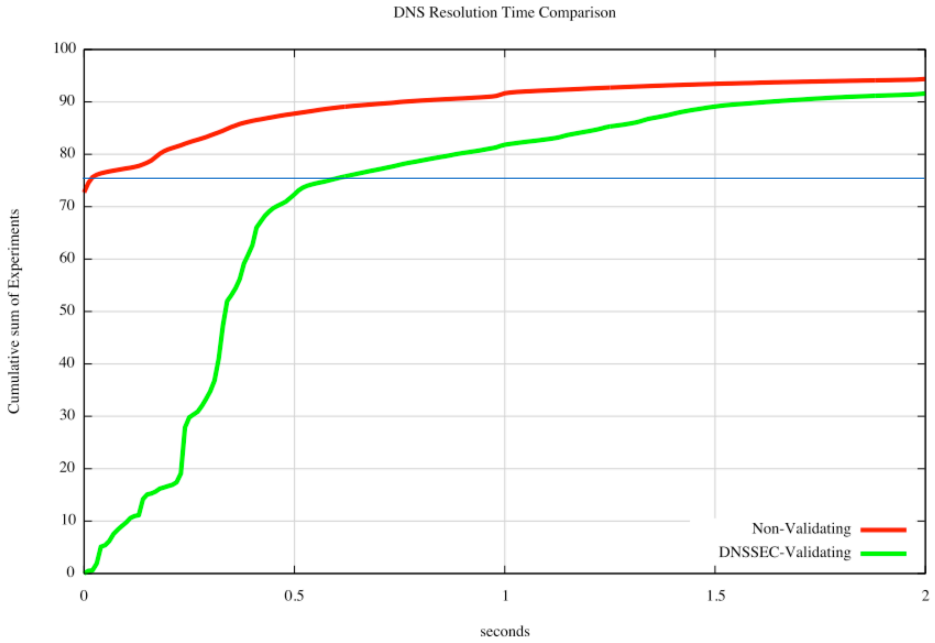
The Resolvers We Use

Geoff Huston
APNIC

One of those wtf moments…

Like-vs-like: unsigned vs signed



This figure was produced as part of some related work that was measuring the additional time penalty that would apply when the name being resolved was signed using DNSSEC.

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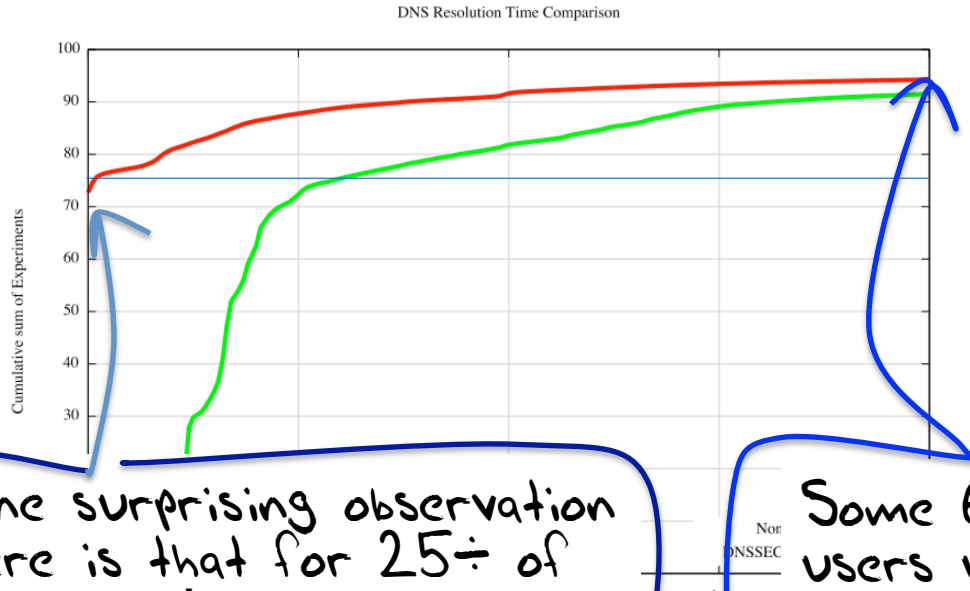

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Some 6÷ of internet users use resolvers that take more than 2 seconds to complete the resolution function

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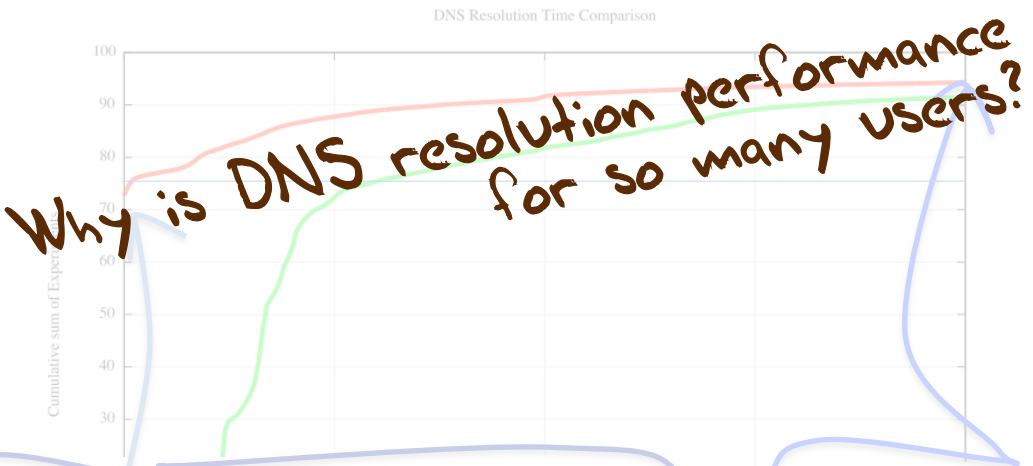

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Why is DNS resolution performance so incredibly bad for so many users?

One surprising observation here is that for 25÷ of the world's users a simple uncached DNS name is not resolved in a single query

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And that leads to…

- It appears that what we think about how the DNS works and how folk actually are using the DNS is not well aligned
- We all think we understand how DNS resolution works in terms of the interchange of DNS protocol elements
  - But the performance of DNS name resolution depends on a number of additional factors, both in terms of the users' choice of resolvers and the name admin's choice of authoritative servers

But…

The issue is more than just a question of unexpected poor performance of name resolution.

There's more to this...

Why is DNS resolution data valuable?

- Almost everything we do on the Internet starts with a DNS name resolution operation
- DNS resolver query logs contain a rich vein of real time information about what users do

  query logs and can be analyzed to infer information about the users themselves through the names that their applications resolve

  query logs contains indirect pointers that can be used to derive aggregate aspects of users' demographics, preferences, purchases, etc

Information Leaks

The question of where your DNS query traffic is being sent is also a question of whether you are leaking a real time trail of your online activities

Which leads to an interesting question about today's Internet:

- To what extent is this DNS resolution data stream "leaked" outward?
  - Across network boundaries?
  - Across national boundaries?
- This second form of information leakage is "interesting"

  While many national regimes include regulations concerning personally identifying data, its not clear if these regulations extend these same protections to aliens who are not citizens of the country where the information is held

Measuring the Internet via its Users

At APNIC we've been using online ads to measure the user's view of the Internet for some years

- We ask users to fetch a unique URL
- This involves a DNS resolution and a HTTP GET to our servers
- So we collect sets of DNS queries and WEB queries
- To see
  - how we are doing with the IPv6 transition
  - where DNSSEC validation is being used
  - And similar

Users and Resolvers

These data sets also allow us to match

- the IP address of the resolver that queries the authoritative name server (the “visible resolver”)

to

- the IP address of the client agent that retrieves the URL

Some Numbers

Using data collected across 2014 (Jan-Dec):

104,986,719 individual sample points

404,705 unique resolver IP addresses

This “raw” data is skewed to the ad placement algorithms we used, so we then re-weighted the raw numbers in each country to align to the relativities of the Internet user population in each country. This provides us with a view that does not over-represent certain countries in the data

Top 25 Resolvers

Rank	Resolver	Use	%
1	74.125.189.20	962,729	0.42%
2	74.125.189.16	961,207	0.42%
3	74.125.189.23	960,124	0.42%
4	74.125.189.17	959,964	0.42%
5	74.125.189.21	959,915	0.42%
6	74.125.189.19	959,060	0.42%
7	74.125.189.18	958,675	0.42%
8	74.125.189.22	958,597	0.42%
9	74.125.41.81	879,019	0.39%
10	74.125.41.82	877,909	0.39%
11	74.125.41.84	876,049	0.39%
12	74.125.41.83	875,978	0.39%
13	74.125.41.80	875,355	0.39%
14	74.125.41.16	862,749	0.38%
15	74.125.41.17	862,407	0.38%
16	74.125.41.18	861,868	0.38%
17	74.125.41.20	861,713	0.38%
18	74.125.41.19	861,538	0.38%
19	74.125.16.82	731,702	0.32%
20	74.125.16.81	730,670	0.32%
21	74.125.16.84	730,328	0.32%
22	74.125.16.80	730,098	0.32%
23	74.125.16.83	729,540	0.32%
24	74.125.41.145	669,941	0.30%
25	74.125.41.147	669,081	0.29%

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This list looks pretty strange!

Top Resolvers

Rank	Resolver	Use	%	Origin AS
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2	74.125.189.16	961,207	0.42%	15169 - Google
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When we add origin AS it gets a little clearer

These resolvers are part of Google's Public DNS resolver farms that support 8.8.8.8 and 8.8.4.4 – they are the fetch slaves

So we need a different counting approach -- what if we group all resolvers by their AS?

Top Resolvers by Origin AS

Rank	AS	Count	Share	Cumulative	AS Name
1	15169	77,752,963	34.24%	34.24%	GOOGLE - Google Inc.,US
2	4134	7,515,050	3.31%	37.55%	CHINANET-BACKBONE No.31,Jin-rong Street,CN
3	3462	5,651,005	2.49%	40.04%	HINET Data Communication Business Group,TW
4	3356	5,544,822	2.44%	42.48%	LEVEL3 - Level 3 Communications, Inc.,US
5	6147	5,123,169	2.26%	44.74%	Telefonica del Peru S.A.A.,PE
6	16880	4,120,210	1.81%	46.55%	AS2-TRENDMICRO-COM - TREND MICRO INCORPORATED,US
7	8151	4,090,436	1.80%	48.35%	Uninet S.A. de C.V.,MX
8	7470	3,388,845	1.49%	49.85%	TRUEINTERNET-AS-AP TRUE INTERNET Co.,Ltd.,TH
9	4837	3,150,429	1.39%	51.23%	CHINA169-BACKBONE CNCGROUP China169 Backbone,CN
10	9121	2,958,671	1.30%	52.54%	TTNET Turk Telekomunikasyon Anonim Sirketi,TR
11	7922	2,808,303	1.24%	53.77%	COMCAST-7922 - Comcast Cable Communications, Inc.,US
12	9299	2,719,648	1.20%	54.97%	IPG-AS-AP Philippine Long Distance Telephone Company,PH
13	4766	2,595,704	1.14%	56.11%	KIXS-AS-KR Korea Telecom,KR
14	45758	2,408,824	1.06%	57.17%	TRIPLETNET-AS-AP TripleT Bangkok,TH
15	36692	2,075,246	0.91%	58.09%	OPENDNS - OpenDNS, LLC,US
16	9318	1,839,866	0.81%	58.90%	HANARO-AS Hanaro Telecom Inc.,KR
17	8048	1,740,434	0.77%	59.67%	CANTV Servicios, Venezuela,VE
18	3786	1,675,723	0.74%	60.40%	LGDACOM LG DACOM Corporation,KR
19	9737	1,662,131	0.73%	61.14%	TOTNET-TH-AS-AP TOT Public Company Limited,TH
20	13489	1,634,966	0.72%	61.86%	EPM Telecomunicaciones S.A. E.S.P.,CO
21	17974	1,554,658	0.68%	62.54%	TELKOMNET-AS2-AP PT Telekomunikasi Indonesia,ID
22	7643	1,487,808	0.66%	63.20%	VNPT-AS-VN Vietnam Posts and Telecommunications,VN
23	7303	1,414,687	0.62%	63.82%	Telecom Argentina S.A.,AR
24	19994	1,357,249	0.60%	64.42%	RACKSPACE - Rackspace Hosting,US
25	8708	1,272,774	0.56%	64.98%	RCS-RDS RCS & RDS SA,RO

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3	3462	5,651,005	2.49%	40.04%	HINET Data Communication Business Group,TW
4	3356	5,544,822	2.44%	42.48%	LEVEL3 - Level 3 Communications, Inc.,US
5	6147	5,123,169	2.26%	44.74%	Telefonica del Peru S.A.A.,PE
6	1	4,120,210	1.81%	46.55%	AS2-TRENDMICRO-COM - TREND MICRO INCORPORATED,US
7					,MX
8	7470	3,388,845	1.49%	49.85%	TRUEINTERNET-AS-AP TRUE INTERNET Co.,Ltd.,TH
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This list still looks pretty strange!

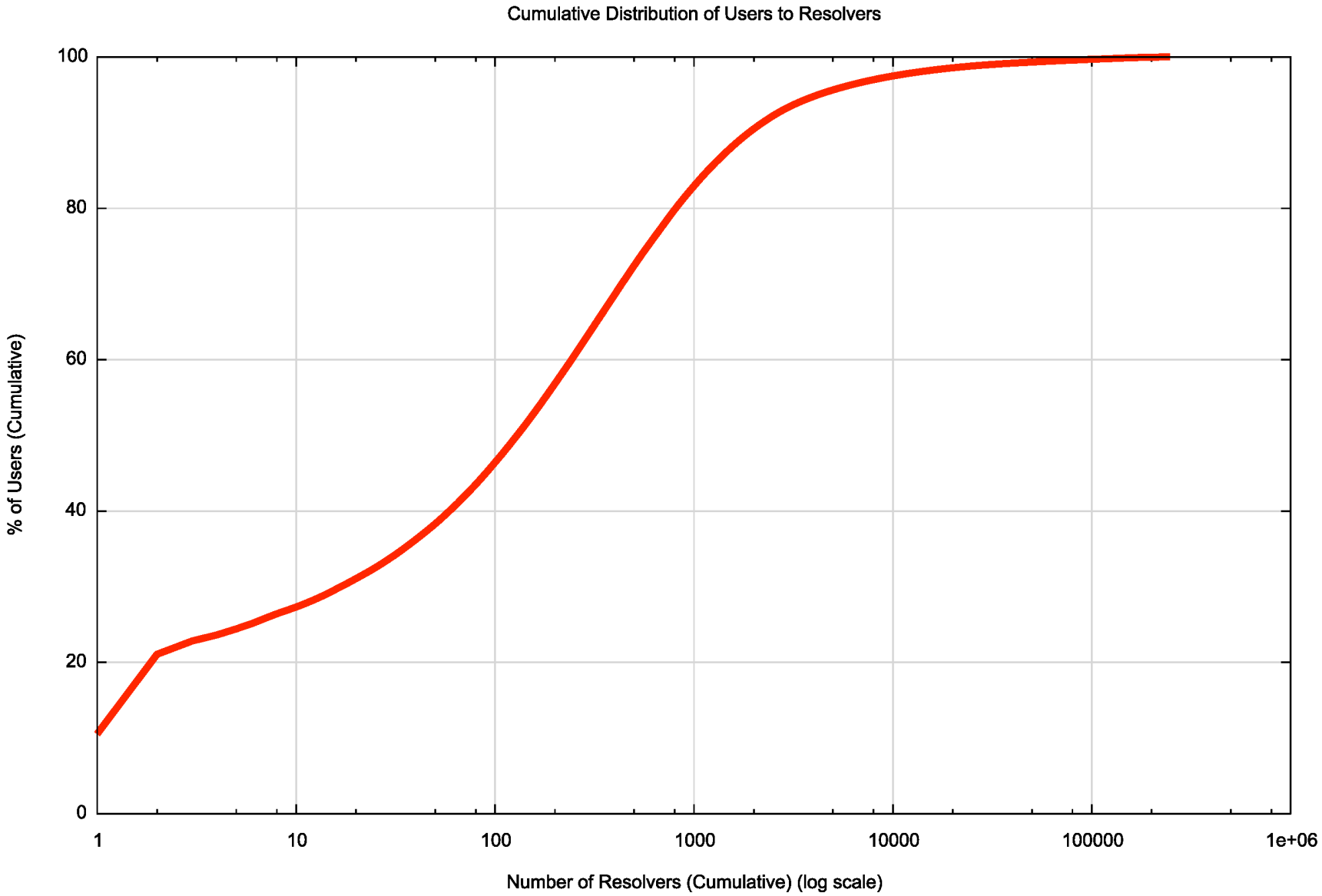
The problem is that resolver farms amplify their presence in this list because they splay multiple instances of the same query across slave resolvers

Can we compensate for this?

Top Resolvers by AS - filtered to initial query

Rank	AS	Use	AS Name
1	15169	9.91%	GOOGLE - Google Inc.,US
2	4134	9.53%	CHINANET-BACKBONE No.31,Jin-rong Street,CN
3	4837	5.95%	CHINA169-BACKBONE CNCGROUP China169 Backbone,CN
4	7922	1.67%	COMCAST-7922 - Comcast Cable Communications, Inc.,US
5	36692	1.32%	OPENDNS - OpenDNS, LLC,US
6	8151	1.27%	Uninet S.A. de C.V.,MX
7	9829	1.17%	BSNL-NIB National Internet Backbone,IN
8	4713	1.13%	OCN NTT Communications Corporation,JP
9	3320	1.02%	DTAG Deutsche Telekom AG,DE
10	10753	0.93%	LVLT-10753 - Level 3 Communications, Inc.,US
11	4812	0.92%	CHINANET-SH-AP China Telecom (Group),CN
12	4813	0.90%	BACKBONE-GUANGDONG-AP China Telecom(Group),CN
13	4766	0.86%	KIXS-AS-KR Korea Telecom,KR
14	28573	0.84%	NET Servicos de Comunicatio S.A.,BR
15	4808	0.76%	CHINA169-BJ CNCGROUP IP network China169 Beijing Province Network,CN
16	24560	0.75%	AIRTELBROADBAND-AS-AP Bharti Airtel Ltd., Telemedia Services,IN
17	3215	0.72%	AS3215 Orange S.A.,FR
18	701	0.71%	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
19	9121	0.64%	TTNET Turk Telekomunikasyon Anonim Sirketi,TR
20	8452	0.63%	TE-AS TE-AS,EG
21	9394	0.62%	CTTNET China TieTong Telecommunications Corporation,CN
22	9808	0.60%	CMNET-GD Guangdong Mobile Communication Co.Ltd.,CN
23	6713	0.57%	IAM-AS,MA
24	6830	0.56%	LGI-UPC Liberty Global Operations B.V.,EU
25	18881	0.55%	Global Village Telecom,BR

Resolver Distribution



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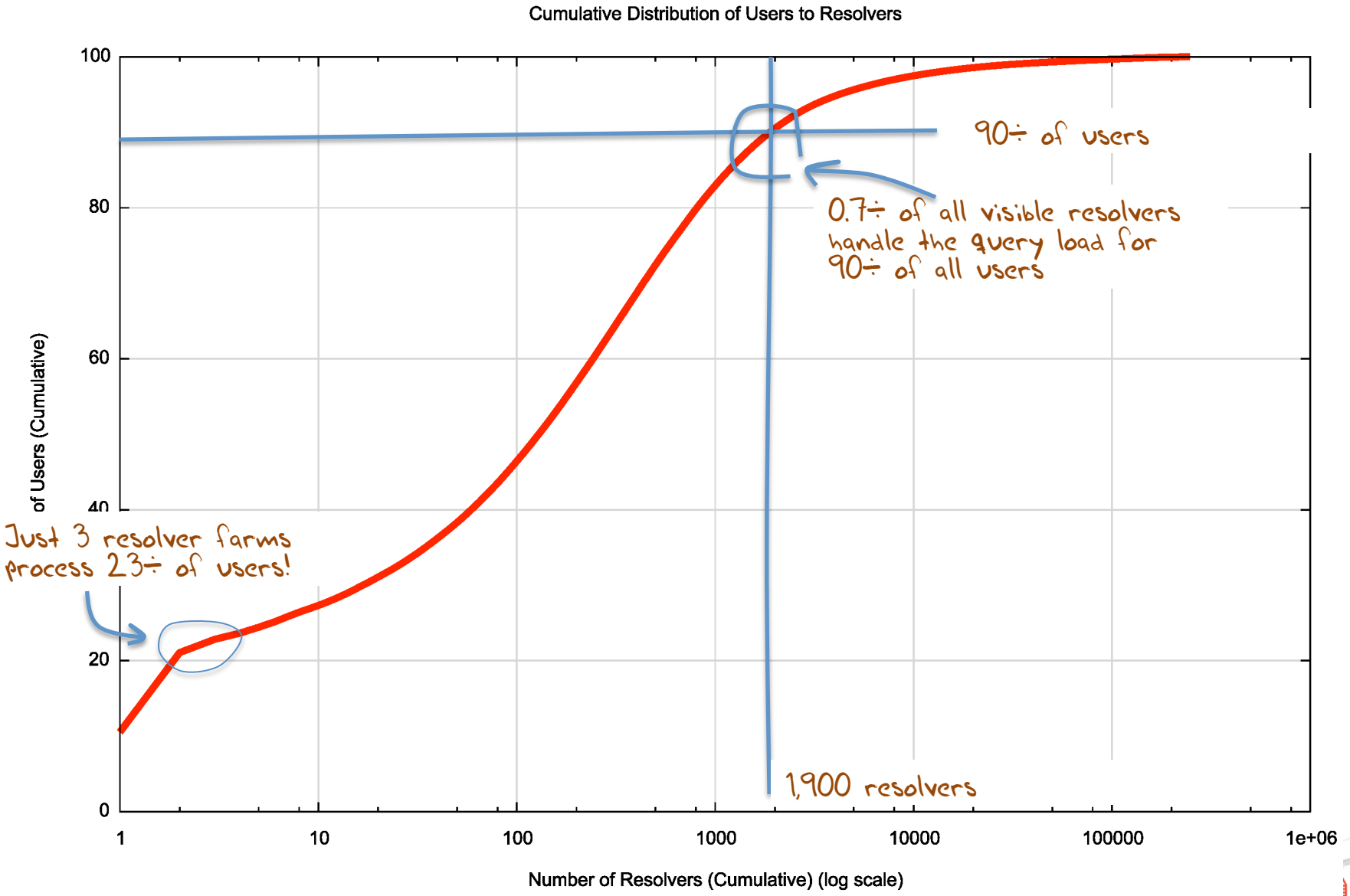


Who's Resolving "*Locally*" and Who's Not?

Let's filter this data by removing all entries where the user and the visible resolver are located within the same network (same AS)

Which non-local resolvers are being used?

Non-Local (AS) Resolution: Top Resolvers (by AS)

Rank	AS	Use		AS Name
1	15169	2,494,244	36.87%	GOOGLE - Google Inc.,US
2	36692	332,762	4.92%	OPENDNS - OpenDNS, LLC,US
3	10753	233,568	3.45%	LVLT-10753 - Level 3 Communications, Inc.,US
4	4813	227,137	3.36%	BACKBONE-GUANGDONG-AP China Telecom(Group),CN
5	7132	126,454	1.87%	SBIS-AS - AT&T Internet Services,US
6	6713	116,586	1.72%	IAM-AS,MA
7	4134	104,840	1.55%	CHINANET-BACKBONE No.31,Jin-rong Street,CN
8	18209	86,197	1.27%	BEAMTELE-AS-AP Beam Telecom Pvt Ltd,IN
9	4837	75,780	1.12%	CHINA169-BACKBONE CNCGROUP China169 Backbone,CN
10	4808	75,497	1.12%	China169 China Unicom Beijing Province Network,CN
11	18101	73,760	1.09%	Reliance Communications Ltd.DAKC MUMBAI,IN
12	20746	68,061	1.01%	ASN-IDC Telecomitalia s.p.a.,IT
13	3786	65,025	0.96%	LGDACOM LG DACOM Corporation,KR
14	9394	64,963	0.96%	CTTNET China TieTong Telecommunications Corporation,CN
15	7843	55,329	0.82%	TWCABLE-BACKBONE - Time Warner Cable Internet LLC,US
16	17621	54,542	0.81%	CNCGROUP-SH China Unicom Shanghai network,CN
17	17816	52,618	0.78%	China Unicom China169 Guangdong province,CN
18	7643	48,236	0.71%	VNPT-AS-VN Vietnam Posts and Telecommunications (VNPT),VN
19	5713	46,887	0.69%	SAIX-NET,ZA
20	23724	42,281	0.62%	CHINANET-IDC-BJ-AP IDC, China Telecommunications Corporation,CN
21	3356	40,161	0.59%	LEVEL3 - Level 3 Communications, Inc.,US
22	7470	39,916	0.59%	TRUEINTERNET-AS-AP TRUE INTERNET Co.,Ltd.,TH
23	2914	36,238	0.54%	NTT-COMMUNICATIONS-2914 - NTT America, Inc.,US
24	58466	35,730	0.53%	CT-GUANGZHOU-IDC CHINANET Guangdong province network,CN
25	4835	34,897	0.52%	CHINANET-IDC-SN China Telecom (Group),CN

Total: 27% of total end users

Who's using "*Foreign*" Resolvers?

Let's apply a further filter and look only at those instances where the IP address of the end users and that of the resolvers that they are using are geo-located in *different countries*

Foreign Resolution: Top Resolvers by AS

Rank	AS	Use		AS Name
1	15169	2,501,732	67.00%	GOOGLE - Google Inc.,US
2	36692	280,737	7.52%	OPENDNS - OpenDNS, LLC,US
3	10753	205,897	5.51%	LVLT-10753 - Level 3 Communications, Inc.,US
4	6830	67,353	1.80%	LGI-UPC Liberty Global Operations B.V.,AT
5	3356	30,737	0.82%	LEVEL3 - Level 3 Communications, Inc.,US
6	2914	28,814	0.77%	NTT-COMMUNICATIONS-2914 - NTT America, Inc.,US
7	1273	26,120	0.70%	CW Cable and Wireless Worldwide plc,GB
8	9050	23,194	0.62%	RTD ROMTELECOM S.A,RO
9	174	18,097	0.48%	COGENT-174 - Cogent Communications,US
10	198605	16,564	0.44%	AVAST-AS-DC AVAST Software a.s.,CZ
11	30689	16,483	0.44%	FLOW-NET - FLOW,JM
12	3257	15,298	0.41%	TINET-BACKBONE Tinet SpA,DE
13	29791	14,078	0.38%	VOXEL-DOT-NET - Voxel Dot Net, Inc.,US
14	13238	12,961	0.35%	YANDEX Yandex LLC,RU
15	35838	10,761	0.29%	CCANET CCANet Limited,GB
16	35074	10,591	0.28%	COBRANET-AS Cobranet Limited,LB
17	42523	10,575	0.28%	PLATINIUM-AS Platinium Star TV SRL,RO
18	13210	9,878	0.26%	ASE ACADEMIA DE STUDII ECONOMICE,RO
19	36351	9,748	0.26%	SOFTLAYER - SoftLayer Technologies Inc.,US
20	6939	9,221	0.25%	HURRICANE - Hurricane Electric, Inc.,US
21	37204	8,897	0.24%	TELONE,ZW
22	3462	8,761	0.23%	HINET Data Communication Business Group,TW
23	13127	7,710	0.21%	VERSATEL Tele 2 Nederland B.V.,NL
24	30607	7,137	0.19%	302-DIRECT-MEDIA-ASN - 302 Direct Media LLC,US
25	6663	6,813	0.18%	TTI-NET Euroweb Romania SA,RO

Total: 15% of total end users

Countries with users that have the lowest foreign resolution counts

CC	%	Foreign	Domestic	Country
KR	1.52	6,922	448,705	Republic of Korea
UY	2.96	571	18,715	Uruguay
CN	3.29	19,3273	5,673,988	China
PF	3.35	50	1,460	French Polynesia
LT	3.56	743	20,179	Lithuania
JP	3.68	40,465	1,058,919	Japan
QA	3.82	675	17,009	Qatar
HR	4.22	1,140	25,851	Croatia
FR	4.30	23,787	528,936	France
MN	4.53	180	3,797	Mongolia
FI	4.62	2,450	50,550	Finland
MT	4.64	148	3,061	Malta
GR	4.67	2,942	60,038	Greece
NZ	4.75	1,933	38,791	New Zealand
FM	4.83	12	247	Micronesia (Federated States of)
AE	4.96	4,061	77,743	United Arab Emirates
MD	5.04	722	13,627	Republic of Moldova
GE	5.12	762	14,133	Georgia
PT	5.13	3,297	60,940	Portugal
CL	5.38	5,498	96,718	Chile
PE	5.55	6,782	115,421	Peru
GY	5.60	153	2,583	Guyana
FO	5.61	24	412	Faroe Islands
SR	5.65	108	1,807	Suriname
SA	5.68	8,771	145,574	Saudi Arabia
EE	5.95	638	10,104	Estonia
BE	6.19	6,178	93,695	Belgium
IL	6.58	3,912	55,516	Israel
VE	7.23	9,909	127,117	Venezuela

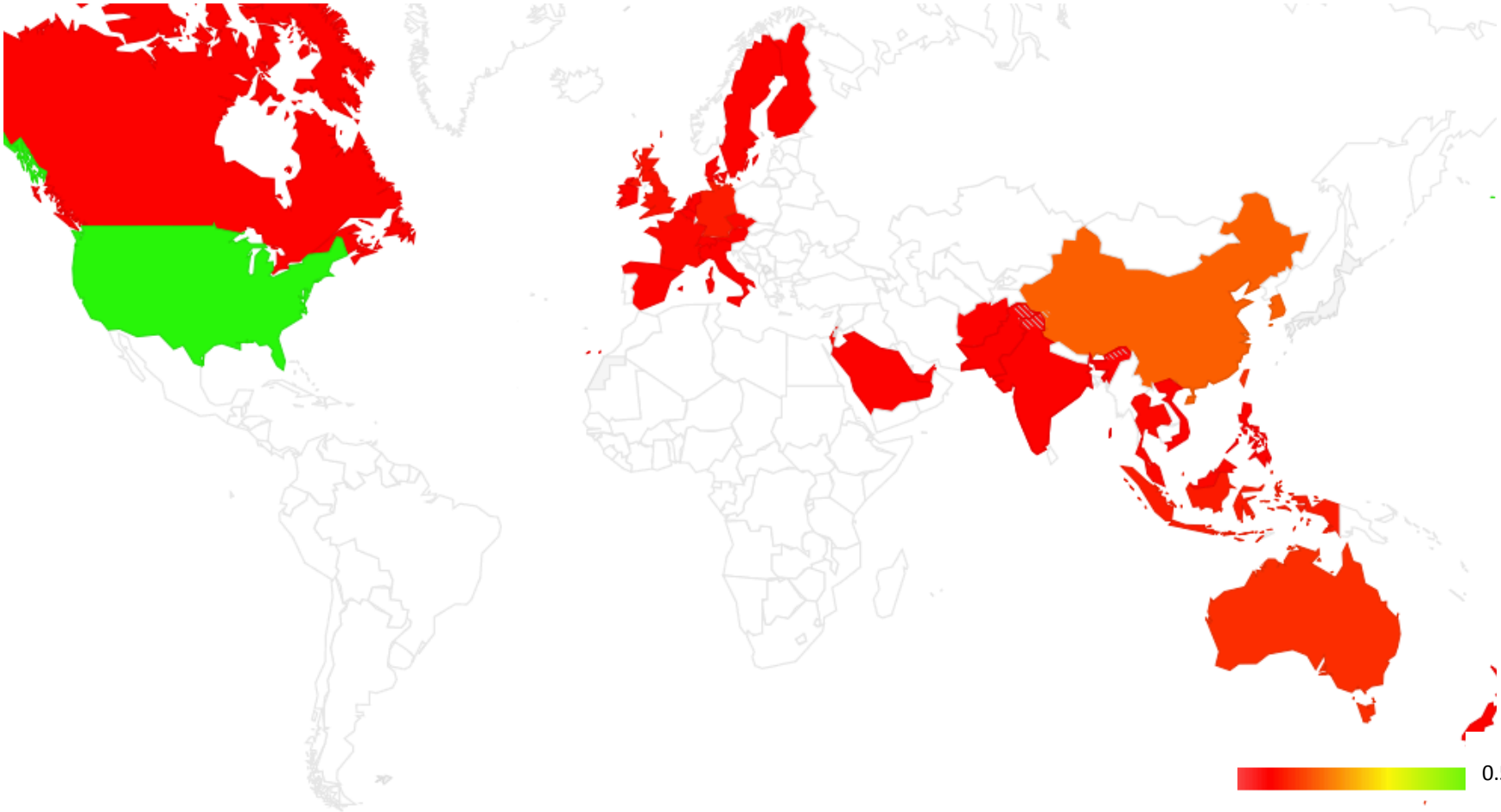
Countries with highest foreign resolution counts

CC	%	Foreign	Domestic	Country
MQ	100.00	1,837	0	Martinique
DZ	98.91	61,171	673	Algeria
LR	98.56	1,443	21	Liberia
GF	98.07	781	15	French Guiana
AF	96.85	16,807	546	Afghanistan
BF	95.27	5,537	274	Burkina Faso
SO	94.66	1,422	80	Somalia
DJ	94.40	646	38	Djibouti
RE	93.38	3,153	223	Reunion
TD	91.00	2,542	251	Chad
GQ	90.19	897	97	Equatorial Guinea
CD	88.12	8,152	1,098	Democratic Republic of the Congo
IM	86.96	375	56	Isle of Man
GN	86.47	1,503	235	Guinea
SV	84.94	11,266	1,997	El Salvador
IR	84.88	154,305	27,487	Iran (Islamic Republic of)
ZW	78.64	20,042	5,444	Zimbabwe
CG	78.44	2,620	720	Congo
BN	77.37	2,023	591	Brunei Darussalam
SL	72.02	445	172	Sierra Leone
VN	68.04	243,186	114,206	Vietnam
NI	67.30	4,858	2,360	Nicaragua
NG	61.17	345,177	219,107	Nigeria
BZ	60.39	425	279	Belize
ZM	59.45	11,444	7,805	Zambia
NE	56.22	1,514	1,179	Niger
CY	55.27	3,992	3,231	Cyprus
SY	54.53	29,657	24,734	Syrian Arab Republic
BI	54.21	702	593	Burundi

Mapping the resolver spread

For each country can we show the distribution of the resolvers used by users located within that country?

Mapping Foreign Resolution- JP



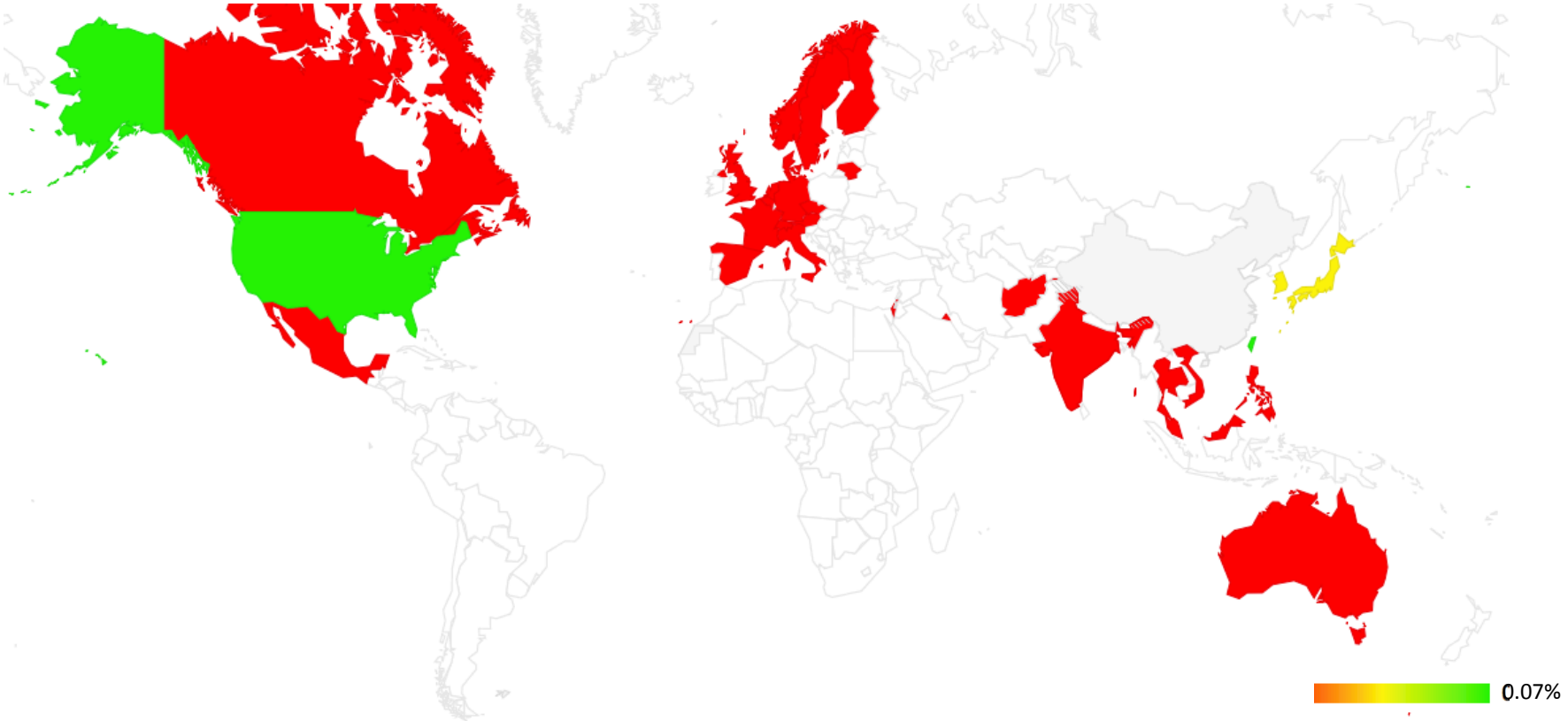
Mapping Foreign Resolution- JP

DNS Resolution Distribution for Japan

CC	Country	Resolver Samples	Resolver Share
JP	Japan	1058919	96.32%
XX	Total Foreign DNS resolution	40402	3.68%
ZZ	Google Public DNS	27712	2.52%
US	United States of America	5656	0.51%
SG	Singapore	1666	0.15%
CN	China	1092	0.10%
KR	Republic of Korea	1047	0.10%
TW	Taiwan	583	0.05%
AU	Australia	508	0.05%
DE	Germany	327	0.03%
ID	Indonesia	318	0.03%
HK	Hong Kong Special Administrative Region of China	257	0.02%
GB	United Kingdom of Great Britain and Northern Ireland	224	0.02%
TH	Thailand	138	0.01%
FR	France	103	0.01%
EU	European Union	86	0.01%
IL	Israel	66	0.01%
CZ	Czech Republic	57	0.01%
MY	Malaysia	57	0.01%

% of foreign name resolution per country

Mapping Foreign Resolution - CN



% of foreign name resolution per country

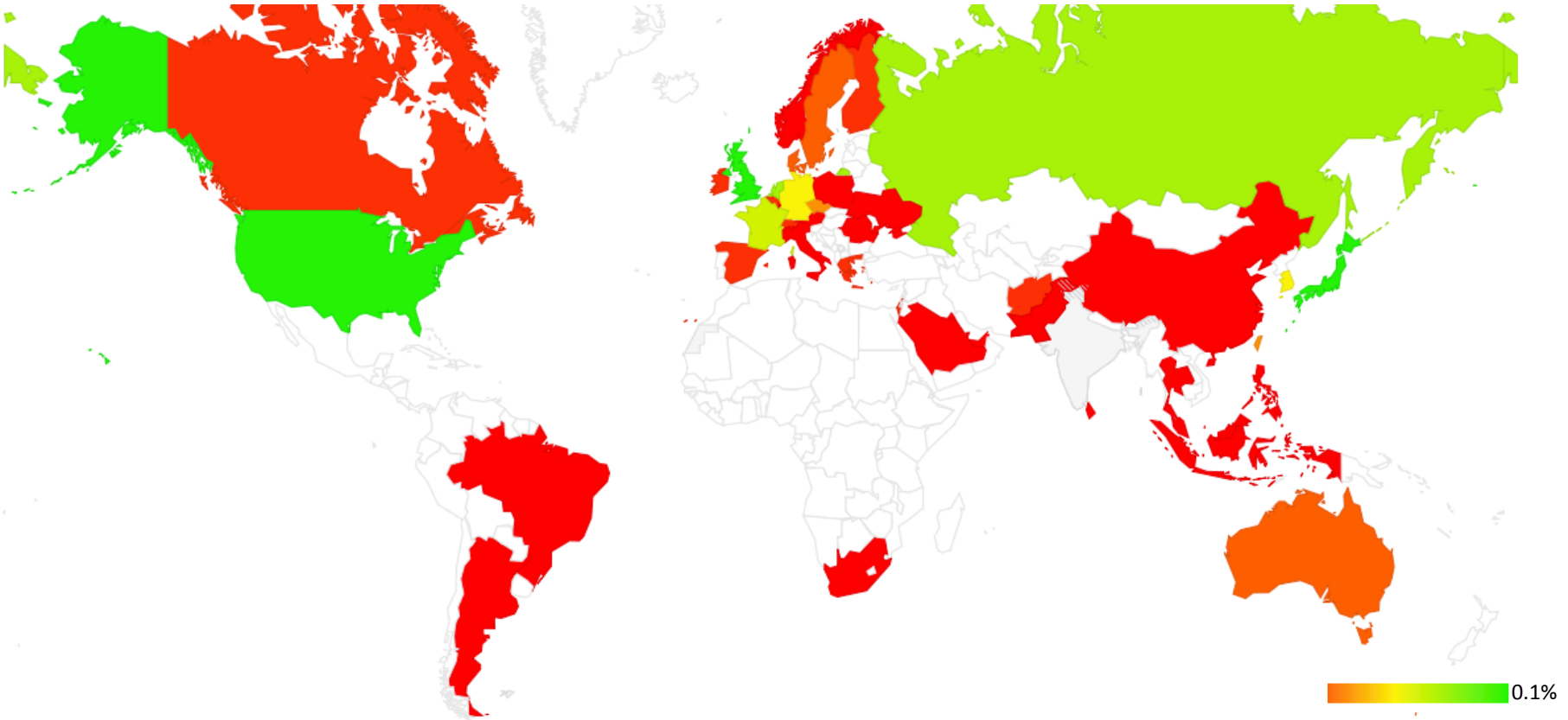
Mapping Foreign Resolution - CN

DNS Resolution Distribution for China

CC	Country	Resolver Samples	Resolver Share
CN	China	5673988	96.71%
XX	Total Foreign DNS resolution	193220	3.29%
ZZ	Google Public DNS	182953	3.12%
US	United States of America	5603	0.10%
TW	Taiwan	1694	0.03%
KR	Republic of Korea	797	0.01%
HK	Hong Kong Special Administrative Region of China	632	0.01%
JP	Japan	619	0.01%
SG	Singapore	294	0.01%
GB	United Kingdom of Great Britain and Northern Ireland	92	0.00%
DE	Germany	89	0.00%
FR	France	40	0.00%
CA	Canada	37	0.00%
AU	Australia	36	0.00%
MY	Malaysia	30	0.00%
DK	Denmark	28	0.00%
FI	Finland	25	0.00%
SE	Sweden	21	0.00%
AF	Afghanistan	20	0.00%
EU	European Union	19	0.00%
CZ	Czech Republic	18	0.00%
NL	Netherlands	18	0.00%
CH	Switzerland	17	0.00%
AT	Austria	15	0.00%
IT	Italy	13	0.00%

% of foreign name resolution per country

Mapping Foreign Resolution - IN

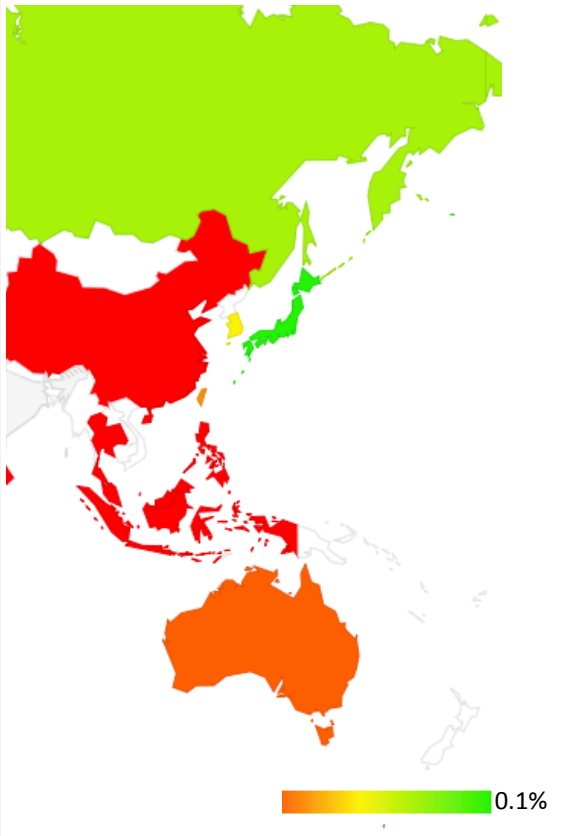


% of foreign name resolution per country

Mapping Foreign Resolution - IN

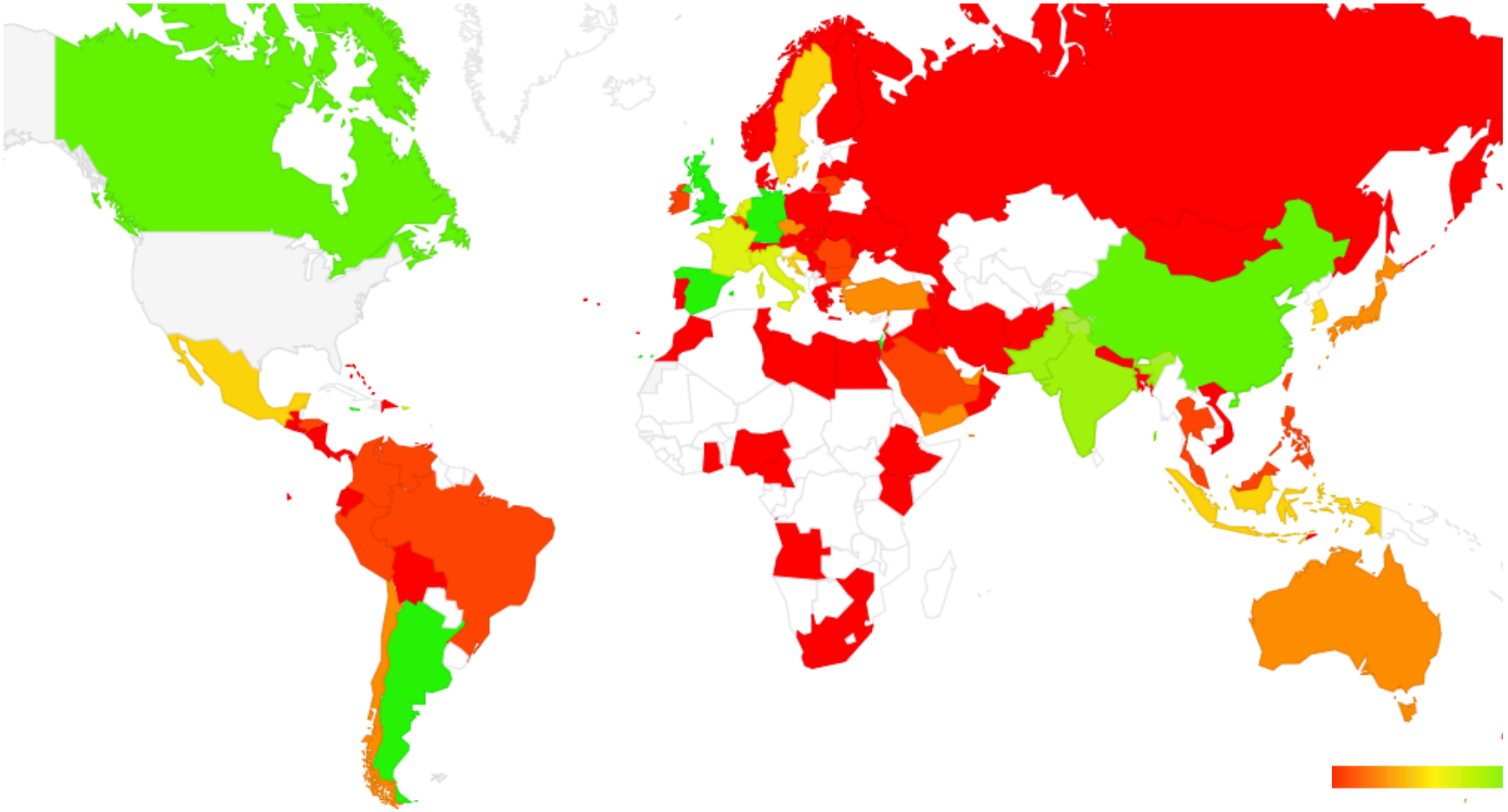
DNS Resolution Distribution for India

CC	Country	Resolver Samples	Resolver Share
IN	India	1088582	77.35%
XX	Total Foreign DNS resolution	318851	22.65%
ZZ	Google Public DNS	200298	14.23%
US	United States of America	104311	7.41%
GB	United Kingdom of Great Britain and Northern Ireland	2966	0.21%
JP	Japan	1581	0.11%
SG	Singapore	1455	0.10%
RU	Russian Federation	1015	0.07%
NL	Netherlands	931	0.07%
FR	France	844	0.06%
DE	Germany	677	0.05%
KR	Republic of Korea	671	0.05%
CZ	Czech Republic	475	0.03%
TW	Taiwan	419	0.03%
AU	Australia	337	0.02%
EU	European Union	303	0.02%
SE	Sweden	286	0.02%
HK	Hong Kong Special Administrative Region of China	240	0.02%
DK	Denmark	222	0.02%
CA	Canada	177	0.01%
GR	Greece	164	0.01%
FI	Finland	158	0.01%
CH	Switzerland	125	0.01%
IE	Ireland	112	0.01%
BE	Belgium	96	0.01%
AF	Afghanistan	95	0.01%
ES	Spain	86	0.01%
IL	Israel	85	0.01%
AT	Austria	67	0.00%
LK	Sri Lanka	65	0.00%



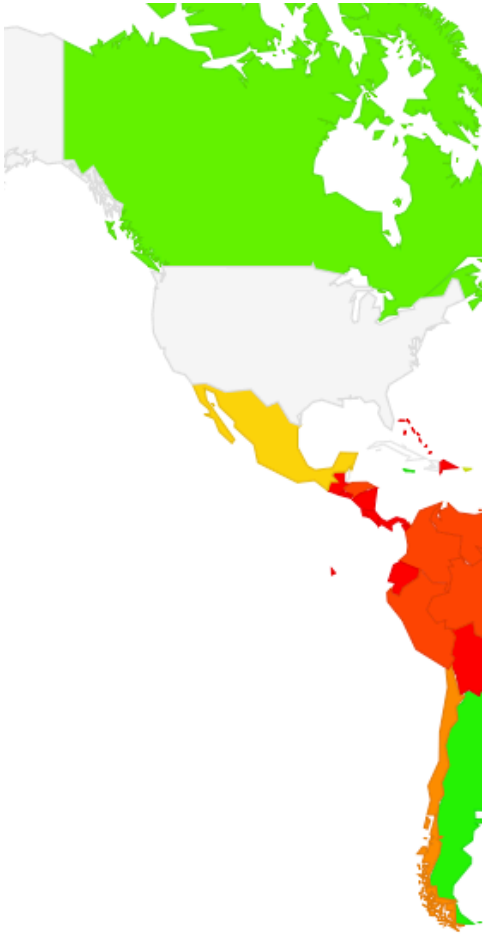
% of foreign name resolution per country

Mapping Foreign Resolution- US



% of foreign name resolution per country

Mapping Foreign Resolution- US

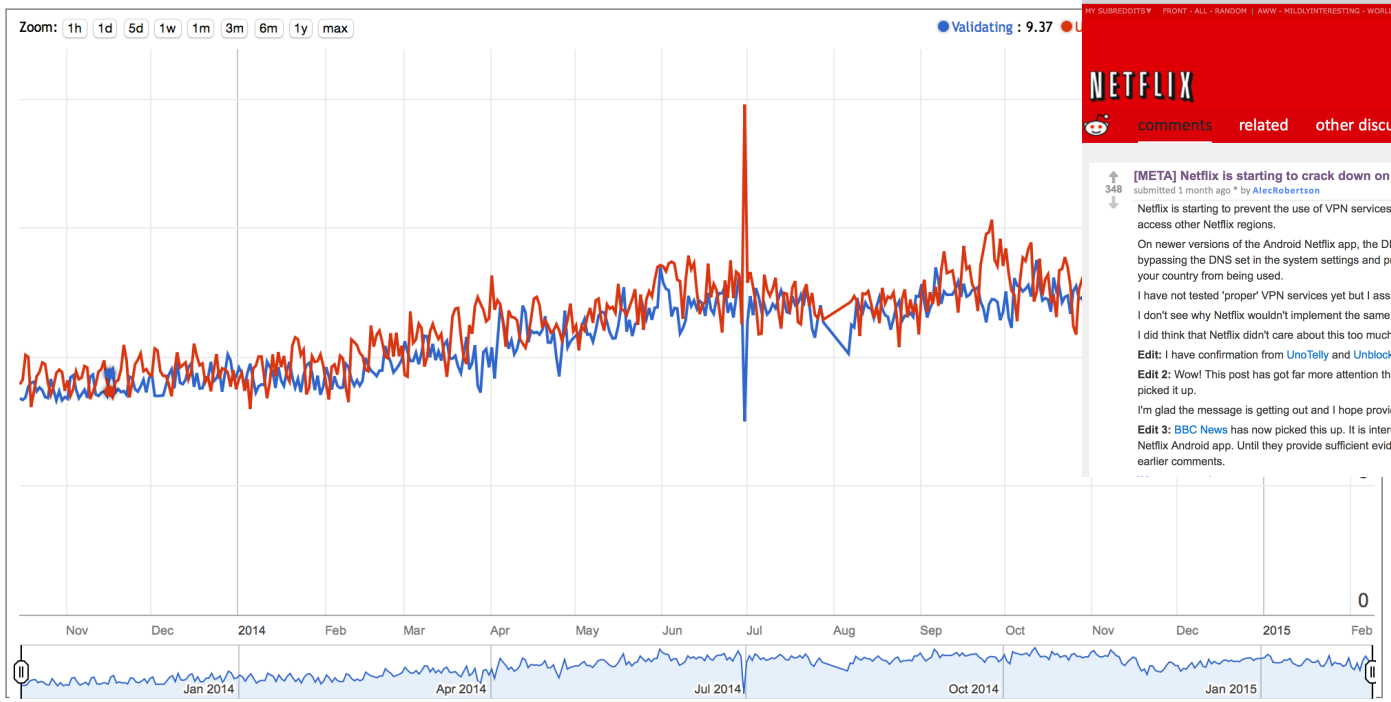


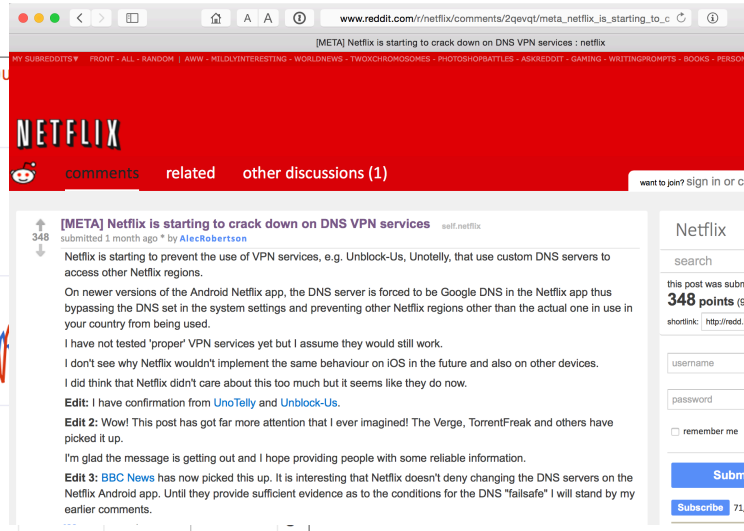
DNS Resolution Distribution for United States of America

CC	Country	Resolver Samples	Resolver Share
US	United States of America	2206667	89.16%
XX	Total Foreign DNS resolution	268218	10.84%
ZZ	Google Public DNS	198897	8.04%
JM	Jamaica	16621	0.67%
IL	Israel	7508	0.30%
GB	United Kingdom of Great Britain and Northern Ireland	4657	0.19%
ES	Spain	4038	0.16%
DE	Germany	3849	0.16%
AR	Argentina	2489	0.10%
VI	United States Virgin Islands	1603	0.06%
CA	Canada	1493	0.06%
CN	China	1435	0.06%
SG	Singapore	1422	0.06%
BB	Barbados	1415	0.06%
PK	Pakistan	1195	0.05%
IN	India	1156	0.05%
PR	Puerto Rico	1099	0.04%
NL	Netherlands	1054	0.04%
EU	European Union	961	0.04%
FR	France	933	0.04%
IT	Italy	895	0.04%
SE	Sweden	815	0.03%
ID	Indonesia	757	0.03%
KR	Republic of Korea	754	0.03%

What About Google's Public DNS?

Use of DNSSEC Validation for World (XA)

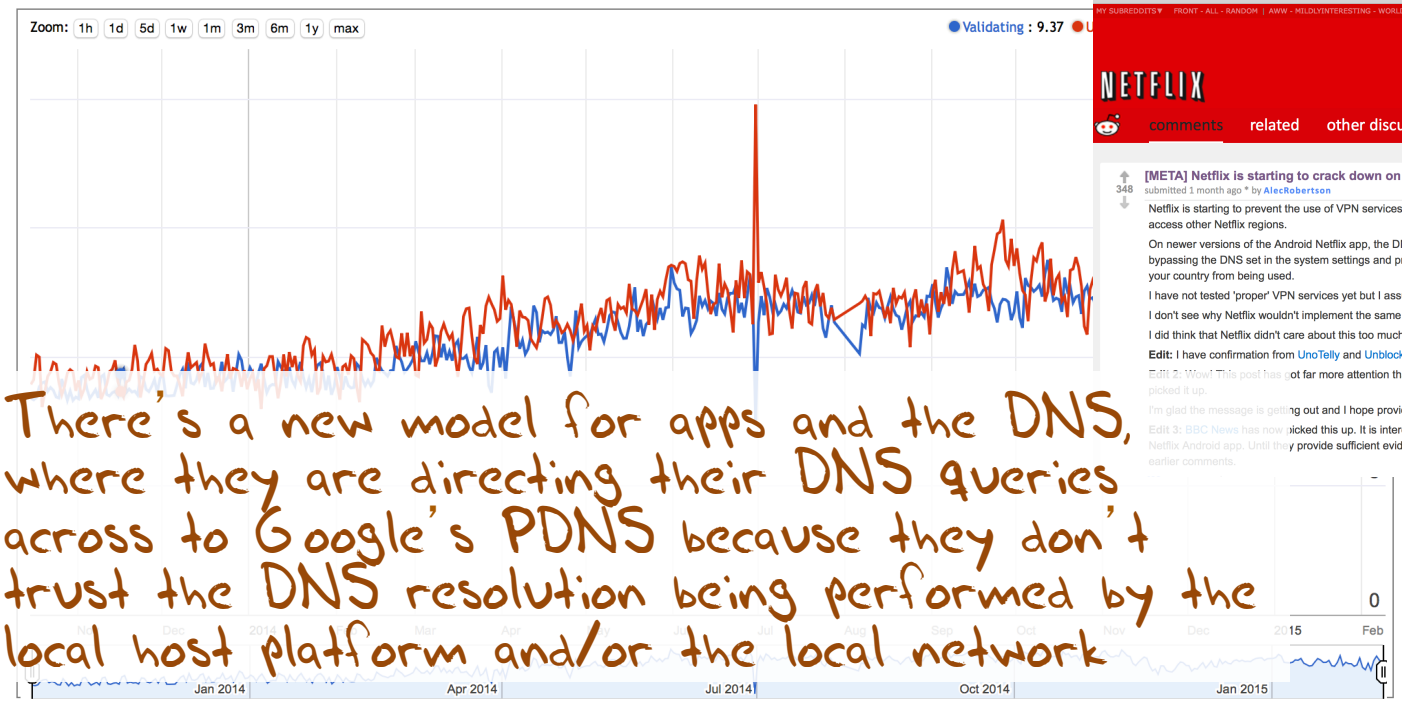


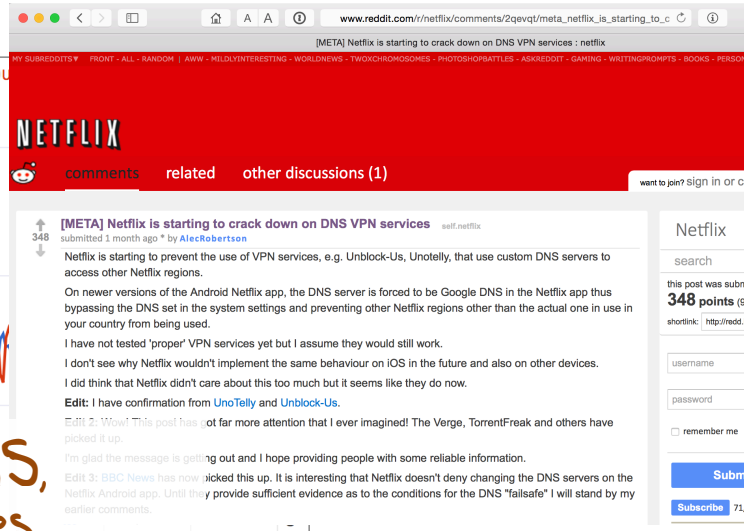


% of users who have their queries resolved by Google's PDNS service

What About Google's Public DNS?

Use of DNSSEC Validation for World (XA)

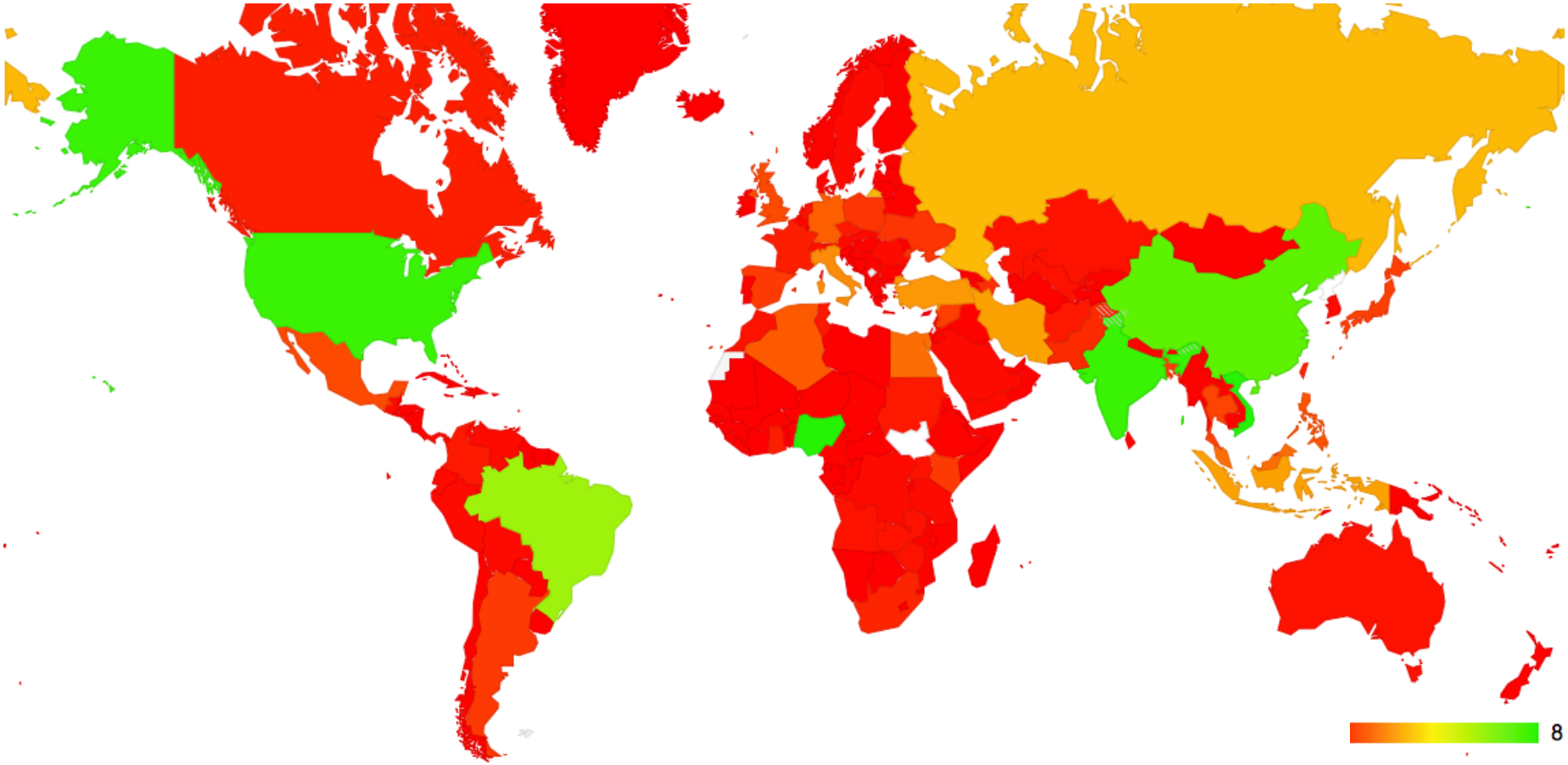




There's a new model for apps and the DNS, where they are directing their DNS queries across to Google's PDNS because they don't trust the DNS resolution being performed by the local host platform and/or the local network

% of users who have their queries resolved by Google's PDNS service

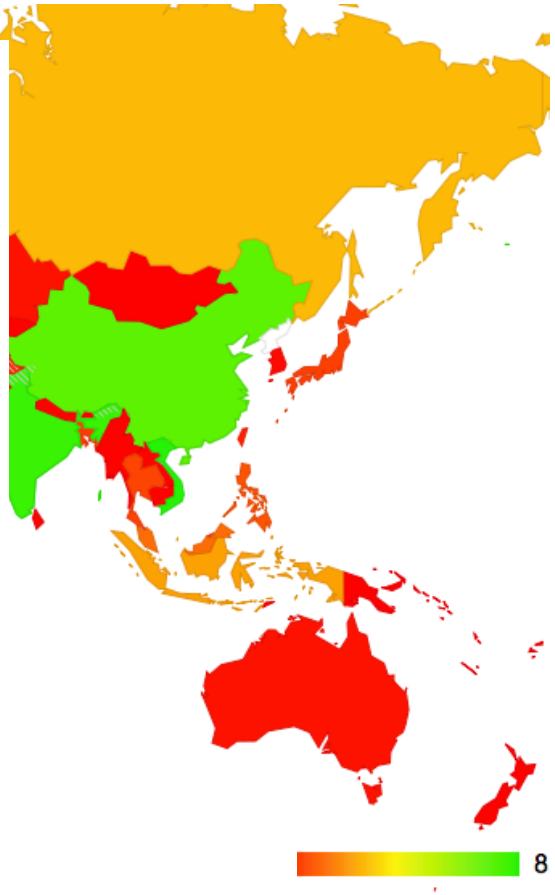
Where is Google's Public DNS used?



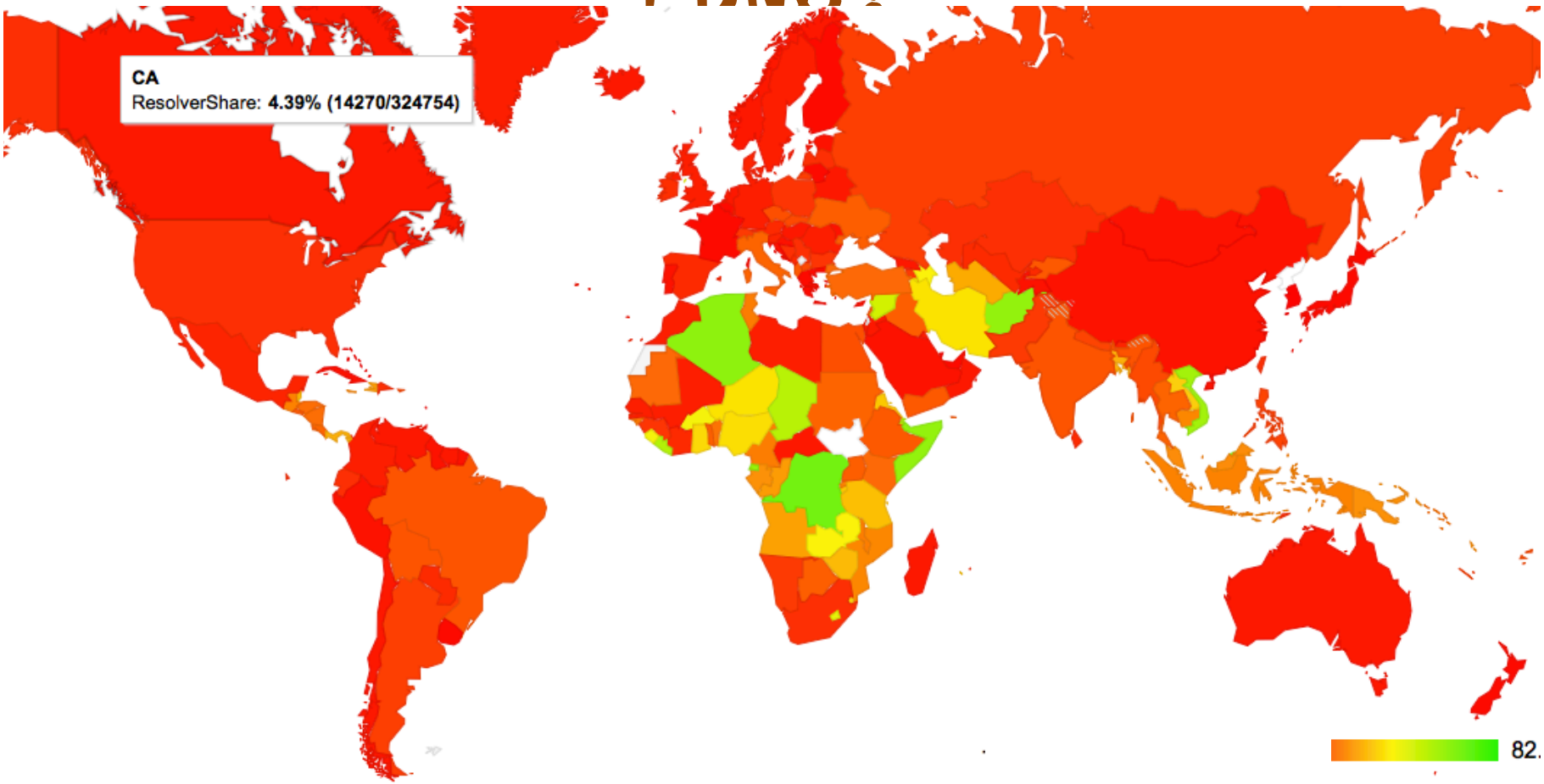
Where is Google's Public DNS used?

DNS Resolution Distribution for Google Public DNS

CC	Country	Resolver Samples	Resolver Share
ZZ	Google Public DNS	0	0.00%
NG	Nigeria	210849	8.43%
VN	Vietnam	209941	8.39%
IN	India	200298	8.01%
US	United States of America	198897	7.95%
CN	China	182953	7.31%
BR	Brazil	150816	6.03%
RU	Russian Federation	80251	3.21%
IR	Iran (Islamic Republic of)	70363	2.81%
ID	Indonesia	69858	2.79%
TR	Turkey	65820	2.63%
IT	Italy	61907	2.47%
EG	Egypt	49062	1.96%
MY	Malaysia	48893	1.95%
DE	Germany	40543	1.62%
DZ	Algeria	38665	1.55%
PH	Philippines	36560	1.46%
GB	United Kingdom of Great Britain and Northern Ireland	32555	1.30%
MX	Mexico	31736	1.27%
TH	Thailand	29410	1.18%
JP	Japan	27712	1.11%
SY	Syrian Arab Republic	27139	1.08%
BD	Bangladesh	26130	1.04%
KE	Kenya	25972	1.04%
ES	Spain	25473	1.02%
AR	Argentina	24673	0.99%
PL	Poland	24387	0.97%
UA	Ukraine	22710	0.91%
AZ	Azerbaijan	21829	0.87%
PK	Pakistan	19070	0.76%
ZA	South Africa	17130	0.68%
TW	Taiwan	15136	0.61%



Which Countries make extensive use of Google's PDNS?



DNS Resolution Distribution for Google Public DNS

CC	Country	Resolver Samples	Resolver Share
ZX	Google Public DNS	2501535	2501535/2501535 (0.00%)
ST	Sao Tome and Principe	365	365/443 (82.60%)
CD	Democratic Republic of the Congo	6209	6209/9251 (67.12%)
BN	Brunei Darussalam	1667	1667/2615 (63.77%)
DZ	Algeria	38665	38665/61844 (62.52%)
AF	Afghanistan	10733	10733/17354 (61.85%)
SO	Somalia	922	922/1502 (61.40%)
GQ	Equatorial Guinea	605	605/994 (60.85%)
VN	Vietnam	209941	209941/357392 (58.74%)
KI	Kiribati	66	66/114 (57.89%)
LR	Liberia	805	805/1465 (54.97%)
DJ	Djibouti	371	371/685 (54.23%)
TD	Chad	1508	1508/2793 (54.00%)
SY	Syrian Arab Republic	27139	27139/54391 (49.90%)
LS	Lesotho	442	442/975 (45.41%)
VC	Saint Vincent and the Grenadines	228	228/515 (44.37%)
IM	Isle of Man	187	187/431 (43.48%)
BF	Burkina Faso	2494	2494/5787 (43.10%)
SL	Sierra Leone	263	263/617 (42.66%)
ZM	Zambia	8103	8103/19249 (42.10%)
AZ	Azerbaijan	21829	21829/52429 (41.64%)
GI	Gibraltar	86	86/208 (41.58%)
SC	Seychelles	176	176/442 (40.00%)
IR	Iran (Islamic Republic of)	70363	70363/181792 (38.71%)
NE	Niger	1031	1031/2694 (38.30%)
VG	British Virgin Islands	52	52/140 (37.50%)
NG	Nigeria	210849	210849/564285 (37.37%)
GH	Ghana	15068	15068/41339 (36.45%)
SZ	Swaziland	912	912/2538 (35.96%)
LA	Lao People's Democratic Republic	2420	2420/6865 (35.26%)
ER	Eritrea	173	173/509 (34.09%)
BI	Burundi	438	438/1296 (33.79%)
RE	Reunion	1129	1129/3376 (33.44%)
TZ	United Republic of Tanzania	6452	6452/19776 (32.63%)
BZ	Belize	222	222/704 (31.63%)
ZW	Zimbabwe	8027	8027/25482 (31.50%)
BQ	Bonaire, Saint Eustatius and Saba	60	60/203 (29.94%)
BD	Bangladesh	26130	26130/87384 (29.90%)
PA	Panama	5523	5523/18524 (29.82%)
YT	Mayotte	371	371/1254 (29.60%)
TM	Turkmenistan	855	855/2926 (29.25%)
GP	Guadeloupe	239	239/843 (28.35%)
GU	Guam	296	296/1066 (27.82%)
AO	Angola	10078	10078/36438 (27.66%)

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no direct queries to Google

Why is this happening?

- At lot of this story is Google's Public DNS, which now has a "market share" of more than 10 % of the Internet's user population
- User's efforts to circumvent content control via national DNS filtering measures
- Also there is Users' efforts to circumvent DNS-based geo-loc content access controls (think Netflix)
- 3rd party DNS query monitoring/stalking (yes, there is some of this going on, but that's a lightning talk for another time!)
- Virus contamination of the host (yes, captured systems often show a redirected DNS config)
- <insert your favourite theory here>

Where is the DNS heading?

- Is the DNS under pressure to aggregate to ever larger resolvers and server farms?
- What is the economic model of name resolution in a highly aggregated environment? Will resolver operators turn to data mining of queries to generate revenue streams?
- Is it possible to reduce the information exposure while still using common resolver caches?
- What is the nature of the trade-off between resolution performance and information leakage in DNS resolution?

If you want to play with these maps, here's a (temporary) URL:

http://bit.ly/13oU09X

Thanks!