Visualising AS interconnection and measuring IPv6 deployment

Issue Date: 12 June 2015

Revision: 1.0

APNIC

Overview

- IP addresses and ASNs
- Visualising the AS interconnections
- Comparing AS transit map in different AP region economies
- Measuring end-user IPv6 capabilities and preferences
- Conclusion

IP addresses and ASNs

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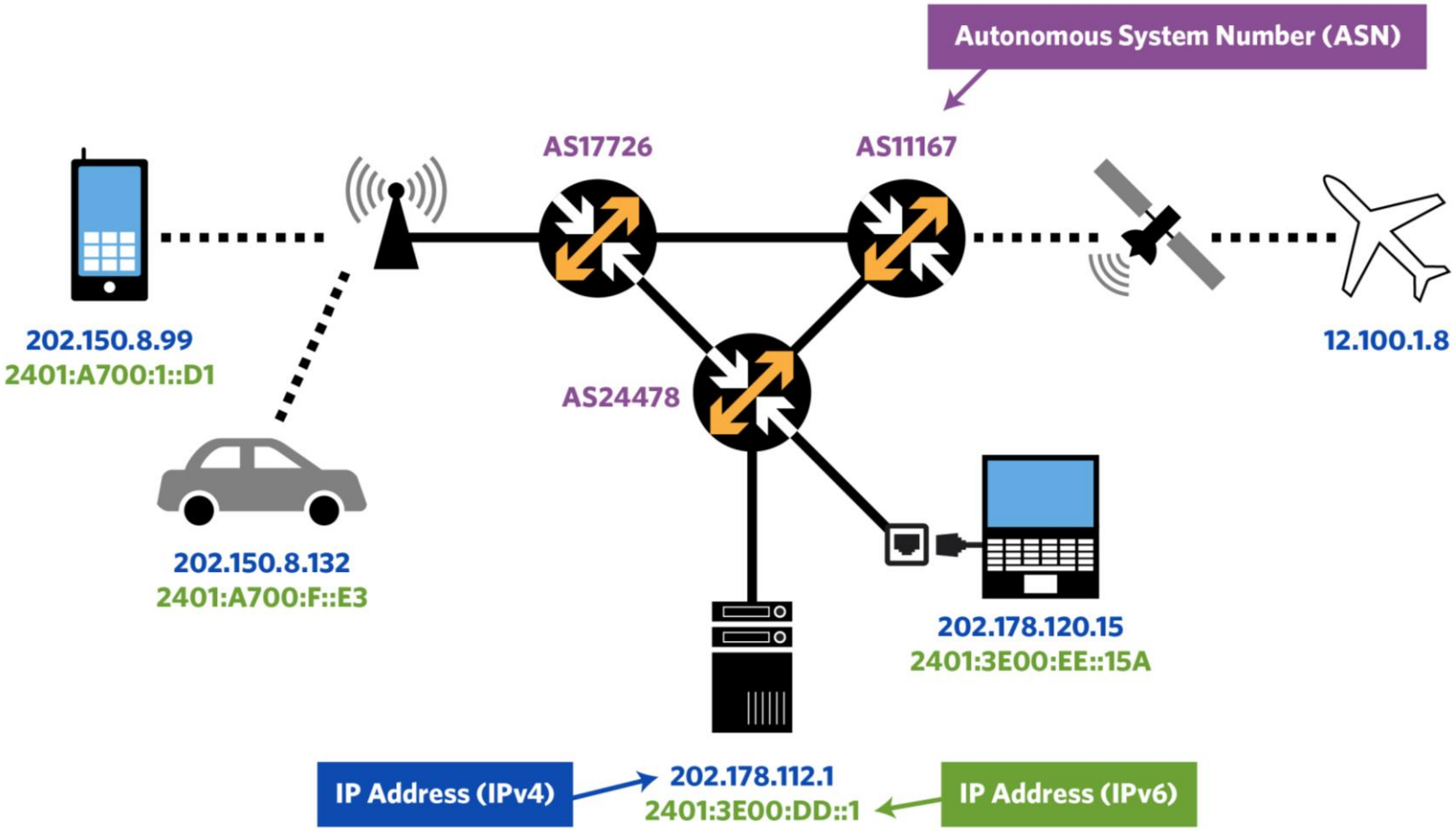
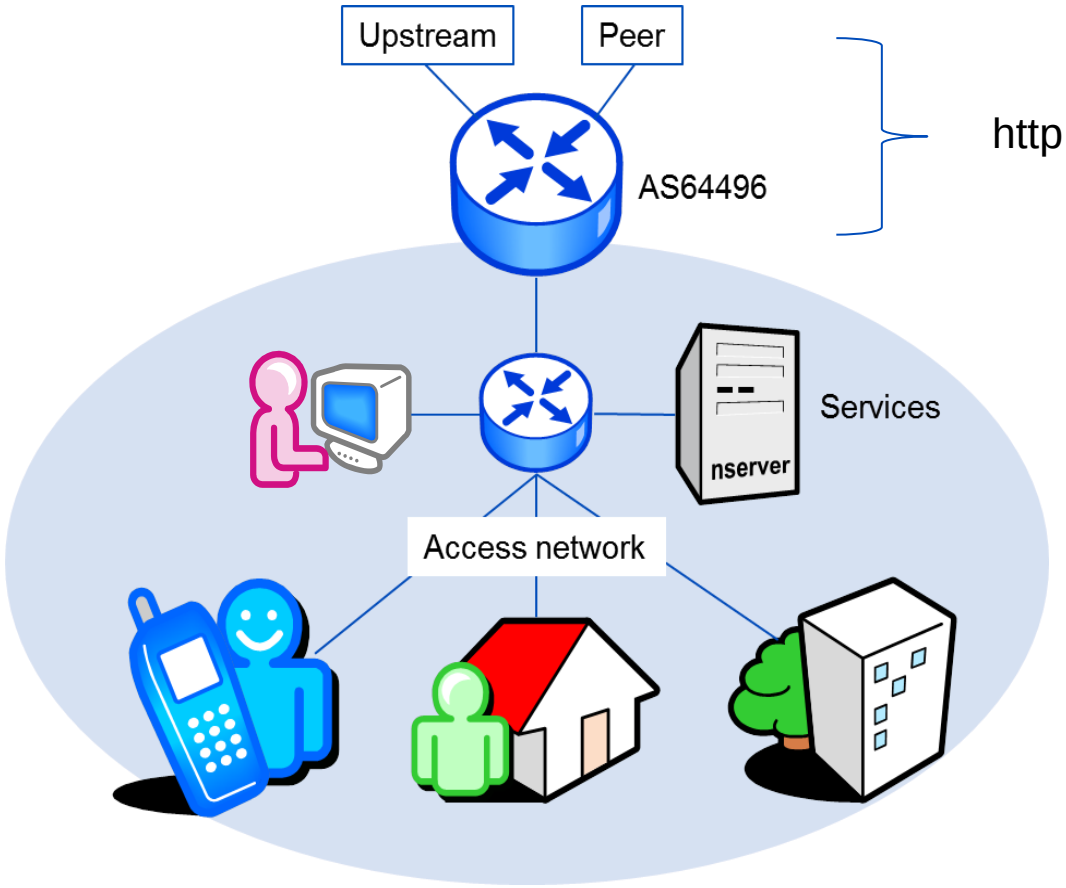
IP addresses and ASNs



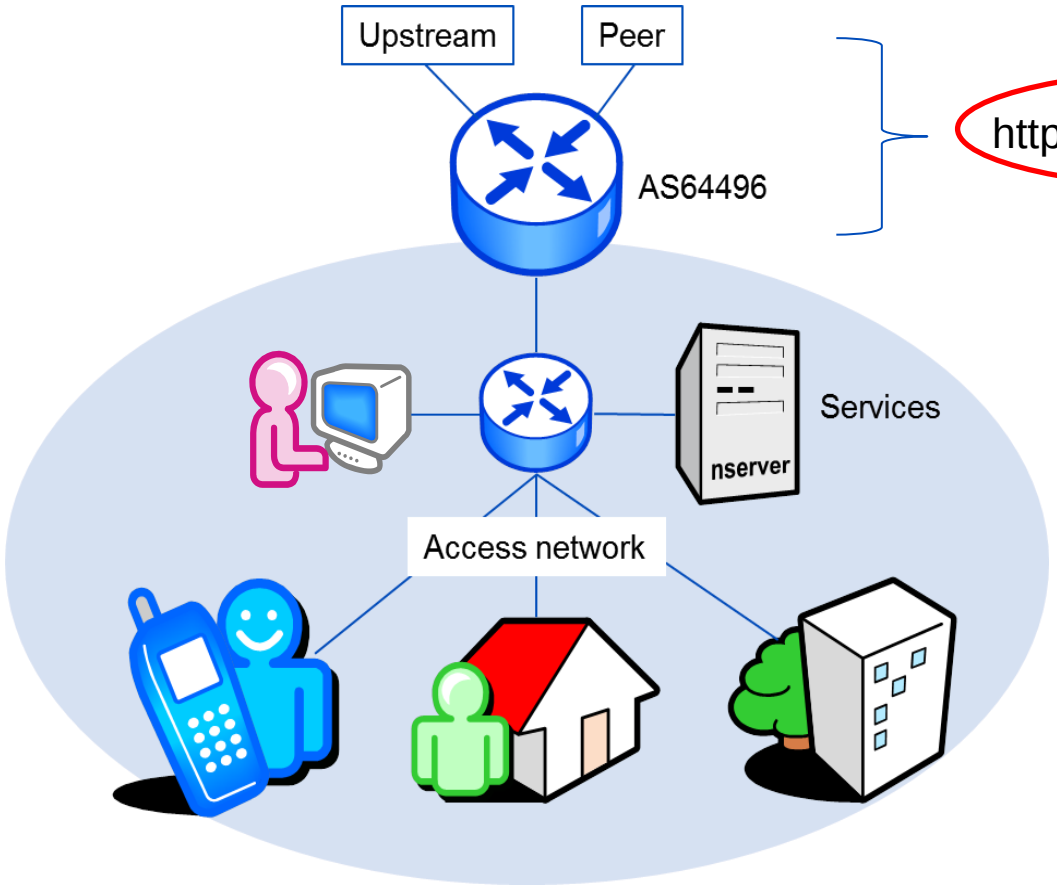
Visualisation and measurement tools



http://labs.apnic.net/vizAS

http://stats.labs.apnic.net/ipv6

Visualisation and measurement tools



http://labs.apnic.net/vizAS

http://stats.labs.apnic.net/ipv6

APNIC vizAS: Visualising the AS interconnections

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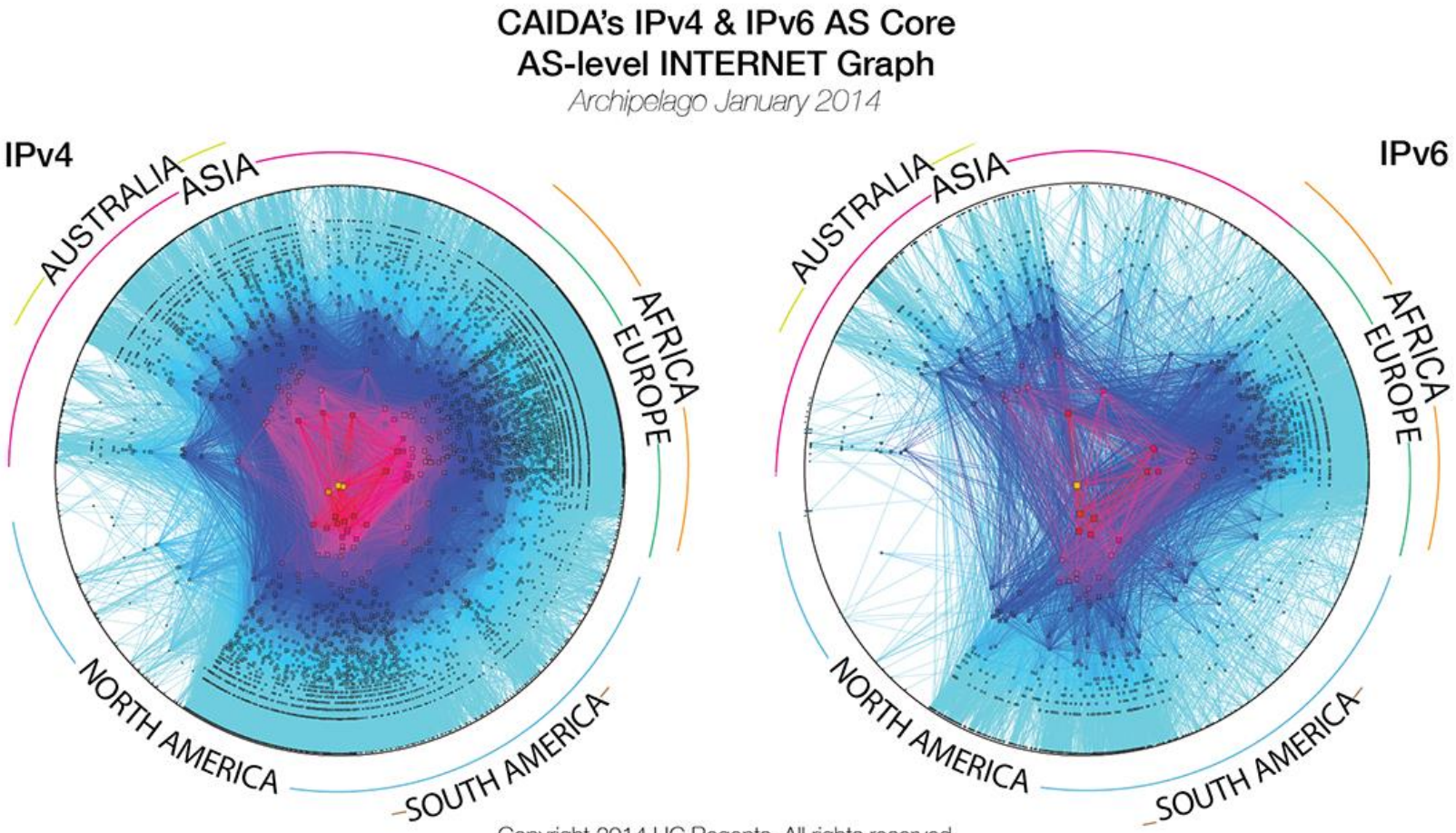
There’s an app for that

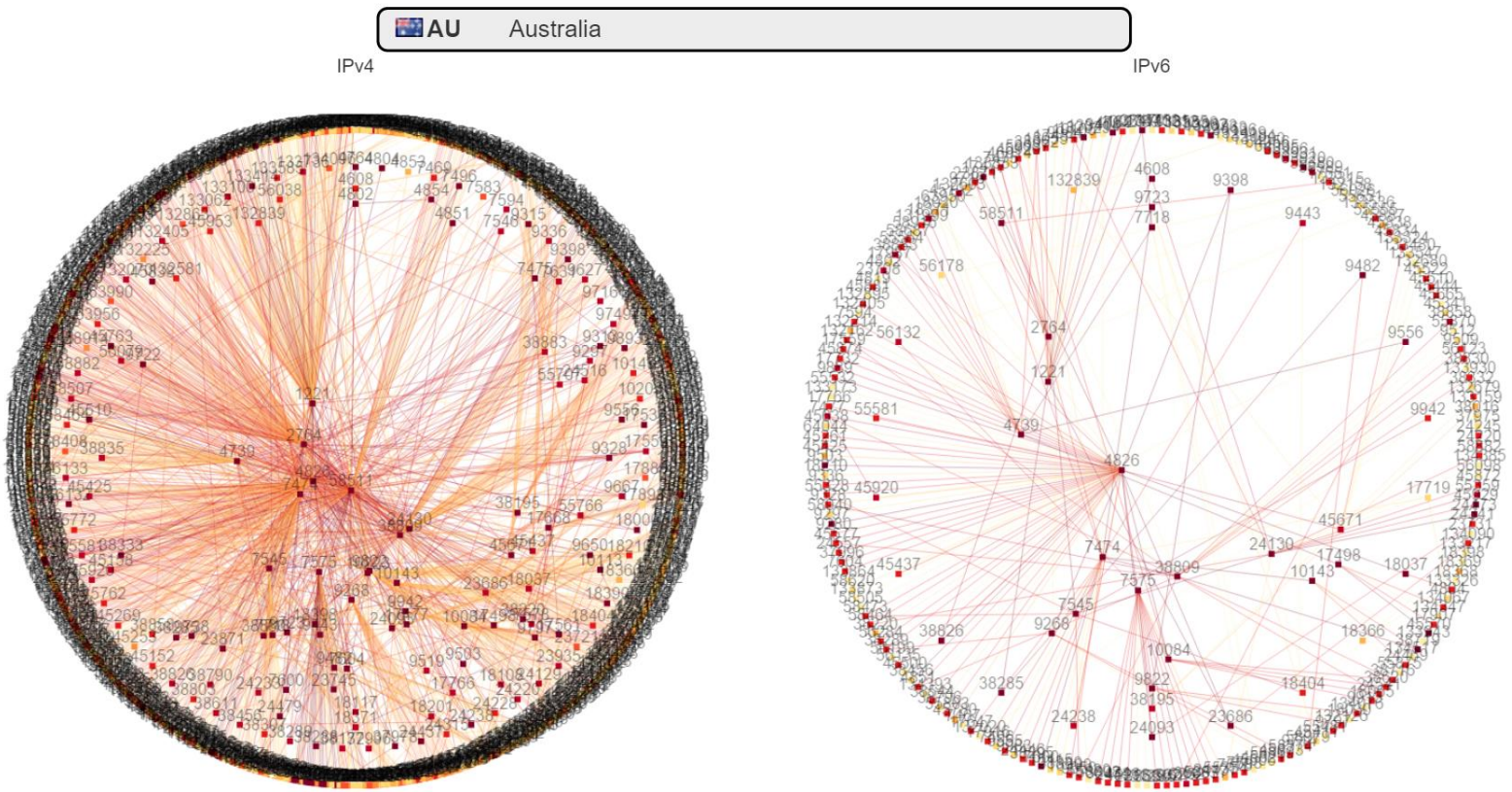
- **Networks worldwide interconnect** to form the Internet. They include ISPs, Internet Exchange Points, Universities, Corporate networks, etc.
- Each dot represents an AS
- There are **50,000+ ASNs** currently active in the Internet

source: peer1.com

Global AS Core



Country/economy level AS transit map



https://labs.apnic.net/vizas/

Data source

- Routeviews.org
  - RIBs from the Oregon Internet Exchange, for both IPv4 and IPv6
- 12 November 2015 data (taken at 2am UTC)
- This is a snapshot, not live data
- The list of ASNs per country/economy is sourced from the NRO's global delegated statistics file (https://www.nro.net/statistics)

Sample data

12.180.218.0/24 195.208.112.161 3277 3267 1299 7018 15253

12.180.218.0/24 80.91.255.137 1299 7018 15253

12.180.218.0/24 216.221.157.162 40191 3257 701 15253

12.180.218.0/24 208.51.134.246 3549 7018 15253

12.180.219.0/24 217.192.89.50 3303 3320 7018 19111

12.180.219.0/24 66.185.128.1 1668 7018 19111

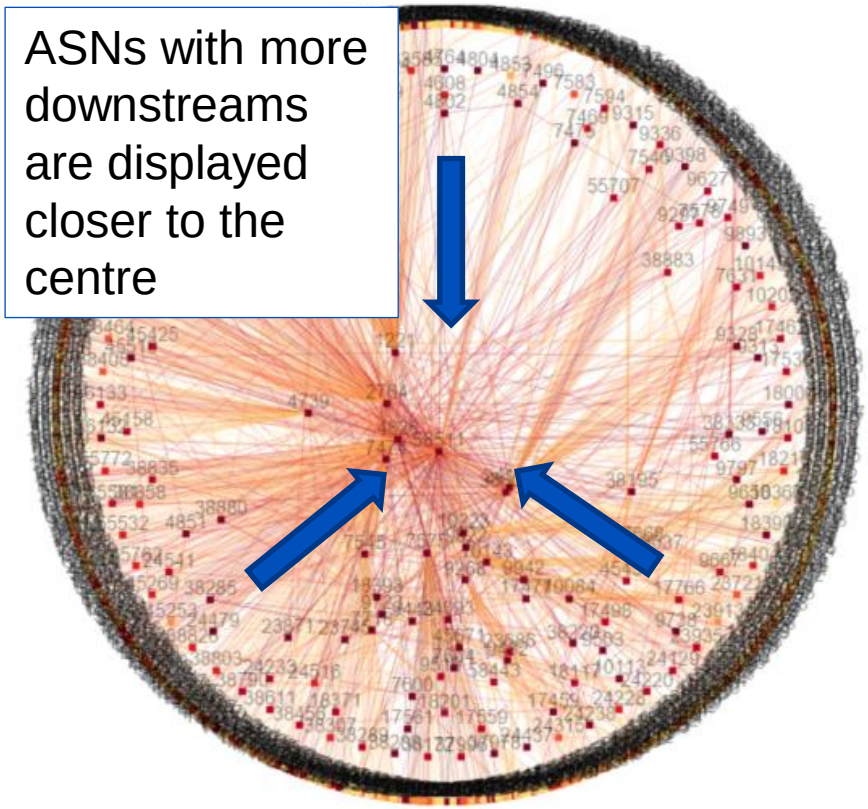
12.180.219.0/24 192.241.164.4 62567 2914 7018 19111

12.180.219.0/24 5.101.110.2 3.5410 2914 7018 19111

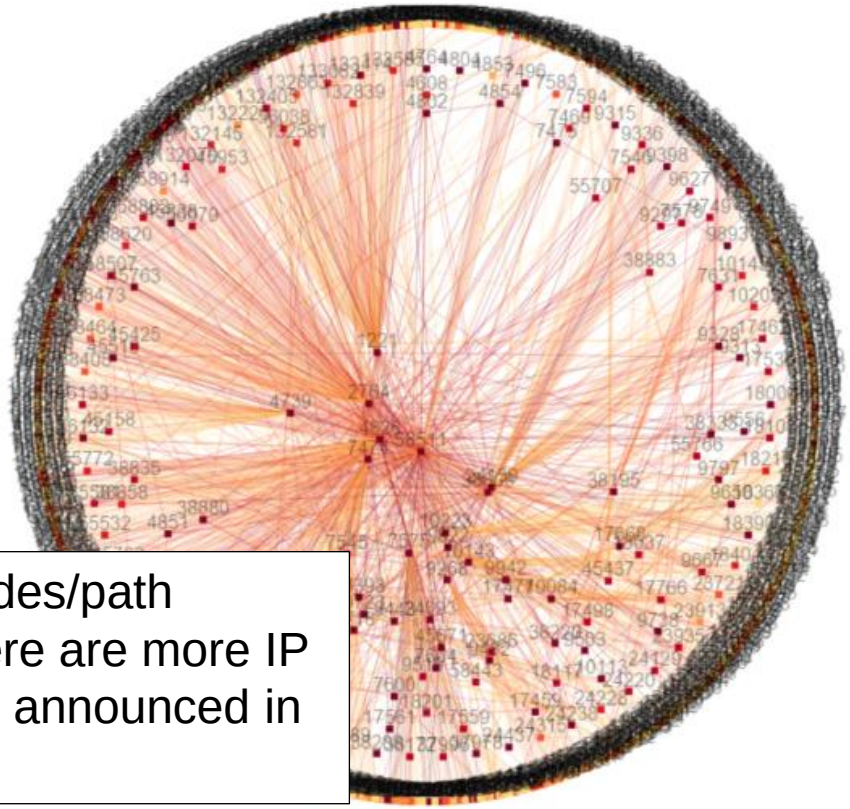
12.180.219.0/24 198.129.33.85 293 6939 1299 7018 19111

12.180.219.0/24 129.250.0.11 2914 7018 19111

Explanation

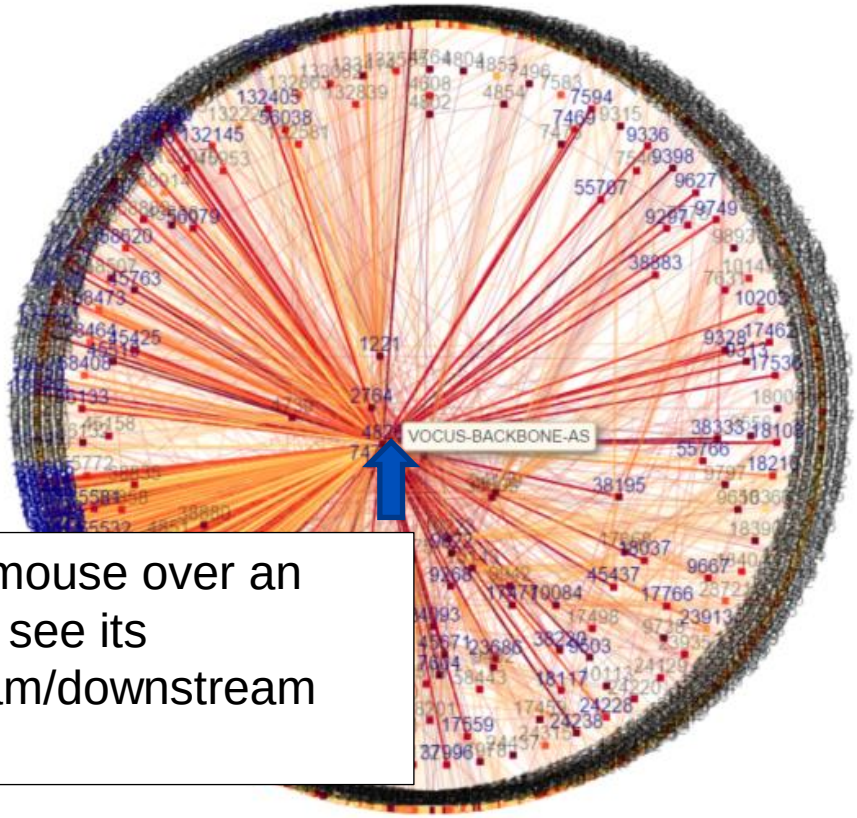


Explanation



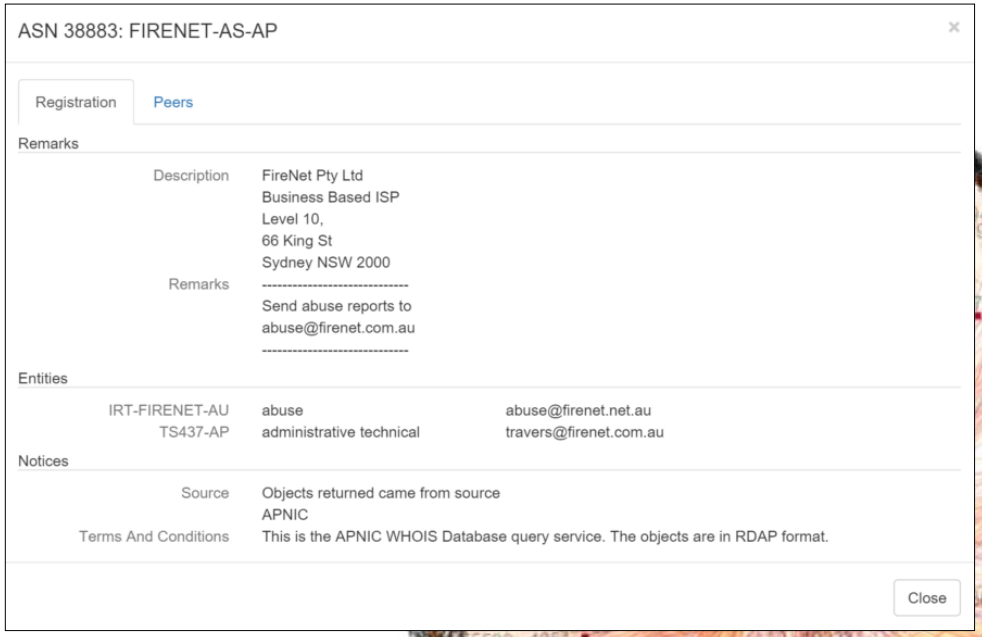
Darker nodes/path means there are more IP addresses announced in that route

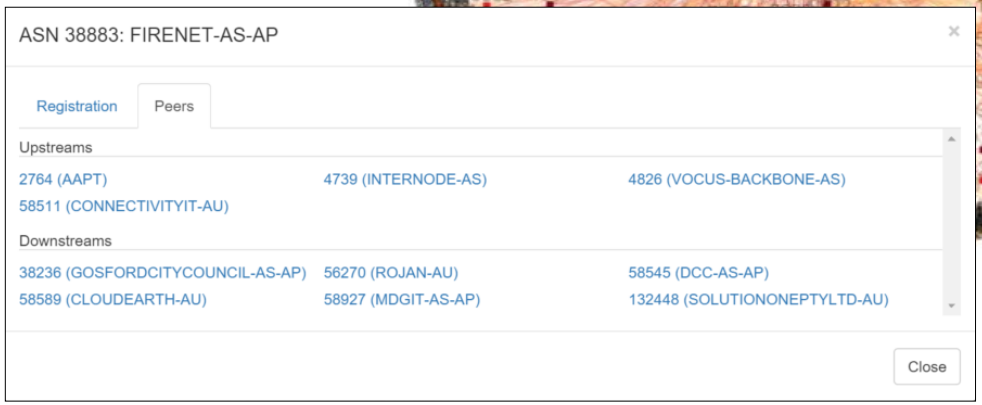
Explanation



Hover mouse over an ASN to see its upstream/downstream ASNs

Explanation





Click an ASN to see registration detail and its AS neighbours

Demo

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Comparing AS transit map in different AP region economies

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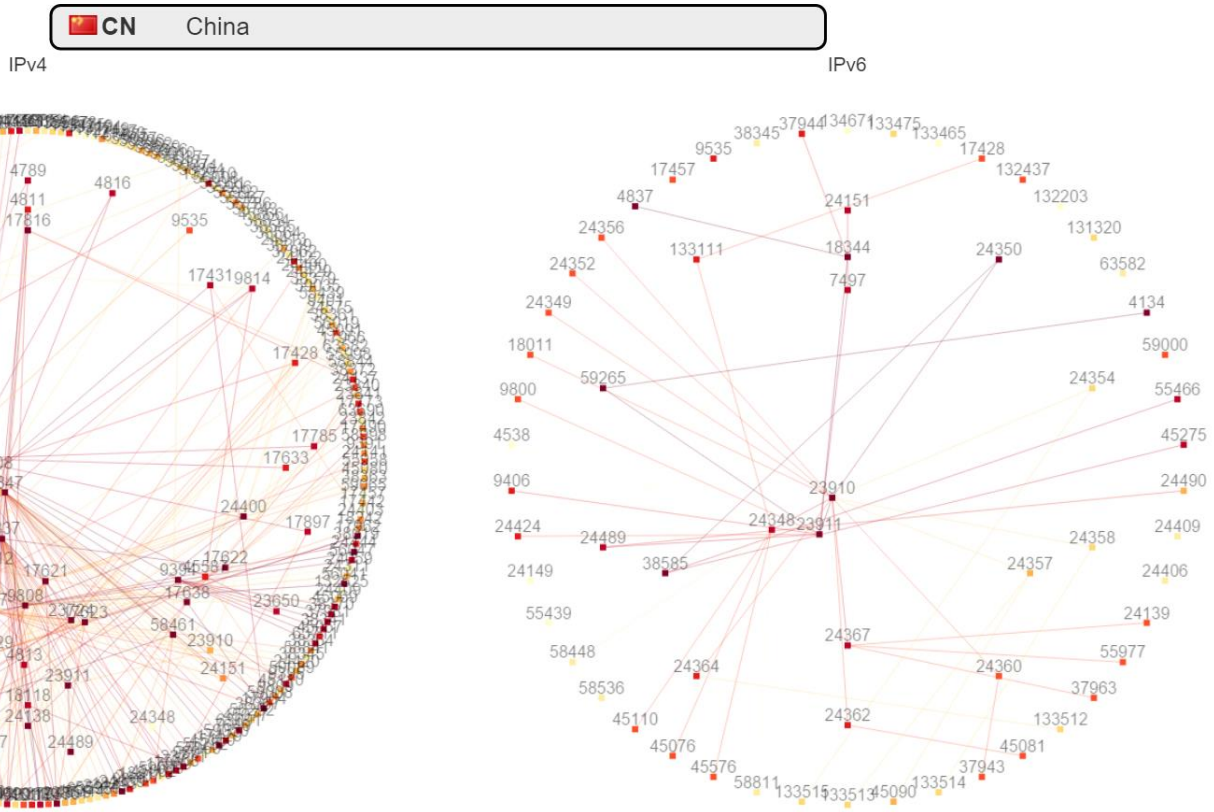
China

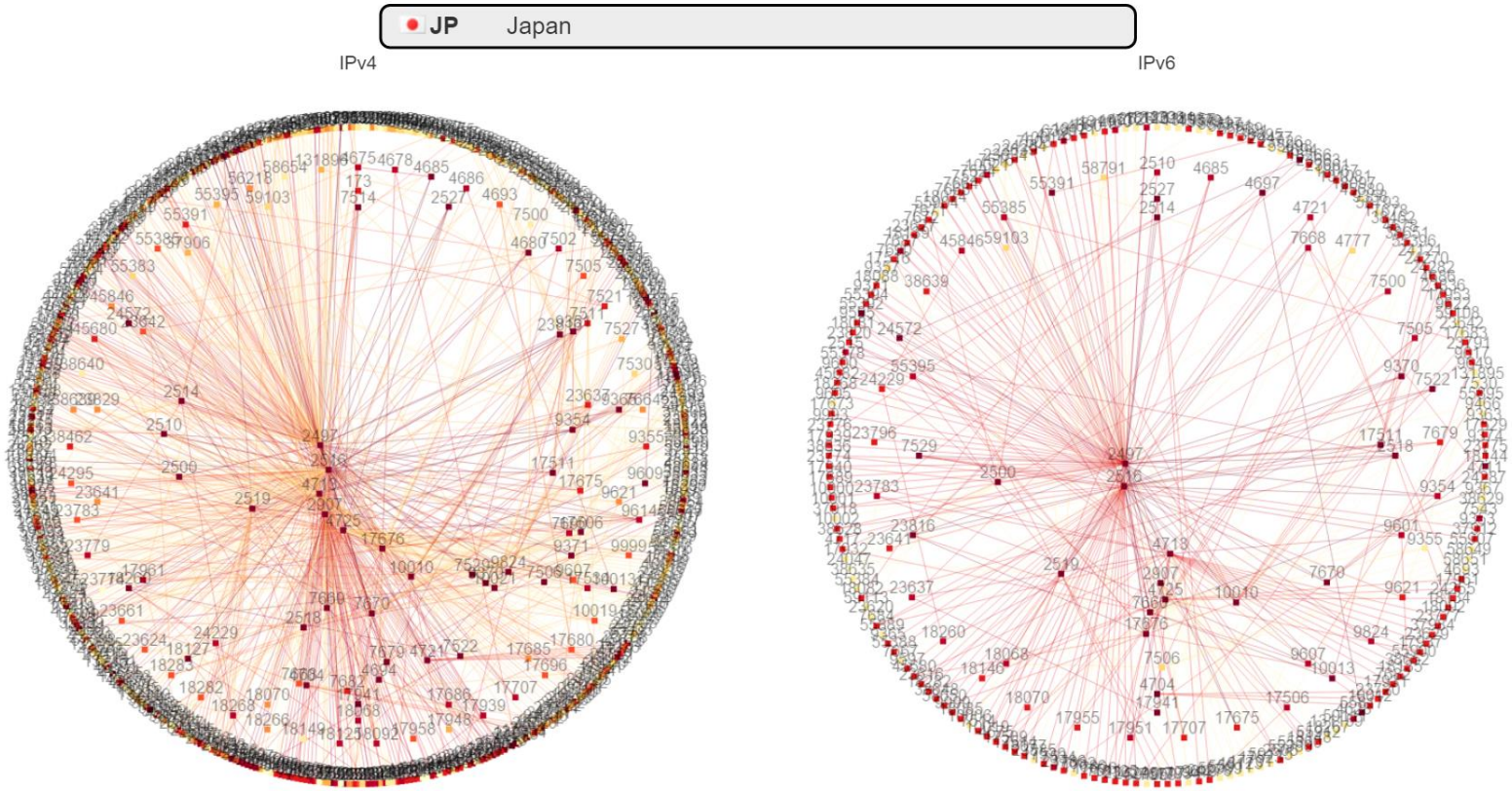
1.364 billion population



Population data from World Bank statistics 2014

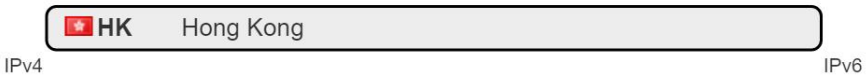
Japan

127.1 million population

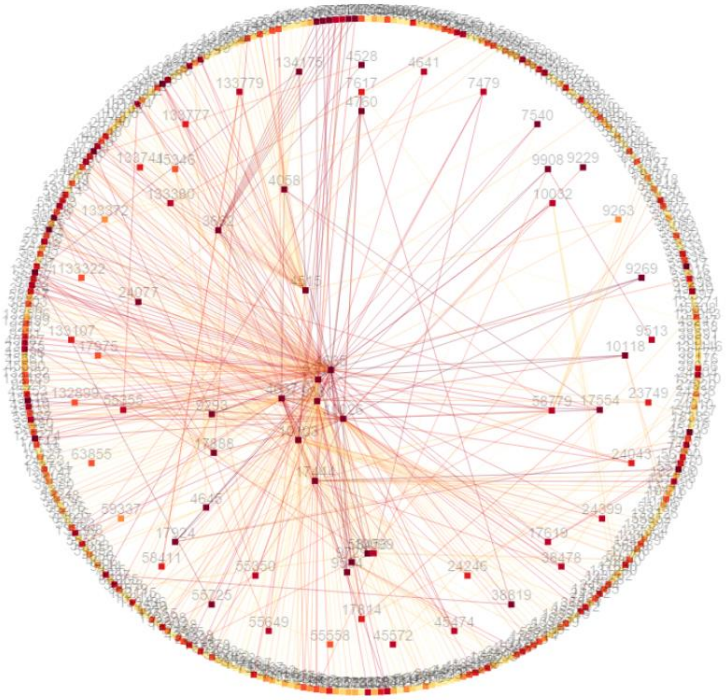


Hong Kong

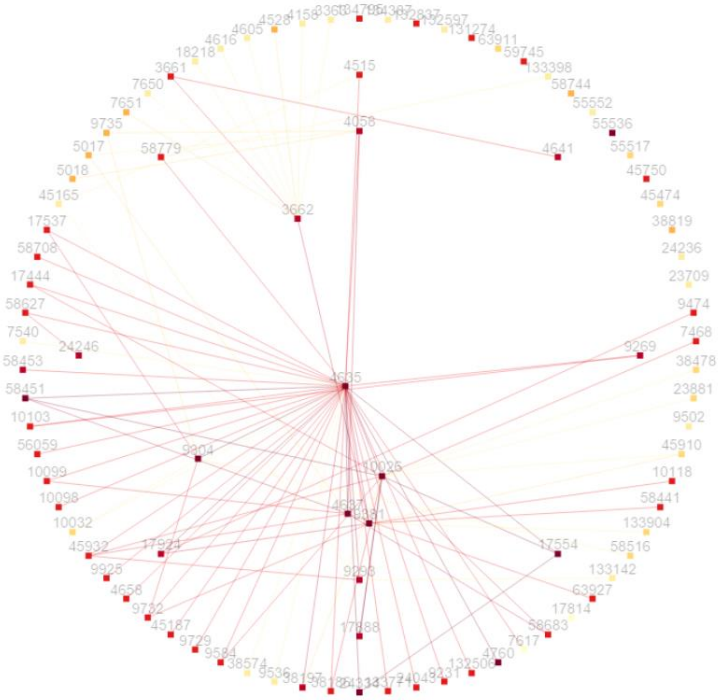
7.2 million population



IPv4

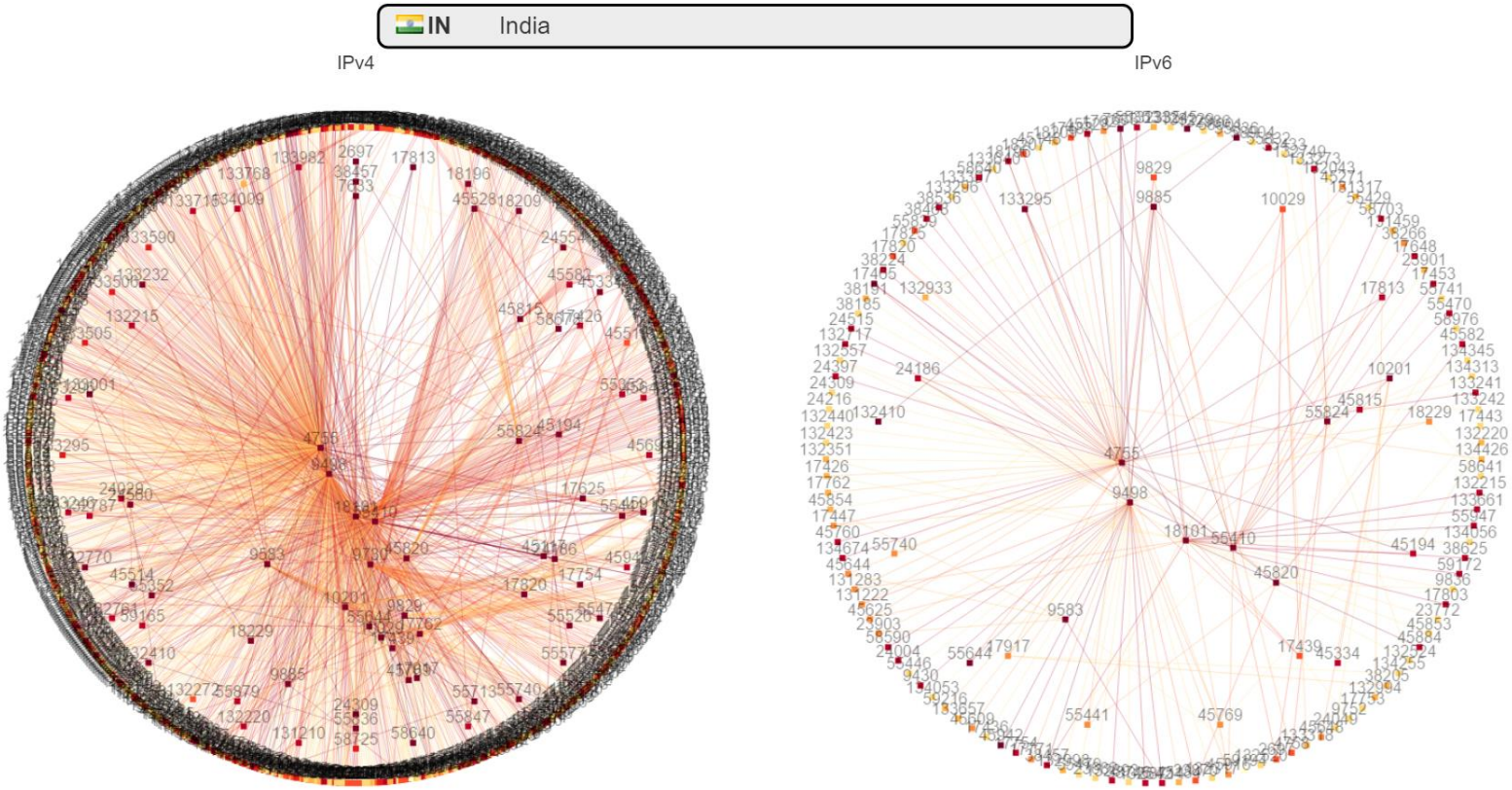


IPv6



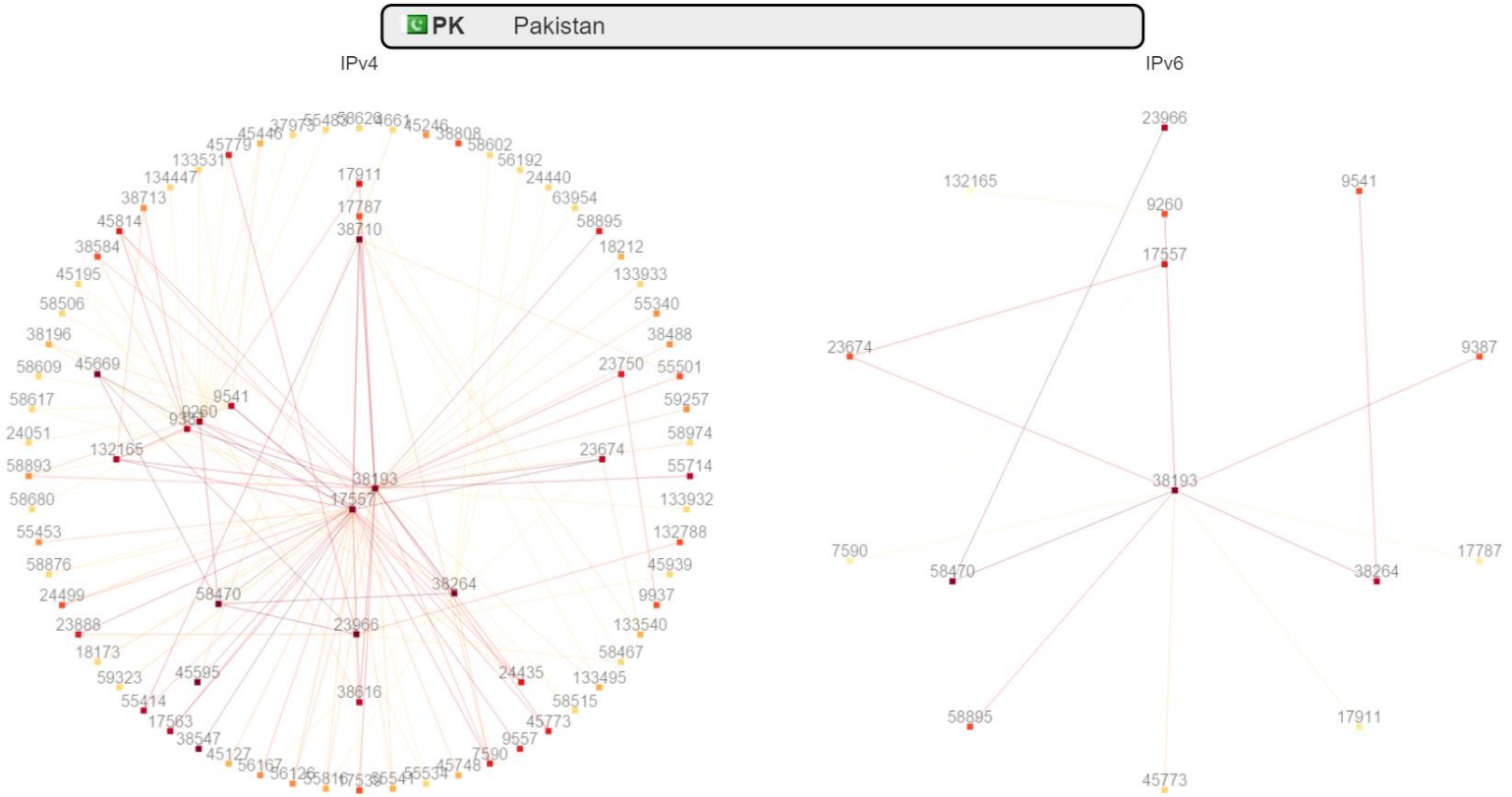
India

1.295 billion population



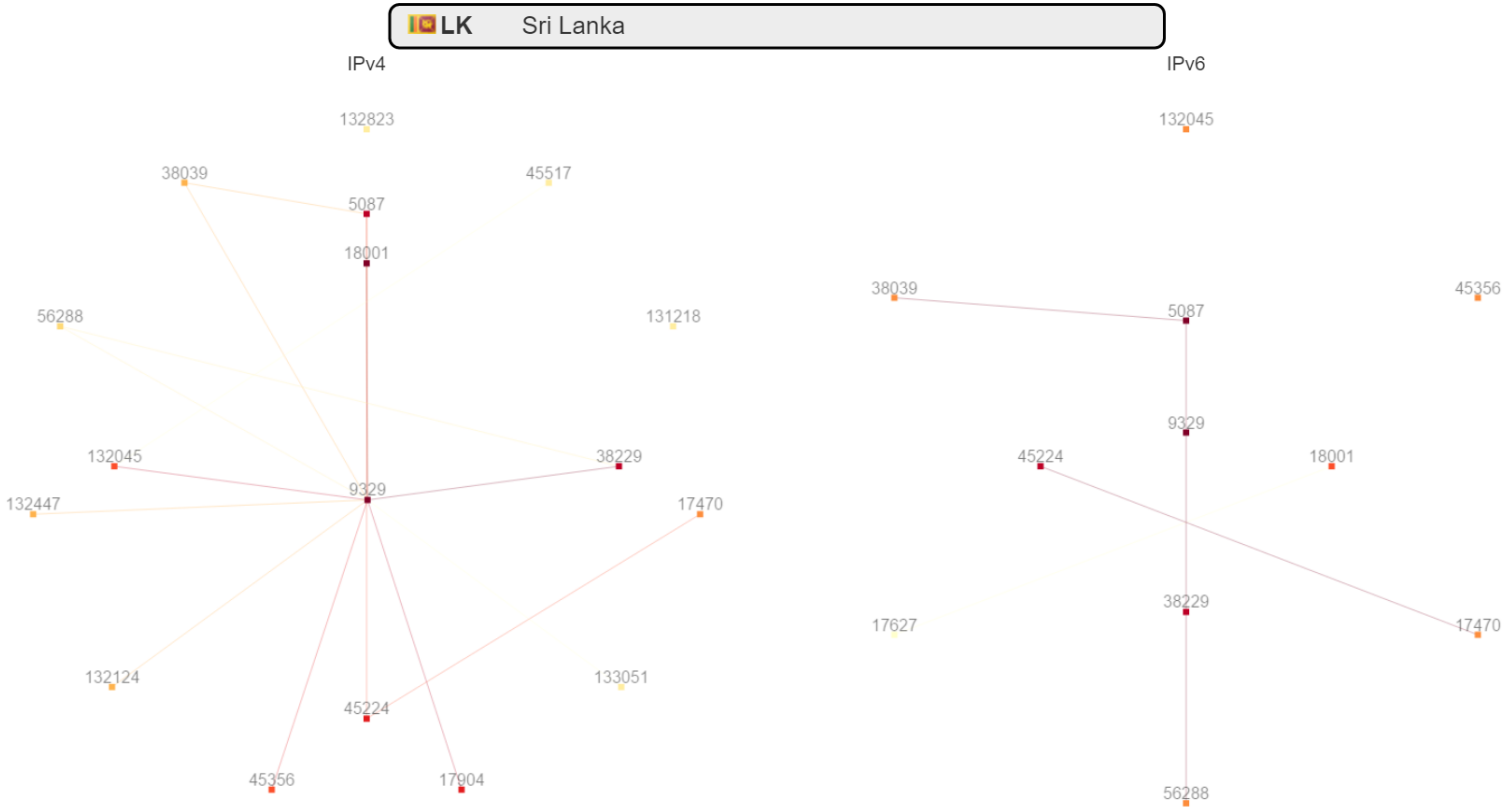
Pakistan

185 million population



Sri Lanka

20.6 million population

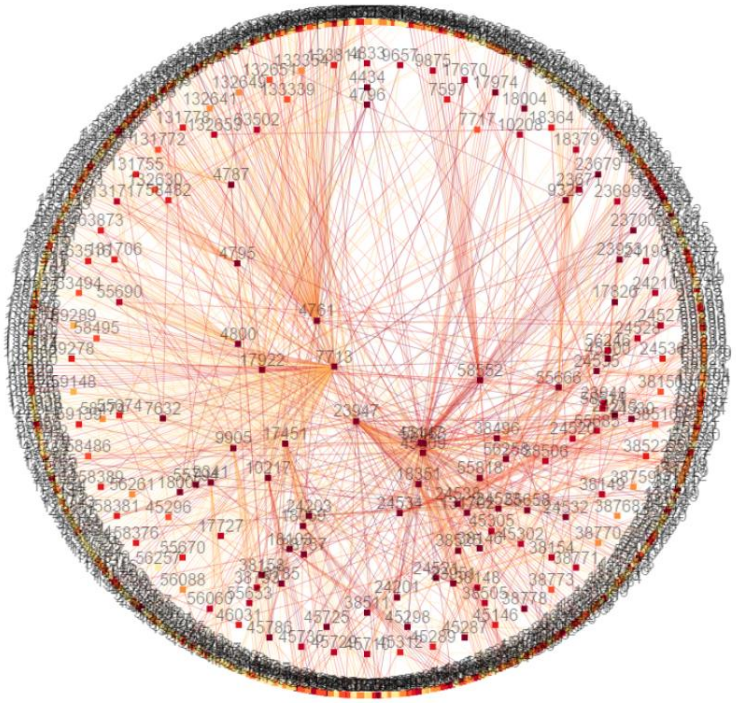


Indonesia

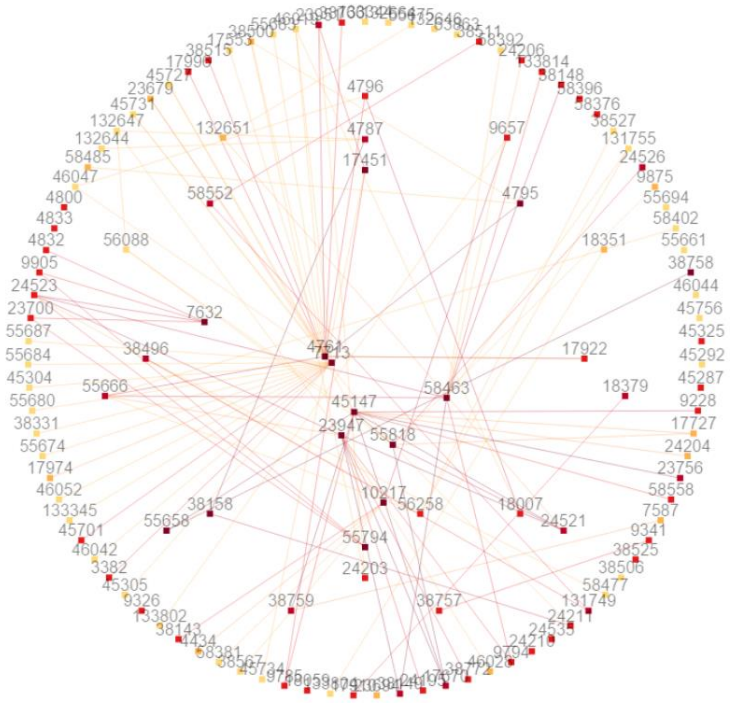
254.4 million population

ID Indonesia

IPv4

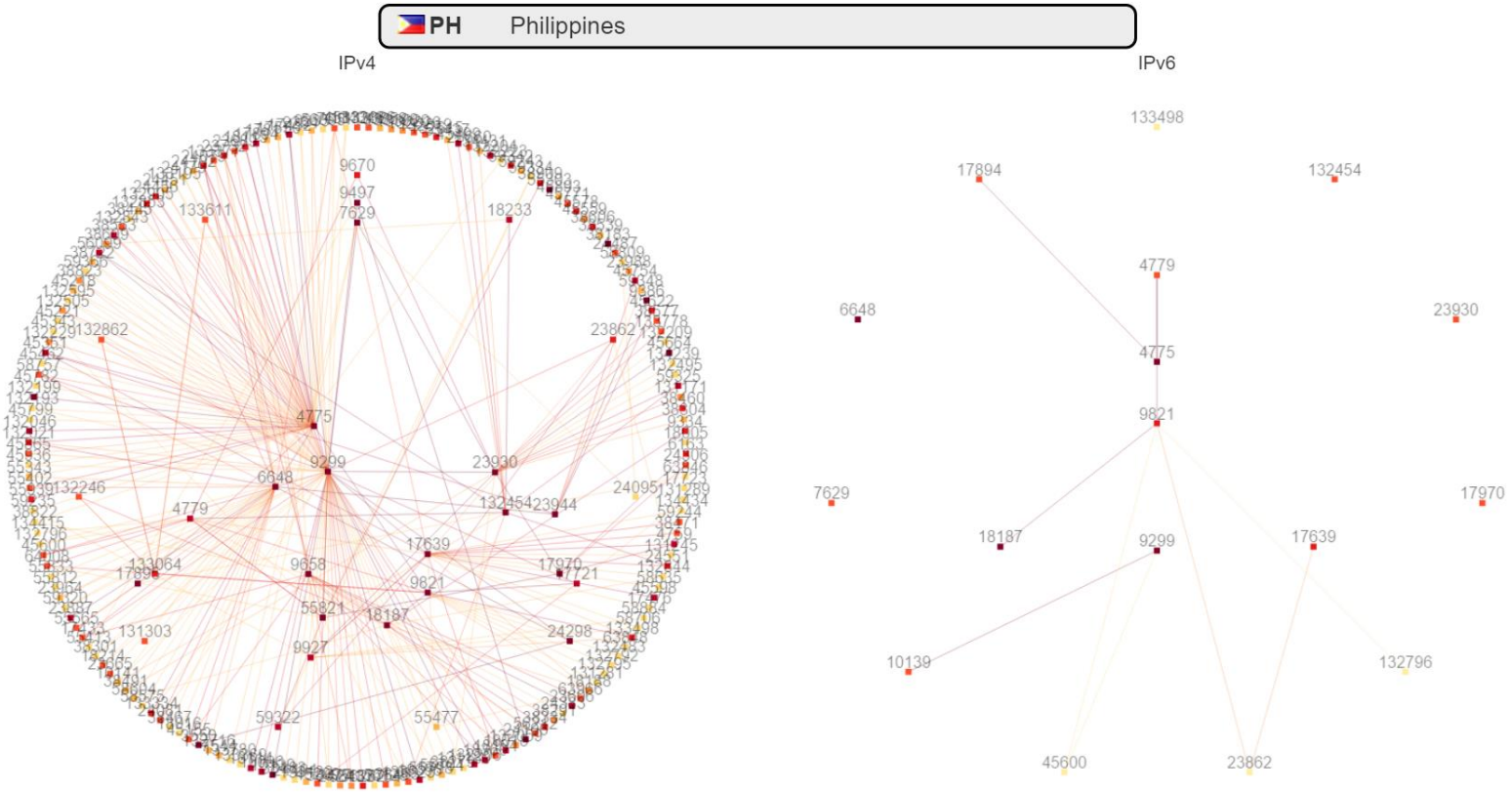


IPv6



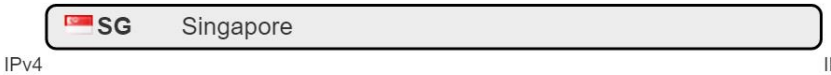
Philippines

99.1 million population

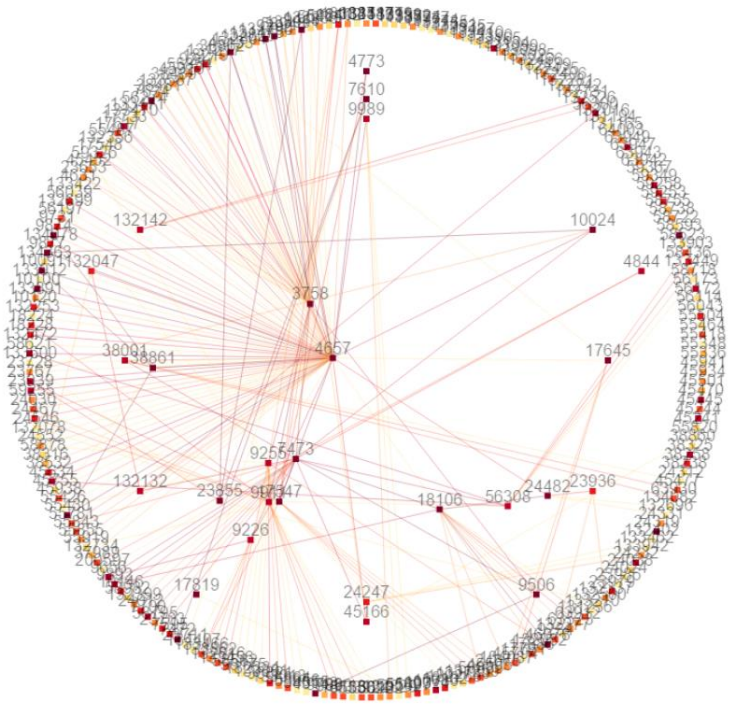


Singapore

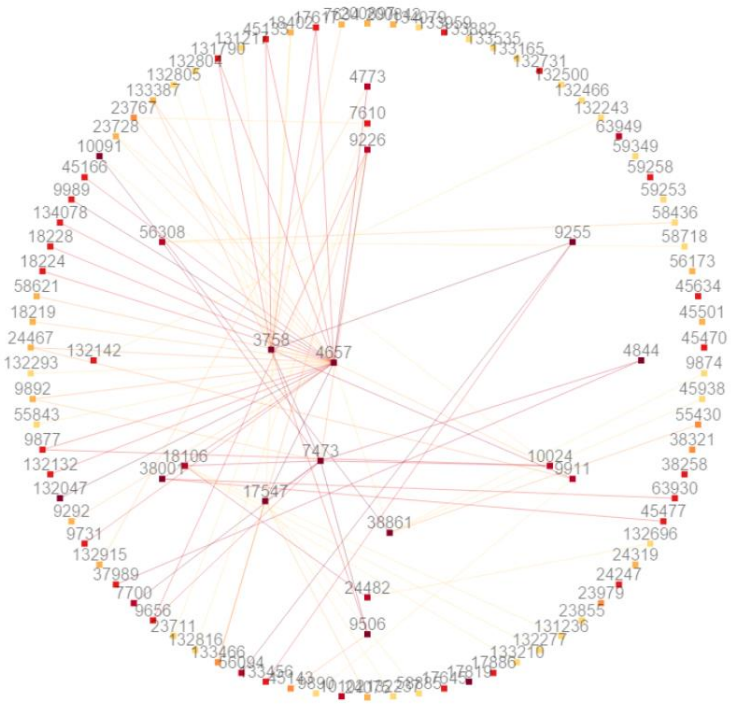
5.5 million population



IPv4

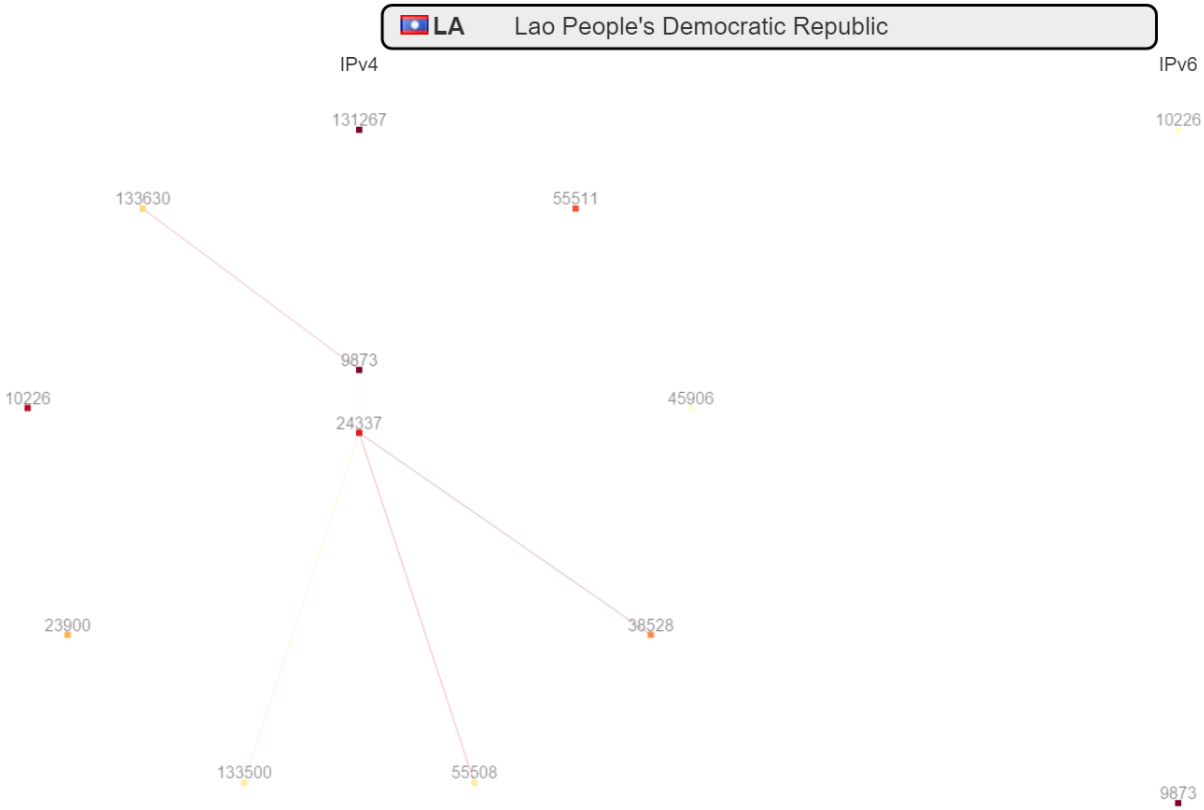


IPv6



Laos

6.7 million population

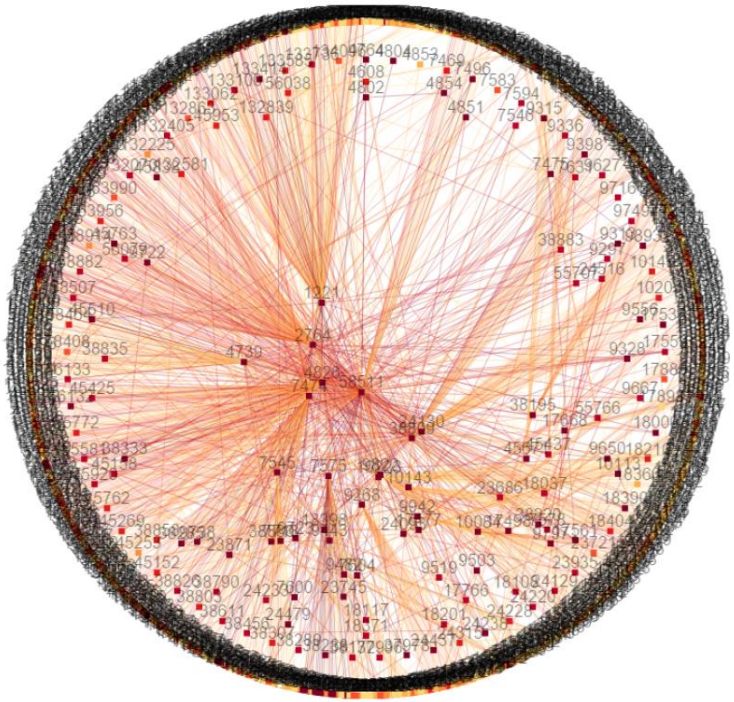


Australia

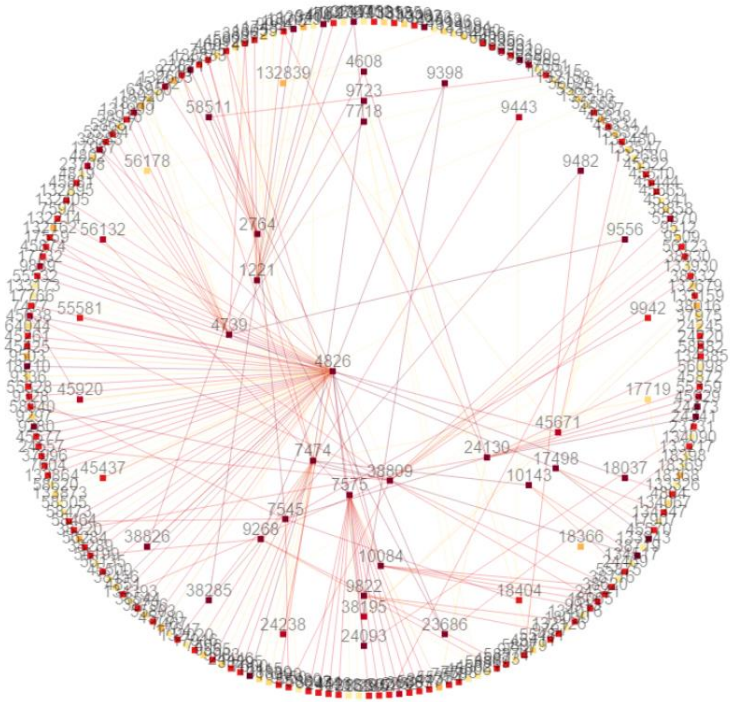
23.5 million population

AU Australia

IPv4

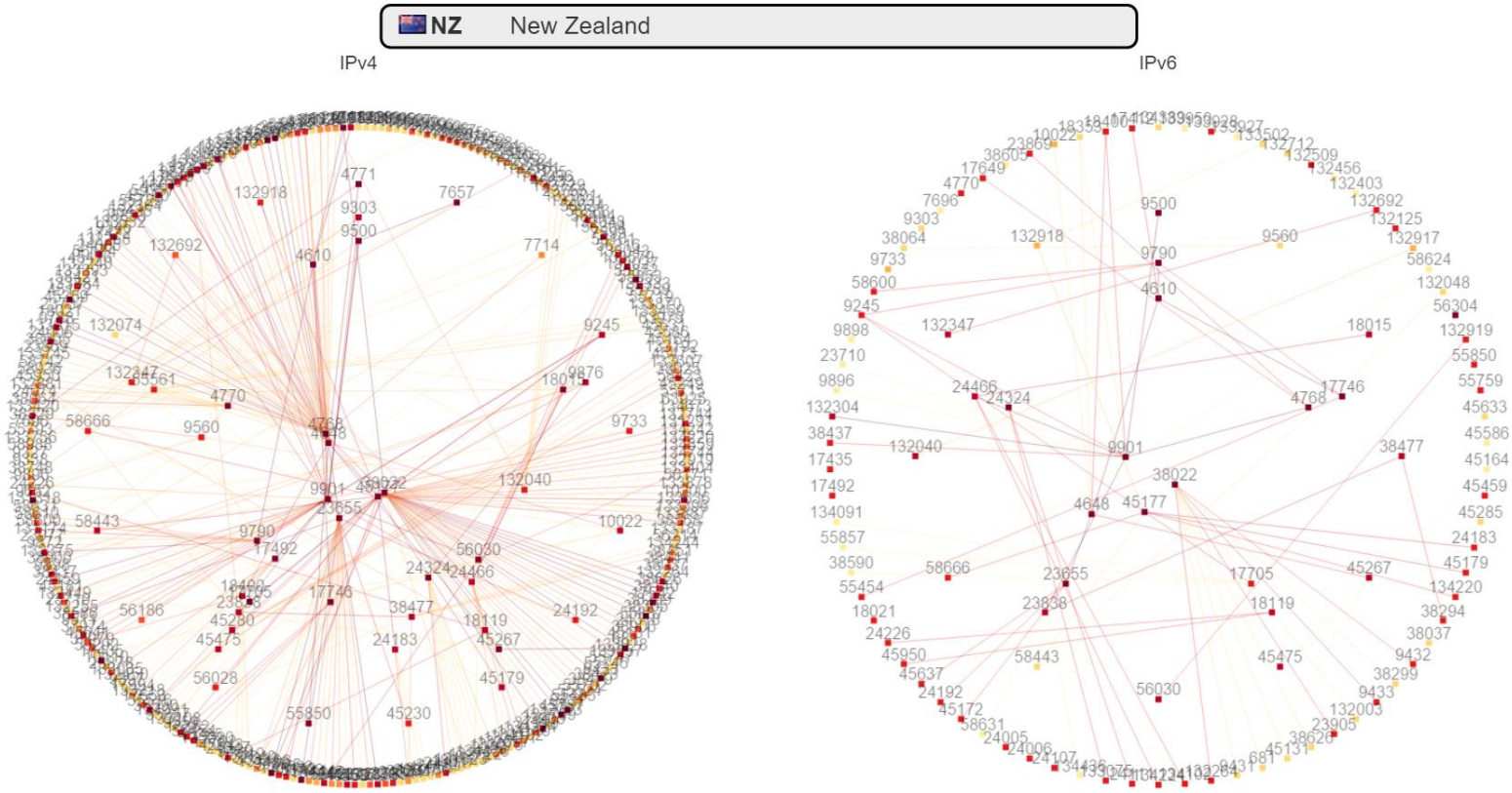


IPv6



New Zealand

4.5 million population

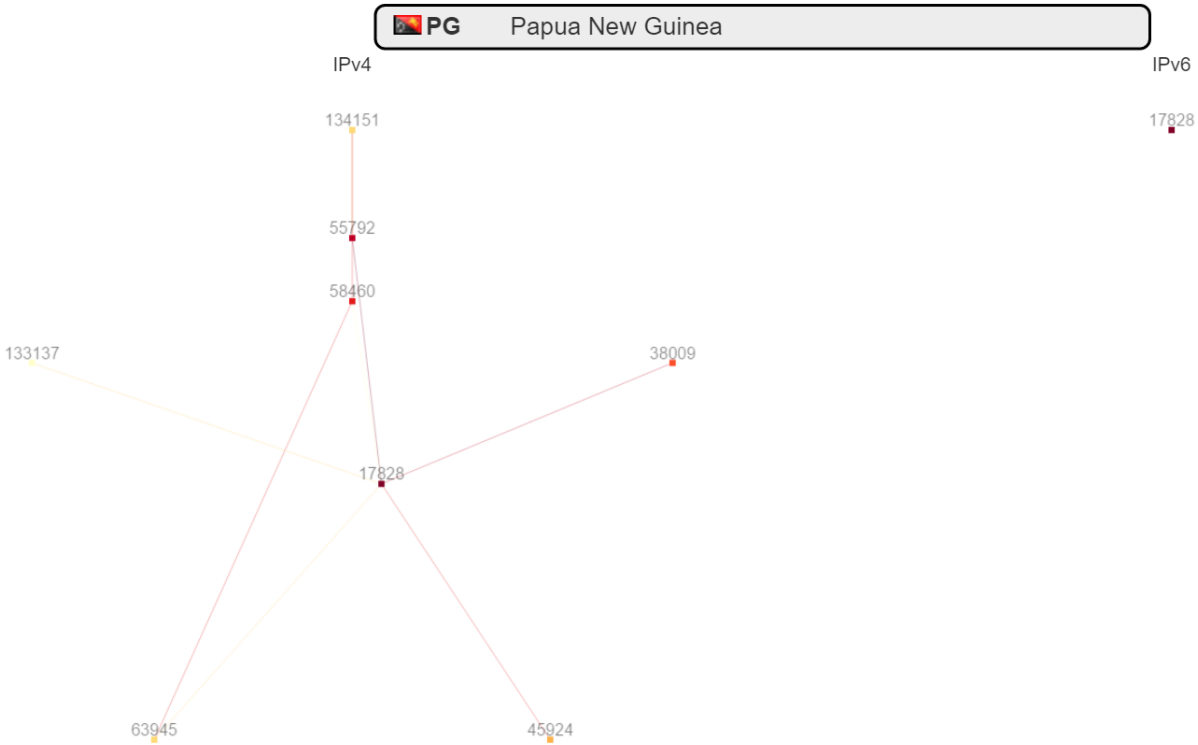


Fiji

0.87 million population

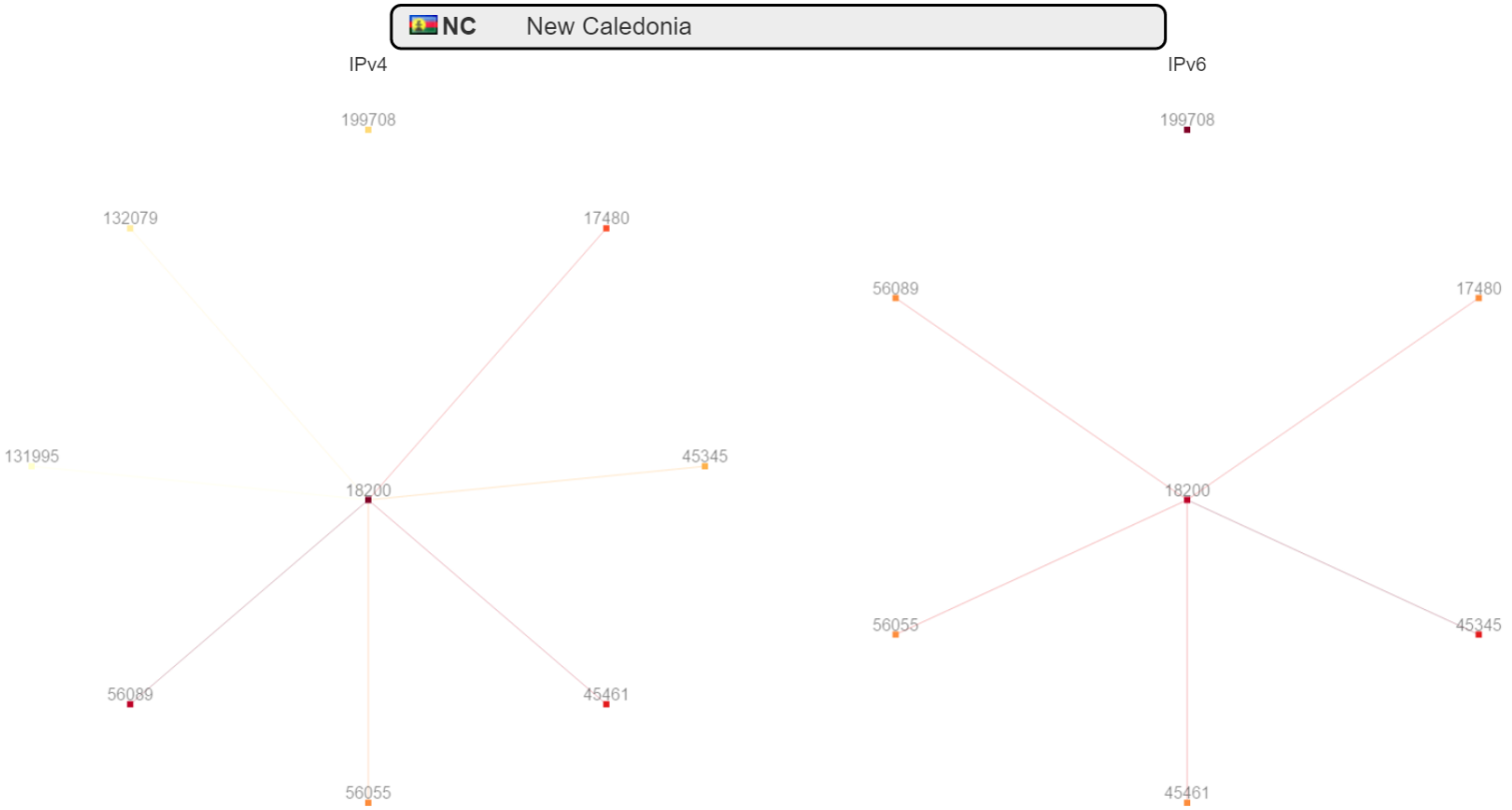
Papua New Guinea

7.5 million population



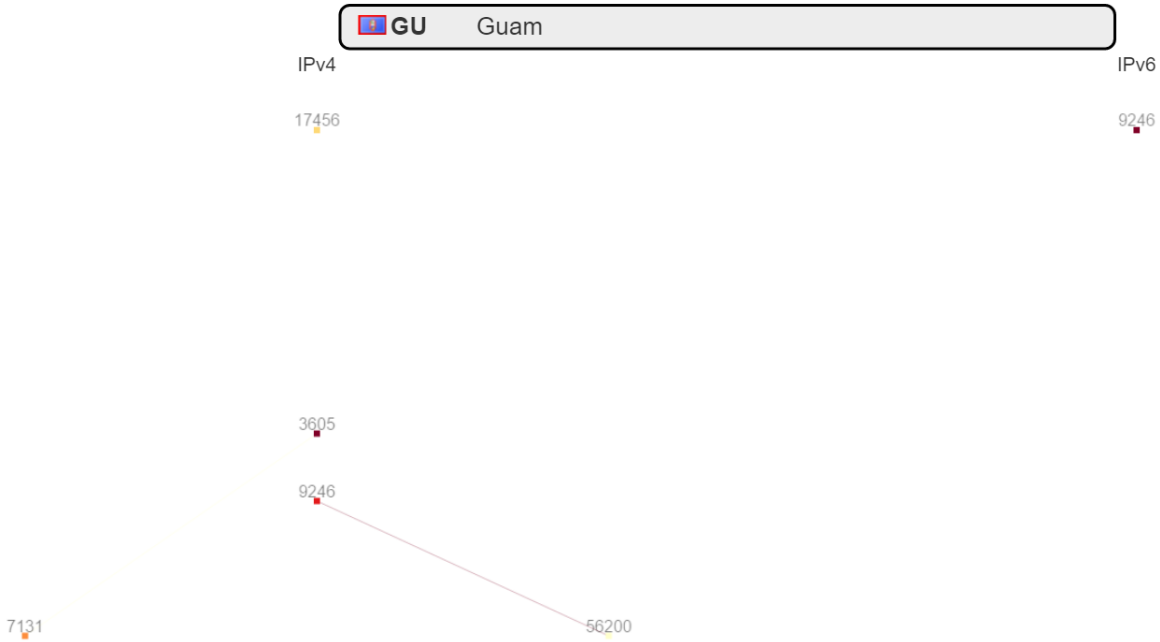
New Caledonia

0.27 million population



Guam

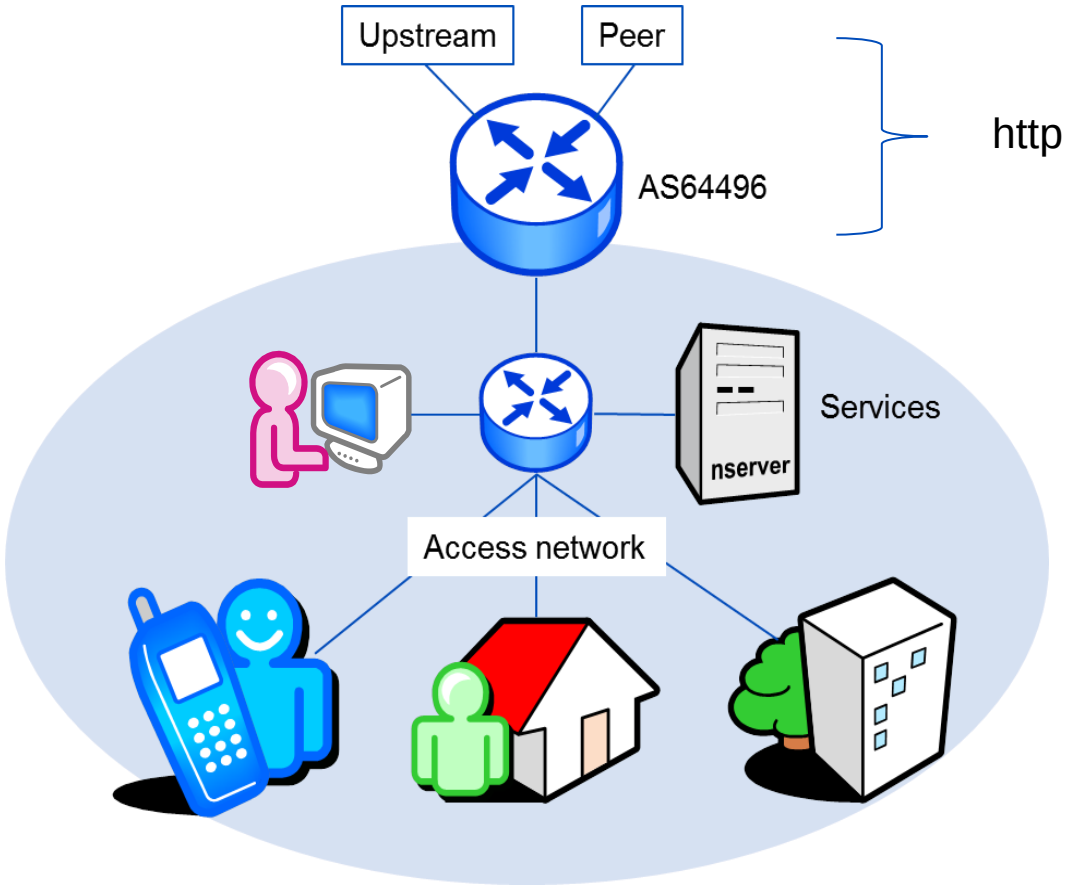
0.17 million population



Measuring end-user IPv6 capabilities and preferences

APNIC

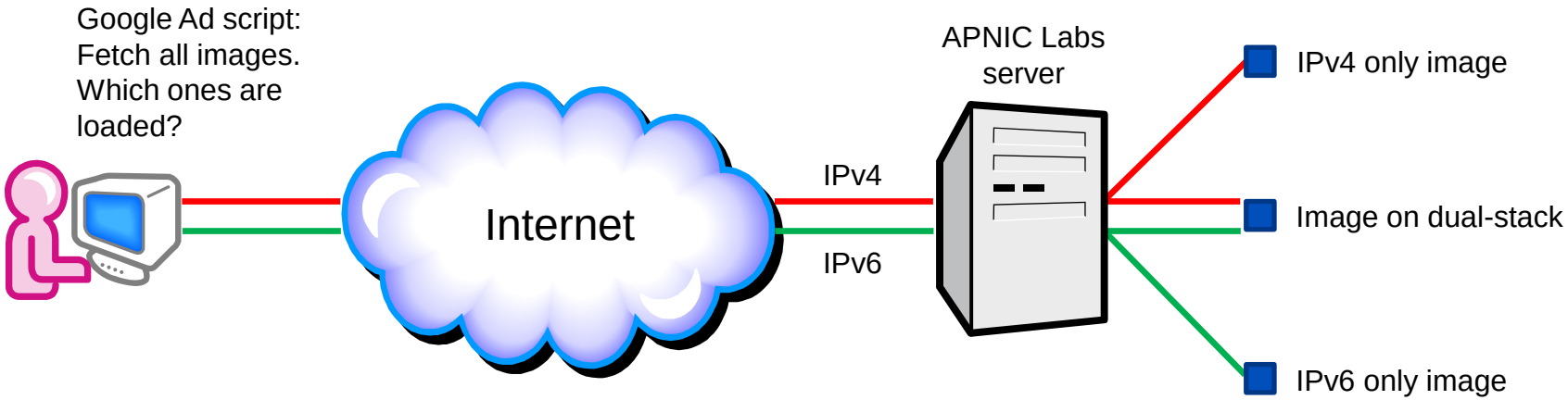
Visualisation and measurement tools



http://labs.apnic.net/vizAS

http://stats.labs.apnic.net/ipv6

Measurement method

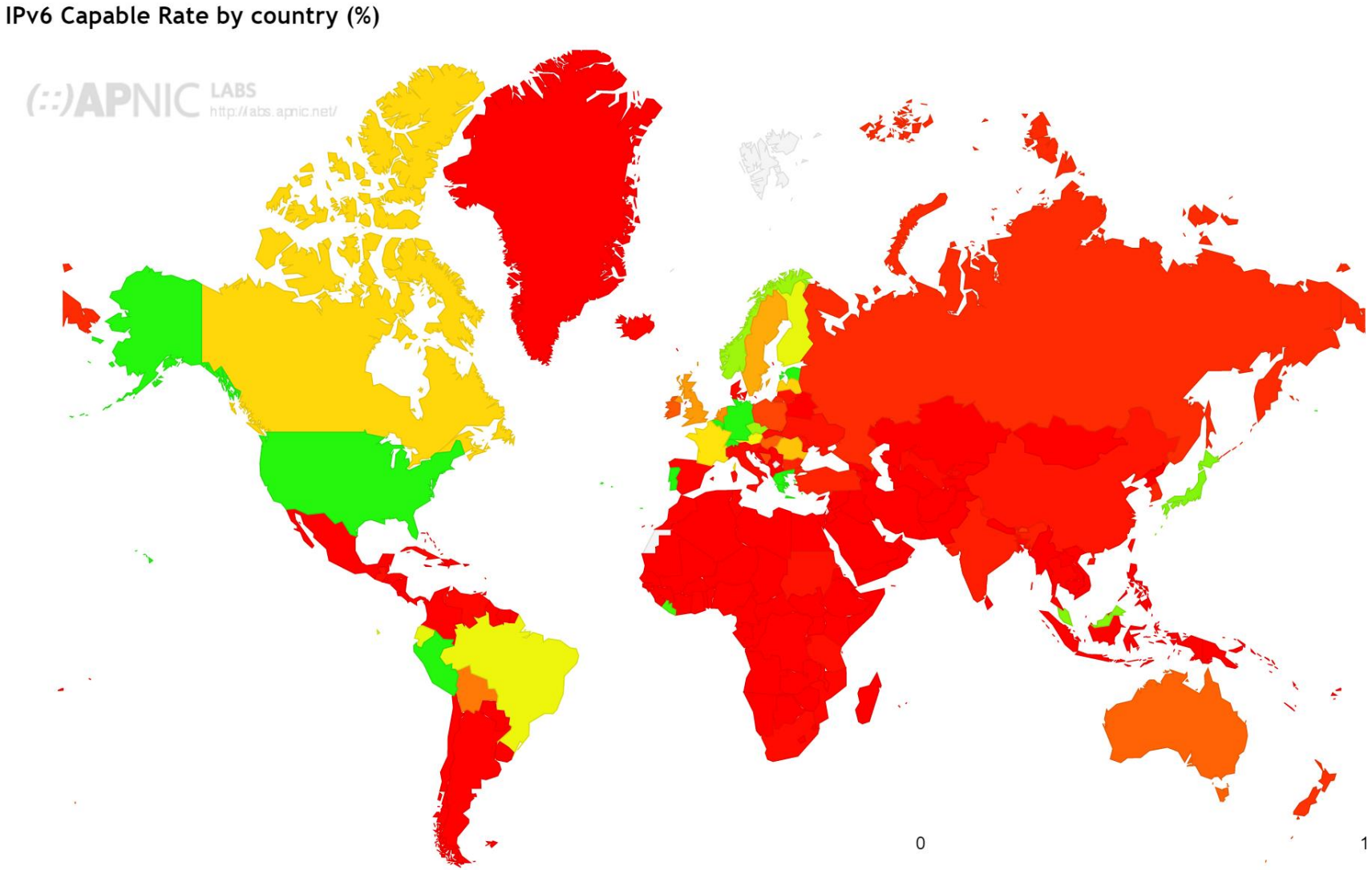


Measurement method

The measurement test itself attempts to load five images. The first is an image that is only accessible using IPv4. The second is an image that is accessible over IPv4 or IPv6. The third is an image only accessible using IPv6. The fourth is also an IPv6 image, but in this case the URL does not rely on the Domain Name System to access the image (with certain operating systems and browsers this test generates a different response from the browser). The final image is a "result" load, which is delayed by 10 seconds. This image contains the timer measurements that the browser contains to report back which for the first four images were loaded, and the amount of time takes to load each one.

Image fetch result	IPv4 only	IPv6 preferred	IPv6 capable
IPv4 only image loaded	✓		
Image on dual stack loaded over IPv6		✓	
IPv6 only image loaded			✓

Measurement as of 29 Nov 2015



IPv6 capable sub-region ranking

Code	SubRegion	IPv6 Capable	IPv6 Preferred	Samples
XQ	Northern America, Americas	24.70%	22.21%	59948348
QO	Western Europe, Europe	18.50%	17.19%	31112239
XP	South America, Americas	4.95%	4.61%	45407198
QM	Northern Europe, Europe	4.71%	4.17%	17545674
QP	Australia and New Zealand, Oceania	3.52%	2.77%	4736347
XS	Eastern Asia, Asia	2.81%	2.55%	165283684
QN	Southern Europe, Europe	2.71%	2.58%	18673919
XW	Eastern Europe, Europe	2.09%	1.75%	32728475
XU	South-Eastern Asia, Asia	1.24%	1.08%	40949754
XT	Southern Asia, Asia	0.53%	0.47%	90490627
XV	Western Asia, Asia	0.30%	0.02%	22808504
XK	Southern Africa, Africa	0.26%	0.25%	5310468
XH	Eastern Africa, Africa	0.06%	0.04%	15866206
XN	Caribbean, Americas	0.04%	0.01%	3223912
XJ	Northern Africa, Africa	0.04%	0.03%	17920008
XO	Central America, Americas	0.03%	0.03%	14573116
XL	Western Africa, Africa	0.03%	0.01%	16695468
QQ	Melanesia, Oceania	0.03%	0.01%	205391
XI	Middle Africa, Africa	0.01%	0.00%	2195435
XR	Central Asia, Asia	0.01%	0.00%	5100641
QR	Micronesia, Oceania	0.01%	0.00%	34022
QS	Polynesia, Oceania	0.01%	0.01%	46308

Top-15 IPv6 capable countries/economies

CC	Country	IPv6 Capable	IPv6 Preferred	Samples
BE	Belgium, Western Europe, Europe	47.58%	45.49%	2466172
US	United States of America, Northern America, Americas	28.11%	25.51%	33927269
CH	Switzerland, Western Europe, Europe	27.82%	26.27%	1326048
DE	Germany, Western Europe, Europe	27.54%	25.58%	2192498
PT	Portugal, Southern Europe, Europe	20.14%	19.19%	3846114
GR	Greece, Southern Europe, Europe	18.57%	18.08%	6988798
LU	Luxembourg, Western Europe, Europe	18.53%	16.47%	282909
EE	Estonia, Northern Europe, Europe	17.96%	17.56%	853679
PE	Peru, South America, Americas	16.87%	16.09%	5970512
JP	Japan, Eastern Asia, Asia	16.10%	15.00%	3163674
CZ	Czech Republic, Eastern Europe, Europe	11.66%	11.16%	1251304
NO	Norway, Northern Europe, Europe	10.48%	9.59%	942975
MY	Malaysia, South-Eastern Asia, Asia	10.39%	9.50%	10194173
RO	Romania, Eastern Europe, Europe	9.54%	7.14%	7382829
SG	Singapore, South-Eastern Asia, Asia	9.30%	6.73%	2599713

Top-10 IPv6 capable economies in Oceania

CC	Country	IPv6 Capable	IPv6 Preferred	Samples
AU	Australia, Australia and New Zealand, Oceania	3.56%	2.81%	1582524
NZ	New Zealand, Australia and New Zealand, Oceania	1.20%	1.06%	949935
MP	Northern Mariana Islands, Micronesia, Oceania	0.44%	0.00%	55615
TO	Tonga, Polynesia, Oceania	0.06%	0.05%	8524
SB	Solomon Islands, Melanesia, Oceania	0.04%	0.00%	5538
GU	Guam, Micronesia, Oceania	0.03%	0.00%	373259
PG	Papua New Guinea, Melanesia, Oceania	0.02%	0.00%	32448
FJ	Fiji, Melanesia, Oceania	0.01%	0.00%	213960
NC	New Caledonia, Melanesia, Oceania	0.01%	0.00%	163119
AS	American Samoa, Polynesia, Oceania	0.01%	0.01%	21344

Top-15 IPv6 capable AS in Australia

ASN		IPv6 Capable ▼	IPv6 Preferred	Samples
AS38544	CRUCIALX-AS-AP Crucial Paradigm Pty Ltd	95.45%	95.45%	88
AS6262	CSIRO Commonwealth Scientific and Industrial	94.87%	92.31%	117
AS56132	MONASHUNI-AU-AS-AP Monash University	86.35%	84.94%	5317
AS7477	TEREDONN-AS-AP SkyMesh Pty Ltd	26.93%	25.76%	1114
AS55354	ACEINT-AS-AP Ace Internet Services Pty Ltd	17.81%	9.59%	73
AS45920	SKYMESH-AS-AP SkyMesh Pty Ltd	11.60%	11.60%	405
AS9297	COLOCITY-AS-AP Colocity Pty Ltd	11.24%	0.00%	7198
AS1221	ASN-TELSTRA Telstra Pty Ltd	7.76%	5.84%	534740
AS133414	FOXTEL-AS-AP Foxtel Management Pty Ltd	6.61%	5.97%	5733
AS38883	FIRENET-AS-AP FireNet Pty Ltd	4.60%	4.60%	87
AS4739	INTERNODE-AS Internode Pty Ltd	2.31%	2.07%	149235
AS38220	SIS-GROUP-SYD-AS-AP SIS Group Datacentre Sydney	2.00%	0.00%	50
AS7575	AARNET-AS-AP Australian Academic and Reasearch Network (AARNet)	1.63%	1.50%	12705
AS9503	FX-PRIMARY-AS FX Networks Limited	0.44%	0.44%	4116

Top-15 IPv6 capable AS in New Zealand

ASN		IPv6 Capable	IPv6 Preferred	Samples
AS45164	ALLIED-TELESYS-NZ-AS-AP Allied Telesis ASN	78.05%	78.05%	82
AS23655	SNAP-NZ-AS Snap Internet Limited	33.65%	30.01%	18691
AS23905	VUW-AS-AP Victoria University of Wellington	16.98%	14.62%	1943
AS55561	TWO-TALK 2talk Global IP Network	16.72%	16.72%	1268
AS9433	MASSEY-AS Massey University	13.64%	0.00%	770
AS45637	UNIFONENETWORKS-AS-AP UniFone New Zealand Ltd	9.79%	7.12%	562
AS17649	DMZGLOBAL-AP DMZGlobal Ltd	8.16%	0.00%	147
AS681	ERX-KAWAIHIKO-1 The University of Waikato	7.55%	7.41%	715
AS17746	ORCONINTERNET-NZ-AP Orcon Internet	6.97%	6.46%	55102
AS132040	CITYLINK-CT-AP Citylink Ltd	4.02%	4.02%	224
AS55454	ORCONNET Orcon Internet Ltd	3.76%	3.23%	186
AS24006	KNOSSOS-AS-NZ Knossos Networks Limited	2.94%	2.94%	102
AS58443	RACK-CENTRAL-AS-AP RackCentral	1.89%	1.89%	53
AS9431	AKUNI-NZ The University of Auckland	1.72%	1.70%	4129
AS58666	NASL-AS-AP Vorco	1.69%	0.42%	236

Top-20 IPv6 capable AS in USA

ASN		IPv6 Capable	IPv6 Preferred	Samples
AS29697	CNS - Commercial Network Services	100.00%	98.41%	63
AS32934	FACEBOOK - Facebook, Inc.	99.94%	99.76%	84961
AS8123	POLYBASE - Polybase	99.73%	98.91%	366
AS27357	RACKSPACE - Rackspace Hosting	99.01%	96.21%	16623
AS4250	ALENT-ASN-1 - Alentus Corporation	98.42%	98.41%	7987
AS62753	SCA-SD - Sony Corporation of America	98.08%	0.00%	52
AS7888	CSI-CORP - Component Software International, Inc.	97.00%	96.77%	867
AS11925	DDWI - Delta Dental of Wisconsin, Inc	95.88%	90.00%	170
AS33070	RMH-14 - Rackspace Hosting	95.60%	93.97%	9198
AS26462	AS-GENESEO - SUNY Geneseo Computer Center	94.61%	85.53%	1113
AS25926	HOSTUS-SOLUTIONS-LLC - HostUS	94.57%	94.14%	5799
AS36384	GOOGLE-IT - Google Incorporated	93.37%	87.78%	2291
AS30013	PIXAR-AS - Pixar	92.94%	77.65%	85
AS17234	GAC - Gustavus Adolphus College	91.77%	82.04%	401
AS13443	LINKEDIN - LinkedIn Corporation	90.91%	89.45%	275
AS4436	AS-GTT-4436 - nLayer Communications, Inc.	90.21%	90.15%	12449
AS22394	CELLCO - Cellco Partnership DBA Verizon Wireless	89.81%	80.84%	1352164
AS393475	AS-CMWR-02 - Compuware Corporation	89.66%	89.66%	58
AS91	RPI-AS - Rensselaer Polytechnic Institute	88.36%	86.51%	1520
AS13953	SVCC-EDU - Sauk Valley Community College	88.24%	88.24%	51

Conclusion

- The AS transit map shows that in most countries/economies, there are networks capable of managing IPv6 traffic
- The end-user IPv6 capability measurement shows that some networks are actually able of sending IPv6 traffic all the way to the end-user devices
- While the AS transit map indicates that most Telcos/ISPs are able to provide IPv6 transit, the end-user IPv6 capability measurement shows that deploying IPv6 on the ‘last mile’ is still a challenge, but it can be done (e.g. Verizon wireless, Google Fibre etc.)

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