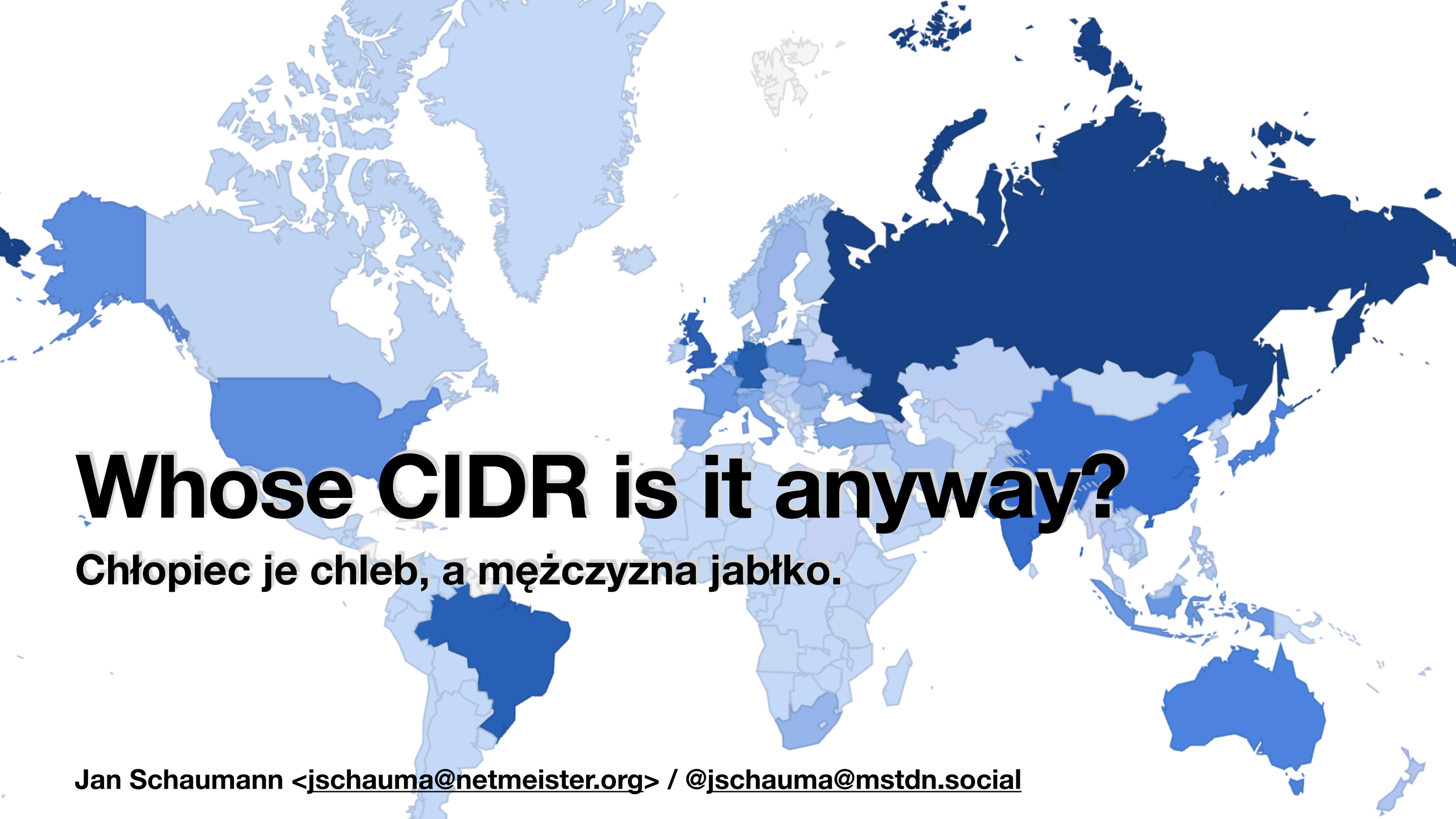
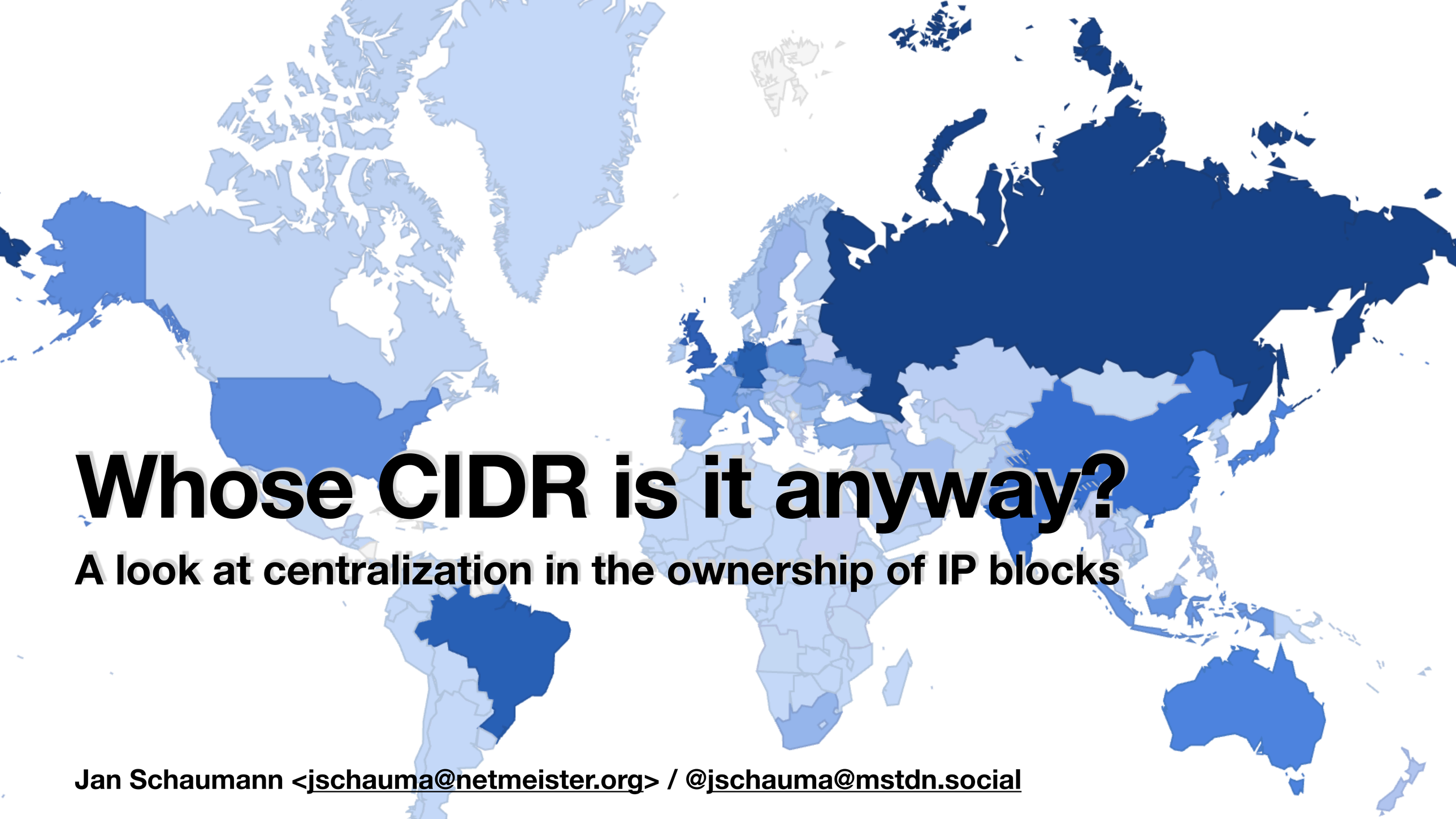


Whose CIDR is it anyway?

Chłopiec je chleb, a mężczyzna jabłko.

Jan Schaumann <jschauma@netmeister.org> / @jschauma@mstdn.social



Whose CIDR is it anyway?

A look at centralization in the ownership of IP blocks

Jan Schaumann <jschauma@netmeister.org> / @jschauma@mstdn.social

RIPE NCC

Réseaux IP Européens

European IP **Networks**

Network Coordination Centre

Network Coordination Centre

RAS SYNDROME

REDUNDANT ACRONYM SYNDROME

ALSO SEE :
ISBN Number, PDF format, MLS Soccer, DC Comics
Hiv Virus, LCD Display, Please RSVP, RIPE NCC

https://sketchplanations.com/ras-syndrome

sketchplanations


AFRINIC
APNIC
ARIN
LACNIC
RIPE NCC
This is a lie.

https://imgur.com/a/baileys-portfolio-WlgnC - used with permission

The year is 2035…

Terminal — 80×24

```
$ curl -s https://ip-ranges.amazonaws.com/ip-ranges.json | more
{
  "createDate": "2035-05-16-17-43-07",
  "prefixes": [
    {
      "ip_prefix": "0.0.0.0/1",
      "region": "us-east-1",
      "service": "AMAZON"
    },
    {
      "ip_prefix": "128.0.0.0/2",
      "region": "eu-all",
      "service": "AMAZON"
    },
    {
      "ip_prefix": "192.0.0.0/3",
      "region": "apac-all",
      "service": "AMAZON"
    },
    {
      "ip_prefix": "224.0.0.0/3",
      "region": "everything-else",
      "service": "AMAZON"
    },
```

Terminal — 112×35

$

“The future has arrived, and it wants IPv4 unicast addresses

far more than it wants permanently unusable IPv4 addresses.”

https://datatracker.ietf.org/doc/draft-schoen-intarea-unicast-240/

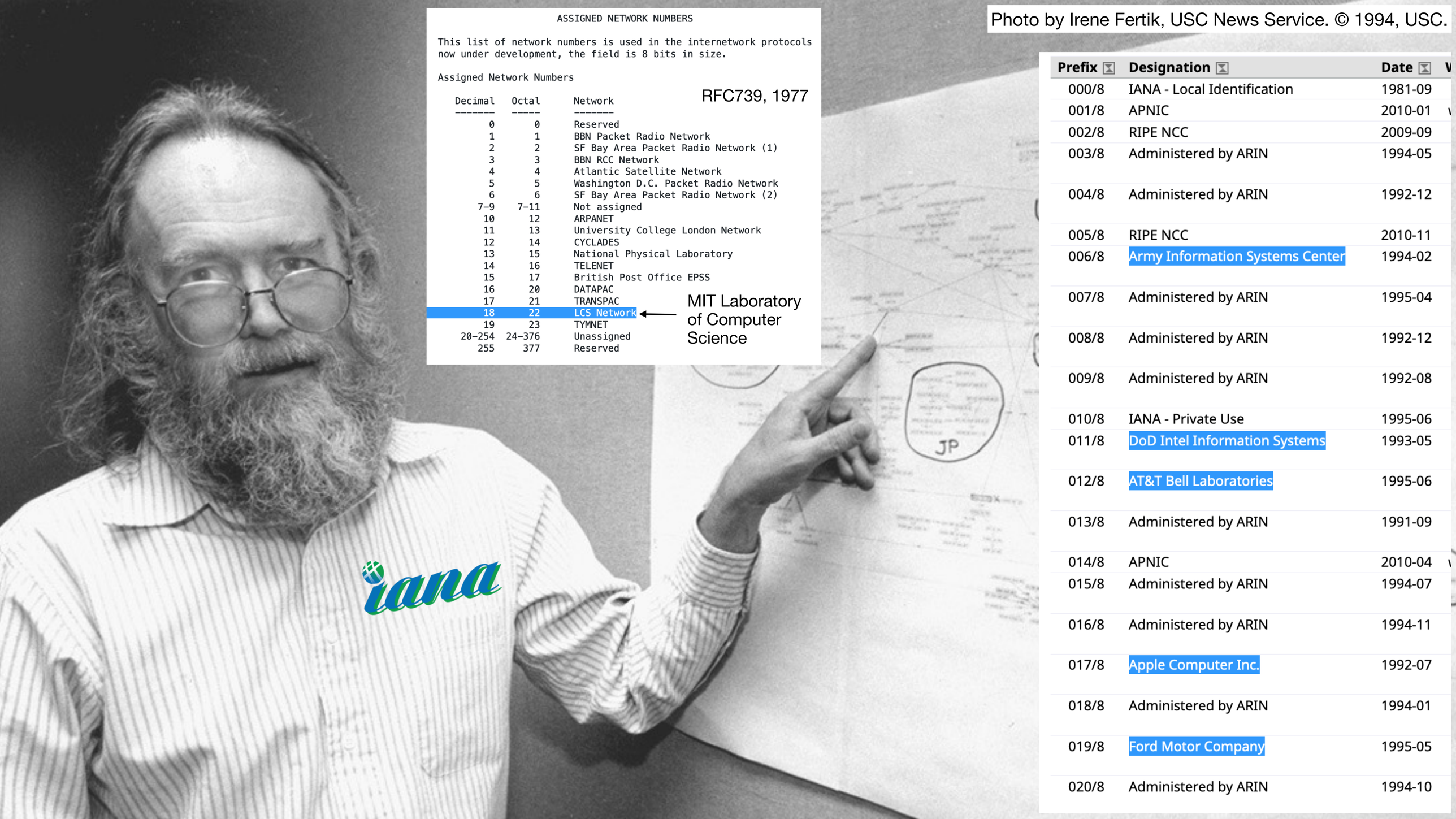


Photo by Irene Fertik, USC News Service. © 1994, USC.

ASSIGNED NETWORK NUMBERS

This list of network numbers is used in the internetwork protocols now under development, the field is 8 bits in size.

Assigned Network Numbers

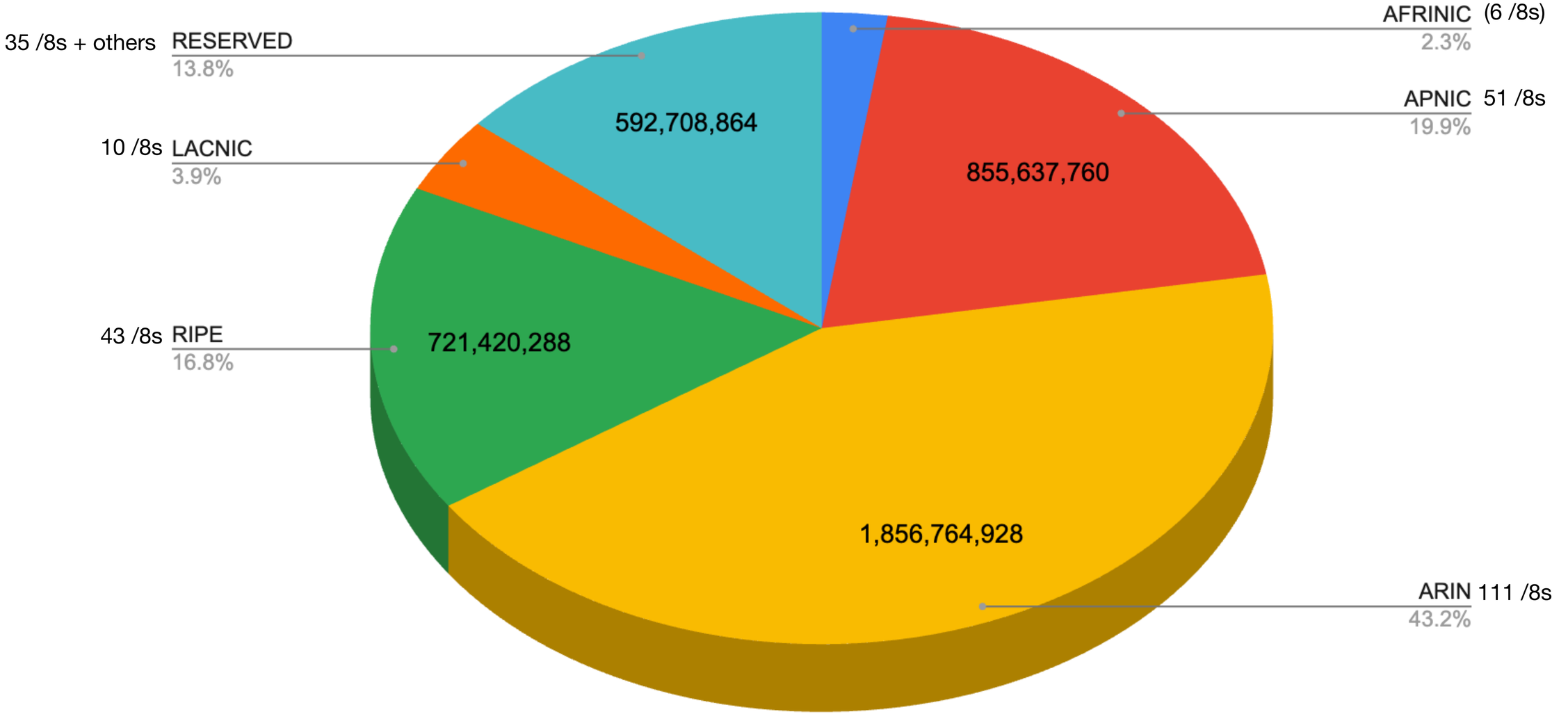
RFC739, 1977

Decimal	Octal	Network
0	0	Reserved
1	1	BBN Packet Radio Network
2	2	SF Bay Area Packet Radio Network (1)
3	3	BBN RCC Network
4	4	Atlantic Satellite Network
5	5	Washington D.C. Packet Radio Network
6	6	SF Bay Area Packet Radio Network (2)
7-9	7-11	Not assigned
10	12	ARPANET
11	13	University College London Network
12	14	CYCLADES
13	15	National Physical Laboratory
14	16	TELENET
15	17	British Post Office EPSS
16	20	DATAPAC
17	21	TRANSPAC
18	22	LCS Network
19	23	TYMNET
20-254	24-376	Unassigned
255	377	Reserved

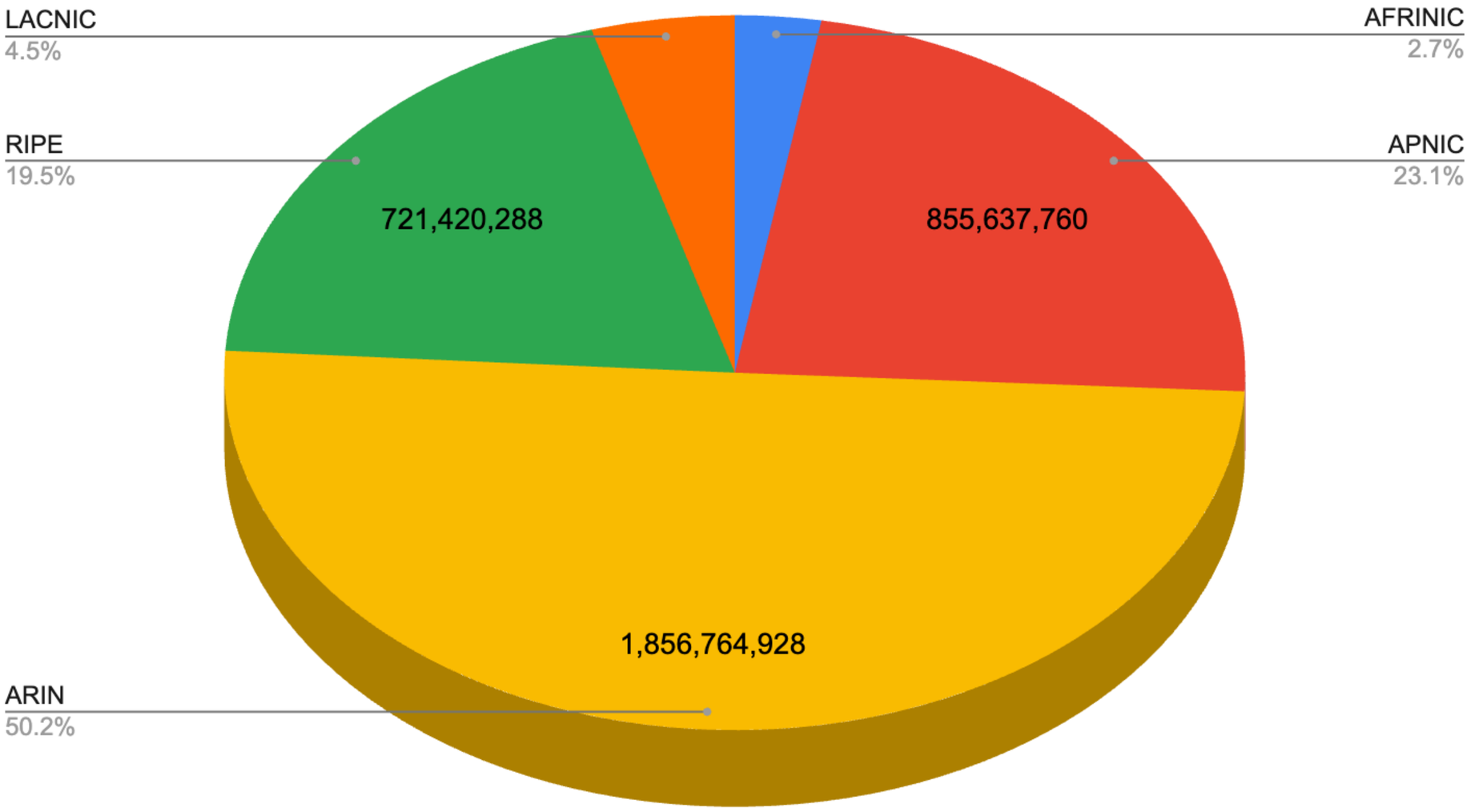
MIT Laboratory of Computer Science

Prefix	Designation	Date
000/8	IANA - Local Identification	1981-09
001/8	APNIC	2010-01
002/8	RIPE NCC	2009-09
003/8	Administered by ARIN	1994-05
004/8	Administered by ARIN	1992-12
005/8	RIPE NCC	2010-11
006/8	Army Information Systems Center	1994-02
007/8	Administered by ARIN	1995-04
008/8	Administered by ARIN	1992-12
009/8	Administered by ARIN	1992-08
010/8	IANA - Private Use	1995-06
011/8	DoD Intel Information Systems	1993-05
012/8	AT&T Bell Laboratories	1995-06
013/8	Administered by ARIN	1991-09
014/8	APNIC	2010-04
015/8	Administered by ARIN	1994-07
016/8	Administered by ARIN	1994-11
017/8	Apple Computer Inc.	1992-07
018/8	Administered by ARIN	1994-01
019/8	Ford Motor Company	1995-05
020/8	Administered by ARIN	1994-10

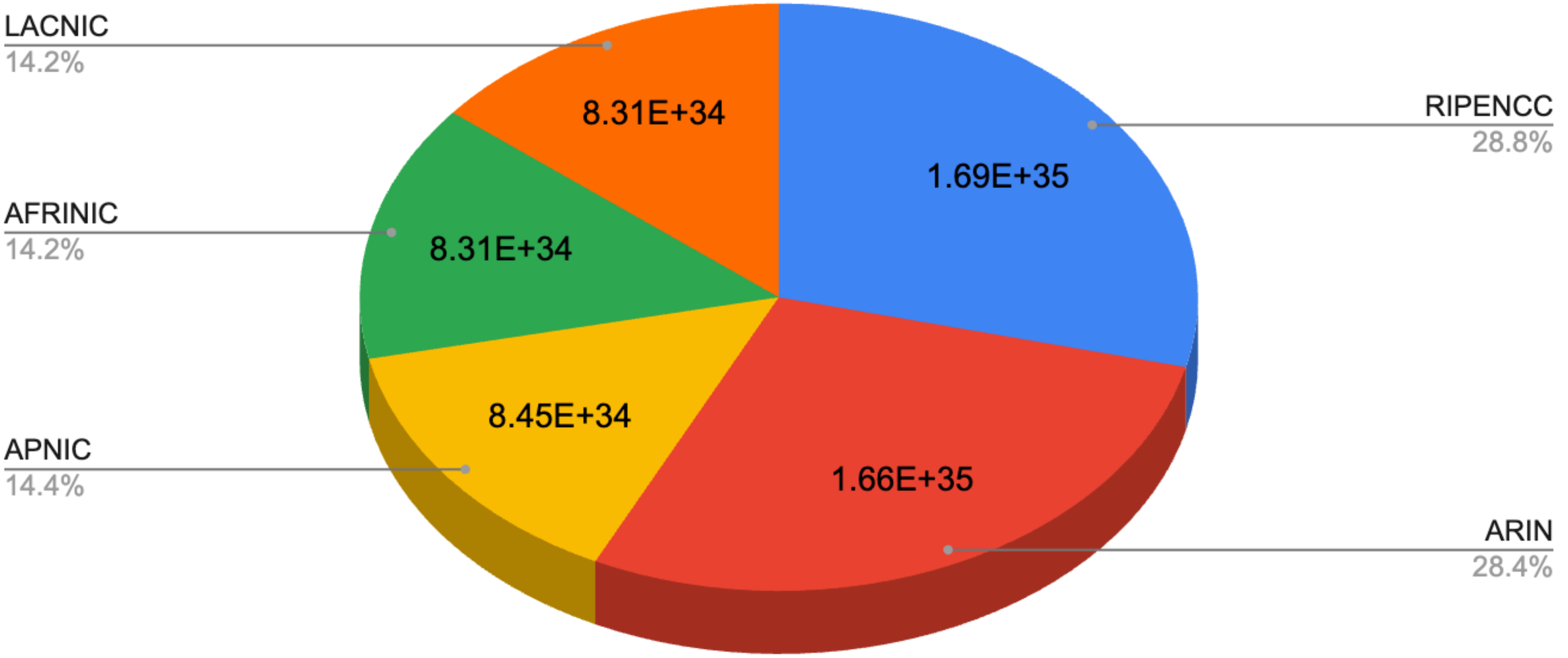
Allocations by IANA (# of IPs)



Allocations by IANA (# of IPs)



IPv6 Allocations by RIR (in # of IPs)



https://data.iana.org/rdap/ipv6.json

account.arin.net/public/transfer-log

ARIN

Statistics: Specified Transfers of Internet Number Resources

Completed Specified Transfers

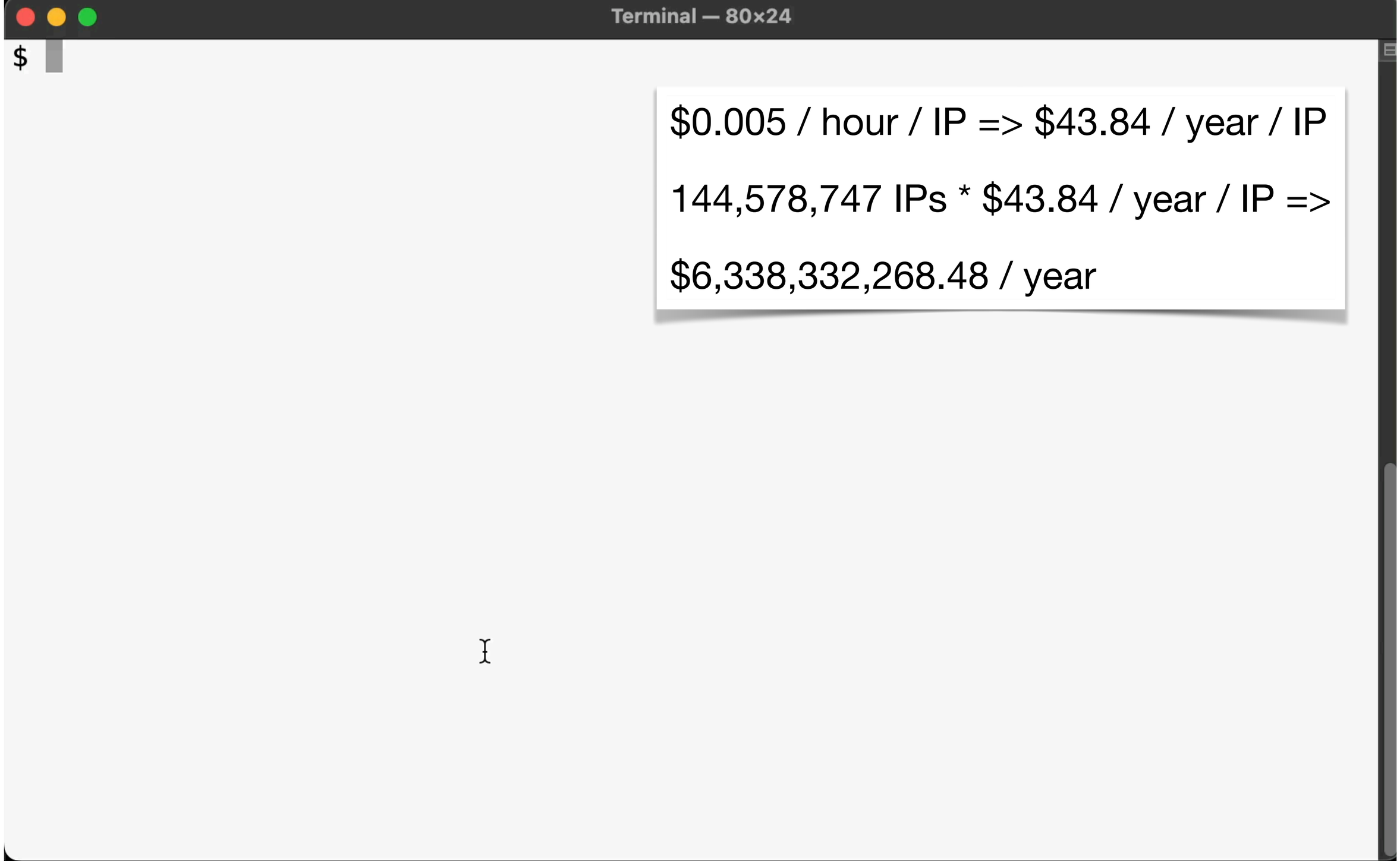
IPv4 Address Blocks Transferred to and from the ARIN Region

Resource Range	Region of Source	Region of Recipient	Effective Date
136.143.000.000 - 136.143.127.255	RIPE NCC	ARIN	01-04-2024
159.180.000.000 - 159.180.063.255	RIPE NCC	ARIN	01-04-2024
163.158.000.000 - 163.158.255.255	RIPE NCC	ARIN	01-04-2024
104.219.072.000 - 104.219.075.255	ARIN	RIPE NCC	01-04-2024
104.245.088.000 - 104.245.091.255	ARIN	RIPE NCC	01-04-2024
158.053.000.000 - 158.053.255.255	ARIN	RIPE NCC	01-08-2024
193.227.122.000 - 193.227.122.255	RIPE NCC	ARIN	01-10-2024
193.227.125.000 - 193.227.125.255	RIPE NCC	ARIN	01-10-2024
193.227.129.000 - 193.227.129.255	RIPE NCC	ARIN	01-10-2024
193.227.135.000 - 193.227.135.255	RIPE NCC	ARIN	01-10-2024
169.148.168.000 - 169.148.175.255	ARIN	APNIC	01-11-2024
169.148.176.000 - 169.148.183.255	ARIN	APNIC	01-11-2024

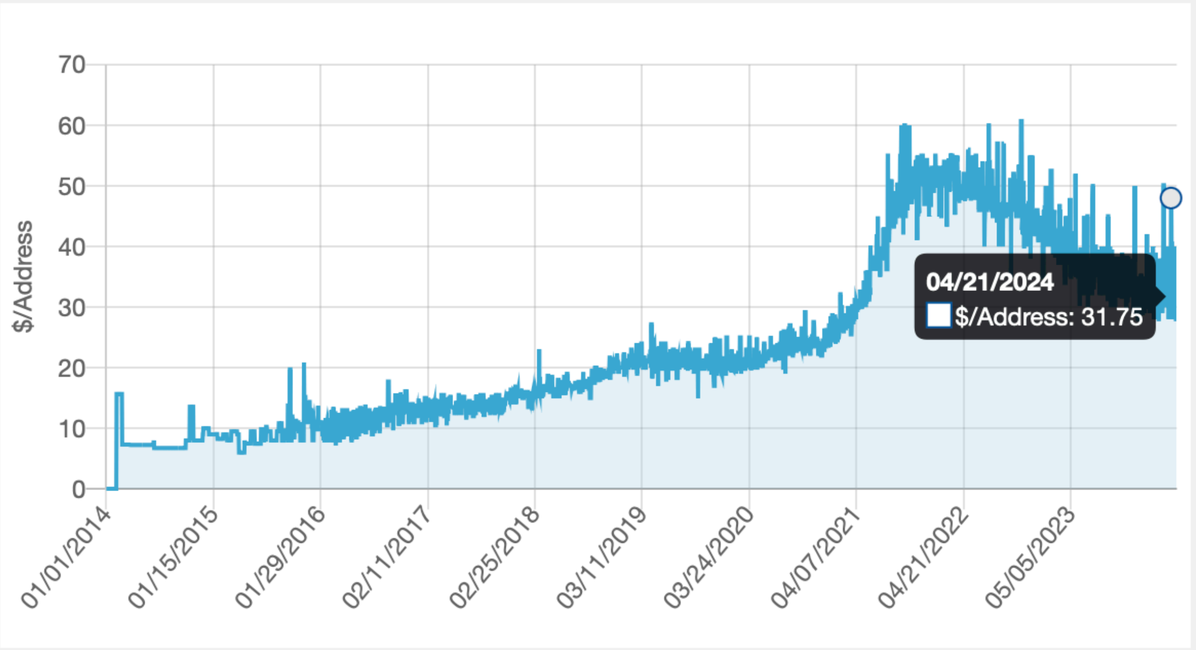
IP Space Trades

Example: Amazon

- 2013: Amazon buys 52.0.0.0/11 and 52.64.0.0/11 from DuPont (today owns 52.0.0.0/10, 52.64.0.0/12)
- 2017: Amazon buys 18.128.0.0/9 from MIT
- 2018: Amazon buys 3.0.0.0/8 from GE
- 2019: Amazon buys 44.192.0.0/10 from Amateur Radio Digital Communications (ARDC)
- 2023: AWS now charges for public IPv4 addresses ($0.005 / hour)


Terminal — 80×24
$
$0.005 / hour / IP => $43.84 / year / IP
144,578,747 IPs * $43.84 / year / IP =>
$6,338,332,268.48 / year

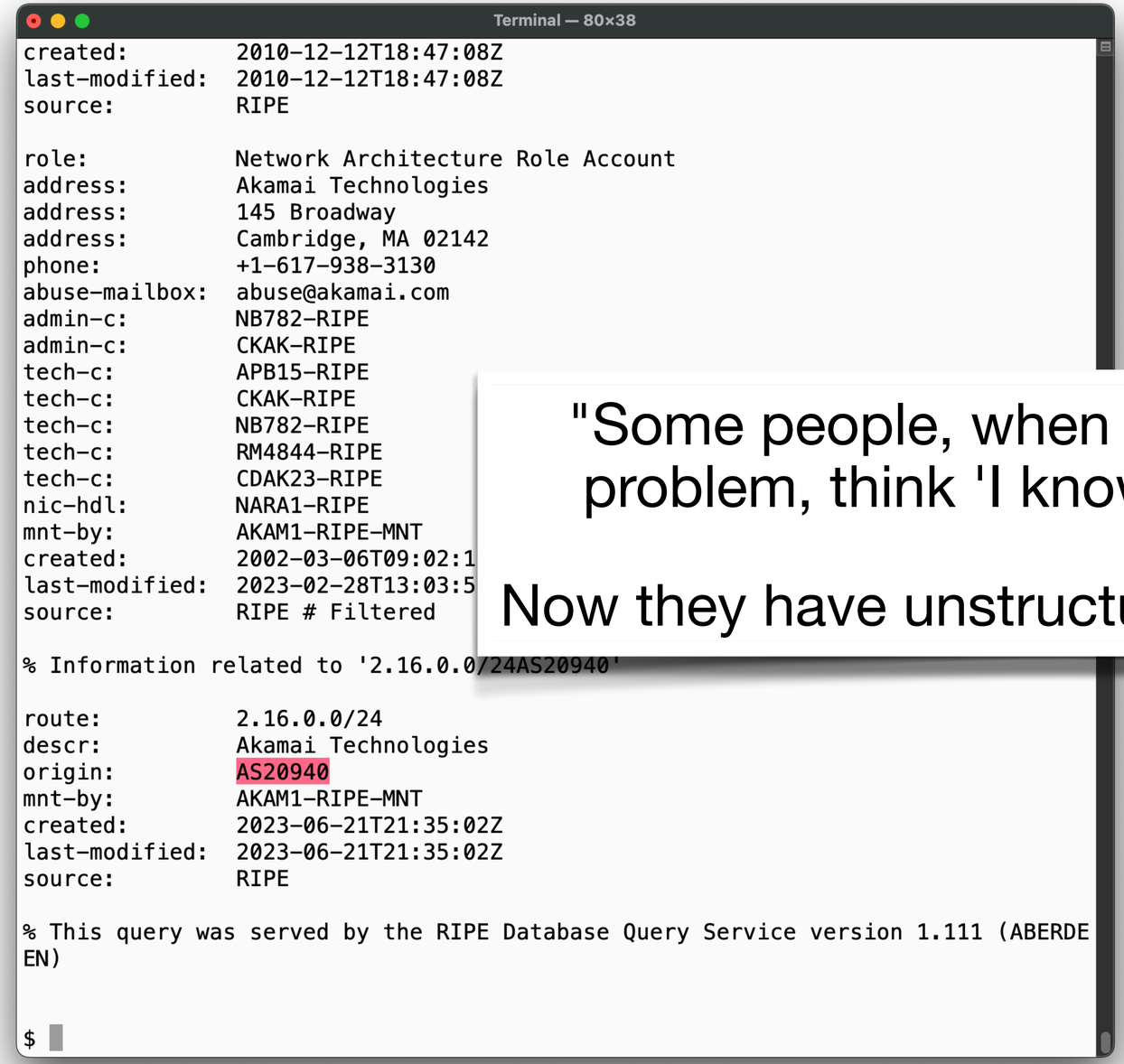
DATE	BLOCK	RIR	FINAL PRICE	$/ADDRESS
08/18/2022	/15	RIPE	$7,471,104.00	$57.00
08/18/2022	/15	RIPE	$7,471,104.00	$57.00
02/23/2023	/15	RIPE	$6,750,208.00	$51.50
06/24/2021	/15	ARIN	$5,068,592.00	$38.67
05/25/2021	/15	ARIN	$4,194,304.00	$32.00

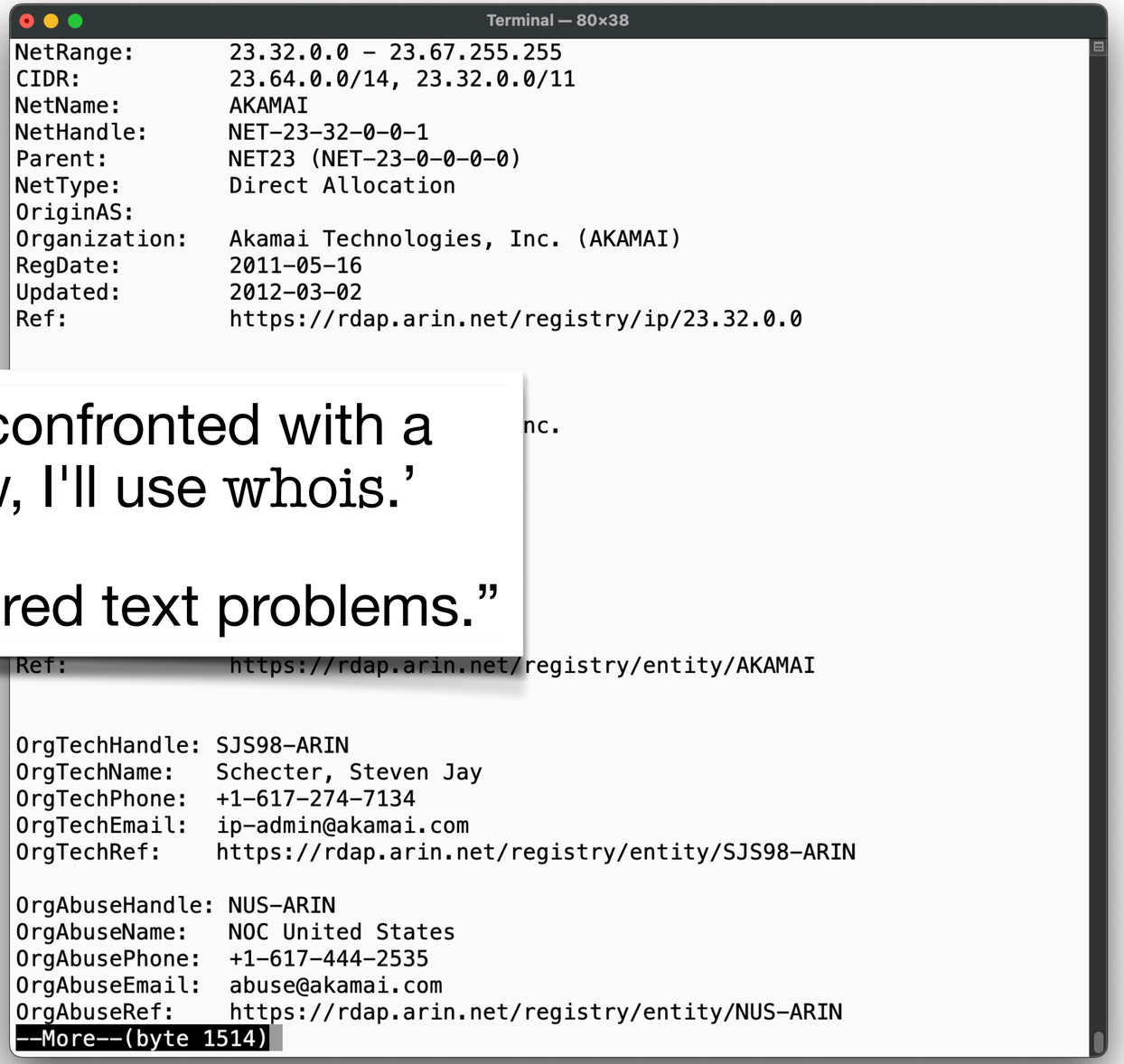


https://auctions.ipv4.global/prior-sales

Wiem, użyję „whois”!

Photo by Areallysmartman11, unmodified, CC BY-SA 4.0; https://commons.wikimedia.org/wiki/File:God_of_the_Century_.jpg



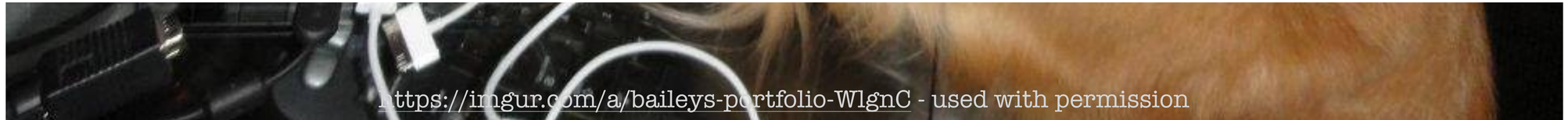


"Some people, when confronted with a problem, think 'I know, I'll use whois.'

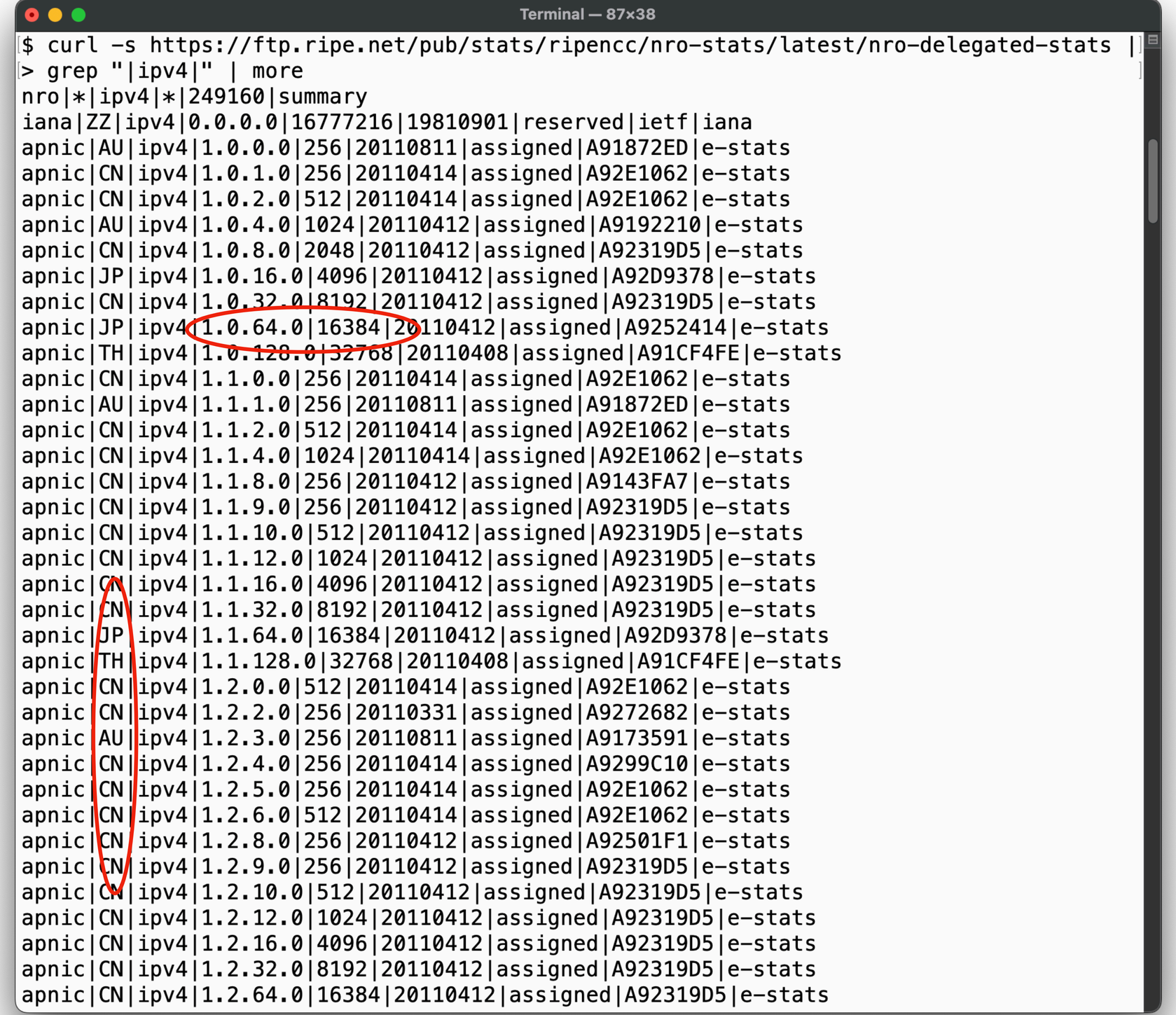
Now they have unstructured text problems."

Wiem, użyję statystyk RIR!

https://ftp.ripe.net/pub/stats/ripencc/nro-stats/latest/nro-delegated-stats



https://imgur.com/a/baileys-portfolio-WlgnC - used with permission

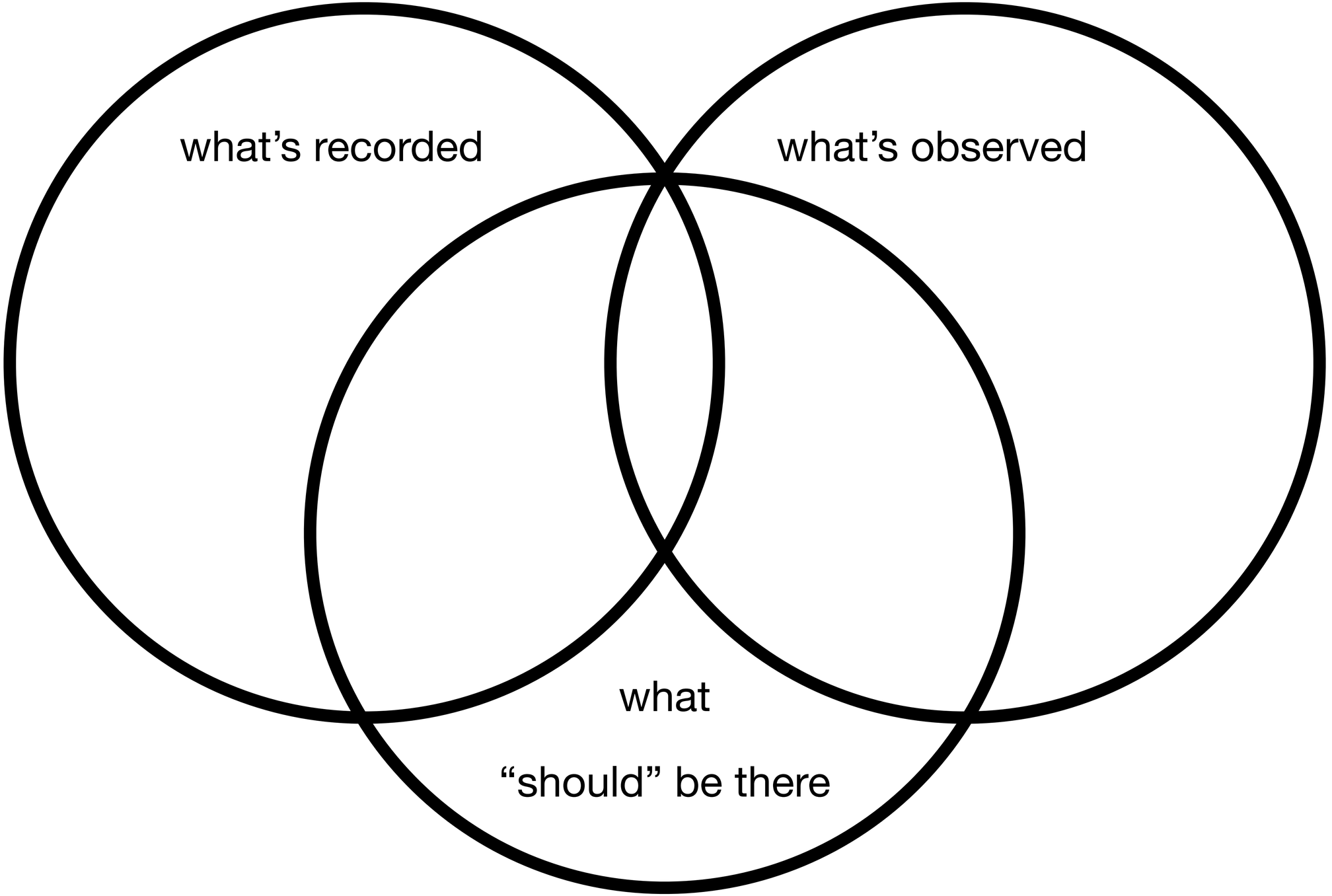

Terminal — 87×38
$ curl -s https://ftp.ripe.net/pub/stats/ripencc/nro-stats/latest/nro-delegated-stats |
> grep "|ipv4|" | more
nro|*|ipv4|*|249160|summary
iana|ZZ|ipv4|0.0.0.0|16777216|19810901|reserved|ietf|iana
apnic|AU|ipv4|1.0.0.0|256|20110811|assigned|A91872ED|e-stats
apnic|CN|ipv4|1.0.1.0|256|20110414|assigned|A92E1062|e-stats
apnic|CN|ipv4|1.0.2.0|512|20110414|assigned|A92E1062|e-stats
apnic|AU|ipv4|1.0.4.0|1024|20110412|assigned|A9192210|e-stats
apnic|CN|ipv4|1.0.8.0|2048|20110412|assigned|A92319D5|e-stats
apnic|JP|ipv4|1.0.16.0|4096|20110412|assigned|A92D9378|e-stats
apnic|CN|ipv4|1.0.32.0|8192|20110412|assigned|A92319D5|e-stats
apnic|JP|ipv4|1.0.64.0|16384|20110412|assigned|A9252414|e-stats
apnic|TH|ipv4|1.0.128.0|32768|20110408|assigned|A91CF4FE|e-stats
apnic|CN|ipv4|1.1.0.0|256|20110414|assigned|A92E1062|e-stats
apnic|AU|ipv4|1.1.1.0|256|20110811|assigned|A91872ED|e-stats
apnic|CN|ipv4|1.1.2.0|512|20110414|assigned|A92E1062|e-stats
apnic|CN|ipv4|1.1.4.0|1024|20110414|assigned|A92E1062|e-stats
apnic|CN|ipv4|1.1.8.0|256|20110412|assigned|A9143FA7|e-stats
apnic|CN|ipv4|1.1.9.0|256|20110412|assigned|A92319D5|e-stats
apnic|CN|ipv4|1.1.10.0|512|20110412|assigned|A92319D5|e-stats
apnic|CN|ipv4|1.1.12.0|1024|20110412|assigned|A92319D5|e-stats
apnic|CN|ipv4|1.1.16.0|4096|20110412|assigned|A92319D5|e-stats
apnic|CN|ipv4|1.1.32.0|8192|20110412|assigned|A92319D5|e-stats
apnic|JP|ipv4|1.1.64.0|16384|20110412|assigned|A92D9378|e-stats
apnic|TH|ipv4|1.1.128.0|32768|20110408|assigned|A91CF4FE|e-stats
apnic|CN|ipv4|1.2.0.0|512|20110414|assigned|A92E1062|e-stats
apnic|CN|ipv4|1.2.2.0|256|20110331|assigned|A9272682|e-stats
apnic|AU|ipv4|1.2.3.0|256|20110811|assigned|A9173591|e-stats
apnic|CN|ipv4|1.2.4.0|256|20110414|assigned|A9299C10|e-stats
apnic|CN|ipv4|1.2.5.0|256|20110414|assigned|A92E1062|e-stats
apnic|CN|ipv4|1.2.6.0|512|20110414|assigned|A92E1062|e-stats
apnic|CN|ipv4|1.2.8.0|256|20110412|assigned|A92501F1|e-stats
apnic|CN|ipv4|1.2.9.0|256|20110412|assigned|A92319D5|e-stats
apnic|CN|ipv4|1.2.10.0|512|20110412|assigned|A92319D5|e-stats
apnic|CN|ipv4|1.2.12.0|1024|20110412|assigned|A92319D5|e-stats
apnic|CN|ipv4|1.2.16.0|4096|20110412|assigned|A92319D5|e-stats
apnic|CN|ipv4|1.2.32.0|8192|20110412|assigned|A92319D5|e-stats
apnic|CN|ipv4|1.2.64.0|16384|20110412|assigned|A92319D5|e-stats

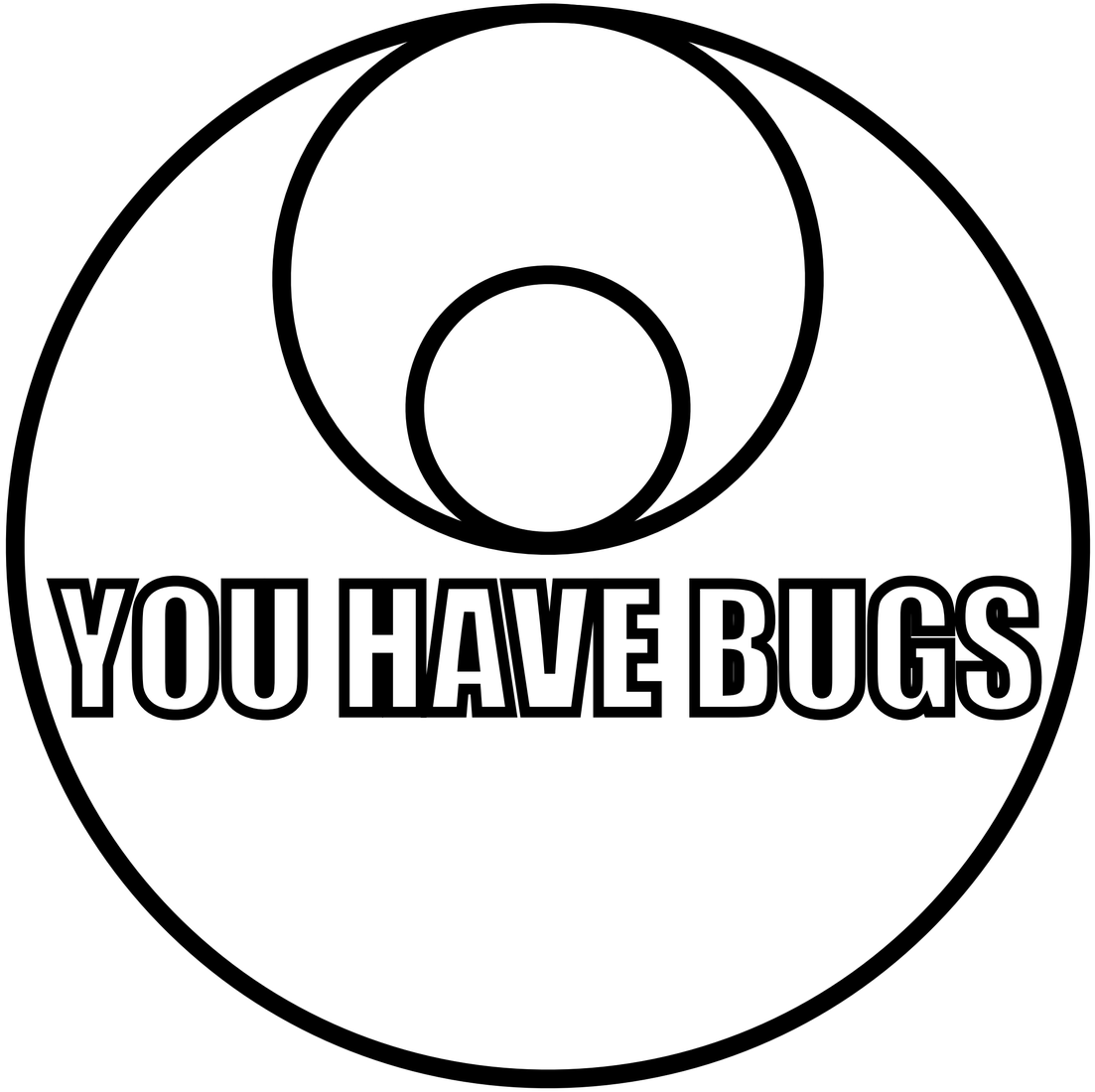
https://imgur.com/a/baileys-portfolio-WlgnC - used with permission

Terminal — 128×38

```
$ curl -s -L https://rdap.db.ripe.net/ip/2.19.4.0 | more
{
  "handle" : "2.19.0.0 - 2.19.15.255",
  "startAddress" : "2.19.0.0",
  "endAddress" : "2.19.15.255",
  "ipVersion" : "v4",
  "name" : "AKAMAI-PA",
  "type" : "ASSIGNED PA",
  "country" : "EU",
  "parentHandle" : "2.16.0.0 - 2.23.255.255",
  "cidr0_cidrs" : [ {
    "v4prefix" : "2.19.0.0",
    "length" : 20
  } ],
  "status" : [ "active" ],
  "entities" : [ {
    "handle" : "AKAM1-RIPE-MNT",
    "vcardArray" : [ "vcard", [ [ "version", { }, "text", "4.0"
", "individual" ] ] ],
    "roles" : [ "registrant" ],
    "links" : [ {
      "value" : "https://rdap.db.ripe.net/ip/2.19.4.0",
      "rel" : "self",
      "href" : "https://rdap.db.ripe.net/entity/AKAM1-RIPE-MNT"
    }, {
      "value" : "http://www.ripe.net/data-tools/support/documentation/terms",
      "rel" : "copyright",
      "href" : "http://www.ripe.net/data-tools/support/documentation/terms"
    } ],
    "objectClassName" : "entity"
  }, {
    "handle" : "NARA1-RIPE",
    "vcardArray" : [ "vcard", [ [ "version", { }, "text", "4.0" ], [ "fn", { }, "text", "Network Architecture Role Account" ], [
 "kind", { }, "text", "group" ], [ "adr", {
      "label" : "Akamai Technologies\n145 Broadway\nCambridge, MA 02142"
    }, "text", [ "", "", "", "", "", "", "" ] ], [ "tel", {
      "type" : "voice"
    }, "text", "+1-617-938-3130" ], [ "email", {
```

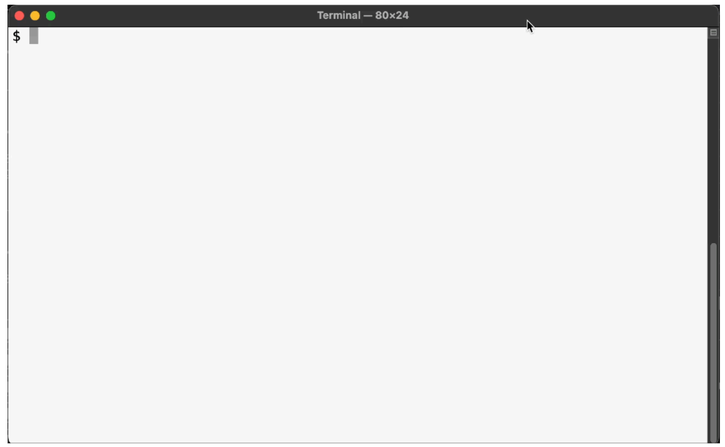
```
for each i in `jot 255`; do

    ip = $i.0.0.0

    while ($ip != $i.255.255.255)

        query RDAP for $ip

        $ip = endAddress + 1
```


what's recorded
what's observed
what
"should" be there


YOU HAVE BUGS

“whois is stupid*, use RDAP. It’ll be great!”

… they said.



- Sometimes RDAP redirects with data, sometimes without
- Sometimes RDAP has redirect loops (e.g., 45.68.33.0)
- RDAP doesn’t include AS numbers (whois *may*)
- AFRINIC has API limits (but won’t tell you what they are); return[illegible]29 without Retry-After
- https://rdap.registro.br/ says their API limit is 1 request / 2[illegible]ou exceed, they return a 403 - goodbye!
- AFRINIC sometimes returns a netmask of -1 (e.g., 196.28.2[illegible]
- ‘notices’->’source’ *may* contain the RIR, ‘port43’ is more reliable
- Sometimes cidr0 and endAddress don’t match (e.g., 1.179.148.0)
- ARIN & LACNIC RDAP do not include country-code info
- JPNIC doesn’t include allocation type
- …

RDAP: same GIGO as “whois”, but at least it’s JSON.

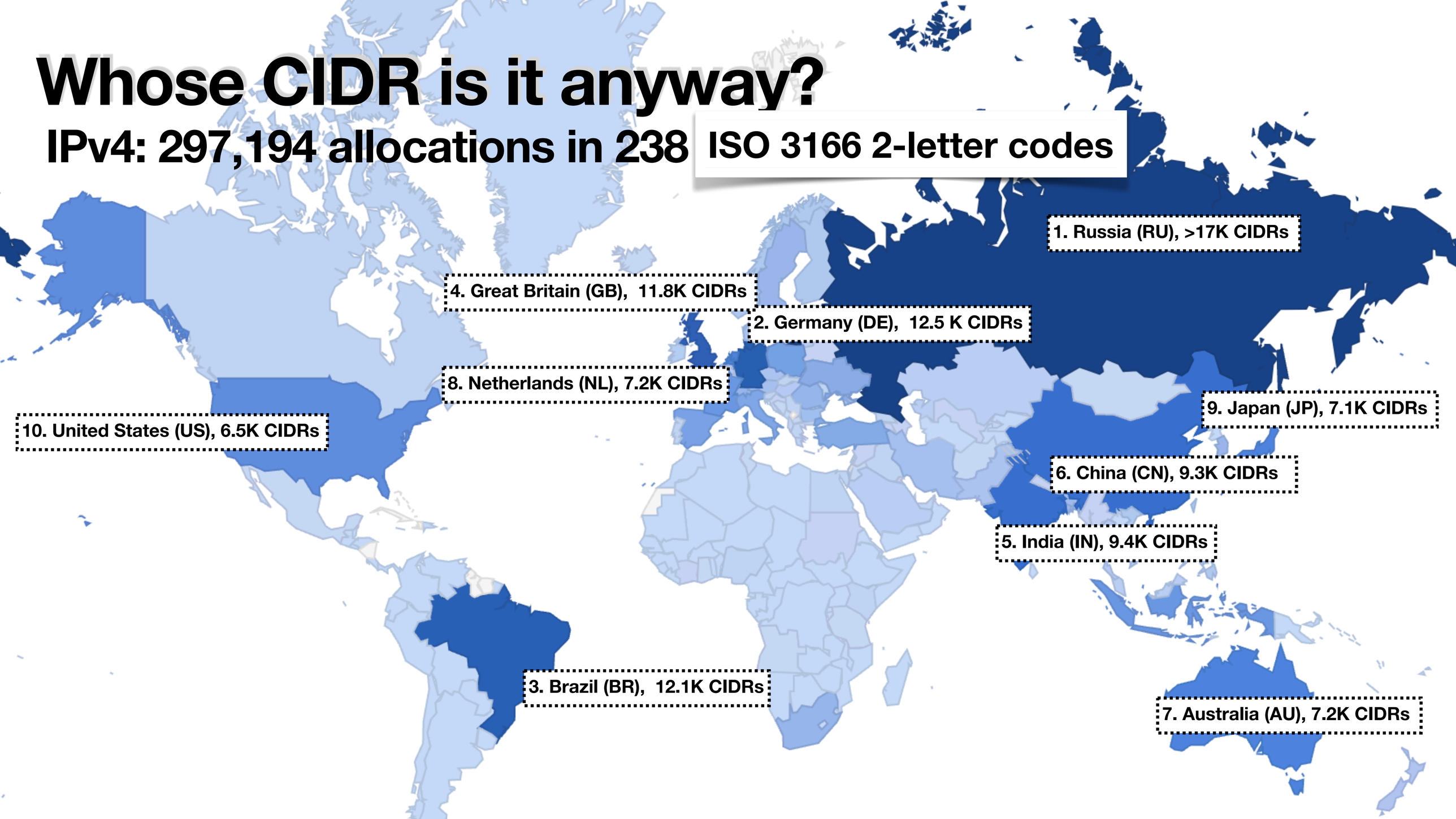
[*] https://www.netmeister.org/blog/whois.html

Mój poduszkowiec jest pełen węgorzy.

Photo by Drew Hays on Unsplash

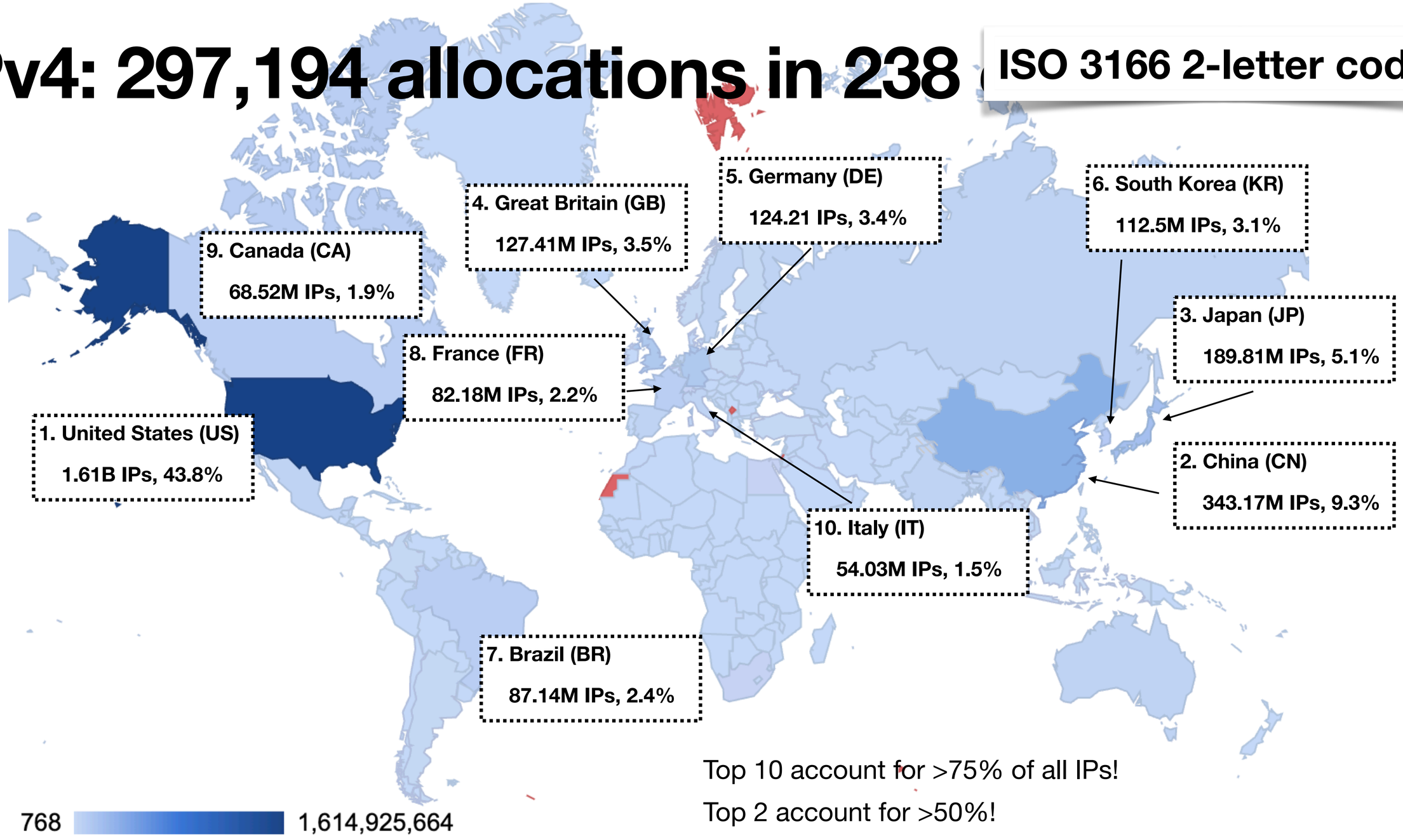
Whose CIDR is it anyway?

IPv4: 297,194 allocations in 238 ISO 3166 2-letter codes



IPv4: 297,194 allocations in 238

ISO 3166 2-letter codes

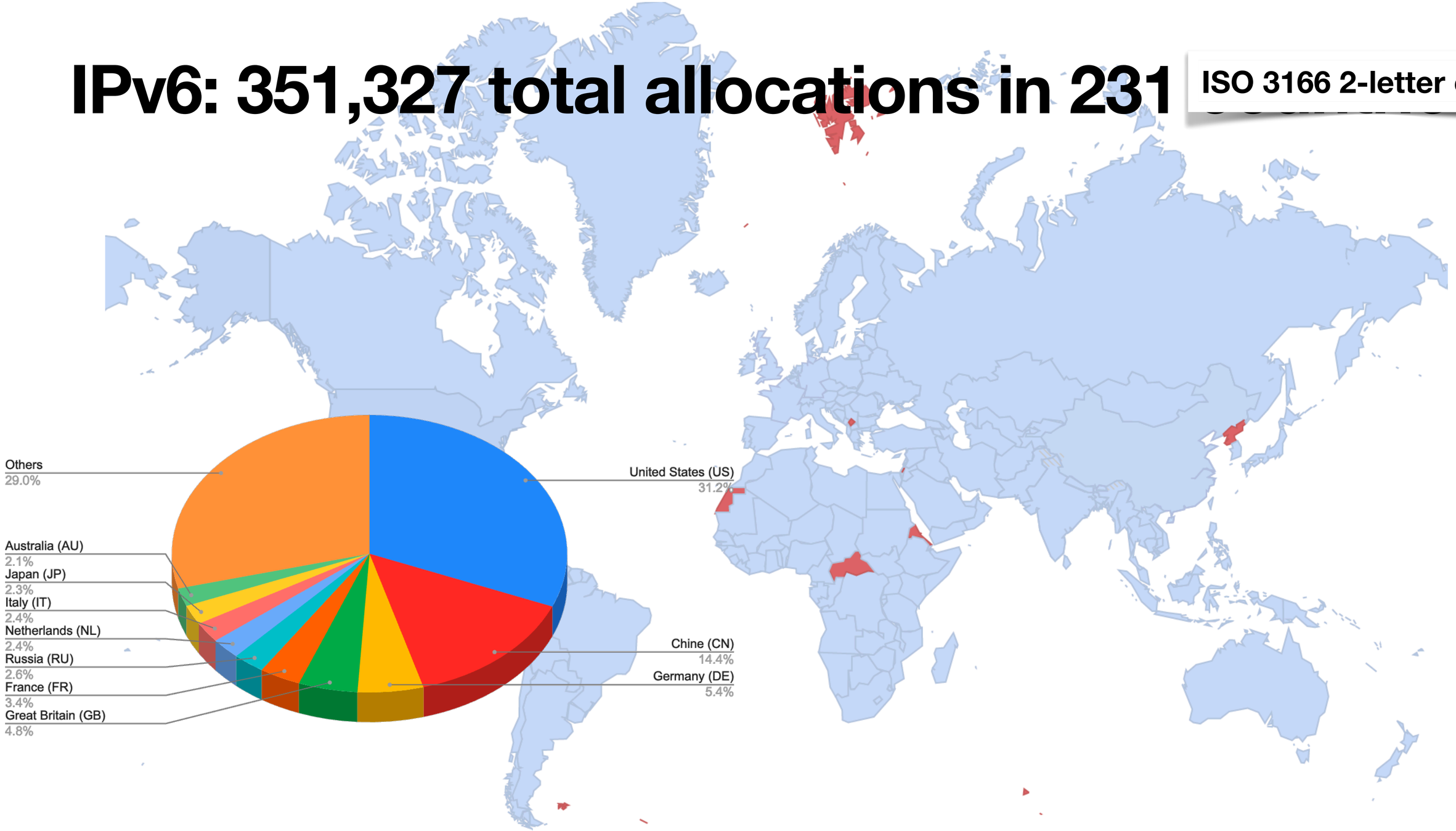


Top 10 account for >75% of all IPs!

Top 2 account for >50%!

IPv6: 351,327 total allocations in 231 countries

ISO 3166 2-letter codes

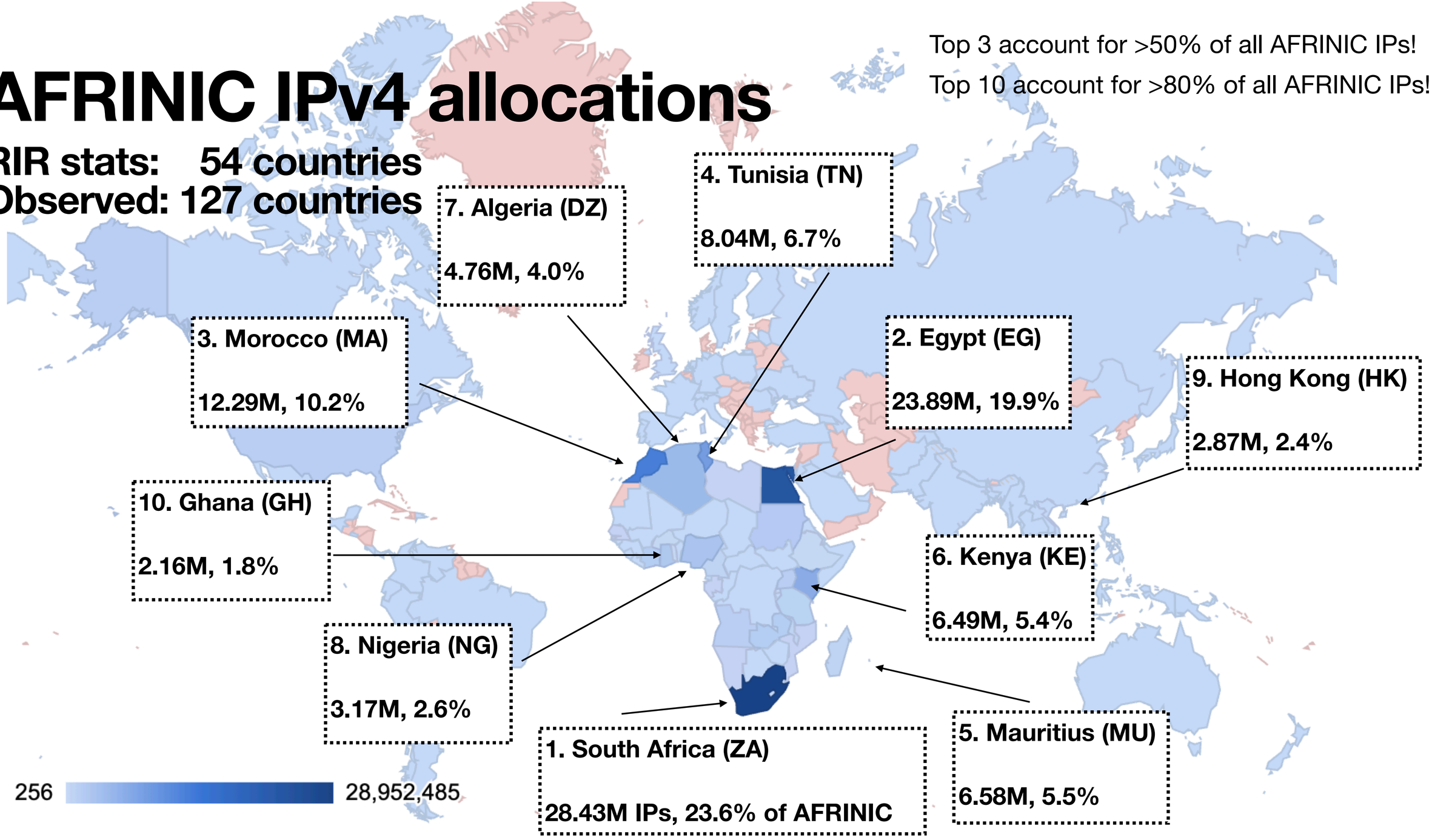


AFRINIC IPv4 allocations

RIR stats: 54 countries
Observed: 127 countries

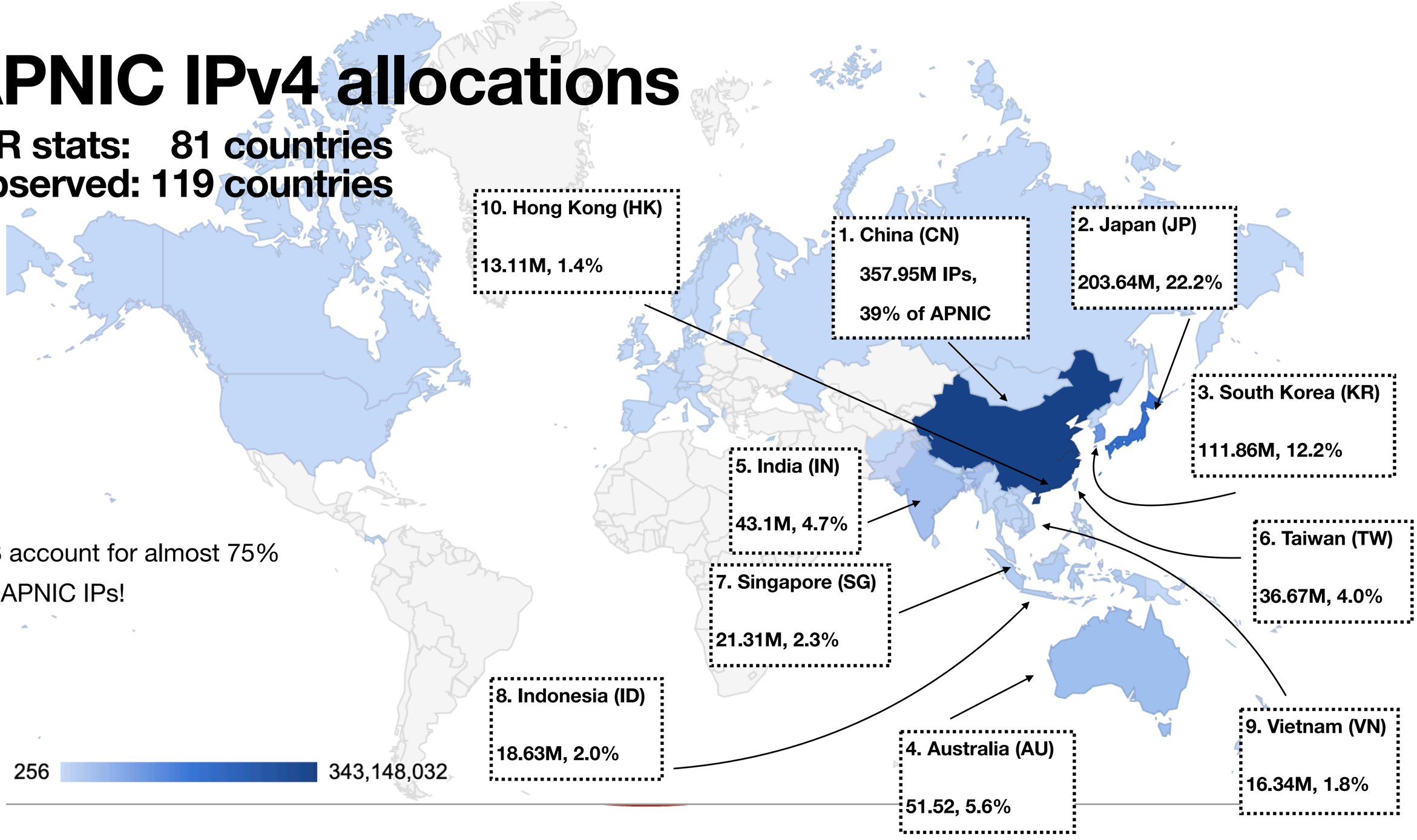
Top 3 account for >50% of all AFRINIC IPs!

Top 10 account for >80% of all AFRINIC IPs!



APNIC IPv4 allocations

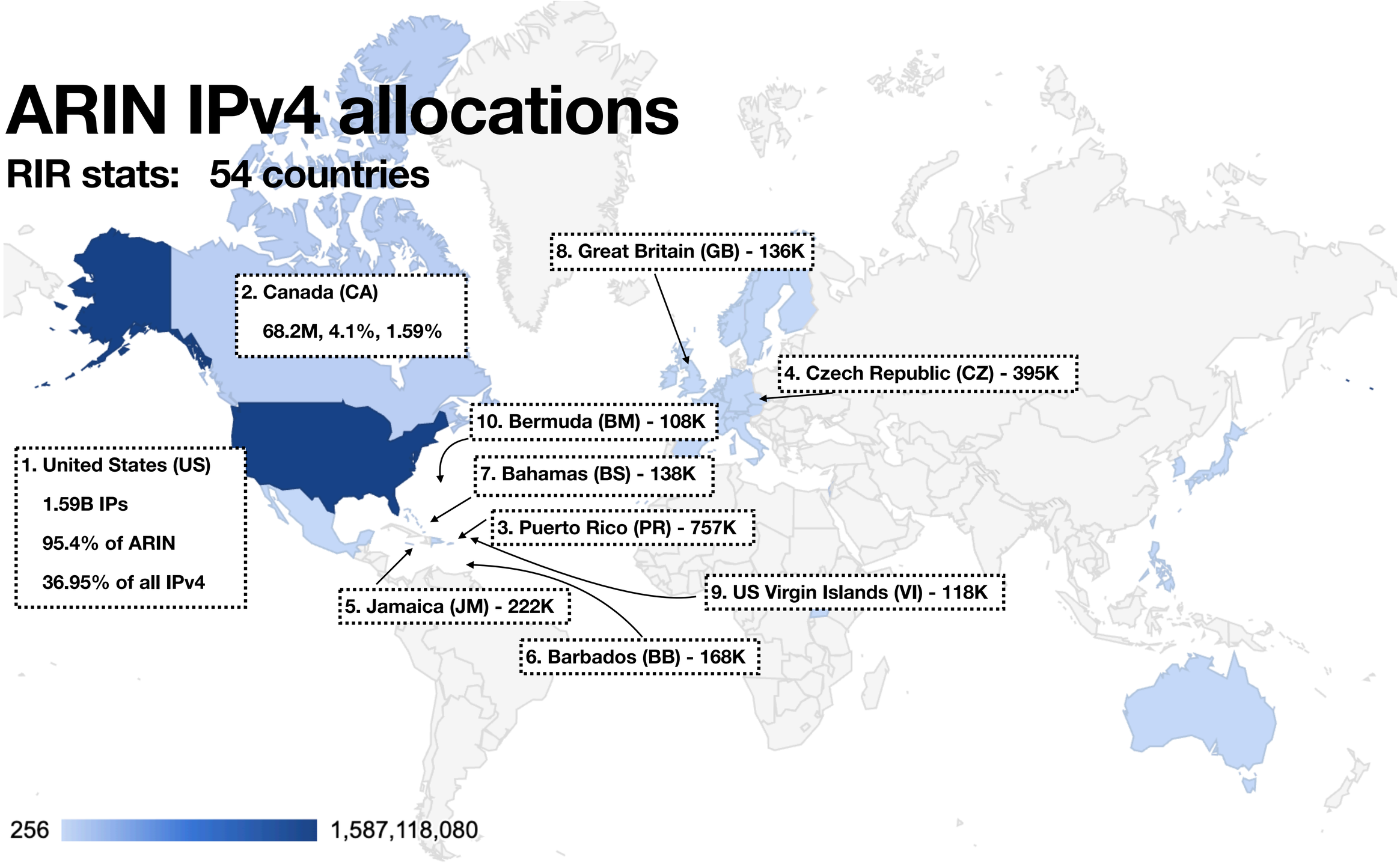
RIR stats: 81 countries
Observed: 119 countries



Top 3 account for almost 75%
of all APNIC IPs!

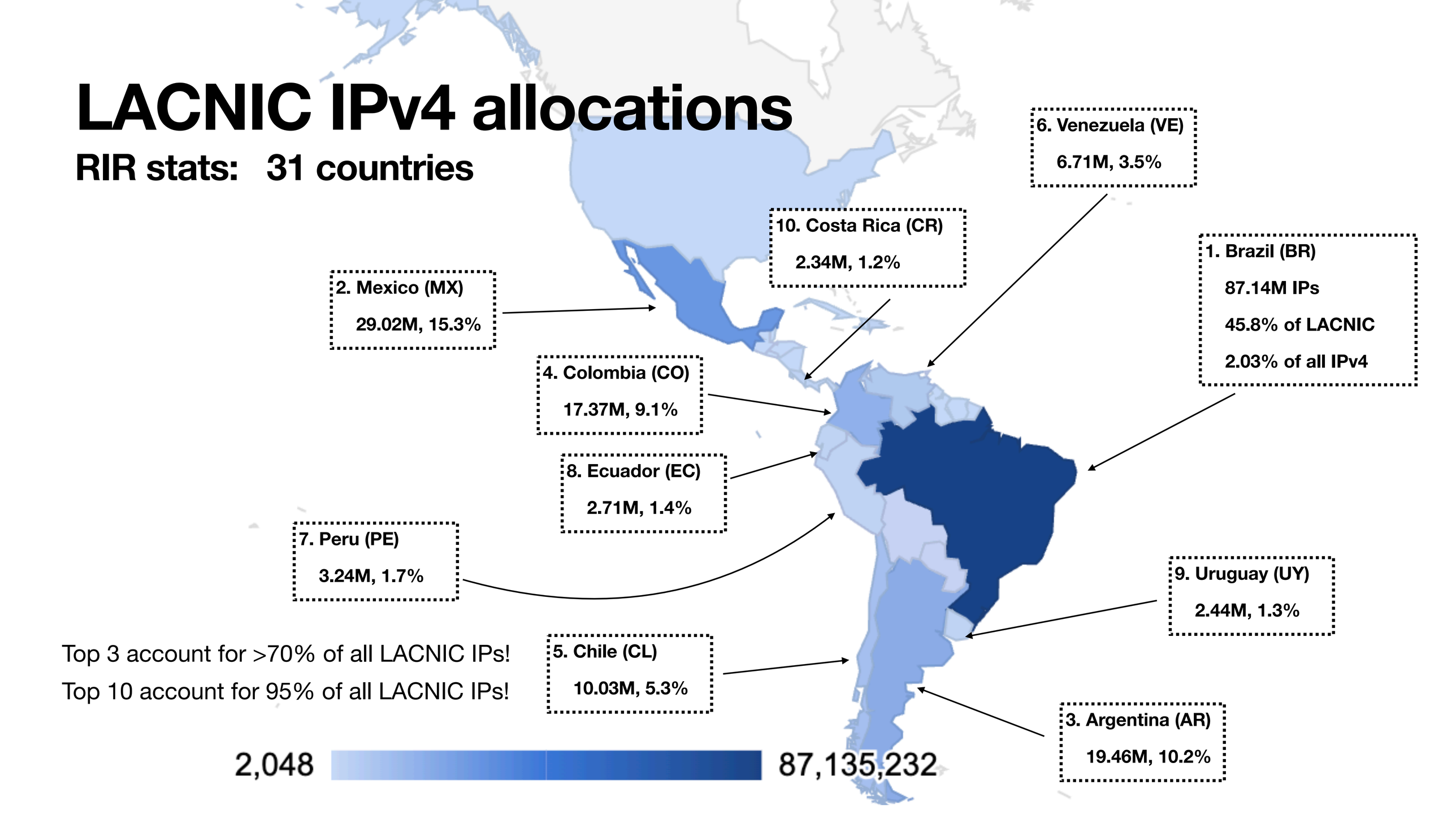
ARIN IPv4 allocations

RIR stats: 54 countries



LACNIC IPv4 allocations

RIR stats: 31 countries

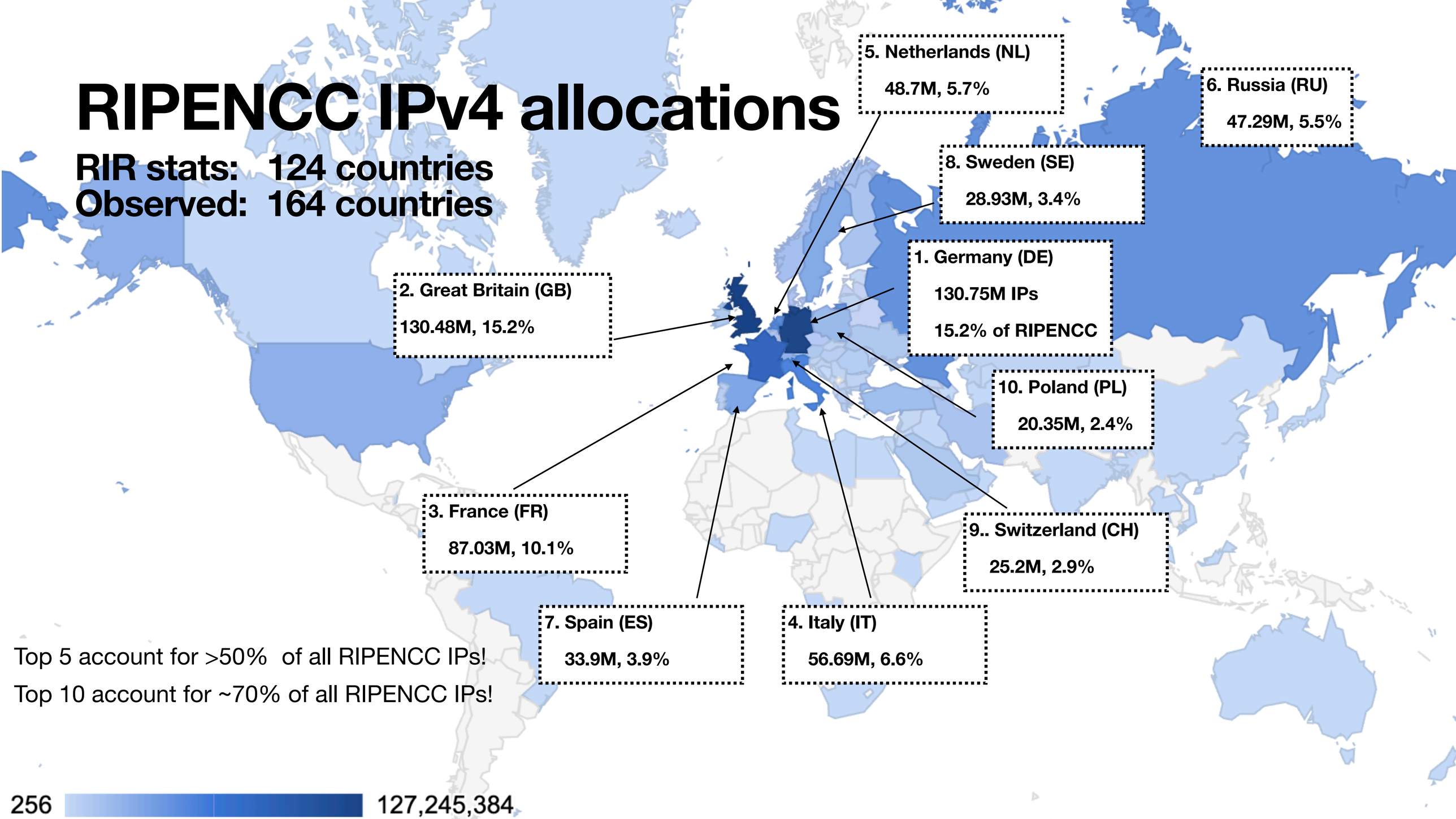


Top 3 account for >70% of all LACNIC IPs!

Top 10 account for 95% of all LACNIC IPs!

RIPENCC IPv4 allocations

RIR stats: 124 countries
Observed: 164 countries



Top 5 account for >50% of all RIPENCC IPs!

Top 10 account for ~70% of all RIPENCC IPs!

256 127,245,384

Allocation Types

ALLOCATED, ASSIGNED, REASSIGNED, …

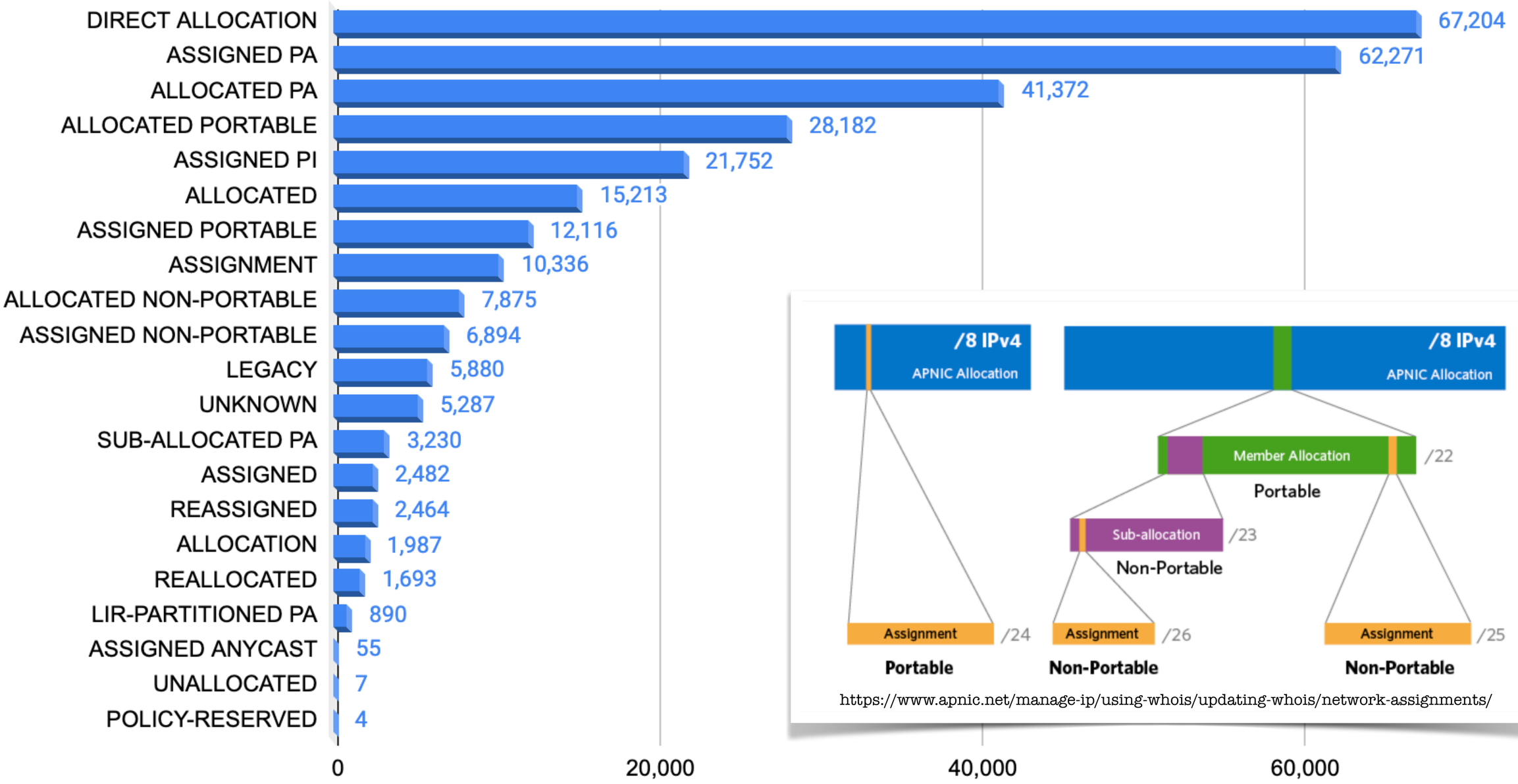
type -- a string containing an RIR-specific classification of the network per that RIR's registration model — RFC9083

- AFRINIC: 7 types
- ARIN: 4 types
- APNIC: 5 types
- LACNIC: 5 types observed
- RIPENCC: 11 types (7 observed)

IPv4 Netblock Allocation Type

PA = Provider Aggregatable

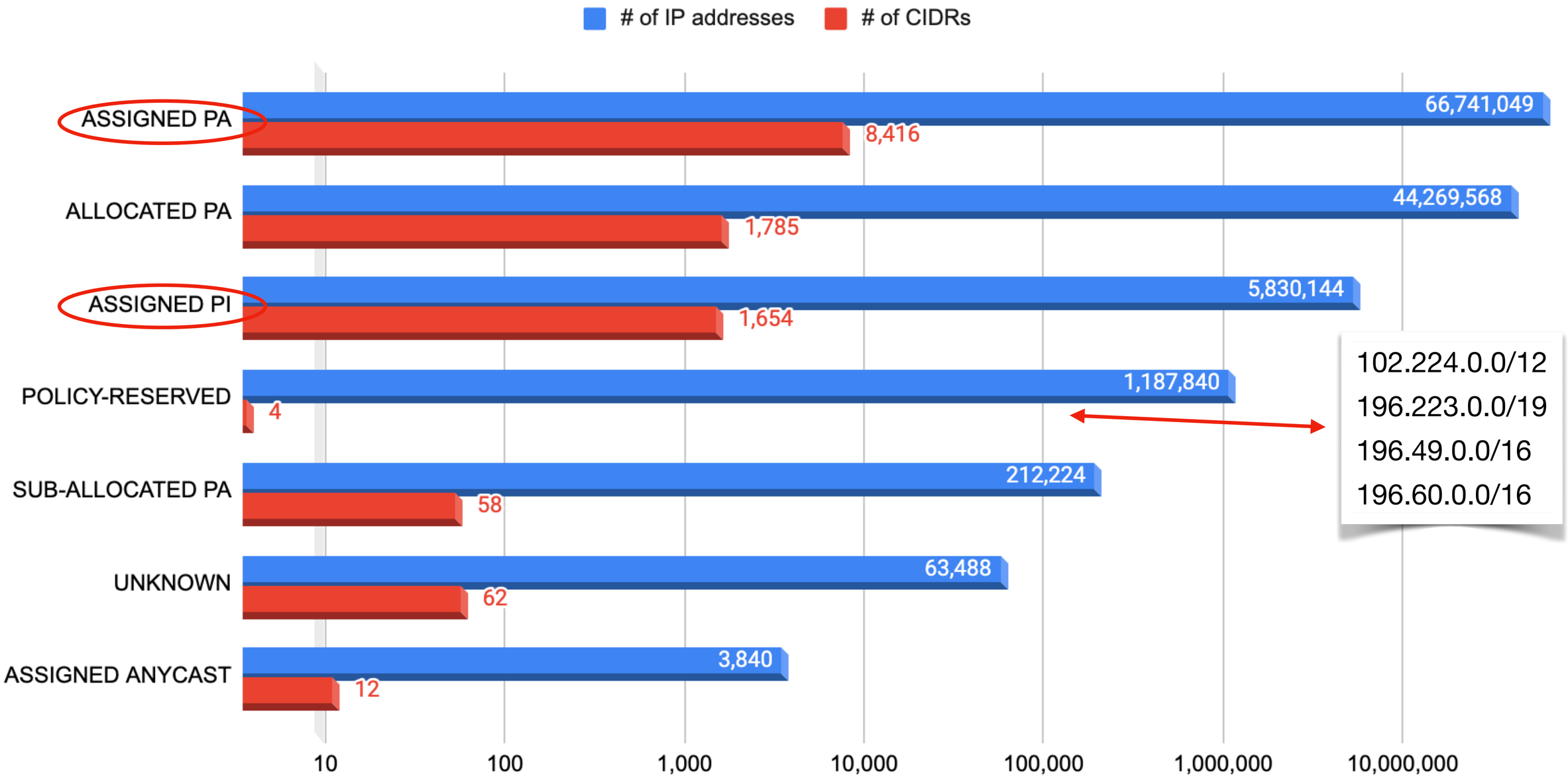
PI = Provider Independent



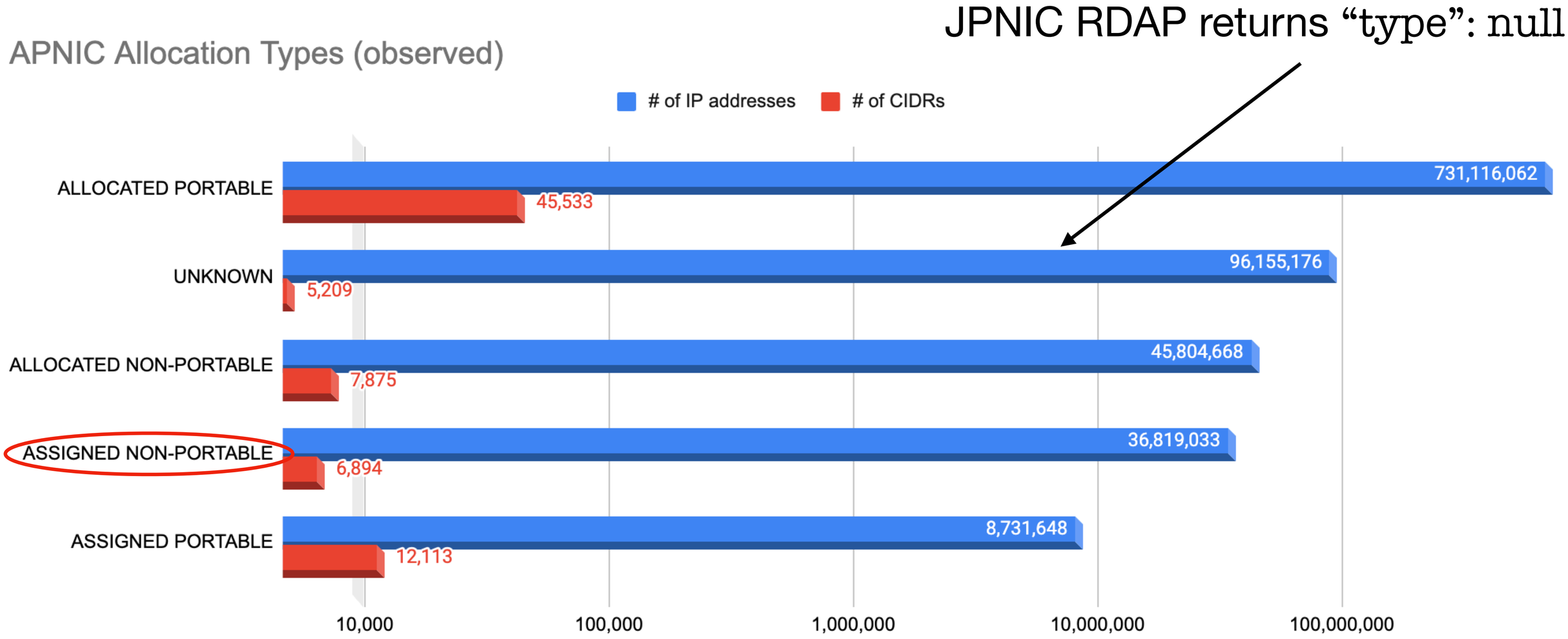
https://www.apnic.net/manage-ip/using-whois/updating-whois/network-assignments/

AFRINIC Allocation Types (observed)

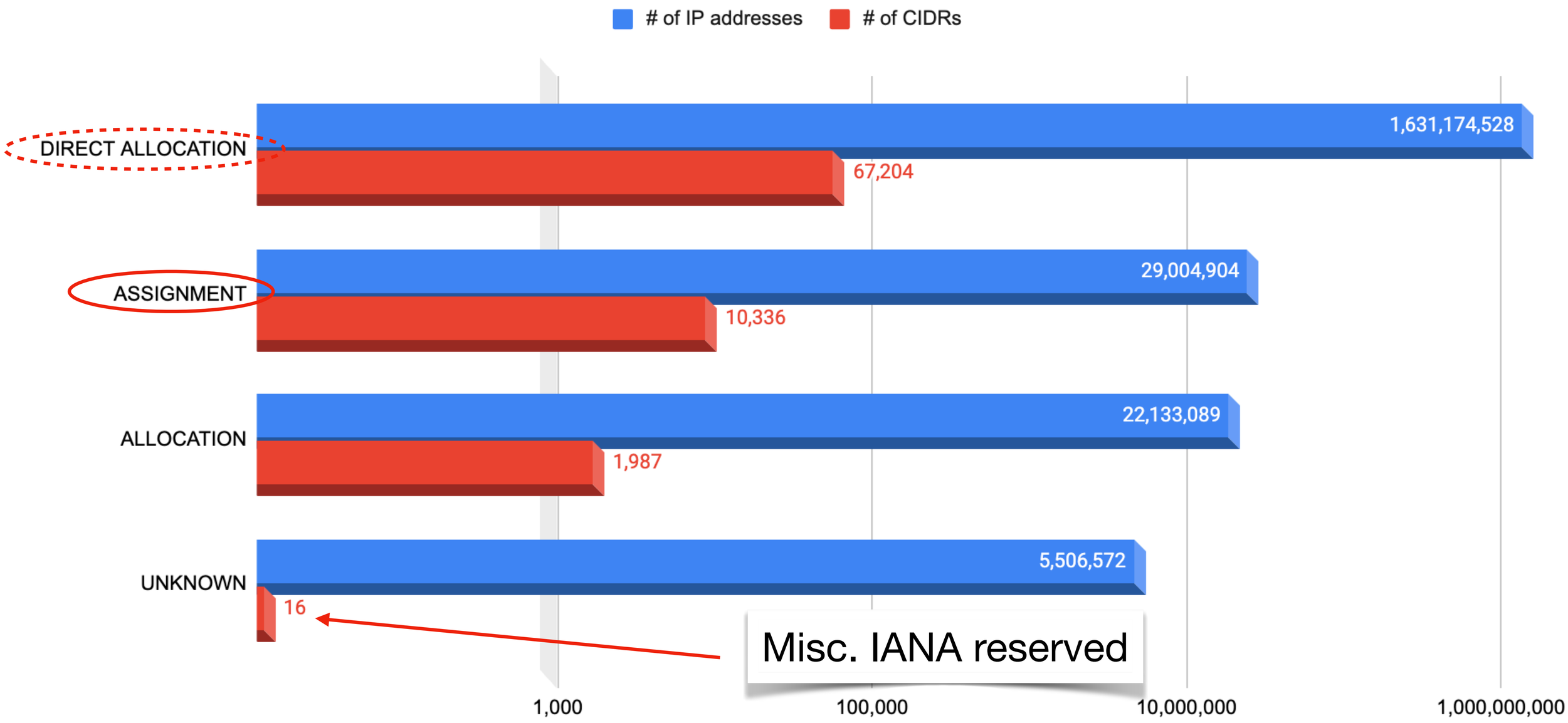
PA = Provider Aggregatable
PI = Provider Independent



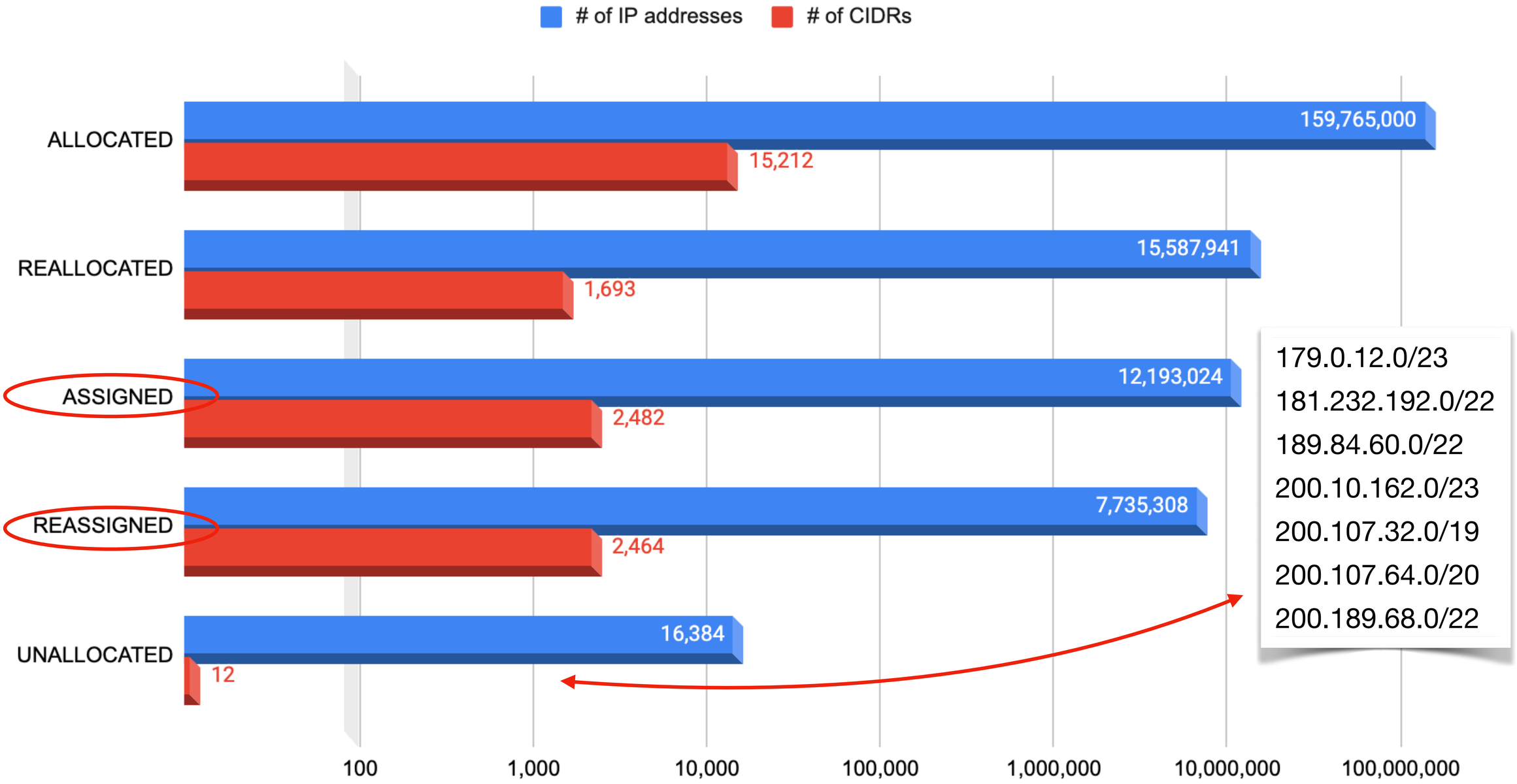
JPNIC RDAP returns “type”: null



ARIN Allocation Types (observed)



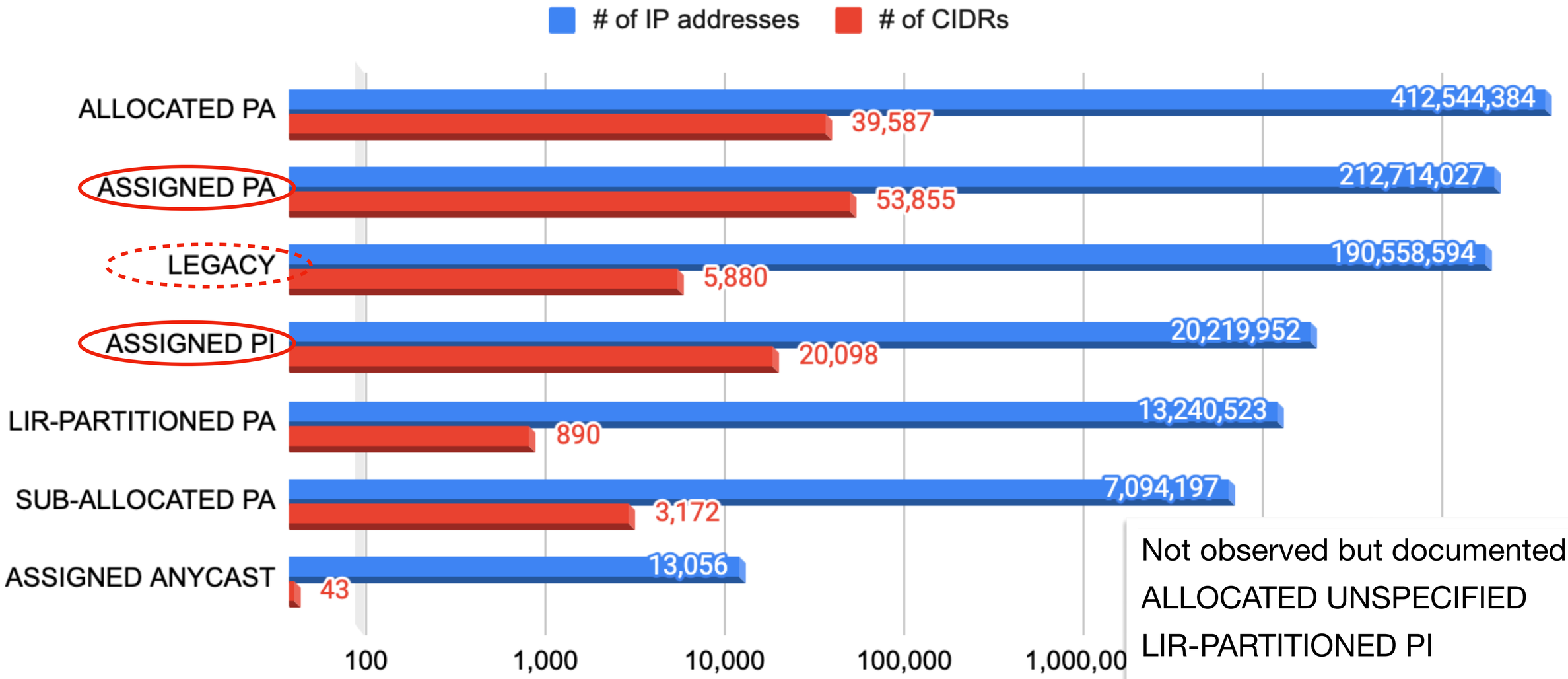
LACNIC Allocation Types (observed)



PA = Provider Aggregatable

PI = Provider Independent

RIPENCC Allocation Types (observed)



Not observed but documented:

ALLOCATED UNSPECIFIED

LIR-PARTITIONED PI

EARLY-REGISTRATION

NOT-SET

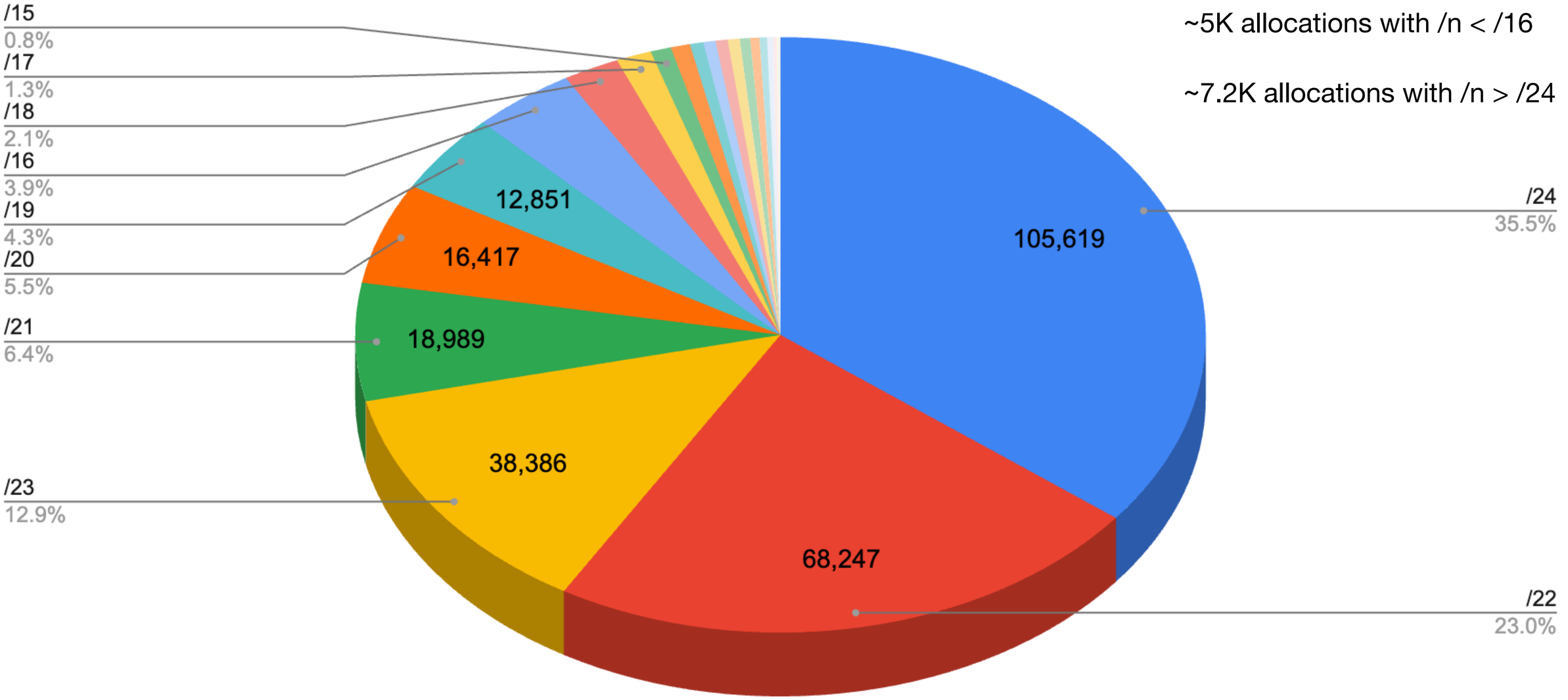
IPv4 Allocation Sizes

25 different CIDR sizes

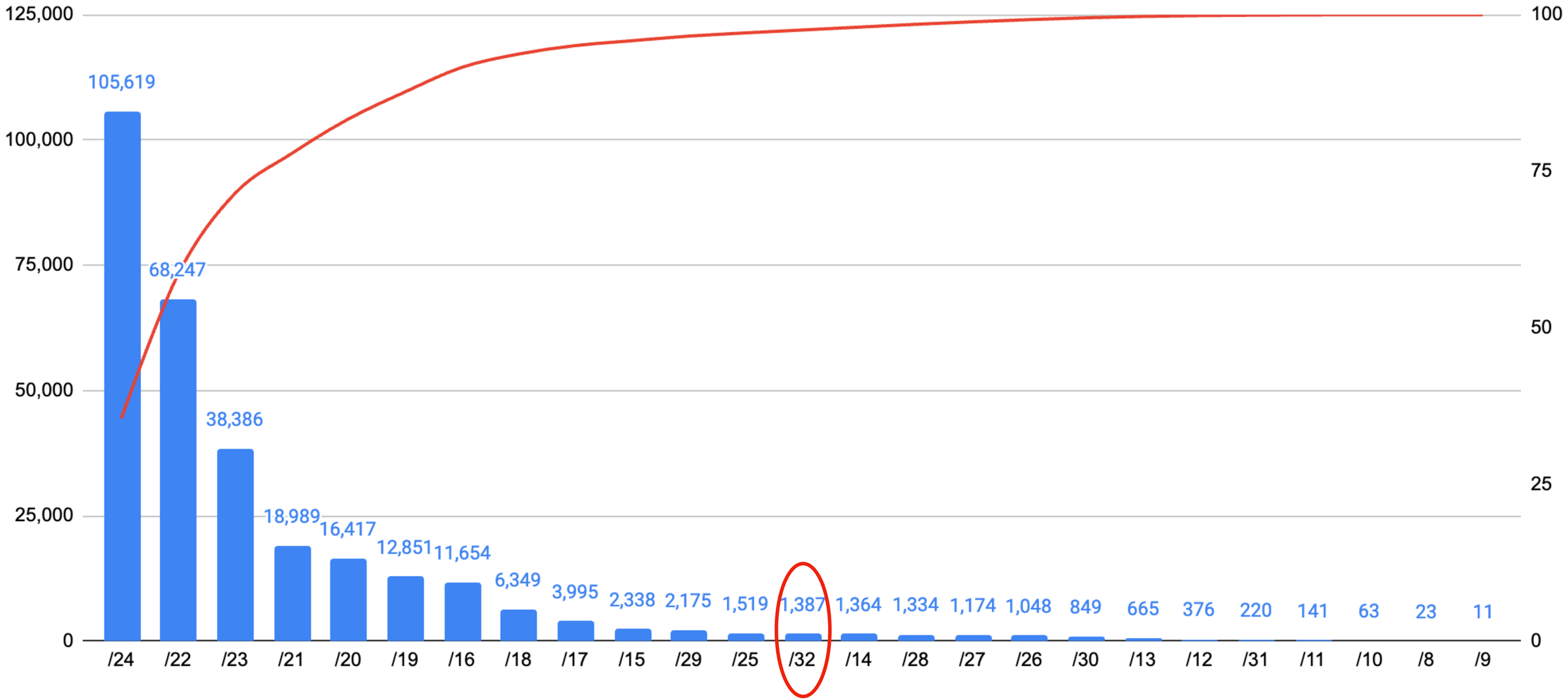
23 /8s

~5K allocations with /n < /16

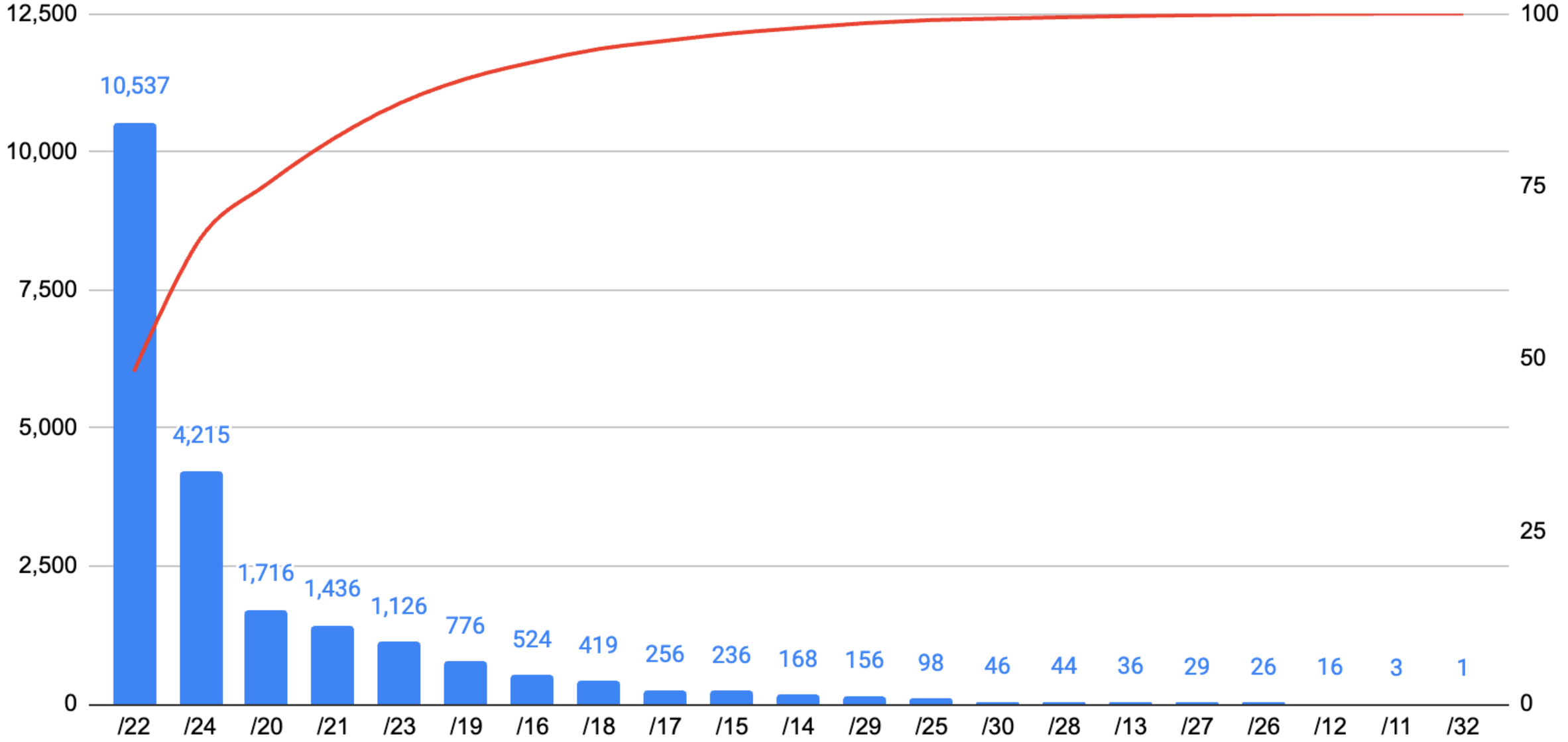
~7.2K allocations with /n > /24



IPv4 Allocation Size



LACNIC Allocation Size



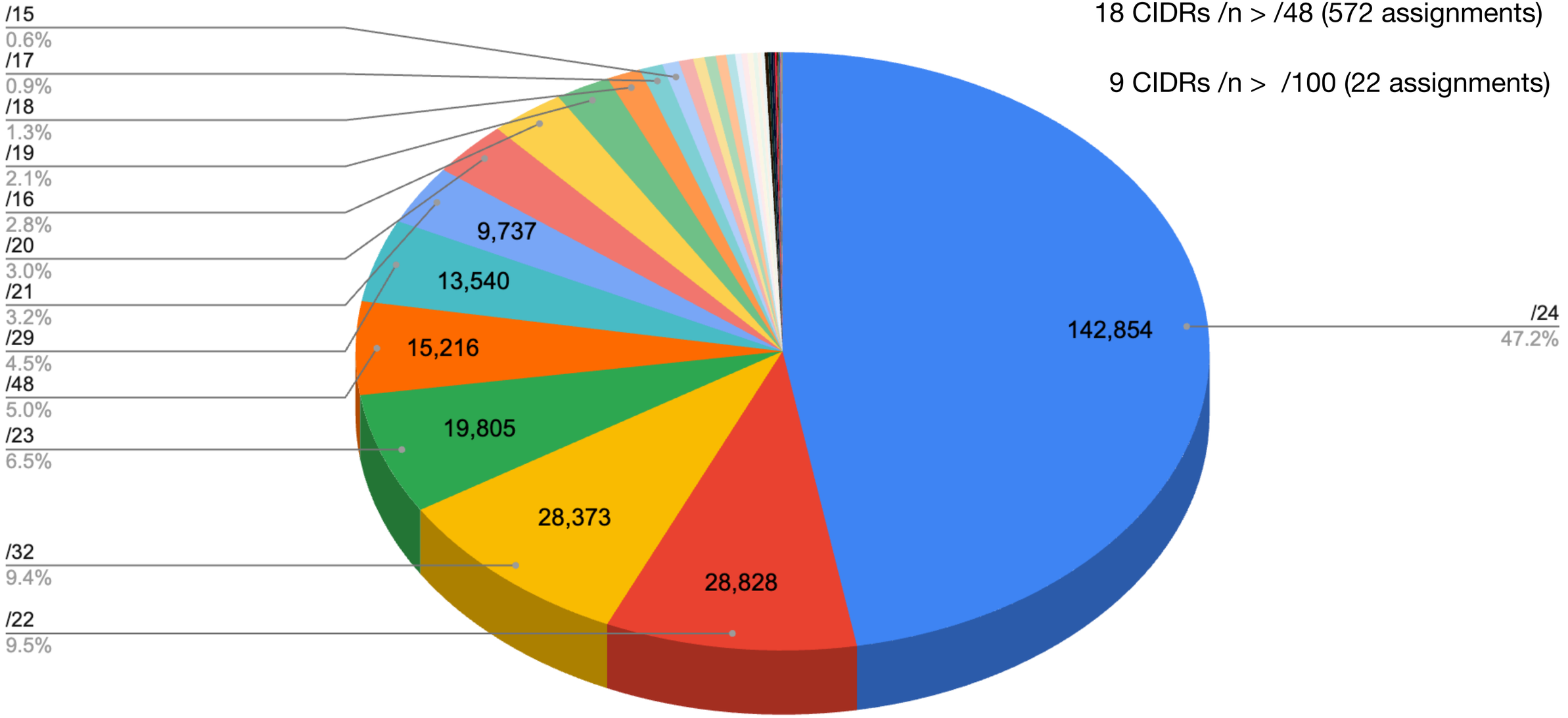
IPv6 Allocation Sizes

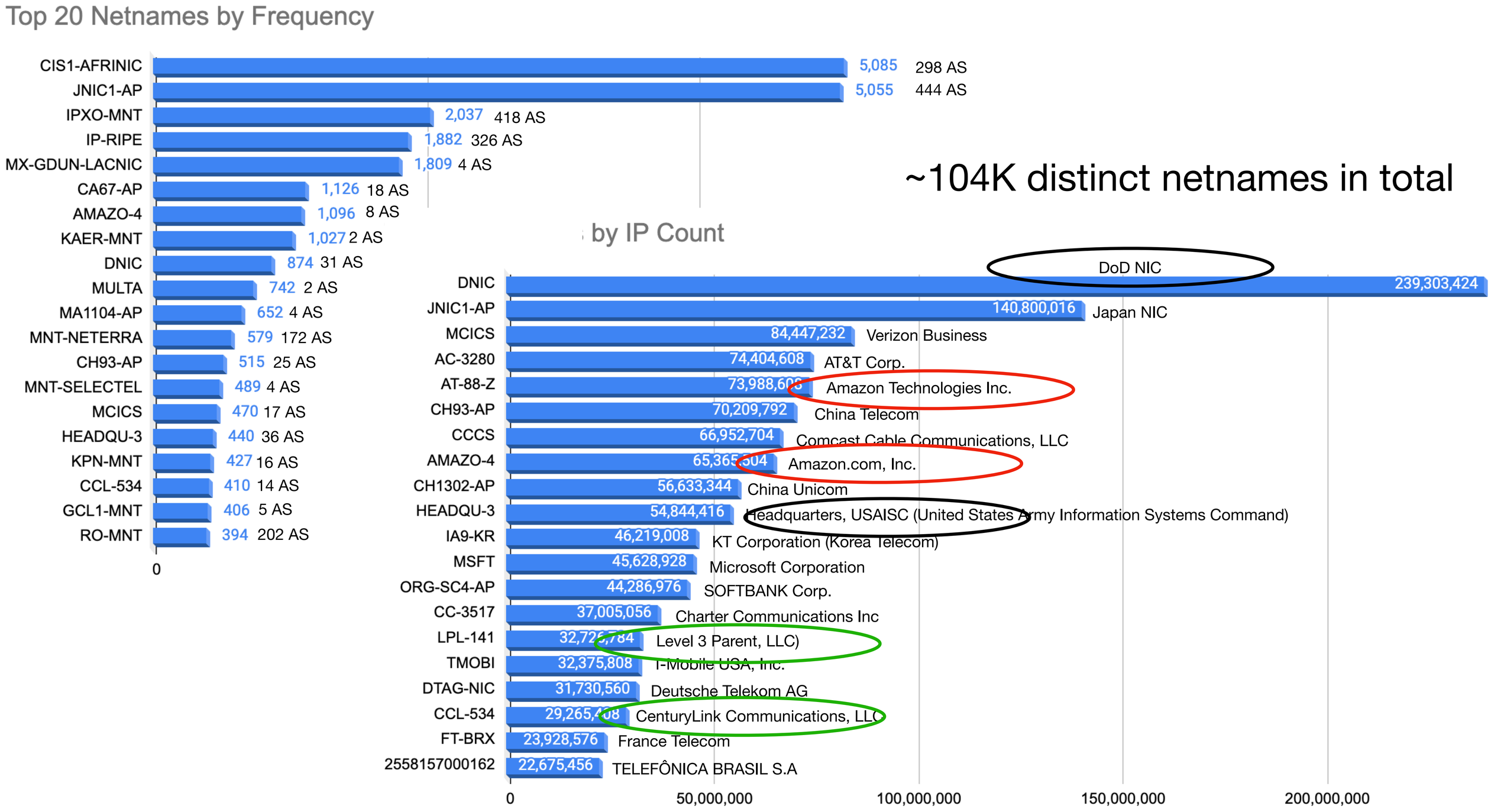
70 different CIDR sizes

22 CIDRs /n < /32 (252K assignments)

18 CIDRs /n > /48 (572 assignments)

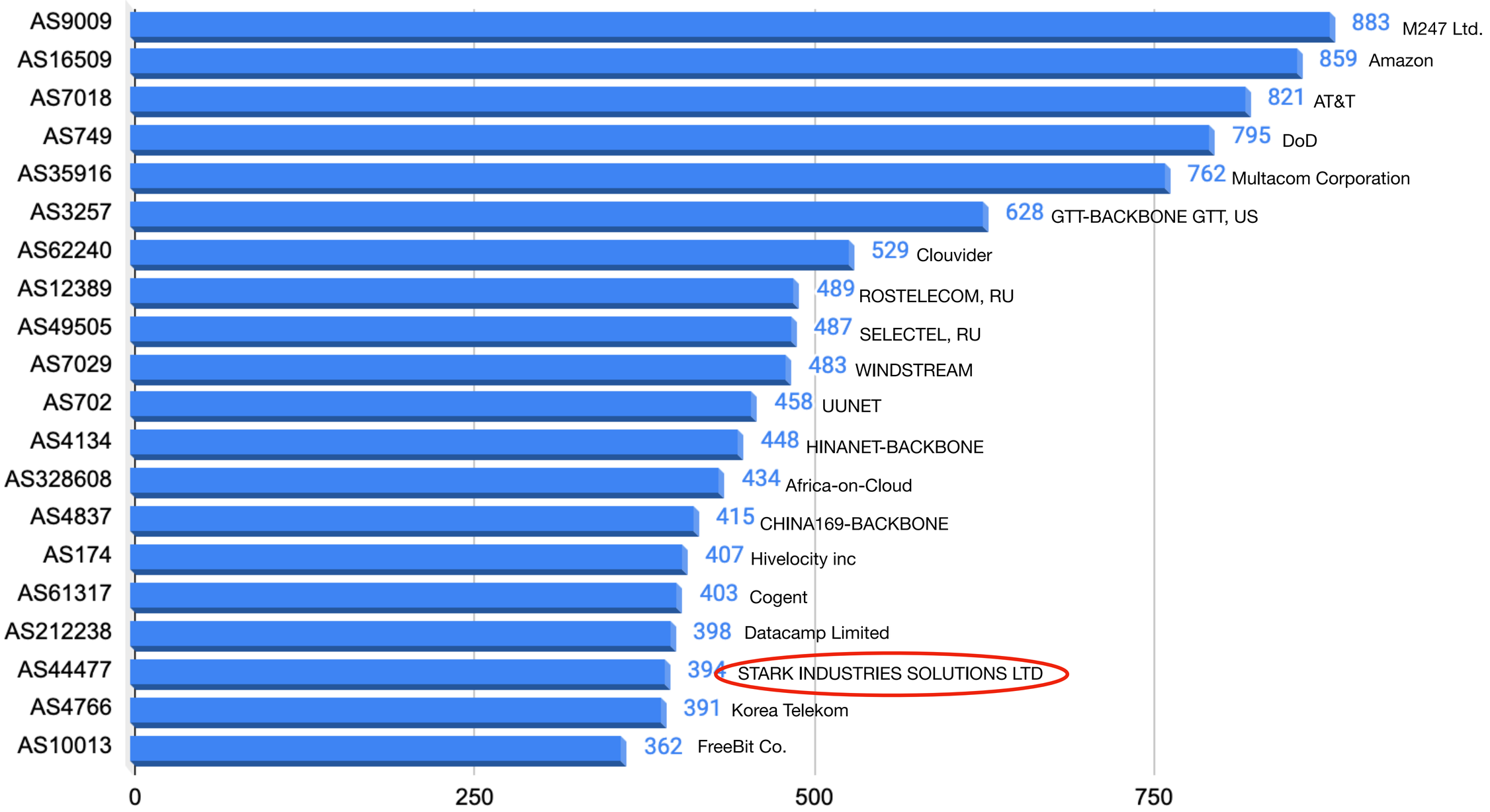
9 CIDRs /n > /100 (22 assignments)




Top 20 Netnames by Frequency
CIS1-AFRINIC 5,085 298 AS
JNIC1-AP 5,055 444 AS
IPXO-MNT 2,037 418 AS
IP-RIPE 1,882 326 AS
MX-GDUN-LACNIC 1,809 4 AS
CA67-AP 1,126 18 AS
AMAZO-4 1,096 8 AS
KAER-MNT 1,027 2 AS
DNIC 874 31 AS
MULTA 742 2 AS
MA1104-AP 652 4 AS
MNT-NETERRA 579 172 AS
CH93-AP 515 25 AS
MNT-SELECTEL 489 4 AS
MCICS 470 17 AS
HEADQU-3 440 36 AS
KPN-MNT 427 16 AS
CCL-534 410 14 AS
GCL1-MNT 406 5 AS
RO-MNT 394 202 AS
0
~104K distinct netnames in total
by IP Count
DoD NIC
DNIC 239,303,424
JNIC1-AP 140,800,016 Japan NIC
MCICS 84,447,232 Verizon Business
AC-3280 74,404,608 AT&T Corp.
AT-88-Z 73,988,608 Amazon Technologies Inc.
CH93-AP 70,209,792 China Telecom
CCCS 66,952,704 Comcast Cable Communications, LLC
AMAZO-4 65,365,504 Amazon.com, Inc.
CH1302-AP 56,633,344 China Unicom
HEADQU-3 54,844,416 Headquarters, USAISC (United States Army Information Systems Command)
IA9-KR 46,219,008 KT Corporation (Korea Telecom)
MSFT 45,628,928 Microsoft Corporation
ORG-SC4-AP 44,286,976 SOFTBANK Corp.
CC-3517 37,005,056 Charter Communications Inc
LPL-141 32,726,784 Level 3 Parent, LLC)
TMOBI 32,375,808 T-Mobile USA, Inc.
DTAG-NIC 31,730,560 Deutsche Telekom AG
CCL-534 29,265,408 CenturyLink Communications, LLC
FT-BRX 23,928,576 France Telecom
2558157000162 22,675,456 TELEFÔNICA BRASIL S.A
0
50,000,000
100,000,000
150,000,000
200,000,000

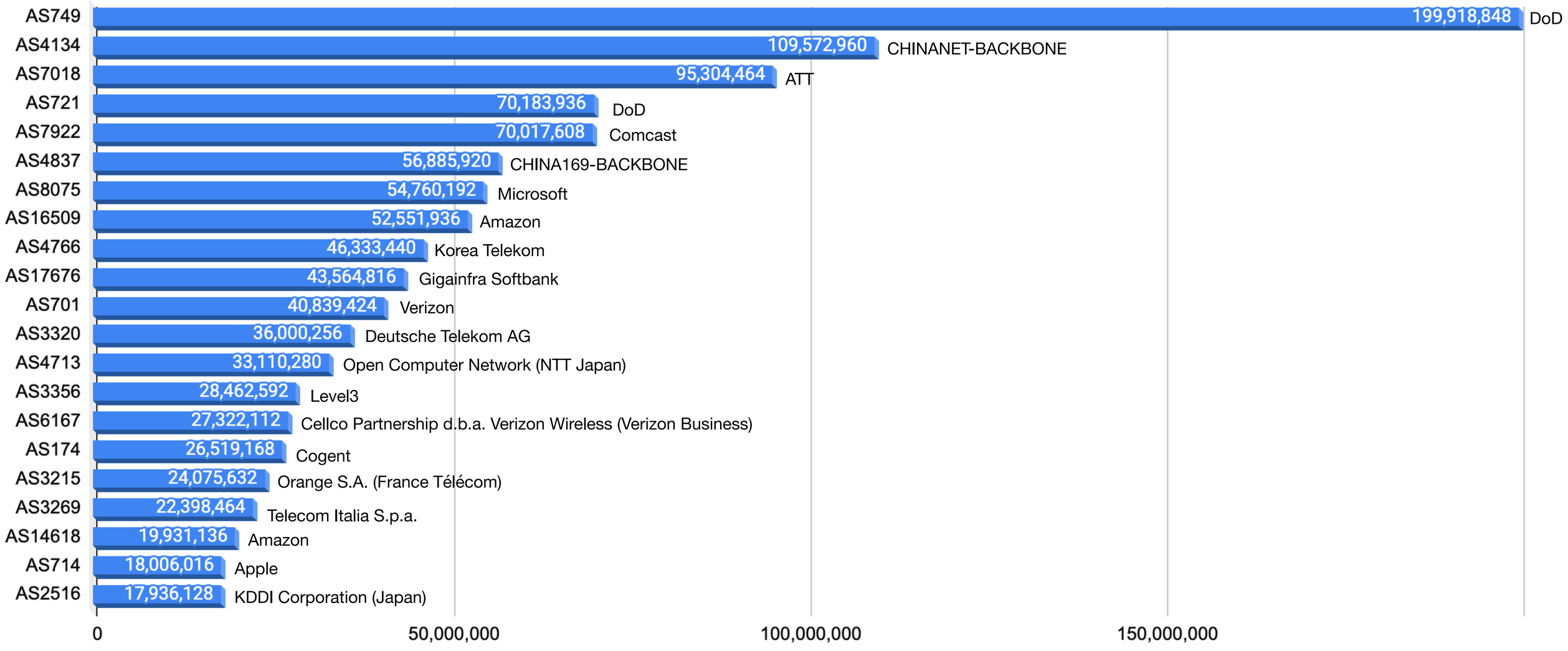
Top 20 AS by frequency

~63K distinct AS in total

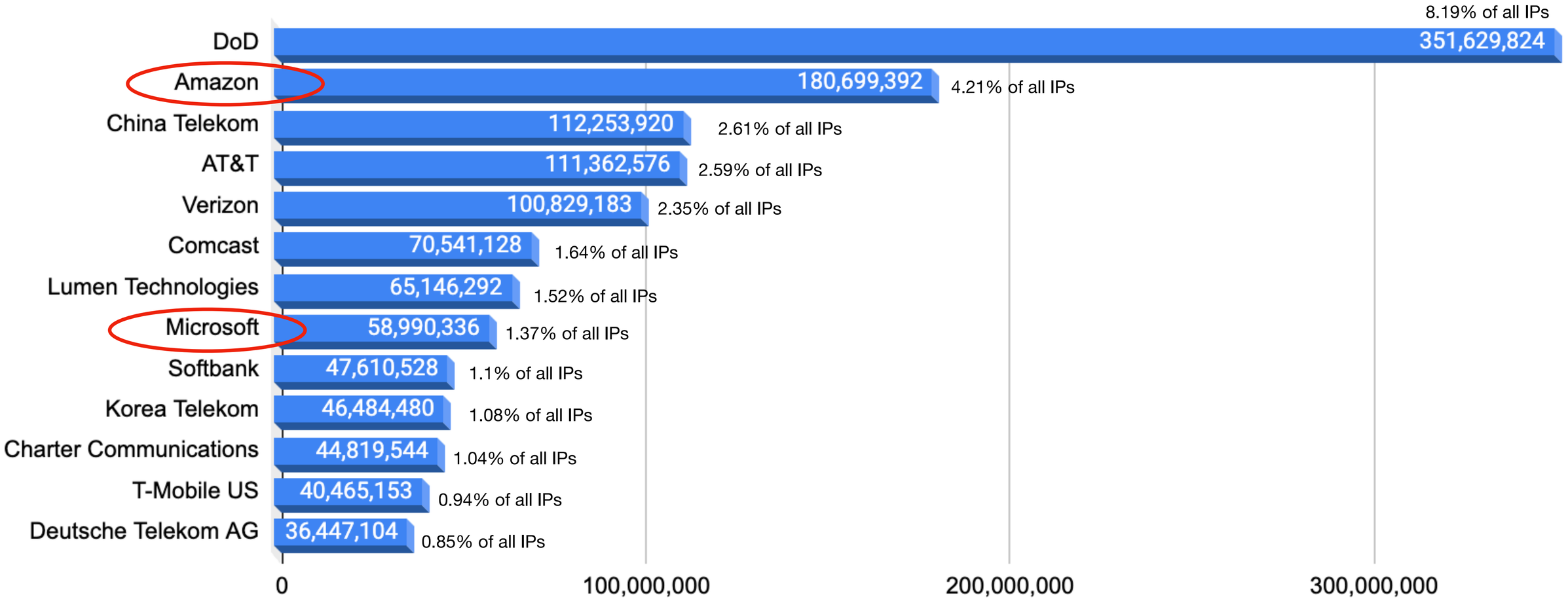


Top 20 AS by IP count

~63K distinct AS in total



Top Organizations as Combined by IP Count



Whose CIDR…?

- distinguishing between LIR and end-user is… fuzzy
- inconsistencies across RIRs definitions and data models
- inconsistent data in RDAP
- *Regional* Internet Registries seem a lot less regional than you might think
- ~30% of all IPs are managed by 13 organizations
- DoD (still) controls > 8% of all IPs

Whose C

- distinguishing bet
- inconsistencies a
- inconsistent data
- *Regional* Internet
- ~30% of all IPs a
- DoD (still) control

nk

Minutes before Trump departed office, a mysterious Florida company reportedly took over a slice of the Pentagon's internet space

Kevin Shalvey Apr 25, 2021, 8:02 AM EDT

Share | Save

The Pentagon. Bill Clark/CQ Roll Call via Getty Images

- **A Florida firm took over a slice of the internet owned by the Pentagon during Biden's inauguration.**
- **It now controls nearly 175 million IP addresses, The Washington Post reported on Saturday.**

Remember AS8003?

Whose CIDR…?

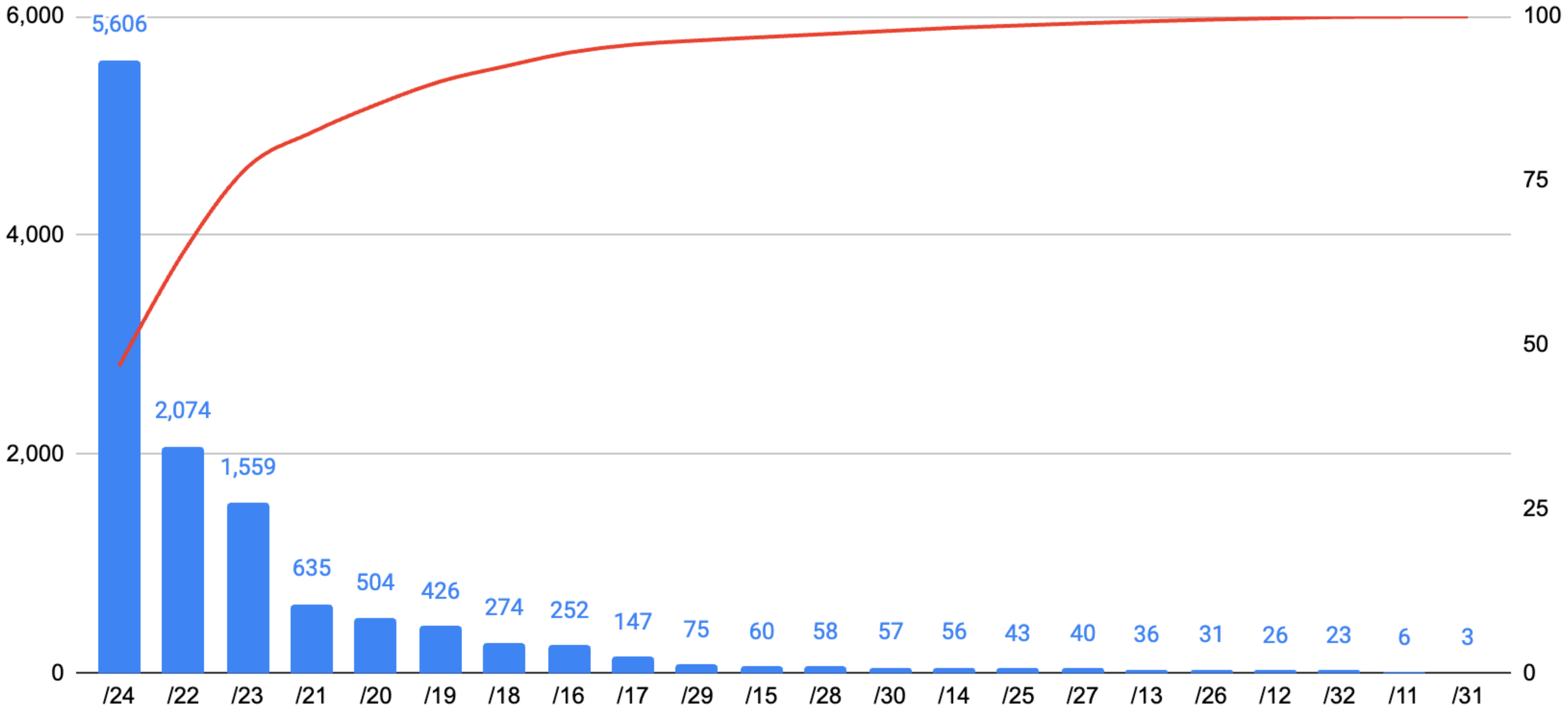
- distinguishing between LIR and end-user is… fuzzy
- inconsistencies across RIRs definitions and data models
- inconsistent data in RDAP
- *Regional* Internet Registries seem a lot less regional than you might think
- ~30% of all IPs are managed by 13 organizations
- DoD (still) controls > 8% of all IPs
- Amazon (4.1%) & Microsoft (1.37%) amongst top ten as only non-ISPs
- IPv6 is a lot more boring (I like boring. We should do more of that.)

Dziękuję!

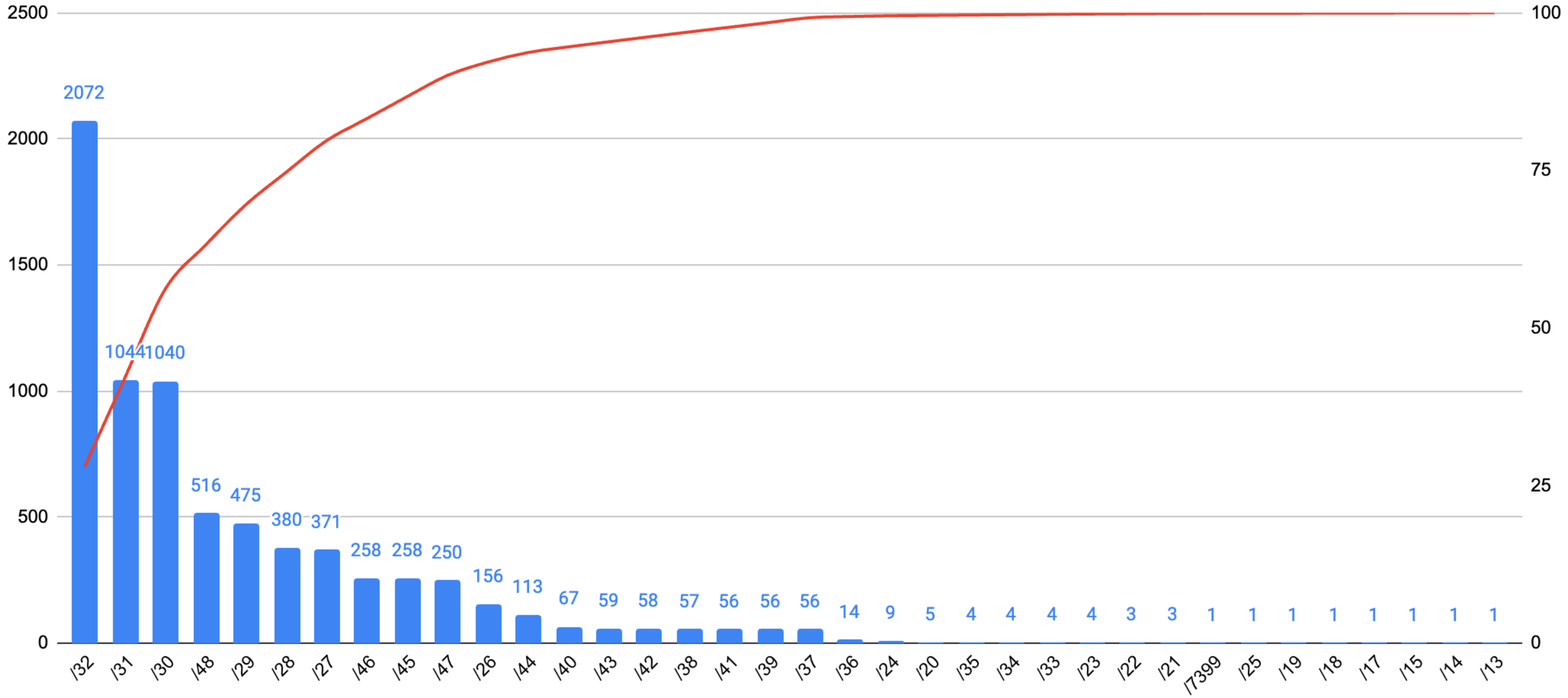
Jan Schaumann <jschauma@netmeister.org> / @jschauma@mstdn.social

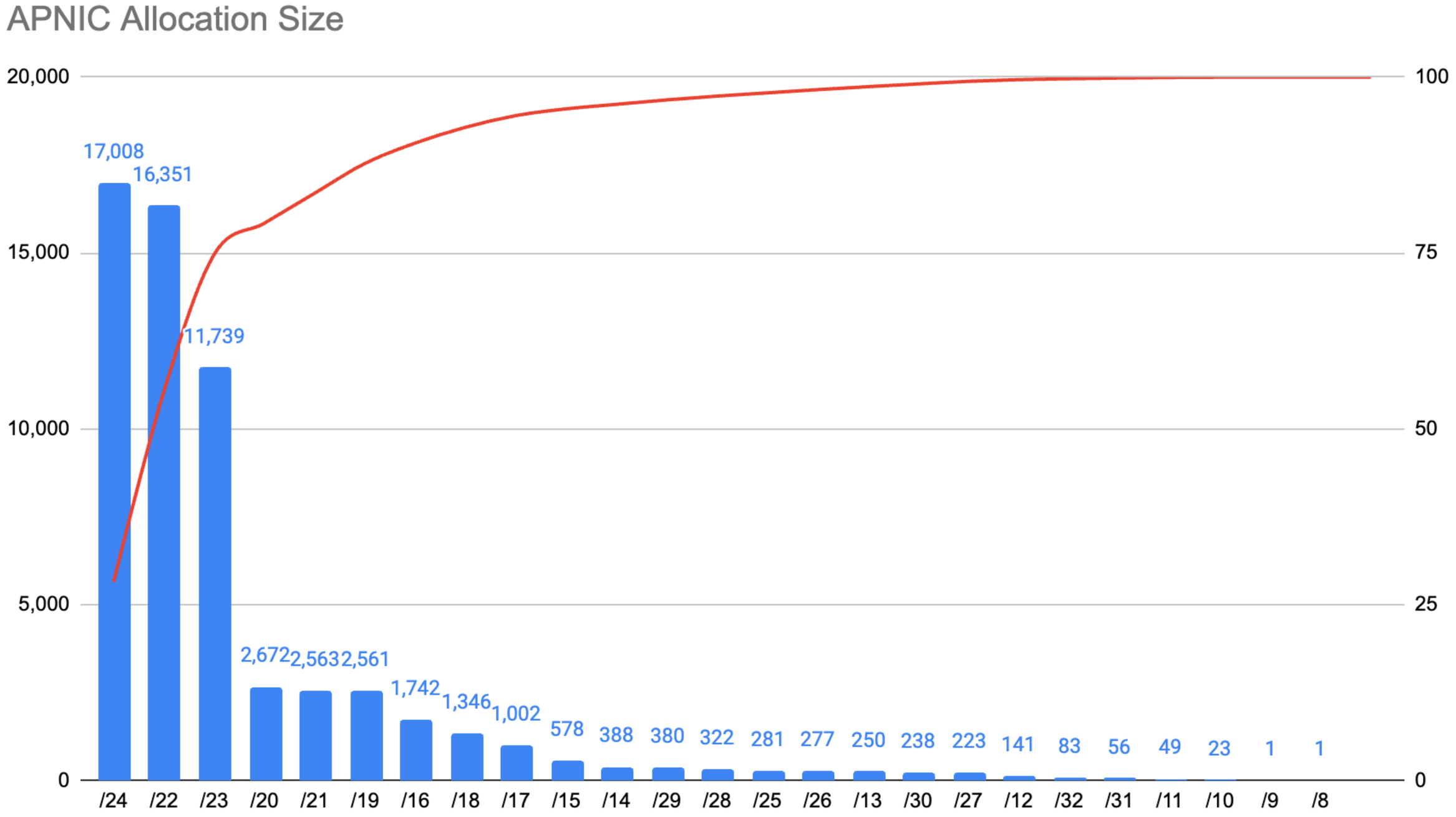
Additional Slides

AFRINIC Allocation Size



AFRINIC IPv6 Allocation Sizes




APNIC Allocation Size
20,000
15,000
10,000
5,000
0
100
75
50
25
0
17,008
16,351
11,739
2,672
2,563
2,561
1,742
1,346
1,002
578
388
380
322
281
277
250
238
223
141
83
56
49
23
1
1
/24
/22
/23
/20
/21
/19
/16
/18
/17
/15
/14
/29
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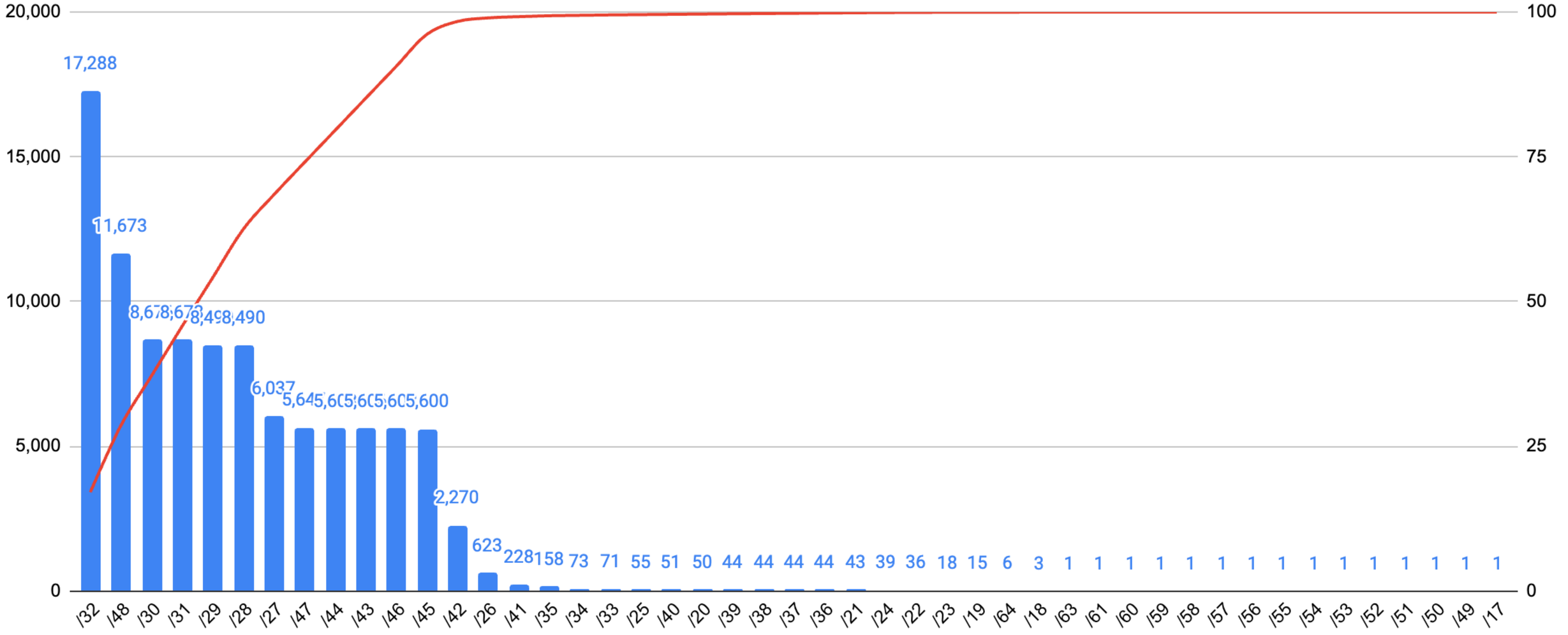
/25
/26
/13
/30
/27
/12
/32
/31
/11
/10
/9
/8


APNIC IPv6 Allocation Sizes
20,000
15,000
10,000
5,000
0
100
75
50
25
0
17,288
11,673
8,678
8,678
8,498
8,490
6,037
5,645
5,605
5,605
5,605
5,600
2,270
623
228
158
73
71
55
51
50
44
44
44
44
43
39
36
18
15
6
3
1
1
1
1
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/48
/30
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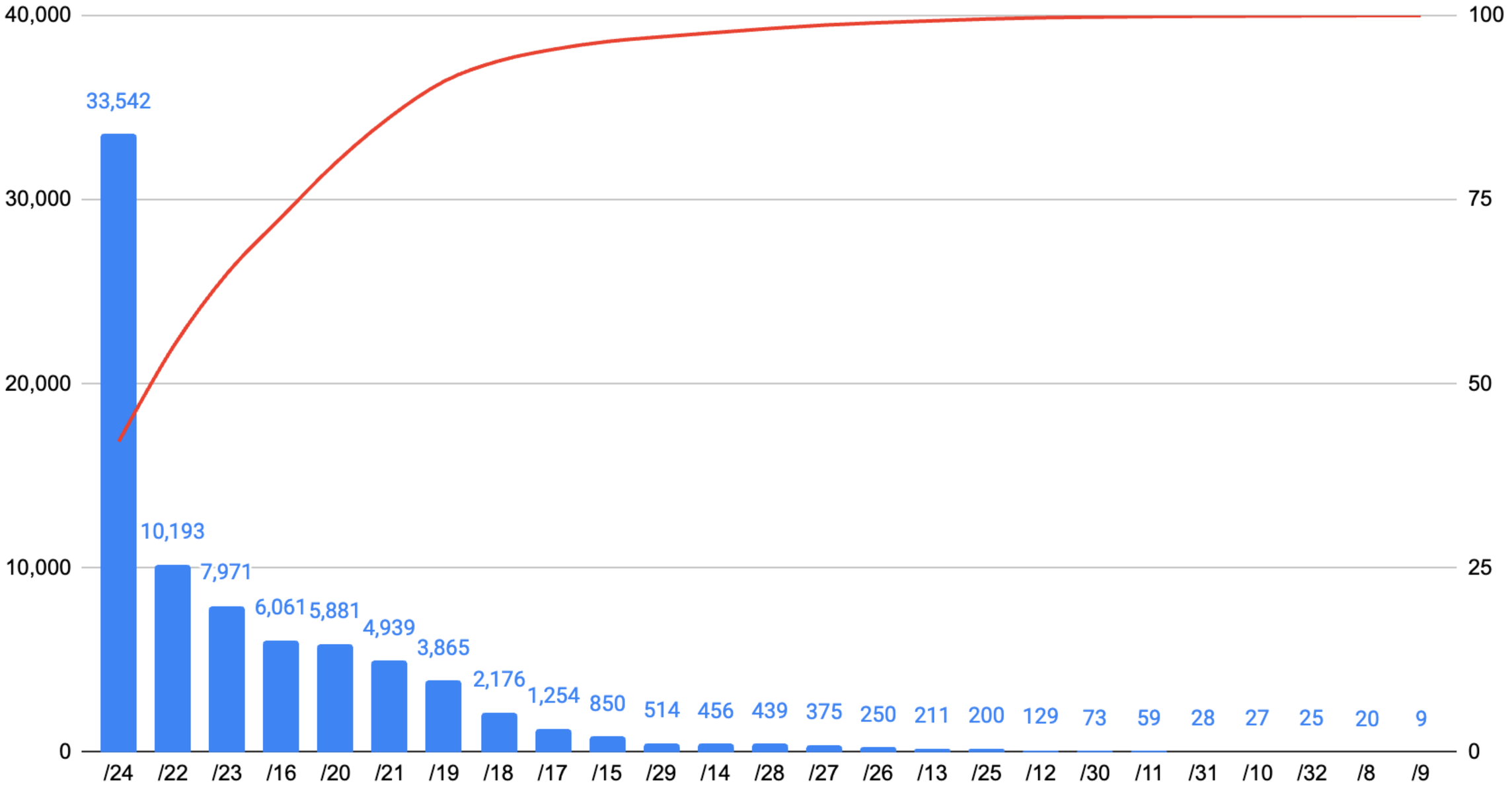
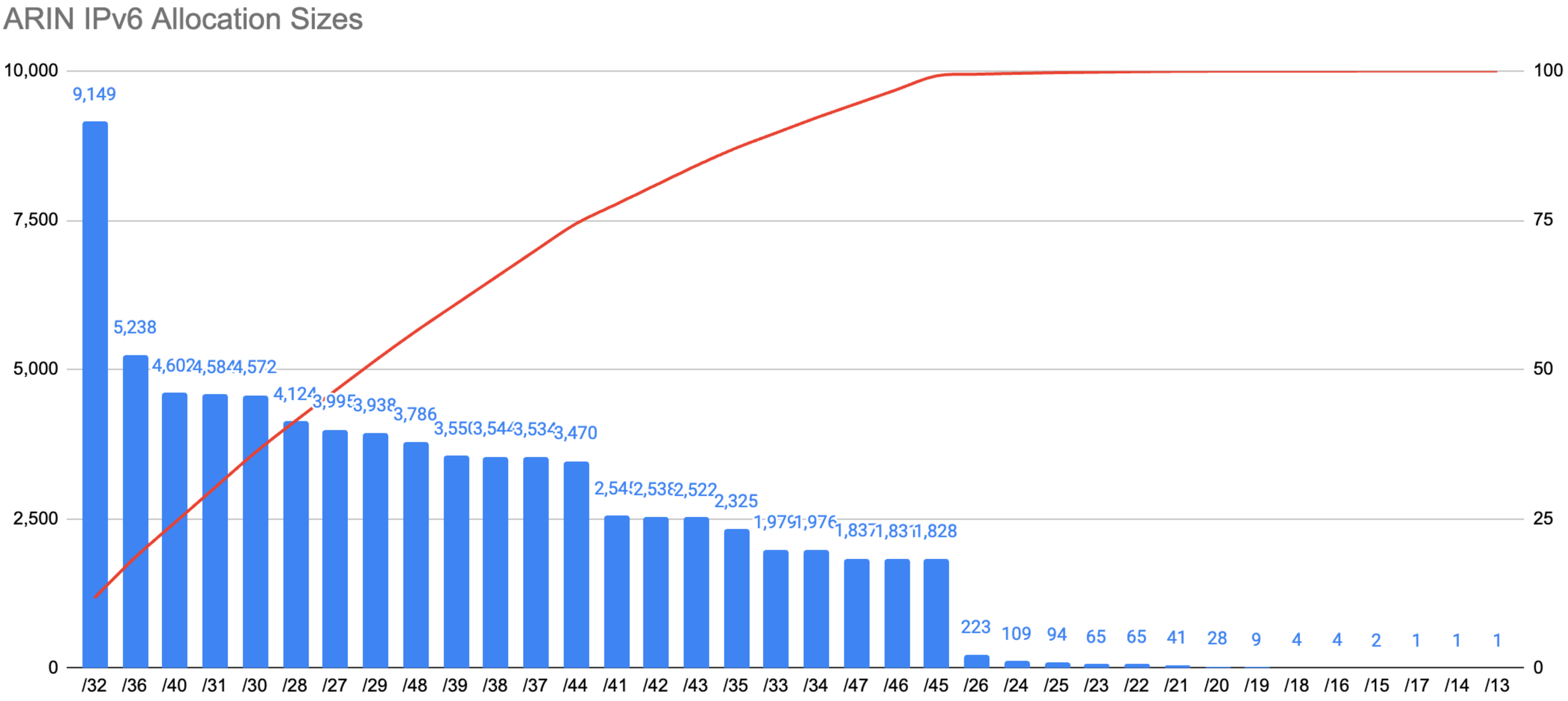
/51
/50
/49
/17

ARIN Allocation Size




ARIN IPv6 Allocation Sizes
10,000
7,500
5,000
2,500
0
100
75
50
25
0
9,149
5,238
4,602
4,584
4,572
4,124
3,995
3,938
3,786
3,55(
3,544
3,534
3,470
2,54
2,53
2,522
2,325
1,979
1,976
1,837
1,83
1,828
223
109
94
65
65
41
28
9
4
4
2
1
1
1
/32
/36
/40
/31
/30
/28
/27
/29
/48
/39
/38
/37
/44
/41
/42
/43
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/26
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/25
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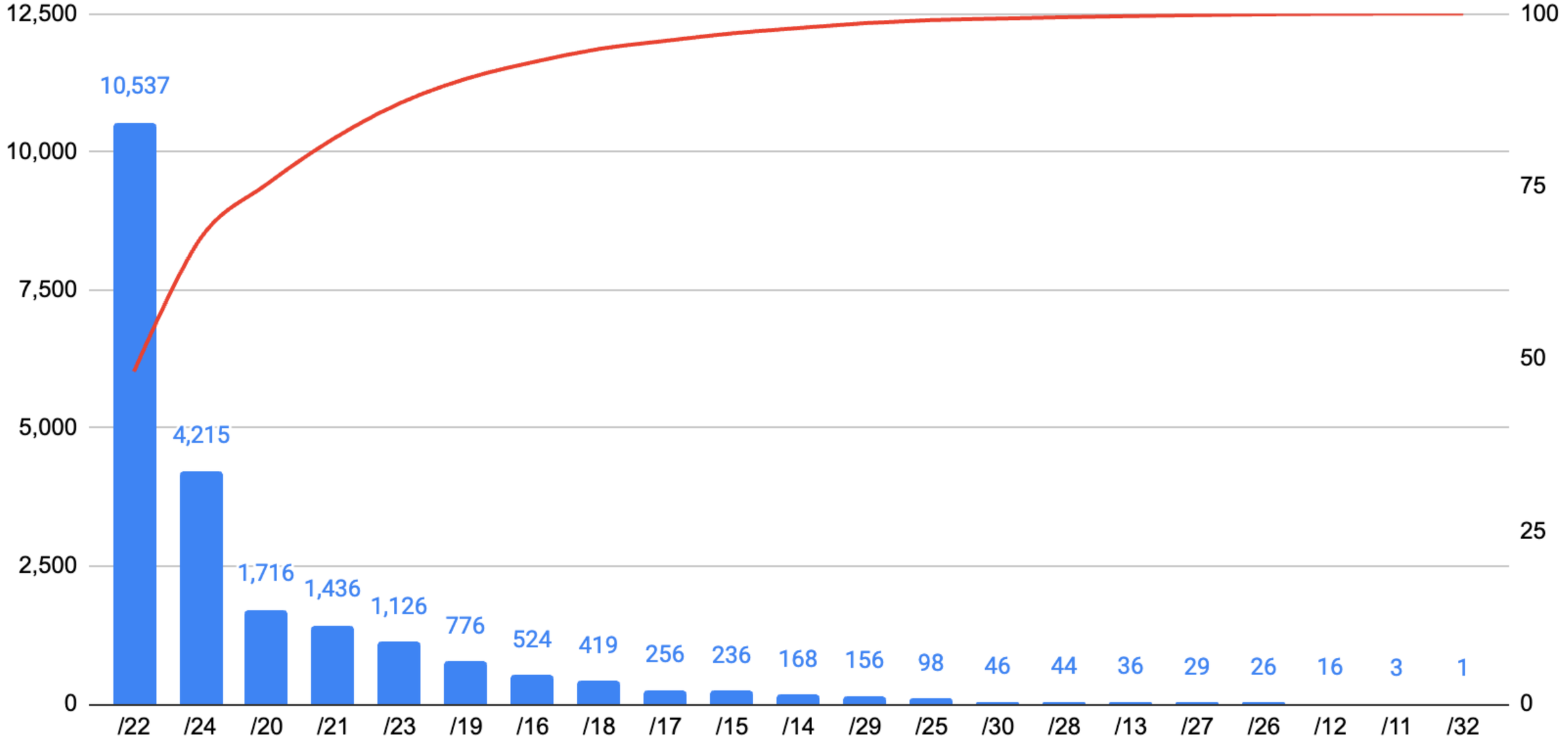
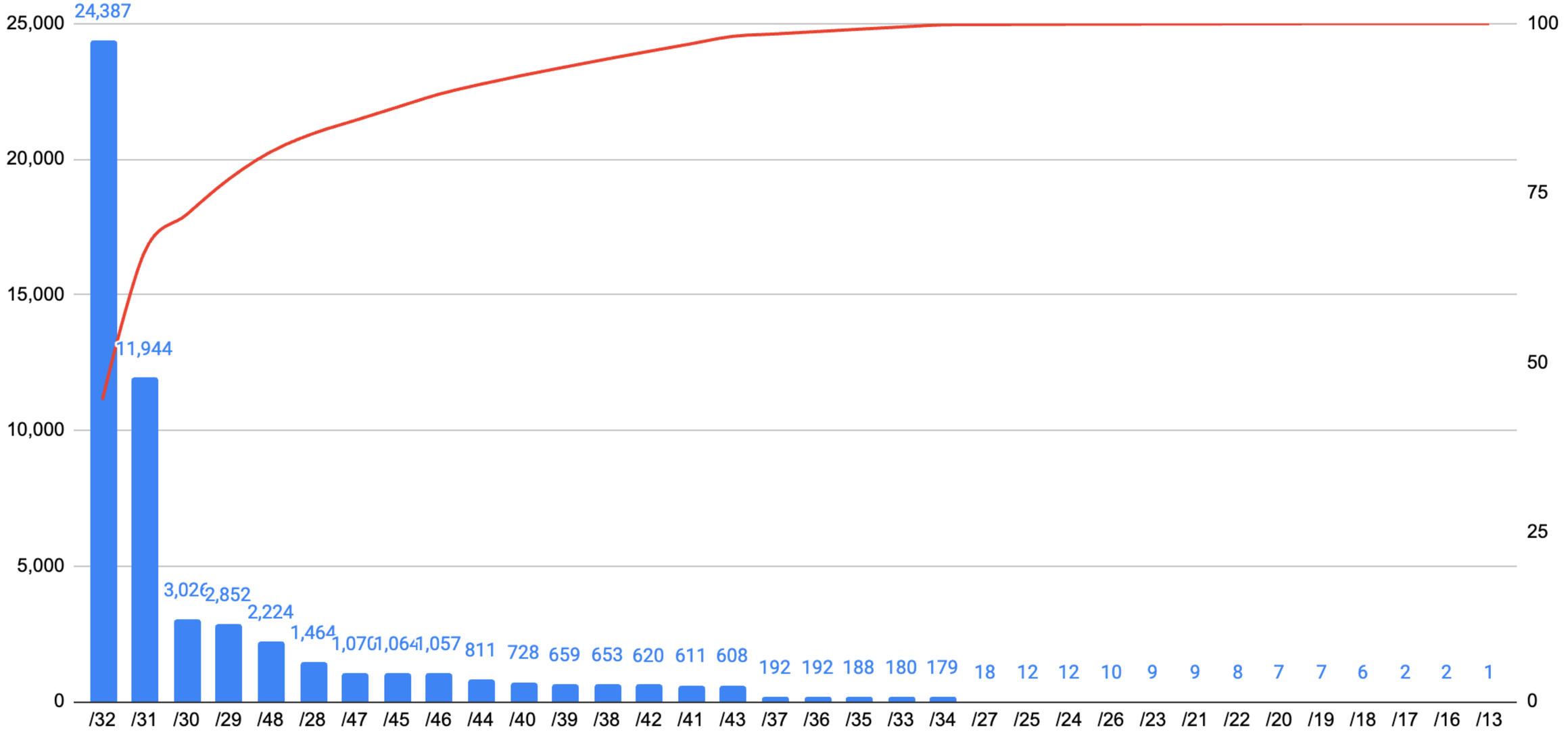
/19
/18
/16
/15
/17
/14
/13

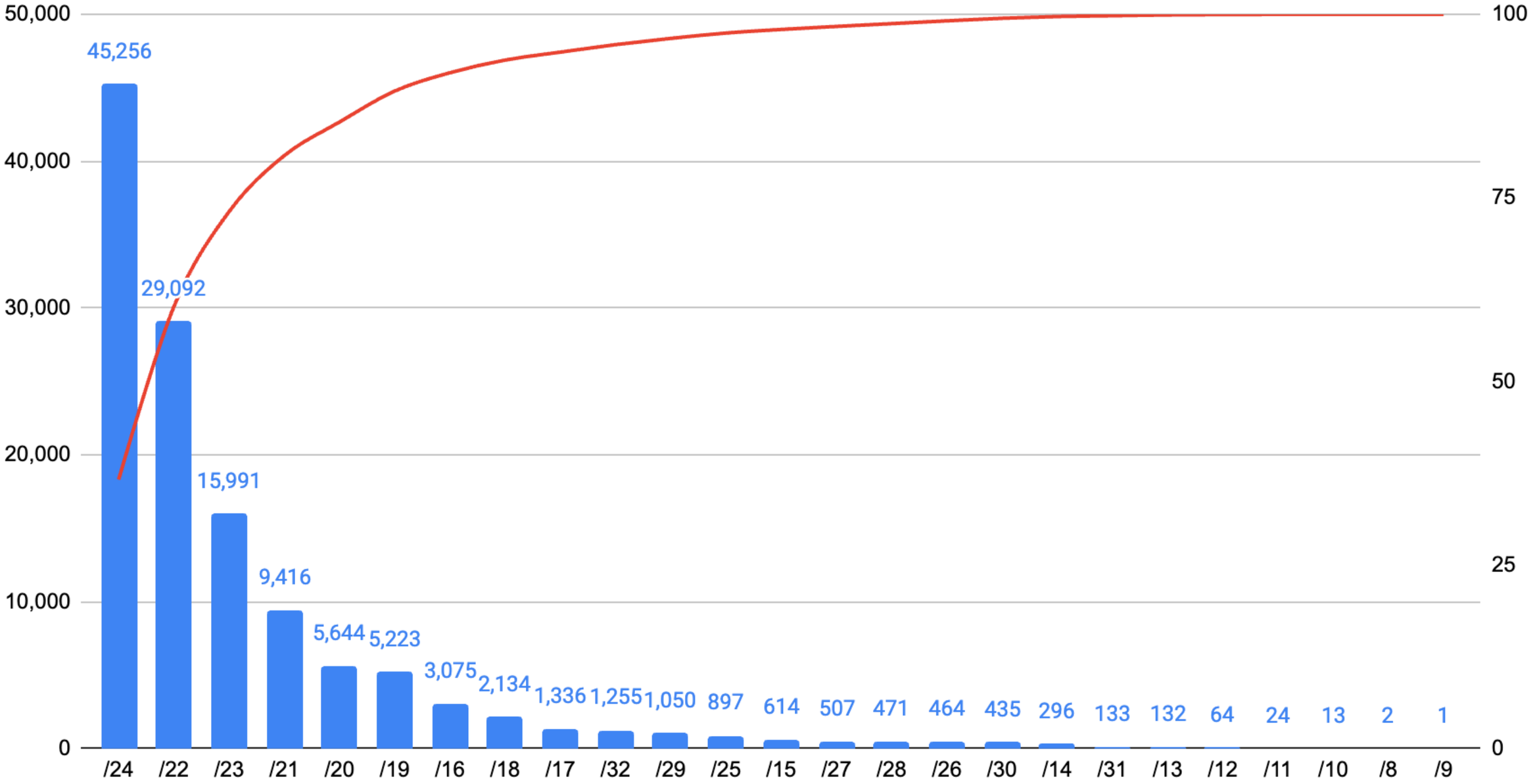
LACNIC Allocation Size

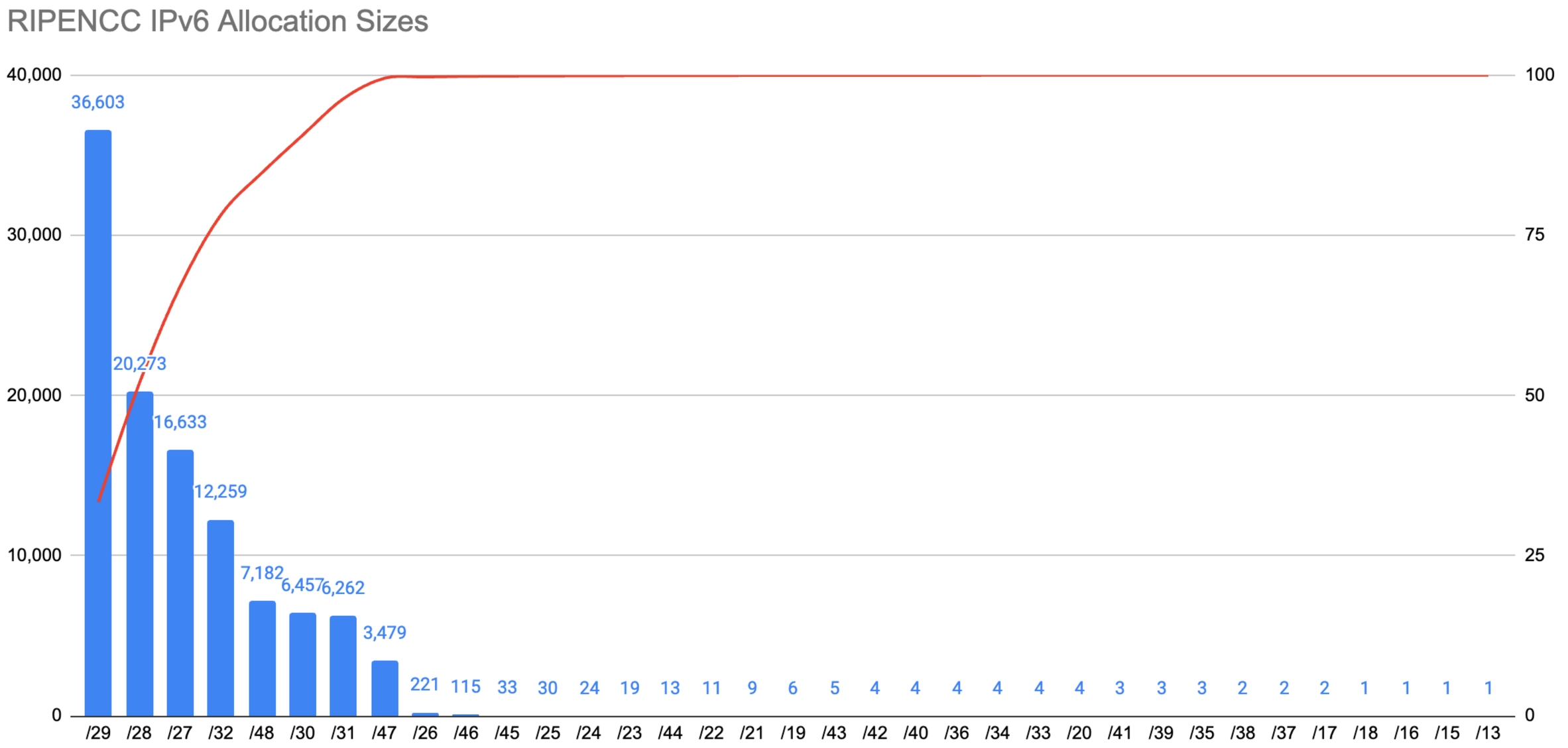


LACNIC IPv6 Allocation Sizes



RIPENCC Allocation Size




RIPENCC IPv6 Allocation Sizes
40,000
30,000
20,000
10,000
0
100
75
50
25
0
36,603
20,273
16,633
12,259
7,182
6,457
6,262
3,479
221
115
33
30
24
19
13
11
9
6
5
4
4
4
4
4
4
3
3
3
2
2
2
1
1
1
1
/29
/28
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/32
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/25
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/40
/36
/34
/33
/20
/41
/39
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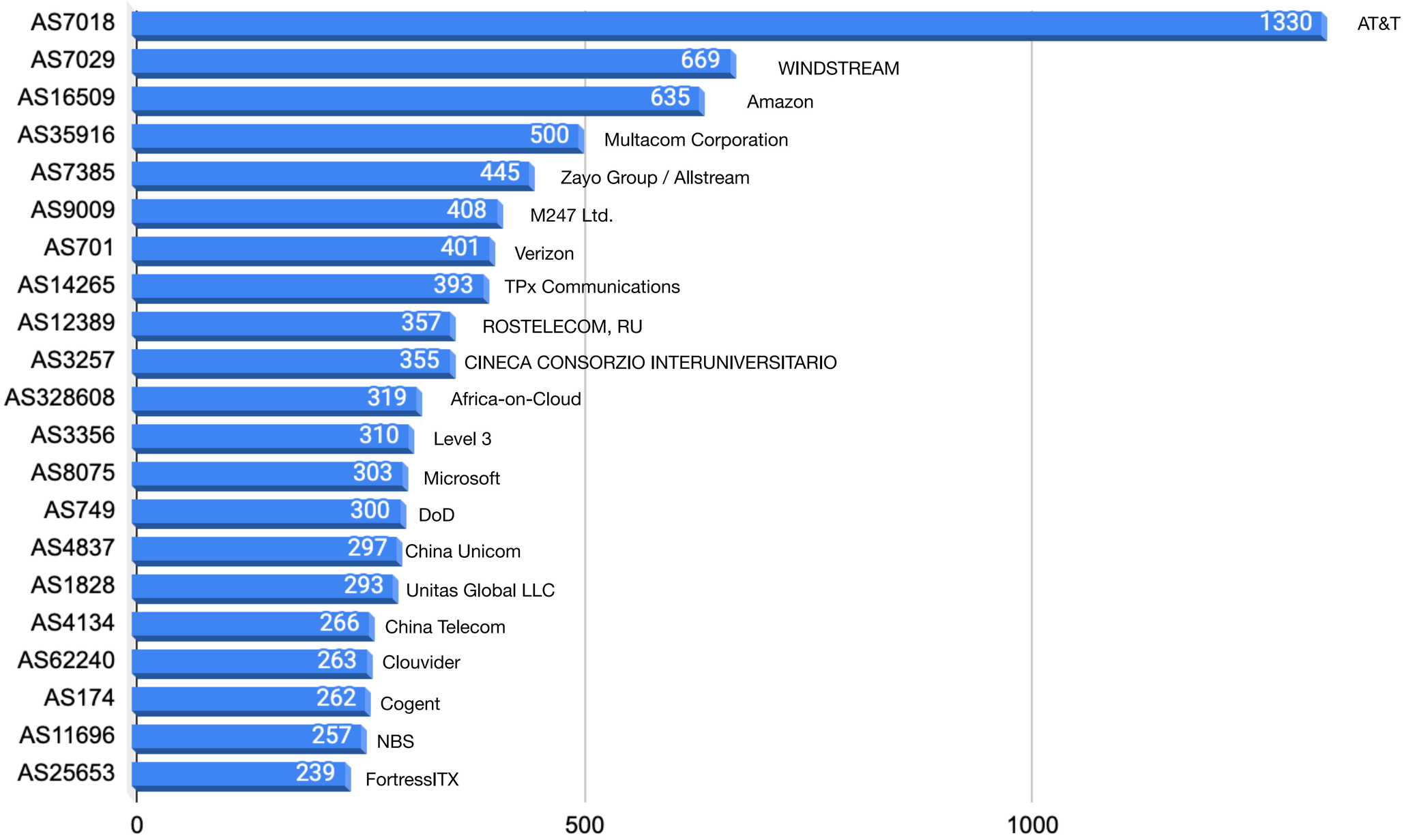
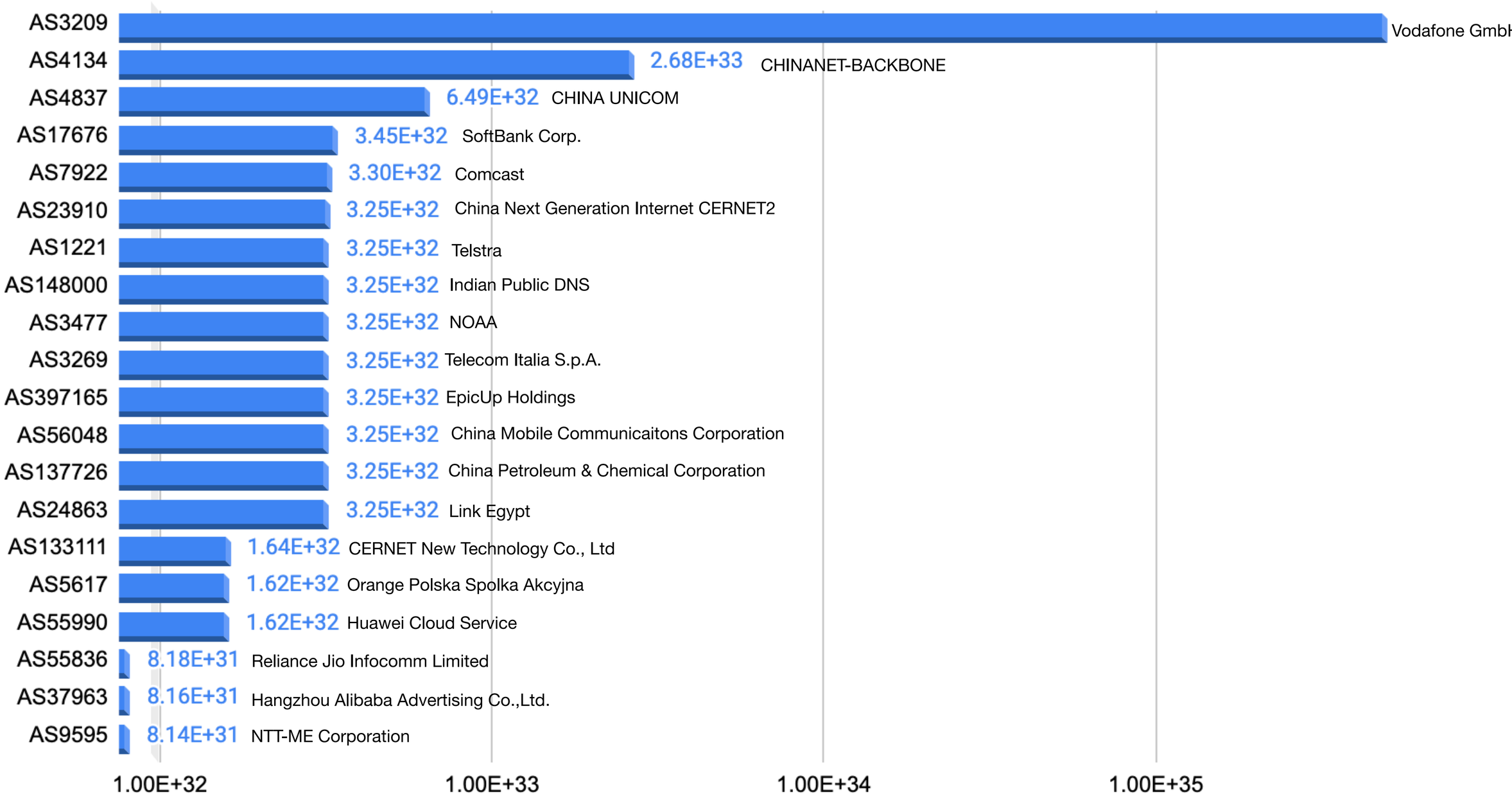
/17
/18
/16
/15
/13

Top 20 IPv6 AS by frequency

~63K distinct AS in total



Top 20 AS by IPv6 count



Unused Slides

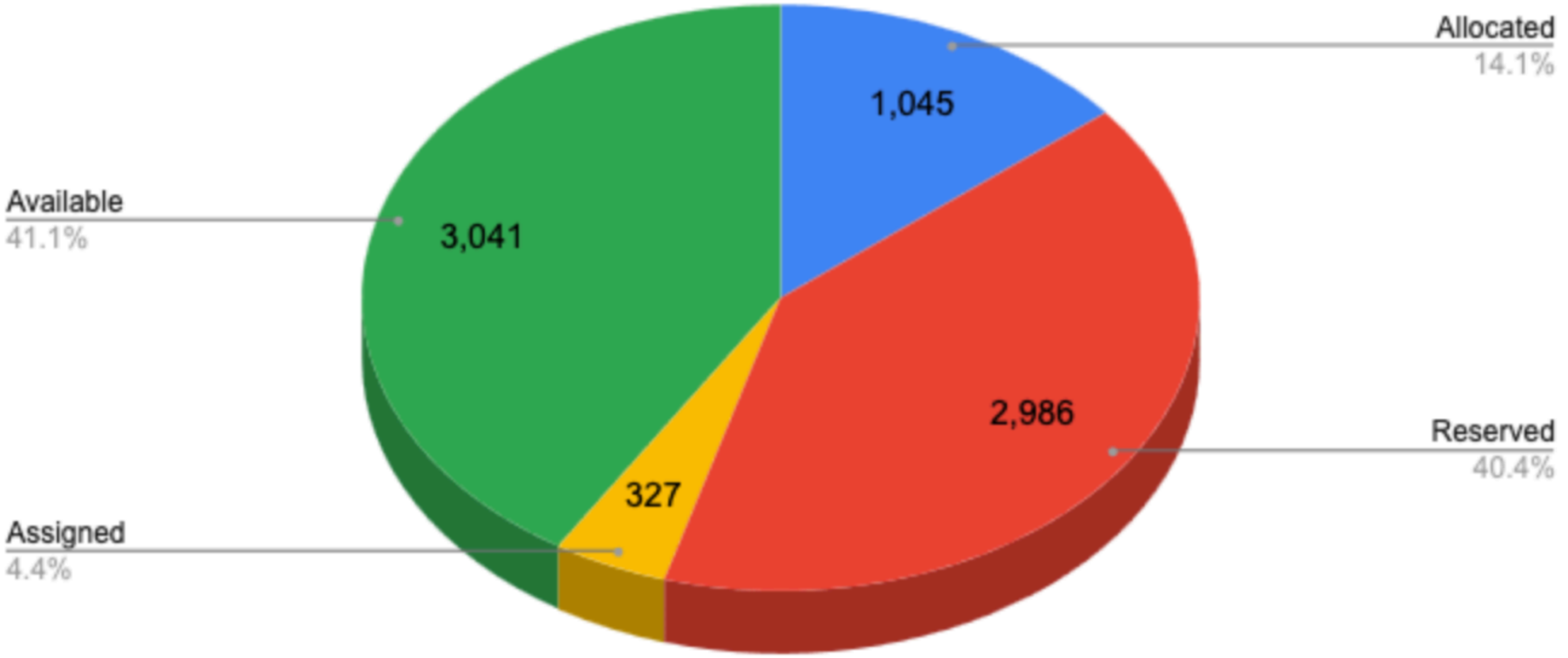
IP Space Trades

- https://arstechnica.com/information-technology/2021/04/pentagon-explains-odd-transfer-of-175-million-ip-addresses-to-obscure-company/
- https://account.arin.net/public/transfer-log
- https://www.iana.org/assignments/ipv4-address-space/ipv4-address-space.xhtml
- Plenty of data from RIR's view, e.g., https://blog.apnic.net/2024/01/17/ip-addresses-through-2023/

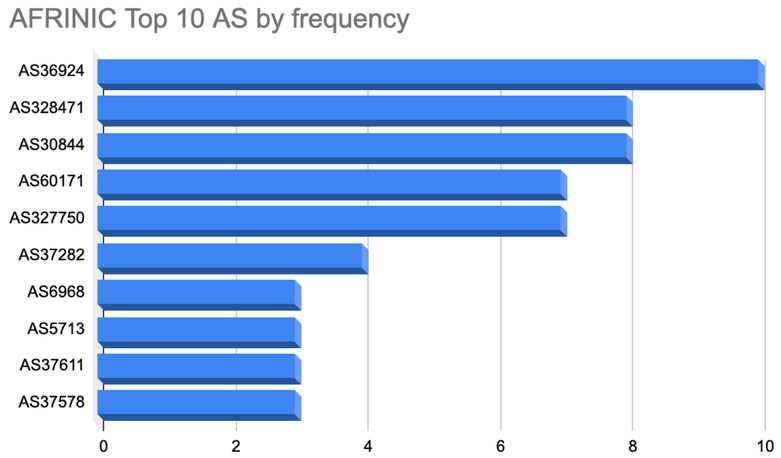
Example: Global Resource Systems LLC

- Shell company managing previously unannounced DoD IP space (6% of all IPv4 addresses, including 11.0.0.0/8)
- AS8003 - https://www.kentik.com/blog/the-mystery-of-as8003/
- https://auctions.ipv4.global/prior-sales:
- 12/18/2023 /16 ARIN total:$3,276,800.00 per-ip:$50.00

AFRINIC # of IPv6 Netblocks

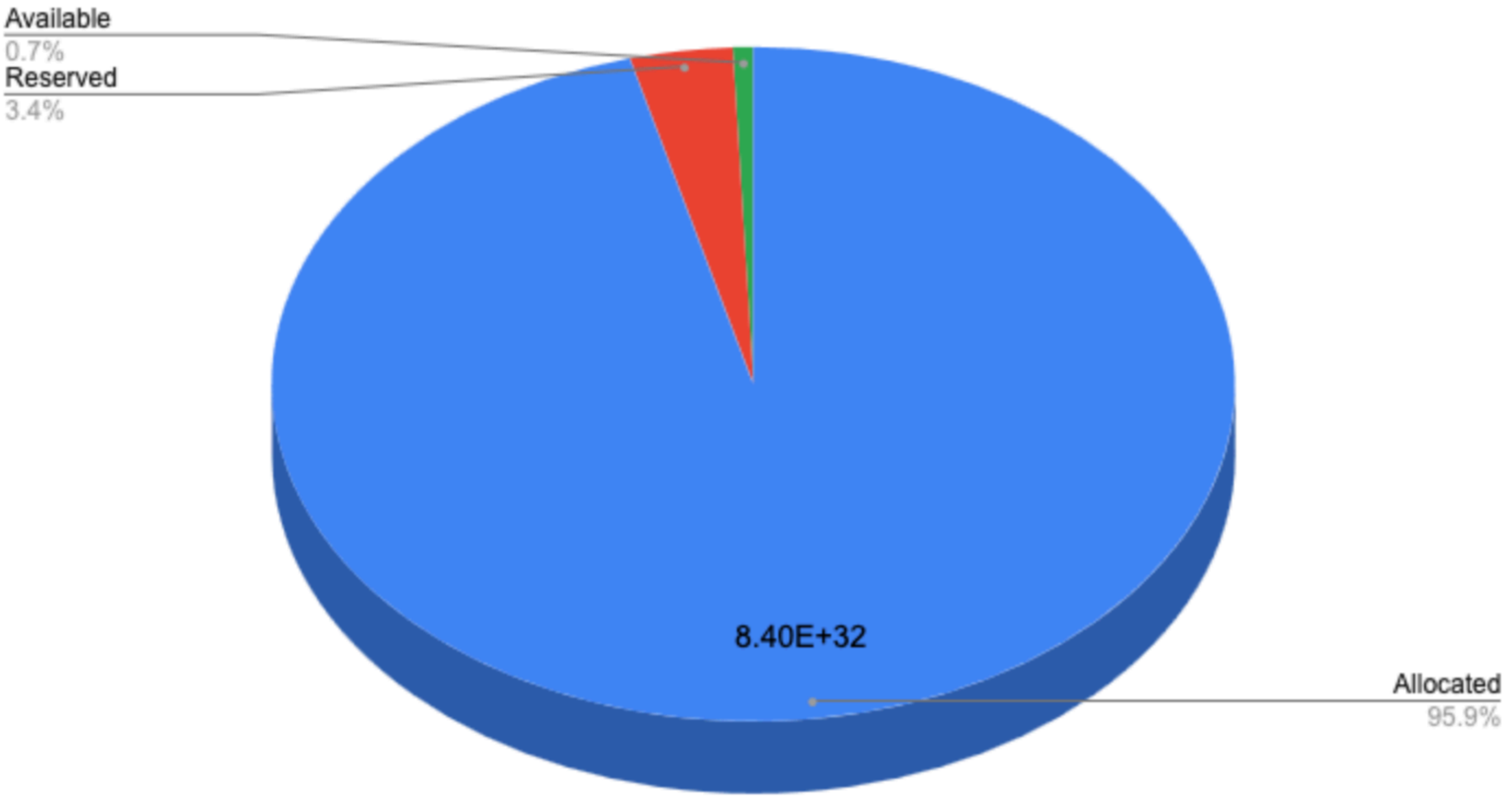


IPv6

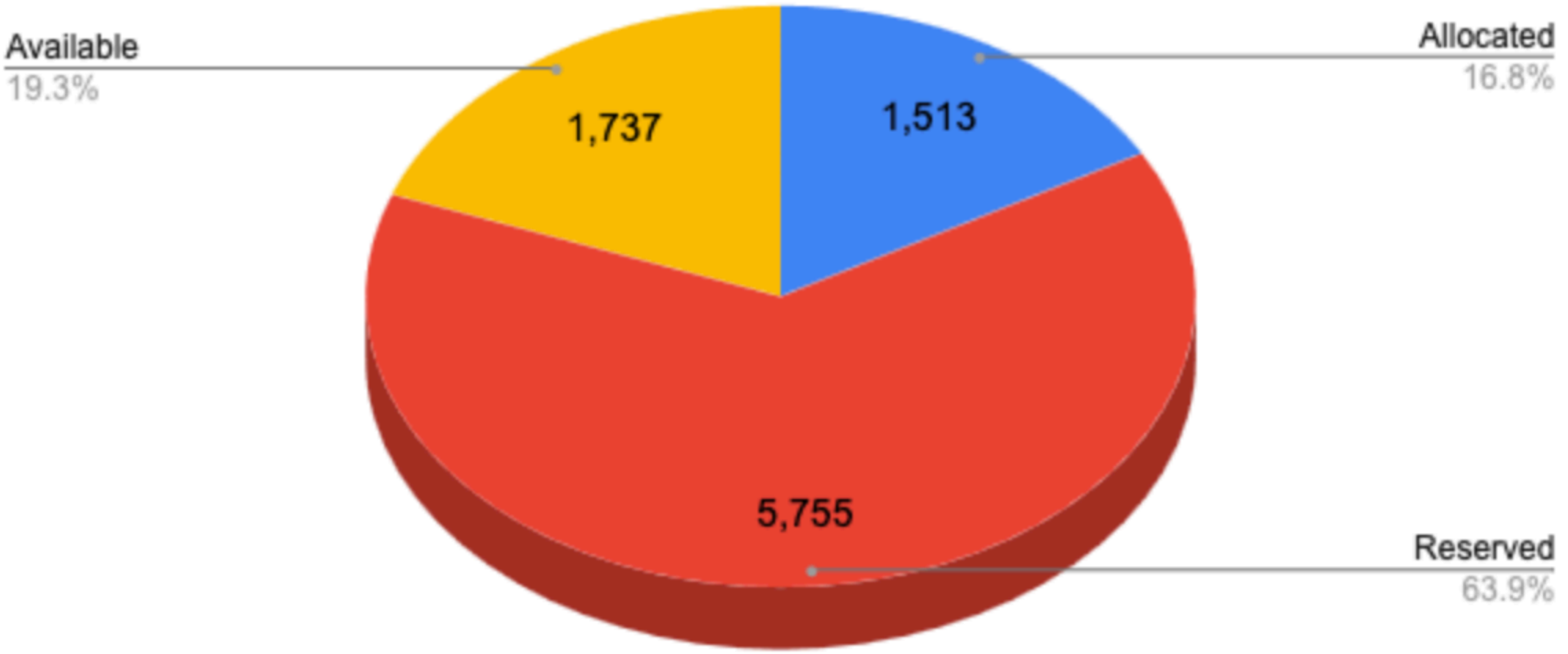


- AS36924 GVA Cote d'Ivoire SAS (5 /32, 4 /48, 1 /28)
- AS328471 HERO TELECOMS (PTY) LTD ((6 /32, 1 /64, 1 /33)
- AS30844 Liquid Telecommunications Ltd (3 /64, 3 /33, 1 /48, 1 /32)
- AS60171 AFR-IX TELECOM SAU (7 /32)
- AS327750 JENNY INTERNET (PTY) LTD (5 /36, 2 /32)
- AS37282 MainOne Cable Company (3 /32, 1 /48)
- AS6968 ZA CENTRAL REGISTRY NPC (3 /48)
- AS5713 Telkom SA Ltd. (1 /44, 1 /32, 1 /30)
- AS37611 Afrihost (Pty) Ltd (2 /32, 1 /36)
- AS37578 TESPOK (3 /48)

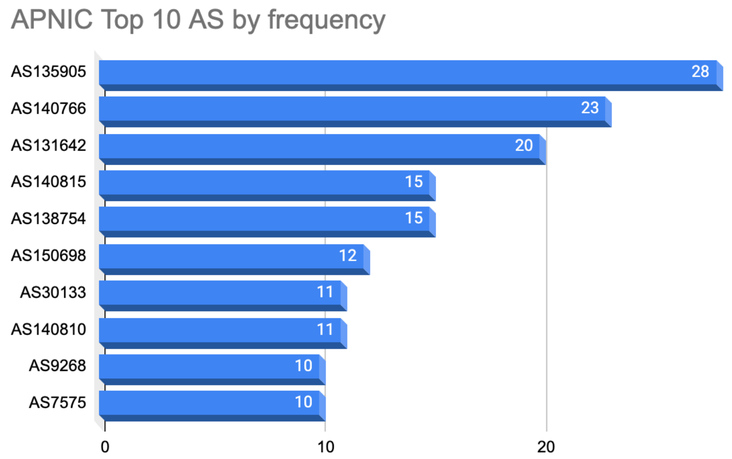
AFRINIC IPv6 Addresses



APNIC # of IPv6 Netblocks

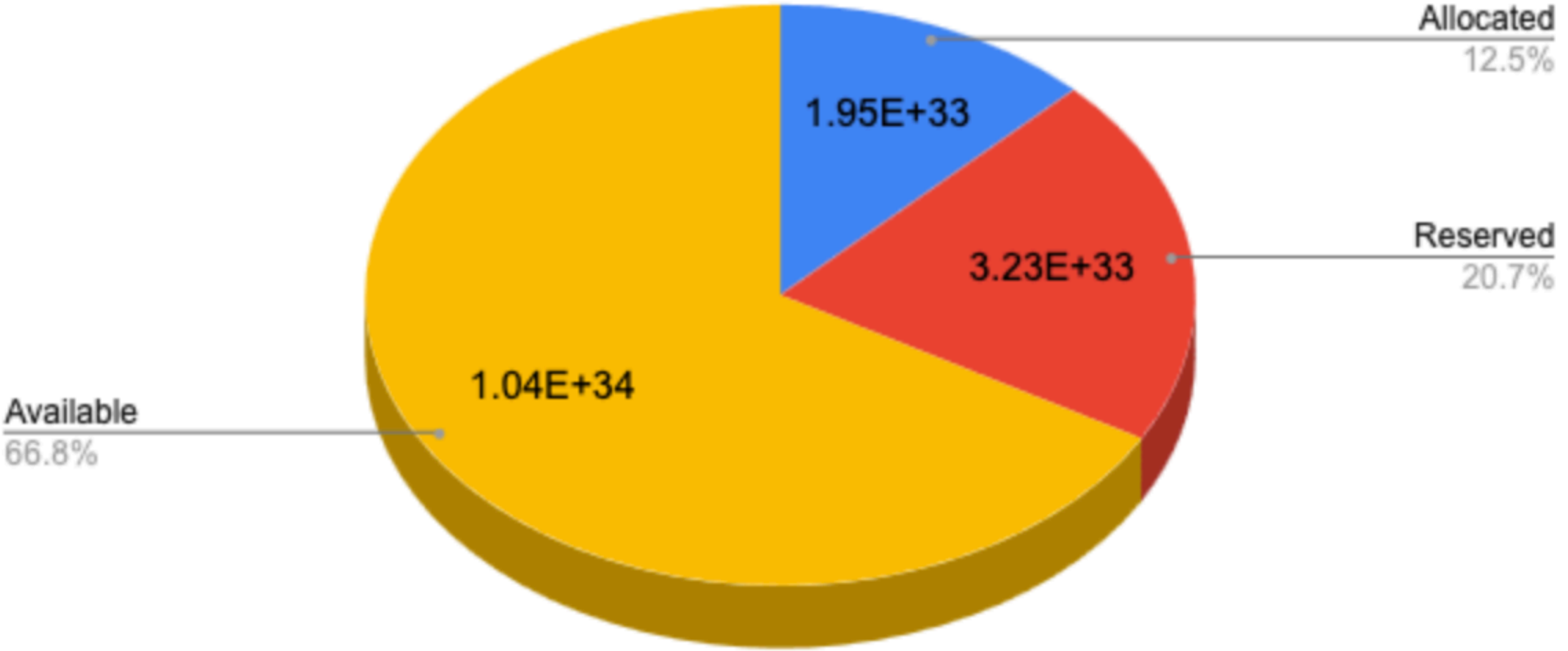


IPv6

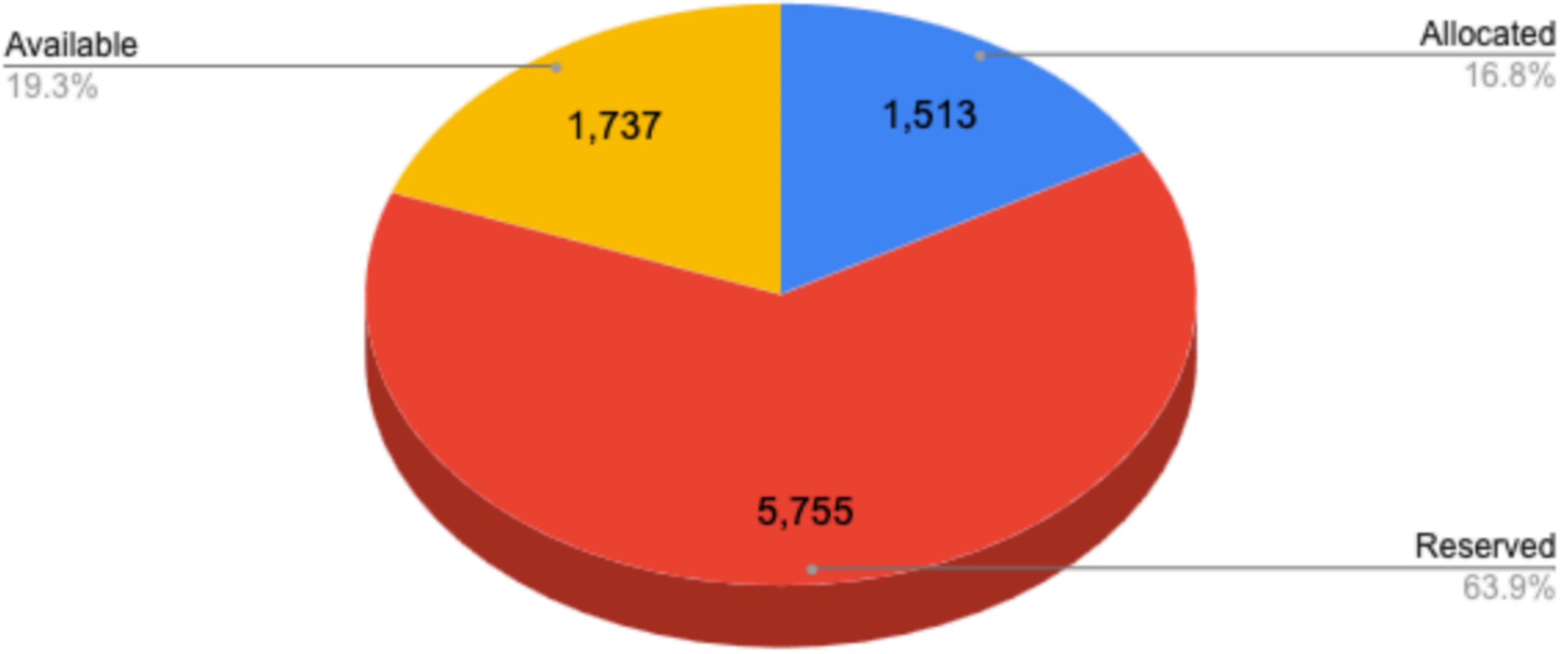


- AS135905 VIETNAM POSTS AND TELECOMMUNICATIONS GROUP (24 /48, 4
- AS140766 FPT Smart Cloud Company Limited (19 /48, 4 /32)
- AS131642 Pittqiao Network Information Co.,Ltd. (20 /32)
- AS140815 HTTVSERVER TECHNOLOGY COMPANY LIMITED (15 /48)
- AS138754 Kerala Vision Broad Band Private Limited (13 /48, 2 /32)
- AS150698 VCORE (11 /48, 1 /32)
- AS30133 ISC (11 /48)
- AS140810 Megacore Technology Company Limited (11 /48)
- AS9268 Over The Wire Pty Ltd (8 /32, 1 /64, 1/48)
- AS7575 Australian Academic and Research Network (AARNet) (8 /32, 2 /48)

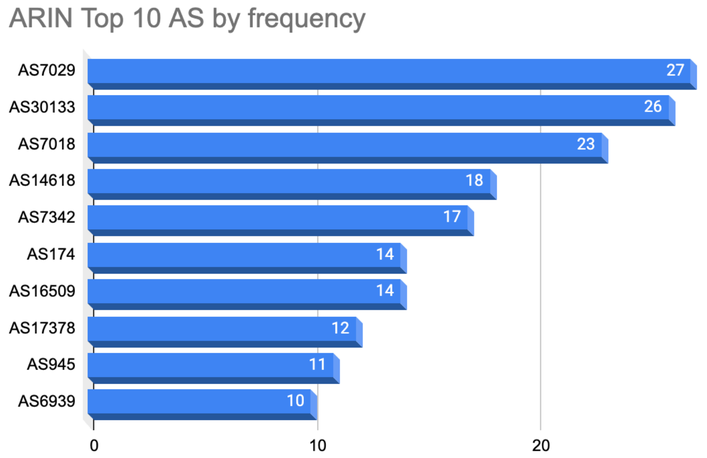
APNIC IPv6 Addresses



ARIN # of IPv6 Netblocks

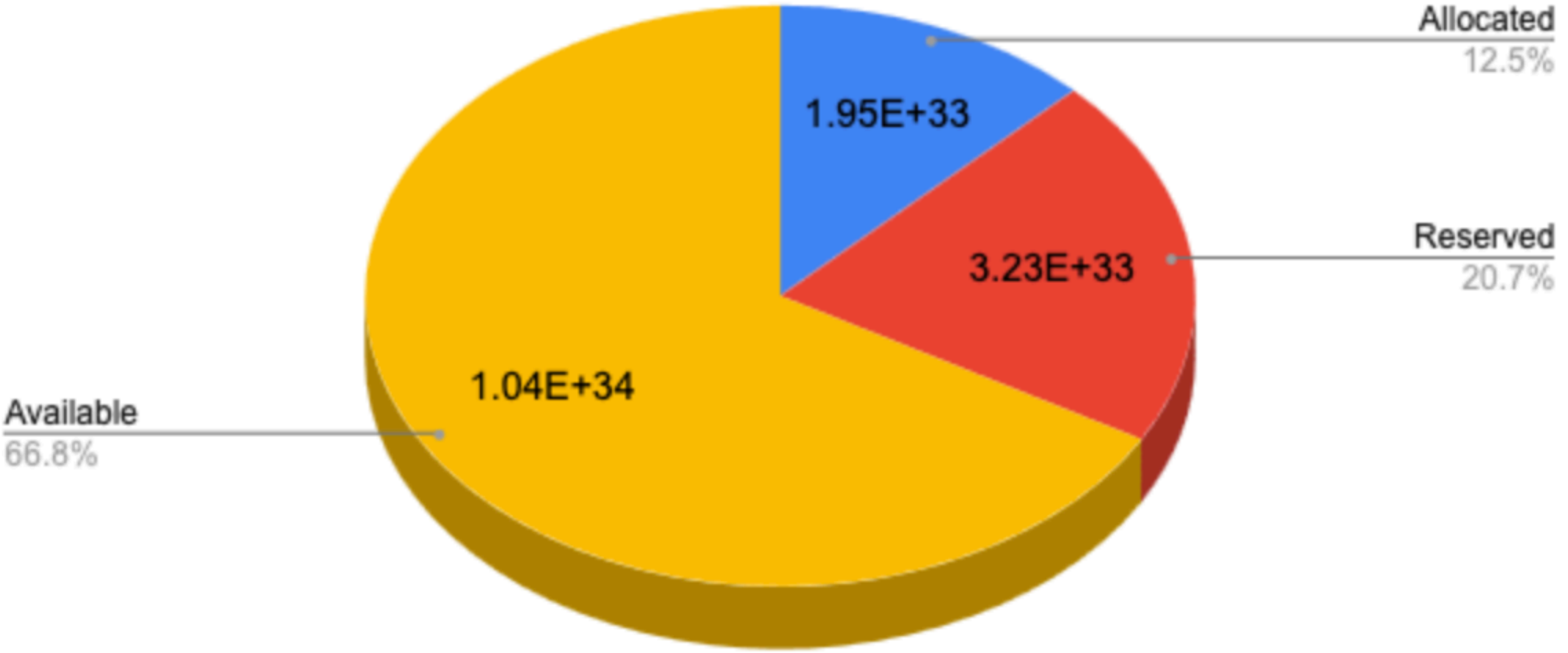


IPv6

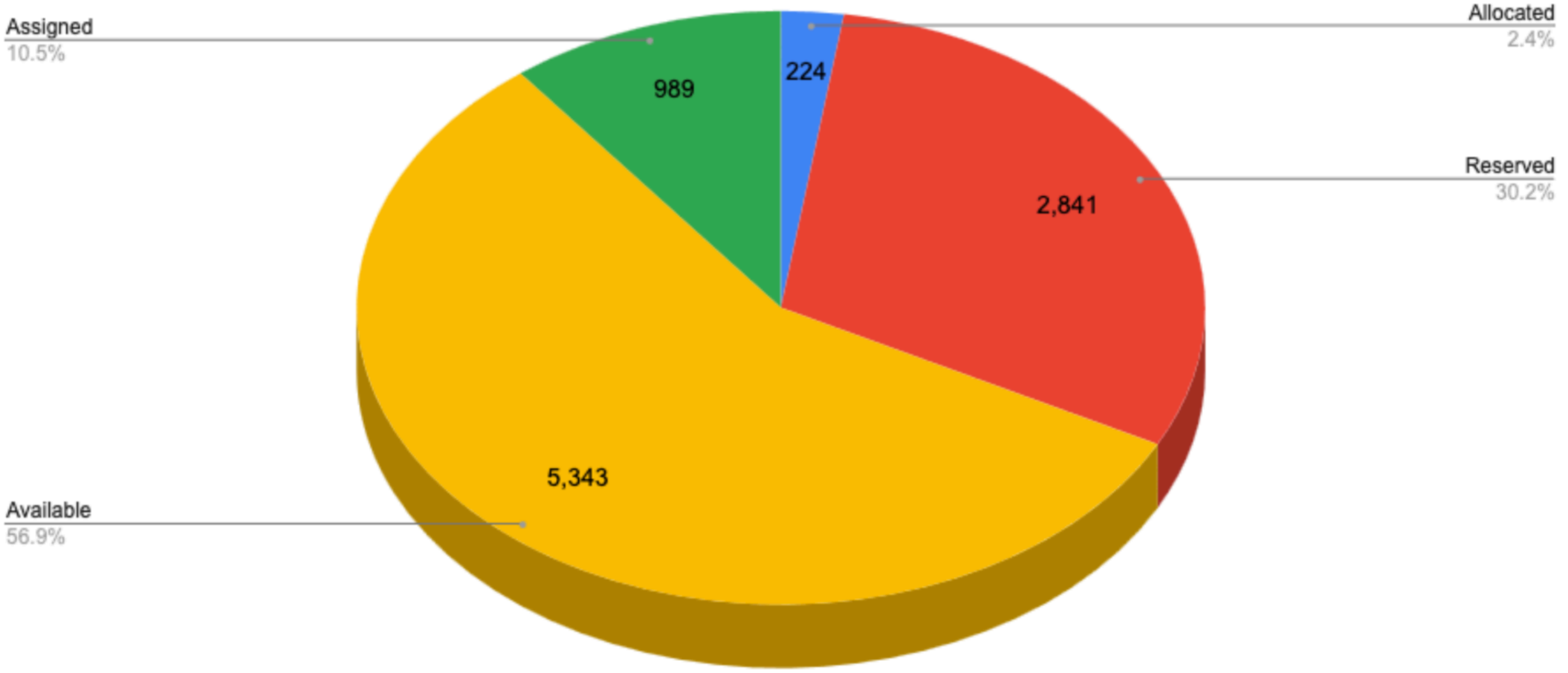


- AS7029 Windstream Communications LLC (21 /32, 4 /28, 2 /48)
- AS30133 ISC (25 /48, 1 /47)
- AS7018 AT&T (8 /32, 4 /48, 4 /28, 3 /36, 2 /24, 1 /40, 1 /29)
- AS14618 Amazon (6 /44, 4 /48, 4 /36, 3 /32, 1 /40)
- AS7342 Verisign (15 /48, 1 /42, 1 /41)
- AS174 Cogent (6 /48, 4 /32, 3 /36, 1 /44)
- AS16509 Amazon (4 /48, 3 /44, 3 /32, 2 /40, 2 /36)
- AS17378 TierPoint, LLC (10 /32, 1 /48, 1 /30)
- AS945 hkgo LLC (4 /36, 3 /48, 3 /32, 1 /44)
- AS6939 Hurricane Electric LLC (4 /36, 3 /32, 1 /48, 1 /40, 1 /24)

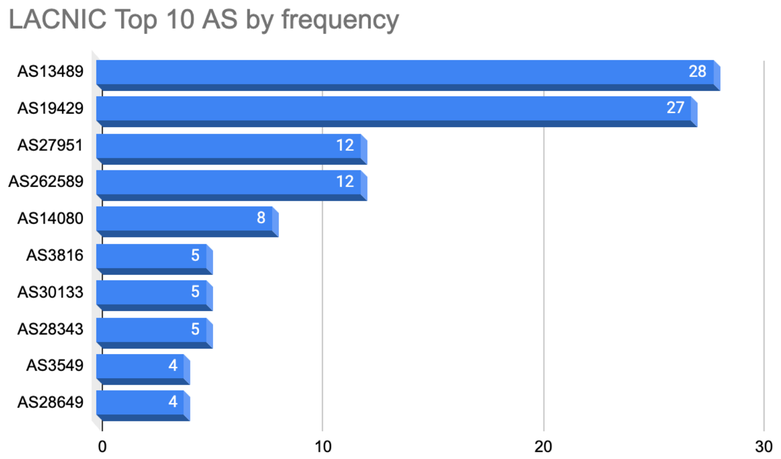
ARIN IPv6 Addresses



LACNIC # of IPv6 Netblocks

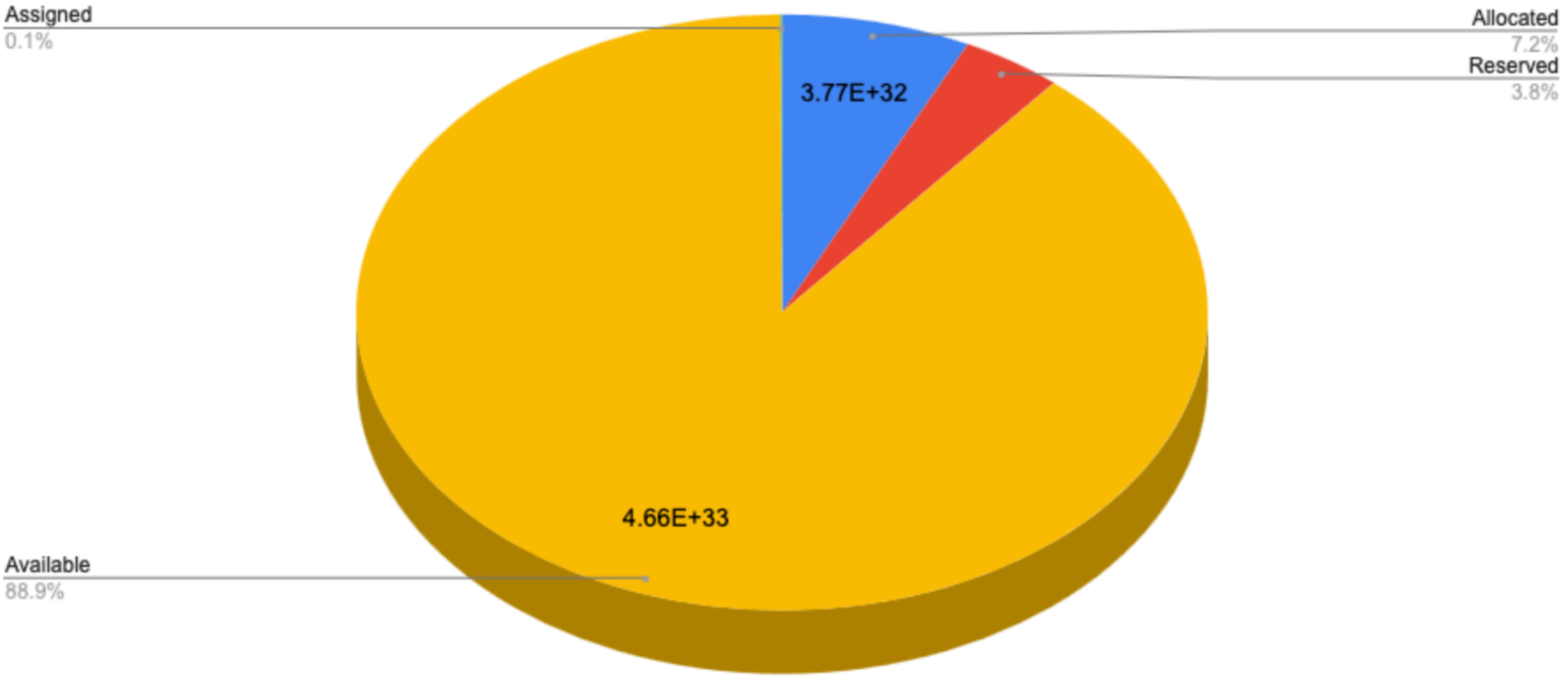


IPv6

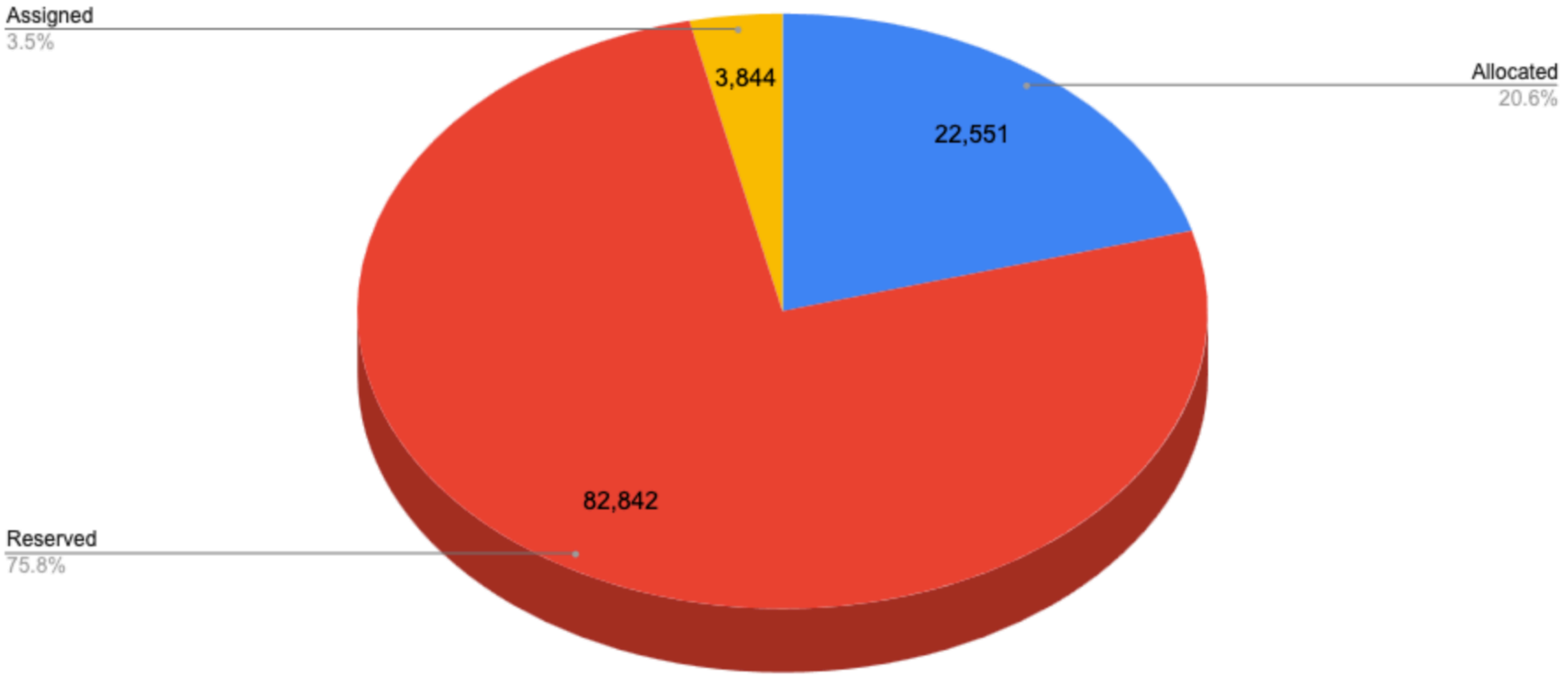


- AS13489 EPM Telecomunicaciones S.A. E.S.P. (27 /48, 1 /28)
- AS19429 ETB - Colombia (25 /48, 1 /44, 1 /28)
- AS27951 Media Commerce Partners S.A (10 /48, 1 /56, 1 /44)
- AS262589 INTERNEXA (9 /48, 3 /32)
- AS14080 Telmex Colombia S.A. (6 /48, 1 /44, 1 /29)
- AS3816 COLOMBIA TELECOMUNICACIONES S.A. ESP (4 /48, 1 /32)
- AS30133 ISC (5 /48)
- AS28343 UNIFIQUE TELECOMUNICACOES S/A (5 /32)
- AS3549 Level 3 (1 /48, 1 /44, 1 /32, 1 /29)
- AS28649 Desktop Sigmanet Comunicaï¿½ï¿½o Multimï¿½dia SA (4 /32)

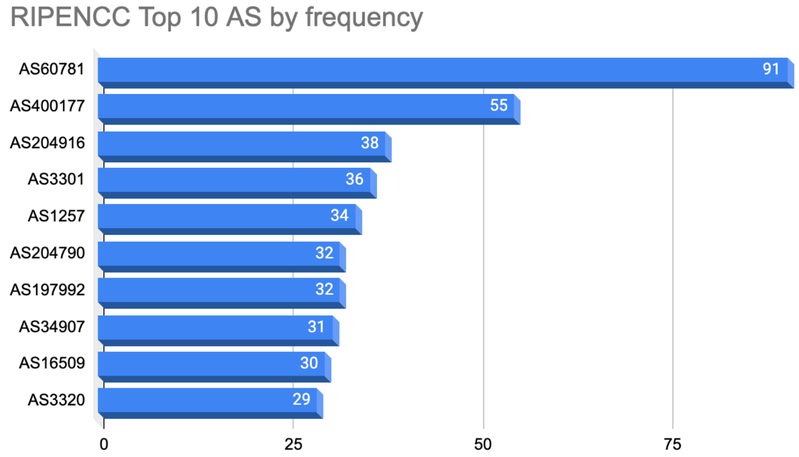
LACNIC IPv6 Addresses



RIPENCC # of IPv6 Netblocks

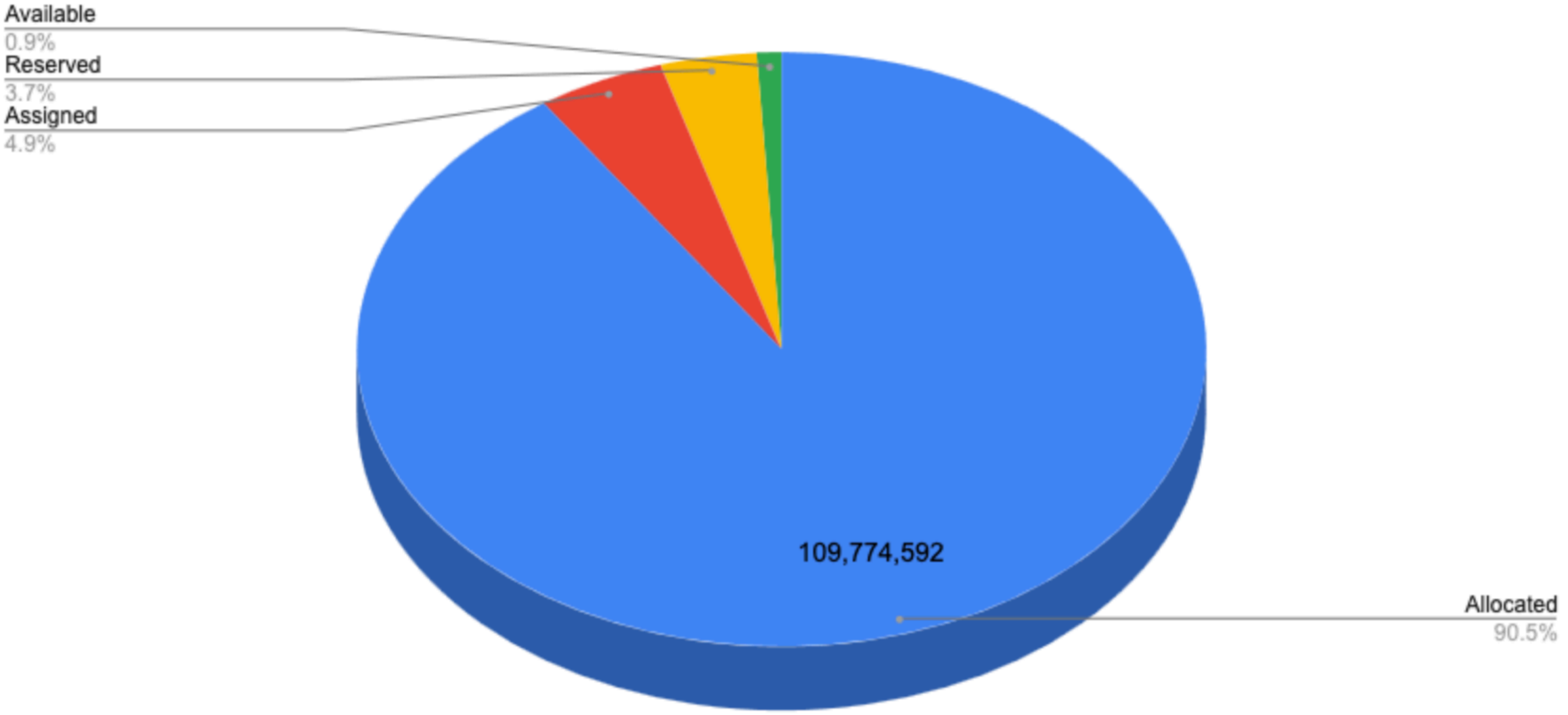


IPv6

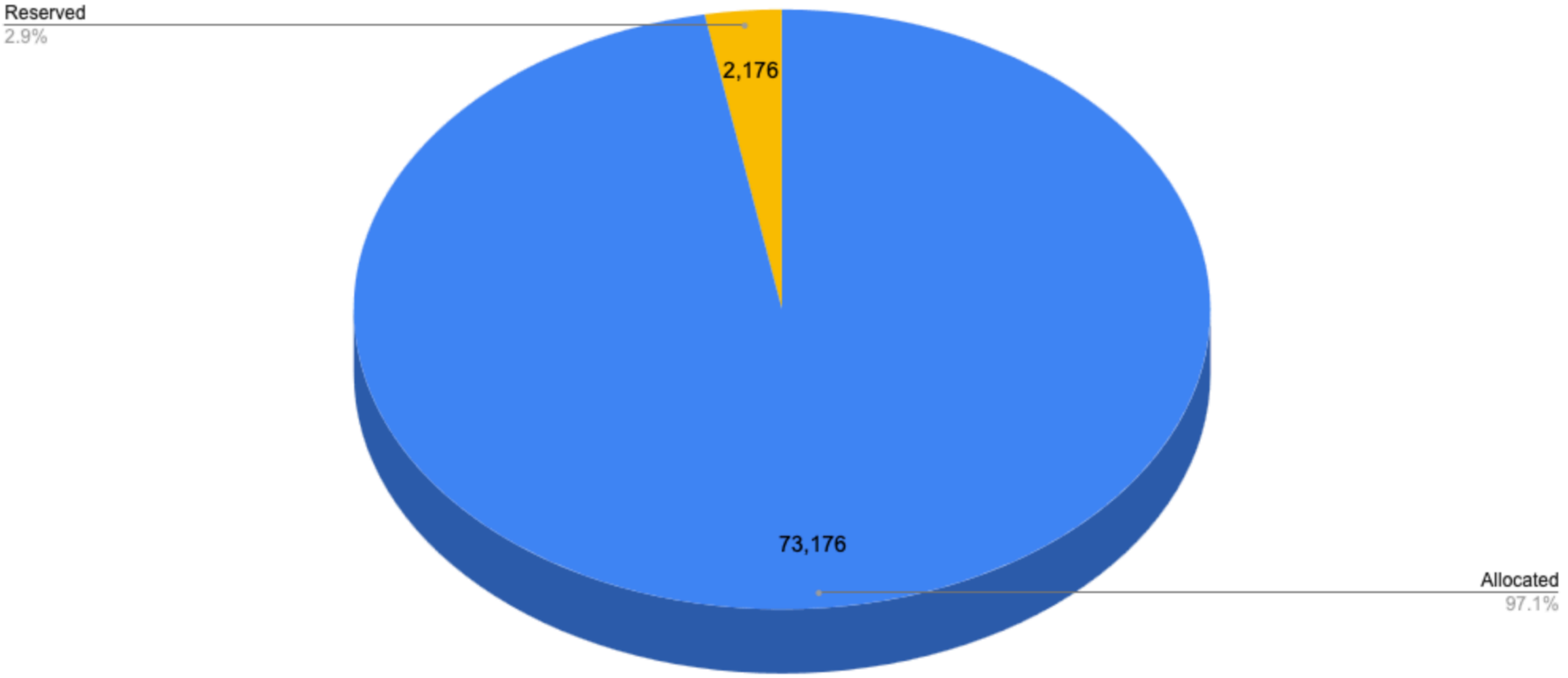


- AS60781 LeaseWeb Netherlands B.V. (57 /29, 14 /32, 10 /30, 7 /48, 1 /44,
- AS400177 rootcloud LLC (55 /30)
- AS204916 RACKTECH CO., LTD. (21 /32, 14 /29, 2 /30, 1 /36)
- AS3301 Telia Company AB (33 /48, 2 /29, 1 /32)
- AS1257 Tele2 Sverige AB (28 /48, 3 /32, 1 /64, 1 /29, 1 /28)
- AS204790 Falco ISP Services B.V. (32 /29)
- AS197992 DEFSOLUTION LLC (29 /29, 3 /32)
- AS34907 IP SERVICES Sp. zo.o.(30 /29, 1 /48)
- AS16509 Amazon (15 /48, 8 /32, 6 /29, 1 /40)
- AS3320 Deutsche Telekom AG (21 /48, 3 /32, 1 /56, 1 /46, 1 /40, 1 /30, 1 /29)

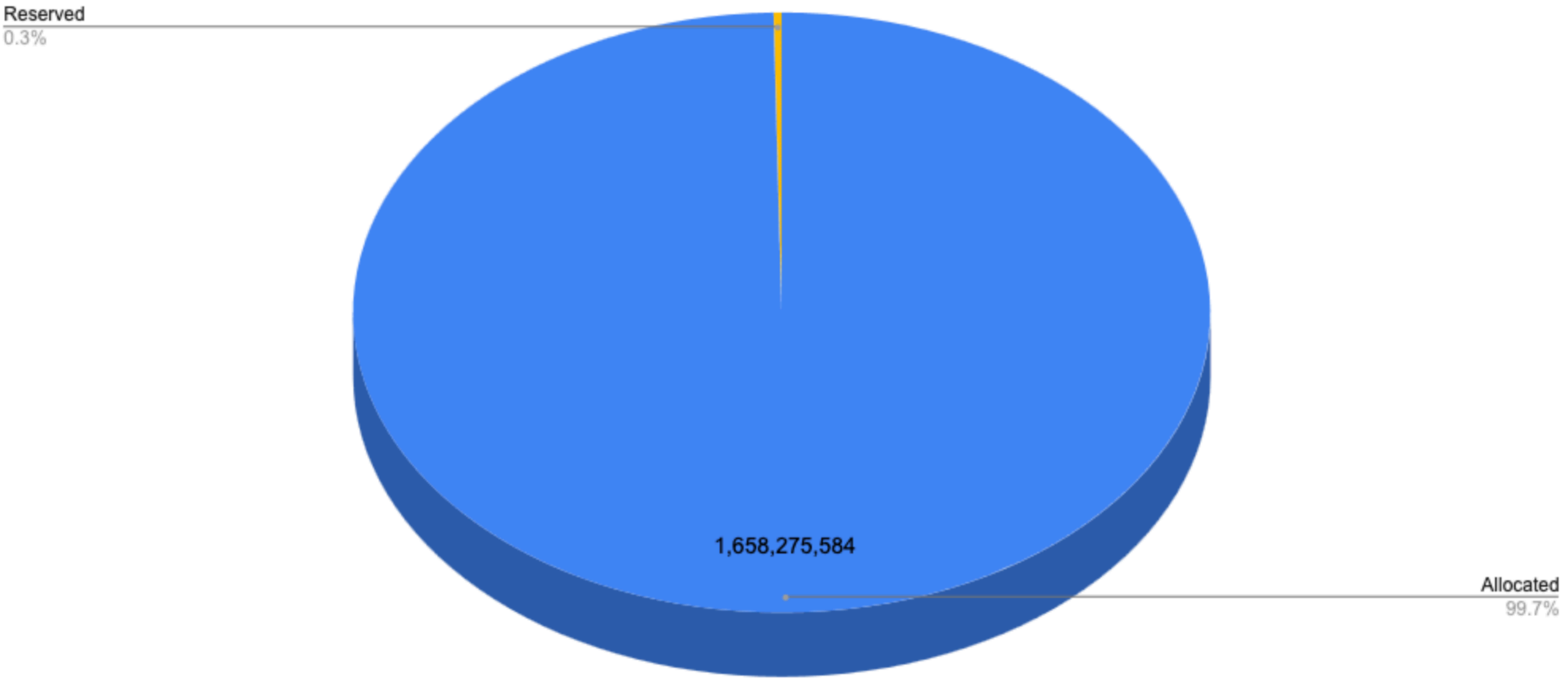
AFRINIC # of IPv4 Addresses



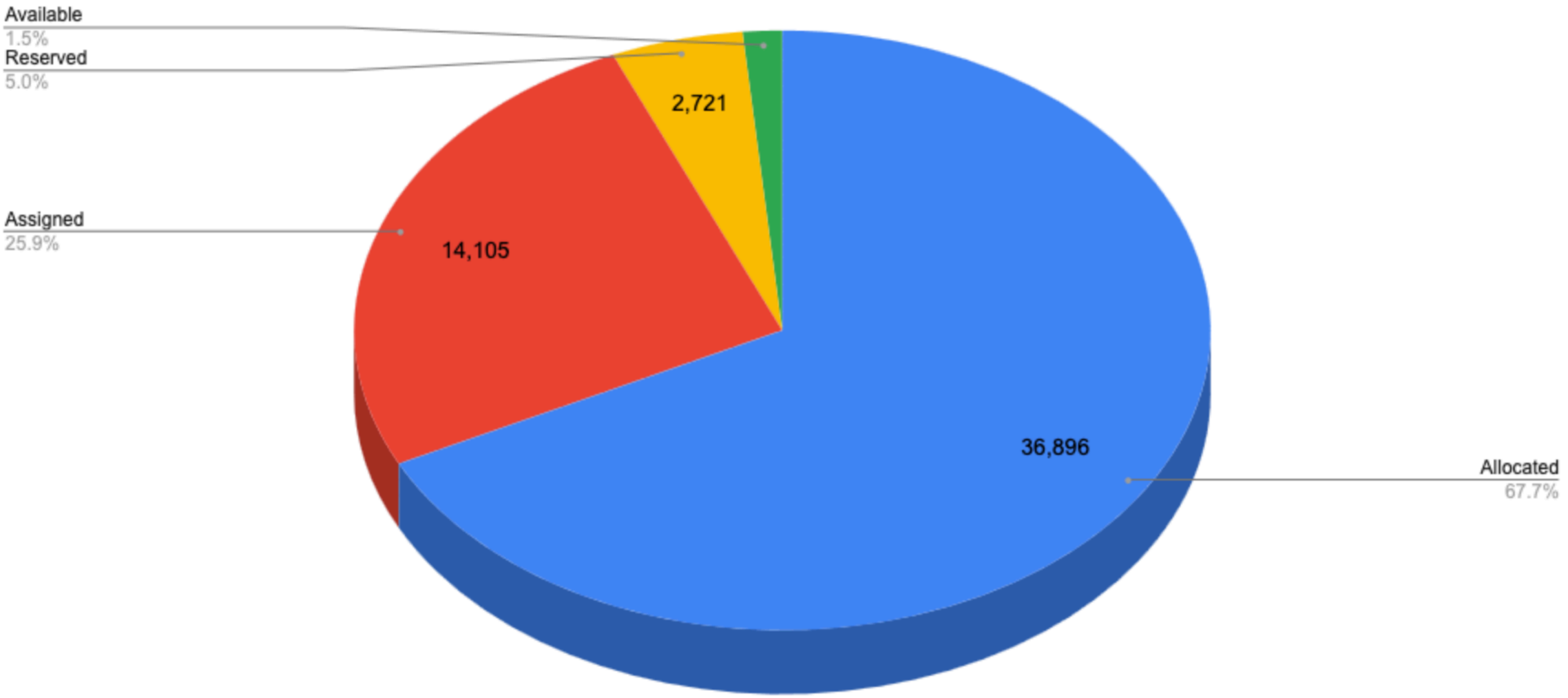
ARIN IPv4 Netblocks



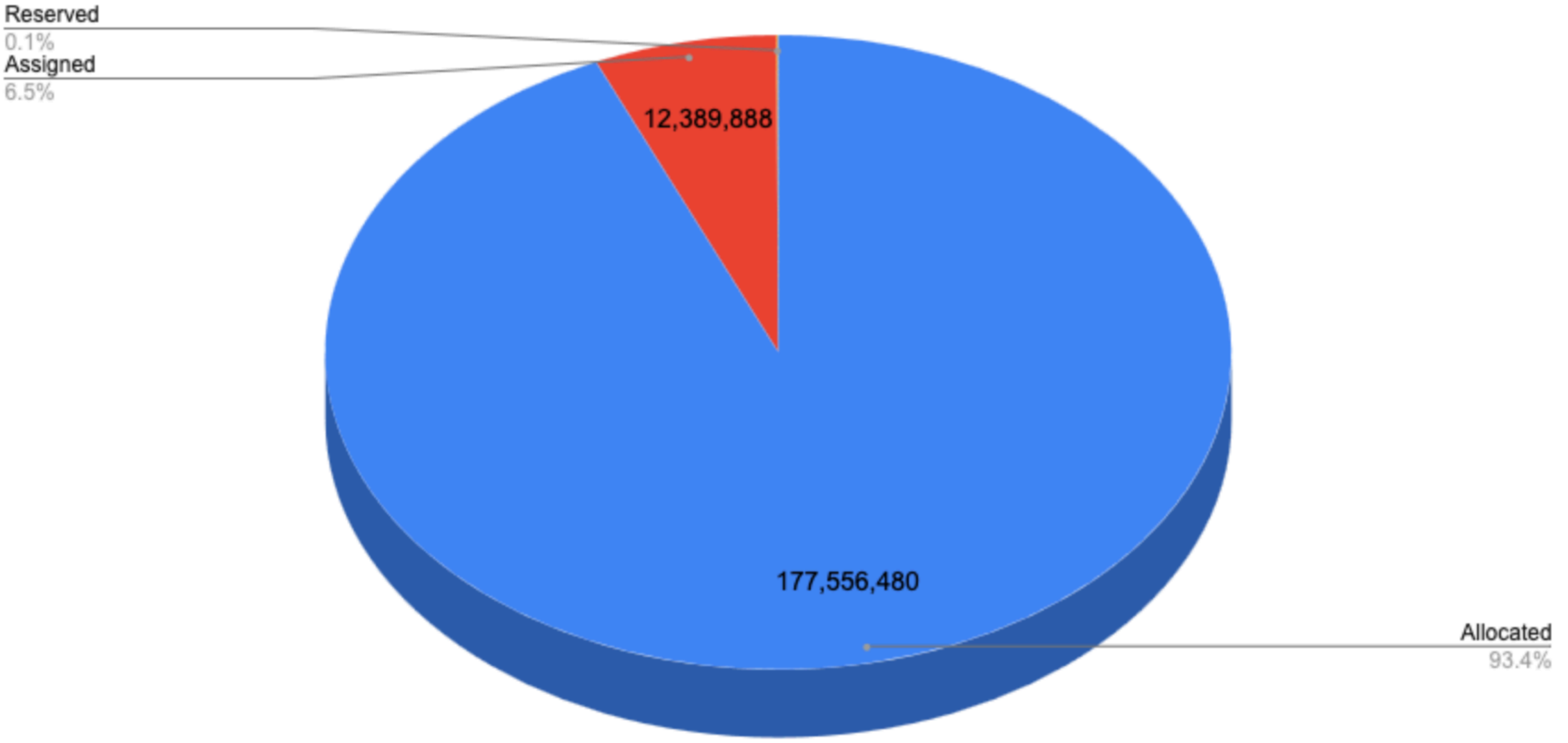
ARIN # of IPv4 Addresses



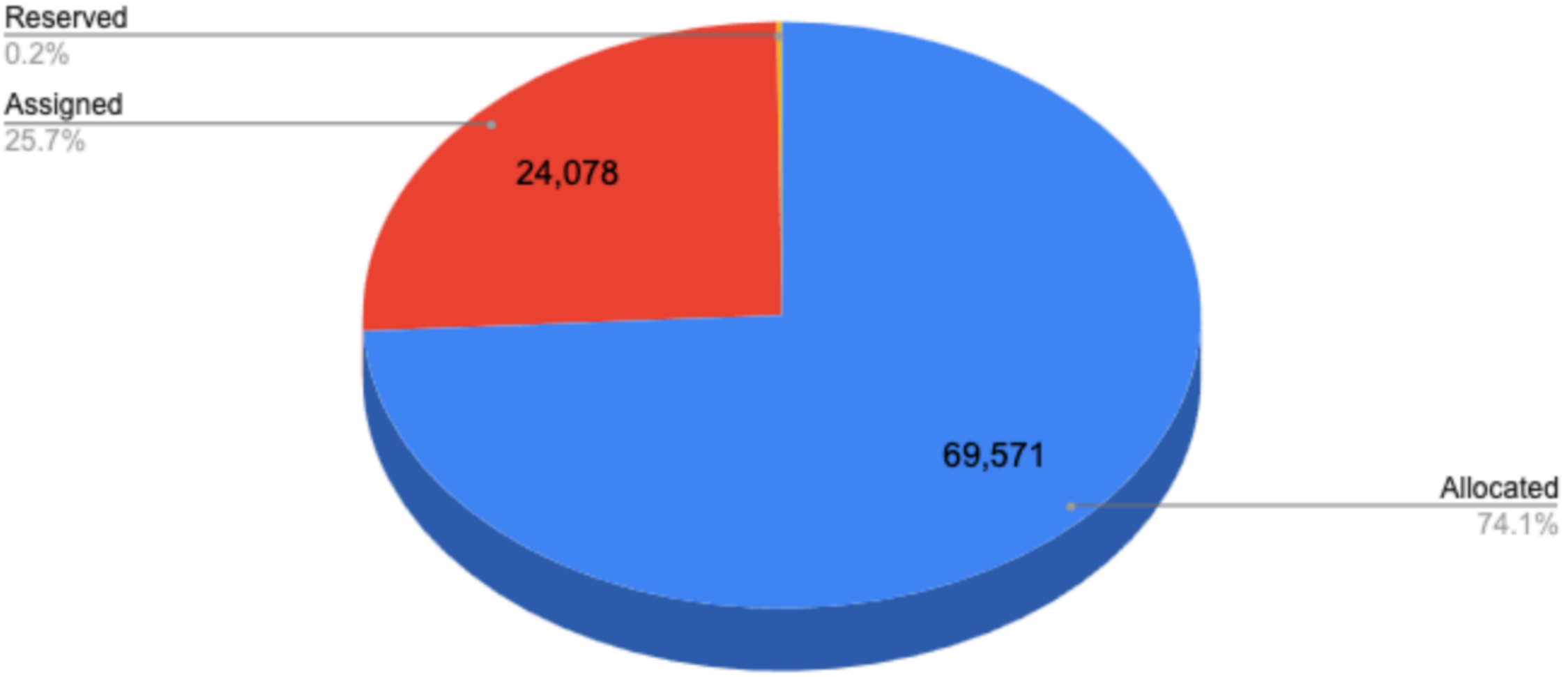
APNIC IPv4 Netblocks



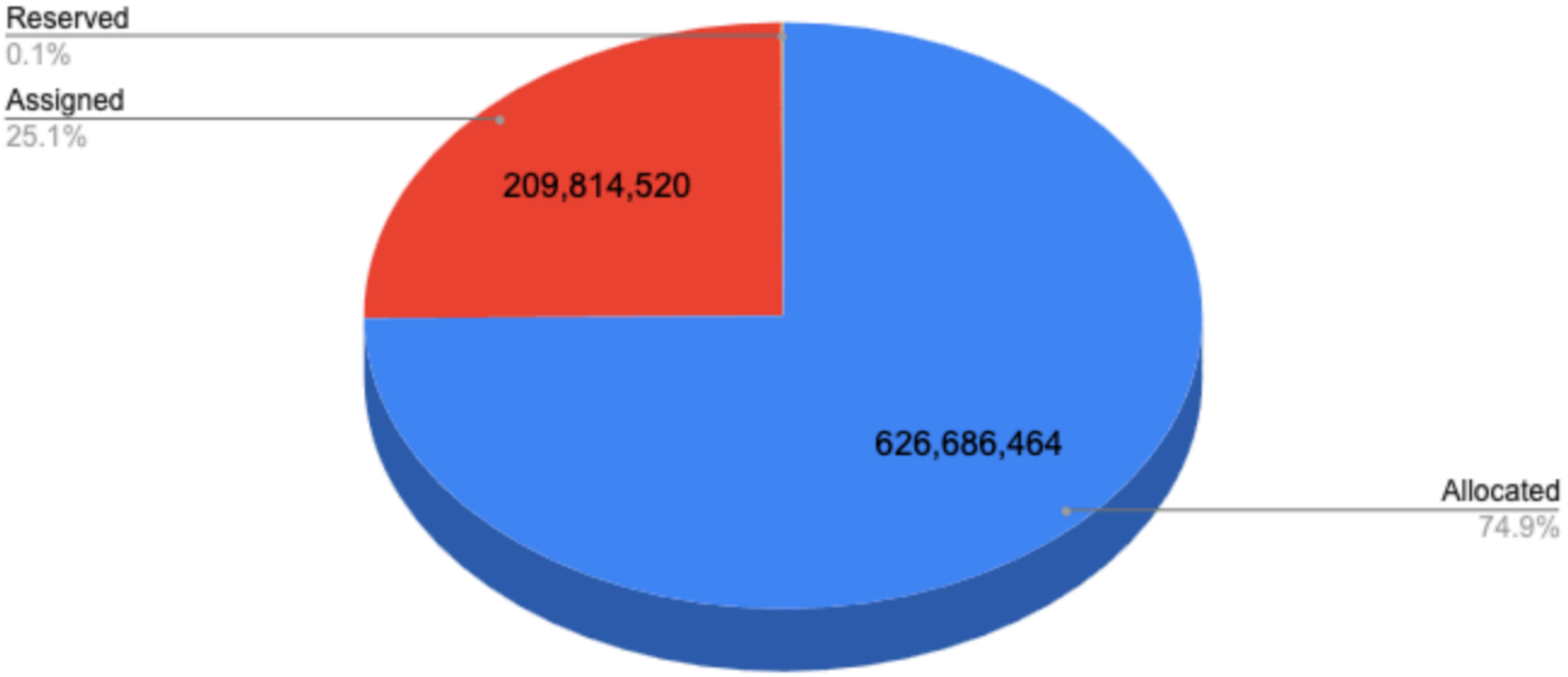
LACNIC # of IPv4 Addresses



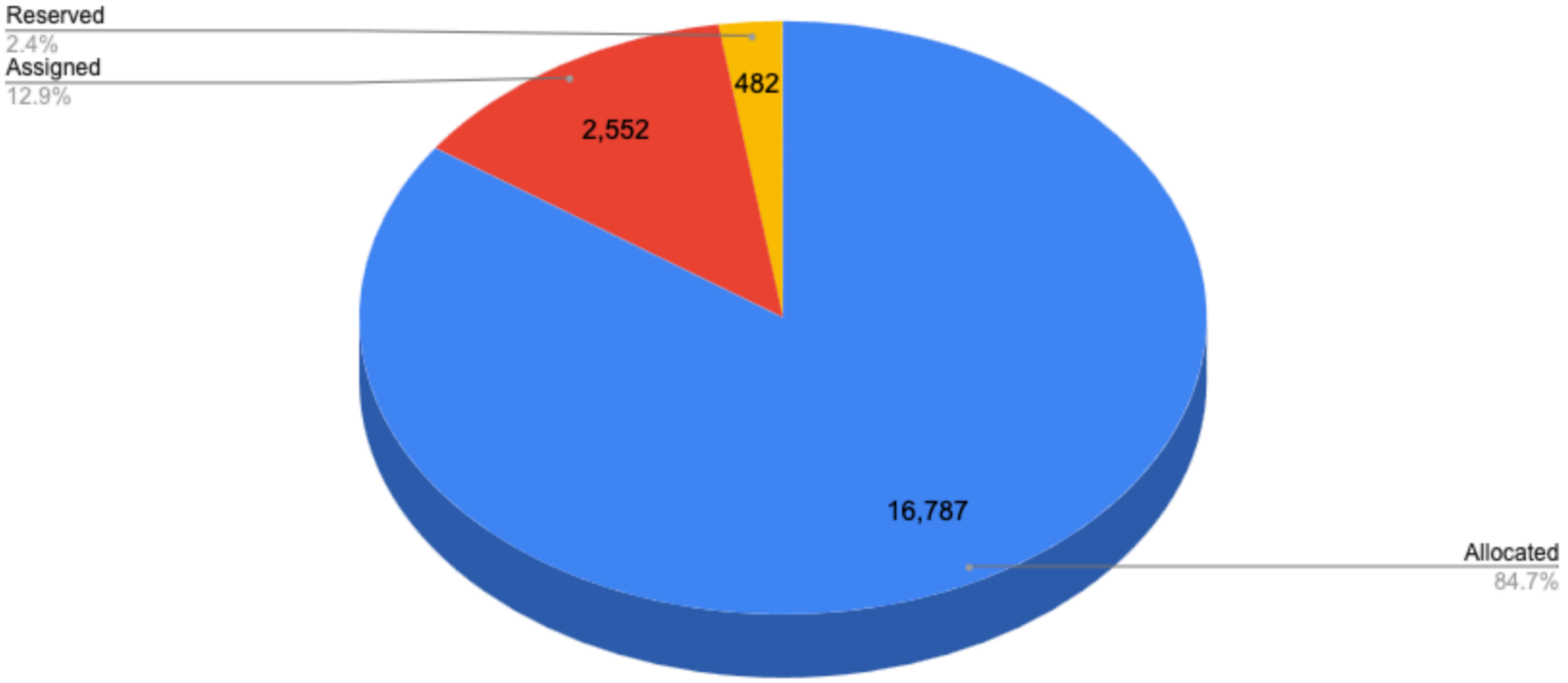
RIPENCC IPv4 Netblocks



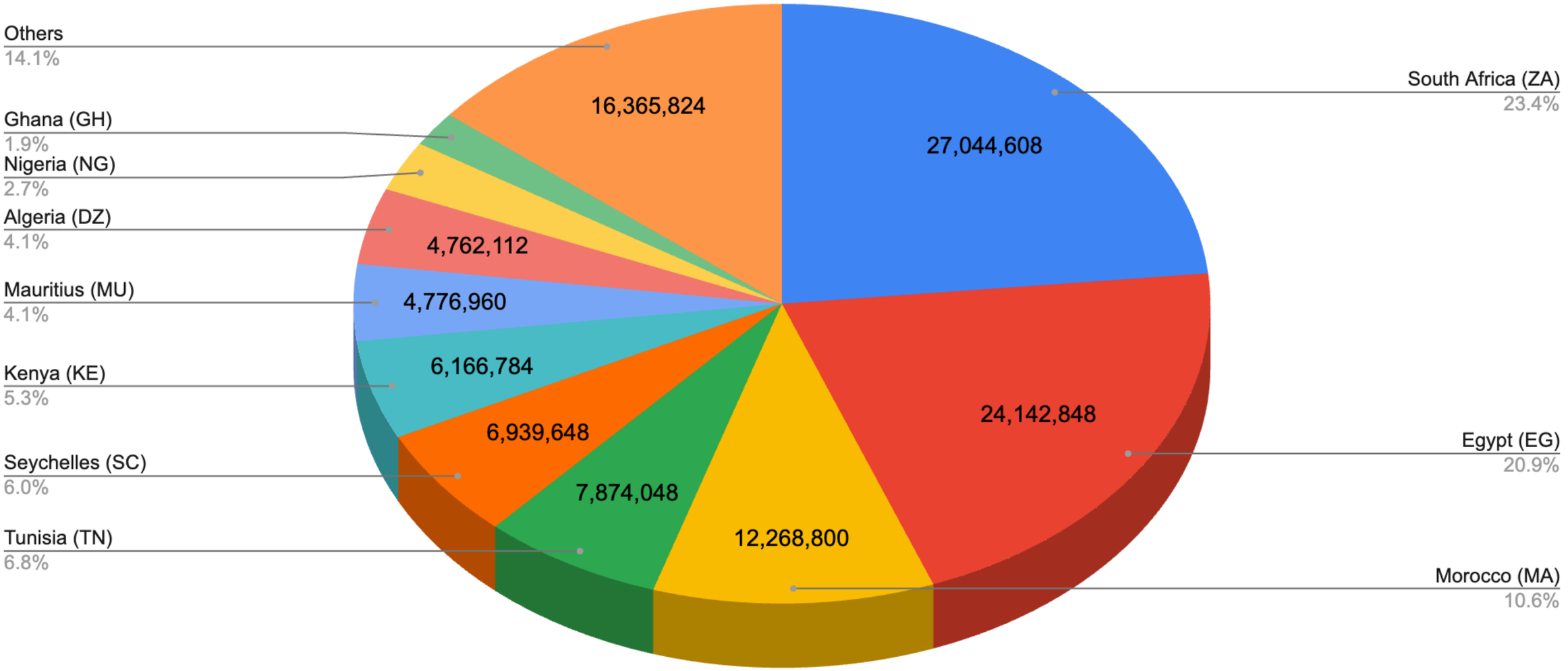
RIPENCC # of IPv4 Addresses



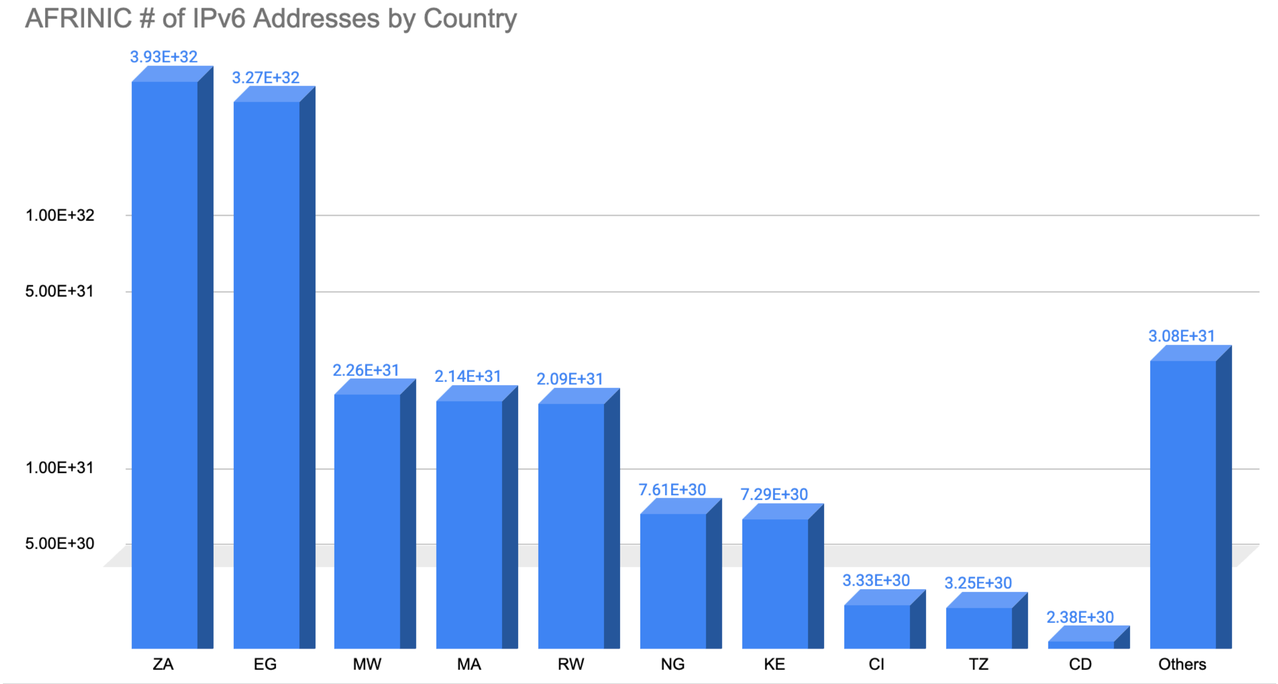
LACNIC IPv4 Netblocks



AFRINIC IPv4 Addresses by Country (RIR Statistics)



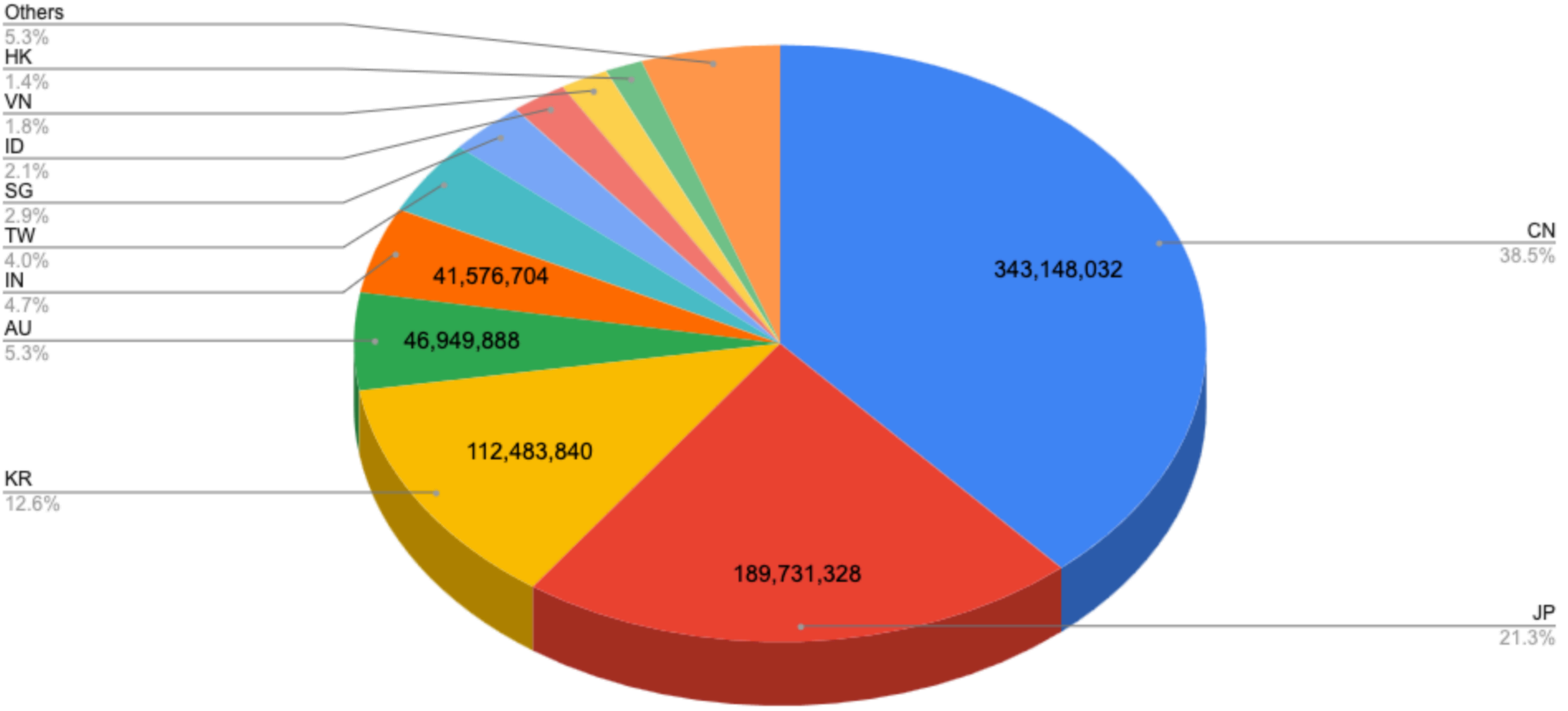
- zz used for reserved and available
- ZA: 46.8% of all assigned IPs
- EG: 38.9%
- MW: 2.7%
- MA: 2.5%
- RW: 2.5%
- NG: 0.9%
- KE: 0.9%
- All others: 3.7%



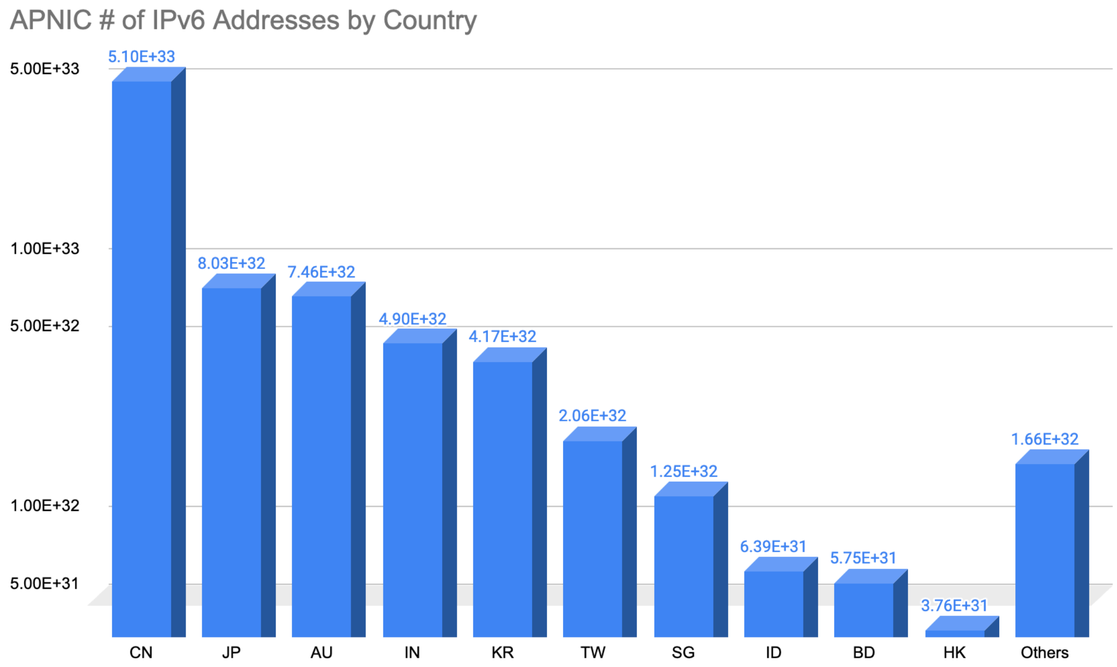
54 countries / 127 countries

- AFRINIC error:
- afrinic|CA|ipv6|2001:42c8::|32|20070619|allocated|F362FF17
- is actually ZA (now fixed)
- AFRINIC IPv6 AS:
    - 54,813 distinct;
    - 741 N/A
    - Only 43 AS with more than 1 allocation
    - Top 10:
        - AS36924 10 (Group Vivendi Africa)
        - AS328471 8 (Hero Telecoms Pty Ltd)
        - AS30844 8 (Liquid Intelligent Technologies / Cassava Technologies)
        - AS60171 7 (AFR-IX)
        - AS327750 7 (Jenny Internet)
        - AS37282 4 (MainOne Cable)
        - AS6968 3 (DNS Africa Media and Communications)
        - AS5713 3 (Telkom SA SOC Limited)
        - AS37611 3 (Afrihost)
        - AS37578 3 (Telecommunication Sevice Providers Association of Kenya (TESPOK))

APNIC IPv4 Addresses by Country

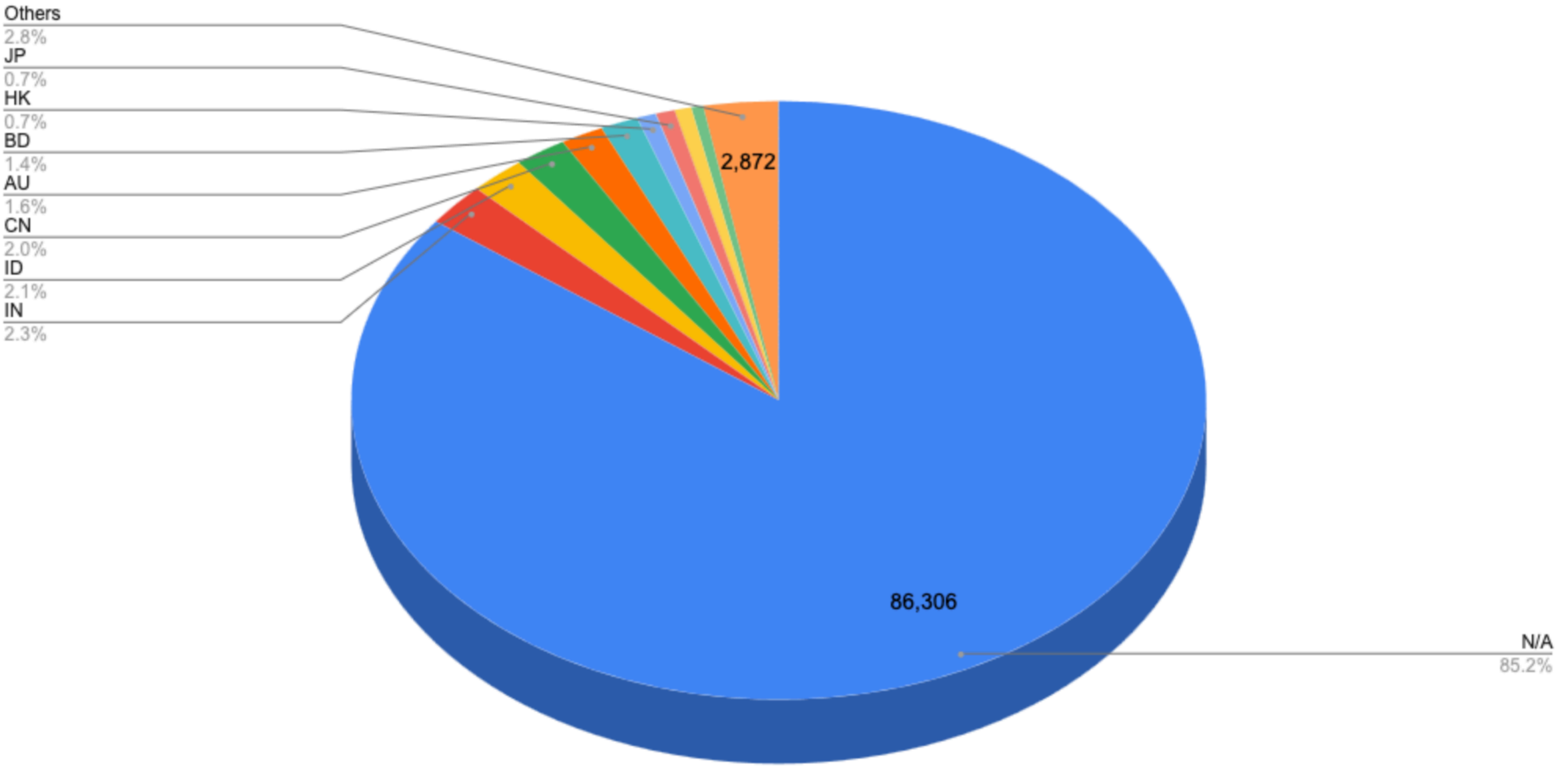


- CN: 62% of assigned IPs
- JP: 9.8%
- AU: 9.1%
- IN: 6.0%
- KR: 5.1%
- TW: 2.5%
- SG: 1.5%
- Others combined: 2%

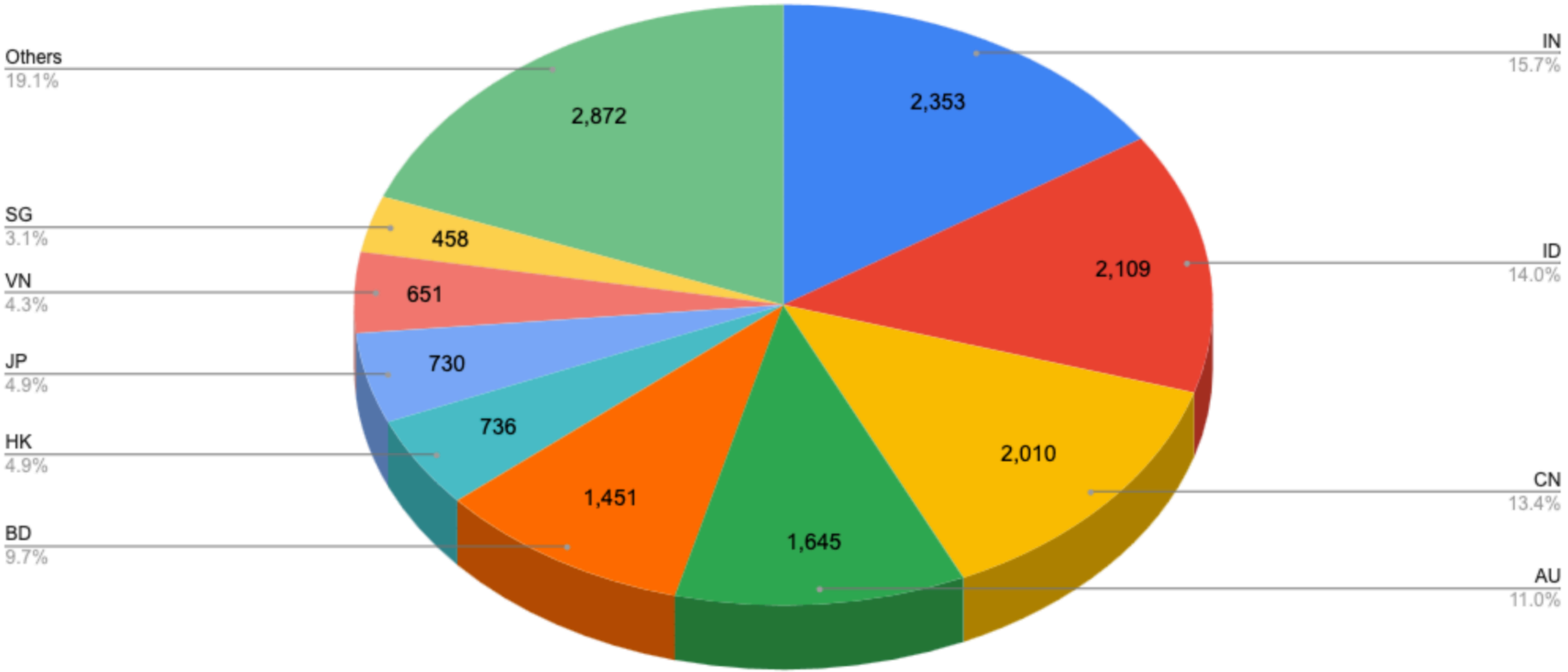


- APNIC IPv6 AS:
  - 3,615 distinct
  - 9827 N/A
  - 496 AS with more than 1 allocation
  - Top 10:
    - AS135905 28 (VNPT Vietnam Posts and Telecommunications Group)
    - AS140766 23 (FPT Corporation)
    - AS131642 20 (Pittqiao Network Information Co.,Ltd.)
    - AS140815 15 (HTTVSERVER TECHNOLOGY COMPANY)
    - AS138754 15 (Kerala Vision Broadband Limited)
    - AS150698 12 (FTP Corporation)
    - AS30133 11 (ISC)
    - AS140810 11 (VCore VN,
    - AS9268 10 (Over The Wire Pty)
    - AS7575 10 (Australian Academic and Research Network AARNet)

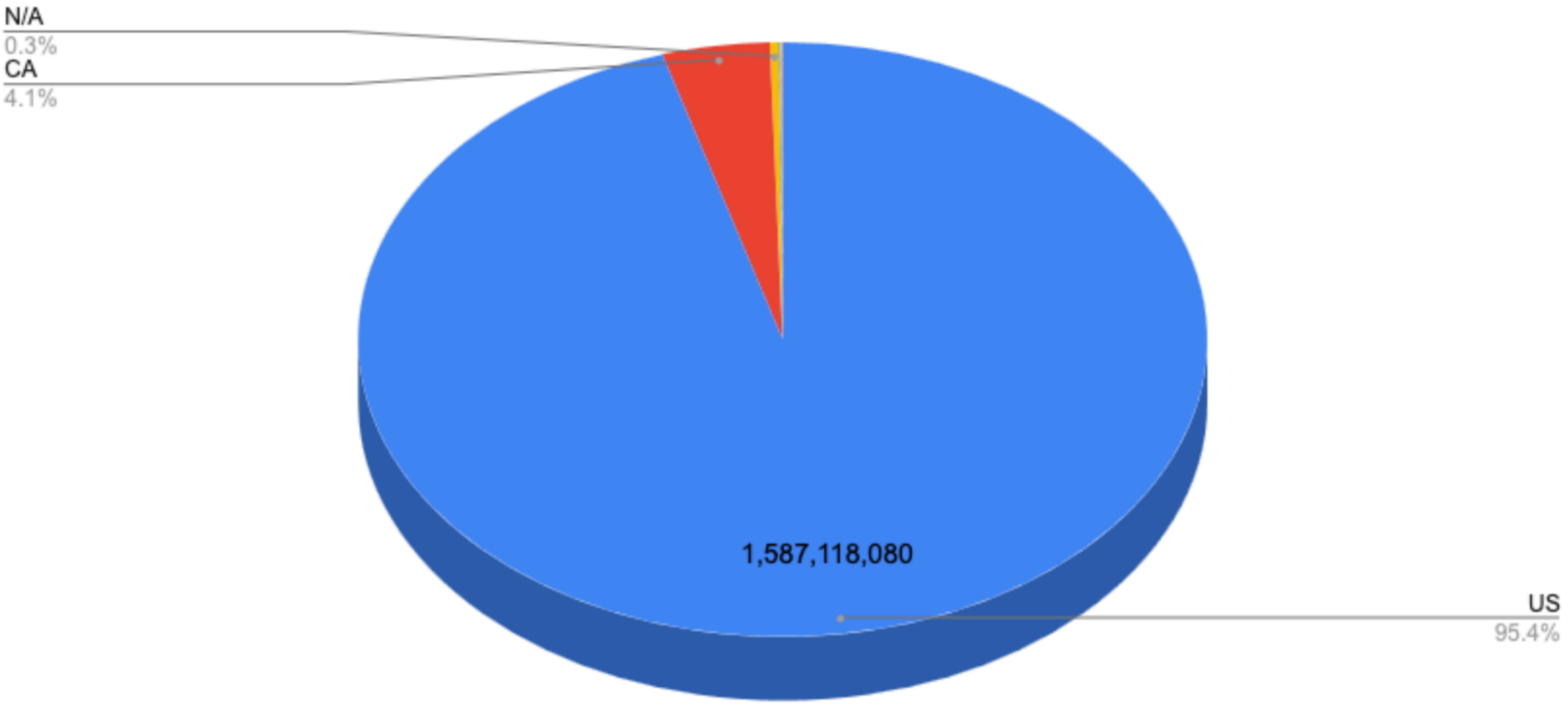
APNIC IPv6 Netblocks by Country



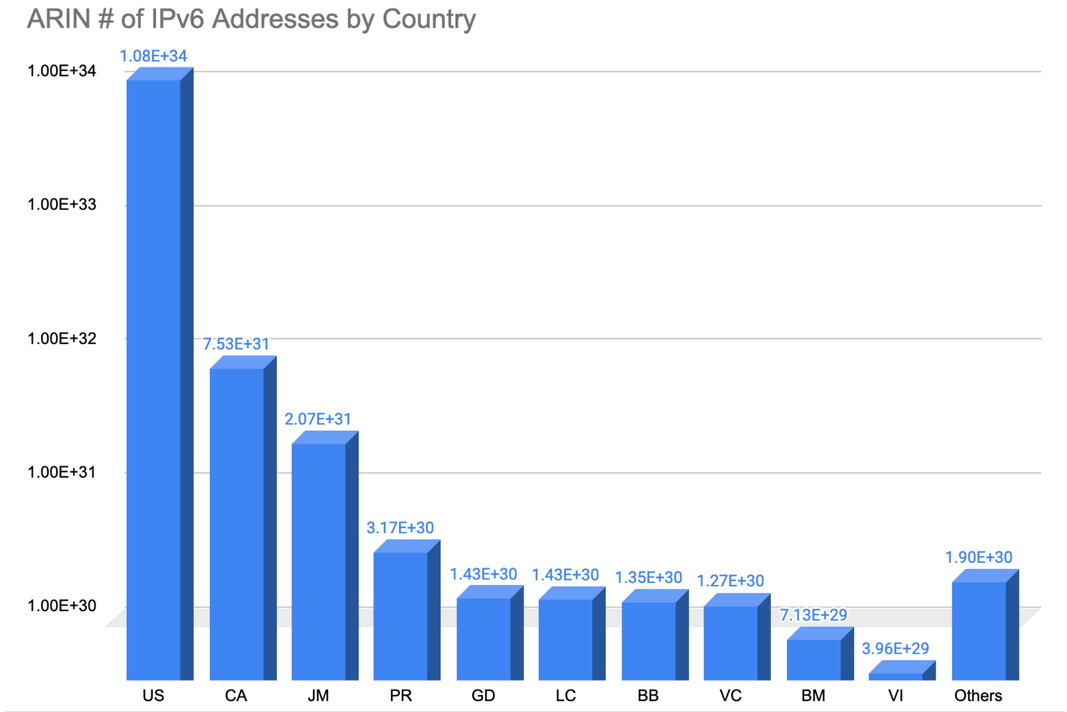
APNIC IPv6 Netblocks by Country



ARIN IPv4 Addresses by Country

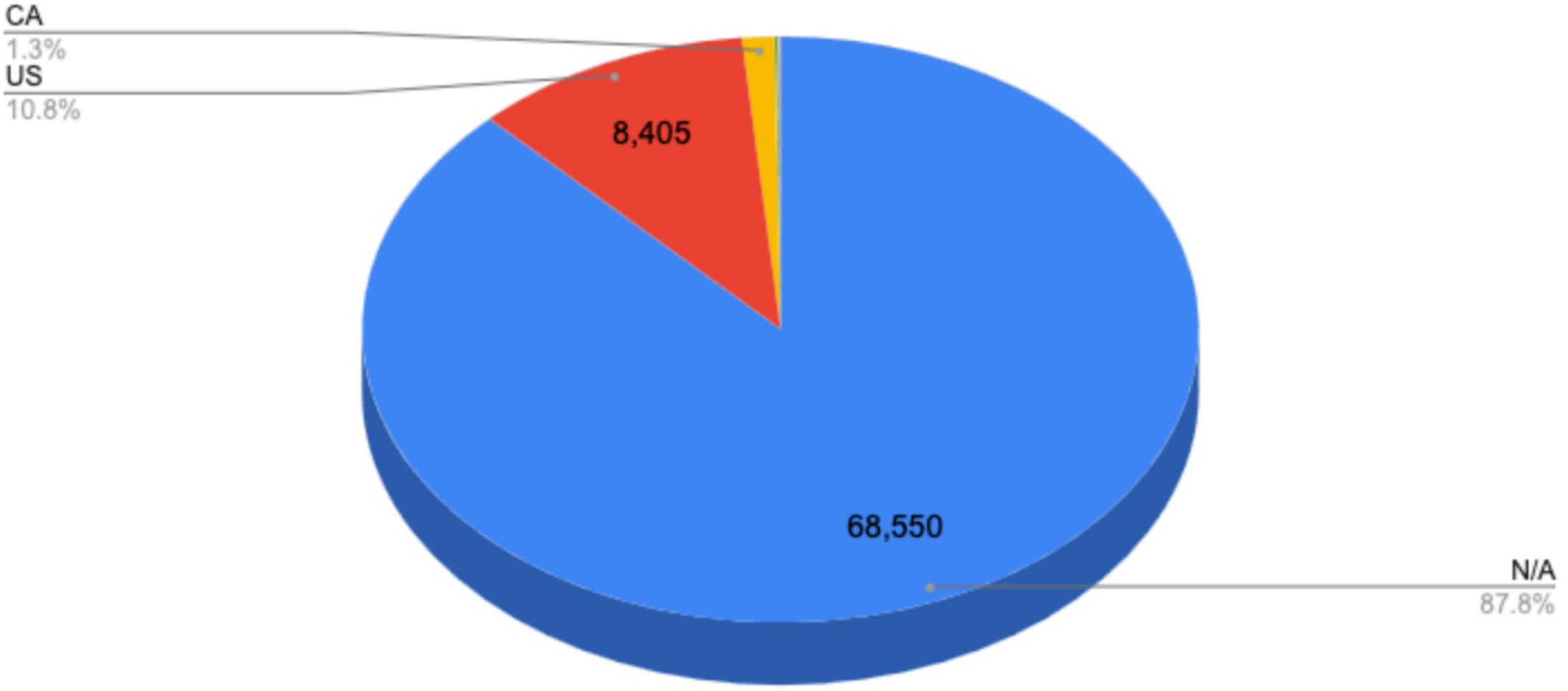


- Logarithmic scale
- US: 99% of assigned IPs
- CA: 0.7%
- …
- 54 countries for IPv4, 34 for IPv6

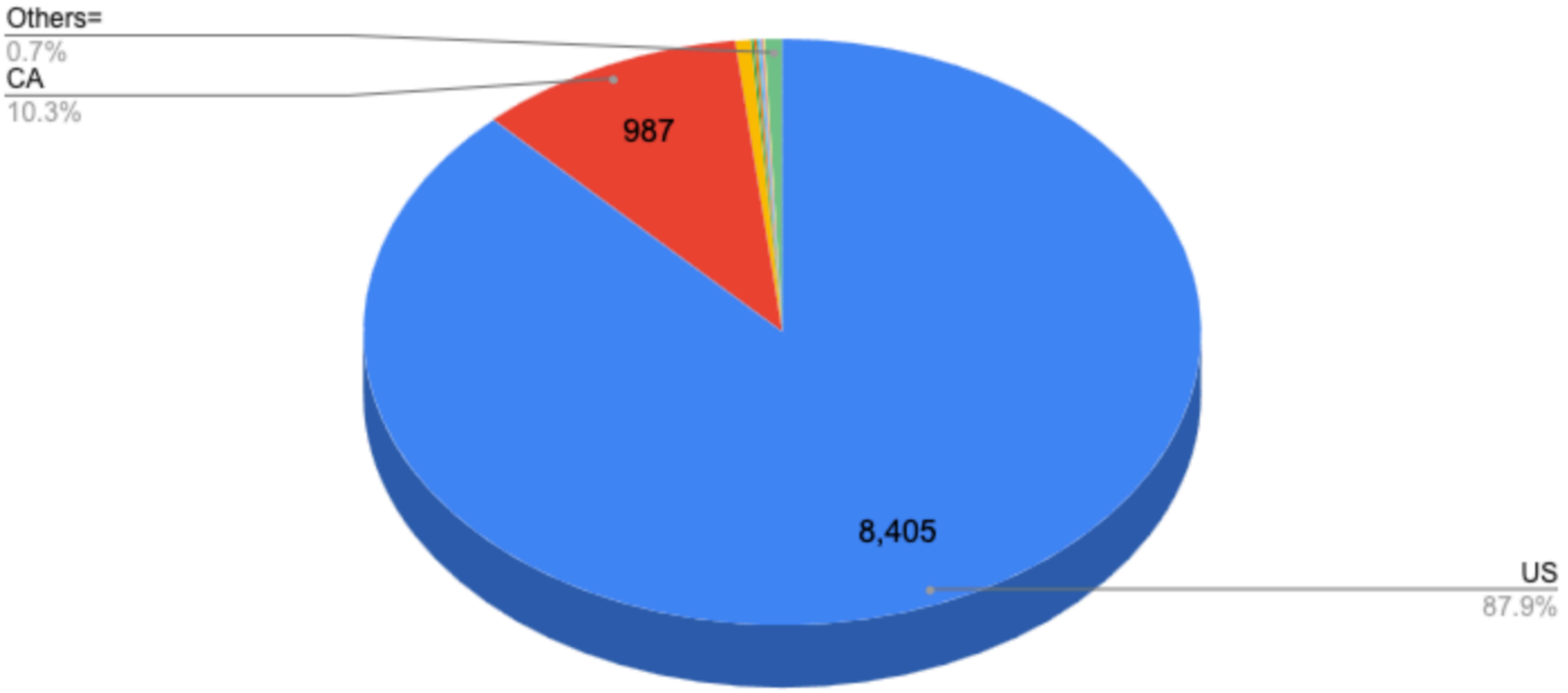


- RIN IPv6 AS:
    - 3,360 distinct
    - 5485 N/A
    - 358 AS with more than one allocation
    - Top 10:
        - AS7029 27 (Windstream Holdings)
        - AS30133 26 (ISC)
        - AS7018 23 (AT&T)
        - AS14618 18 (Amazon)
        - AS7342 17 (VERISIGN)
        - AS174 14 (COGENT)
        - AS16509 14 (Amazon)
        - AS17378 12 (TierPoint)
        - AS945 11 (August Internet hkgo
        - AS6939 10 (Hurricane Electrics)

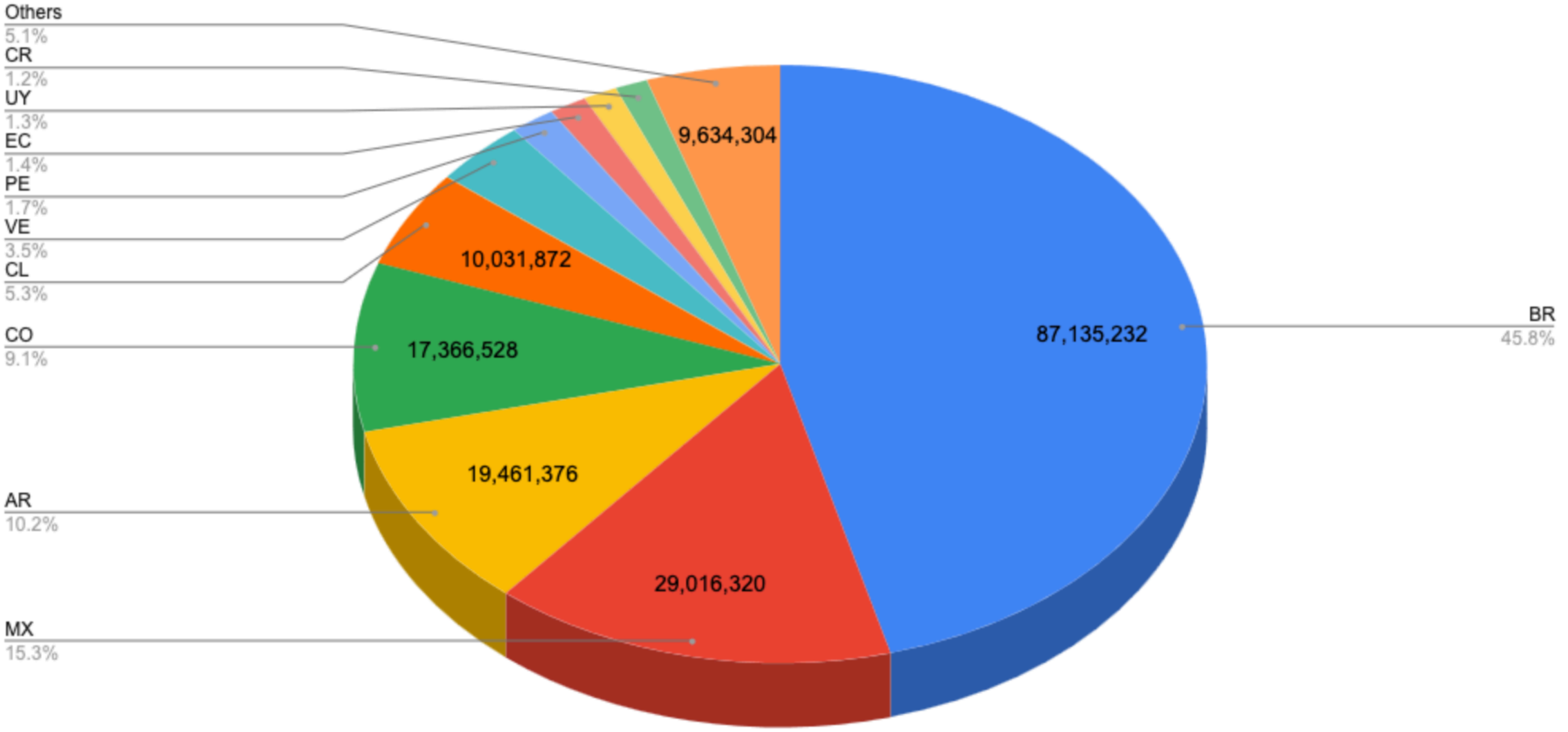
ARIN IPv6 Netblocks by Country



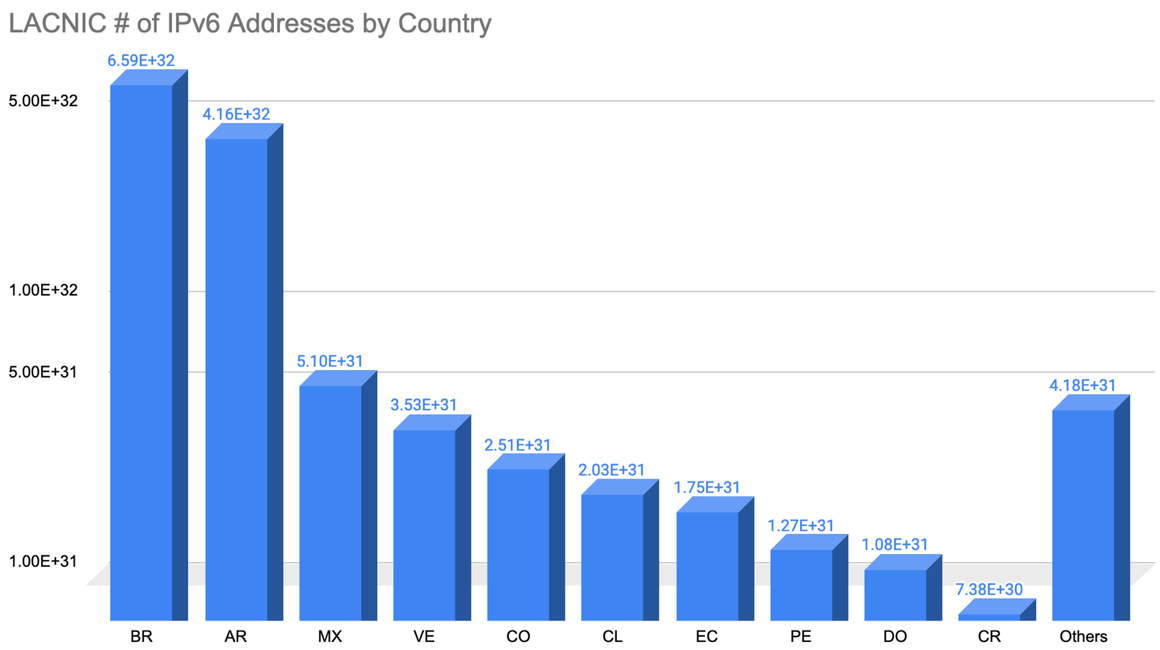
ARIN IPv6 Netblocks by Country



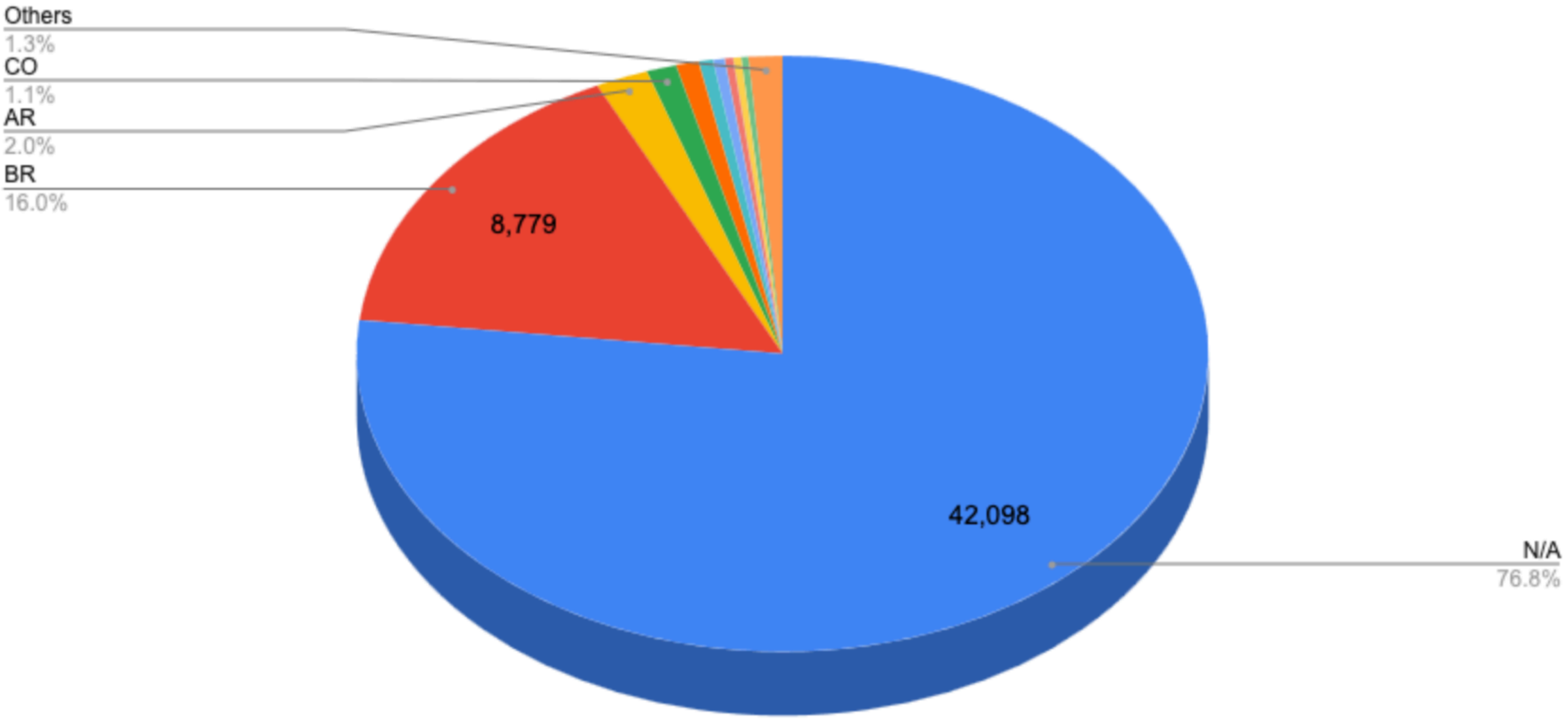
LACNIC IPv4 Addresses by Country



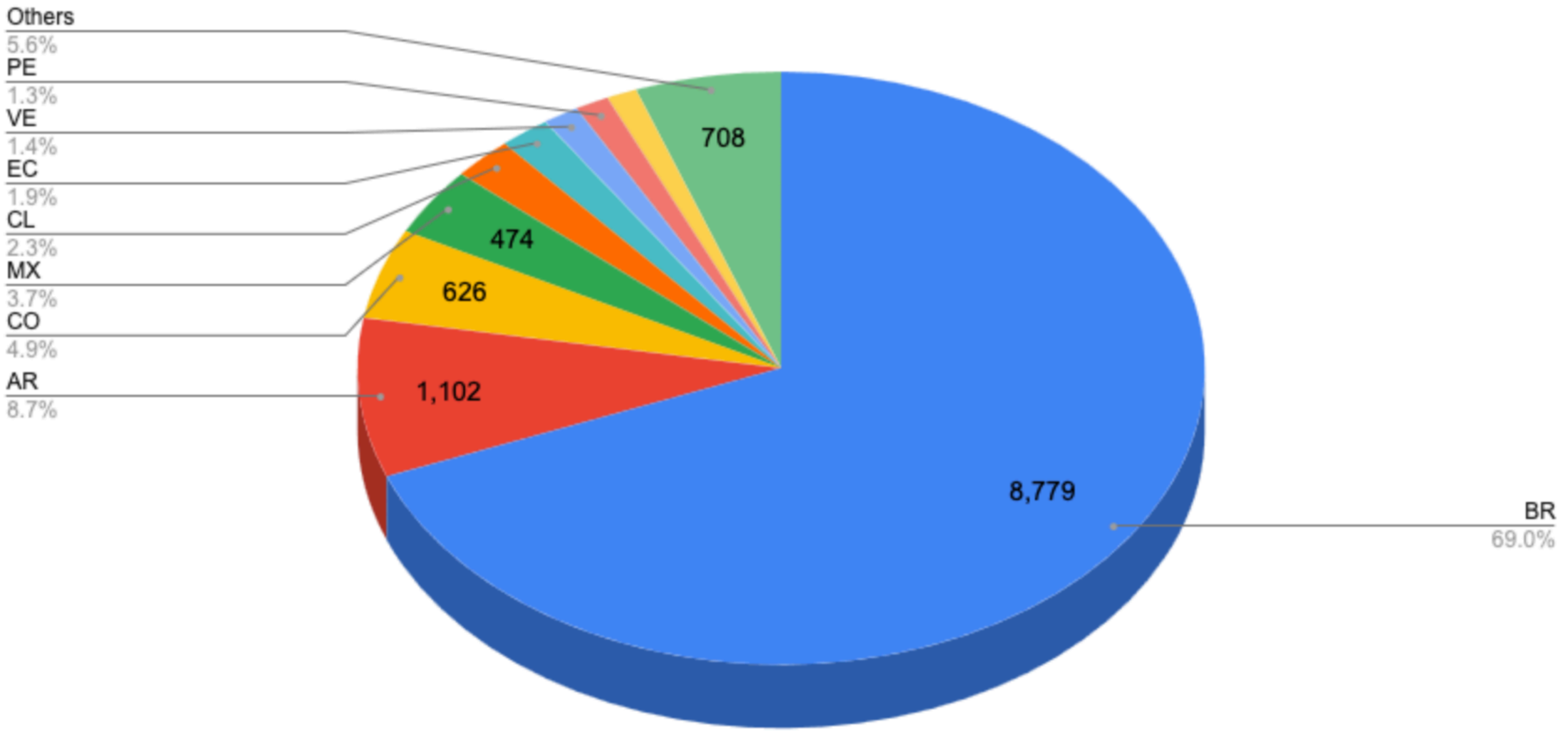
- BR: 50.8%
- AR: 32.1%
- MX: 3.9%
- VE: 2.7%
- CO: 1.9%
- CL: 1.6%
- EC: 1.3%
- PE: 1.0%
- Others combined: 3.2%



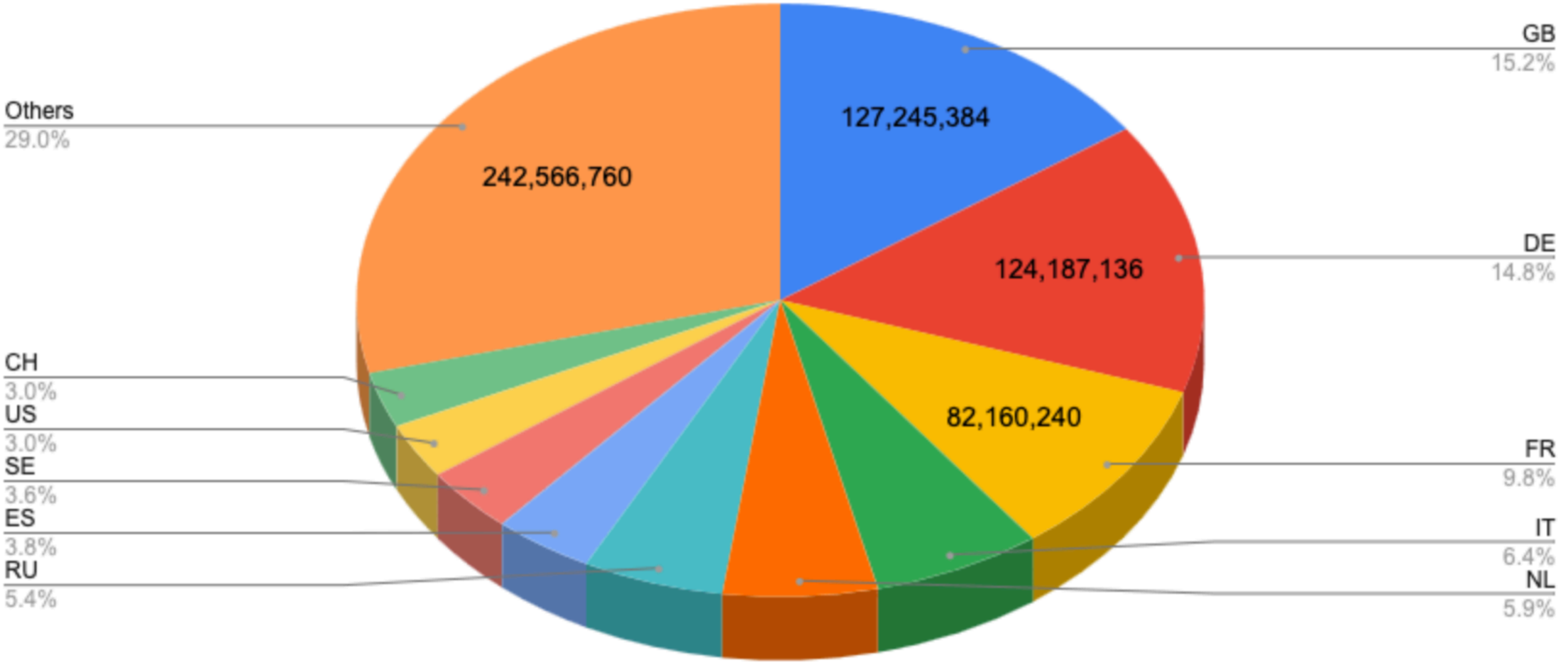
LACNIC IPv6 Netblocks by Country



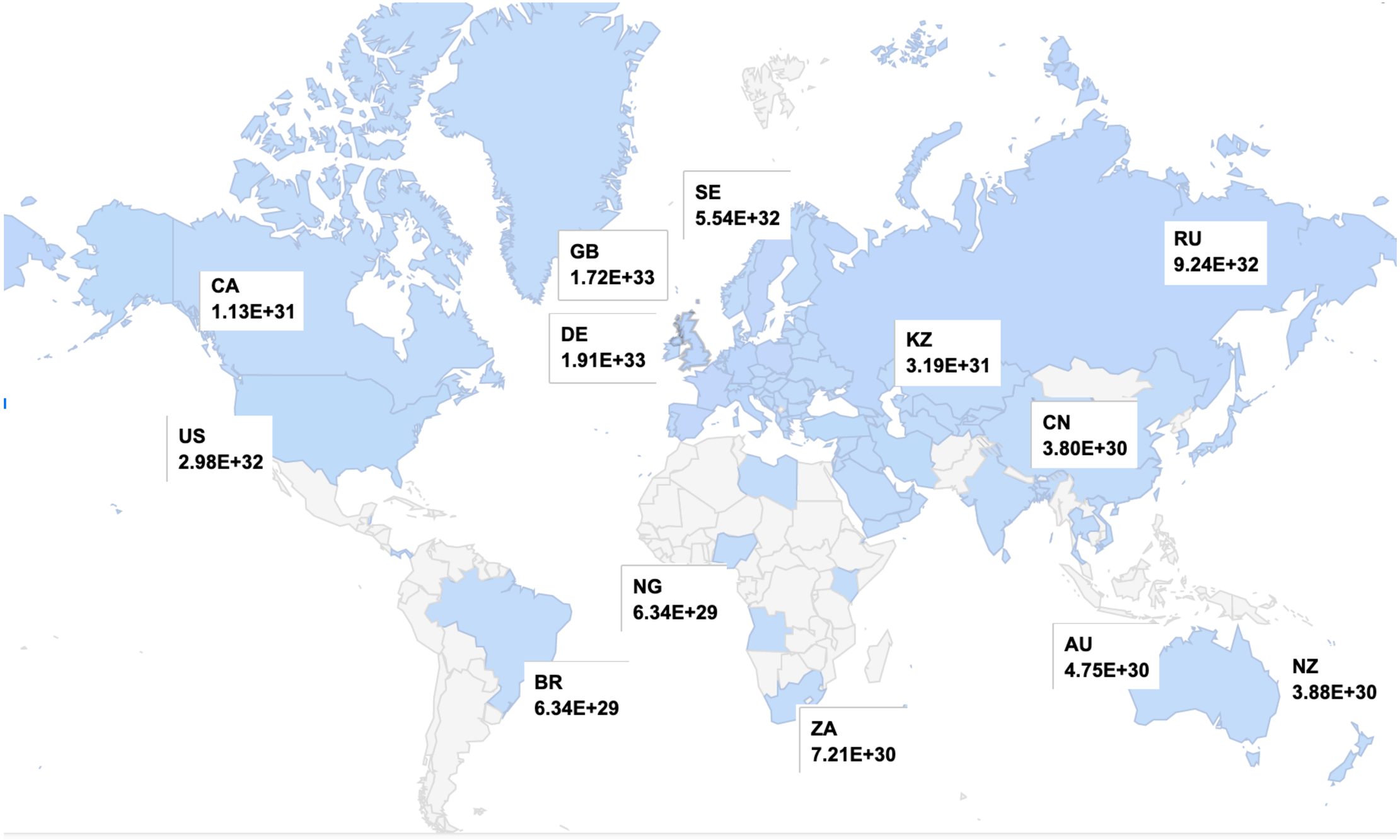
LACNIC IPv6 Netblocks by Country



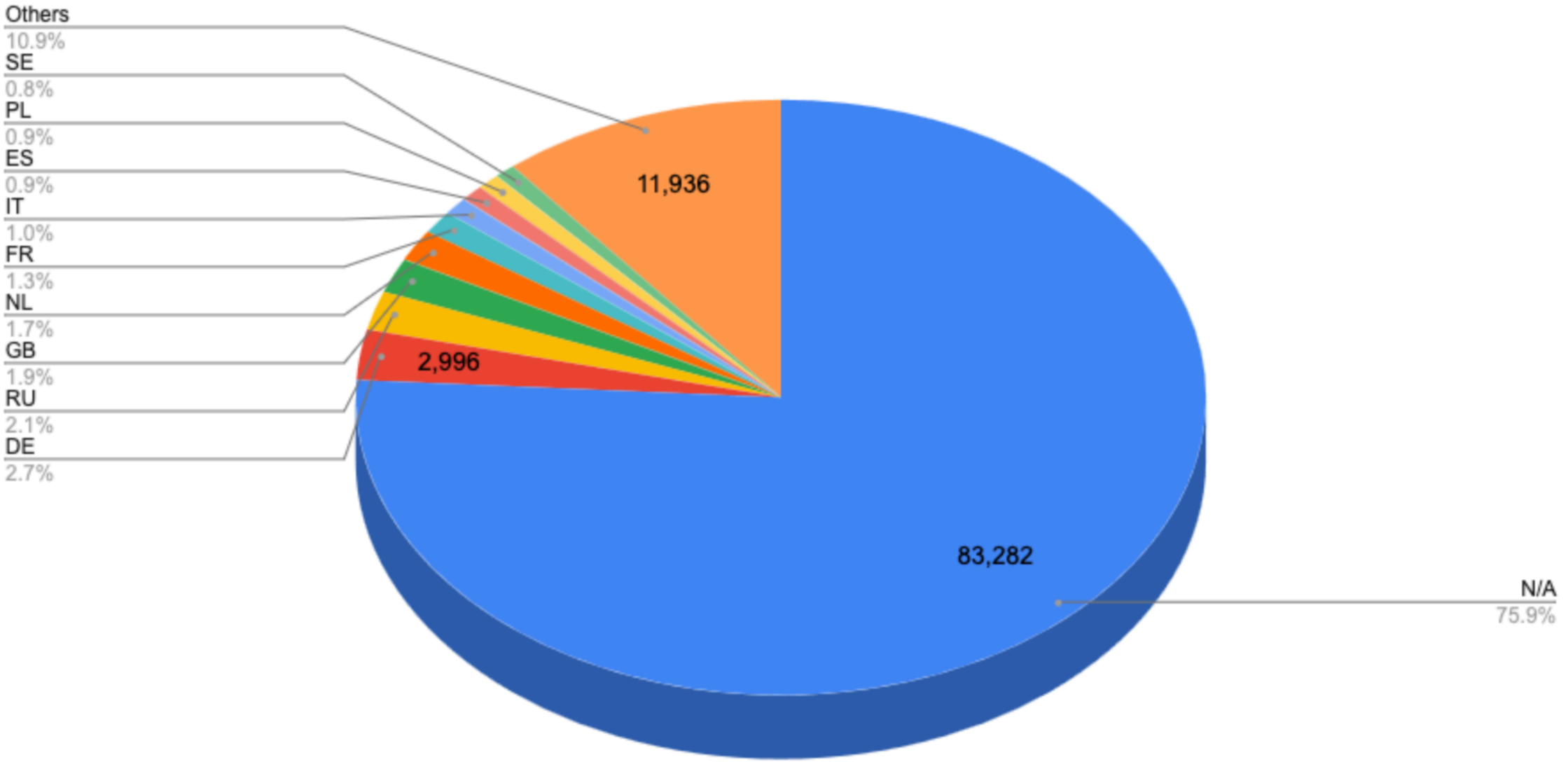
RIPENCC IPv4 Addresses by Country



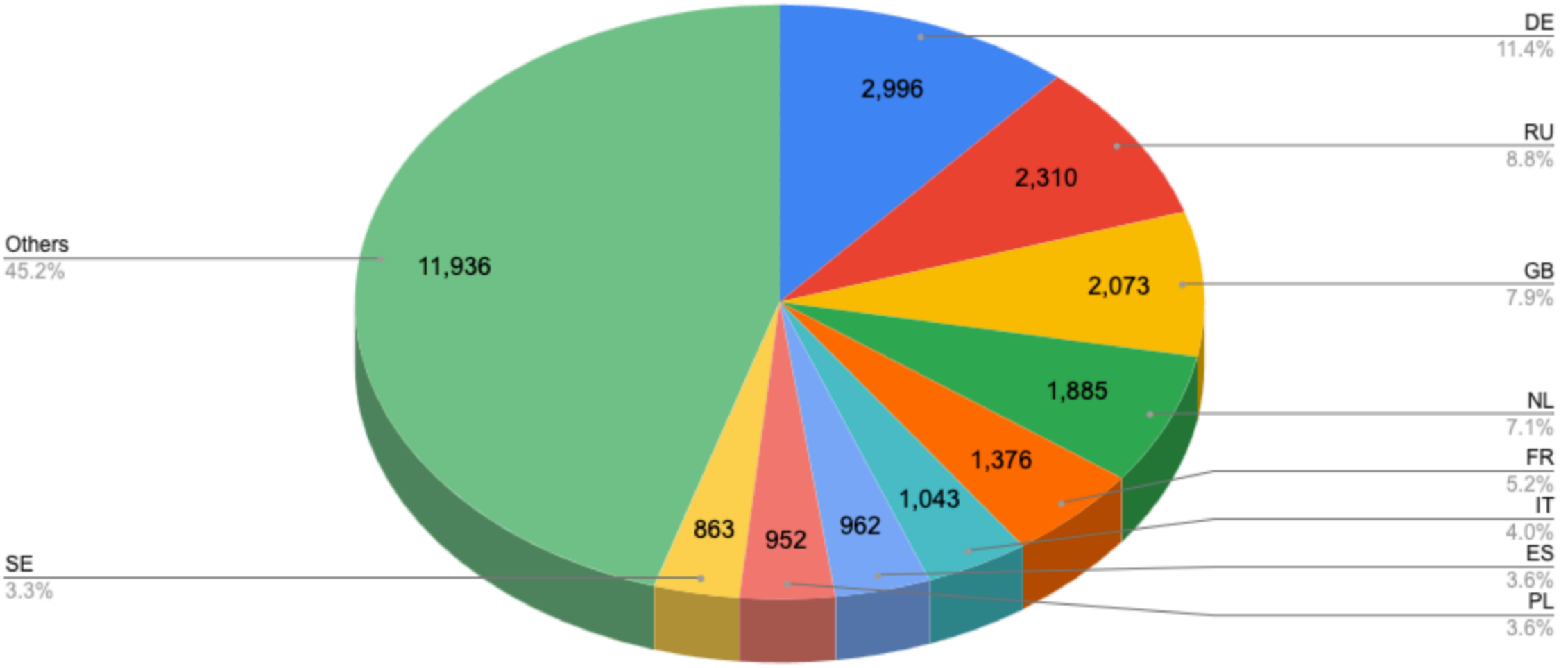
- RIPENCC IPv6 AS:
    - 7,794 distinct
    - 14,734 N/A
    - 1,422 AS with more than one allocation
    - Top 10:
        - AS60781 91 (Leaseweb, NL)
        - AS400177 55 (Rootcloud)
        - AS204916 38 (Racktech)
        - AS3301 36 (Telia)
        - AS1257 34 (Tele2)
        - AS204790 32 (Floccus)
        - AS197992 32 (Defsolution)
        - AS34907 31(IP SERVICES Sp.)
        - AS16509 30 (Amazon)
        - AS3320 29 (Deutsche Telekom (DTAG))


SE
5.54E+32
GB
1.72E+33
RU
9.24E+32
CA
1.13E+31
DE
1.91E+33
KZ
3.19E+31
US
2.98E+32
CN
3.80E+30
NG
6.34E+29
AU
4.75E+30
NZ
3.88E+30
BR
6.34E+29
ZA
7.21E+30

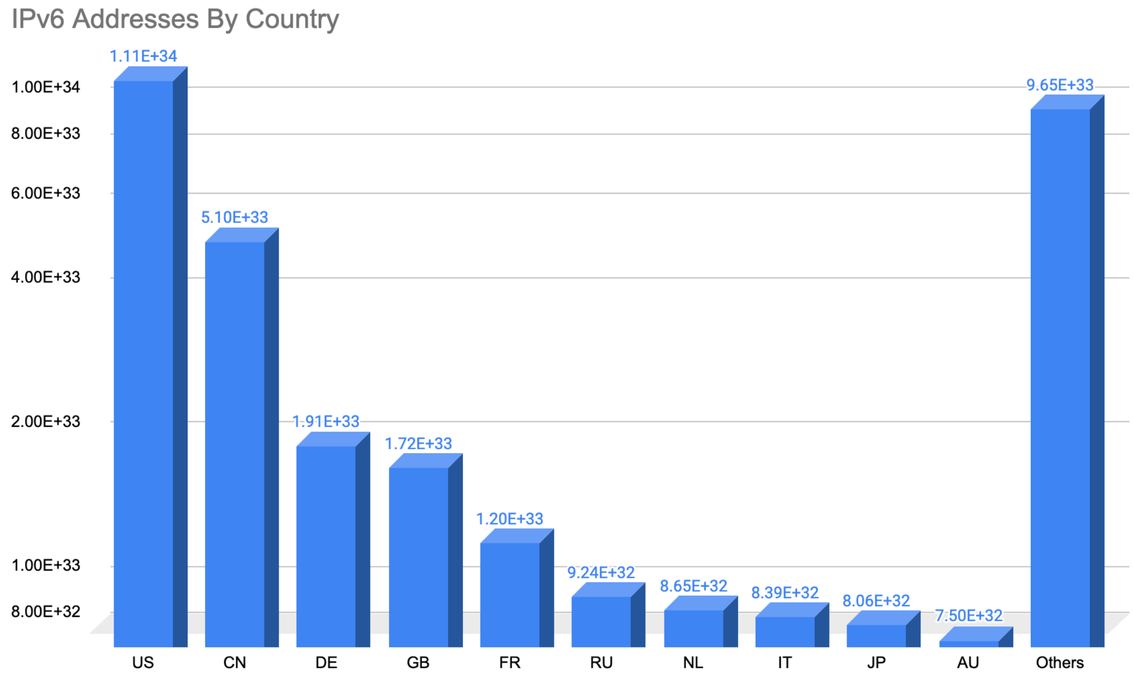
RIPENCC IPv6 Netblocks by Country



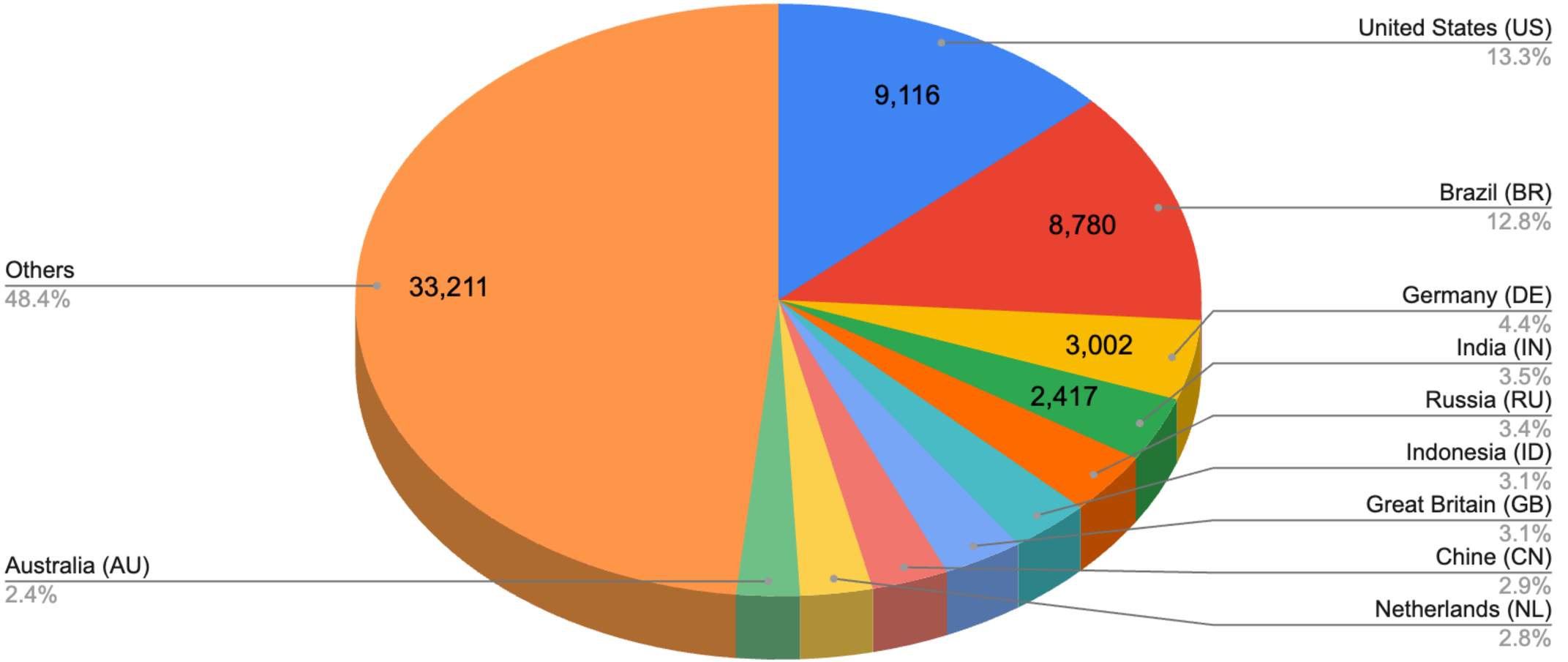
RIPENCC IPv6 Netblocks by Country



- US: 31.8%
- CN: 14.6%
- DE: 5.5%
- GB: 4.9%
- FR: 3.4%
- RU: 2.7%
- NL: 2.5%
- IT: 2.4%
- AU: 2.2%
- All others combined: 27.7%



Allocated/Assigned IPv6 Netblocks by Country

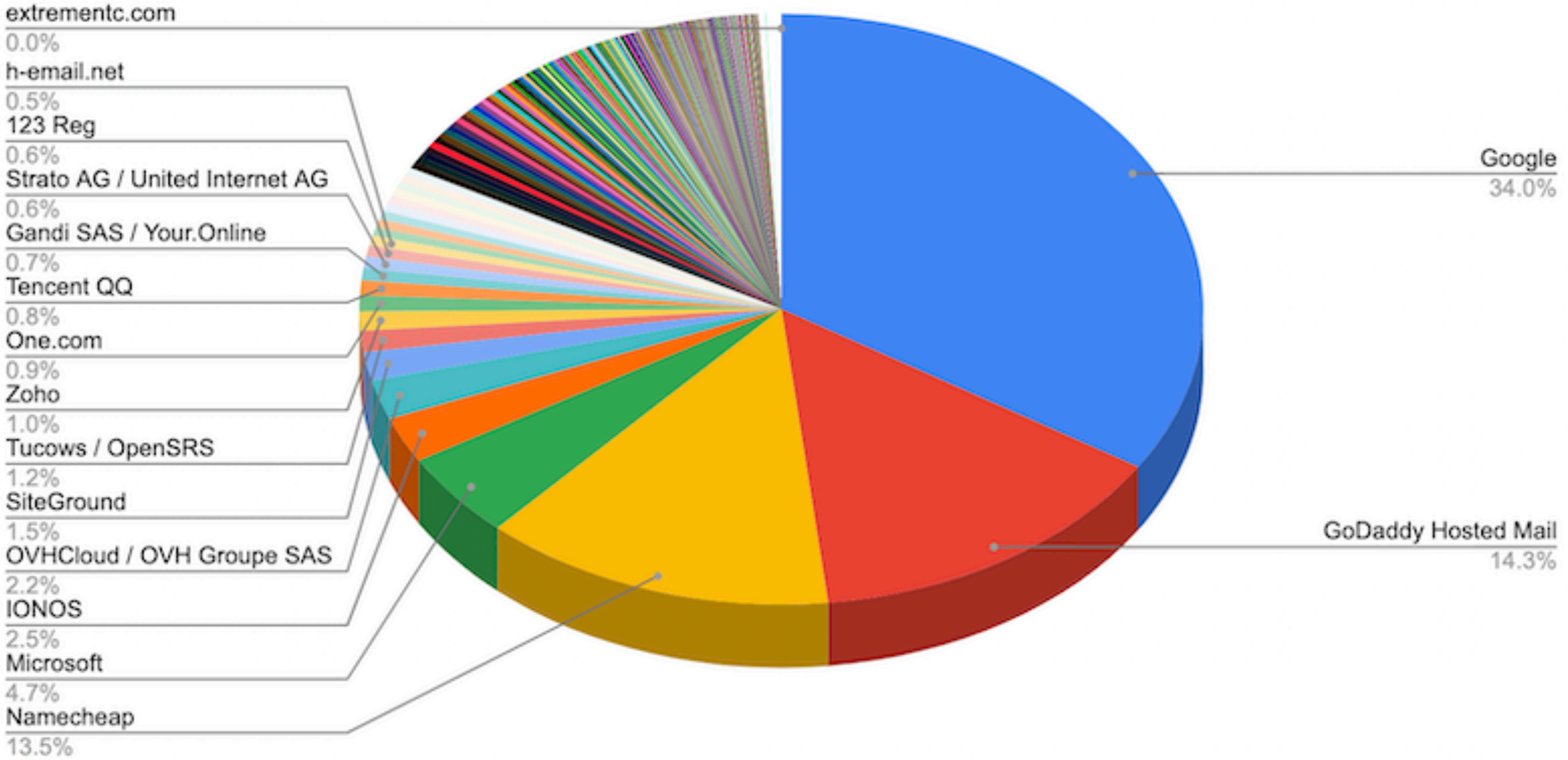


Routing Information Service (RIS)

View from the routing tables

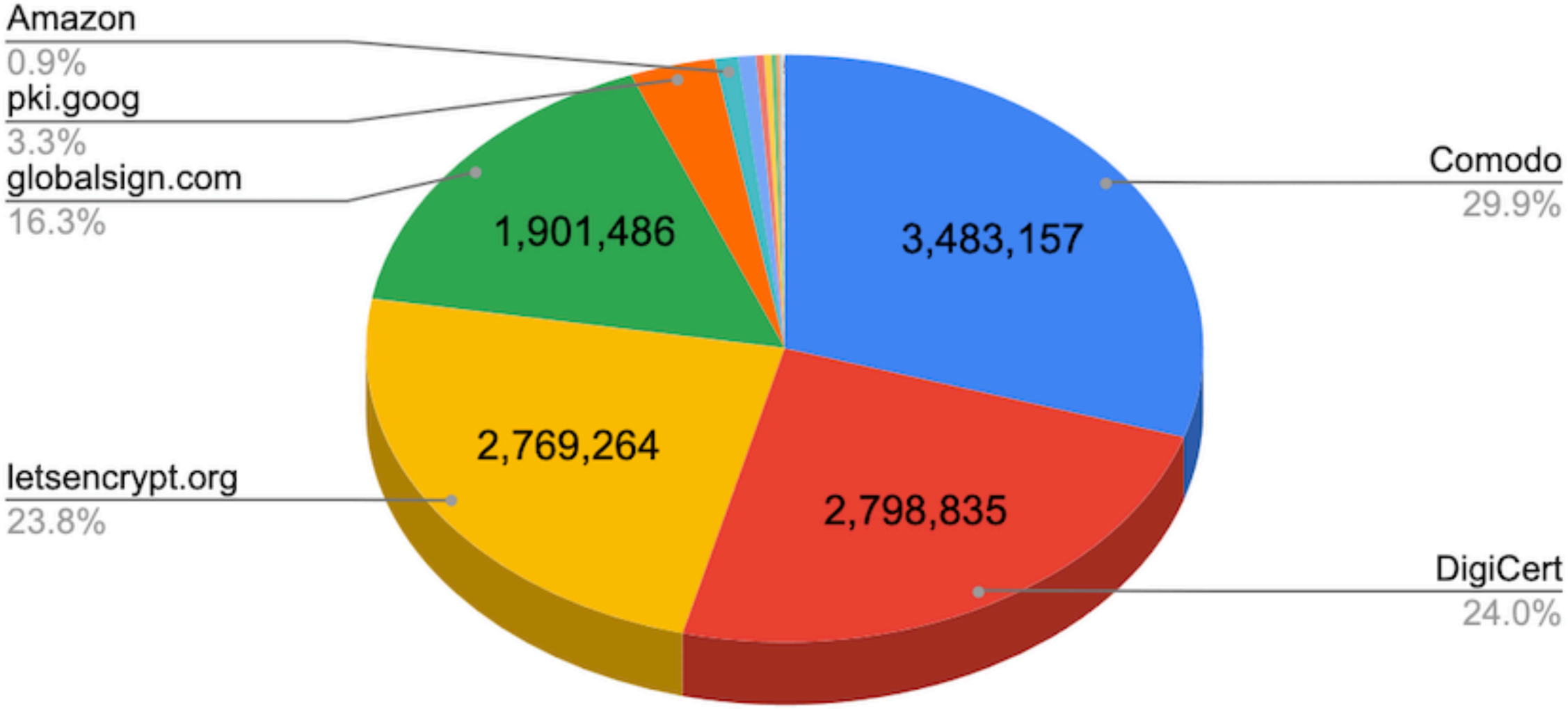
- https://www.ripe.net/analyse/internet-measurements/routing-information-service-ris/
- https://stat.ripe.net/app/launchpad
- https://ris.ripe.net/docs/ris-whois/
- Or ask whois.cymru.com ?
- Discrepancy of announced CIDRs vs. assigned CIDRs

MX domains (>1K instances)



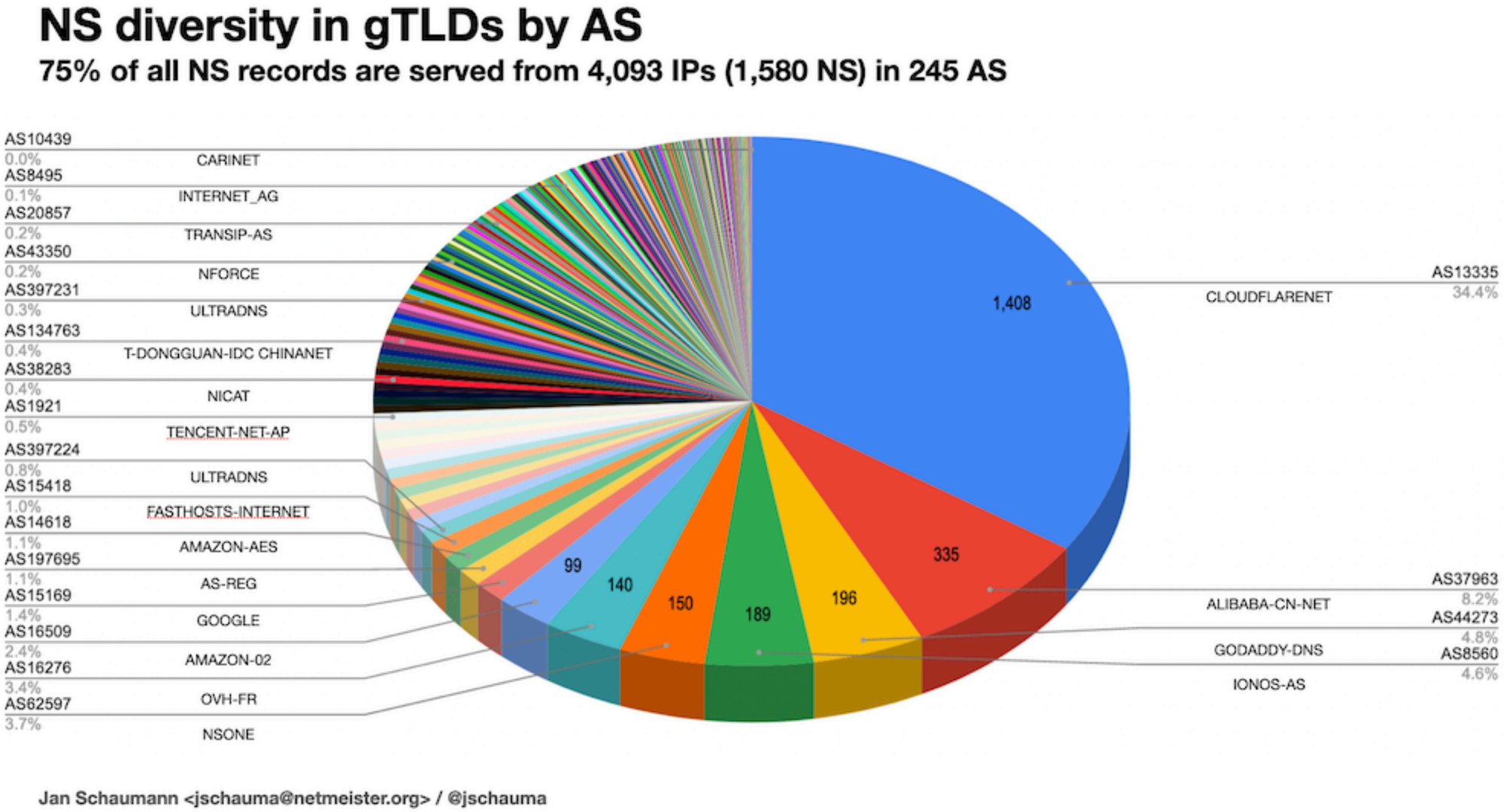
https://www.netmeister.org/blog/mx-diversity.html

Top CAA issue records (all TLDs)



https://www.netmeister.org/blog/caa-diversity.html

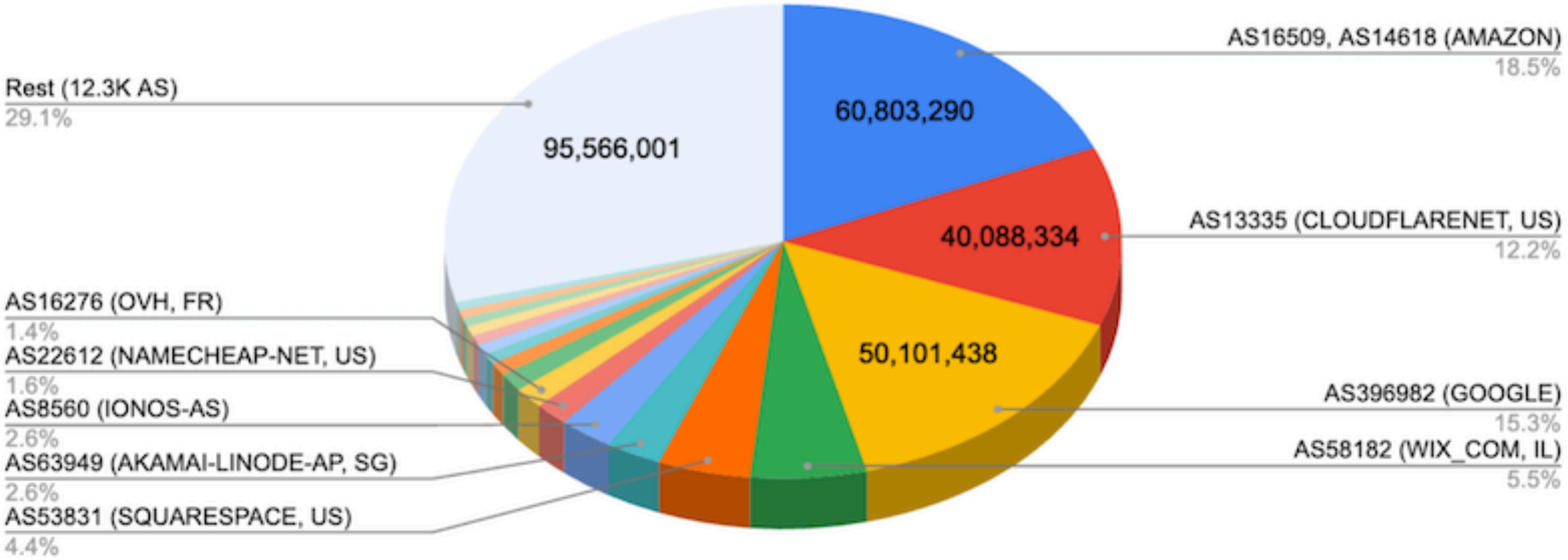
Previously



https://www.netmeister.org/blog/nsauth-diversity.html

Previously

Top AS by cumulative A / AAAA records' PTR records



https://www.netmeister.org/blog/naked-domains.html

MAP OF THE INTERNET

THE IPv4 SPACE, 2006

https://xkcd.com/195/