

IPv6 Address Populations in the Wild

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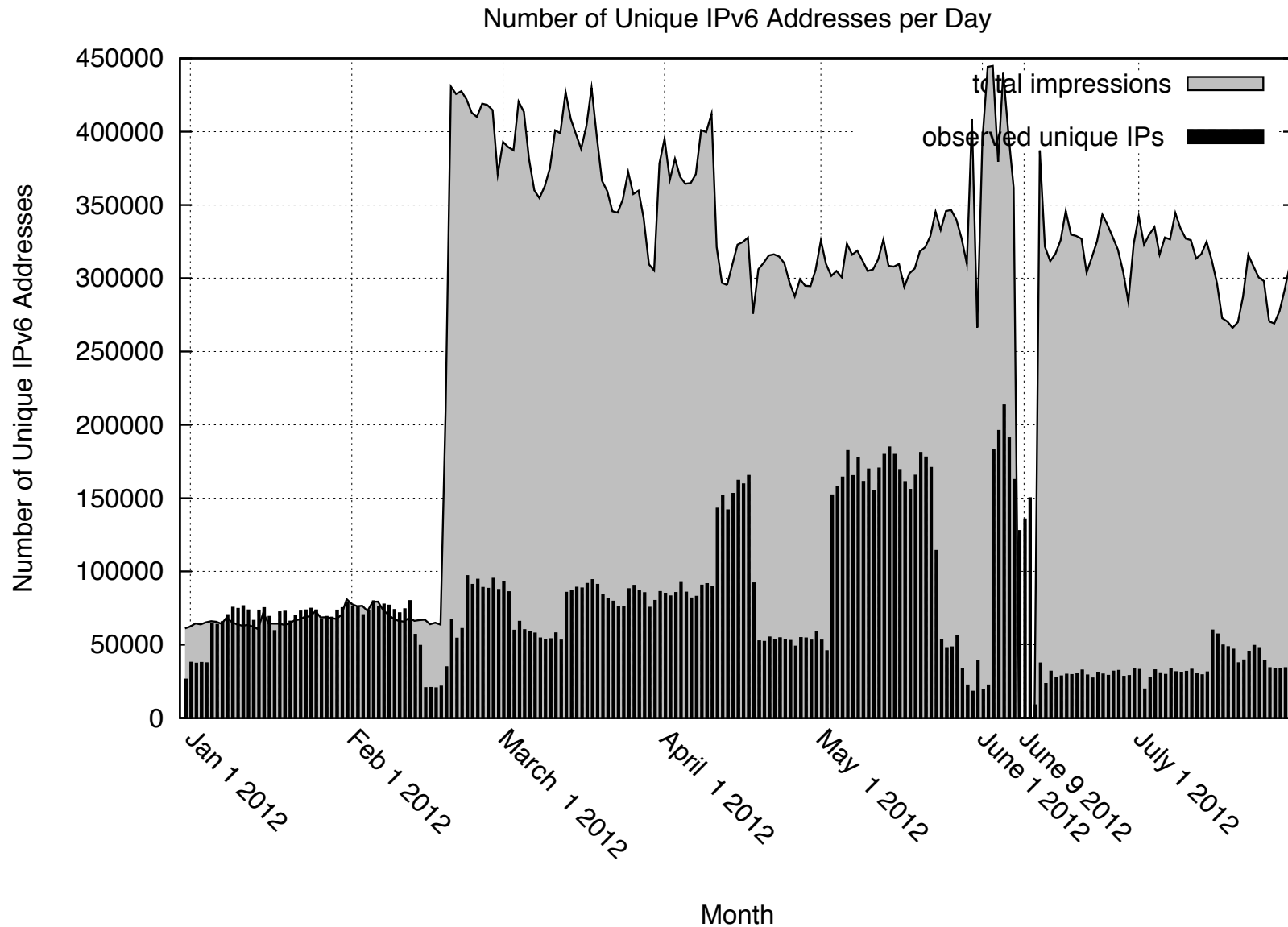
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Outline

- The experiment
- Results and analysis
 - Population mix
 - Teredo
 - 6to4
 - MAC and EUI-64
- Conclusions

Unique IPv6 Addresses per day



IPv6 Population Mix

Address Type	Unique IPv6 Addresses	Percentage
Native	LACNIC.....1.3K	1.3
	APNIC.....41.6K	
	RIPE.....90.9K	
	ARIN.....40.5K	
	AFRINIC.....0.1K	
	TOTAL.....174.4K	
Teredo	11.12M	79.2
6to4	2.75M	19.5
Total IPv6 hosts	14.04M	100%
IPv6 Ready Hosts	1.37M	9.75%
Additional IPv6 Capable Hosts (Literal-only)	3.90M	27.7%

Table 1. IPv6 capability population mix

Regional Distribution of Native IPv6 Addresses

Region	Unique ASNs	Top 5 ASNs	Organization	IPv6 Addresses
ARIN	277	7018 22394 812 53347 7922	ATT-Internet4 Cellco/Verizon-Wireless ROGERS-CABLE PREMIER-COMM COMCAST-7922	20499 6811 2993 2217 2170
RIPE	708	12322 8708 15557 42689 8426	PROXAD RDSNET LDCOMNET CABLECOM CLARANET	47492 22335 1994 1954 1813
APNIC	282	2516 23655 681 38083 17412	KDDI SNAP-NZ-AS ERX-KAWAIIHIKO-1 CURTIN-UNI-AS-AP WOOSHWIRELESSNZ	14150 2664 1709 1644 1544
LACNIC	109	53166 11242 28140 13679 27947	- POP-SC - Po - Centros Culturales/Mexico Telconet S.A	172 155 77 77 69
AFRINIC	8	36959 37349 14988 36989 15808	afczas Aptus BTC-GATE1 ANWARNET ACCESSKENYA-KE	34 17 17 12 12

Table 2. Sources of Native IPv6 Addresses

Decoding Teredo

Bits	0 - 31	32 - 63	64 - 79	80 - 95	96 - 127
Length	32 bits	32 bits	16 bits	16 bits	32 bits
Description	Prefix	Teredo server IPv4	Flags	Obfuscated UDP port	Obfuscated Client public IPv4
Part	2001:0000	4136:e378	8000	63bf	3fff:fdd2
Decoded		65.54.227.120	cone NAT	40000	192.0.2.45

Source: Wikipedia

- Encoded Information:
 - Prefix 2001:0000::/32
 - Teredo server
 - NAT flag
 - UDP Port
 - Client IPv4

Teredo Servers

Country	Teredo Servers
US - United States	76
GB - Great Britain	33
SE - Sweden	25
DK - Denmark	14
NO - Norway	13

Teredo Server	Teredo Clients
65.55.158.118	6.58M
94.245.121.253	2.43M
94.245.121.251	1.92M
94.245.115.184	182.45K
83.170.6.76	1.42K

- 11M unique IPv6 addresses
- Overall 258 Teredo servers in 171 unique ASNs in 39 countries
- 150 in RIPE region, 86 in ARIN, 19 in APNIC, 3 in AFRINIC, none in LACNIC
- Top 5 servers account for almost all of the addresses observed

Teredo and Cone NAT

Region	Cone NAT
ARIN	939
RIPE	4821
APNIC	7589
LACNIC	1311
AFRINIC	293

ASN	Cone NAT
17974 - Indonesia Telecom	2186
4771 - NZTELECOM	1470
6799 - OTENET-Greece	421
9556 - ADAM Internet	378
4768 - TelstraClear	335

Country	Cone NAT
ID - Indonesia	2464
NZ - New Zealand	2272
AU - Australia	841
GR - Greece	751
US - United States	707
BR - Brazil	574
GB - Great Britain	452
KR - South Korea	382
RO - Romain	369

- 15K unique IPv6 addresses had “cone NAT” flag set
- Almost half in APNIC region – 7.5K, 5K in RIPE
- Indonesia and New Zealand Telecom largest contributors

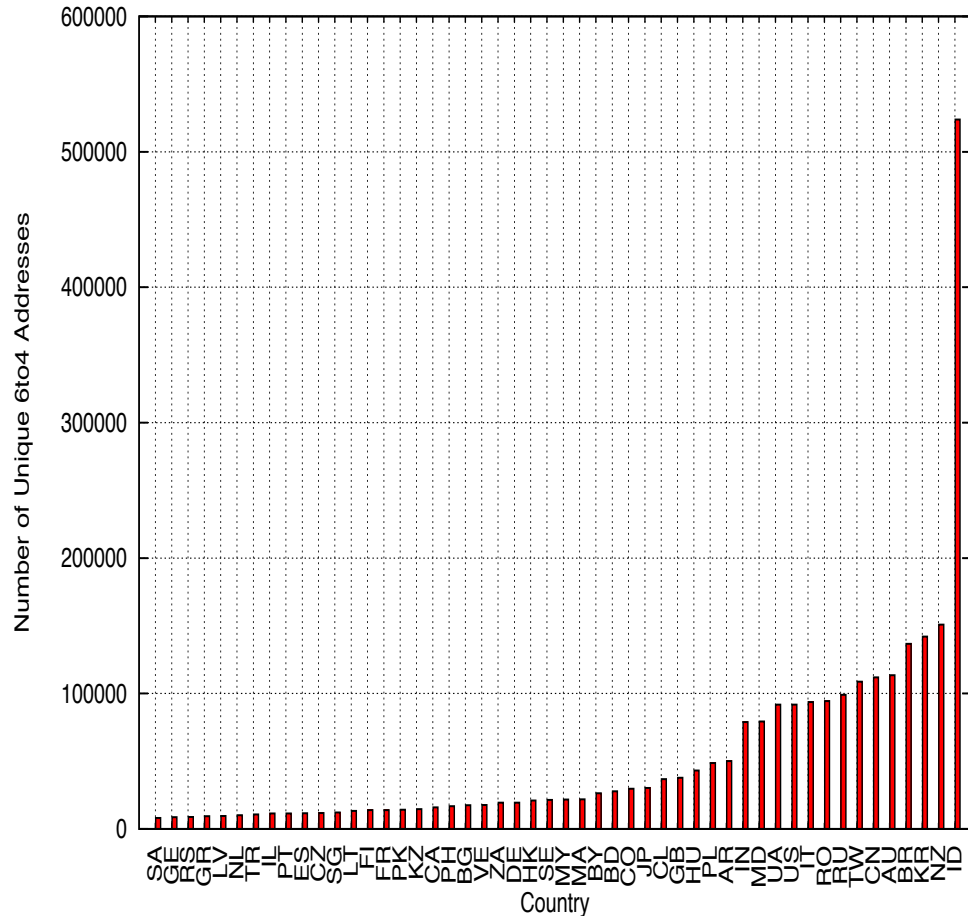
6to4 Usage by Country

IPv4:

192.0.2.4

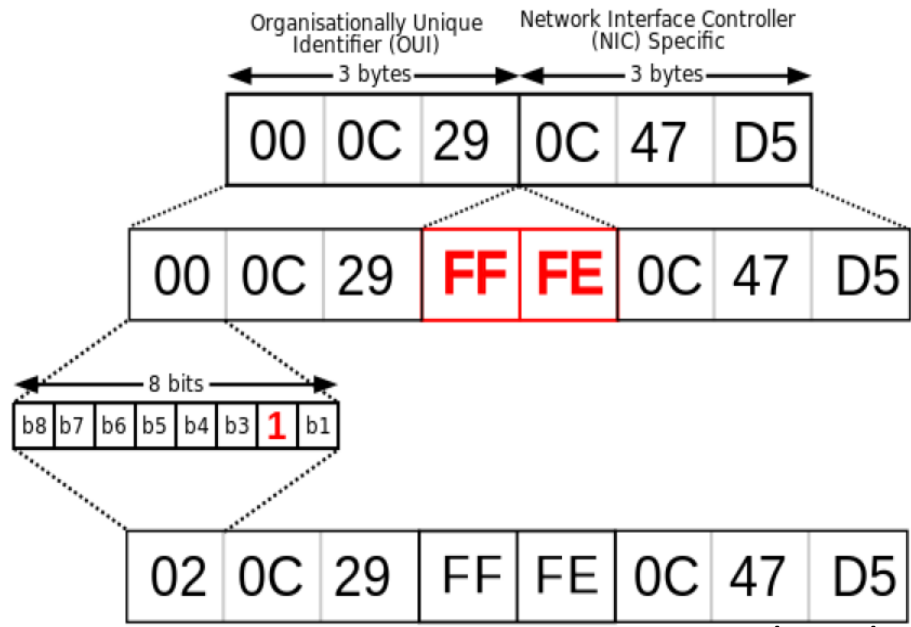
IPv6: 2002:c000:0204::/48

- Prefix: 2002::/16
- Next 32 bits are IPv4 address



- 2.78M unique 6to4 addresses
- RIPE- 92K, 1.4M – APNIC, 112K – ARIN, 292K – LACNIC, 65K – AFRINIC
- 205 unique country codes
- Indonesia largest – 500K – 18%
- New Zealand, Korea, Brazil, Australia, China ~100K - 4% each

Decoding MAC addresses



Source: Wikipedia

- The bottom 64bits of an IPv6 address are the host identifier which can be generated based on the 48-bit MAC address
- Identified by the tag "FF:FE" in 12,13 bytes
- Possible for both native IPv6 as well as 6to4 addresses
- Host identifiers can also be generated via DHCPv6 or randomly

Observed MAC Addresses

Vendor	Native MAC	6to4 MAC
Apple, Inc.	6.86K	6.83K
FREEBOX SA	0.94K	-
Dell Inc.	0.93K	0.07K
ASUSTek Computer Inc.	0.45K	0.17K
Intel Corporate	0.46K	0.22K
HTC	0.24K	0.2K
Total	13.2K	8.94K

Region	IPv6 Addresses	EUI-64 tag
LACNIC	1.3K	222
APNIC	41.6K	2800
RIPE	90.9K	6122
ARIN	40.5K	4060
AFRINIC	0.1K	19
6to4	2.78M	8944
Total	2.95M	22.1K

- Of 174K native IPv6 addresses only 10% had FF:FE tag – 13K
- Of 2.78M 6to4 addresses only 9K had FF:FE tag
- Apple vendor ID accounts for largest number of hosts identified close to 7K for each native and 6to4 addresses

Conclusions

- 14M IPv6 hosts
- Mostly transition technologies – Teredo ~80%
- Low usage of native IPv6 ~1.3%
- Higher Teredo usage in RIPE region
- Significantly higher usage of 6to4 in APNIC region
- Not seeing very many host identifiers with MAC addresses
- Many more hosts IPv6 literal capable ~30% (of all IPv6 addresses observed)