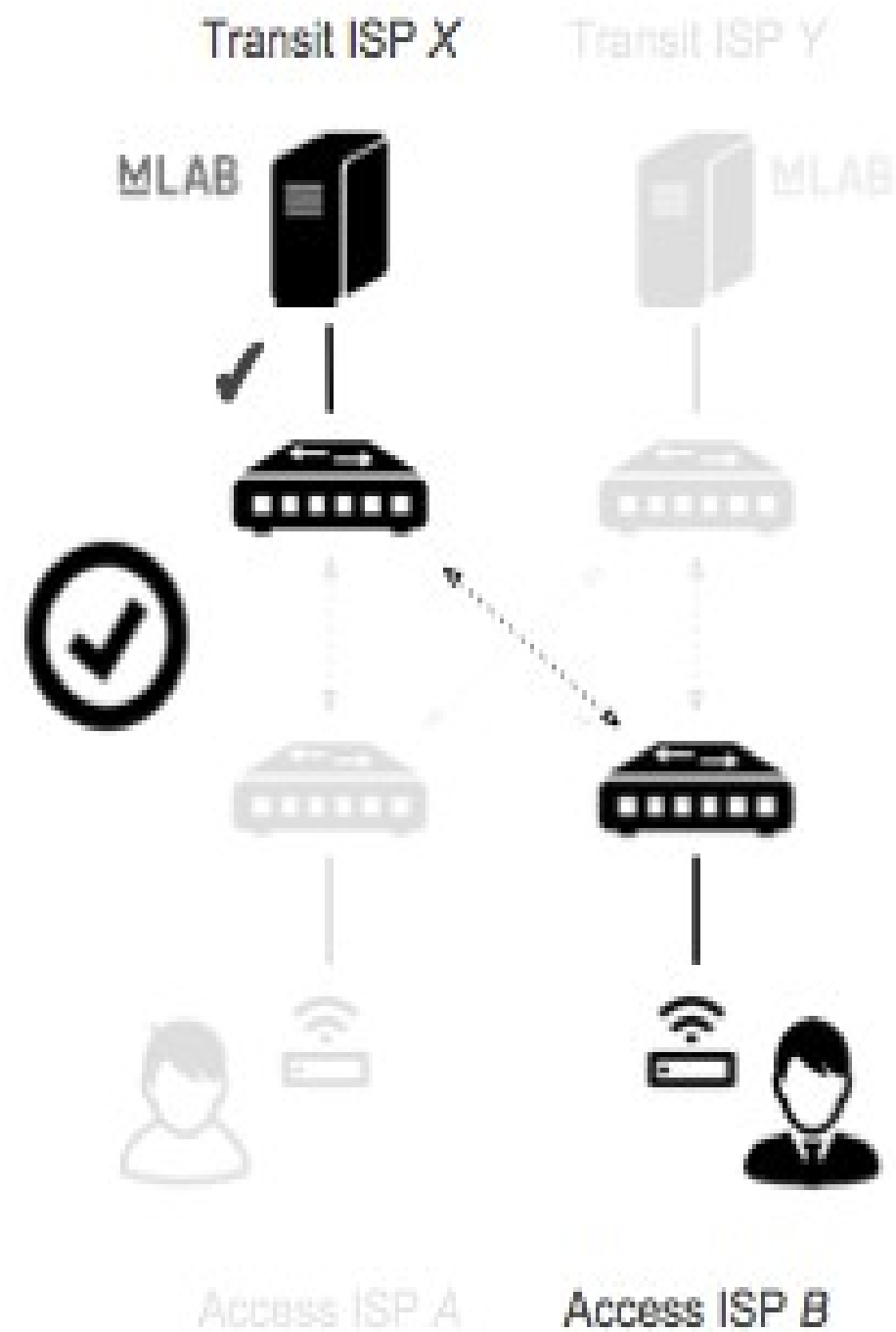
3



Methodology

Inferring the Source of
Congestion

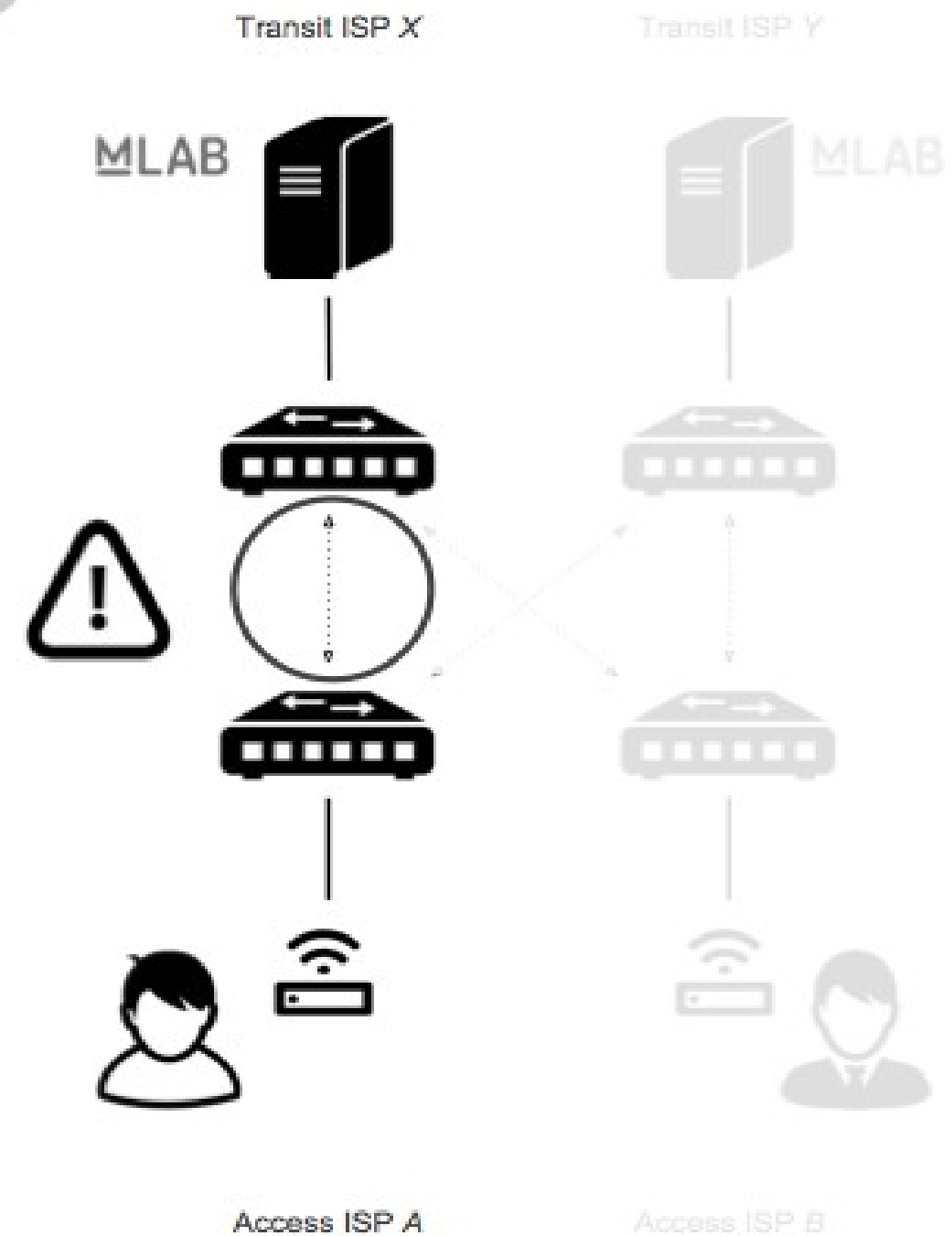
4



Methodology

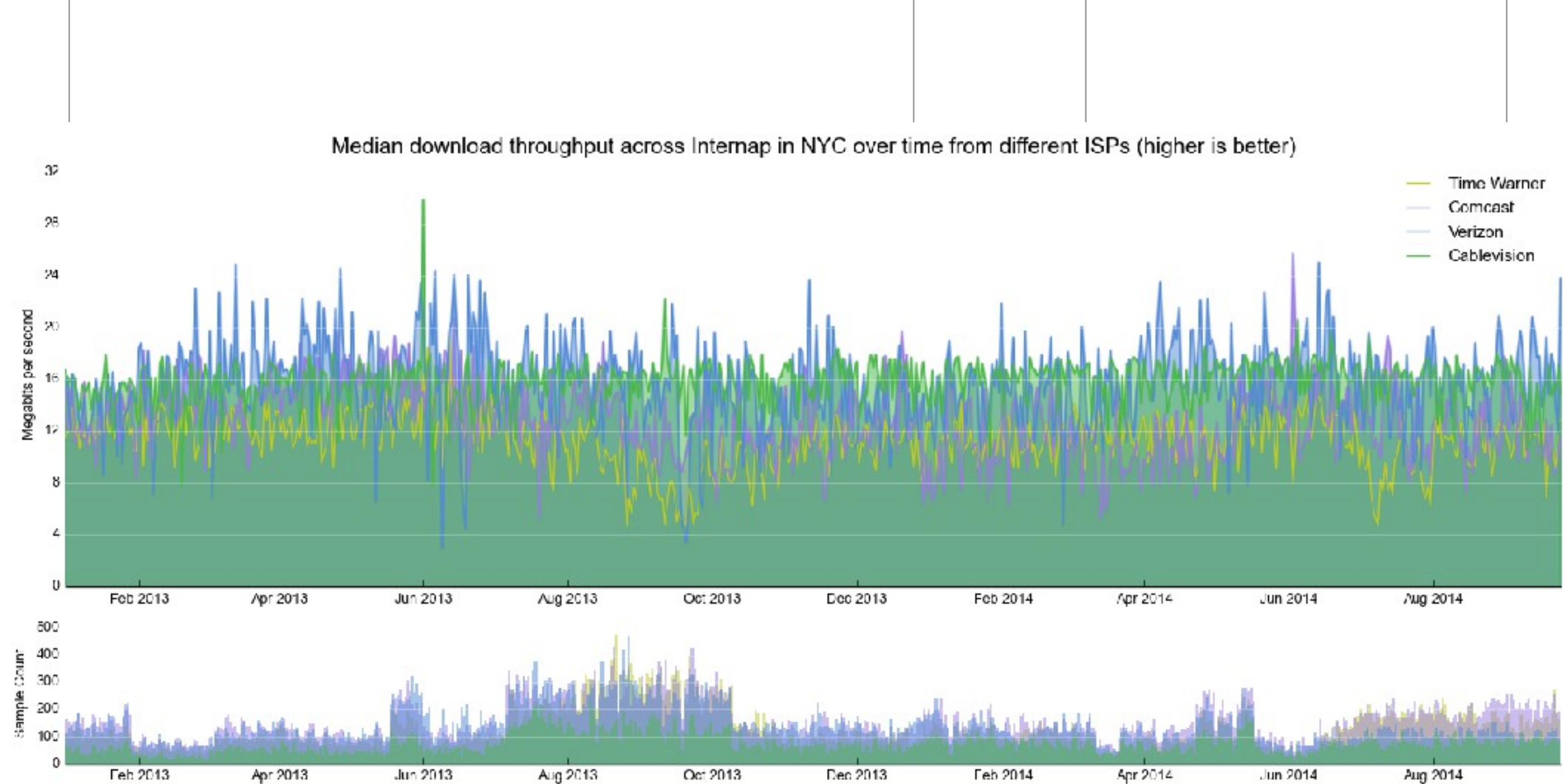
Inferring the Source of Congestion

5



Consumer Internet Measurement Case Study

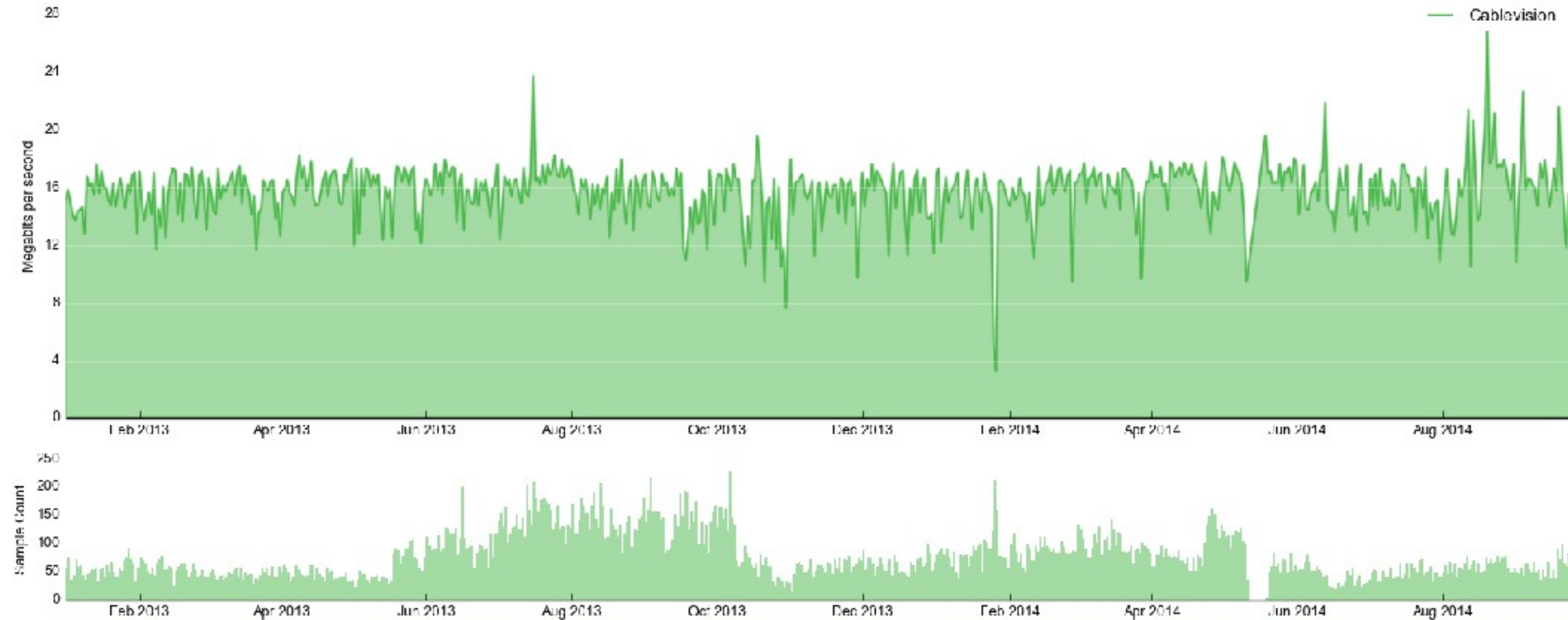
Interconnection Disputes in the United States



Inferring Sources of Congestion in Practice

US Access ISPs and Cogent (2013-2014)

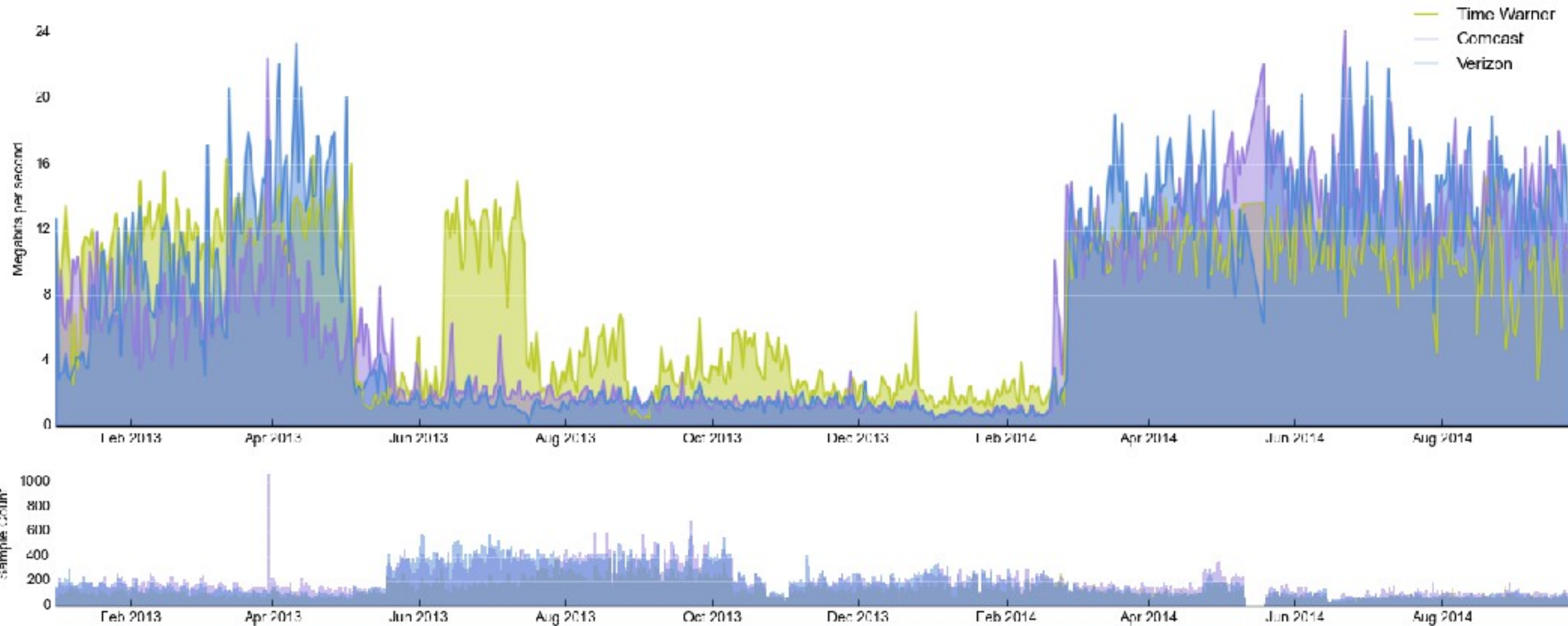
Median download throughput across Cogent to Cablevision in NYC over time (higher is better)



Inferring Sources of Congestion in Practice

US Access ISPs and Cogent (2013-2014)

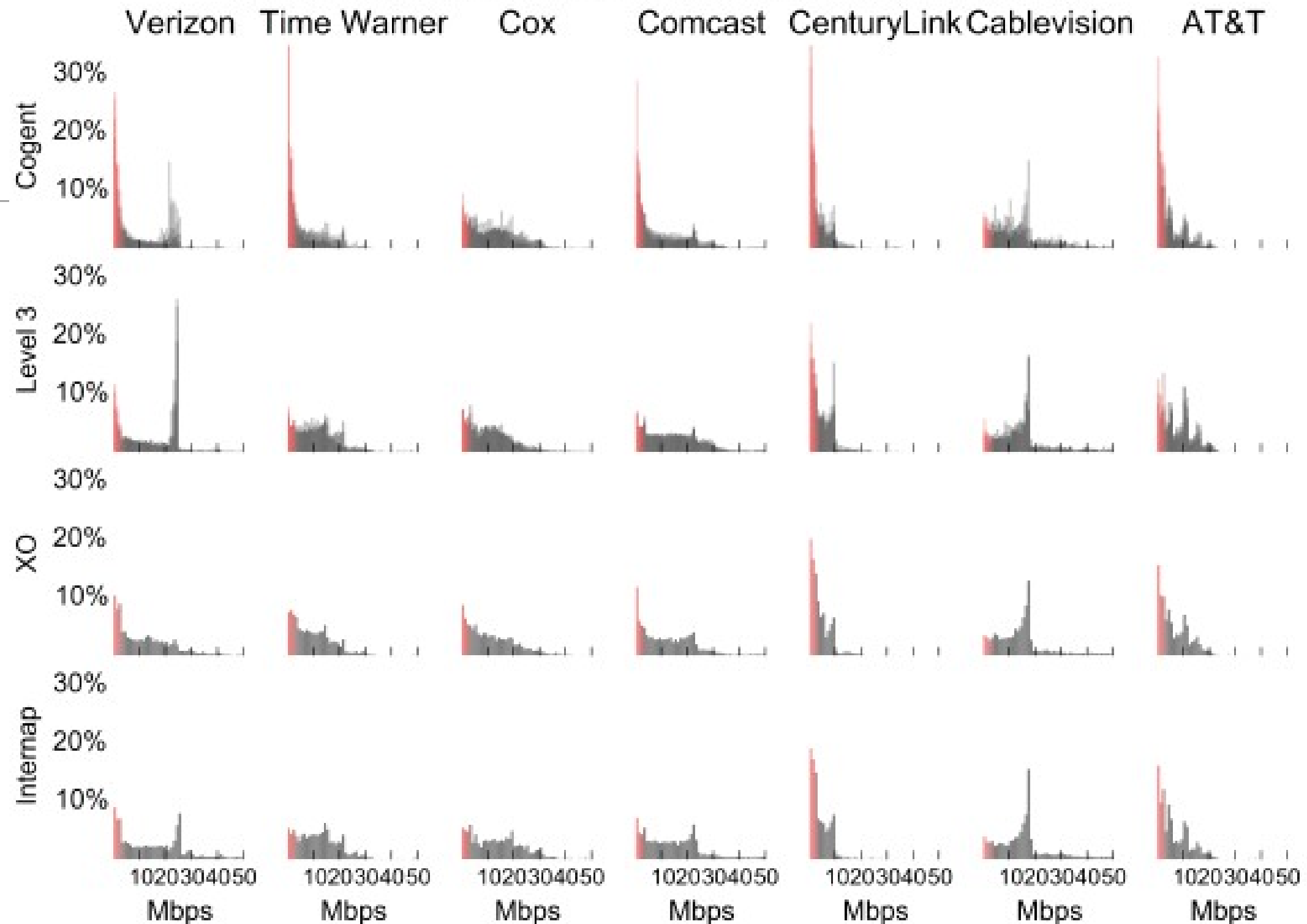
Median download throughput across Cogent in NYC over time from different ISPs (higher is better)



Inferring Sources of Congestion in Practice

US Access ISPs and Cogent (2013-2014)

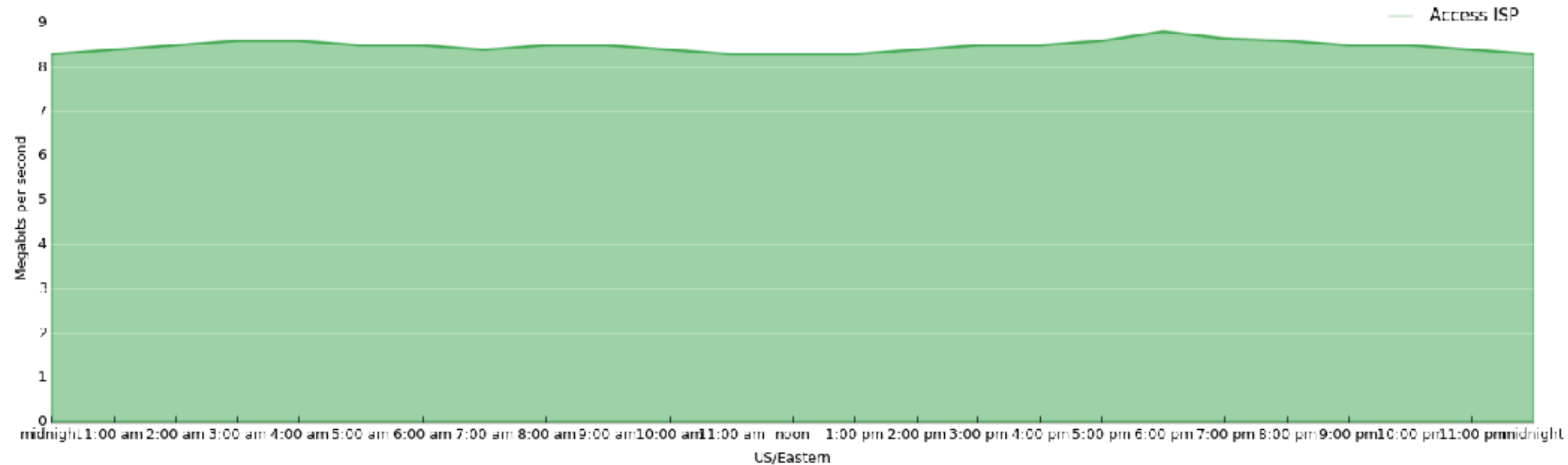
Access/Transit pair download throughput performance in Mbps in 2013



Comparative Performance across ISPs

No Access ISPs or Transit ISPs Universally
Underperforming

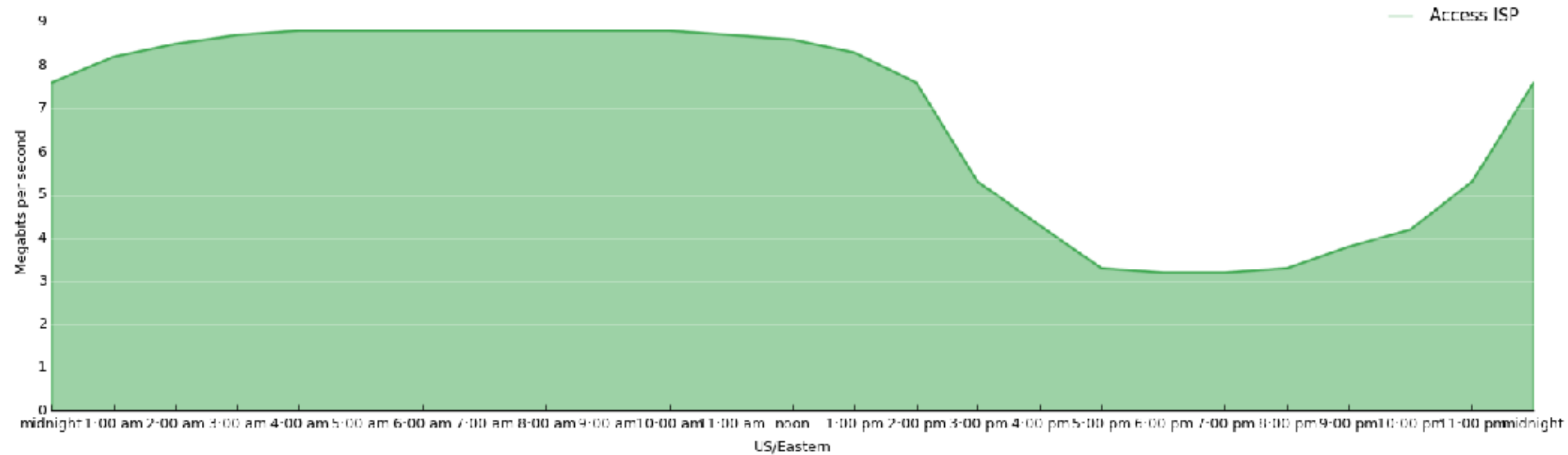
Median download throughput during the average day between access ISP and transit ISP (higher is better)



Diurnal Patterns Are
Instructive

Expectations of Normal
Performance

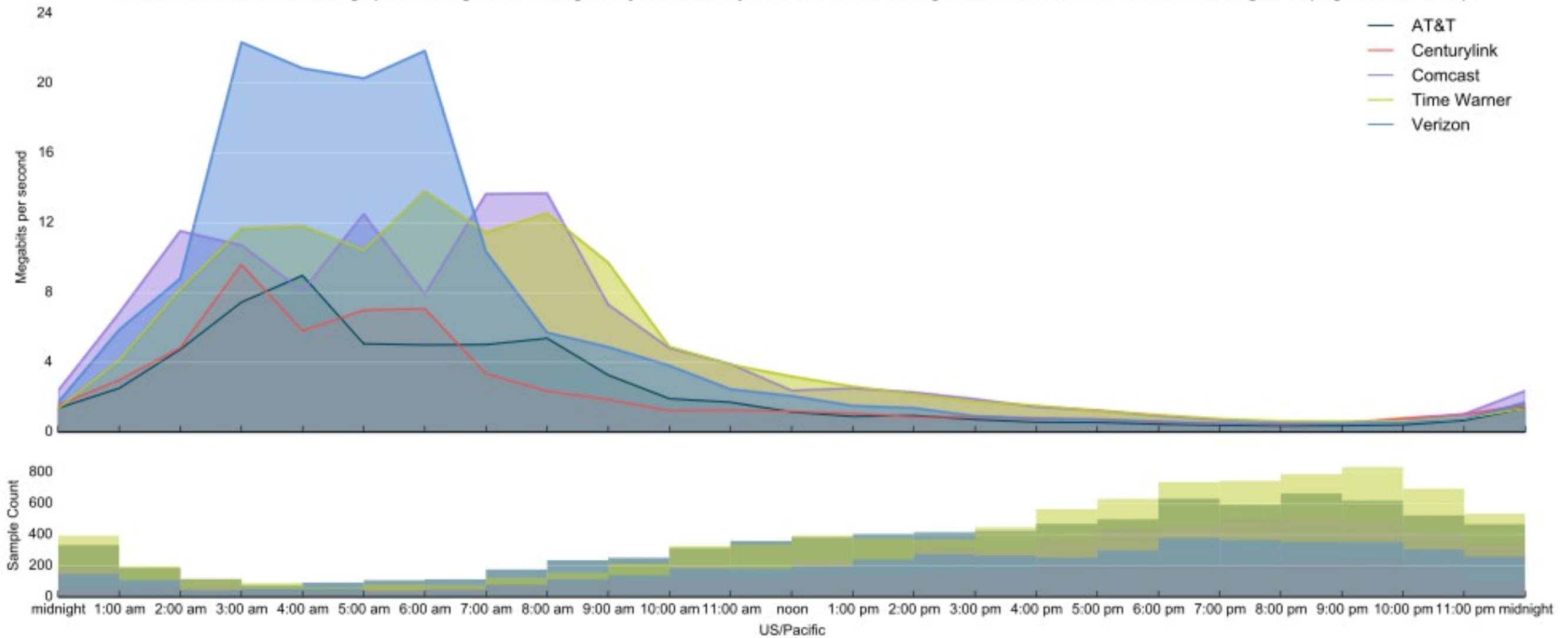
Median download throughput during the average day between access ISP and transit ISP (higher is better)



Diurnal Patterns Are Instructive

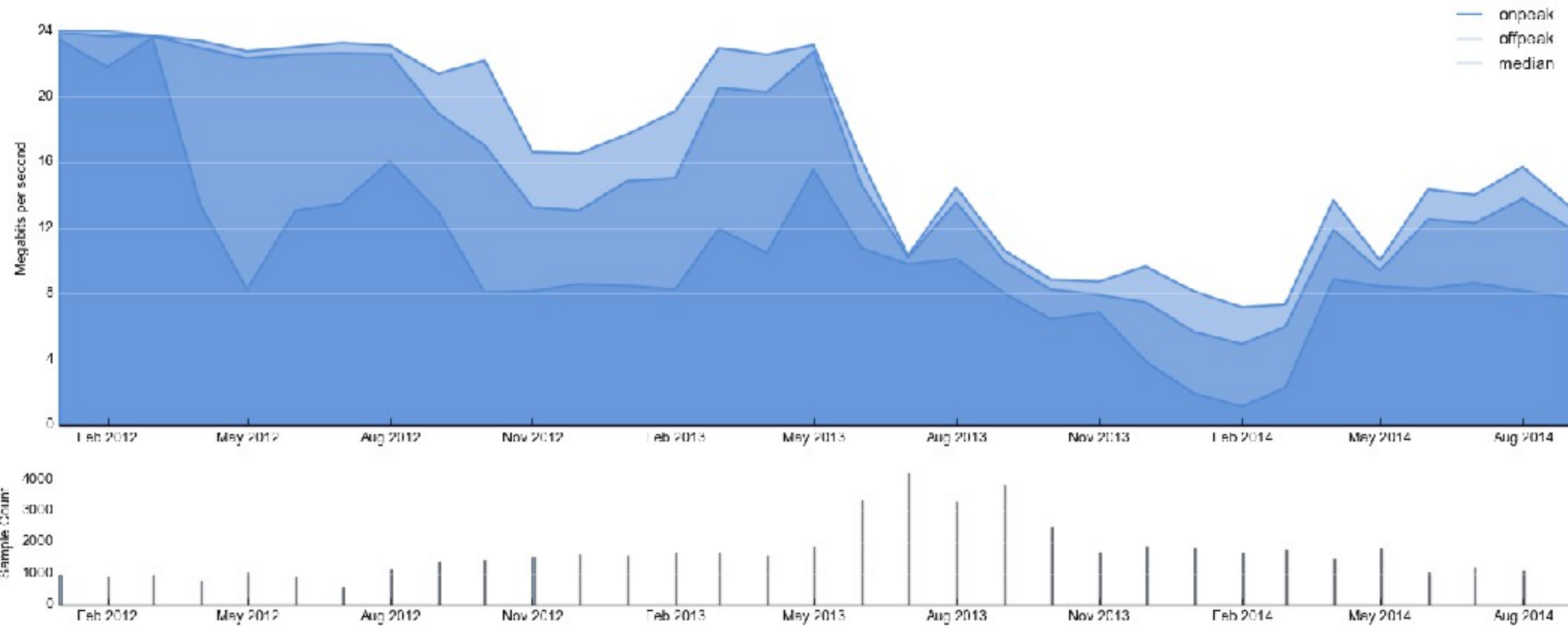
Expectations of Congested Performance

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)

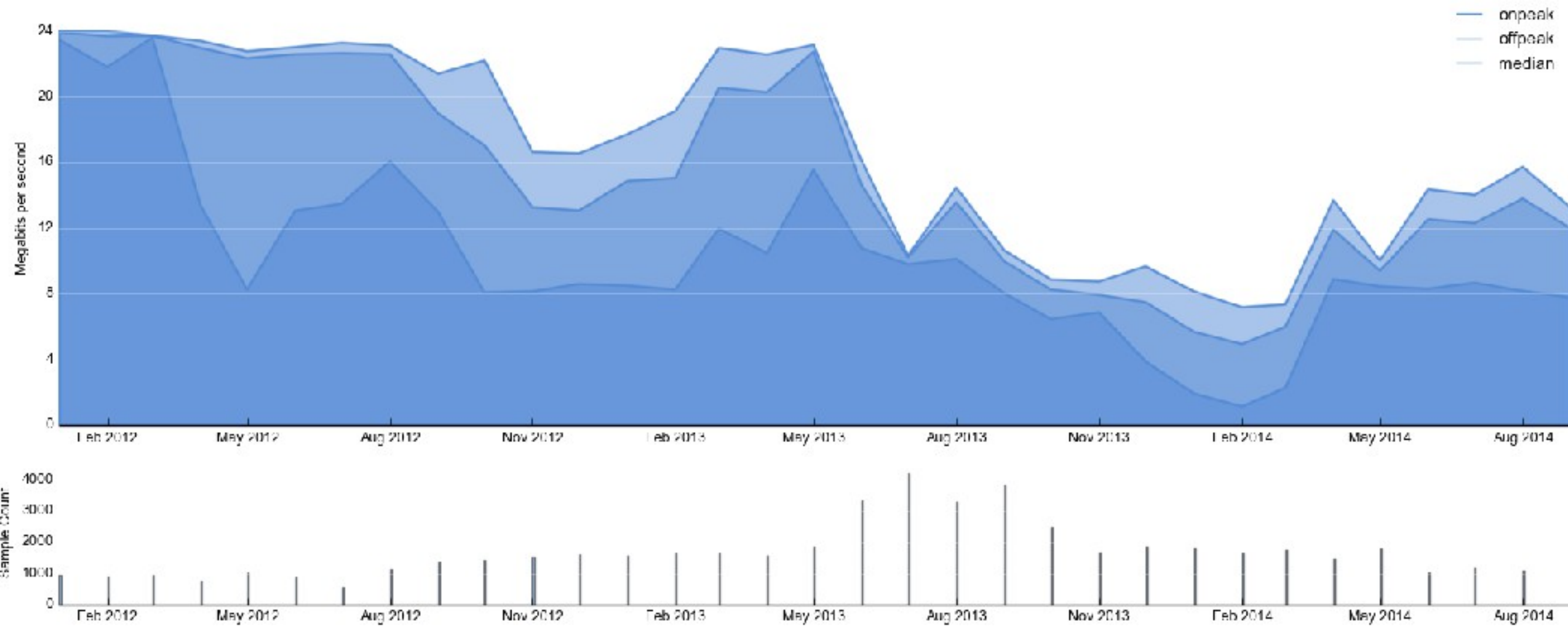


Diurnal Patterns Are Instructive

Peak Congestion Can Augur Future Degradation

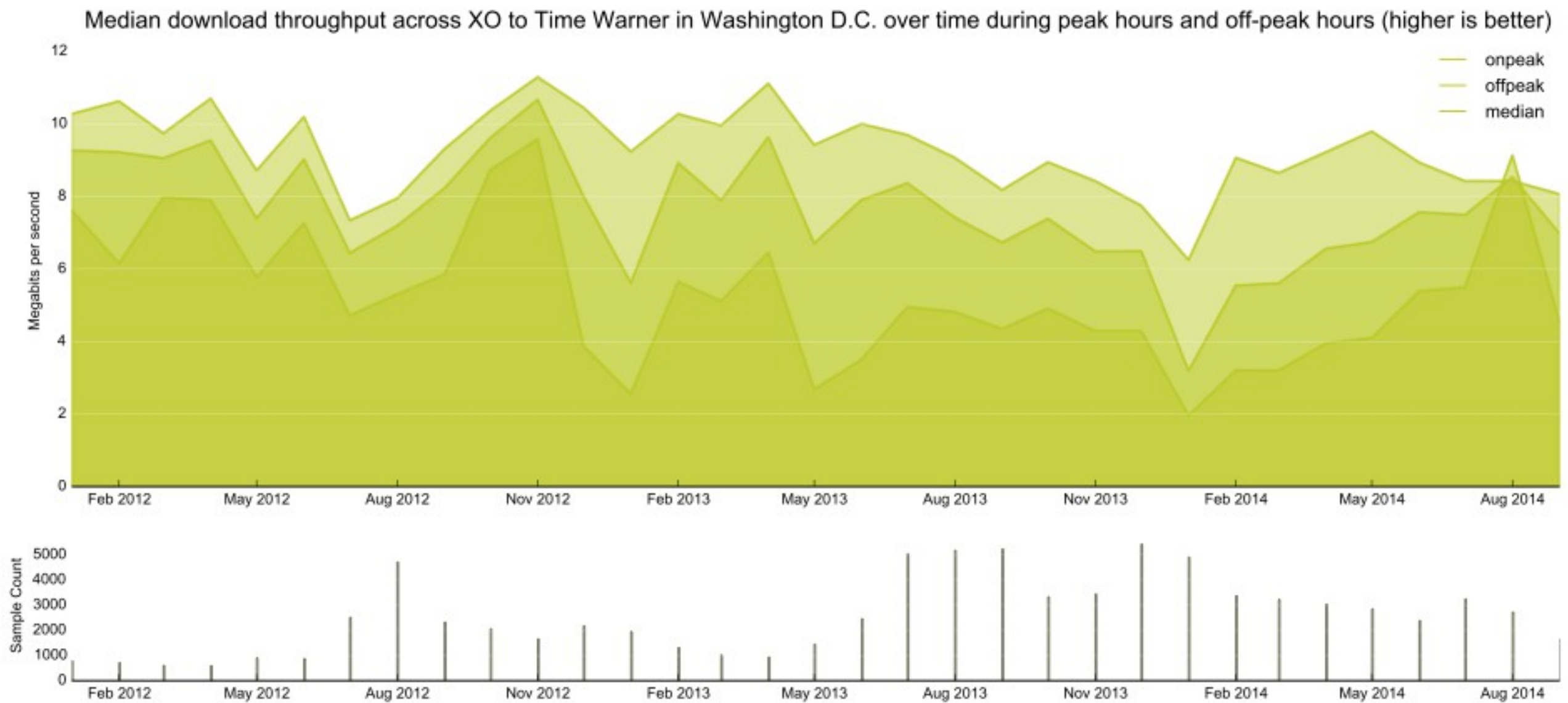
Congestion affecting consumers has not
been limited to interconnections with
Cogent

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



Level 3 and Verizon

Ongoing



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.


```

bash ... root@erlton834~ ... root@laneh~ ... bash ... bash ... bash ... bash ... bash ...
in 8235, options [nop,nop,TS[|tcp]>
14:49:05.789995 IP (tos 0x48, ttl 55, id 10346, 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 49358745:49360193, ack 0, w
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, win 8230,
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, ack 0, w
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, ack 0, w
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, win 8230,
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, ack 0, w
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, ack 0, w
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, win 8230,
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, ack 0, w
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, ack 0, w
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, win 8230,
options [nop,nop,TS[|tcp]>

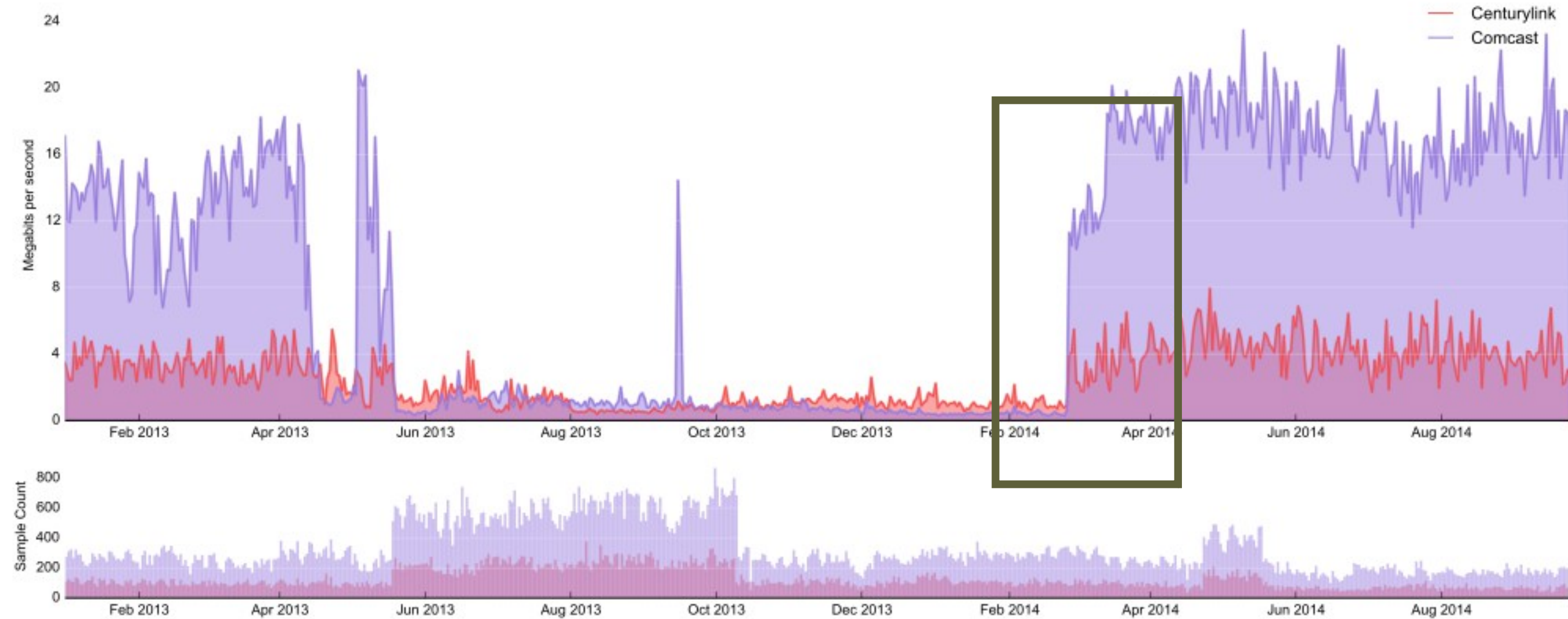
filternet:Downloads cda$ █

```

Assessment of Prioritization

Cross the Board Increases

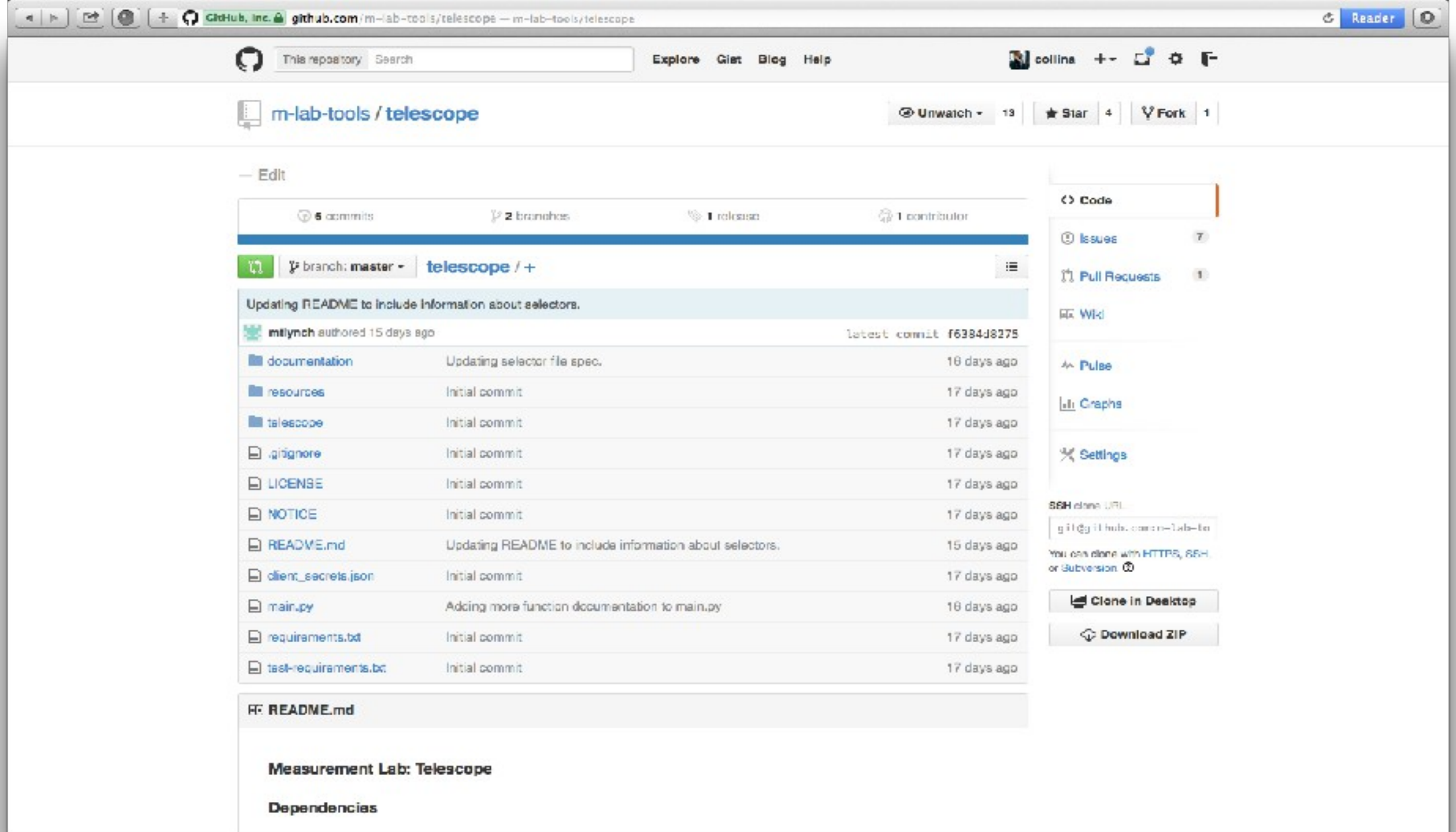
Median download throughput across Cogent in Seattle over time from different ISPs (higher is better)



Assessment of Prioritization

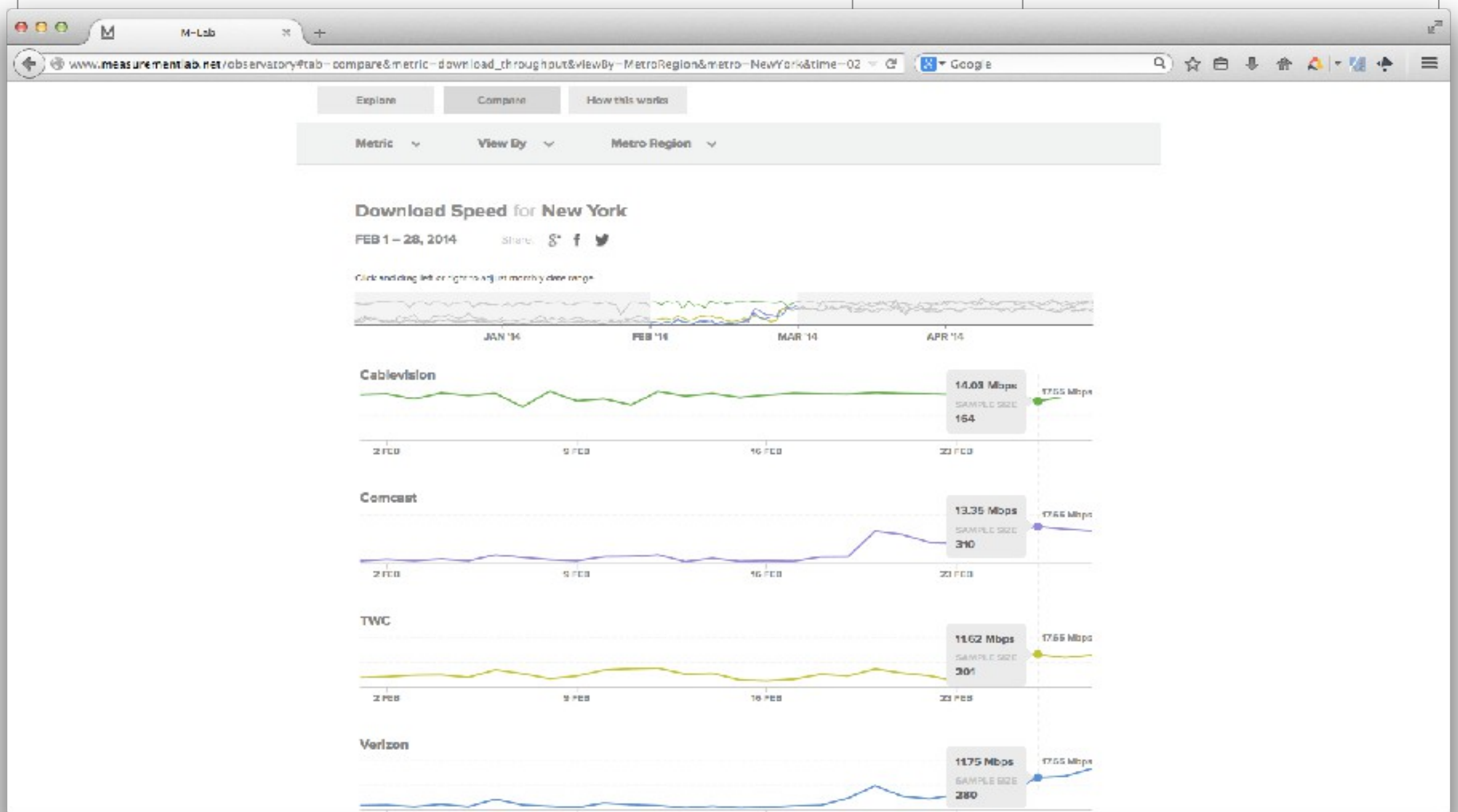
Cross the Board Increases

Raw Data Access and Processed Data Extraction Tools



Measurement Lab Telescope

Python to extract M-Lab data



Measurement Lab
Observatory

Currently US Only

Google BigQuery

https://bigquery.cloud.google.com/results/192795857953:job_J0r8rdFkFDRUF6__nkYAd8AQr50?pli=1

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

Google bigquery

COMPOSE QUERY

Query History
Job History

API Project

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

publ1cdata:samples

- github_nested
- github_timeline
- gsod
- natal ty
- shakespeare
- trigram
- wikipedia

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)

Query Results

8:21pm, 12 Jan 2016

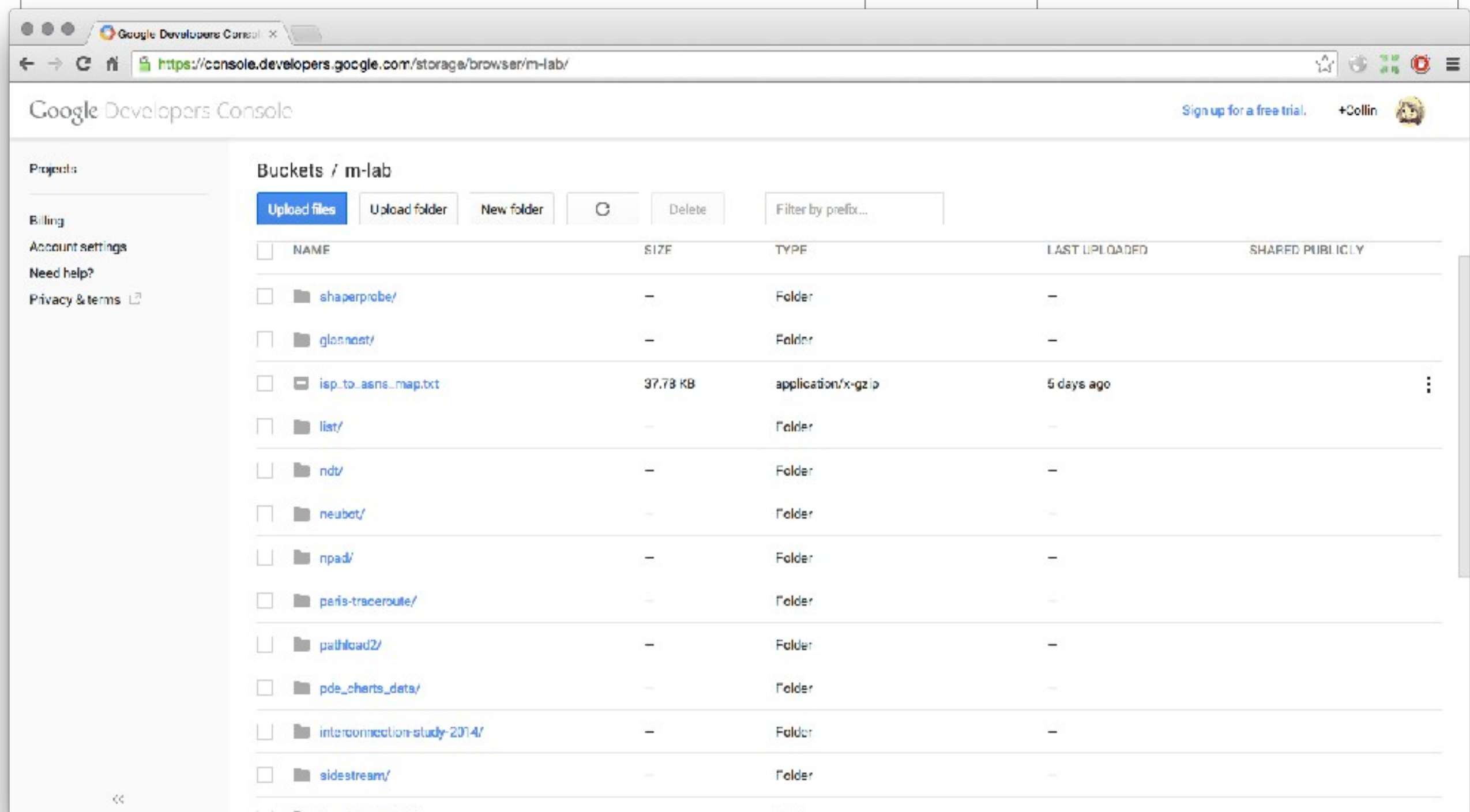
Download as CSV Save as Table

Row	day_timestamp	server_ip	client_ip	raw_download_rate	min_rtt
1	1375320272	38.106.70.147	166.137.86.190	1.2128766828219895	92
2	1375320272	38.106.70.147	166.137.86.190	1.2128766828219895	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	25.548208166466677	32
6	1375357766	38.106.70.147	198.228.197.249	25.548208166466677	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

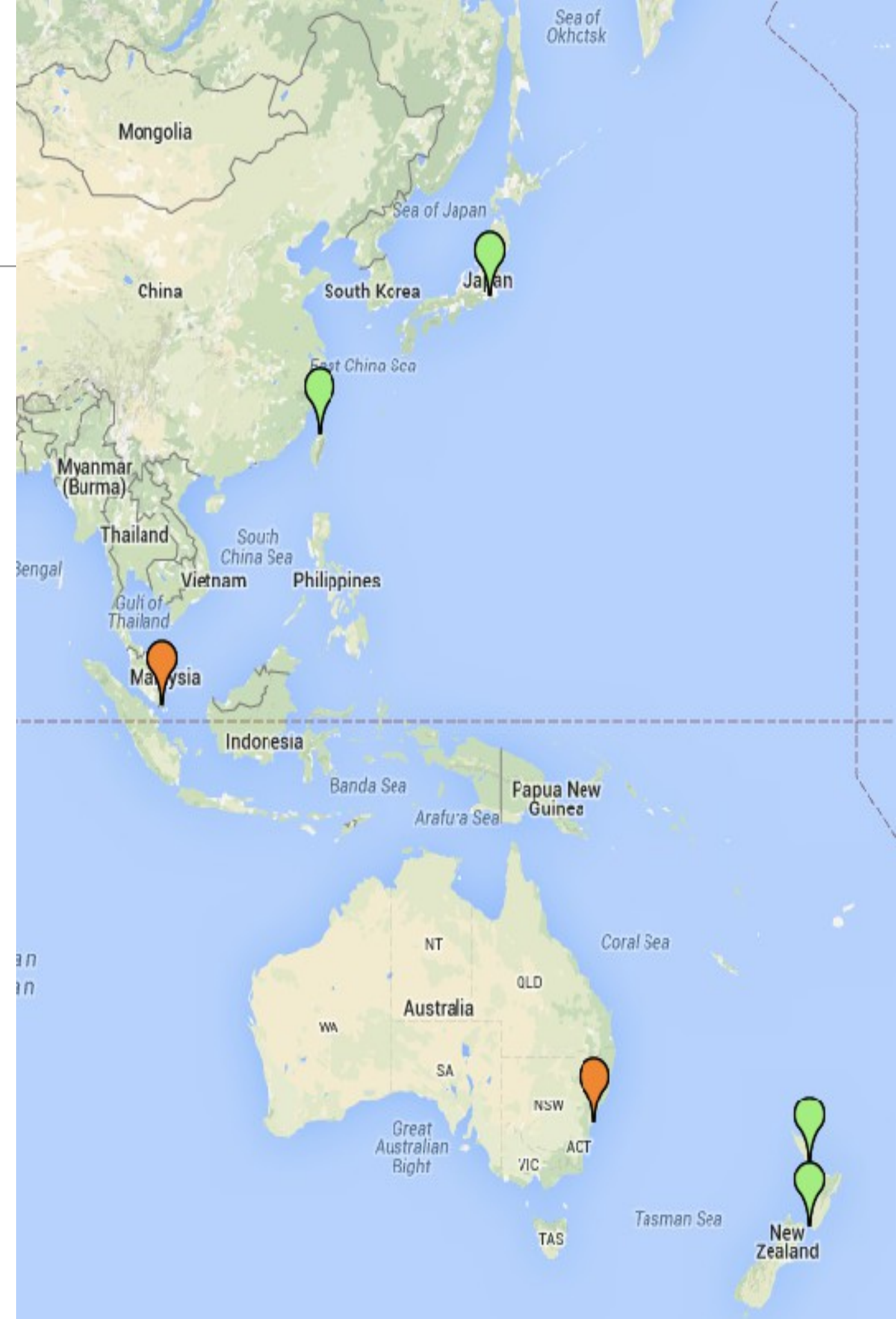


Raw Data: Cloud
Storage

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