

The Resolvers We Use

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Measuring the Internet via 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
- And we can put them together
- To see which DNS resolvers are used by which users

Some Numbers

January to October 2014

55,543,450 individual sample points

510,371 unique resolver IP addresses

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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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%

This list looks pretty strange!

Top Resolvers

Rank	Resolver	Use	%	Origin AS
1	74.125.189.20	962,729	0.42%	15169 - Google
2	74.125.189.16	961,207	0.42%	15169 - Google
3	74.125.189.23	960,124	0.42%	15169 - Google
4	74.125.189.17	959,964	0.42%	15169 - Google
5	74.125.189.21	959,915	0.42%	15169 - Google
6	74.125.189.19	959,060	0.42%	15169 - Google
7	74.125.189.18	958,675	0.42%	15169 - Google
8	74.125.189.22	958,597	0.42%	15169 - Google
9	74.125.41.81	879,019	0.39%	15169 - Google
10	74.125.41.82	877,909	0.39%	15169 - Google
11	74.125.41.84	876,049	0.39%	15169 - Google
12	74.125.41.83	875,978	0.39%	15169 - Google
13	74.125.41.80	875,355	0.39%	15169 - Google
14	74.125.41.16	862,749	0.38%	15169 - Google
15	74.125.41.17	862,407	0.38%	15169 - Google
16	74.125.41.18	861,868	0.38%	15169 - Google
17	74.125.41.20	861,713	0.38%	15169 - Google
18	74.125.41.19	861,538	0.38%	15169 - Google
19	74.125.16.82	731,702	0.32%	15169 - Google
20	74.125.16.81	730,670	0.32%	15169 - Google
21	74.125.16.84	730,328	0.32%	15169 - Google
22	74.125.16.80	730,098	0.32%	15169 - Google
23	74.125.16.83	729,540	0.32%	15169 - Google
24	74.125.41.145	669,941	0.30%	15169 - Google
25	74.125.41.147	669,081	0.29%	15169 - Google



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 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

Top Resolvers by 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	16889	4,170,210	1.81%	46.55%	AS2-TRENDMICRO-COM - TREND MICRO INCORPORATED,US
7	8111	3,800,966	1.68%	48.23%	AS2-TELNET-AS-AP TELNET TELECOMMUNICATIONS,TR
8	7470	3,388,845	1.49%	49.72%	TRUEINTERNET-AS-AP TRUE INTERNET Co.,Ltd.,TH
9	4837	3,150,429	1.39%	51.11%	CHINA169-BACKBONE CNCGROUP china169 Backbone,CN
10	9111	2,808,303	1.24%	52.35%	COMCAST-7922 - Comcast Cable Communications, Inc.,US
11	7922	2,808,303	1.24%	53.59%	COMCAST-7922 - Comcast Cable Communications, Inc.,US
12	9199	2,511,448	1.10%	54.69%	PT TELKOMNET-AS-AP PT Telekomunikasi Indonesia,ID
13	4166	2,505,704	1.10%	55.79%	KTCS-AS-KR Korea Telecom,KR
14	45758	2,408,824	1.06%	56.85%	TRIPLENET-AS-AP TripleNet Bangkok,TH
15	36156	2,156,000	0.95%	57.80%	OPENDNS - OpenDNS, LLC,US
16	9318	1,839,866	0.81%	58.61%	HANARO-AS Hanaro Telecom Inc.,KR
17	8048	1,740,434	0.77%	59.38%	CANTV Servicios, Venezuela,VE
18	3186	1,675,722	0.74%	60.12%	LGDA-COM LG Dacom Corporation,KR
19	9737	1,652,131	0.73%	60.85%	TOTNET-TH-AS-AP TOT Public Company Limited,TH
20	13489	1,634,966	0.72%	61.57%	EPM Telecomunicaciones S.A. E.S.P.,CO
21	17974	1,554,658	0.68%	62.25%	TELKOMNET-AS2-AP PT Telekomunikasi Indonesia,ID
22	7643	1,487,808	0.66%	62.91%	VNPT-AS-VN Vietnam Posts and Telecommunications,VN
23	7303	1,414,687	0.62%	63.53%	Telecom Argentina S.A.,AR
24	19994	1,357,249	0.60%	64.13%	RACKSPACE - Rackspace Hosting,US
25	8708	1,272,774	0.56%	64.69%	RCS-RDS RCS & RDS SA,RO

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

Rank	AS	Use	AS Name
1	15169	11.88%	GOOGLE - Google Inc.,US
2	4134	4.04%	CHINANET-BACKBONE No.31,Jin-rong Street,CN
3	8151	2.68%	Uninet S.A. de C.V.,MX
4	4837	2.19%	CHINA169-BACKBONE CNCGROUP China169 Backbone,CN
5	3356	2.12%	LEVEL3 - Level 3 Communications, Inc.,US
6	6147	2.11%	Telefonica del Peru S.A.A.,PE
7	36692	2.00%	OPENDNS - OpenDNS, LLC,US
8	9121	1.75%	TTNET Turk Telekomunikasyon Anonim Sirketi,TR
9	3462	1.24%	HINET Data Communication Business Group,TW
10	4766	1.18%	KIXS-AS-KR Korea Telecom,KR
11	45758	1.14%	TRIPLETNET-AS-AP Triplet Internet Internet service provider Bangkok,TH
12	7470	1.05%	TRUEINTERNET-AS-AP TRUE INTERNET Co.,Ltd.,TH
13	8452	0.97%	TE-AS TE-AS,EG
14	6713	0.96%	IAM-AS,MA
15	9737	0.92%	TOTNET-TH-AS-AP TOT Public Company Limited,TH
16	7303	0.90%	Telecom Argentina S.A.,AR
17	17974	0.88%	TELKOMNET-AS2-AP PT Telekomunikasi Indonesia,ID
18	7643	0.86%	VNPT-AS-VN Vietnam Posts and Telecommunications (VNPT),VN
19	45595	0.82%	PKTELECOM-AS-PK Pakistan Telecom Company Limited,PK
20	9299	0.80%	IPG-AS-AP Philippine Long Distance Telephone Company,PH
21	8048	0.79%	CANTV Servicios, Venezuela,VE
22	8708	0.79%	RCS-RDS RCS & RDS SA,RO
23	13489	0.77%	EPM Telecomunicaciones S.A. E.S.P.,CO
24	22927	0.75%	Telefonica de Argentina,AR
25	8400	0.73%	TELEKOM-AS TELEKOM SRBIJA a.d.,RS

Total: 78,138,640 end user query sets

Who's “*Local*” and Who's Not?

Let's filter this data by removing all entries where the user and the visible resolver are in 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	29.53%	GOOGLE - Google Inc.,US
2	3356	5.26%	LEVEL3 - Level 3 Communications, Inc.,US
3	36692	4.99%	OPENDNS - OpenDNS, LLC,US
4	7470	2.55%	TRUEINTERNET-AS-AP TRUE INTERNET Co.,Ltd.,TH
5	7643	2.13%	VNPT-AS-VN Vietnam Posts and Telecommunications (VNPT),VN
6	19994	1.75%	RACKSPACE - Rackspace Hosting,US
7	14080	1.62%	Telmex Colombia S.A.,CO
8	16880	1.53%	AS2-TRENDMICRO-COM - TREND MICRO INCORPORATED,US
9	4134	1.33%	CHINANET-BACKBONE No.31,Jin-rong Street,CN
10	174	1.29%	COGENT-174 - Cogent Communications,US
11	4813	1.21%	BACKBONE-GUANGDONG-AP China Telecom(Group),CN
12	9737	0.96%	TOTNET-TH-AS-AP TOT Public Company Limited,TH
13	20746	0.93%	ASN-IDC Telecomitalia s.p.a.,IT
14	3786	0.93%	LGDACOM LG DACOM Corporation,KR
15	3462	0.80%	HINET Data Communication Business Group,TW
16	2914	0.77%	NTT-COMMUNICATIONS-2914 - NTT America, Inc.,US
17	4837	0.73%	CHINA169-BACKBONE CNCGROUP China169 Backbone,CN
18	17894	0.71%	APMI-AS-AP AyalaPort Makati, Inc. / Data Center Operator,PH
19	9121	0.67%	TTNET Turk Telekomunikasyon Anonim Sirketi,TR
20	4766	0.54%	KIXS-AS-KR Korea Telecom,KR
21	23724	0.51%	CHINANET-IDC-BJ-AP IDC, China Telecommunications Corporation,CN
22	29791	0.48%	VOXEL-DOT-NET - Voxel Dot Net, Inc.,US
23	18101	0.47%	RELIANCE-COMMUNICATIONS-IN Reliance Communications Ltd.DAKC MUMBAI,IN
24	4808	0.46%	CHINA169-BJ CNCGROUP IP network China169 Beijing Province Network,CN
25	8151	0.44%	Uninet S.A. de C.V.,MX

Total: 31,366,769 (41% of total) end user query sets

Who's "*Foreign*"?

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 into different countries

Foreign (CC) Resolution: Top Resolvers by AS

Rank	AS	Use	AS Name
1	15169	42.69%	GOOGLE - Google Inc.,US
2	3356	7.47%	LEVEL3 - Level 3 Communications, Inc.,US
3	36692	7.05%	OPENDNS - OpenDNS, LLC,US
4	19994	2.56%	RACKSPACE - Rackspace Hosting,US
5	174	1.87%	COGENT-174 - Cogent Communications,US
6	16880	1.70%	AS2-TRENDMICRO-COM - TREND MICRO INCORPORATED,US
7	2914	1.09%	NTT-COMMUNICATIONS-2914 - NTT America, Inc.,US
8	4134	0.91%	CHINANET-BACKBONE No.31,Jin-rong Street,CN
9	29791	0.70%	VOXEL-DOT-NET - Voxel Dot Net, Inc.,US
10	3462	0.67%	HINET Data Communication Business Group,TW
11	9121	0.64%	TTNET Turk Telekomunikasyon Anonim Sirketi,TR
12	3303	0.64%	SWISSCOM Swisscom (Switzerland) Ltd,CH
13	6939	0.63%	HURRICANE - Hurricane Electric, Inc.,US
14	6147	0.50%	Telefonica del Peru S.A.A.,PE
15	6713	0.48%	IAM-AS,MA
16	8048	0.47%	CANTV Servicios, Venezuela,VE
17	3257	0.47%	TINET-BACKBONE Tinet SpA,DE
18	13238	0.43%	YANDEX Yandex LLC,RU
19	45595	0.41%	PKTELECOM-AS-PK Pakistan Telecom Company Limited,PK
20	9299	0.40%	IPG-AS-AP Philippine Long Distance Telephone Company,PH
21	7643	0.39%	VNPT-AS-VN Vietnam Posts and Telecommunications (VNPT),VN
22	45758	0.39%	TRIPLETNET-AS-AP Triplet Internet Internet service provider Bangkok,TH
23	8151	0.38%	Uninet S.A. de C.V.,MX
24	7470	0.35%	TRUEINTERNET-AS-AP TRUE INTERNET Co.,Ltd.,TH
25	4837	0.35%	CHINA169-BACKBONE CNCGROUP China169 Backbone,CN

Total: 21,770,772 (28% of total) end user query sets

Countries with users that have the **lowest** foreign resolution counts

CC	%	Foreign	Domestic	Country
KR	6.40%	126,289	1,847,614	Republic of Korea
MT	9.19%	6,616	65,386	Malta
PF	9.46%	866	8,289	French Polynesia
EE	10.28%	7,506	65,534	Estonia
LT	10.54%	30,701	260,520	Lithuania
GR	10.76%	75,816	628,865	Greece
NZ	11.46%	16,913	130,625	New Zealand
US	12.27%	345,141	2,468,489	United States of America
CN	12.55%	1,040,371	7,252,198	China
UY	12.71%	18,610	127,825	Uruguay
CL	13.17%	95,664	630,654	Chile
FR	13.45%	135,454	871,551	France
SA	13.62%	65,878	417,676	Saudi Arabia
HR	13.66%	41,844	264,445	Croatia
FI	13.88%	11,941	74,069	Finland
PT	14.05%	36,183	221,333	Portugal
NO	14.16%	5,414	32,817	Norway
LV	14.32%	17,282	103,380	Latvia
MD	14.51%	13,058	76,947	Republic of Moldova
PE	14.95%	312,380	1,776,943	Peru
OM	15.20%	7,959	44,402	Oman
ES	15.83%	100,854	536,200	Spain
UZ	15.89%	1,927	10,199	uzbekistan
SI	16.36%	30,856	157,700	Slovenia
BE	16.47%	22,420	113,685	Belgium
RO	16.49%	246,980	1,250,893	Romania
SE	17.01%	14,803	72,197	Sweden
IL	17.07%	42,632	207,185	Israel
MX	17.14%	620,083	2,996,650	Mexico
DE	17.57%	84,623	397,127	Germany

Countries with highest foreign resolution counts

CC	%	Foreign	Domestic	Country
DZ	99.20%	1,421,962	11,481	Algeria
VC	99.07%	5,727	54	Saint Vincent and the Grenadines
TC	99.05%	1,667	16	Turks and Caicos Islands
AW	98.55%	4,978	73	Aruba
AF	94.94%	17,816	949	Afghanistan
BF	93.58%	3,572	245	Burkina Faso
SO	93.50%	6,125	426	Somalia
DJ	93.06%	8,075	602	Djibouti
GN	87.93%	1,901	261	Guinea
GQ	87.55%	1,048	149	Equatorial Guinea
LR	85.84%	1,358	224	Liberia
CD	84.67%	2,336	423	Democratic Republic of the Congo
NI	82.95%	51,406	10,567	Nicaragua
CG	81.10%	1,952	455	Congo
SV	78.61%	88,730	24,147	El Salvador
IR	76.26%	1,031	321	Iran (Islamic Republic of)
RE	74.56%	3,057	1,043	Reunion
SL	72.16%	1,296	500	Sierra Leone
ZW	71.46%	3,305	1,320	Zimbabwe
VN	68.42%	2,265,186	1,045,587	Vietnam
BN	67.66%	22,813	10,904	Brunei Darussalam
BI	67.40%	827	400	Burundi
ZM	64.17%	2,644	1,476	Zambia
NG	63.29%	21,066	12,217	Nigeria
HN	60.19%	34,908	23,084	Honduras
GH	59.30%	31,273	21,464	Ghana
AZ	57.01%	134,218	101,222	Azerbaijan

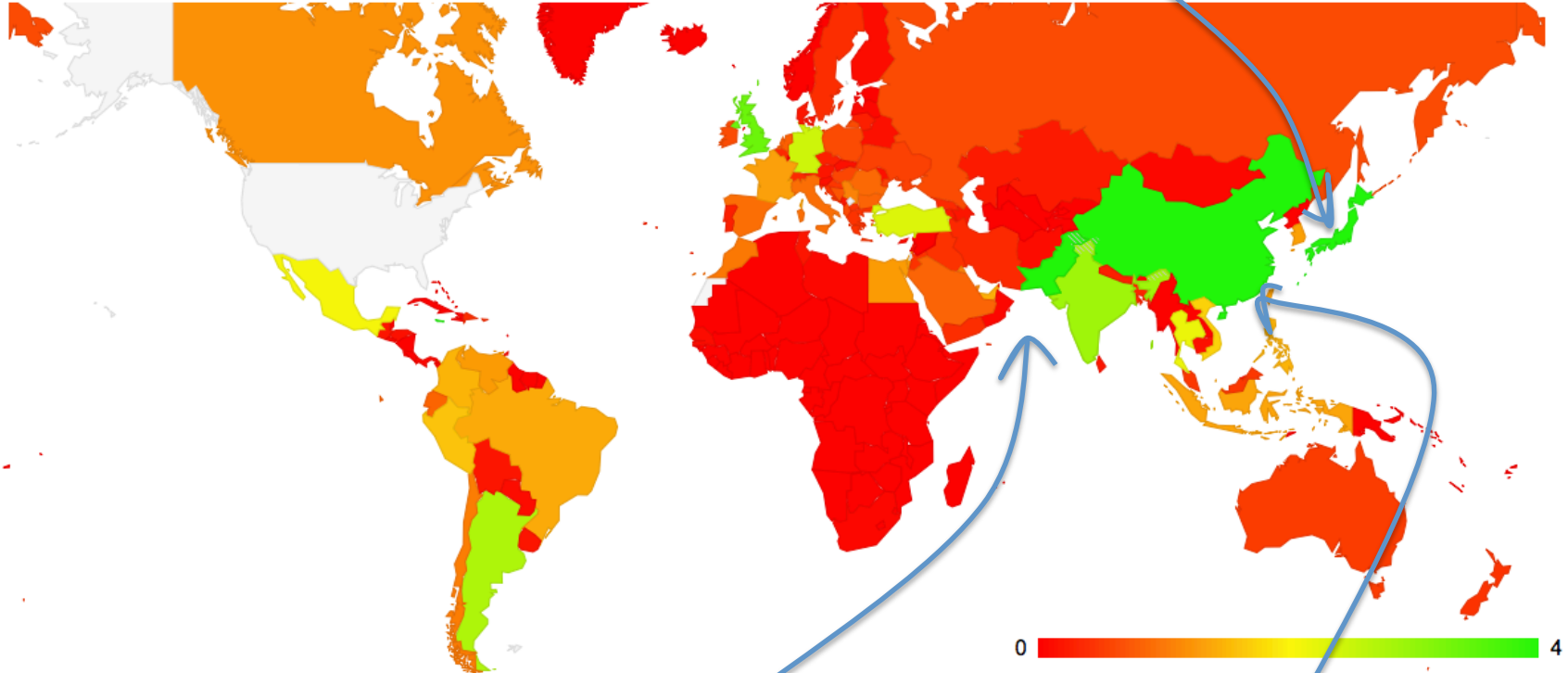
Mapping the resolver spread

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

Mapping Foreign Resolution- US

11.95% use JP resolvers

Foreign Resolver Distribution for United States of America (2014)



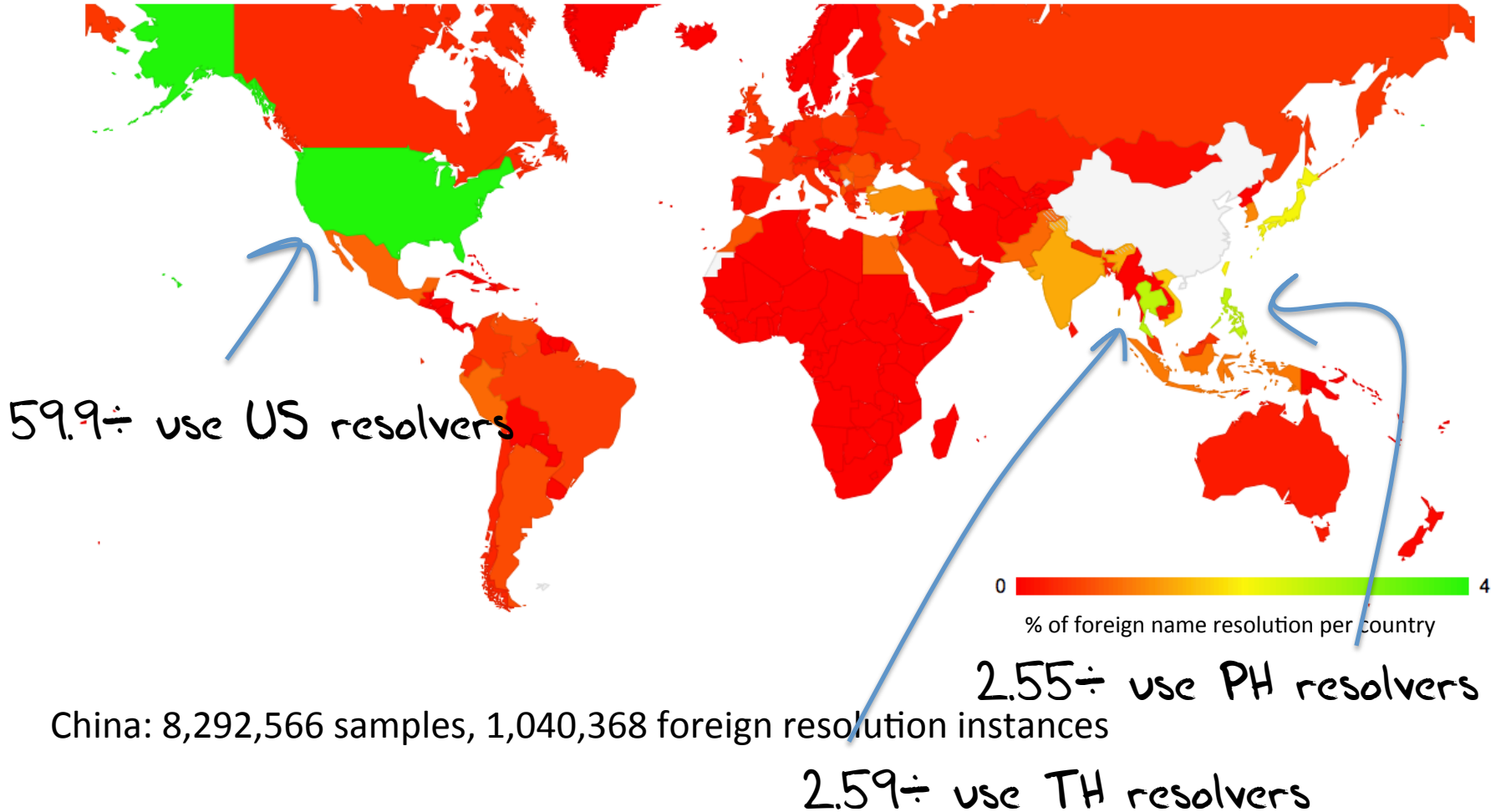
6.46% use PK resolvers

US: 2,813,576 samples, 345,087 foreign resolution instances

7.23% use CN resolvers

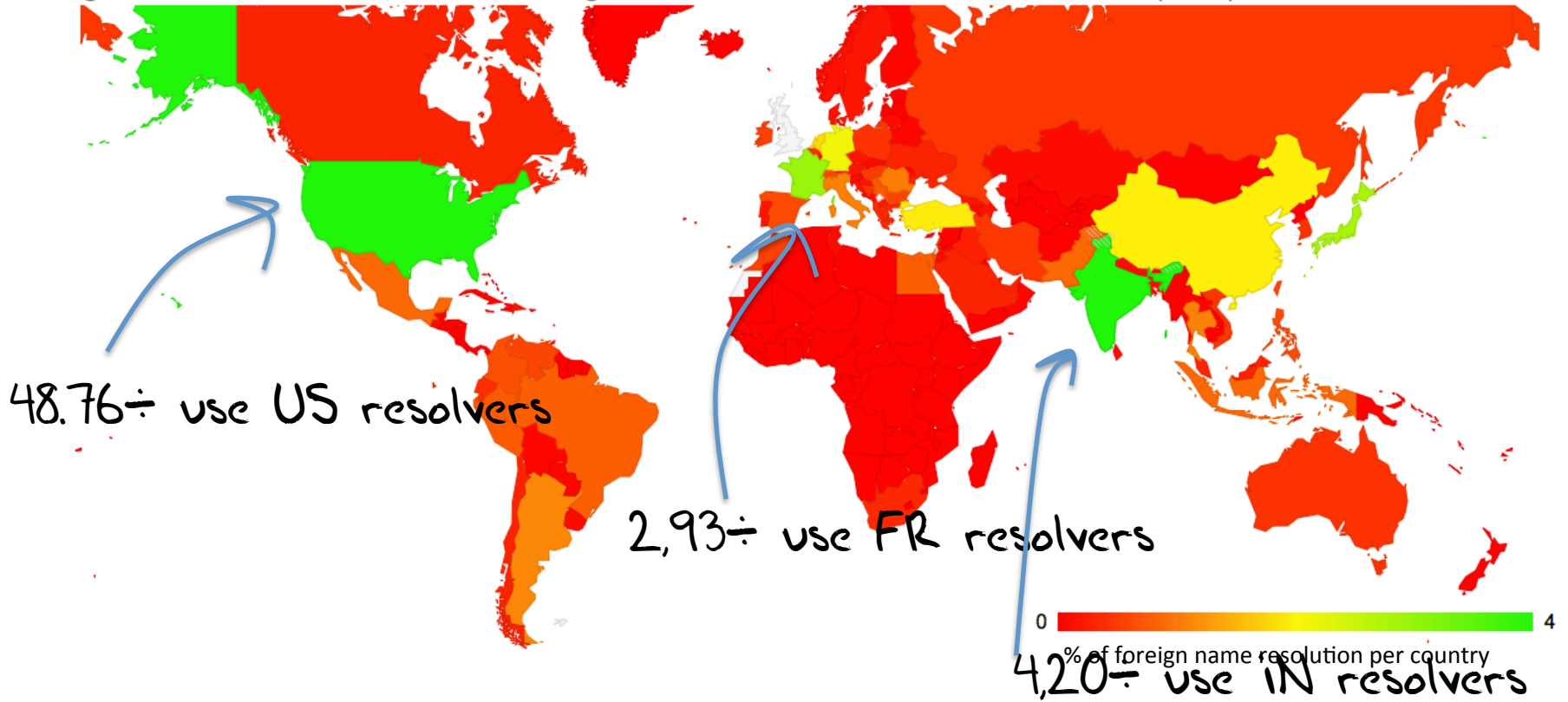
Mapping Foreign Resolution - CN

Foreign Resolver Distribution for China (2014)



Mapping Foreign Resolution - GB

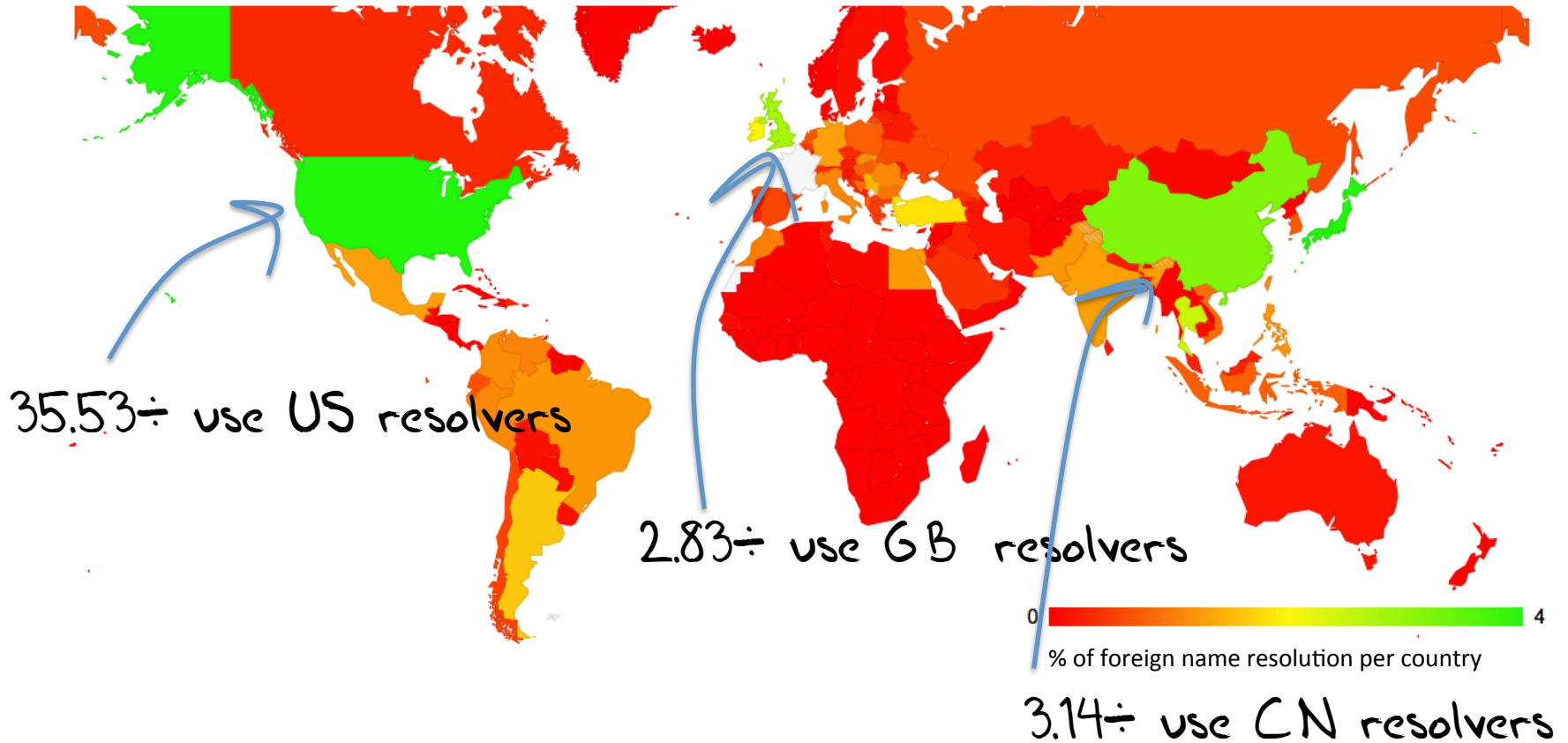
Foreign Resolver Distribution for United Kingdom of Great Britain and Northern Ireland (2014)



UK: 519,190 samples, 106,638 foreign resolution instances

Mapping Foreign Resolution - FR

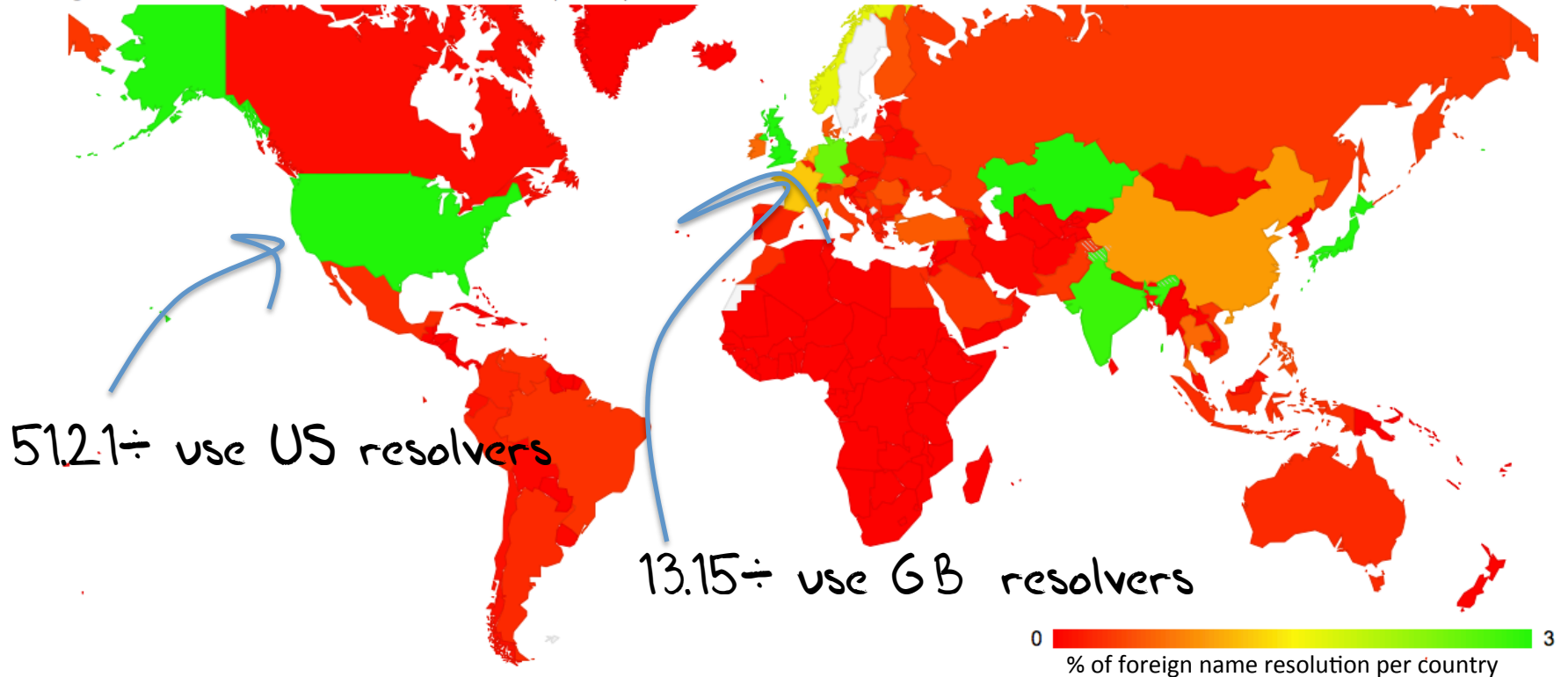
Foreign Resolver Distribution for France (2014)



France: 1,007,004 samples, 135,453 foreign resolution instances

Mapping Foreign Resolution - SE

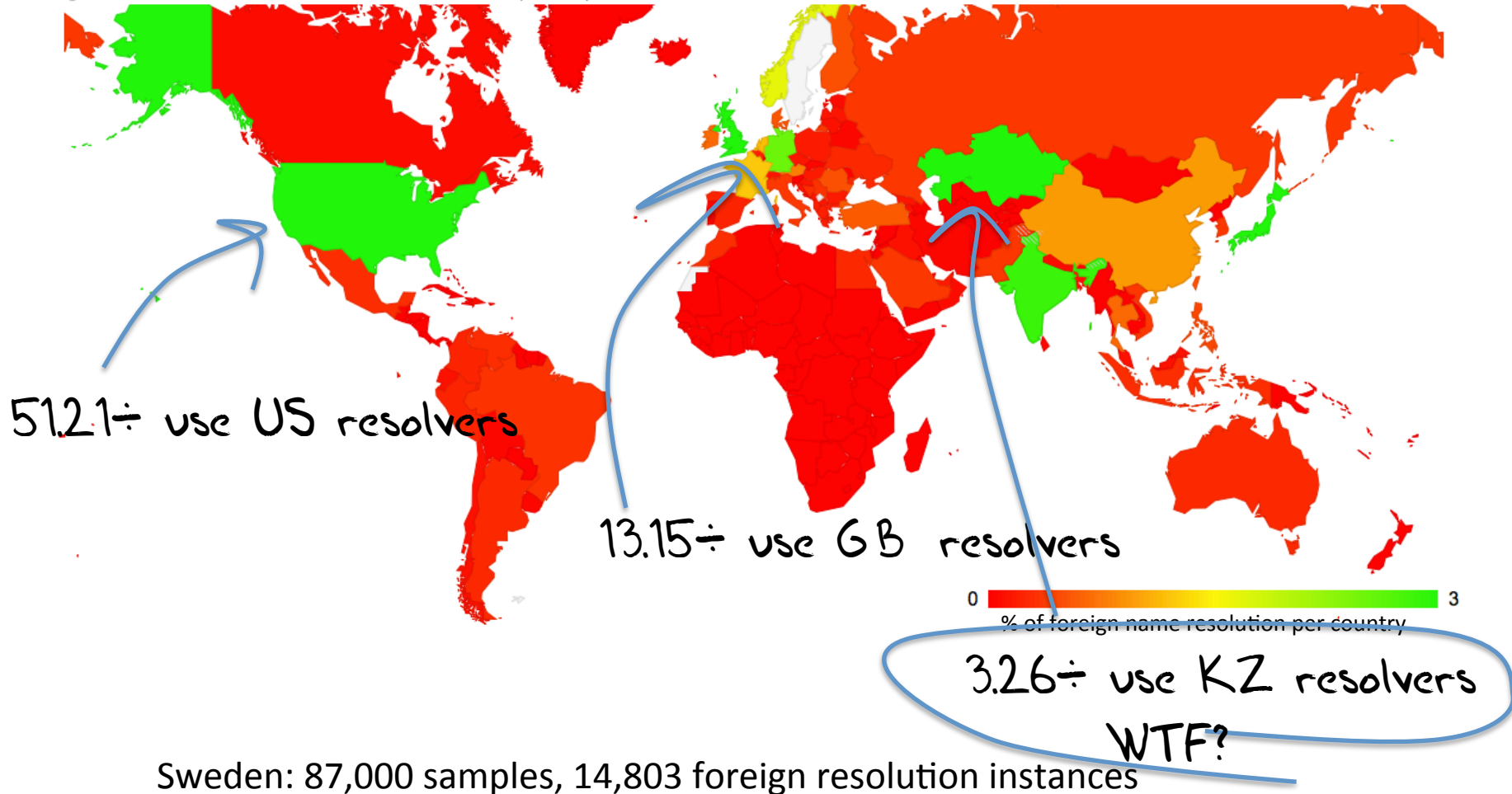
Foreign Resolver Distribution for Sweden (2014)



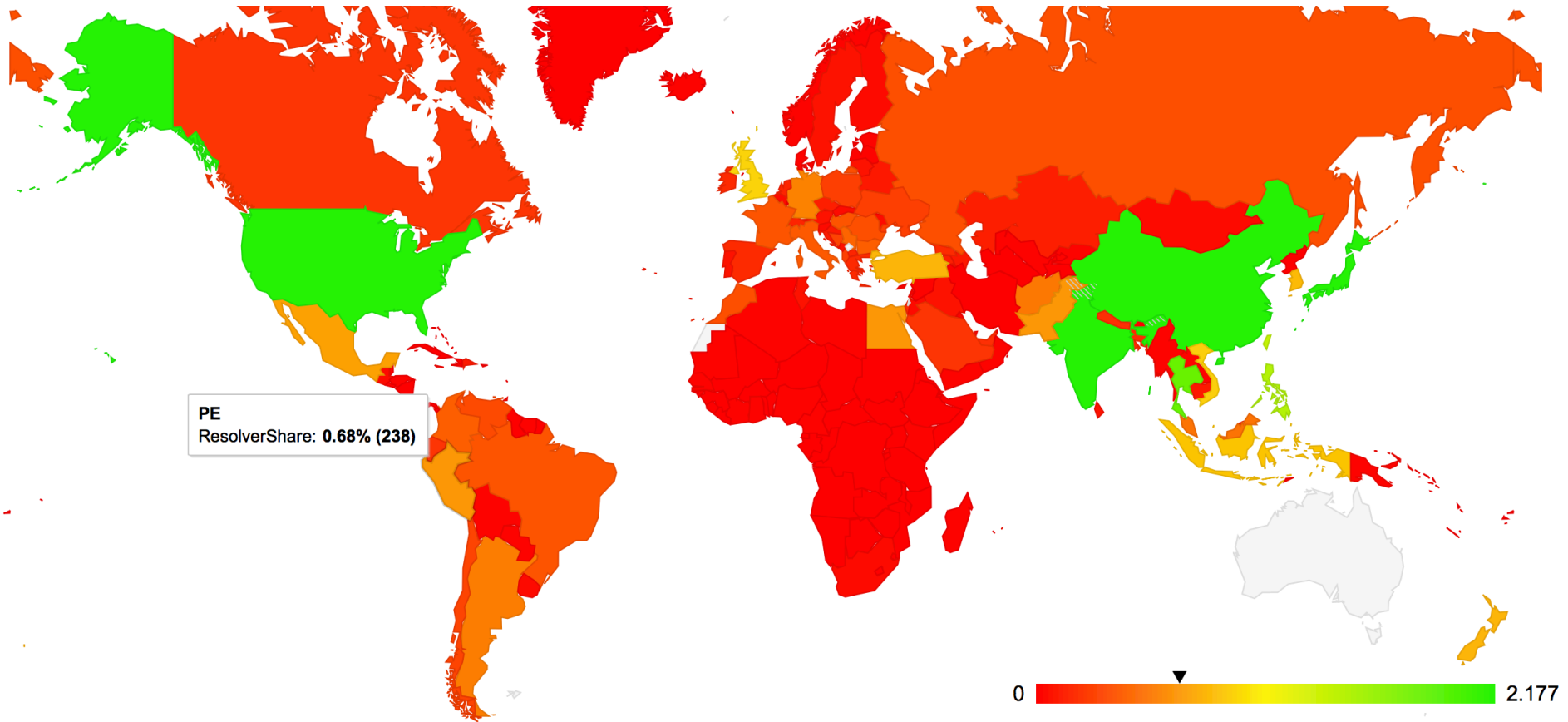
Sweden: 87,000 samples, 14,803 foreign resolution instances

Mapping Foreign Resolution - SE

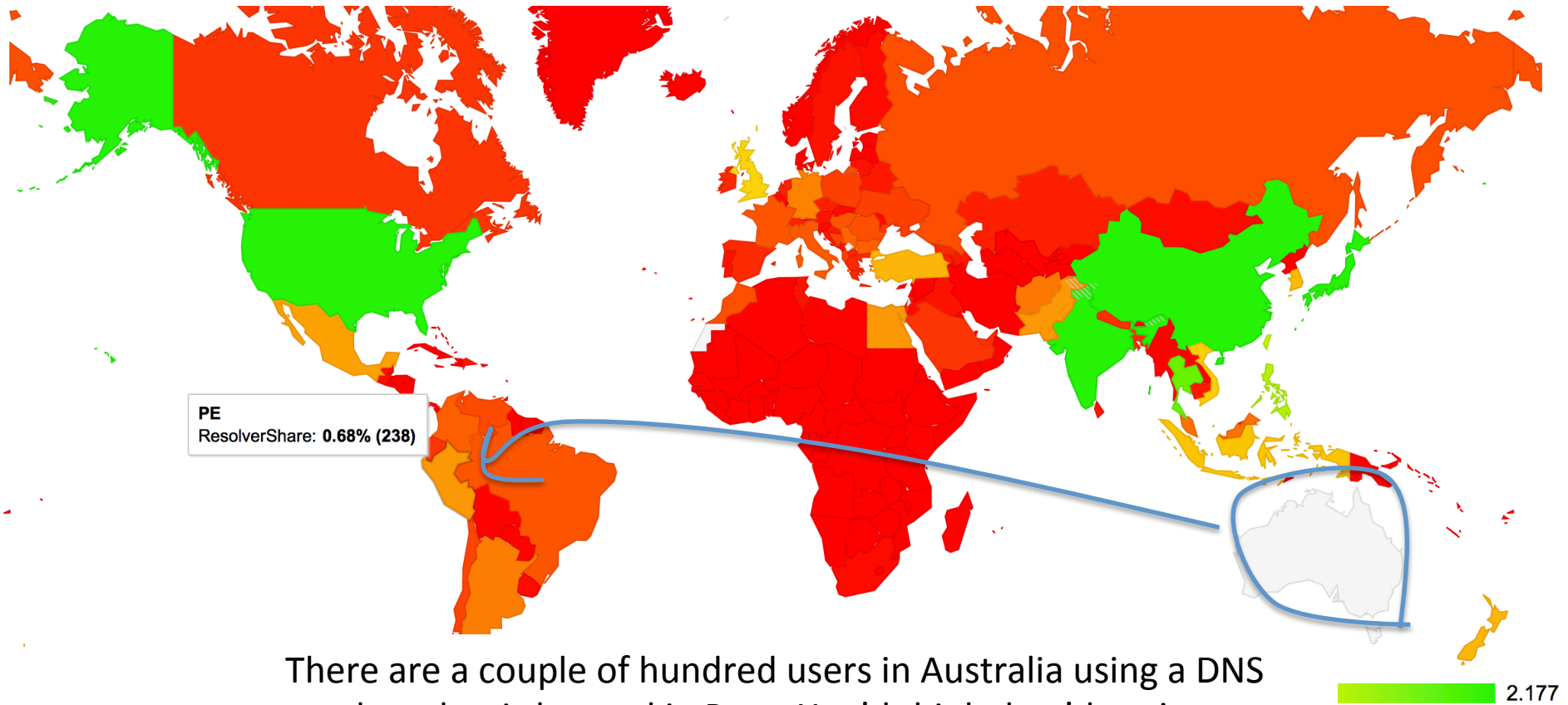
Foreign Resolver Distribution for Sweden (2014)



Mapping Foreign Resolution - AU



Mapping Foreign Resolution - AU



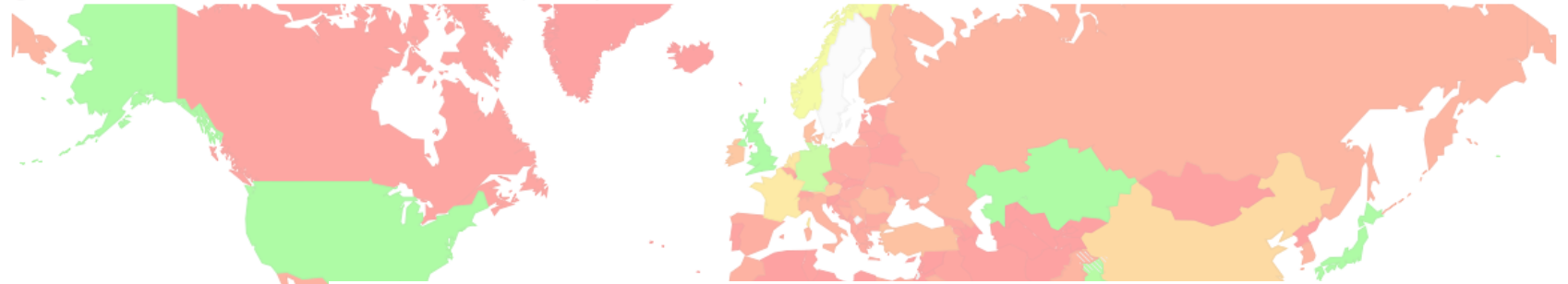
There are a couple of hundred users in Australia using a DNS resolver that is located in Peru. You'd think they'd notice that something was sort of slow with their Internet if all their DNS queries are being sent out via Peru!

Why is this happening?

- ❑ It's Google: Google's Public DNS (all instances are mapped to the US in this per-AS analysis)
- ❑ 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>

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

Foreign Resolver Distribution for Sweden (2014)



<http://bit.ly/13oU09X>



0 3
% of foreign name resolution per country

Thanks!

