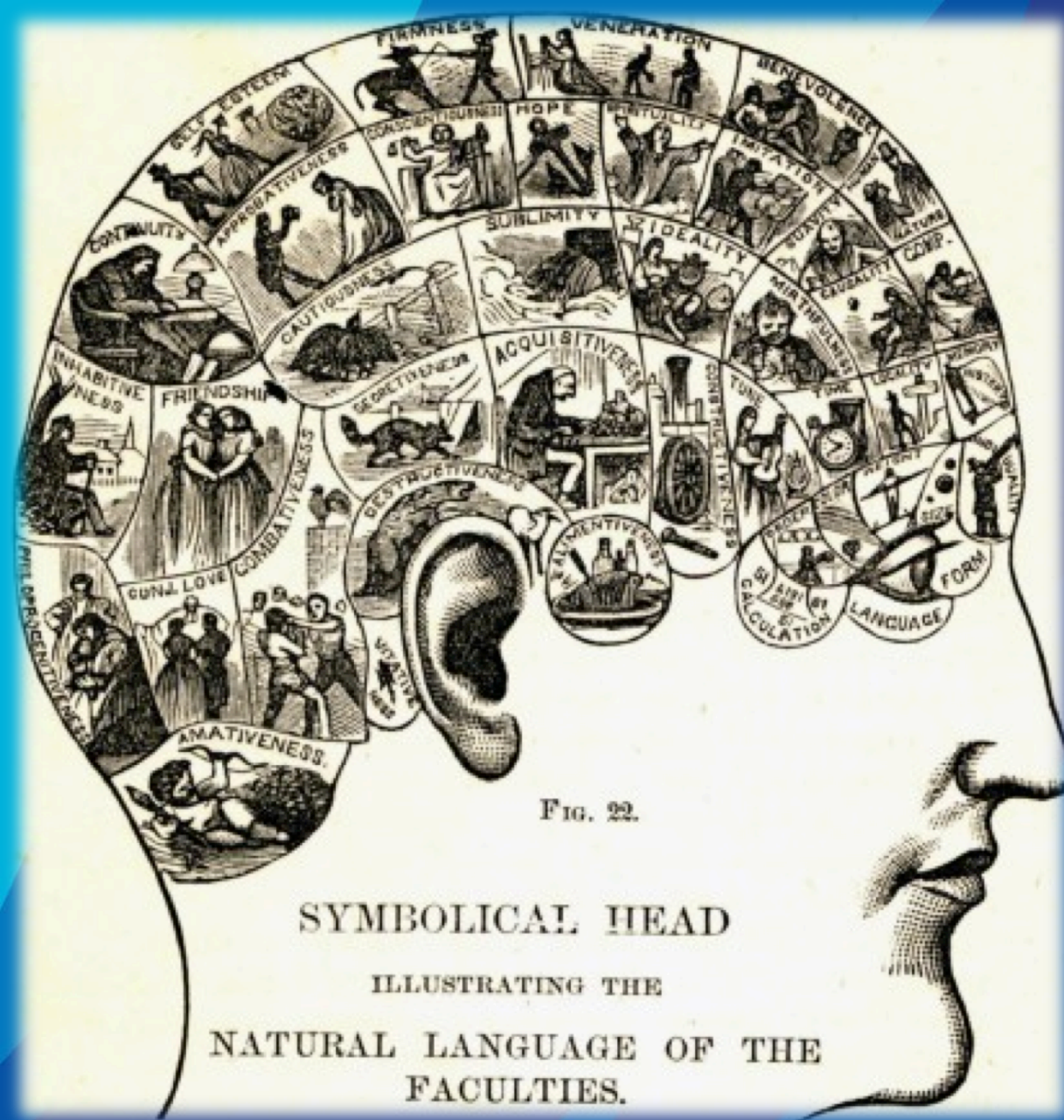# Measuring IPv6 Users

George Michaelson,
Geoff Huston
APNIC

APNIC

How to measure the end user

How to measure the end user

How to measure a million end users

How to measure a million end users

- be www.google.net

How to measure a million end users

- be   www.google.net

or

How to measure a million end users

- be   www.google.net

or

- Get your code run on millions of machines

Approaches to Measurement

A case study: APNIC's approach

- we wanted to measure IPv6 deployment as seen by end users

- We wanted to say something about ALL users

- Our website isn't that popular

- …So we were looking at a way to sample end users in a random but statistically significant fashion

- We stumbled across the advertising networks...

…buy the measurement

Placement

At low CPM, the advertising network needs to present unique, new eyeballs to harvest impressions and take your money.
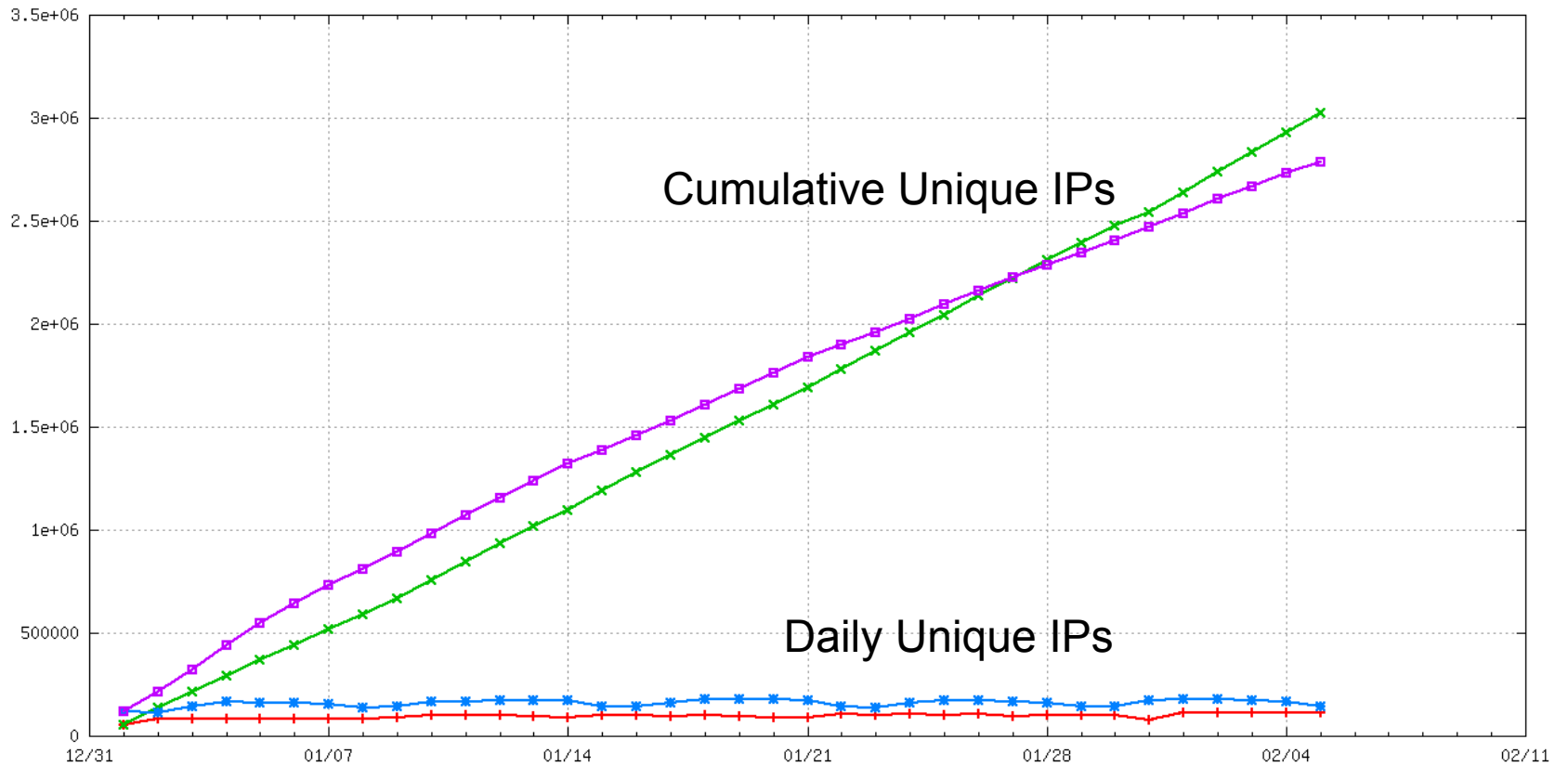
- Therefore, a 'good' advertising network provides a fresh crop of unique clients per day
- Pay for placement of ads, embed the measurement in flashcode.
- Result is lots of Unique IP addresses to measure.

Unique IPS?

- Collect list of unique IP addresses seen
  - Per day
  - Since inception

- Plot to see behaviours of system
  - Do we see 'same eyeballs' all the time?

Lots of Unique IP'S

What are we finding?

- http://labs.apnic.net/ipv6_measurement
  - Breakdowns by ASN, Economy, Region, Organisation

- 125+ economies provide >200 samples/ interval consistently in weeklies

- 150+ at monthlies.

- 2400 ASN provide graphable data

- Over 35,000 ASN seen during the last year.

Google visualization API

AU
flash IPv6 preferred: **0.363226**

0   0.6

APNIC

Google visualization API

CN
flash IPv6 preferred: **0.624441**

0   1
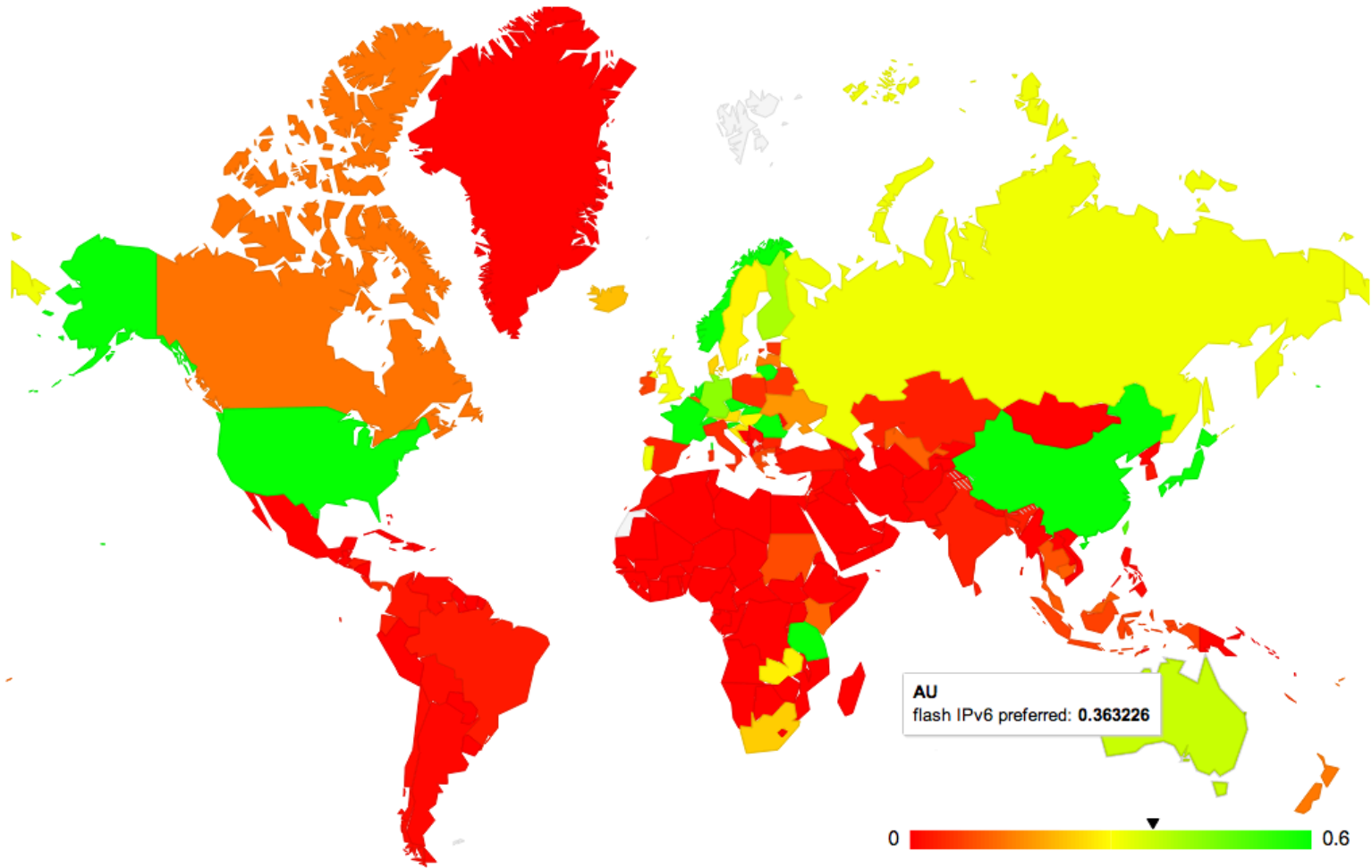
Google visualization API

Google visualization API

Draw your own graphs

http://labs.apnic.net/ipv6-measurement/datafields.html

[
  [
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    "030 Eastern Asia",
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    528930.0,
    3984.0,
    34934.0,
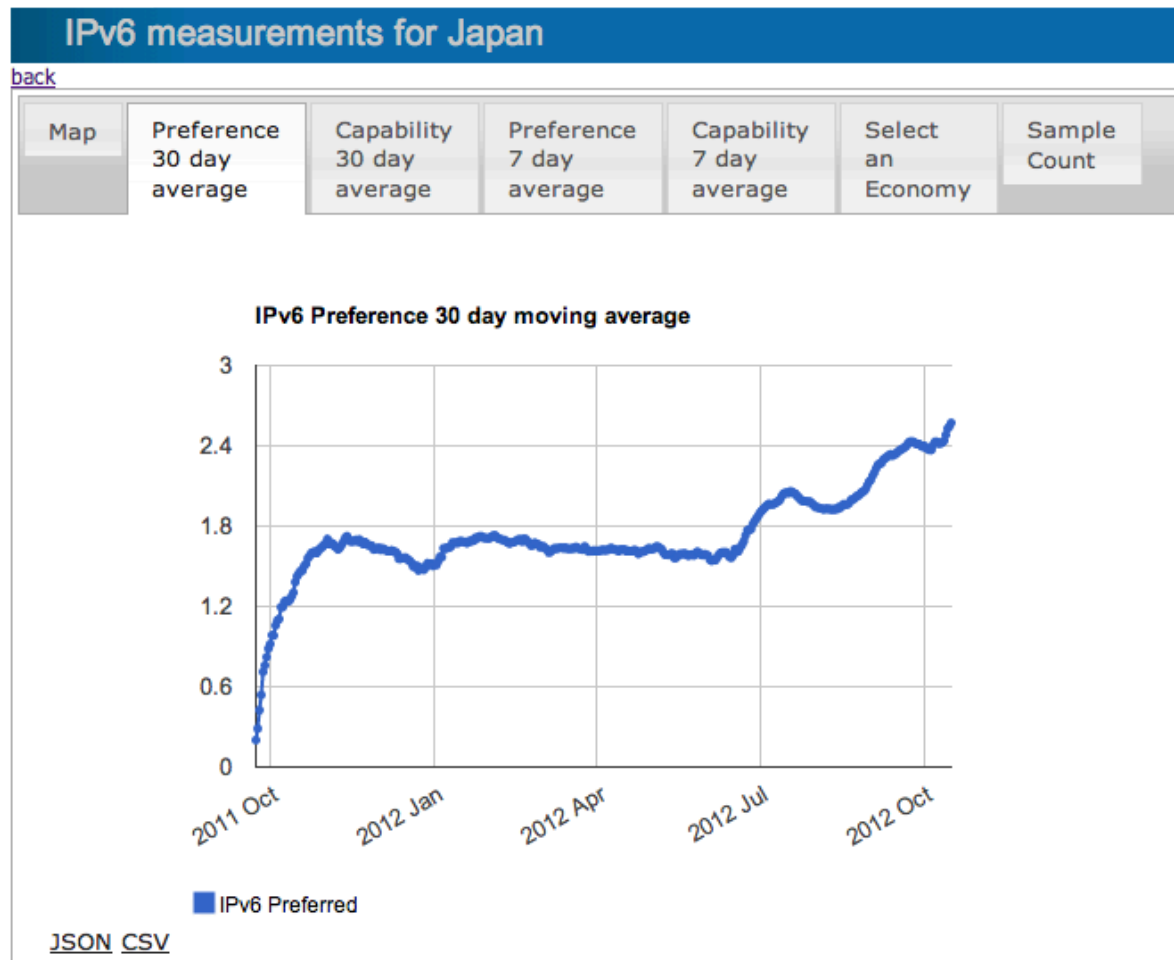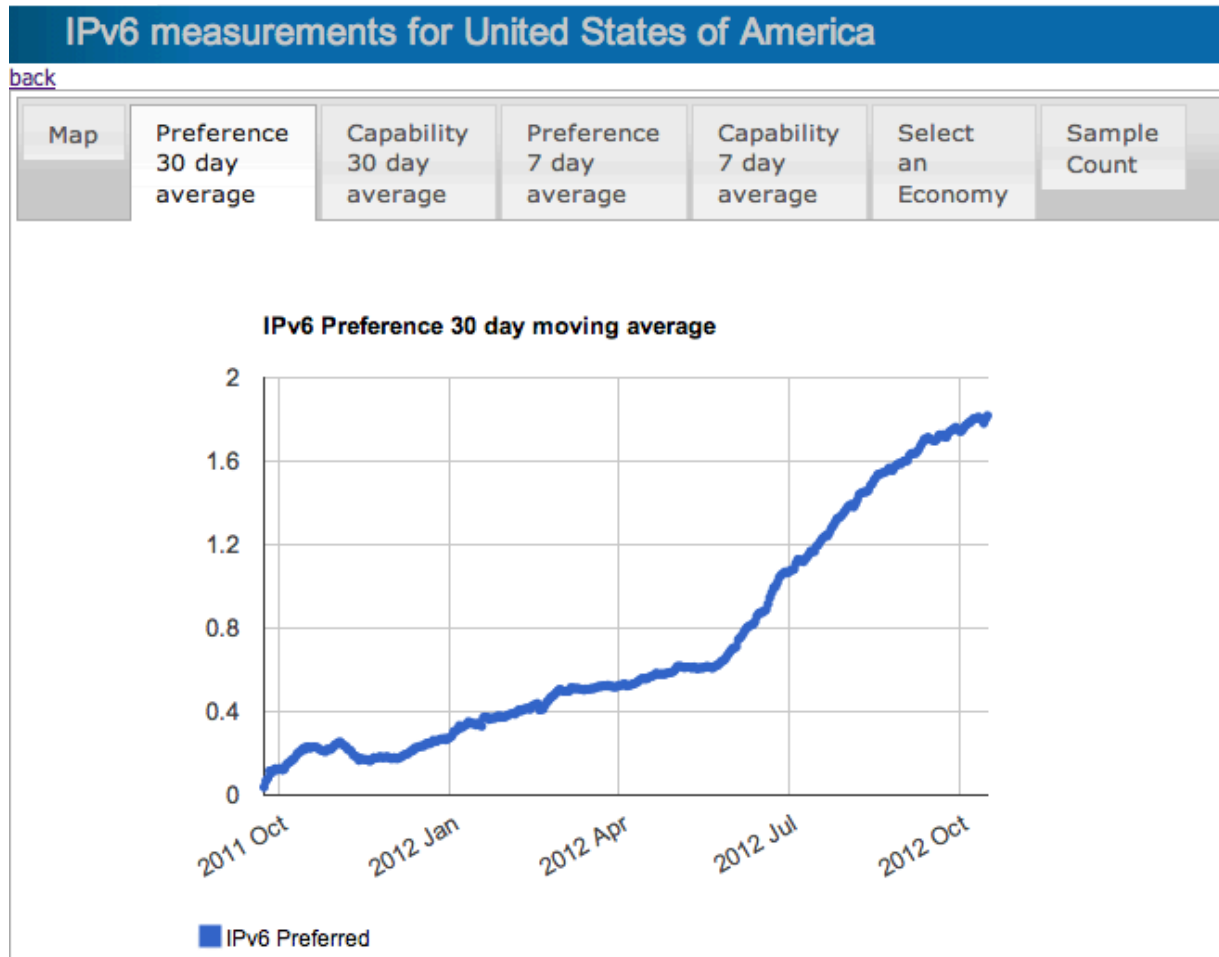   1831.0,
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2010:05,030 Eastern
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2010:08,030 Eastern
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,3541.0,964.0,0.0,3.95485875,3.95485875,1.04451175,0.0
2010:09,030 Eastern
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2010:11,030 Eastern
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2010:12,030 Eastern

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IPv6 Users by Country

Date: 17 Oct 2012

http://labs.apnic.net/dists/v6dcc.html

Index	ISO-3166 Code	Internet Users	V6 Use ratio	V6 Users (Est)	Population	Country
1	RO	8663123	10.66%	923488	22099806	Romania
2	FR	50054365	4.72%	2362566	64837261	France
3	LU	466861	3.84%	17927	510789	Luxembourg
4	JP	100884578	2.76%	2784414	126105723	Japan
5	US	248322022	1.75%	4345635	317141791	United States of America
6	CZ	7214743	1.32%	95234	10175943	Czech Republic
7	CH	6451356	1.27%	81932	7661944	Switzerland
8	NO	4579806	1.02%	46714	4711735	Norway
9	SI	1417654	0.98%	13893	1996697	Slovenia
10	NL	15155363	0.79%	119727	16933367	Netherlands
11	CN	516520397	0.68%	3512338	1345105202	China
12	SK	4345413	0.68%	29548	5486633	Slovakia
13	LT	2095904	0.66%	13832	3522528	Lithuania
14	TZ	5042218	0.61%	30757	43845379	United Republic of Tanzania
15	TW	16195177	0.54%	87453	23135968	Taiwan
16	FI	4664541	0.53%	24722	5264720	Finland
17	AU	19840149	0.49%	97216	22093708	Australia
18	DE	67954292	0.43%	292203	82169640	Germany
19	IS	306969	0.37%	1135	313875	Iceland
20	GB	51871849	0.36%	186738	61678775	United Kingdom of Great Britain and Northern Ireland
21	PT	5473024	0.34%	18608	10794921	Portugal
22	AT	6149834	0.32%	19679	8221704	Austria
23	SE	8460763	0.32%	27074	9107388	Sweden
24	RU	61083537	0.31%	189358	137886089	Russian Federation
25	HU	6413166	0.29%	18598	9821082	Hungary

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7	CH	6451356	1.27%	81932	7661944	Switzerland
8	NO	4579806	1.02%	46714	4711735	Norway
31	CA	28053925	0.14%	39275	34379811	Canada
44	ID	55799398	0.07%	39059	249104458	Indonesia
60	IN	123448145	0.03%	37034	1210275937	India
14	TZ	5042218	0.61%	30757	43845379	United Republic of Tanzania
12	SK	4345413	0.68%	29548	5486633	Slovakia
23	SE	8460763	0.32%	27074	9107388	Sweden
61	BR	87145258	0.03%	26143	206505351	Brazil
16	FI	4664541	0.53%	24722	5264720	Finland
29	UA	15176734	0.16%	24282	44769127	Ukraine
49	IT	34036599	0.06%	20421	57983985	Italy
22	AT	6149834	0.32%	19679	8221704	Austria
21	PT	5473024	0.34%	18608	10794921	Portugal
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IPv6 measurement

- Penetration rate of IPv6 into the global AS economy is slowly rising.

- Signs Global-Unicast IPv6 will shortly overtake Teredo

- Widely distributed hop-over for IPv6 being seen.
  - due to the CPE gap ?
  - Even IPv6 enabled ISPs have customers tunnelling over the air-gap

- Much more information about IPv6, global internet behaviour is in the data

What about Australia?

What about Australia?

- Can we "drill down" inside an individual economy?
  - Get the "per AS" view of the IPv6 capability?

What about Australia?

- Can we "drill down" inside an individual economy?
  - Get the "per AS" view of the IPv6 capability

- You bet we can!
  - 600,000 measurements being run against Australian Internet Users in the last 30 days

Australia by ASN

Number of ASN in Australia	Number of Australian ASN seen in globally routable BGP
1402	897

Australia by ASN

Number of ASN in Australia	Number of Australian ASN seen in globally routable BGP
1402	897

Over half the ASN allocated to Australian entities (63%) are visible in the global BGP view.

Australia by ASN

Number of Australian ASN seen in globally routable BGP	Number of Australian ASN seen in this experiment
897	744

Australia by ASN

Number of Australian ASN seen in globally routable BGP	Number of Australian ASN seen in this experiment
897	744

82% of BGP active ASN in Australia have been seen in the experiment.

Australia by ASN

Number of Australian ASN seen in this experiment	Number of Australian ASN with globally routable IPv6 in BGP
744	174

23% of BGP active ASN seen in Australia have at least one globally routable IPv6 prefix

Australia by ASN

Number of Australian ASN seen in this experiment	Number of Australian ASN with globally routable IPv6 in BGP
744	174

23% of BGP active ASN seen in Australia have at least one globally routable IPv6 prefix

..but this is only 20% of all BGP active ASN in Australia

Australia by ASN

Number of Australian ASN with globally routable IPv6 in BGP	Number of Australian ASN seen with globally routable IPv6
174	28

Australia by ASN

Number of Australian ASN with globally routable IPv6 in BGP	Number of Australian ASN seen with globally routable IPv6
174	28

Only 16% of IPv6 BGP active Australian ASN seen, appear <u>end-user</u> active in IPv6, using global-unicast.

The Australian Leaderboard

AS	AS-Name	Description from aut-num	sample count	% IPv6 preference	% IPv6 coercible
38083	CURTIN-UNI-AS-AP	Curtin University	1,136	81.60	82.22
4608	APNIC-AP	Asia Pacific Network Information Centre	635	63.46	82.99
24130	PIPETRANSIT-AS-AP	PIPE Networks Pty Limited	421	59.14	58.91
7575	AARNET-AS-AP	Australian Academic and Reasearch Network (AARNet)	8,319	18.10	30.39
4739	INTERNODE-AS	Internode Pty Ltd	51,889	8.08	25.34
56132	MONASHUNI-AU-AS-AP	Monash University;	1,585	7.38	9.46
18371	NCABLE-AP	Neighbourhood Cable	707	6.36	23.06
24437	UWA-AS-AP	University of Western Australia	924	6.28	22.94
38280	MONASHUNI-MY-AS-AP	Monash University Sunway Campus Malaysia	5,122	1.62	5.17
10148	UNIMELB-AS-AP	The University of Melbourne; Melbourne; Victoria	932	1.39	33.58
18201	SERVICECORP-AS-AP	ServiceCorp Pty Ltd	352	0.85	35.51
7477	TEREDONN-AS-AP	SkyMesh Pty Ltd	524	0.76	22.33
24434	JCU-AS-AP	James Cook University	529	0.57	48.02
7474	OPTUSCOM-AS01-AU	SingTel Optus Pty Ltd	1,672	0.48	7.06
4802	ASN-IINET	iiNet Limited	77,111	0.46	15.61
9942	COMINDICO-AP	SOUL Converged Communications Australia	492	0.20	7.72
7543	PI-AU	Pacific Internet (Australia) Pty Ltd	1,972	0.20	5.68
7718	TransACT-SDN-AS	TransACT Capital Communications Pty Limited	3,020	0.20	23.01
18111	NETSPEED-AS-AP	Netspeed Internet Communications	687	0.15	14.12
9822	AMNET-AU-AP	Amnet IT Services Pty Ltd	2,689	0.11	13.09
23859	UNSW-AS-AP	University of New South Wales	2,140	0.09	3.93
9443	INTERNETPRIMUS-AS-AP	Primus Telecommunications	10,846	0.08	14.31
9543	WESTNET-AS-AP	Westnet Internet Services	1,306	0.08	12.94
4853	Commander-AS-AP	Commander Communications	1,834	0.05	44.17
4804	MPX-AS	Microplex PTY LTD	98,396	0.04	20.56
38484	VIRGIN-BROADBAND-AS-AP	Virgin Broadband VISP	4,716	0.02	42.32
7545	TPG-INTERNET-AP	TPG Internet Pty Ltd	55,319	0.02	19.96
1221	ASN-TELSTRA	Telstra Pty Ltd	228,111	0.02	19.66
		Australia as a whole	**676,767**	**1.20**	**20.15**

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What about that potential market?

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2443					48.02
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480					15.61
994					7.72
754					5.68
771					23.01
1811					14.12
982					13.09
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20% national figure of end-users who can do IPv6 right now, if you deliver it to them.

At least 1/5 of the current market is ready right now…

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Error bars

- We can't directly measure iOS in the google flash mechanism (because flash isn't being run on iOS devices)

- We can't directly measure anyone with adblock enabled in the flash measurement (because .. Its an _advert_!)

- We can't directly measure end users who have ACLs blocking youtube (the predominant ad placement website) in the flash measurement.
  - These are 'low side' effects: we undercount in flash

- The javascript measurement is prone to distortions from repeat visits. We try to account for this.
  - This is a 'high side' effect: we can over count in javascript

Observations

- Some Research/Academic networks have good levels of IPv6 capability.
    - Curtain University appears to have deployed an IPv6 enabled SOE
    - Others appear less active (many Universities fold into AARNet)

- Transit networks, providers clearly have IPv6 capability in their core. (PIPE, the 174 IPv6 active ASN in BGP)

- End user deployment was always going to be hard
        CPE upgrade costs, customer-provisioning costs

- Other economies appear to be facing similar problems
    - But some ISPs are also biting the bullet.
    - Free/Internode/RCS/Comcast

Conclusions

- We have a long way to go

- APNIC believes it can reliably measure end-user IPv6 capability independently of the ISP, both within an economy, and inter-economy

- We're committed to a long-term measurement and will continue to present data, results

- http://labs.apnic.net/ipv6-measurement

IPv6 measurement

If you see the advert

APNIC

IPv6 measurement

If you see the advert

PLEASE DON'T CLICK ON IT

(it costs us more)

A word for our sponsors

- Thanks to
  - the Internet Society
  - Google
  - ISC
  - RIPE NCC

- For funding, platform support, collaboration

APNIC Research & Development