

- 1) Prevalence of Network Address Port Translation (NAPT)
- 2) Traceroutes using ICMP, TCP, and UDP Probes
- 3) HOPS Candidate Measurement Tools

1) Prevalence of NAT

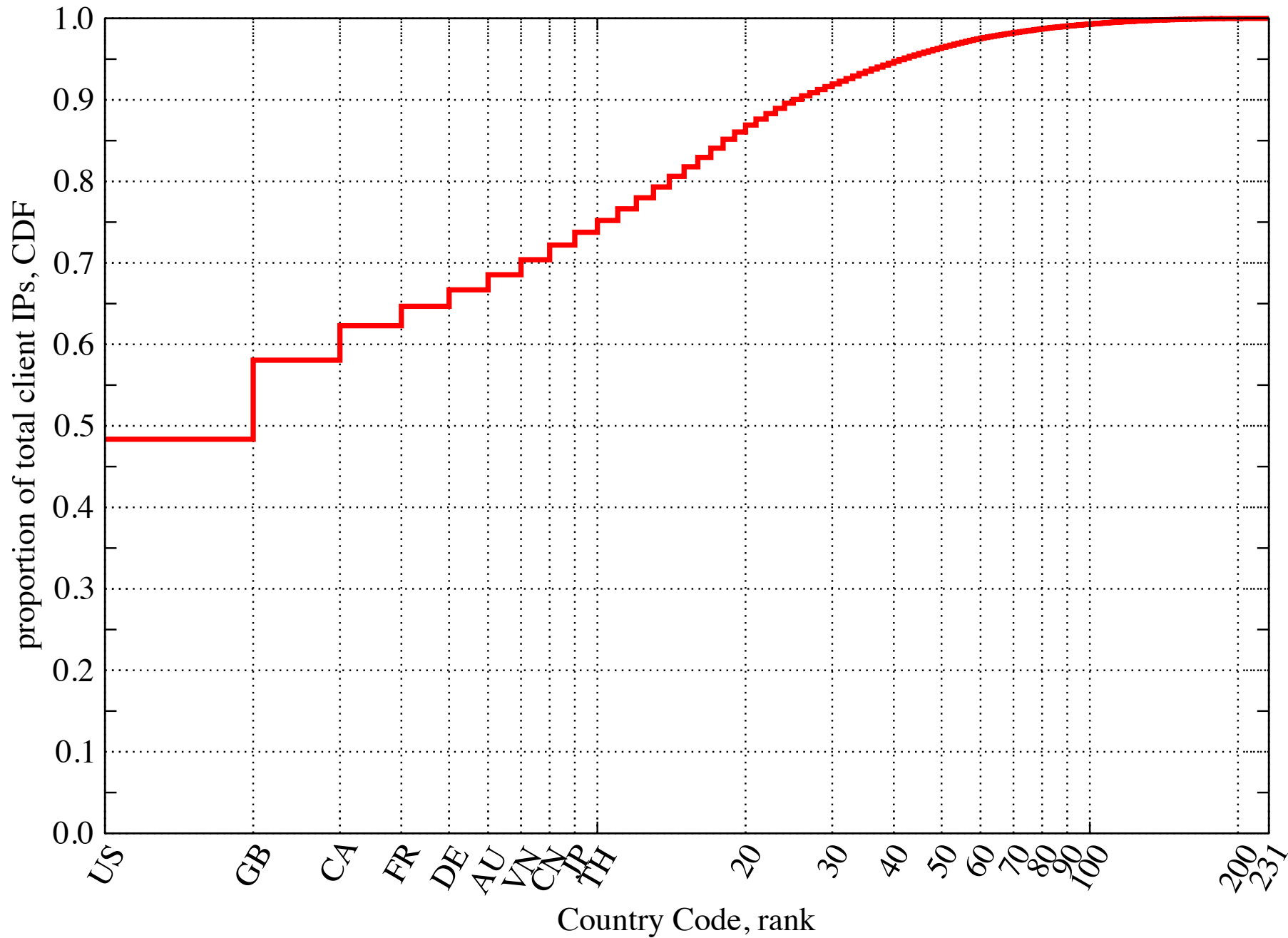


- How and when are port numbers translated by middleboxes?
- A measurement opportunity:
 - There exists a peer-to-peer application that uses a *fixed UDP port number* on the client and TURN (RFC 5928) for connection establishment.
 - When we observe that application's traffic having a *different* client port number, we can assume that it experienced *port translation, e.g.*, by a NAT middlebox.

1) Prevalence of NAPT: What We See



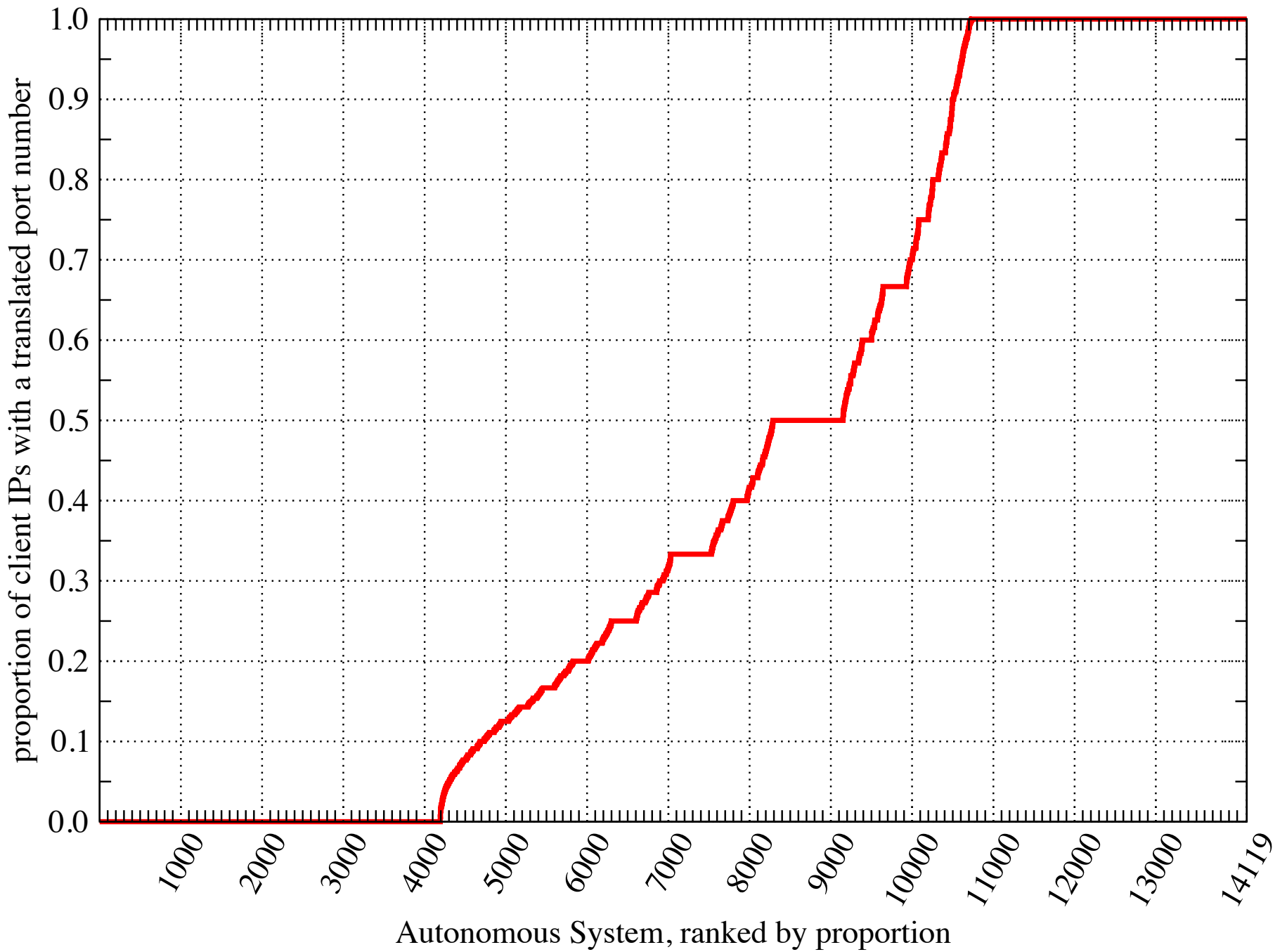
- An initial look, **one day**: July 14, 2015:
 - ~3 million IPv4 clients from 24 observations, 1 hour interval
 - ~14,000 ASNs
 - 231 countries
- **32% of client IPs seem to involve port translation;** *i.e.*, for 68% of client IPs, we observed at least one session in which the client application port number was *not* translated.
- **55% of {IP,port} pairs seem to involve port translation.**

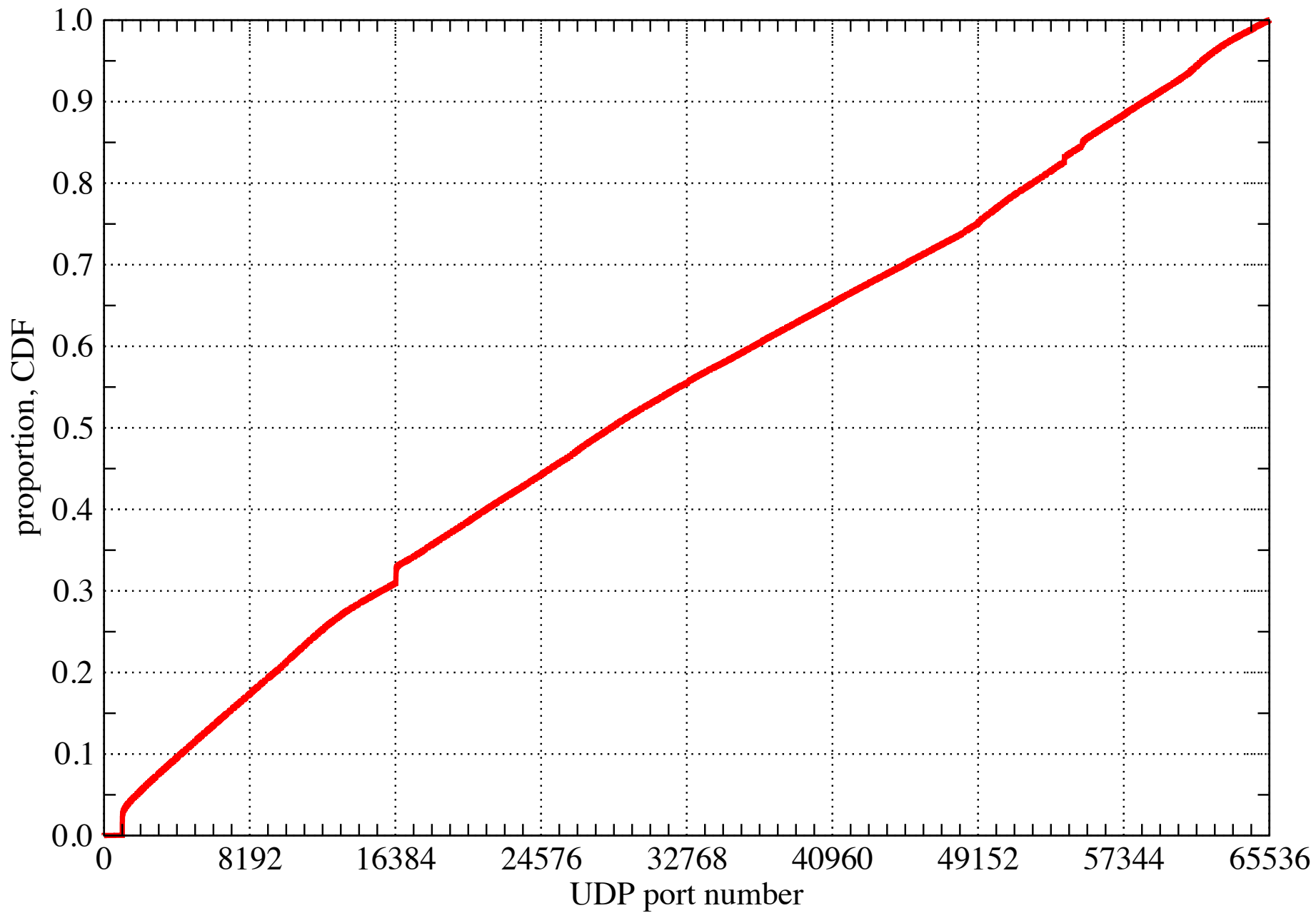


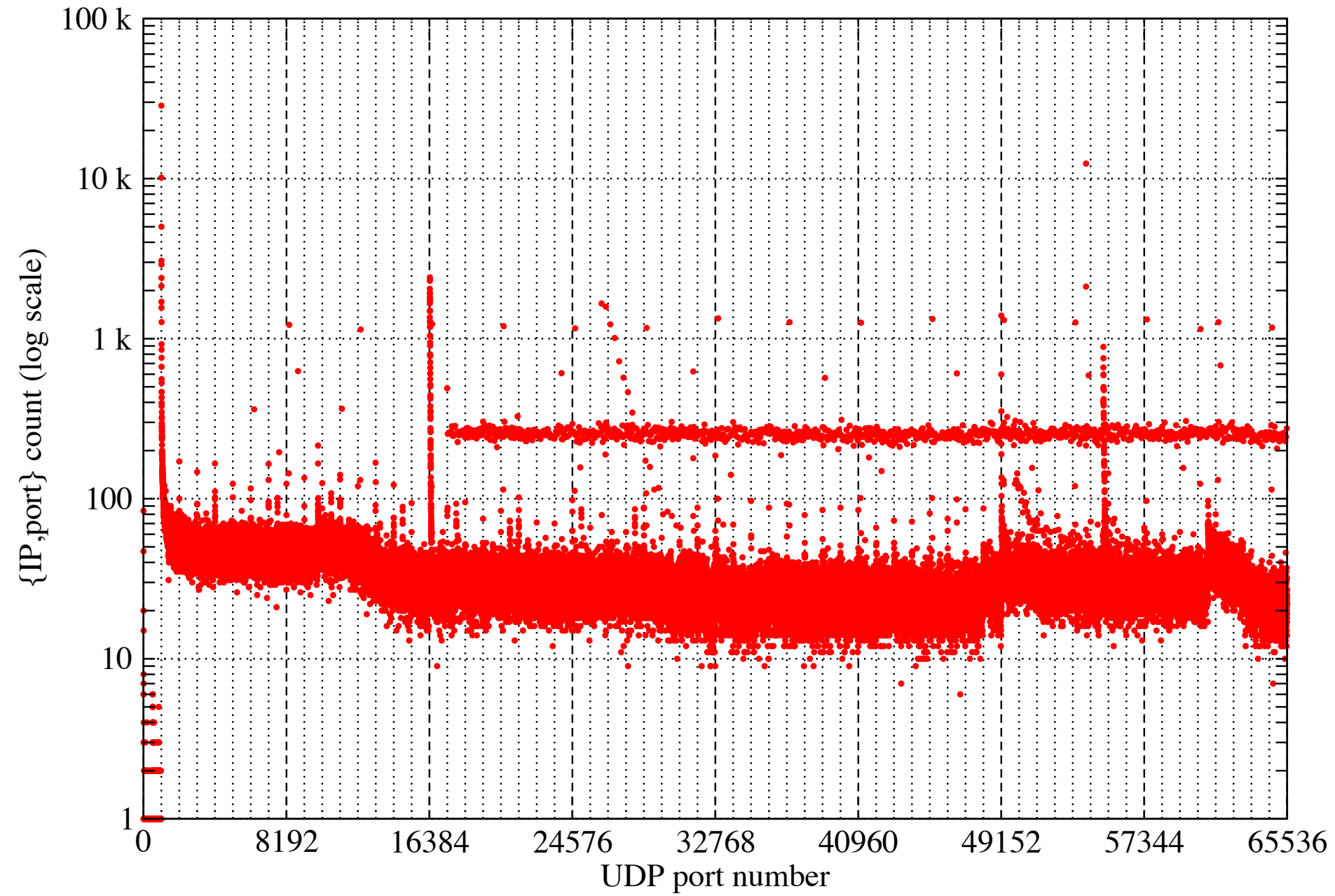
Prevalence: Countries Ranked Most to Least NAPT

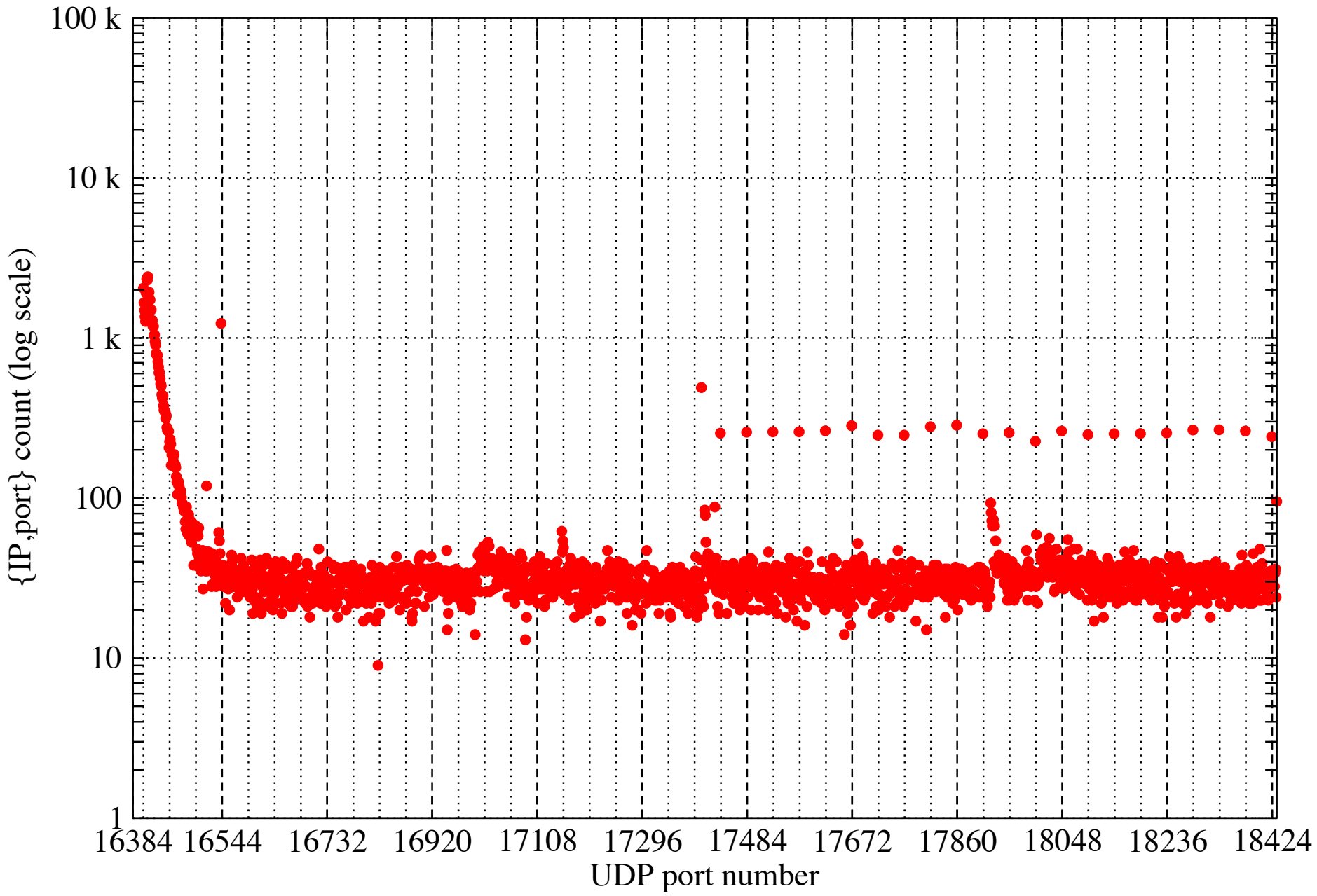


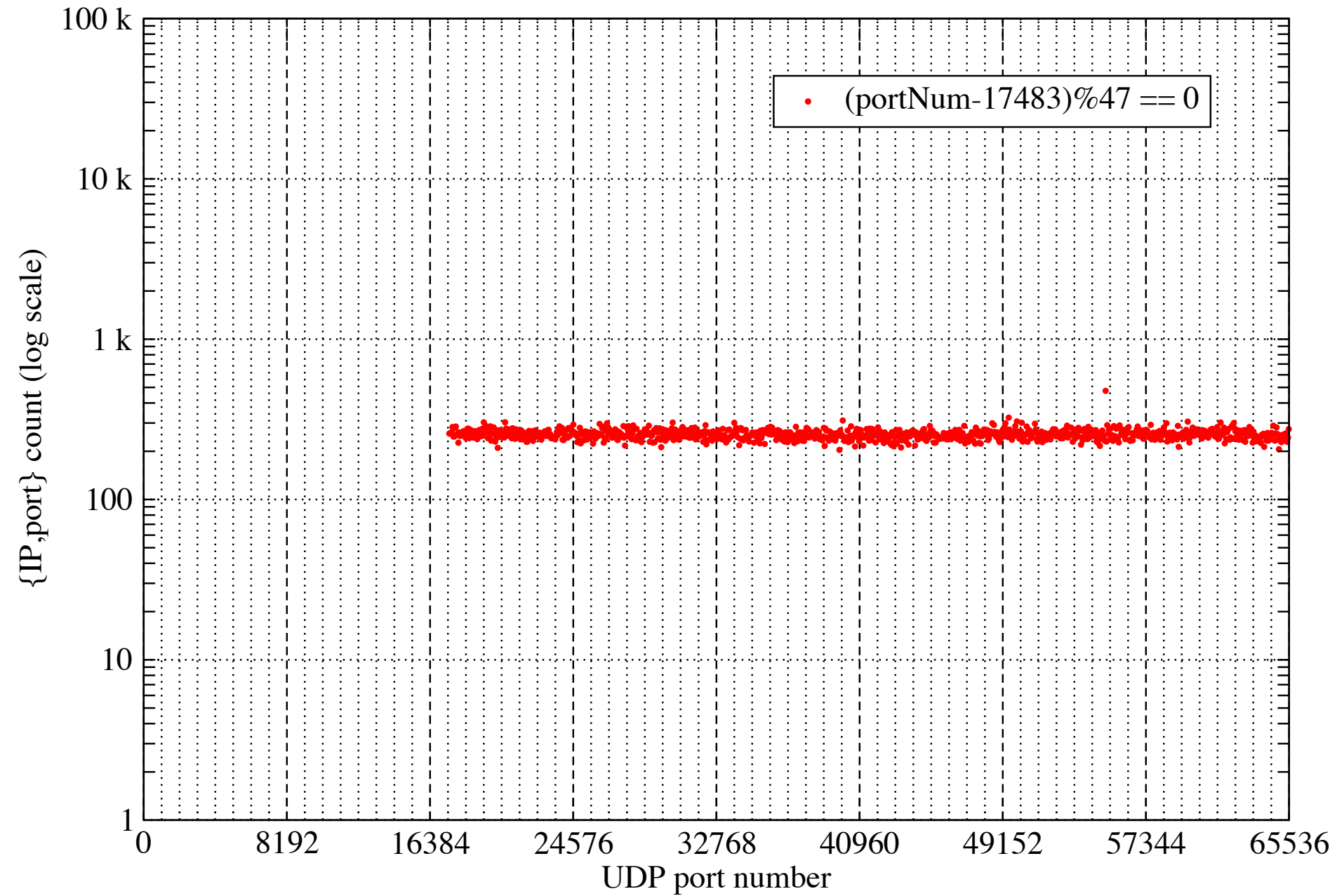
Rank	Proportion	Country	Rank	Proportion	Country
1	0.713143	CN	12	0.450548	AU
2	0.643018	TW	13	0.426142	DE
3	0.626632	TH	14	0.417838	ES
4	0.603640	IN	15	0.393855	KR
5	0.589534	MX	16	0.358887	NL
6	0.586074	IT	17	0.291741	FR
7	0.581910	VN	18	0.262756	US
8	0.575361	TR	19	0.254134	BR
9	0.563807	SE	20	0.222577	CA
10	0.482132	RU	21	0.199231	GB
11	0.472796	BE	22	0.119953	JP











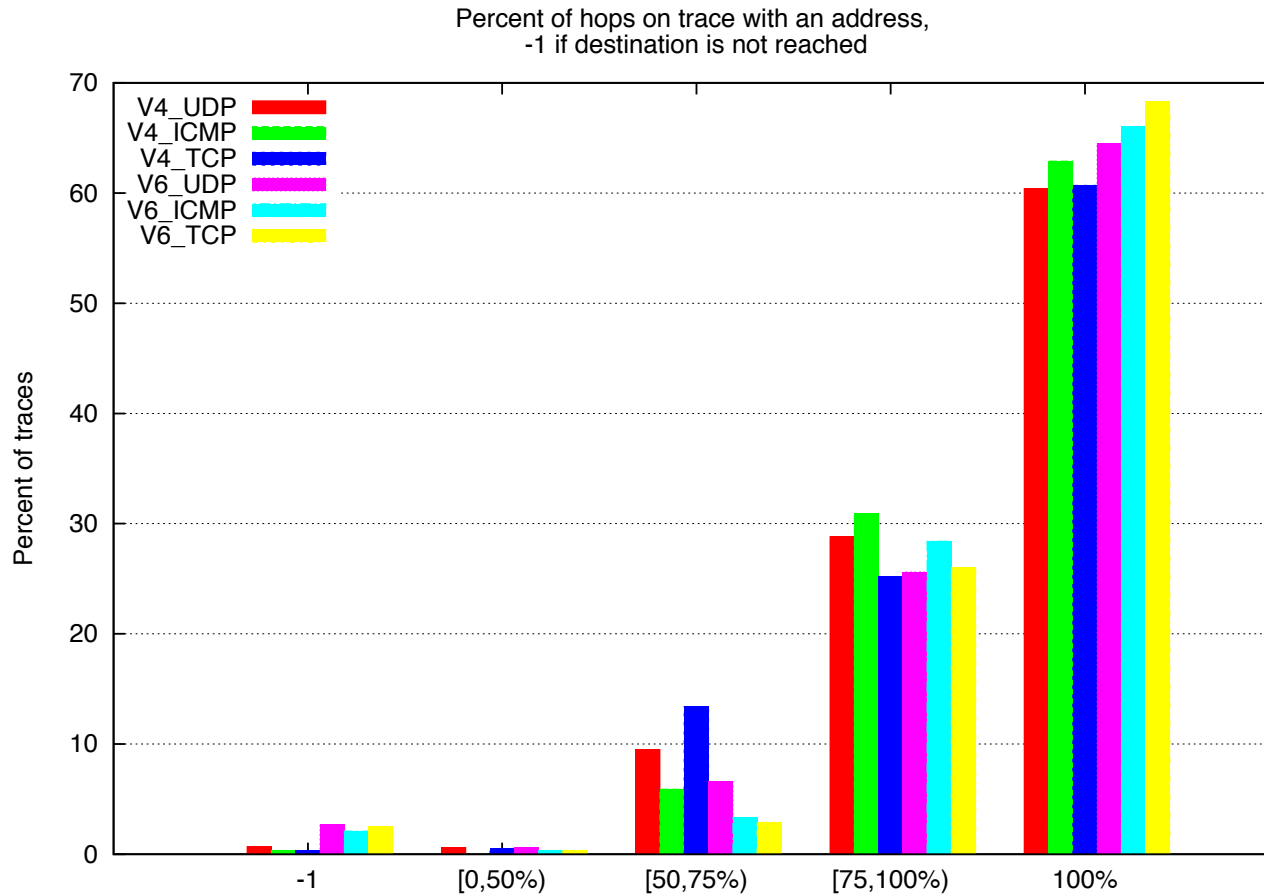
NAPT: Top 10 ASNs for “% 47” port translations



- 1 AS21928 - T-Mobile USA
- 2 AS20057 - AT&T Mobility (Cingular)
- 3 AS3651 - Sprint
- 4 AS29180 - Telefonica UK Limited (O2)
- 5 AS10507 - Sprint PCS
- 6 AS8151 - Uninet S.A.
- 7 AS1221 - Telstra Pty Ltd
- 8 AS25135 - Vodafone Limited
- 9 AS36522 - BELL MOBILITY INC.
- 10 AS7552 - Viettel Corporation

- A Carrier-Grade NAT behavior? To be determined...

2) Traceroutes using ICMP, TCP/SYN, UDP probes over IPv4 & IPv6 to dual-stack servers



- Overall, not a significant difference.
 - IPv6 had a bit more traces where all hops responded.

Do see significant differences for particular AS's



- Consider: traces over IPv4 to 37,000 AS's:
 - 13 vantage points located in the USA, Great Britain, France, Sweden, Japan, & Korea
 - Targets in 226 countries
- The following AS's have significant variation in success of the ICMP, TCP/SYN, UDP probe types.

Example AS's



AS	Router Addr. count	% for which a response was received	UDP	ICMP	TCP	Organization
71	12	58	100	58	HP-INTERNET-AS_Hewlett-Packard_Company_US	
1226	10	100	0	100	CTA-42-AS1226_California_Technology_Agency_US	
2706	13	100	62	100	PI-HK_Pacnet_Internet_Hong_Kong_Limited_HK	
4782	13	100	0	100	GSNET_Data_Communication_Business_Group_TW	
5653	12	100	0	0	UCSF_University_of_California_San_Francisco_US	
6022	20	100	100	0	DNIC-ASBLK-05800-06055_DoD_Network_Inform._Center_US	
8346	13	0	100	100	SONATEL-AS_Autonomous_System_SN	
9644	16	100	0	94	SKTELECOM-NET-AS_SK_Telecom_KR	
9688	17	12	100	12	ICFC-AS-KR_ICFC_KR	
11457	13	100	100	69	TEXLINK_Tex-Link_Communications_Inc_US	
12969	14	93	100	57	VODAFONE_ICELAND_Fjarskipti_ehf_IS	
13445	12	92	0	100	13445_Webex_Communications_Inc_US	
16617	10	50	100	100	COMMUNITYISP_CISP_US	
17310	10	100	100	70	BVU-2_BRISTOL_VIRGINIA_UTILITIES_US	

Example AS's, continued



AS	Router Addr. count	% for which a response was received	UDP	ICMP	TCP	Organization
17561	10	70	90	100	DOFWA-AP_Department_of_Finance_Western_Australia_AU	
19271	20	95	100	55	PEAK10_Peak_10_US	
23575	13	100	69	77	SKN-NW-2-AS-KR_SK_Networks_KR	
26827	10	70	100	70	EPBTELECOM_EPB_Fiber_Optics_US	
27064	13	100	0	0	DNIC-ASBLK-27032-27159_DoD_Network_Inform._Center_US	
28926	11	100	100	64	DONTELE-AS_Telenet_LLC_UA	
32934	28	0	100	0	FACEBOOK_Facebook_Inc_US	
33666	10	90	100	20	CMCS_Comcast_Cable_Communications_Inc_US	
36666	10	100	100	10	GTCOMM_GloboTech_Communications_CA	
38397	12	8	100	100	GANGSEO_DISTRICT_OFFICE_OF_EDUCATION_IN_SEOUL_KR	
38895	10	100	100	60	AMAZON-AS-AP_Amazoncom_Tech_Telecom_JP	
51690	23	4	100	4	APPLIEDTECH-AS_Applied_Technologies_Ltd_RU	
56308	13	77	100	62	TELIN-NET_TELEKOMUNIKASI_INDONESIA_INTERNATIONAL_SG	

3) HOPS Candidate Measurement Tools



- **intrace** – an “inband traceroute” tool that traces within existing locally or remotely initiated TCP connections
<https://github.com/robertswiecki/intrace>
- **DASU** – a P2P measurement framework in the form of a bitTorrent client plug-in (NSDI 2013)
<http://www.aqualab.cs.northwestern.edu/projects/115-dasu-isp-characterization-from-the-network-edge>
- **ALICE** – a mobile experiment and measurement engine in library form for incorporation into multiple Android apps
<http://www.aqualab.cs.northwestern.edu/projects/261-alice>
<http://www.aqualab.cs.northwestern.edu/262-details-alice>