APNIC 42

IPv6 Performance (revisited)

Geoff Huston
APNIC Labs

COLOMBO, SRI LANKA
28 September - 5 October 2016

What are we looking at:

- How “reliable” are IPv6 connections?

- How “fast” are IPv6 connections?

What are we looking at:

- How “reliable” are IPv6 connections?

Do all TCP connection attempts succeed?

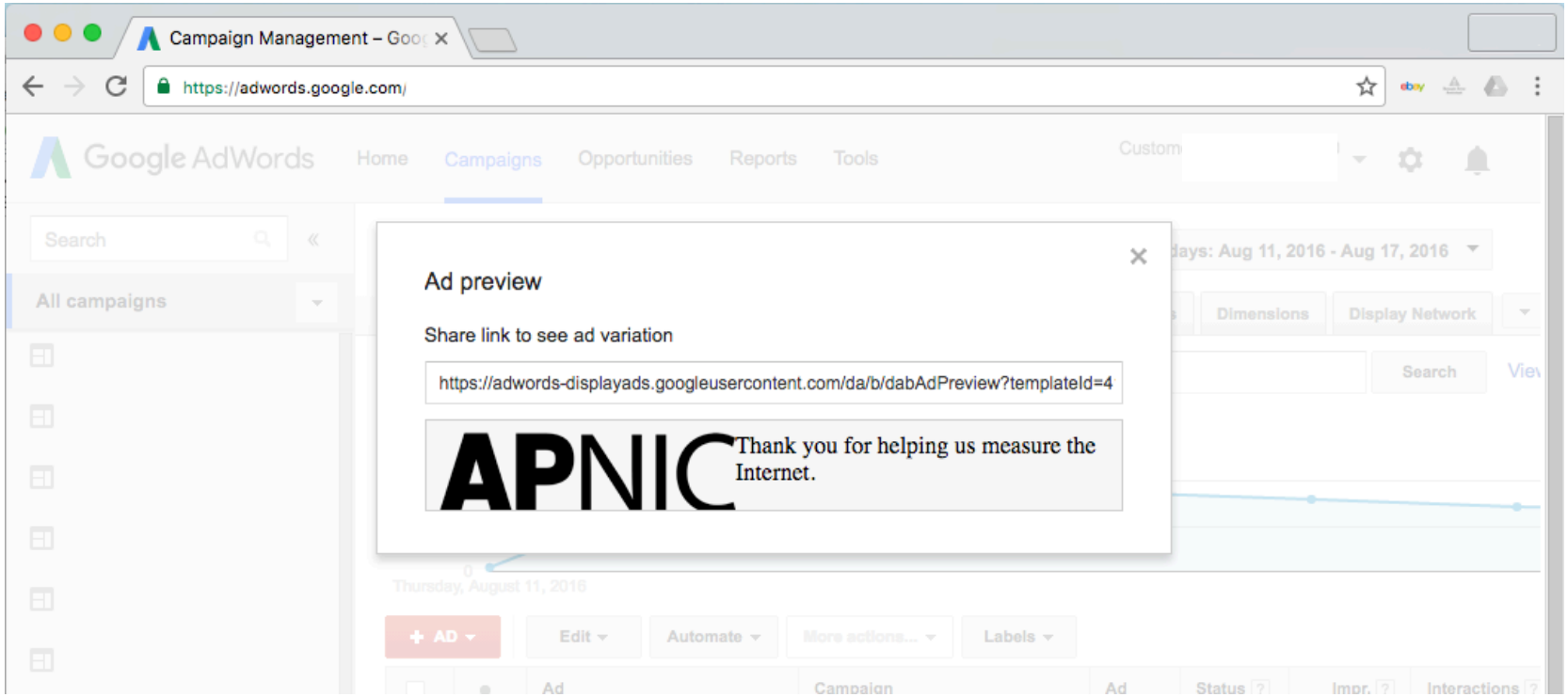
- How “fast” are IPv6 connections?

is V6 slower than V4?

The Measurement Technique

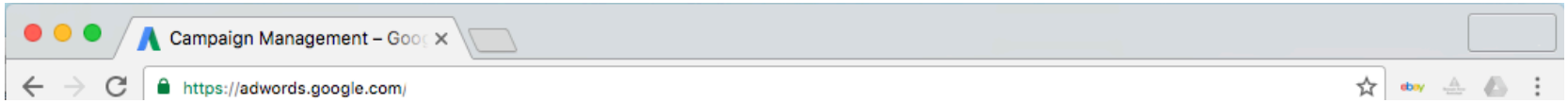
- Embed a script in an online ad
- Have the script generate a set of URLs to fetch
- Examine the packets seen at the server to determine reliability and RTT

How We Measure

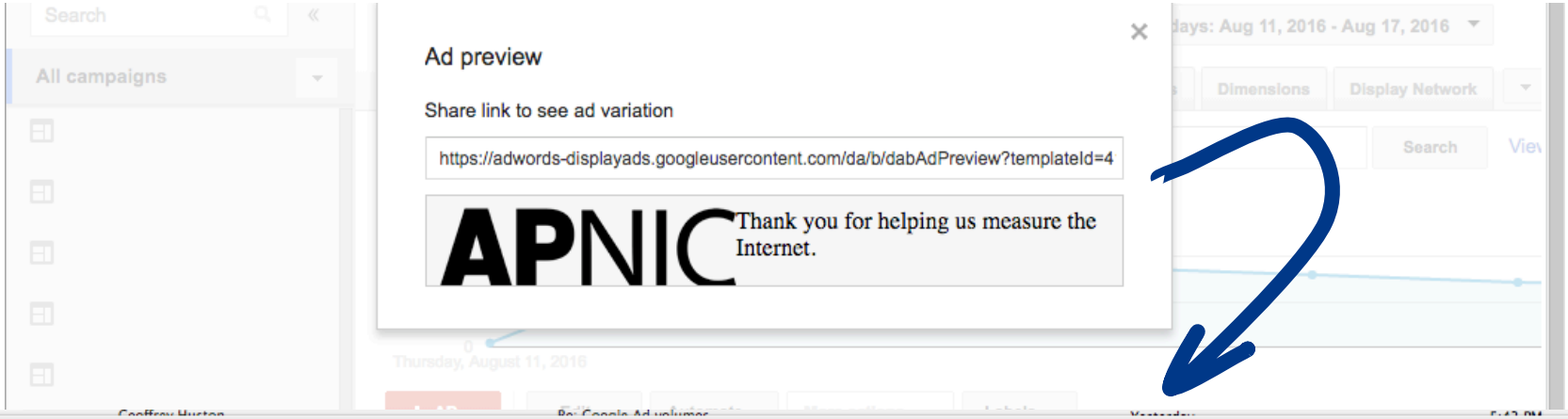


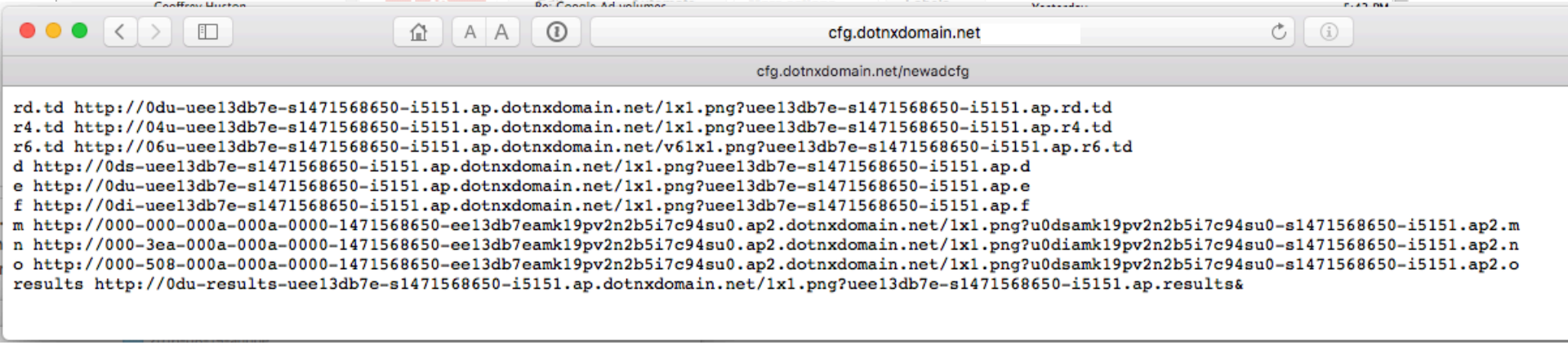
We use an online ad to present a sequence of small fetches to the user's browser

How We Measure



The sequence of tests is used to test a number of types of actions including fetches of IPv
IPv6 and Dual stack

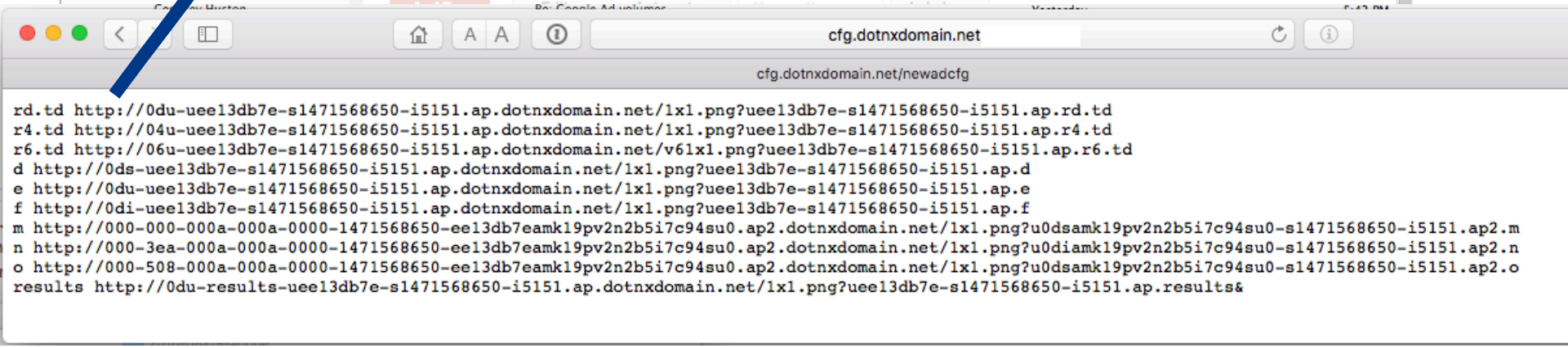




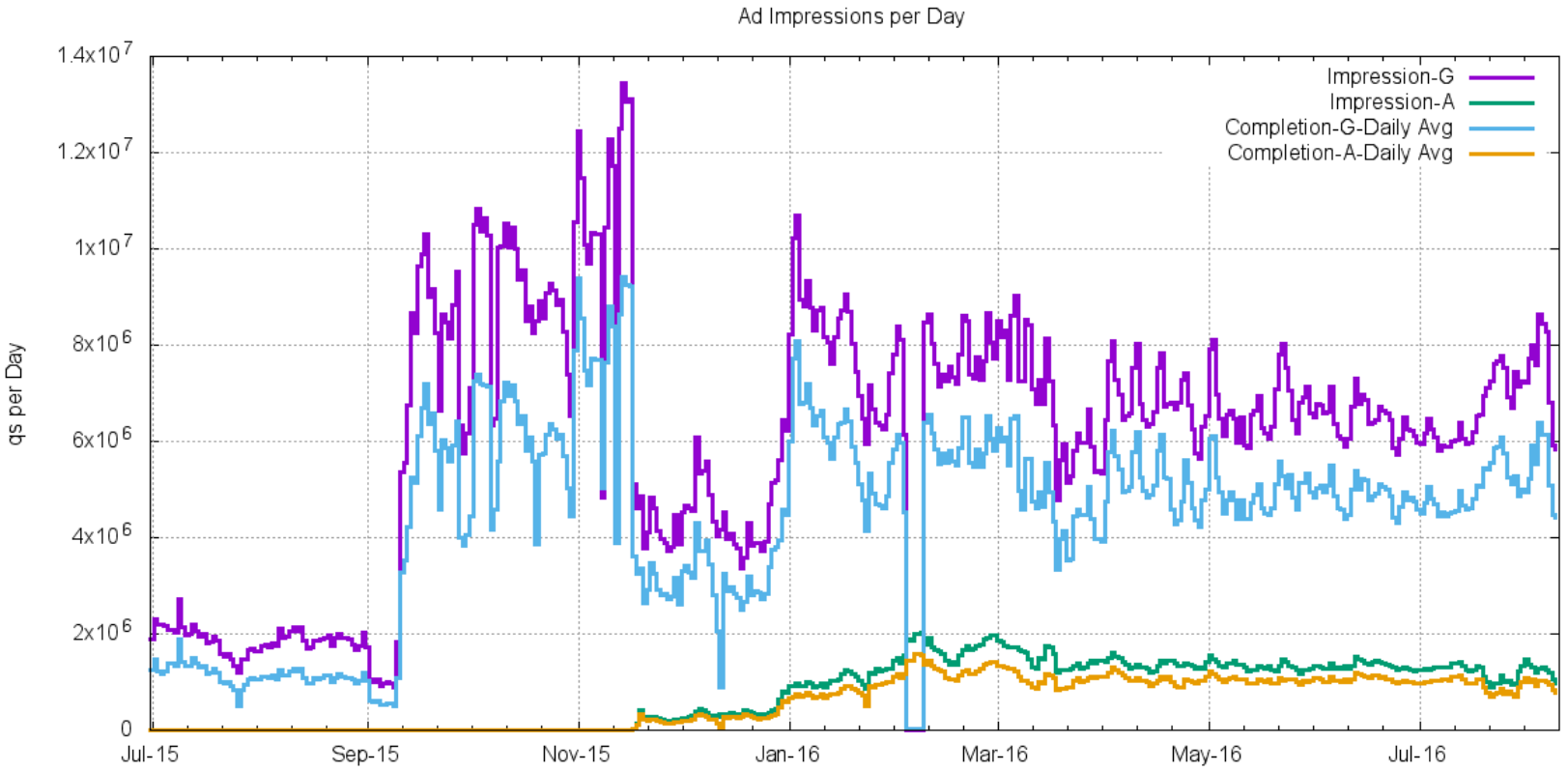
How We Measure

We use tcpdump to record all packet activity at the experiment's servers

```
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 65535 bytes
01:15:56.160383 IP6 2001:388:1000:120:d267:e5ff:feef:a842.40836 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [S], seq 2414246339, win 65535, options [mss 1440,nop,wscale 6,sackOK,TS val 4065295918 ecr 0], length 0
01:15:56.373466 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.40836: Flags [S.], seq 2653147012, ack 2414246340, win 28560, options [mss 1440,sackOK,TS val 763257679 ecr 4065295918,nop,wscale 7], length 0
01:15:56.373486 IP6 2001:388:1000:120:d267:e5ff:feef:a842.40836 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [.], ack 1, win 1026, options [nop,nop,TS val 4065296132 ecr 763257679], length 0
01:15:56.373502 IP6 2001:388:1000:120:d267:e5ff:feef:a842.40836 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [P.], seq 1:222, ack 1, win 1026, options [nop,nop,TS val 4065296132 ecr 763257679], length 221
01:15:56.586494 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.40836: Flags [.], ack 222, win 232, options [nop,nop,TS val 763257743 ecr 4065296132], length 0
01:15:56.586644 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.40836: Flags [P.], seq 1:293, ack 222, win 232, options [nop,nop,TS val 763257743 ecr 4065296132], length 292
01:15:56.592169 IP6 2001:388:1000:120:d267:e5ff:feef:a842.40836 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [F.], seq 222, ack 293, win 1026, options [nop,nop,TS val 4065296350 ecr 763257743], length 0
01:15:56.805026 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.40836: Flags [F.], seq 293, ack 223, win 232, options [nop,nop,TS val 763257809 ecr 4065296350], length 0
01:15:56.805035 IP6 2001:388:1000:120:d267:e5ff:feef:a842.40836 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [.], ack 294, win 1026, options [nop,nop,TS val 4065296563 ecr 763257809], length 0
01:16:08.160813 IP 202.158.221.222.62158 > 139.162.2.194.80: Flags [S], seq 2110718859, win 65535, options [mss 1460,nop,wscale 6,sackOK,TS val 4065307919 ecr 0], length 0
01:16:08.484006 IP 139.162.2.194.80 > 202.158.221.222.62158: Flags [S.], seq 3450703102, ack 2110718860, win 28960, options [mss 1460,sackOK,TS val 763261314 ecr 4065307919,nop,wscale 7], length 0
01:16:08.484018 IP 202.158.221.222.62158 > 139.162.2.194.80: Flags [.], ack 1, win 1040, options [nop,nop,TS val 4065308242 ecr 763261314], length 0
01:16:08.484040 IP 202.158.221.222.62158 > 139.162.2.194.80: Flags [P.], seq 1:222, ack 1, win 1040, options [nop,nop,TS val 4065308242 ecr 763261314], length 221
01:16:08.807080 IP 139.162.2.194.80 > 202.158.221.222.62158: Flags [.], ack 222, win 235, options [nop,nop,TS val 763261411 ecr 4065308242], length 0
01:16:08.807231 IP 139.162.2.194.80 > 202.158.221.222.62158: Flags [P.], seq 1:293, ack 222, win 235, options [nop,nop,TS val 763261411 ecr 4065308242], length 292
01:16:08.807654 IP 202.158.221.222.62158 > 139.162.2.194.80: Flags [F.], seq 222, ack 293, win 1040, options [nop,nop,TS val 4065308566 ecr 763261411], length 0
01:16:09.130793 IP 139.162.2.194.80 > 202.158.221.222.62158: Flags [F.], seq 293, ack 223, win 235, options [nop,nop,TS val 763261508 ecr 4065308566], length 0
01:16:09.130801 IP 202.158.221.222.62158 > 139.162.2.194.80: Flags [.], ack 294, win 1040, options [nop,nop,TS val 4065308889 ecr 763261508], length 0
01:16:20.244088 IP6 2001:388:1000:120:d267:e5ff:feef:a842.31238 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [S], seq 1299030901, win 65535, options [mss 1440,nop,wscale 6,sackOK,TS val 4065320002 ecr 0], length 0
01:16:20.457379 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.31238: Flags [S.], seq 1748054555, ack 1299030902, win 28560, options [mss 1440,sackOK,TS val 763264905 ecr 4065320002,nop,wscale 7], length 0
01:16:20.457397 IP6 2001:388:1000:120:d267:e5ff:feef:a842.31238 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [.], ack 1, win 1026, options [nop,nop,TS val 4065320215 ecr 763264905], length 0
01:16:20.457413 IP6 2001:388:1000:120:d267:e5ff:feef:a842.31238 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [P.], seq 1:224, ack 1, win 1026, options [nop,nop,TS val 4065320215 ecr 763264905], length 223
01:16:20.670828 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.31238: Flags [.], ack 224, win 232, options [nop,nop,TS val 763264969 ecr 4065320215], length 0
01:16:20.670979 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.31238: Flags [P.], seq 1:293, ack 224, win 232, options [nop,nop,TS val 763264969 ecr 4065320215], length 292
01:16:20.671386 IP6 2001:388:1000:120:d267:e5ff:feef:a842.31238 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [F.], seq 224, ack 293, win 1026, options [nop,nop,TS val 4065320429 ecr 763264969], length 0
01:16:20.884786 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.31238: Flags [F.], seq 293, ack 225, win 232, options [nop,nop,TS val 763265033 ecr 4065320429], length 0
01:16:20.884796 IP6 2001:388:1000:120:d267:e5ff:feef:a842.31238 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [.], ack 294, win 1026, options [nop,nop,TS val 4065320643 ecr 763265033], length 0
01:16:36.025996 IP6 2001:388:1000:120:d267:e5ff:feef:a842.64866 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [S], seq 1648543162, win 65535, options [mss 1440,nop,wscale 6,sackOK,TS val 4065335784 ecr 0], length 0
01:16:36.239388 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.64866: Flags [S.], seq 2178829105, ack 1648543163, win 28560, options [mss 1440,sackOK,TS val 763269639 ecr 4065335784,nop,wscale 7], length 0
01:16:36.239407 IP6 2001:388:1000:120:d267:e5ff:feef:a842.64866 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [.], ack 1, win 1026, options [nop,nop,TS val 4065335998 ecr 763269639], length 0
01:16:36.239422 IP6 2001:388:1000:120:d267:e5ff:feef:a842.64866 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [P.], seq 1:232, ack 1, win 1026, options [nop,nop,TS val 4065335998 ecr 763269639], length 231
01:16:36.453147 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.64866: Flags [.], ack 232, win 232, options [nop,nop,TS val 763269703 ecr 4065335998], length 0
01:16:36.453448 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.64866: Flags [P.], seq 1:293, ack 232, win 232, options [nop,nop,TS val 763269703 ecr 4065335998], length 292
01:16:36.453841 IP6 2001:388:1000:120:d267:e5ff:feef:a842.64866 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [F.], seq 232, ack 293, win 1026, options [nop,nop,TS val 4065336212 ecr 763269703], length 0
01:16:36.667228 IP6 2400:8901::f03c:91ff:fe98:63d6.80 > 2001:388:1000:120:d267:e5ff:feef:a842.64866: Flags [F.], seq 293, ack 233, win 232, options [nop,nop,TS val 763269767 ecr 4065336212], length 0
01:16:36.667237 IP6 2001:388:1000:120:d267:e5ff:feef:a842.64866 > 2400:8901::f03c:91ff:fe98:63d6.80: Flags [.], ack 294, win 1026, options [nop,nop,TS val 4065336425 ecr 763269767], length 0
```



How Much do We Measure?



What are we looking at:

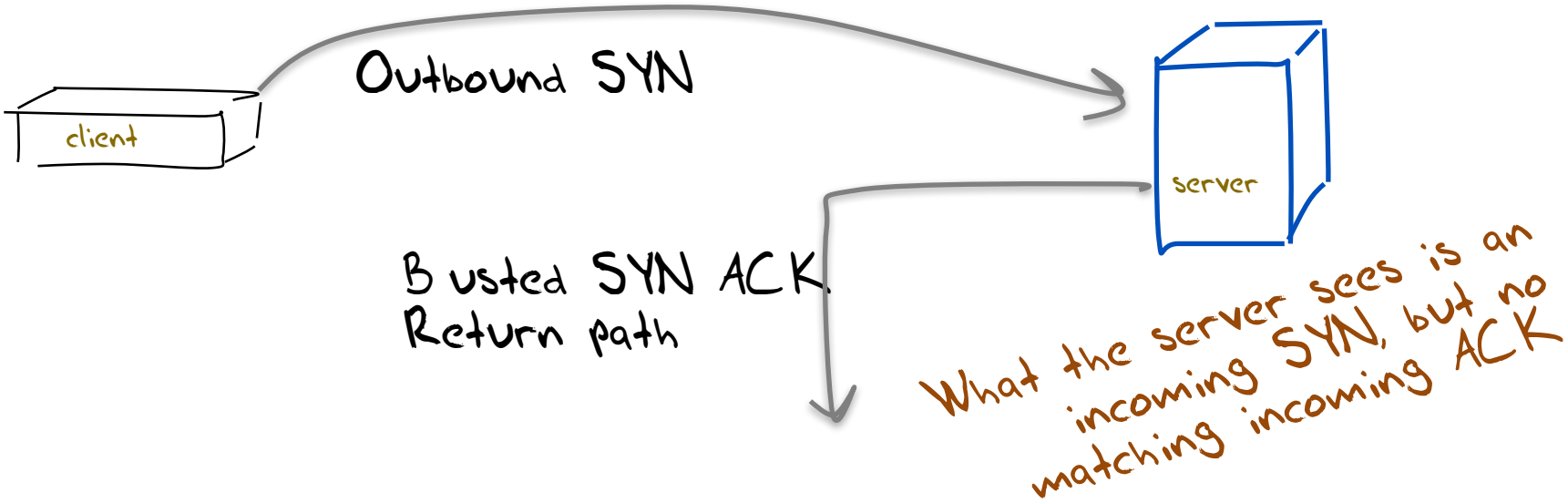
- How “reliable” are IPv6 connections?

Do all TCP connection attempts succeed?

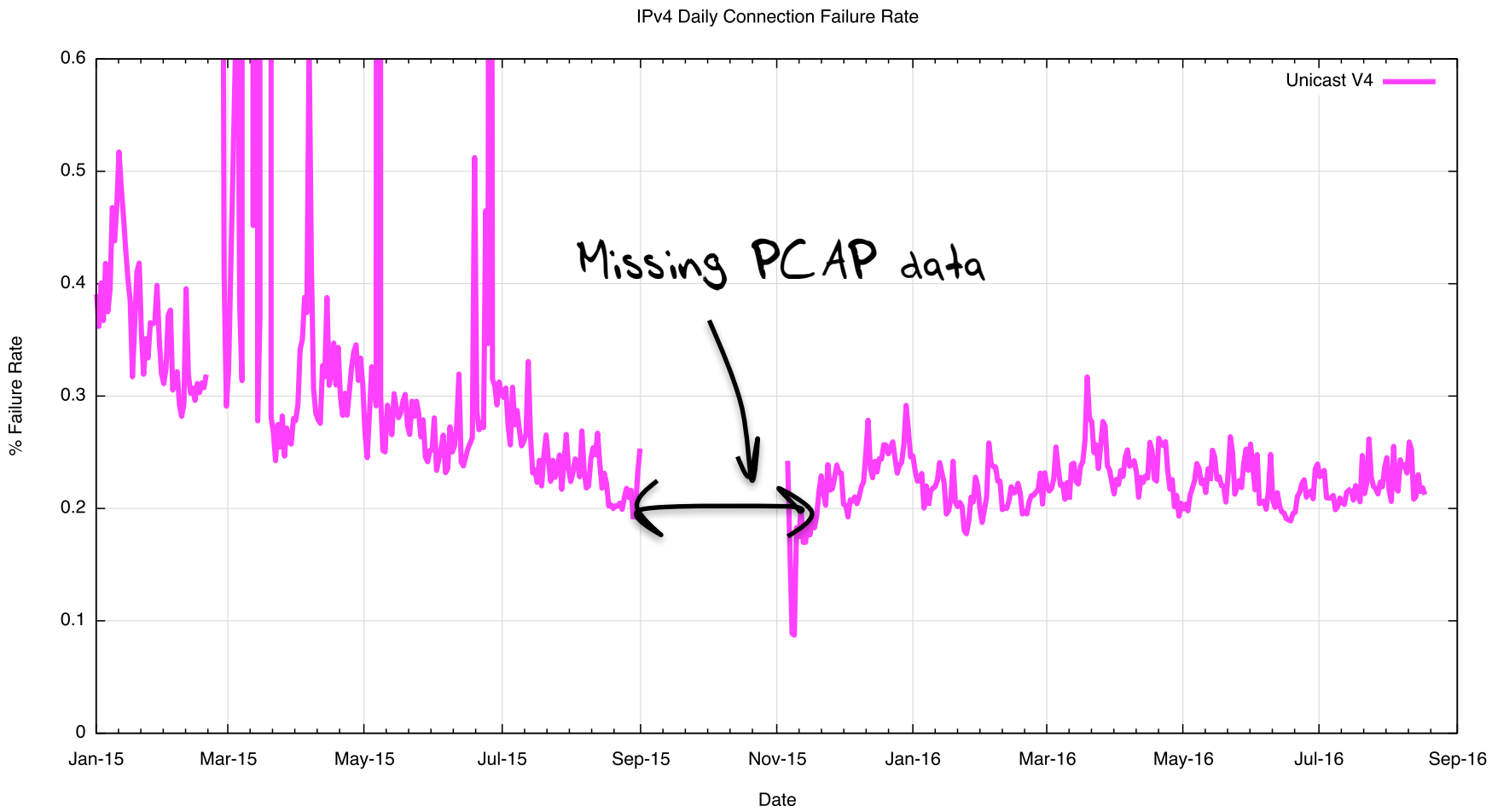
- How “fast” are IPv6 connections?

is V6 slower than V4?

What we see: Connection Failure



IPv4 Connection Failure

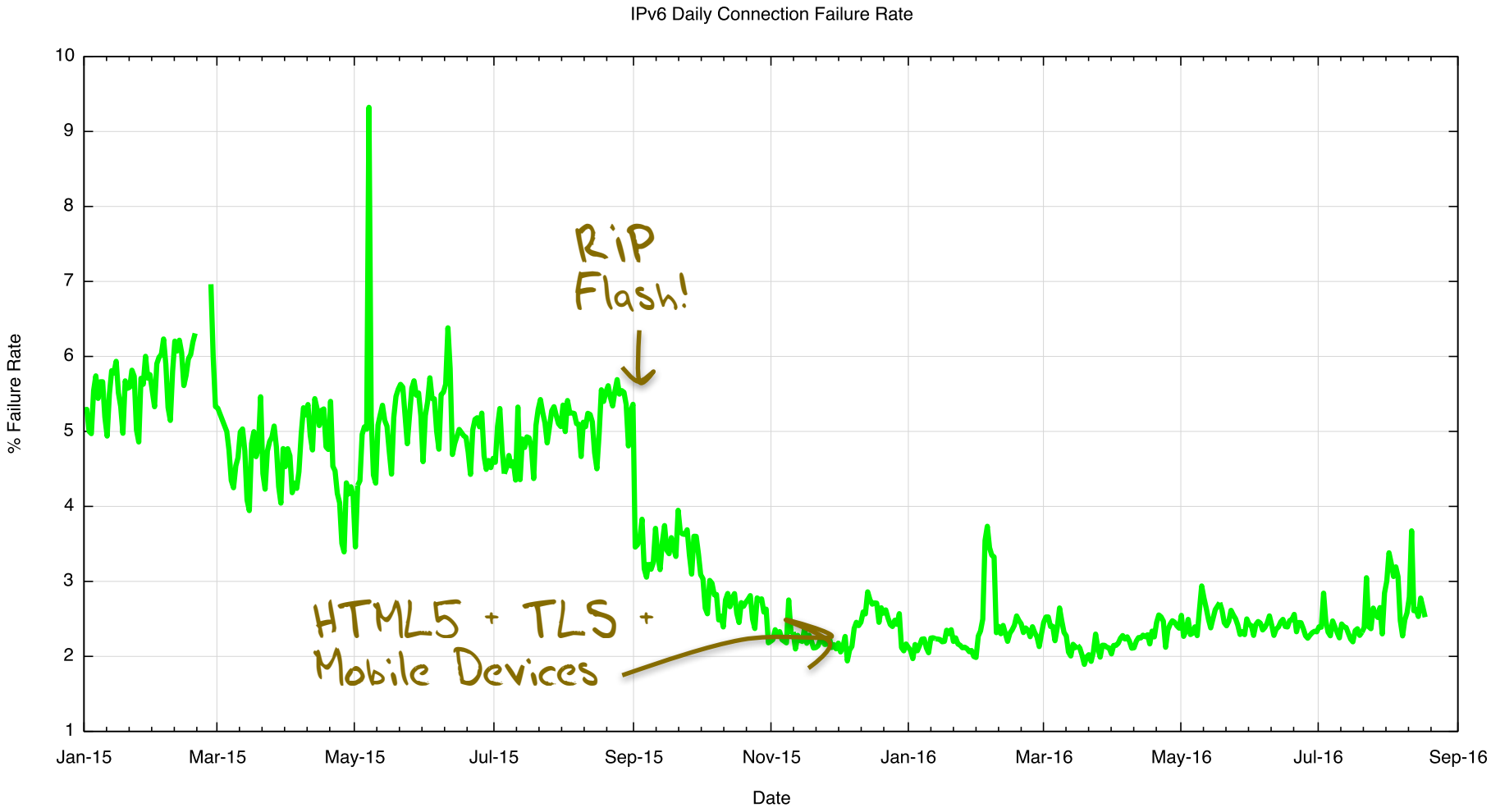


IPv4 Failures

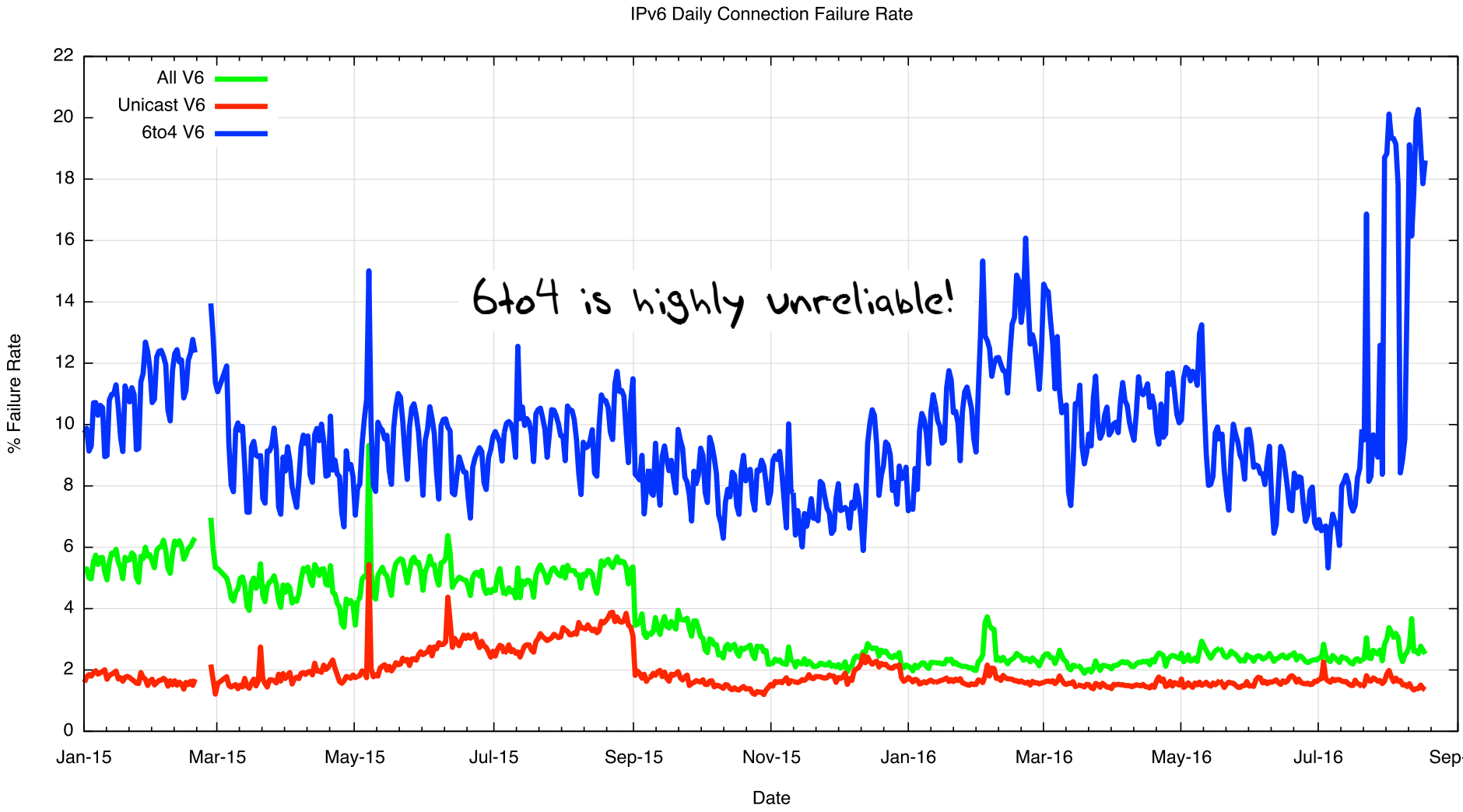
- IPv4 failures are around 1 in 500
- And we are pretty sure its NOT:
  - Auto-tunnelling
  - Lousy CPE firmware
  - Strange firewall filters

- So what is the reason for this residual asymmetric failure rate?
- Is it asymmetric routing connectivity?

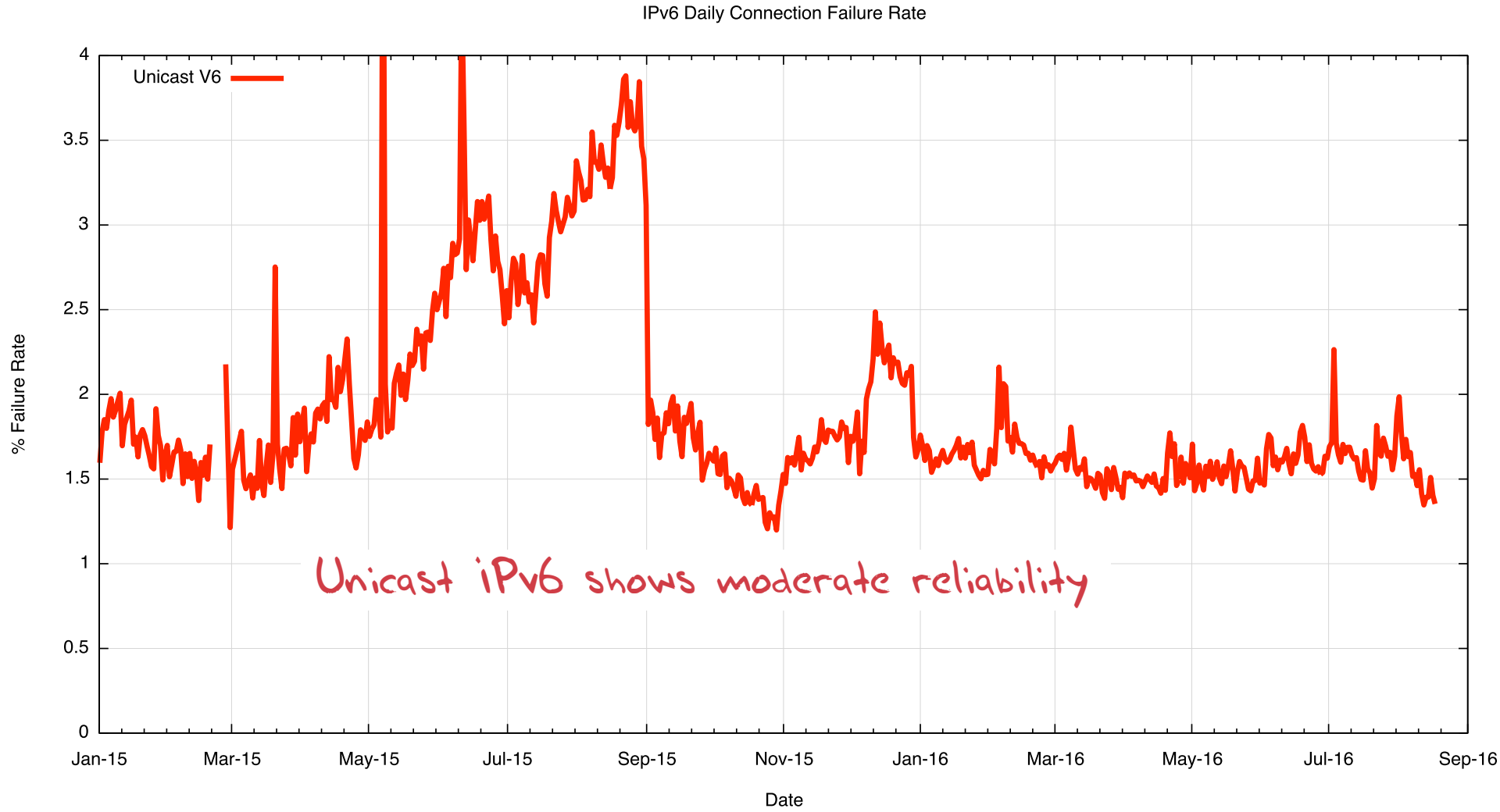
Daily IPv6 Failures



Daily IPv6 Failures



Daily IPv6 Failures

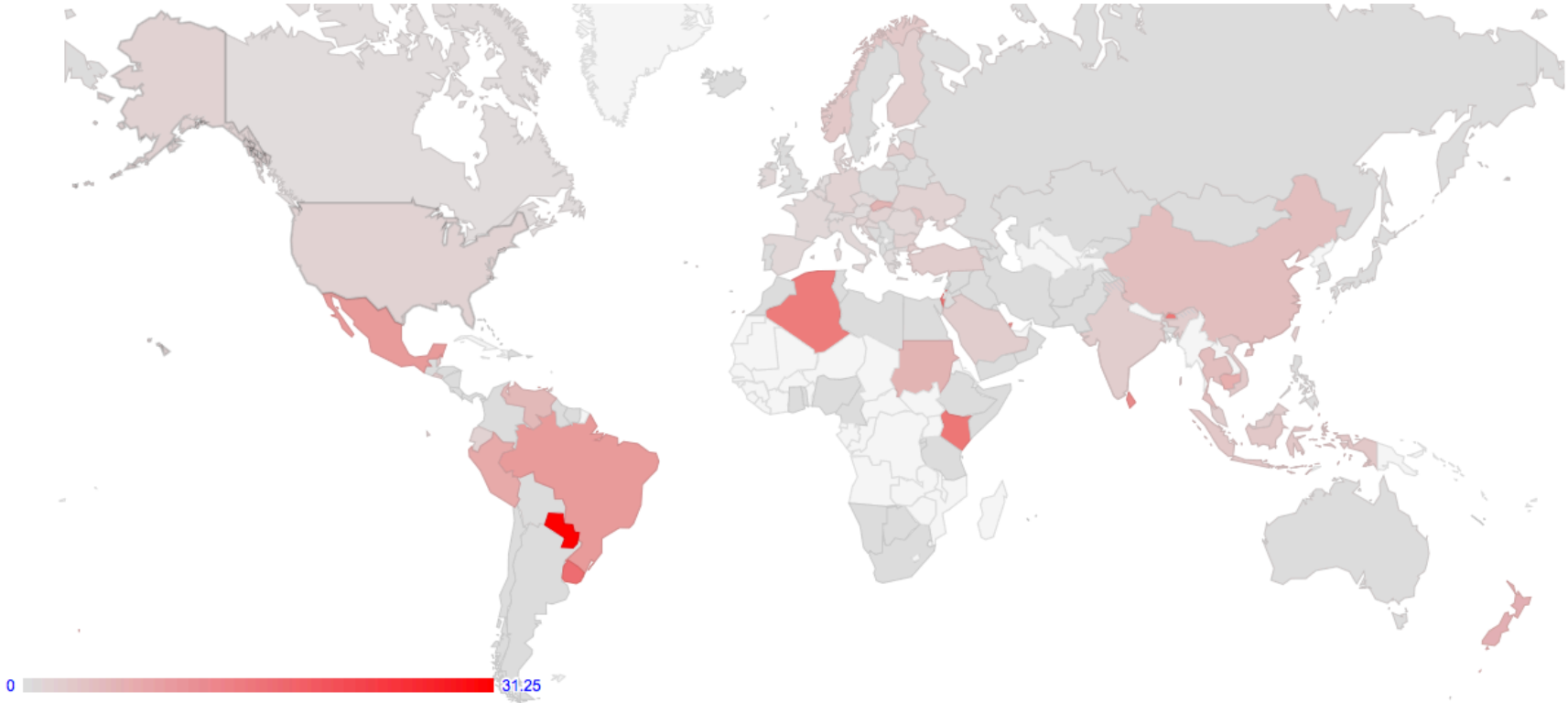


IPv6 Failures

- 1.5% failure for unicast V6 is still unacceptable!
- Why is this happening?
  - Auto-tunnelling?
  - Lousy CPE firmware?
  - Strange firewall filters?
  - Asymmetric routing

Is IPv6 failure uniformly distributed?

Is IPv6 failure uniformly distributed?



Failure by Country

Code	Region	V6 Failure Rate	V6 Samples
IL	Israel, Western Asia, Asia	18.78%	1,965
BR	Brazil, South America, Americas	8.92%	332,619
SD	Sudan, Northern Africa, Africa	7.47%	1,192
LK	Sri Lanka, Southern Asia, Asia	7.40%	104,200
MX	Mexico, Central America, Americas	7.13%	1,866
PE	Peru, South America, Americas	6.74%	650,923
KH	Cambodia, South-Eastern Asia, Asia	6.38%	376
NZ	New Zealand, Australia and New Zealand, Oceania	5.00%	11,195
VE	Venezuela, South America, Americas	4.86%	1,110
CN	China, Eastern Asia, Asia	4.26%	41,837
MD	Republic of Moldova, Eastern Europe, Europe	3.65%	2,299
VN	Vietnam, South-Eastern Asia, Asia	3.61%	54,293
TH	Thailand, South-Eastern Asia, Asia	3.57%	29,623
UA	Ukraine, Eastern Europe, Europe	3.38%	3,283
NO	Norway, Northern Europe, Europe	3.29%	43,574
LV	Latvia, Northern Europe, Europe	3.28%	458
SA	Saudi Arabia, Western Asia, Asia	3.27%	91,915
TT	Trinidad and Tobago, Caribbean, Americas	2.87%	19,327
ID	Indonesia, South-Eastern Asia, Asia	2.76%	4,566
SI	Slovenia, Southern Europe, Europe	2.62%	9,477
IN	India, Southern Asia, Asia	2.56%	142,023
TW	Taiwan, Eastern Asia, Asia	2.55%	5,884
MY	Malaysia, South-Eastern Asia, Asia	2.15%	415,735

Failure by Network

ASN	AS Name	V6 Fail Rate	V6 Fail Count	V6 Samples
AS20880	TELECOLUMBUS Tele Columbus AG, DE	62.57%	326	521
AS14868	COPEL Telecom S.A., BR	20.32%	595	2,928
AS47956	XFONE XFone 018 Ltd, IL	18.42%	147	798
AS26615	Tim Celular S.A., BR	17.63%	898	5,095
AS18881	Global Village Telecom, BR	17.03%	7,115	41,791
AS38229	LEARN-LK Lanka Education Research Network, NREN, LK	14.67%	38	259
AS42689	CABLECOM-AS Cablecom Networking Limited, GB, NL	13.84%	80	578
AS22548	Ncleo de Inf. e Coord. do Ponto BR - NIC.BR, BR	13.16%	35	266
AS7470	TRUEINTERNET-AS-AP TRUE INTERNET Co.,Ltd., TH	13.08%	34	260
AS34779	T-2-AS T-2, d.o.o., SI	11.05%	85	769
AS18001	DIALOG-AS Dialog Axiata PLC., LK	8.62%	3,431	39,794
AS23655	SNAP-NZ-AS Snap Internet Limited, NZ	7.76%	205	2,641
AS197922	FIRSTHEBERG Techcrea Solutions Sarl, FR	7.35%	357	4,855
AS13188	BANKINFORM-AS CONTENT DELIVERY NETWORK LTD, UA	7.29%	35	480
AS37197	SUDREN, SD	6.74%	30	445
AS6147	Telefonica del Peru S.A.A., PE	6.51%	16,362	251,329
AS8167	Brasil Telecom SA - Filial Distrito Federal, BR	6.16%	148	2,403
AS21981	GOEASTON - Easton Utilities Commission, US	6.09%	14	230
AS28580	CILNET Comunicacao e Informatica LTDA., BR	5.44%	19	349
AS4134	CHINANET-BACKBONE No.31,Jin-rong Street, CN	5.18%	300	5,787
AS11232	MIDCO-NET - Midcontinent Media, Inc., US	4.97%	1,275	25,656
AS2119	TELENOR-NEXTEL Telenor Norge AS, NO, SE	4.60%	496	10,779
AS19165	WEBPASS - Webpass Inc., US	4.60%	24	522
AS6360	UNIVHAWAII - University of Hawaii, US	4.43%	9	203
AS60294	DE-DGW FLNK GmbH, DE	4.36%	12	275
AS8151	Uninet S.A. de C.V., MX	4.15%	20	482
AS133481	SBN-FBB-AS-AP Fixed Broadband Network, TH	4.11%	347	8,437
AS11426	SCRR-11426 - Time Warner Cable Internet LLC, US	3.91%	6,101	156,048

A cautionary note

- These are “single shot” measurements rather than sustained repeated test, so there is some noise component here
- Its also likely that connection failure is related to consumer equipment rather than network-level failure, as a network level failure would conventionally give a failure rate closer to 100% than ~10%

What are we looking at:

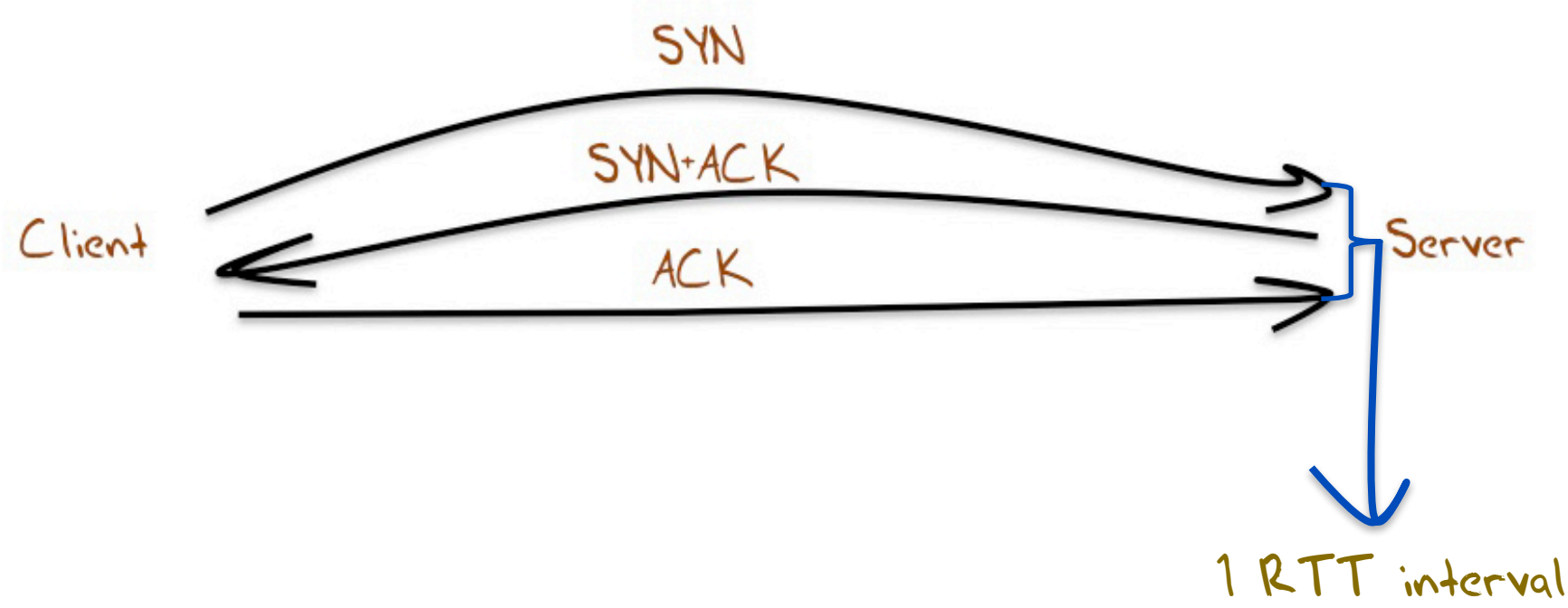
- How “reliable” are IPv6 connections?

Do all TCP connection attempts succeed?

- How “fast” are IPv6 connections?

is V6 slower than V4?

Let's look at TCP SYNs



Why SYNs?

- Every TCP session starts with a SYN handshake
- Its typically a kernel level operation, which means that there is little in the way of application level interaction with the SYN exchange
- On the downside there is only a single sample point per measurement

Generating a comparative RTT profile

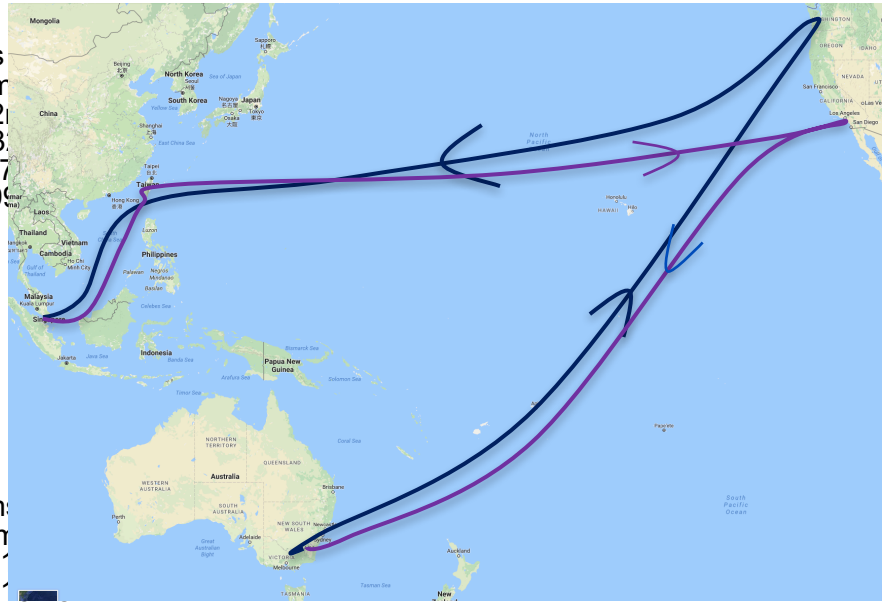
- For each successful connection couplet (IPv4 and IPv4) from the same endpoint, gather the pair of RTT measurements from the SYN-ACK exchanges
  - Use the server's web logs to associate a couplet of IPv4 and IPv6 addresses
  - Use the packet dumps to collect RTT information from the SYN-ACK Exchange
  - Use IPv6 RTT – IPv4 RTT as the metric

An Example of Path Divergence

$ traceroute from Singapore to Canberra, IPv4
traceroute to 202.158.xxxx.yyy, 30 hops max, 60 byte packets
 1 103.3.60.3 0.672ms 0.796ms 0.899ms
 2 139.162.0.9 0.754ms 0.708ms 0.732ms
 3 te0-1-0-21.br03.sin02.pccwbtn.net 1.697ms 0.760ms 0.726ms
 4 ntt.fe3-18.br01.sin02.pccwbtn.net 69.526ms 69.644ms 69.754ms
 5 ae-10.r20.sngpsi05.sg.bb.gin.ntt.net 60.702ms 68.474ms 68.469ms
 6 ae-8.r22.snjsca04.us.bb.gin.ntt.net 168.447ms 168.532ms 168.138m
 7 ae-19.r01.snjsca04.us.bb.gin.ntt.net 167.489ms 170.665ms 178.832
 8 xe-0-8-0-21.r01.snjsca04.us.ce.gin.ntt.net 330.084ms 323.556ms 3
 9 xe-1-0-1.pe1.msct.nsw.aarnet.net.au 330.020ms 323.738ms 334.47
10 et-3-3-0.pe1.rsby.nsw.aarnet.net.au 327.788ms 334.157ms 328.19
11 138.44.161.6 323.644ms 319.455ms 323.563ms
12 202.158.xxx.yyy 319.885ms 333.933ms 325.014ms

$ traceroute from Canberra to Singapore, IPv4
traceroute to 139.162.xxx.yyy, 64 hops max, 52 byte packets
 1 202.158.x.y 0.682ms 0.388ms 0.313ms
 2 xe-5-0-4-205.pe1.actn.act.aarnet.net.a 0.721ms 0.828ms 0.674ms
 3 et-0-3-0.pe1.rsby.nsw.aarnet.net.au 4.548ms 4.733ms 4.533ms
 4 et-7-1-0.pe1.brwy.nsw.aarnet.net.au 4.734ms 5.418ms 4.745ms
 5 et-0-3-0.pe1.bkvl.nsw.aarnet.net.au 5.117ms 5.512ms 5.524ms
 6 xe-0-0-0.bb1.b.sea.aarnet.net.au 148.017ms 148.019ms 148.131ms
 7 ge3-0.cr02.sea01.pccwbtn.net (206.81.80.13) 148.469ms 148.059m
 8 tenge0-2-0-14.br03.sin02.pccwbtn.net 319.435ms 325.053ms 319.1
 9 tenge0-2-0-15.br03.sin02.pccwbtn.net 319.257ms 332.560ms 323.4
10 linode.te0-1-0-21.br03.sin02.pccwbtn.net 323.723ms 323.627ms 323.587ms
11 139.162.aaa.bbb 334.609ms 347.243ms 347.220ms
12 139.162.xxx.yyy 325.186ms 338.209ms 325.603ms

iPv4

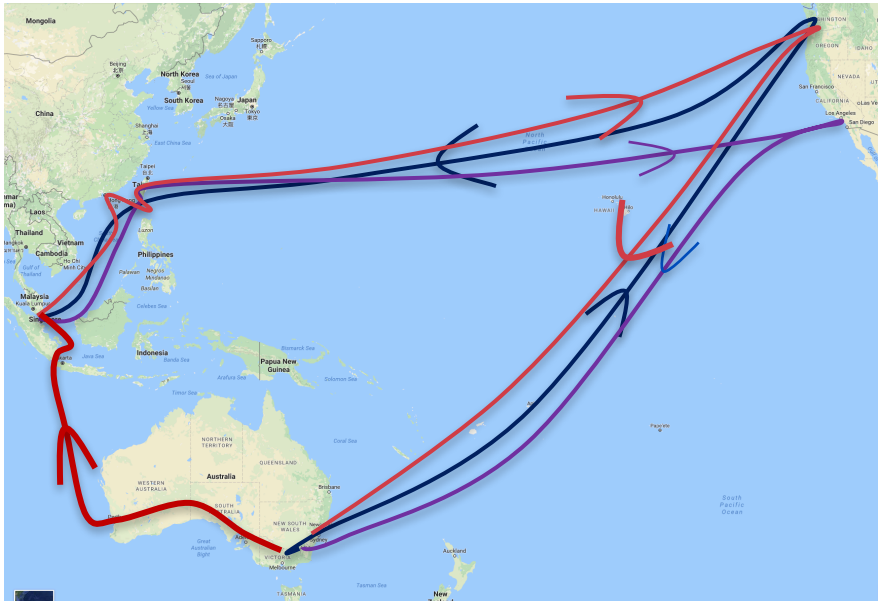


An Example of Path Divergence

```
$ traceroute from Singapore to Canberra, IPv6
traceroute6 to 2001:388:1000:110:e4d:e9ff:x:y, 30 hops max, 80 byte packets
 1  2400:8901::5287:89ff:fe40:9fc1 0.897ms 0.912ms 1.051ms
 2  2400:8901:1111::1 0.851ms 0.827ms 0.792ms
 3  2001:cb0:2102:2:f::1 0.364ms  0.333ms  0.516ms
 4  2001:cb0:2102:2:f::1 0.502ms  0.461ms  0.431ms
 5  2001:cb0:21f0:1:17::2 2.512ms 2.176ms 3.445ms
 6  2001:cb0:21f0:1:17::2 2.354ms  2.382ms 1.238ms
 7  10gigabitethernet3-5.core1.sin1.he.net 1.080ms  1.034ms  1.020ms
 8  10ge1-5.core1.tyo1.he.net 88.053ms
    10ge1-16.core1.hkg1.he.net 39.369ms
    10ge1-5.core1.tyo1.he.net 88.084ms
 9  10ge1-5.core1.tyo1.he.net 88.157ms
    100ge8-1.core1.sea1.he.net 192.408ms  192.642ms
10  100ge8-1.core1.sea1.he.net 192.631ms  192.608ms  196.154ms
11  xe-1-0-1.pe2.brwy.nsw.aarnet.net.au 214.176ms 186.238ms 213.061ms
12  et-3-1-0.pe1.brwy.nsw.aarnet.net.au 211.298ms 211.300ms 214.200ms
13  et-1-1-0.pe1.rsby.nsw.aarnet.net.au 211.492ms 211.359ms 211.427ms
14  et-0-3-0.pe1.actn.act.aarnet.net.au 213.332ms 211.458ms  211.476ms
15  2001:388:1000:110:e4d:e9ff:x.y 213.274ms 213.199ms 213.169ms

$ traceroute from Canberra to Singapore, IPv6
traceroute6 to 2400:8901::f03c:91ff:a:b) 64 hops max, 12 byte packets
 1  2001:388:1000:110::x:y  0.808ms  0.899ms  1.586ms
 2  xe-5-0-4-205.pe1.actn.act.aarnet.net.au  1.633ms  0.646ms  0.578ms
 3  et-0-1-0.pe1.dksn.act.aarnet.net.au  0.682ms  0.649ms  0.694ms
 4  et-5-3-0.pe1.crlt.vic.aarnet.net.au  8.072ms  8.086ms  8.049ms
 5  et-5-1-0.pe1.wmlb.vic.aarnet.net.au  8.116ms  8.055ms  8.073ms
 6  et-0-3-0.pe1.adel.sa.aarnet.net.au  17.790ms  16.984ms  17.036ms
 7  et-1-1-0.pe1.prka.sa.aarnet.net.au  17.080ms  17.152ms
    et-0-3-0.pe1.eper.wa.aarnet.net.au  43.319ms
 8  et-0-3-0.pe1.knsg.wa.aarnet.net.au  43.357ms  43.443ms  43.353ms
 9  gigabitethernet-5-1-0.bb1.b.per.aarnet.net.au  43.849ms  43.919ms  43.850ms
10  so-0-0-0.bb1.a.sin.aarnet.net.au  92.219ms  92.275ms  92.189ms
11  as6939.singapore.megaport.com  212.347ms  212.426ms  212.471ms
12  * * *
13  2400:8901:1110::2  213.924ms 213.904ms  213.717ms
14  2400:8901::f03c:91ff:a:b  213.954ms  213.393ms  213.726ms
```

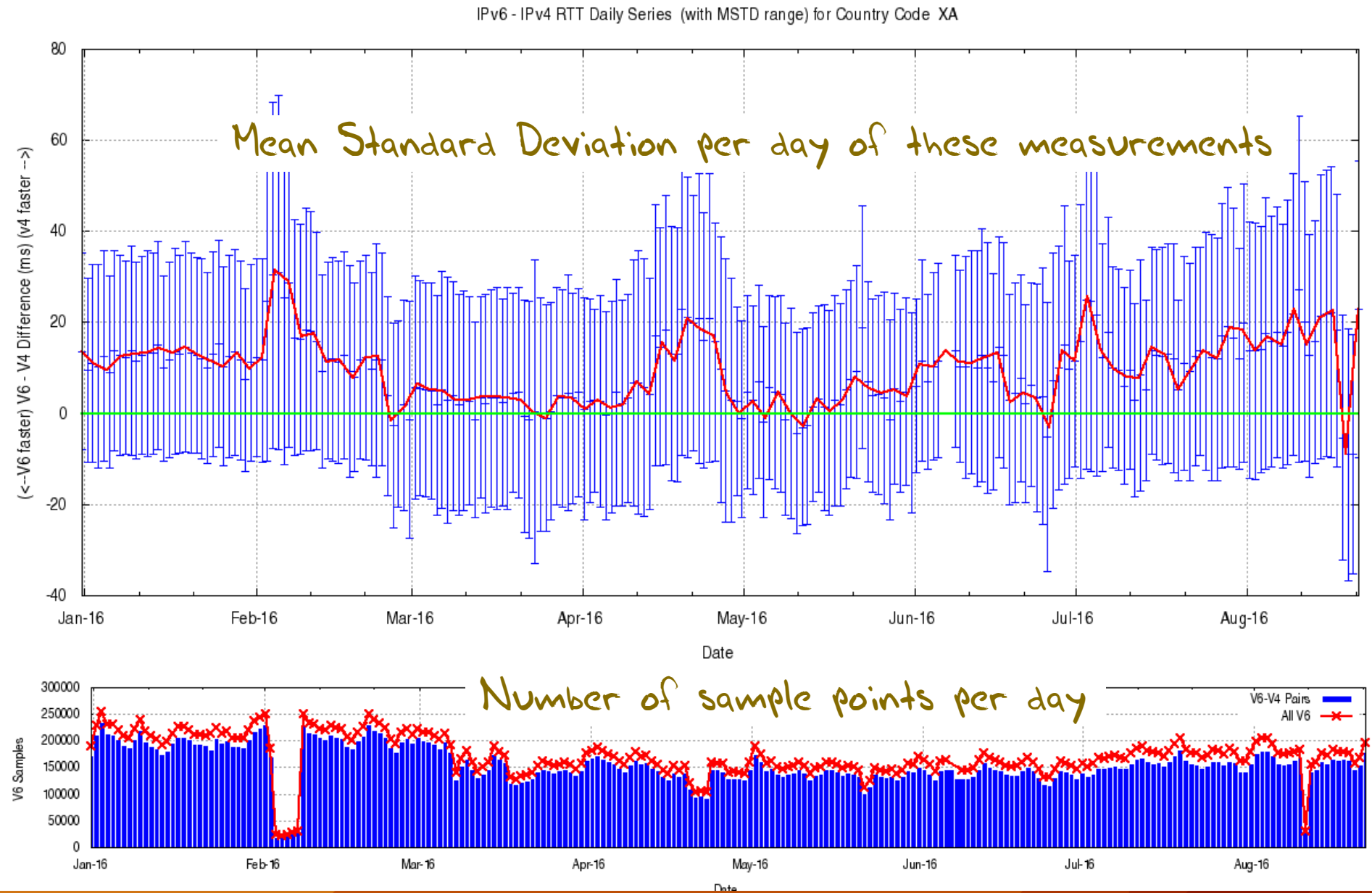
IPv4 - IPv6



Global Results

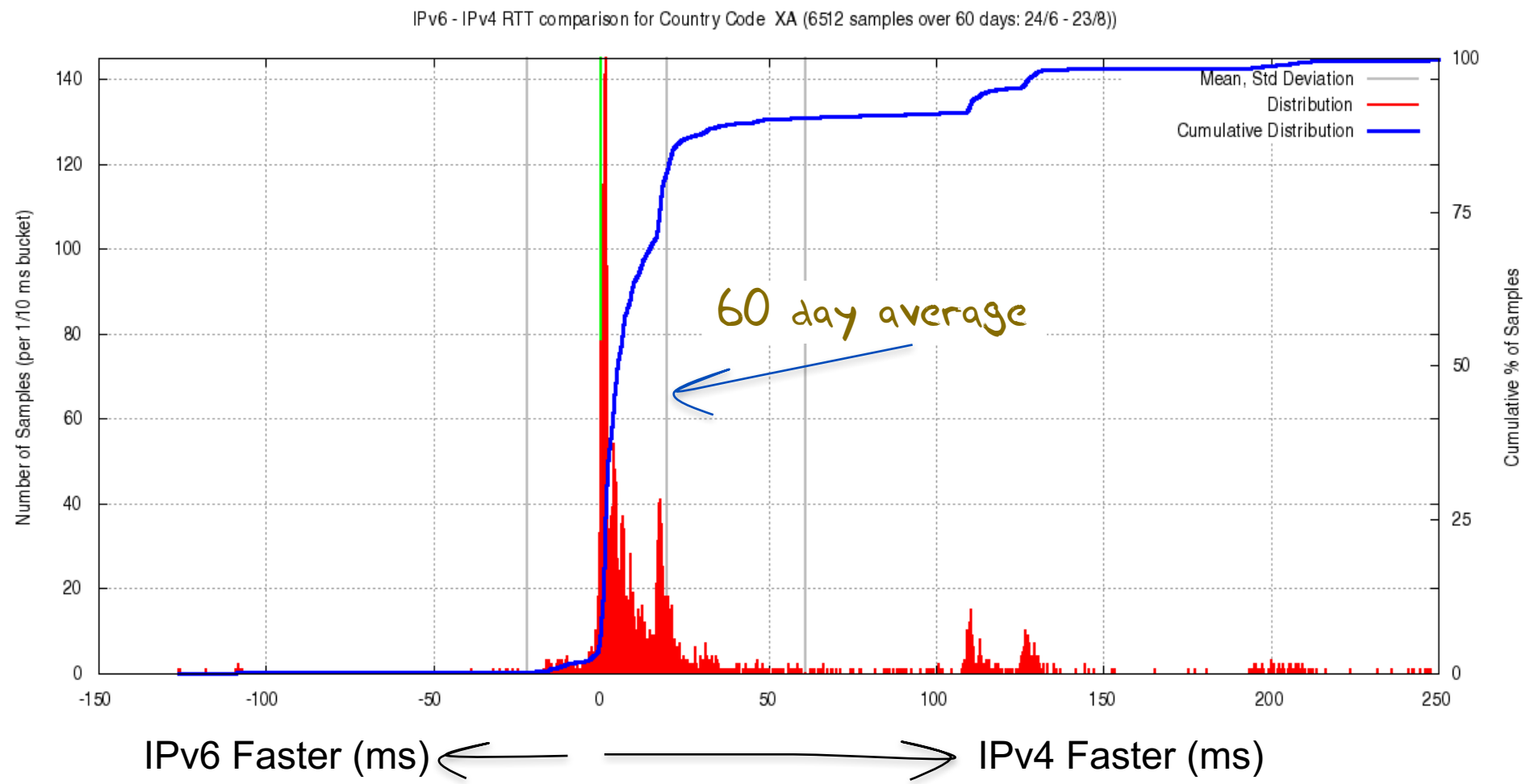
Average RTT Difference (ms) (V6 - V4) for World (XA)

Global Results

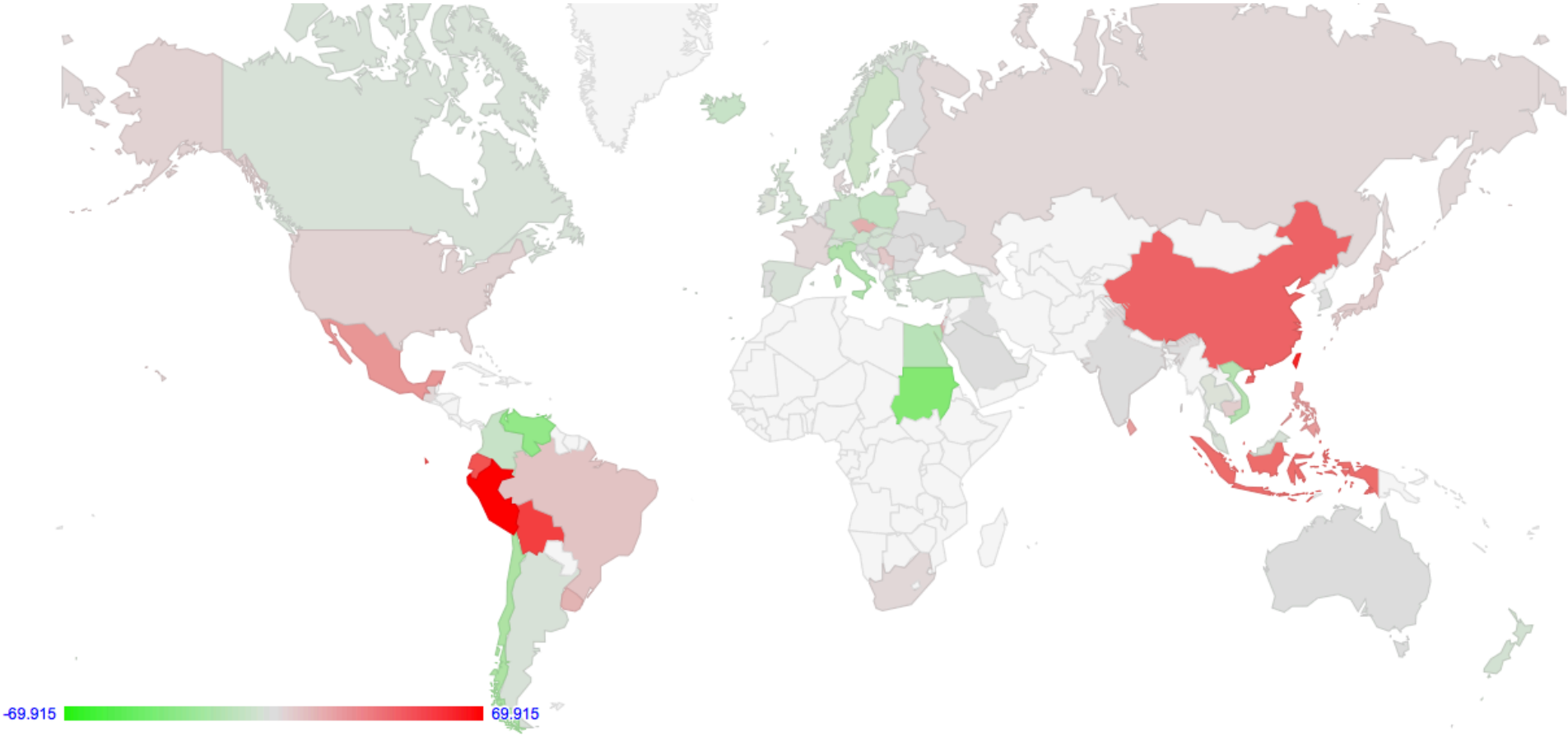


Distribution

Distribution of RTT Difference measurements World (XA) (60 days)



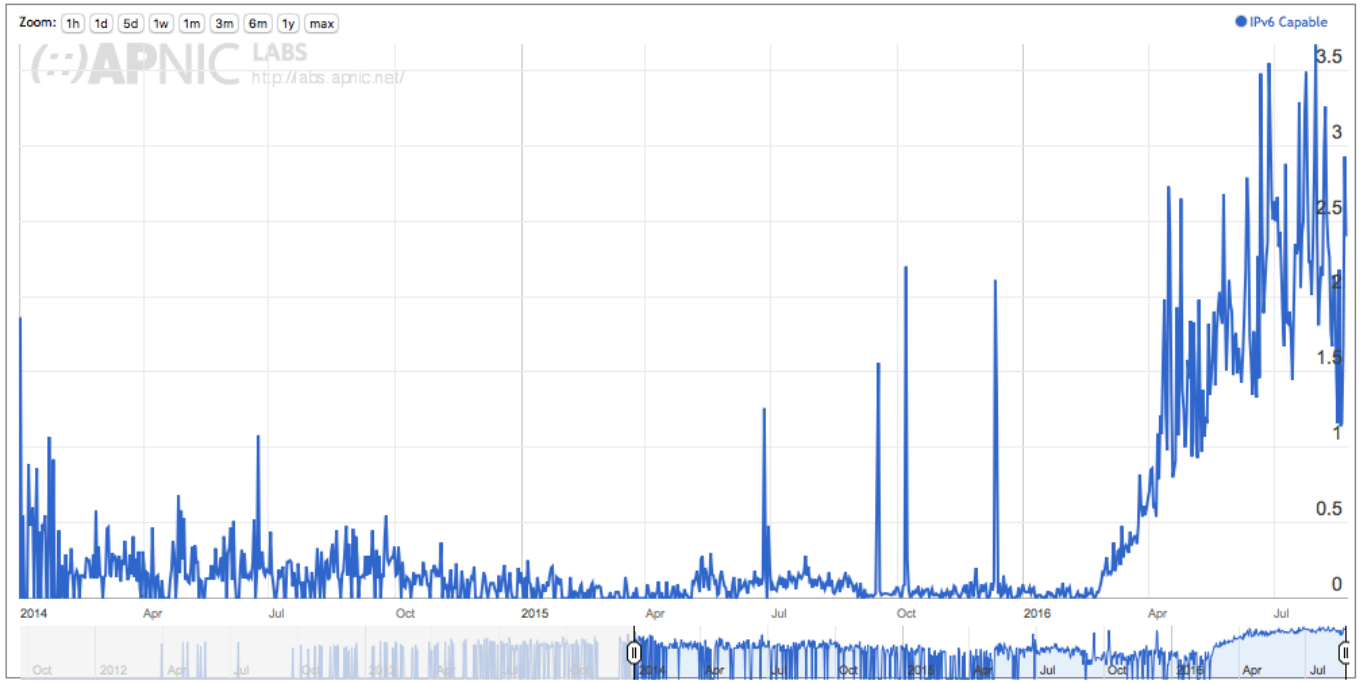
Performance by Country



Performance by Network

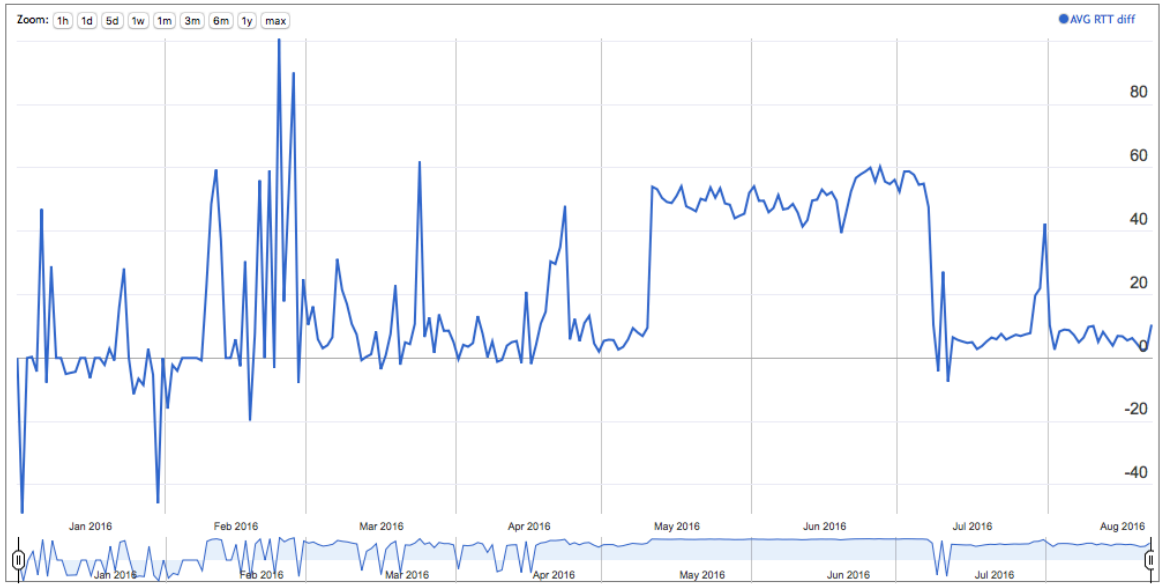
ASN	AS Name	RTT Diff (V6-V4)	Samples
AS1659	ERX-TANET-ASN1 Taiwan Academic Network (TANet) Information Center, TW	117.02 ms	408
AS4713	OCN NTT Communications Corporation, JP	101.52 ms	1,489
AS6147	Telefonica del Peru S.A.A., PE	63.53 ms	112,037
AS14420	CORPORACION NACIONAL DE TELECOMUNICACIONES - CNT EP, EC	56.01 ms	63,639
AS4608	APNIC-SERVICES Asia Pacific Network Information Centre, AU	52.83 ms	143
AS6584	MICROSOFT-GP-AS - Microsoft Corporation, GB	48.03 ms	205
AS45209	UPLB-AS-AP University of the Philippines, Los Banos Campus, PH	47.68 ms	236
AS23910	CNGI-CERNET2-AS-AP China Next Generation Internet CERNET2, CN	46.76 ms	20
AS4250	ALENT-ASN-1 - Alentus Corporation, US	46.02 ms	1,630
AS27839	Comteco Ltda, BO	43.85 ms	7,556
AS22284	DIOS - Department of the Interior, Office of theSecretary, US	43.52 ms	91
AS4818	DIGIIX-AP DiGi Telecommunications Sdn. Bhd., MY	41.32 ms	858
AS13778	JOHNSON-AND-JOHNSON - Johnson Johnson, US, EU	39.56 ms	105
AS4134	CHINANET-BACKBONE No.31,Jin-rong Street, CN	39.39 ms	737
AS46690	SNET-FCC - Southern New England Telephone Company and SNET America, Inc., US	37.20 ms	7,261
AS4837	CHINA169-BACKBONE CNCGROUP China169 Backbone, CN	36.64 ms	261
AS21321	ARETI-AS Areti Internet Ltd., CA, CZ, DE, FR, TR, US, DK, RU, UA, SE, ES, GB, IE	36.36 ms	5,278
AS4795	INDOSATM2-ID INDOSATM2 ASN, ID	35.68 ms	83
AS4538	ERX-CERNET-BKB China Education and Research Network Center, CN	34.01 ms	202
AS701	UUNET - MCI Communications Services, Inc. dba Verizon Business, US	31.43 ms	1,206
AS12576	ORANGE-PCS EE Limited, GB	27.81 ms	126
AS33363	BHN-TAMPA - BRIGHT HOUSE NETWORKS, LLC, US	27.29 ms	152
AS6128	CABLE-NET-1 - Cablevision Systems Corp., US	24.73 ms	410
AS109	CISCOSYSTEMS - Cisco Systems, Inc., AU, CN, EU, GB, IN, SA, US, IL, SG, NL	23.87 ms	1,530
AS29180	O2-ONLINE-AS Telefonica UK Limited, GB	23.56 ms	135
AS9790	CALLPLUS-NZ-AP CallPlus Services Limited, NZ	21.57 ms	705
AS5650	FRONTIER-FRTR - Frontier Communications of America, Inc., US, CA	19.65 ms	401

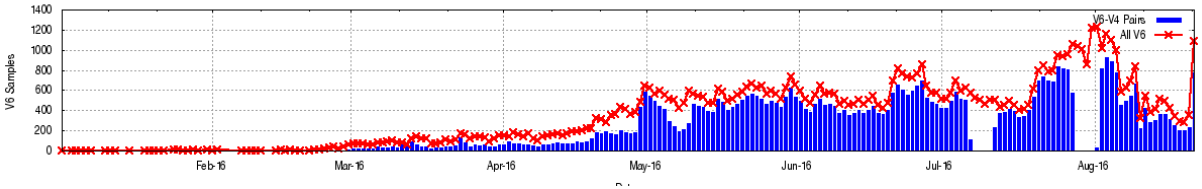
Use of IPv6 for Sri Lanka (LK)



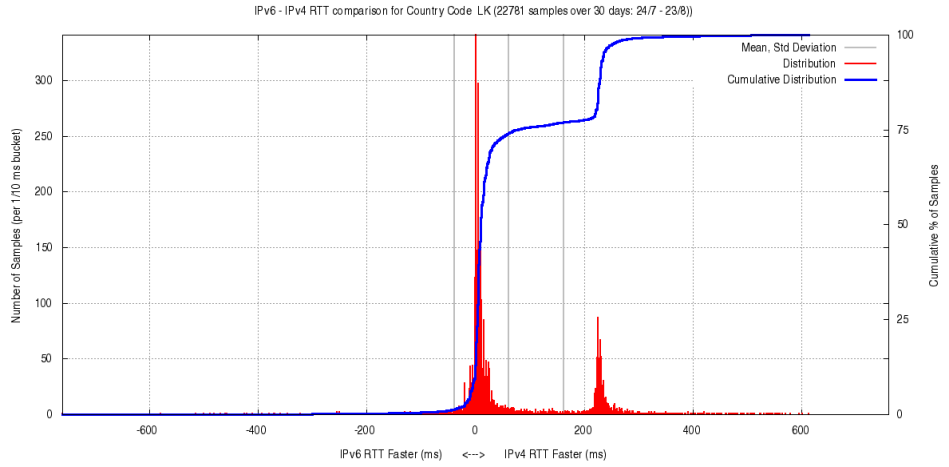
ASN	AS Name	IPv6 Capable	Samples
AS18001	DIALOG-AS Dialog Axiata PLC.	5.67%	2,464,436
AS38229	LEARN-LK Lanka Education Research Network, NREN	3.99%	69,982
AS9329	SLTINT-AS-AP Sri Lanka Telecom Internet	0.03%	2,847,987
AS132045	AIRTEL-AS-ISP Bharti Airtel Lanka Pvt. Limited	0.02%	164,455
AS45356	MOBITEL-LK IS Group, No108, W A D Ramanayake Mawatha	0.01%	491,358
AS17470	ETISALATLK-AS Etisalat Lanka (Pvt) Ltd.	0.01%	208,622
AS5087	LANKA-COM Lanka Communication Services	0.01%	56,016
AS132447	HUTCHISON-LK 234, Galle Road, Colombo 4	0.00%	127,514
AS45224	BELLNET-AS-AP Lanka Bells AS	0.00%	196,231
AS132124	ICTA-LK Information and Communication Technology Agency of Sri Lanka	0.00%	191
AS133051	CBOCP-AS-AP COMMERCIAL BANK OF CEYLON PLC	0.00%	2,855
AS35017	SWIFTWAY-AS Swiftway Sp. z o.o.	0.00%	70
AS54334	ROYA - Roya Hosting LLC	0.00%	99
AS38573	VIRTUSA-IN-AS Virtusa Global AS	0.00%	837
AS56288	SCHOOLNET-LK SchoolNet Network Operation Center	0.00%	724
AS0	Reserved (ietf)	0	3
AS17904	SLTASUL-LK Sri Lankan Airlines	0	26
AS38039	EUREKA-AS-LK Eureka Technology Partners	0	5

Average RTT Difference (ms) (V6 - V4) for Sri Lanka (LK)





Distribution of RTT Difference measurements Sri Lanka (LK) (30 days)

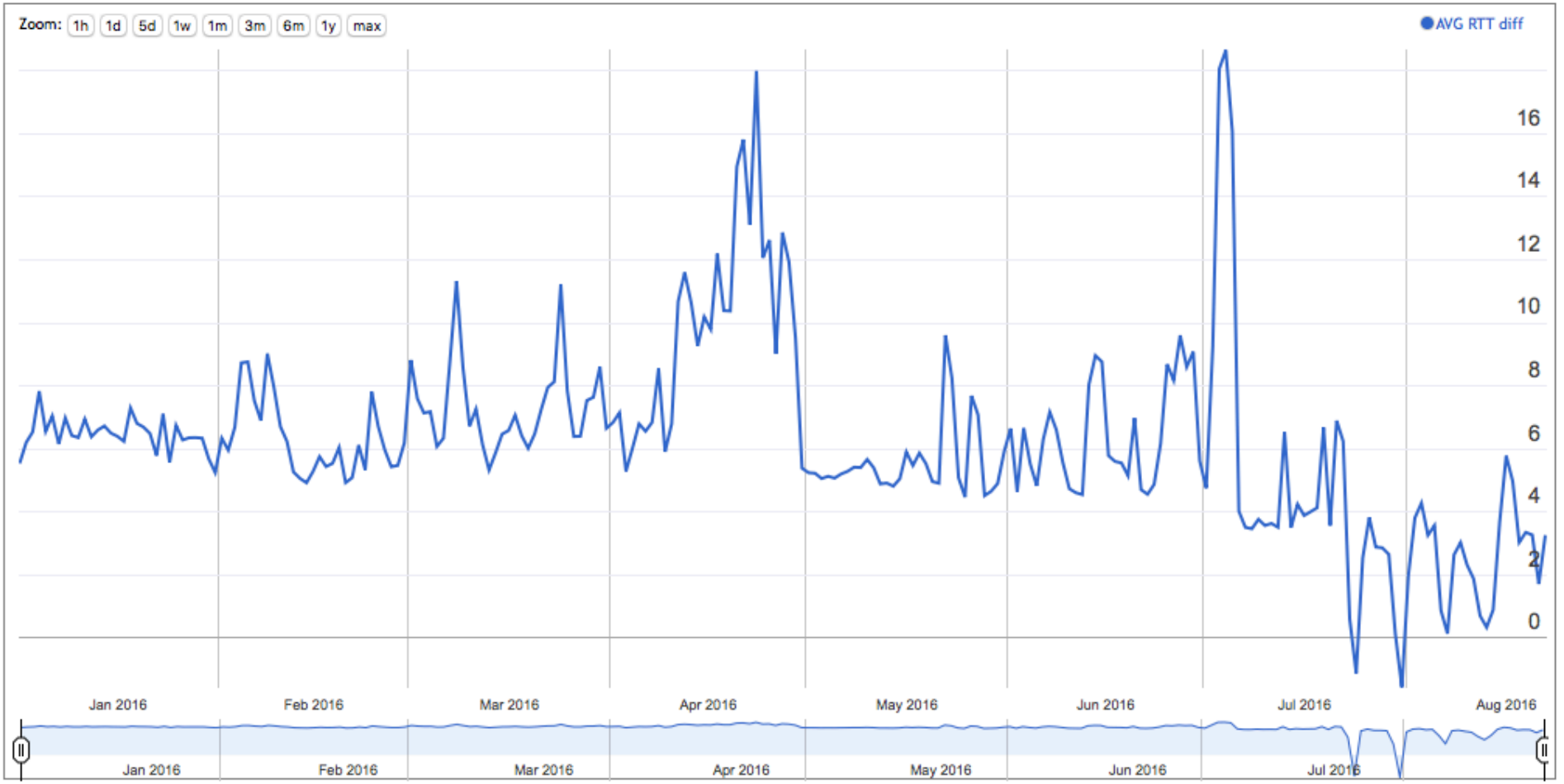


IPv6 Providers in Sri Lanka

ASN	AS Name	RTT Diff (V6-V4)	Samples	V6 Fail Rate	V6 Fail Count	V6 Samples	Dual Stack	Dual Stack (300ms)	V6 Use Rate
AS18001	DIALOG-AS Dialog Axiata PLC.	20.66 ms	26,114	8.62%	3,431	39,794	17.92%	98.32%	6.28%
AS38229	LEARN-LK Lanka Education Research Network, NREN	3.97 ms	159	14.67%	38	259	20.75%	93.08%	3.96%
AS9329	SLTINT-AS-AP Sri Lanka Telecom Internet	0.32 ms	71	1.37%	1	73	29.58%	95.77%	0.02%
AS45356	MOBITEL-LK IS Group, No108, W A D Ramanayake Mawatha	-22.82 ms	9	0.00%	0	9	33.33%	44.44%	0.01%
AS17470	ETISALATLK-AS Etisalat Lanka (Pvt) Ltd.	-4.68 ms	3	0.00%	0	3	66.67%	33.33%	0.01%
AS5087	LANKA-COM Lanka Communication Services	0.88 ms	1	0.00%	0	1	100.00%	0.00%	0.01%
AS132447	HUTCHISON-LK 234, Galle Road, Colombo 4	-34.68 ms	1	0.00%	0	1	100.00%	100.00%	0.01%

The United States

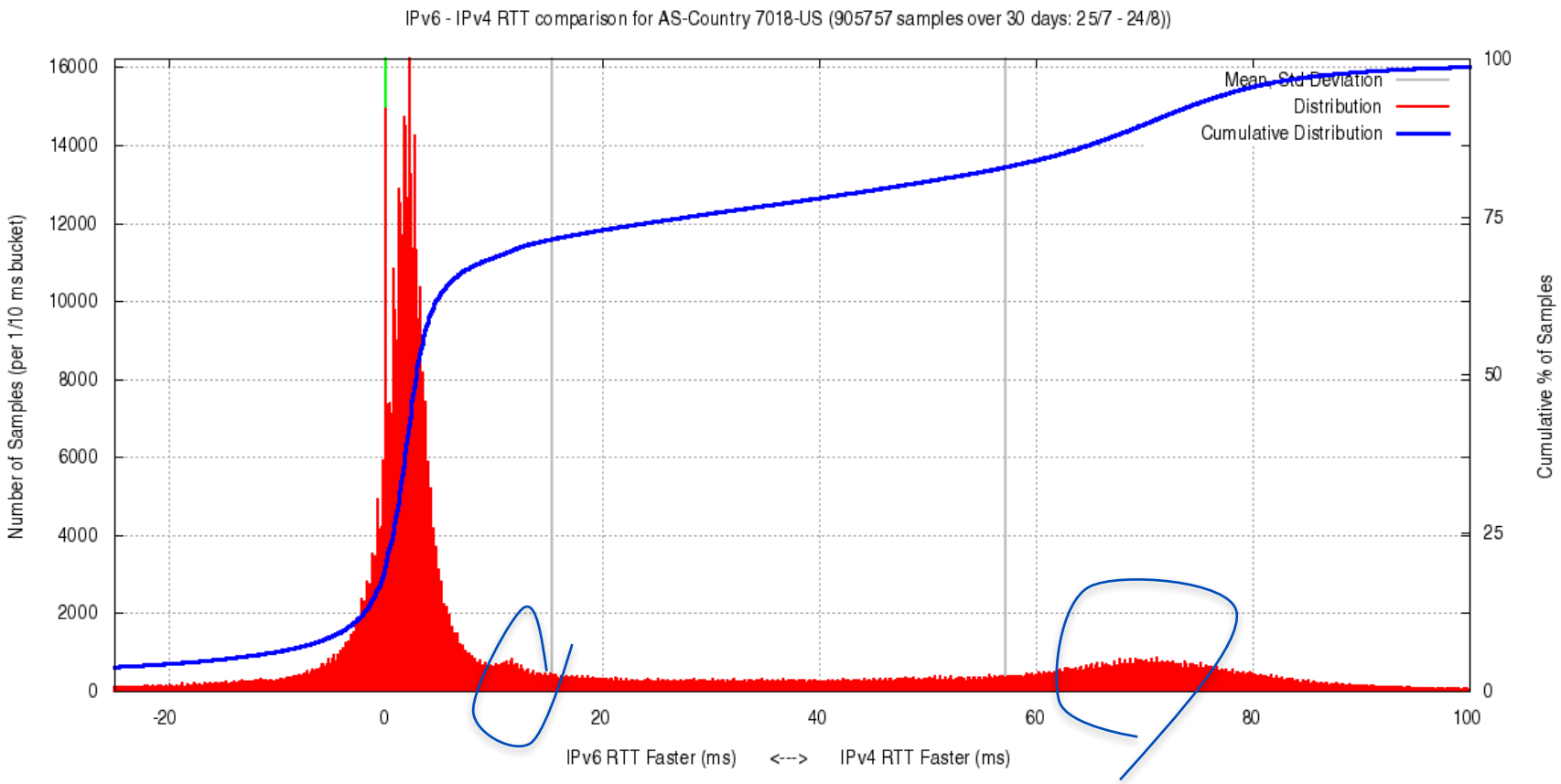
Average RTT Difference (ms) (V6 - V4) for United States of America (US)



The United States

ASN	AS Name	RTT Diff (V6-V4)	Samples	V6 Fail Rate	V6 Fail Count	V6 Samples	Dual Stack	Dual Stack (300ms)	V6 Use Rate
AS7922	COMCAST-7922 - Comcast Cable Communications, Inc.	-2.60 ms	1,290,400	1.05%	14,411	1,373,565	62.48%	95.15%	64.00%
AS7018	ATT-INTERNET4 - ATT Services, Inc.	15.26 ms	903,063	2.05%	20,520	1,000,179	23.92%	93.44%	82.40%
AS22394	CELLCO - Cellco Partnership DBA Verizon Wireless	-1.83 ms	398,294	0.32%	1,421	439,427	56.45%	97.03%	89.94%
AS21928	T-MOBILE-AS21928 - T-Mobile USA, Inc.	-1.21 ms	220,784	0.10%	241	238,115	60.81%	96.67%	71.01%
AS20001	ROADRUNNER-WEST - Time Warner Cable Internet LLC	-6.92 ms	118,051	2.62%	3,358	128,355	85.04%	95.20%	46.46%
AS22773	ASN-CXA-ALL-CCI-22773-RDC - Cox Communications Inc.	-1.83 ms	112,819	0.96%	1,140	118,889	64.42%	94.91%	27.18%
AS11427	SCRR-11427 - Time Warner Cable Internet LLC	-0.46 ms	75,089	2.61%	2,188	83,880	58.33%	95.00%	43.96%
AS11426	SCRR-11426 - Time Warner Cable Internet LLC	4.31 ms	74,643	3.86%	3,150	81,525	28.64%	95.11%	44.62%
AS10796	SCRR-10796 - Time Warner Cable Internet LLC	-0.48 ms	64,786	2.70%	1,882	69,700	55.82%	95.87%	23.85%
AS12271	SCRR-12271 - Time Warner Cable Internet LLC	-4.85 ms	46,444	2.58%	1,302	50,445	75.34%	94.69%	51.95%
AS20057	ATT-MOBILITY-LLC-AS20057 - ATT Mobility LLC	-0.88 ms	36,110	0.02%	6	37,622	64.82%	98.25%	11.43%
AS11351	RR-NYSREGION-ASN-01 - Time Warner Cable Internet LLC	-3.87 ms	28,142	2.15%	647	30,032	68.23%	95.08%	18.59%
AS10507	SPCS - Sprint Personal Communications Systems	-3.71 ms	26,856	0.00%	0	26,856	67.79%	99.33%	18.14%
AS30036	MEDIACOM-ENTERPRISE-BUSINESS - Mediacom Communications Corp	-11.64 ms	25,209	1.64%	443	27,013	73.86%	95.97%	29.82%
AS16591	GOOGLE-FIBER - Google Fiber Inc.	-2.67 ms	13,045	0.39%	53	13,660	80.16%	96.62%	90.89%
AS11232	MIDCO-NET - Midcontinent Media, Inc.	4.61 ms	12,187	4.78%	647	13,525	46.98%	92.83%	49.19%
AS6389	BELLSOUTH-NET-BLK - BellSouth.net Inc.	3.20 ms	10,352	0.00%	0	10,352	55.48%	92.78%	44.65%
AS6621	HNS-DIRECPC - Hughes Network Systems	-0.47 ms	8,619	0.47%	46	9,871	64.85%	95.58%	20.53%
AS15169	GOOGLE - Google Inc.	6.04 ms	8,395	0.11%	29	26,720	86.11%	10.64%	39.50%
AS46690	SNET-FCC - Southern New England Telephone Company and SNET America, Inc.	37.20 ms	7,261	0.61%	47	7,665	11.78%	91.20%	29.66%
AS3651	SPRINT-BB6 - Sprint	-4.16 ms	5,213	0.04%	14	34,387	68.83%	98.91%	14.81%
AS21321	ARETI-AS Areti Internet Ltd.	40.59 ms	4,704	0.00%	0	6,341	56.59%	92.24%	34.82%

AT&T - AS7018


IPv6 - IPv4 RTT comparison for AS-Country 7018-US (905757 samples over 30 days: 25/7 - 24/8))
Mean, Std Deviation
Distribution
Cumulative Distribution
Number of Samples (per 1/10 ms bucket)
Cumulative % of Samples
16000
14000
12000
10000
8000
6000
4000
2000
0
100
75
50
25
0
-20
0
20
40
60
80
100
IPv6 RTT Faster (ms) <---> IPv4 RTT Faster (ms)

Is IPv6 as “good” as IPv4?

Is IPv6 as “good” as IPv4?

Is IPv6 as fast as IPv4?

- Basically, yes
- IPv6 is faster about half of the time
- For 75% of unicast cases, IPv6 is within 10ms RTT of IPv4
- So they perform at much the same rate

(But that’s just for unicast IPv6 - the use of 6to4 makes this a whole lot worse!)

Is IPv6 as “good” as IPv4?

Is IPv6 as robust as IPv4?

IPv4 connection reliability currently sits at 0.2%

The base failure rate of Unicast V6 connection attempts at 1.5% of the total V6 unicast connections is not brilliant.

(6to4 is terribleat this!)

It could be better.

It could be a whole lot better!

Is IPv6 as “good” as IPv4?

If you can establish a connection, then IPv4 and IPv6 appear to have comparable RTT measurements across most of the Internet

But the odds of establishing that connection are still weighted in favour of IPv4!

That's it!

http://stats.labs.apnic.net/v6perf