



Internet Routing Table Analysis Update

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PacNOG 32

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Motivation

- 1998: No one was publishing any Internet routing table analysis
 - Only CIDR-Report reporting on top 20 contributors to routing table, and top 20 bad aggregators
- With support of APNIC, my weekly report started from 23rd February 1999:
 - Routing table size
 - CIDR-Report style reporting on a per-RIR basis
 - ...and many other interesting features
- Started recording global IPv6 table in September 2010

IPv4 Routing Report 25th November 2023

BGP routing table entries examined:	935642
Prefixes after maximum aggregation (per Origin AS):	356140
Deaggregation factor:	2.63
Unique aggregates announced (without unneeded subnets):	454675
Total ASes present in the Internet Routing Table:	75088
Prefixes per ASN:	12.46
Origin-only ASes present in the Internet Routing Table:	64431
Origin ASes announcing only one prefix:	26523
Transit ASes present in the Internet Routing Table:	10657
Transit-only ASes present in the Internet Routing Table:	478
Average AS path length visible in the Internet Routing Table:	4.2
Max AS path length visible:	55
Max AS path prepend of ASN (265020)	50
Prefixes from unregistered ASNs in the Routing Table:	1036
Number of instances of unregistered ASNs:	1038
Special use prefixes present in the Routing Table:	1
Prefixes being announced from unallocated address space:	525
Number of addresses announced to Internet:	3049330944
Equivalent to 181 /8s, 193 /16s and 25 /24s	
Total number of prefixes smaller than registry allocations:	310583

APNIC Region

Prefixes being announced by APNIC Region ASes:	249008
Total APNIC prefixes after maximum aggregation:	71753
APNIC Deaggregation factor:	3.47
Prefixes being announced from the APNIC address blocks:	242249
Unique aggregates announced from the APNIC address blocks:	99279
APNIC Region origin ASes present in the Internet Routing Table:	13790
APNIC Prefixes per ASN:	17.57
APNIC Region origin ASes announcing only one prefix:	4151
APNIC Region transit ASes present in the Internet Routing Table:	1859
Average APNIC Region AS path length visible:	4.4
Max APNIC Region AS path length visible:	32
Number of APNIC addresses announced to Internet:	771834752
Equivalent to 46 /8s, 1 /16s and 67 /24s	
APNIC AS Blocks	4608-4864, 7467-7722, 9216-10239, 17408-18431
(pre-ERX allocations)	23552-24575, 37888-38911, 45056-46079, 55296-56319, 58368-59391, 63488-64098, 64297-64395, 131072-153913
APNIC Address Blocks	1/8, 14/8, 27/8, 36/8, 39/8, 42/8, 43/8, 49/8, 58/8 to 61/8, 101/8, 103/8, 106/8, 110/8 to 126/8, 133/8, 175/8, 180/8, 182/8, 183/8, 202/8, 203/8, 210/8, 211/8, 218/8 to 223/8

Global per AS IPv4 prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
8151	12075	3376	603	UNINET, MX
9808	9751	8730	44	CHINAMOBILE-CN China Mobile Communicati
16509	9350	11143	3300	AMAZON-02, US
12479	7471	1714	146	UNI2-AS, ES
7545	5686	785	697	TPG-INTERNET-AP TPG Telecom Limited, AU
4538	4918	4192	75	ERX-CERNET-BKB China Education and Rese
39891	4570	271	54	ALJAWWALSTC-AS, SA
11492	4559	302	677	CABLEONE, US
18403	4333	347	25	FPT-AS-AP FPT Telecom Company, VN
7155	4175	288	98	VIASAT-SP-BACKBONE, US
20940	4010	3397	142	AKAMAI-ASN1, NL
7713	3600	1047	70	TELKOMNET-AS-AP PT Telekomunikasi Indon
6327	3559	1320	68	SHAW, CA
10620	3528	499	871	Telmex Colombia S.A., CO
22773	3510	3055	301	ASN-CXA-ALL-CCI-22773-RDC, US
9009	3458	299	1612	M247, RO
8551	3433	368	34	BEZEQ-INTERNATIONAL-AS Bezeqint Interne
9498	3381	494	247	BBIL-AP BHARTI Airtel Ltd., IN
45899	3264	1872	99	VNPT-AS-VN VNPT Corp, VN
749	3159	54932	2411	DNIC-AS-00749, US

AfrINIC APNIC ARIN LACNIC RIPE NCC



What about IPv6 ?

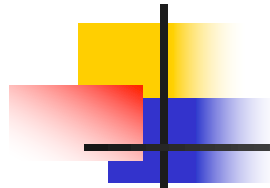
IPv6 Routing Report 24th November 2023 (Singapore)

BGP routing table entries examined:	185004
Number of IPv6 prefixes with a valid ROA:	102833
Number of IPv6 prefixes with an invalid ROA:	483
Number of IPv6 prefixes with no ROA:	81688
Total ASNs present in the IPv6 Routing Table:	31693
Average AS path length:	4.9
Longest AS path:	34
Total Origin ASNs present in the IPv6 Routing Table:	31396
Paths with bogon ASNs present in the IPv6 Routing Table:	3

Global IPv6 per AS prefix count summary (Singapore)

ASN	No of Nets	Description
11172	6255	Alestra, S. de R.L. de C.V., MX
9808	4621	CHINAMOBILE-CN China Mobile Communications Group Co., Ltd.,
16509	4343	AMAZON-02, US
18403	4270	FPT-AS-AP FPT Telecom Company, VN
7552	2544	VIETEL-AS-AP Viettel Group, VN
45609	2494	BHARTI-MOBILITY-AS-AP Bharti Airtel Ltd. AS for GPRS Service
24547	2013	CMNET-V4HEBEI-AS-AP Hebei Mobile Communication Company Limit
45271	1824	ICLNET-AS-AP Idea Cellular Limited, IN
12479	1647	UNI2-AS, ES
17622	1533	CNCGROUP-GZ China Unicom Guangzhou network, CN
32098	1511	TRANSTELCO-INC, US
28573	1458	Claro NXT Telecomunicacoes Ltda, BR
38266	1455	VIL-AS-AP Vodafone Idea Ltd, IN
36183	1381	AKAMAI-AS, US
13335	1323	CLOUDFLARENET, US
17072	1308	TOTAL PLAY TELECOMUNICACIONES SA DE CV, MX
39891	1212	ALJAWWALSTC-AS, SA
22773	1185	ASN-CXA-ALL-CCI-22773-RDC, US
6167	1151	CELLCO-PART, US
56046	1146	CMNET-JIANGSU-AP China Mobile communications corporation, CN

AfriNIC APNIC ARIN LACNIC RIPE NCC



IPv6 deaggregation example – Alestra

Network	Path
V*> 2001:1248:1::/48	6939 1299 11172 i
V*> 2001:1248:2::/48	6939 1299 11172 i
V*> 2001:1248:3::/48	6939 1299 11172 11172 11172 11172 11172 11172 11172 11172 11172 11172 11172 i
V*> 2001:1248:4::/48	6939 1299 11172 11172 11172 11172 11172 11172 11172 11172 11172 11172 11172 i
V*> 2001:1248:3000::/42	6939 1299 11172 i
V*> 2001:1248:3001::/48	6939 1299 11172 i
V*> 2001:1248:3002::/48	6939 1299 11172 I
...	
V*> 2001:1248:33e0::/48	6939 1299 11172 i
V*> 2001:1248:33e1::/48	6939 1299 11172 i
V*> 2001:1248:33e2::/48	6939 1299 11172 i
V*> 2001:1248:33e3::/48	6939 1299 11172 i
V*> 2001:1248:33e4::/48	6939 1299 11172 I
...	
V*> 2001:1248:4200::/42	6939 6461 11172 i
V*> 2001:1248:4200::/48	6939 1299 11172 11172 11172 11172 11172 11172 11172 11172 11172 11172 i
V*> 2001:1248:4201::/48	6939 1299 11172 11172 11172 11172 11172 11172 11172 11172 11172 11172 i
V*> 2001:1248:4203::/48	6939 1299 11172 11172 11172 11172 11172 11172 11172 11172 11172 11172 i
V*> 2001:1248:4204::/48	6939 1299 11172 11172 11172 11172 11172 11172 11172 11172 11172 11172 i
V*> 2001:1248:4205::/48	6939 1299 11172 11172 11172 11172 11172 11172 11172 11172 11172 11172 i

Points to Ponder:

1. there are 65536 /48s in a /32
2. No announcement of covering /32
3. 9x prepend doing nothing!
4. What "traffic engineering" ?

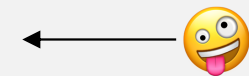
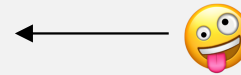
Non-routable ASNs for IPv4

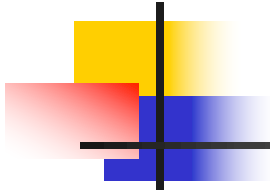
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Network Path
N*> 5.102.30.0/24 6461 174 198471 65536
I*> 36.90.182.0/23 7713 64503
I*> 36.90.186.0/23 7713 64501
I*> 36.90.220.0/23 7713 64503
I*> 36.90.222.0/23 7713 64501
I*> 36.90.224.0/23 7713 64501
V*> 46.221.6.0/24 6762 15924 65989
I*> 61.5.100.0/22 7713 64500
N*> 66.186.61.0/24 4213 64524
N*> 67.55.182.0/23 6461 174 5056 65778
N*> 70.39.15.0/24 6461 174 5056 65777
N*> 81.222.184.0/23 6762 3216 16345 4241496521
N*> 81.222.186.0/23 6762 3216 16345 4241496521
N*> 102.221.75.0/24 6939 37662 328722 36873 36873 761467
N*> 103.20.204.0/22 24482 45430 134240 {45458,65000,134240}
N*> 103.75.143.0/24 9498 132717 132717 132717 132717 65501 65503 133386
I*> 103.102.137.0/24 9498 17806 17806 17806 17806 137029 84565
V*> 103.224.48.0/24 2914 9583 134922 134922 1342922 134922 134922 134922
V*> 103.224.54.0/24 2914 9583 134922 134922 1342922 134922 134922 134922
N*> 119.40.94.0/24 9498 10075 24122 24122 24122 {65542,65634}
N*> 122.15.208.0/24 9498 55410 55410 55410 55410 55410 55410 {65004}
N*> 123.63.162.0/24 9498 55410 {65001}
N*> 125.7.8.0/24 38195 17477 {65800}
N*> 125.7.37.0/24 38195 17477 {65800}
N*> 134.204.208.0/24 24482 45430 45458 18723 65007
N*> 154.91.36.0/24 6762 48237 35819 29684 65539
N*> 158.224.2.0/23 6461 26585 26585 26585 26585 26585 26585 {26585,65559}
N*> 158.224.18.0/23 6461 26585 26585 26585 26585 26585 26585 {26585,65560}
N*> 159.215.24.0/22 9498 7772 7772 7772 64752
N*> 164.115.251.0/24 4651 38450 38450 38450 66666 66666
N*> 167.167.107.0/24 6461 30012 4230330000
N*> 177.47.208.0/20 6762 16735 268200 262473 66004 66023 66023 66023 66021 66018 66017 66017 66017 66017 66017 66017 6503101
N*> 178.18.218.0/23 6762 31500 211609 {4200000000,4200000004}
N*> 178.18.220.0/23 6762 31500 211609 {4200000001,4200000002,4200000003}
I*> 180.242.244.0/23 7713 64505
I*> 180.242.246.0/23 7713 64505
I*> 180.254.32.0/21 7713 64501
N*> 185.37.99.0/24 6762 8781 42298 65540
N*> 192.55.18.0/23 24482 45430 45458 18723 65044
N*> 198.208.209.0/24 9498 45241 65420
N*> 198.208.255.0/24 9498 45241 65420
I*> 200.76.152.0/24 6461 11172 64501
I*> 200.94.67.0/24 6461 11172 64501
N*> 203.91.204.0/24 9498 23664 65483
N*> 216.176.207.0/24 4213 64512
```

Documentation ASN

IANA Reserved ASN

Private ASN





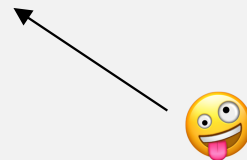
Non-routable ASNs for IPv6

```
Network Path
I*> 2001:c20:48b9::/48 6461 7473 3758 9255 65564
I*> 2401:4900:5cc0::/44 9498 45609 64001 64671 64680
I*> 2405:2300:ff02::/48 9498 13443 65514
I*> 2405:2300:ff05::/48 9498 13443 65514
I*> 2405:2300:ff0c::/48 9498 13443 65514
N*> 2602:801:1000::/48 22697 11281 {65900,65901,65910,4203902001}
N*> 2602:fc01::/48 8796 395886 64512
N*> 2607:f8f0::/40 6509 271 {65540,65541}
V*> 2620:131:3009::/48 6939 6453 4755 58419 58419 58419 58419 58419 58419 58419 58419
I*> 2800:2b03:100::/40 6762 7303 64500 64501
N*> 2801:19:c800::/48 6461 174 13489 64500
V*> 2803:1f90::/32 6762 27947 4200000464 273081
V*> 2803:1f90:1a::/48 6762 27947 4200000464 273081
N*> 2a01:42e0:ff00::/40 6762 31133 35168 29046 65556
N*> 2a0c:a641::/32 6762 8781 42298 65540
```

Documentation ASN

IANA Reserved ASN

Private ASN





Deprecated AS Set

- Use of BGP AS Set is not recommended
 - RFC6472/BCP172 (December 2011)
- There are still some in both IPv4 and IPv6 BGP tables
 - IPv4 has 267 entries
 - IPv6 has 33 entries

IPv4 Prefixes using Deprecated AS_SET

Net Originated	AS Path
5.172.183.0/24	3257 56595 {210467}
5.180.210.0/24	3257 62240 62240 {62240}
8.41.202.0/24	3257 1828 13789 13789 13789 13789 13789 13789 13789 13789 30372 {40179}
15.20.64.0/18	1299 2686 25888 21302 {13979}
15.36.64.0/18	2687 25888 {21326}
20.137.0.0/21	3356 21877 {4237}
20.137.160.0/20	3356 206 {4237}
20.137.176.0/20	3356 21877 {4237}
20.137.240.0/20	3356 21877 {4237}
23.56.208.0/24	1299 20940 {12222}
23.200.20.0/24	3257 20940 20940 {12222}
23.217.64.0/19	1299 8151 20940 20940 {16625}
24.49.144.0/20	3257 22646 {400511}
27.71.16.0/21	4637 7552 {38731}
37.52.0.0/14	1299 6849 {6877}
37.221.128.0/19	3257 3255 {62384}
41.215.160.0/20	6762 37613 37030 {37140}
41.215.160.0/21	6762 37613 37030 37030 37030 37030 {37140}
...	
212.55.185.0	3356 6453 12849 21450 21450 {21450}
213.161.144.0/23	3320 9121 9021 {197042}
213.186.96.0/19	1299 6849 {6877}
213.255.226.0	3257 62240 62240 62240 {62240}
216.16.208.0/20	3257 22646 {400511}
216.110.102.0	3491 23520 14813 {11139}
216.126.96.0/20	577 22573 {6058}
216.183.128.0/19	174 19752 11727 {62865}
216.221.208.0/22	3356 26585 26585 {26585}
216.221.212.0/22	3356 26585 26585 {26585}
216.221.220.0/22	3356 26585 26585 {26585}
216.241.10.0	6461 52320 52468 52468 52468 18747 {52411}
217.24.112.0/20	12389 {28860}
217.25.32.0/20	2119 25146 {41943}
217.27.240.0/20	1299 2914 29006 {36483}
217.65.248.0/21	174 3255 {59671}
217.112.32.0/20	1273 3216 30943 {40966}
217.168.16.0/20	1299 2914 29006 {36483}

IPv6 Prefixes using Deprecated AS_SET

Net Originated	AS Path
2001:510::/32	3257 376 {36786}
2001:678:16::/48	12389 45029 42385 {20764,42385,43832}
2001:678:6d0::/48	3216 212748 {212748}
2001:6d0:ffd5::/48	12389 45029 42385 {8359,20764,42139,42385}
2001:4220::/32	1273 24835 {36935}
2001:4220::/33	1273 24835 {36935}
2402:4640::/33	4788 38044 {23736}
2402:4640:8000::/33	4788 38044 {23736}
2402:7500::/32	3491 9924 {24158}
2402:8100::/32	3491 55644 {36040,38266,45271,55410}
2403:8400::/48	9498 17917 {36040}
2404:c000::/32	7473 45147 {16625,17727,55818}
2404:c000::/33	7473 45147 {16625,55818}
2606:b400:8814::/48	3356 7160 {7160}
2607:f280::/32	174 14615 {398053}
2607:f390::/32	3257 32440 {2055,17244}
2607:f7a8:600::/39	3257 46887 {397488}
2607:f7a8:800::/39	3257 46887 {395749}
2607:f7a8:c00::/39	3257 46887 {21687}
2607:f8f0::/40	2603 6509 271 {65540,65541}
2620:1b2::/36	16735 26673 {64966}
2620:1b2:cb0::/44	16735 26673 {64966}
2800:480::/32	6453 14080 14080 14080 14080 {10620,264718}
2800:486::/32	6453 14080 {10620}
2a00:6480::/32	1299 35548 35548 35548 35548 {29018}
2a02:2578:2001::/48	3356 39386 51375 {211612}
2a02:6680:1::/48	174 8551 16116 {211612}
2a05:f940::/29	1299 24785 39647 {16131}
2a09:bd00::/48	12389 45029 42385 {20764,42385,43832}
2a0a:39c0::/32	1299 62240 {62240}
2a0a:bcc0::/29	2603 1653 41001 {64600,65001,65002,65501,65502}
2a0e:b2c4::/30	3216 212748 {212748}
2a13:7bc0::/29	1299 200999 {200217}



Unassigned resources

- Use of unassigned address space is rampant
 - Currently 525 unassigned prefixes in IPv4 routing table
- Use of unassigned ASNs is also a big problem
 - Currently 400 unassigned ASNs in use
- Many are transited by well-known / reputable operators
 - Why??

List of Unregistered ASNs

The complete list in use:

940, 1636, 1782, 4879, 6081, 6485, 6565, 7064, 7257, 7607, 10425, 10475, 10981, 11011, 11044, 11091, 11223,
11316, 11490, 11540, 11570, 11593, 11610, 11636, 11819, 11945, 12109, 12169, 12240, 13224, 13339, 13342, 13492,
13920, 13980, 14015, 14076, 14167, 14350, 14428, 14461, 14545, 14605, 14651, 14736, 14889, 15178, 15200, 15220,
15238, 15249, 15804, 16615, 16666, 16769, 16804, 16860, 16994, 17341, 18586, 18591, 18691, 18799, 18805, 18821,
18976, 19081, 19140, 19142, 19176, 19359, 19396, 19507, 19533, 19708, 19926, 19987, 20118, 20190, 20200, 20227,
20380, 20421, 20443, 21649, 21695, 21704, 21861, 21942, 21986, 22160, 22271, 22272, 22484, 22538, 22539, 22694,
22698, 22733, 22736, 22774, 22778, 22830, 23021, 23176, 23190, 23194, 23262, 23288, 23357, 23411, 23448, 23507,
23658, 23985, 25568, 25600, 25641, 25647, 25779, 25786, 25800, 25831, 25978, 26016, 26018, 26030, 26140, 26171,
26286, 26295, 26345, 26443, 26520, 26643, 26682, 26712, 26758, 26759, 26799, 26861, 26920, 26961, 26986, 27174,
27180, 27247, 27284, 27289, 27291, 27335, 27361, 27426, 27470, 27593, 28161, 29763, 29782, 29829, 30004, 30037,
30104, 30155, 30218, 30248, 30426, 30442, 30550, 30699, 31781, 31813, 32094, 32103, 32121, 32187, 32282, 32346,
32358, 32457, 32534, 32596, 32772, 32801, 32916, 33017, 33027, 33051, 33123, 33137, 33232, 33245, 33394, 33417,
33484, 33492, 33625, 33684, 35941, 36002, 36045, 36077, 36264, 36267, 36283, 36357, 36465, 36605, 36679, 36774,
36782, 36893, 36900, 36928, 36979, 37103, 37155, 37162, 37169, 37320, 37338, 37442, 37475, 37476, 37544, 37591,
37703, 38055, 39991, 40077, 40186, 40255, 40279, 40493, 40600, 40654, 40687, 40726, 40751, 40804, 40909, 40920,
46086, 46123, 46226, 46228, 46233, 46472, 46559, 46673, 46772, 46815, 46876, 46913, 46916, 47044, 47086, 52806,
53059, 53298, 53367, 53419, 53552, 53657, 53715, 53722, 53737, 53771, 53775, 53786, 53854, 53886, 53929, 53947,
54215, 54231, 54278, 54338, 54424, 54776, 54787, 55084, 55203, 55227, 62641, 62770, 62801, 62820, 62828, 63092,
63125, 63190, 63198, 63248, 63305, 63387, 63401, 63433, 64011, 64203, 64235, 64339, 65536, 65539, 65540, 65777,
65778, 65989, 66666, 84565, 132172, 132238, 134182, 138184, 138918, 140682, 140712, 149486, 227171, 230105,
262509, 262692, 262745, 262992, 264493, 264959, 265039, 265872, 266239, 266974, 268652, 269313, 270345, 271585,
271675, 271724, 327869, 327933, 328007, 328149, 328226, 328248, 328369, 328771, 393218, 393266, 393305, 393314,
393320, 393377, 393446, 393476, 393808, 394076, 394108, 394156, 394293, 394402, 394519, 394607, 394721, 394754,
394787, 394788, 394839, 394879, 394936, 394939, 395195, 395270, 395282, 395293, 395312, 395350, 395376, 395377,
395438, 395514, 395522, 395556, 395557, 396015, 396314, 396324, 396330, 396451, 396831, 396894, 396993, 397327,
397607, 397658, 398118, 398829, 399382, 399572, 399618, 399836, 400352, 761467, 6503101

List of Unregistered Origin ASNs

Far too many to list. See <http://thyme.apnic.net/current/data-badAS>:

Bad AS	Designation	Net Originated	Transit AS	Transit AS Name
65536	DOCUMENT	5.102.30.0/24	65512	-Private Use AS-, ZZ
33492	UNALLOCATED	8.6.184.0/23	33650	COMCAST-33650, US
33123	UNALLOCATED	8.10.69.0/24	174	COGENT-174, US
12169	UNALLOCATED	8.15.207.0/24	32787	PROLEXIC-TECHNOLOGIES-DDOS-M
40493	UNALLOCATED	8.17.26.0/24	3356	LEVEL3, US
53775	UNALLOCATED	8.20.88.0/24	7029	WINDSTREAM, US
62828	UNALLOCATED	8.21.130.0/24	3356	LEVEL3, US
393266	UNALLOCATED	8.23.52.0/24	46887	LIGHTTOWER, US
396894	UNALLOCATED	8.28.201.0/24	46887	LIGHTTOWER, US
394936	UNALLOCATED	8.33.224.0/24	22442	HOU-PHONOSCOPE, US
54338	UNALLOCATED	8.33.241.0/24	6461	ZAYO-6461, US
395195	UNALLOCATED	8.38.115.0/24	33132	FIBERNET-DIRECT, US
1782	UNALLOCATED	8.42.19.0/24	3356	LEVEL3, US
395438	UNALLOCATED	8.42.206.0/24	3356	LEVEL3, US
396451	UNALLOCATED	12.6.254.0/24	7018	ATT-INTERNET4, US
13342	UNALLOCATED	12.17.5.0/24	7018	ATT-INTERNET4, US
26345	UNALLOCATED	12.21.93.0/24	40264	TWC-40264-WI-MN-UPPERMI-C3,
396831	UNALLOCATED	12.23.198.0/24	33491	COMCAST-33491, US
21861	UNALLOCATED	12.37.59.0/24	7018	ATT-INTERNET4, US
33684	UNALLOCATED	12.37.144.0/24	7018	ATT-INTERNET4, US
63305	UNALLOCATED	12.49.58.0/24	7018	ATT-INTERNET4, US
33684	UNALLOCATED	12.68.34.0/24	6461	ZAYO-6461, US
31781	UNALLOCATED	12.71.107.0/24	7018	ATT-INTERNET4, US
21861	UNALLOCATED	12.106.212.0/24	7018	ATT-INTERNET4, US
12169	UNALLOCATED	12.109.164.0/24	32787	PROLEXIC-TECHNOLOGIES-DDOS-M

List of Unassigned IPv4 addresses

Far too many to list (over 500!!). See <http://thyme.apnic.net/current/data-add-IANA>:

Unassigned Network	ASN Information	AS Name
23.140.216.0/24	Origin: 27176	DATAWAGON, US
23.140.216.0/24	Transit: 20278	NEXEON, US
23.141.0.0/24	Origin: 395350	RESERVED, ZZ
23.141.0.0/24	Transit: 11426	TWC-11426-CAROLINAS, US
23.176.160.0/24	Origin: 397327	RESERVED, ZZ
23.176.160.0/24	Transit: 19108	SUDDENLINK-COMMUNICATIONS, US
23.189.192.0/24	Origin: 27593	RESERVED, ZZ
23.189.192.0/24	Transit: 174	COGENT-174, US
36.255.139.0/24	Origin: 56050	NEW-SHINE-INTERNET-TH 134 Yenchit Road,
36.255.139.0/24	Transit: 58913	HCL-TH 4819 Supapong 3 Alley, Srinakarin
41.57.124.0/22	Origin: 37442	RESERVED, ZZ
41.57.124.0/22	Transit: 37204	TELONE, ZW
41.57.124.0/23	Origin: 37442	RESERVED, ZZ
41.57.124.0/23	Transit: 37204	TELONE, ZW
41.57.124.0/24	Origin: 37442	RESERVED, ZZ
41.57.124.0/24	Transit: 37204	TELONE, ZW
41.57.125.0/24	Origin: 37442	RESERVED, ZZ
41.57.125.0/24	Transit: 37204	TELONE, ZW
41.57.126.0/24	Origin: 37442	RESERVED, ZZ
41.57.126.0/24	Transit: 37204	TELONE, ZW
41.57.127.0/24	Origin: 37442	RESERVED, ZZ
41.57.127.0/24	Transit: 37204	TELONE, ZW
41.57.203.0/24	Origin: 206283	YAHSAT-FRANKFURT, AE
41.57.203.0/24	Transit: 3491	BTN-ASN, US
41.57.204.0/24	Origin: 206283	YAHSAT-FRANKFURT, AE
41.57.204.0/24	Transit: 3491	BTN-ASN, US

Number of IPv4 prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0	/7:0	/8:16
/9:14	/10:38	/11:99	/12:298	/13:582	/14:1194	/15:2060	/16:13465
/17:8298	/18:13834	/19:25150	/20:44384	/21:51581	/22:110716	/23:99682	/24:563499
/25:732	/26:0	/27:0	/28:0	/29:0	/30:0	/31:0	/32:0

25th November 2023↑

25th November 2022↓

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0	/7:0	/8:16
/9:13	/10:39	/11:100	/12:295	/13:587	/14:1199	/15:2045	/16:13524
/17:8317	/18:13911	/19:25184	/20:44364	/21:52396	/22:110250	/23:97921	/24:544784
/25:824	/26:0	/27:0	/28:0	/29:0	/30:0	/31:0	/32:0

Number of IPv6 prefixes announced by prefix length

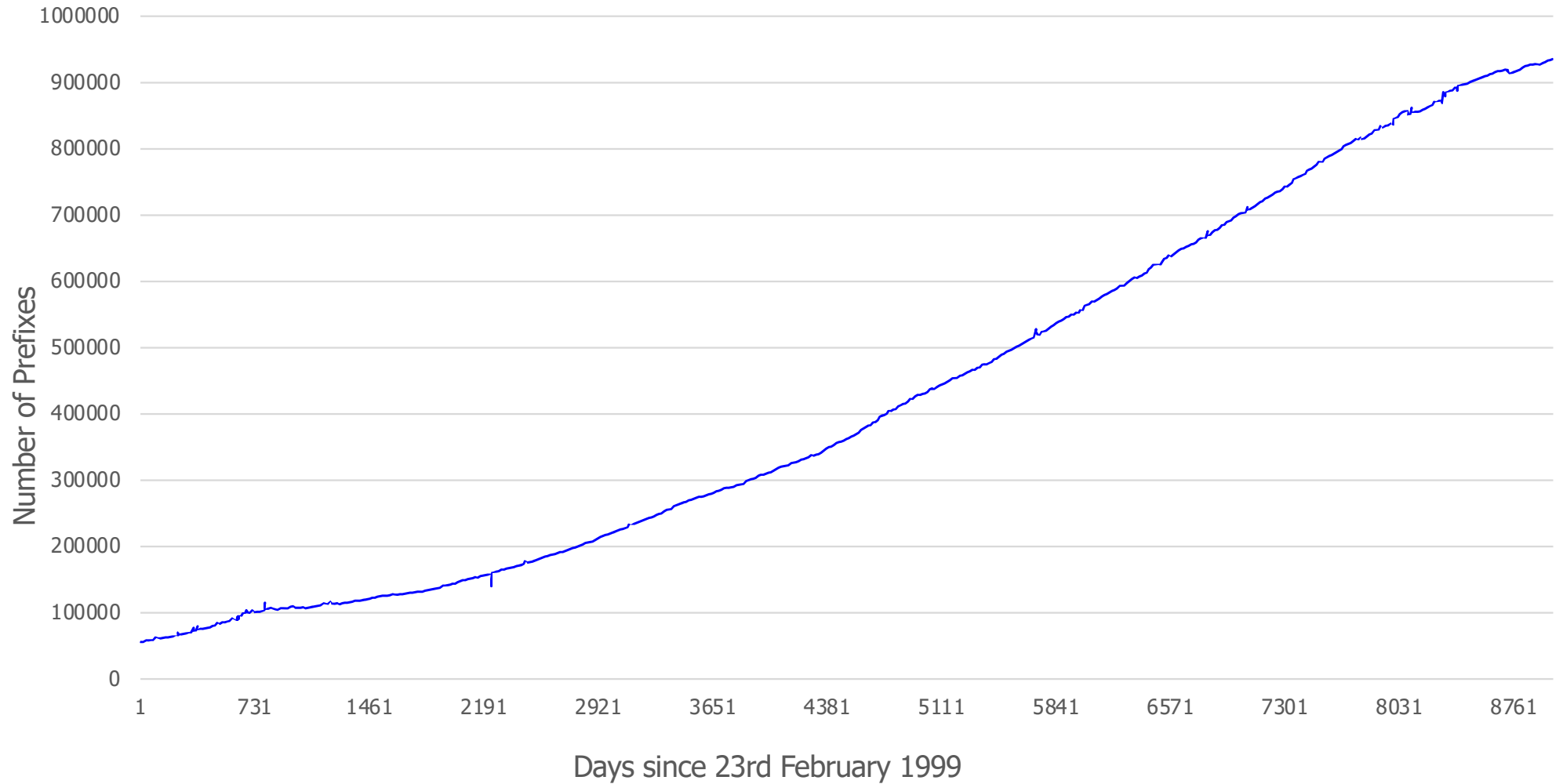
/16:1	/17:0	/18:0	/19:1	/20:14	/21:4	/22:7	/23:7
/24:32	/25:8	/26:16	/27:22	/28:209	/29:4371	/30:622	/31:324
/32:23352	/33:3345	/34:2912	/35:1071	/36:6467	/37:1018	/38:1823	/39:1354
/40:15424	/41:967	/42:3608	/43:1087	/44:17006	/45:2241	/46:3406	/47:5052
/48:87592	/49:4	/50:0	/51:0	/52:1	/53:0	/54:0	/55:0
/56:1	/57:0	/58:0	/59:0	/60:0	/61:0	/62:0	/63:0
/64:2							

25th November 2023↑

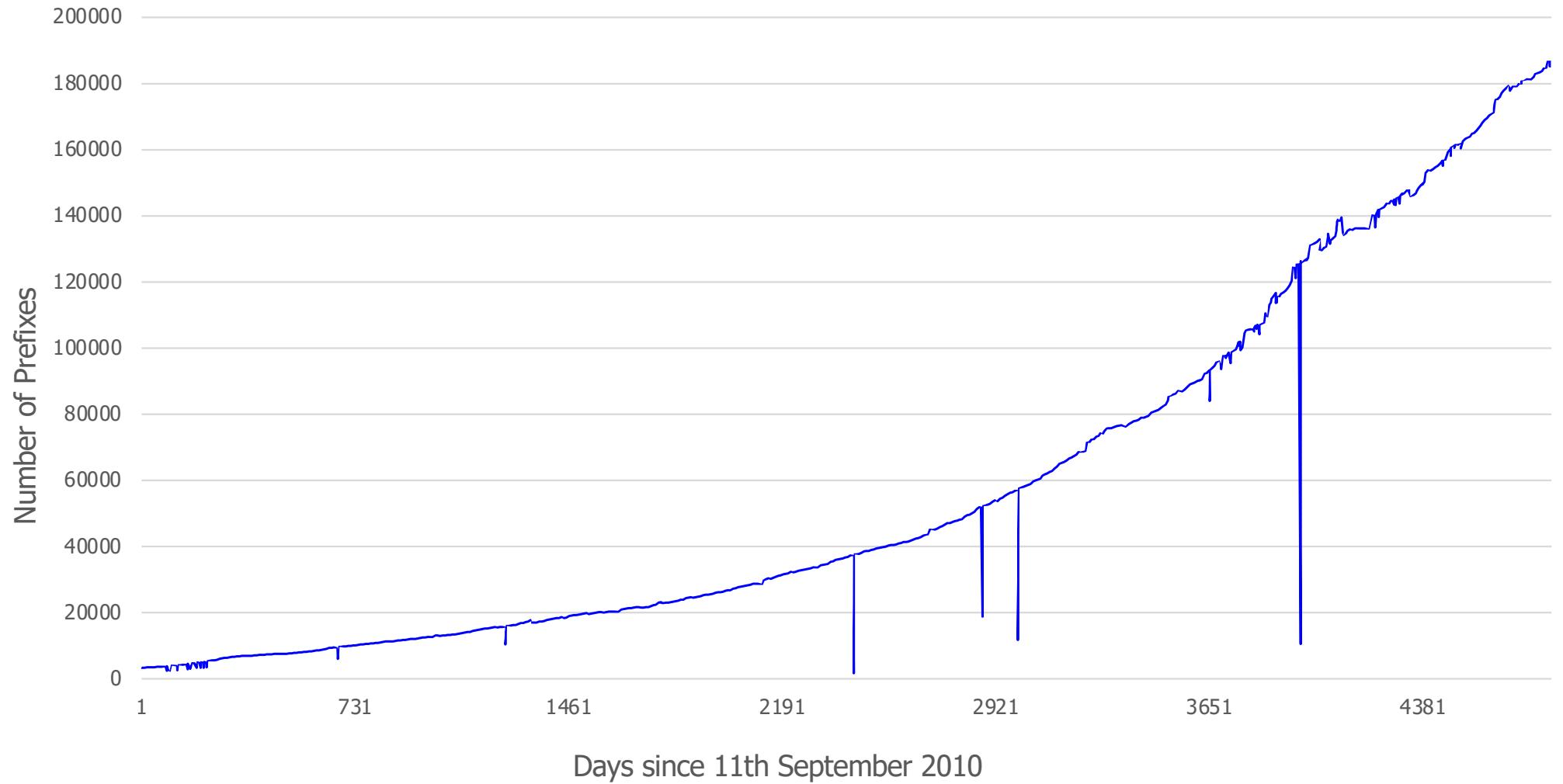
25th November 2022↓

/16:1	/17:0	/18:0	/19:1	/20:16	/21:3	/22:7	/23:8
/24:29	/25:8	/26:15	/27:20	/28:196	/29:4318	/30:630	/31:282
/32:22629	/33:2870	/34:2450	/35:993	/36:5810	/37:852	/38:1564	/39:1076
/40:12835	/41:905	/42:2309	/43:1005	/44:14010	/45:1544	/46:3183	/47:2805
/48:76296	/49:0	/50:0	/51:0	/52:0	/53:0	/54:0	/55:0
/56:0	/57:0	/58:0	/59:0	/60:0	/61:0	/62:0	/63:0
/64:0							

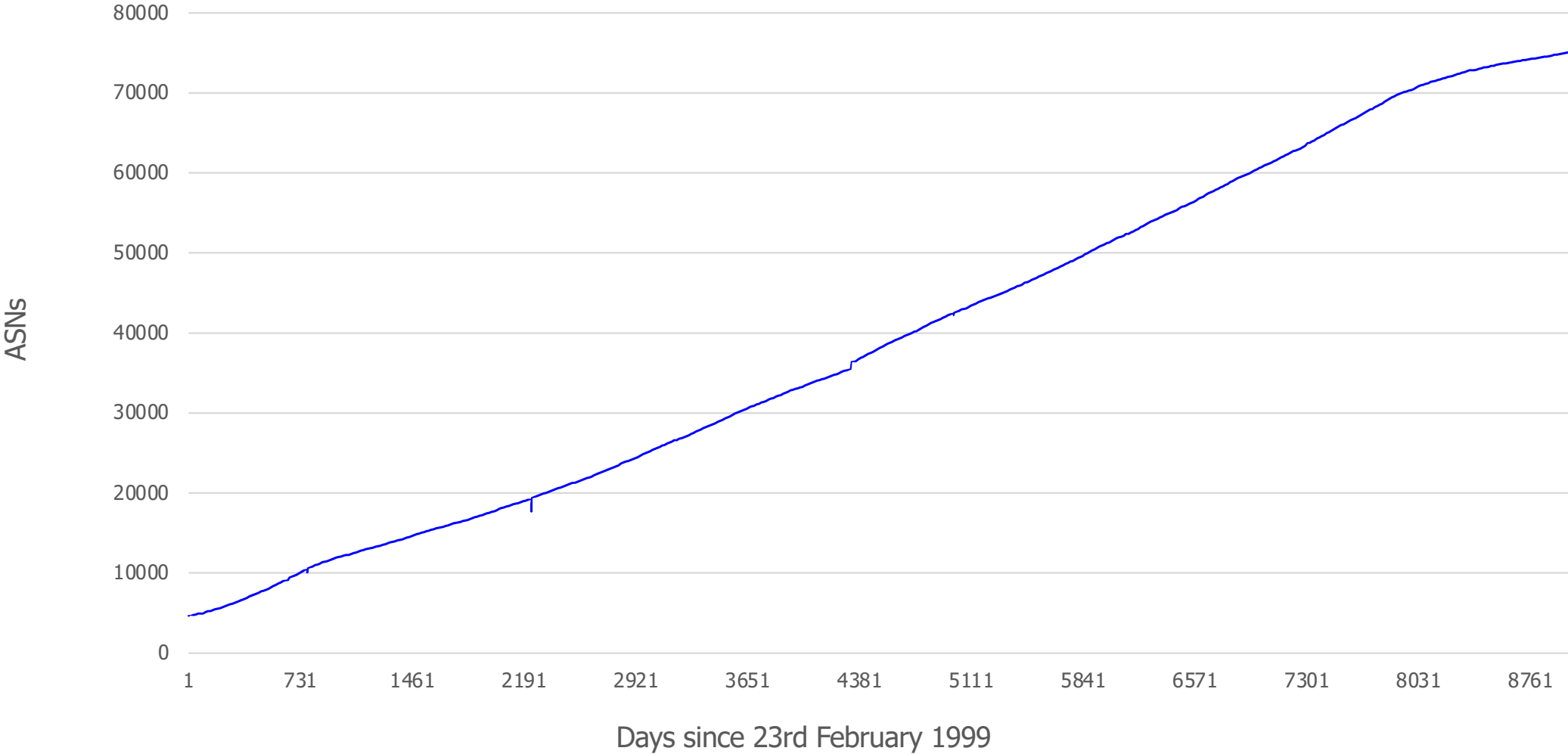
Global IPv4 Routing Table



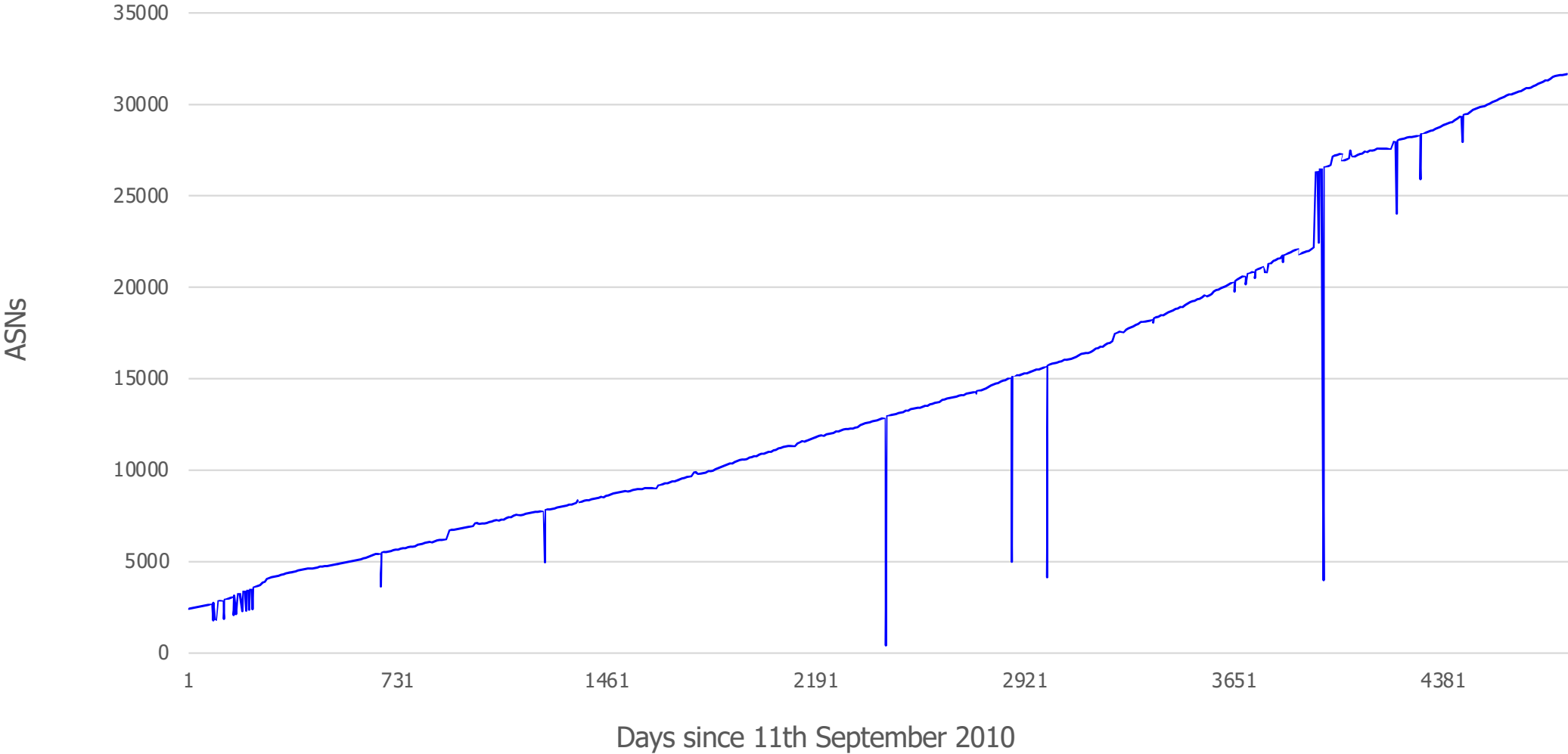
Global IPv6 Routing Table



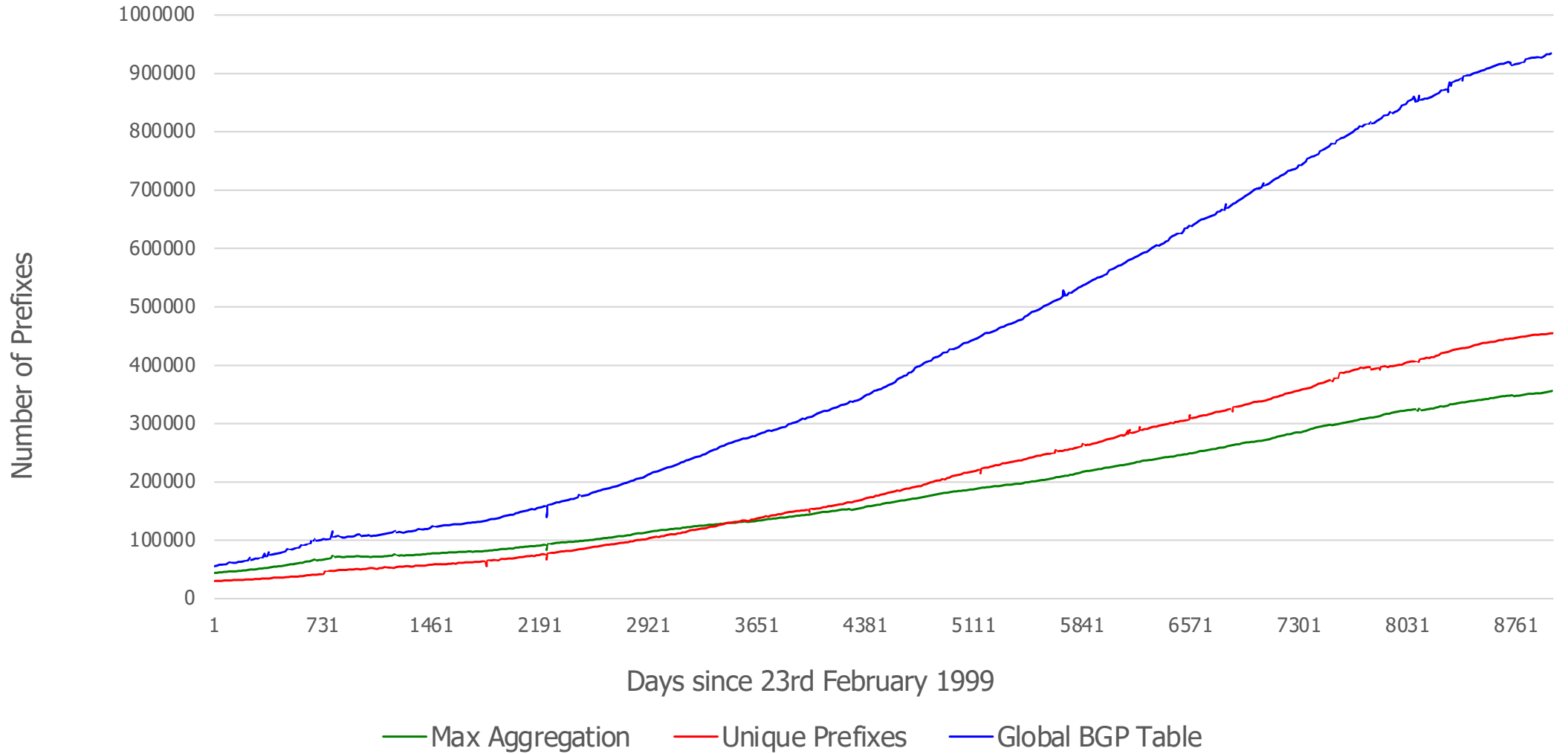
IPv4 AS Growth



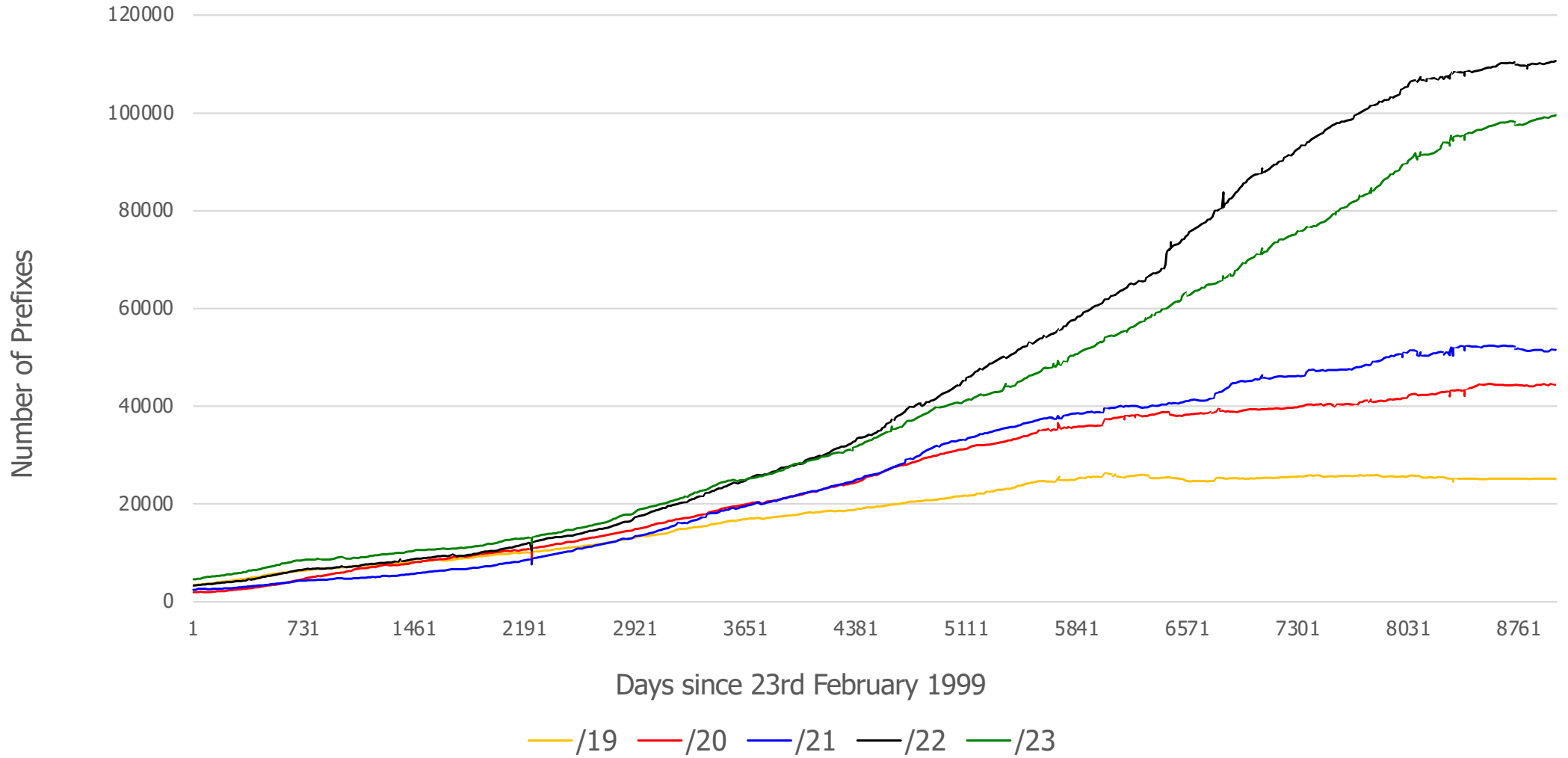
IPv6 AS Growth



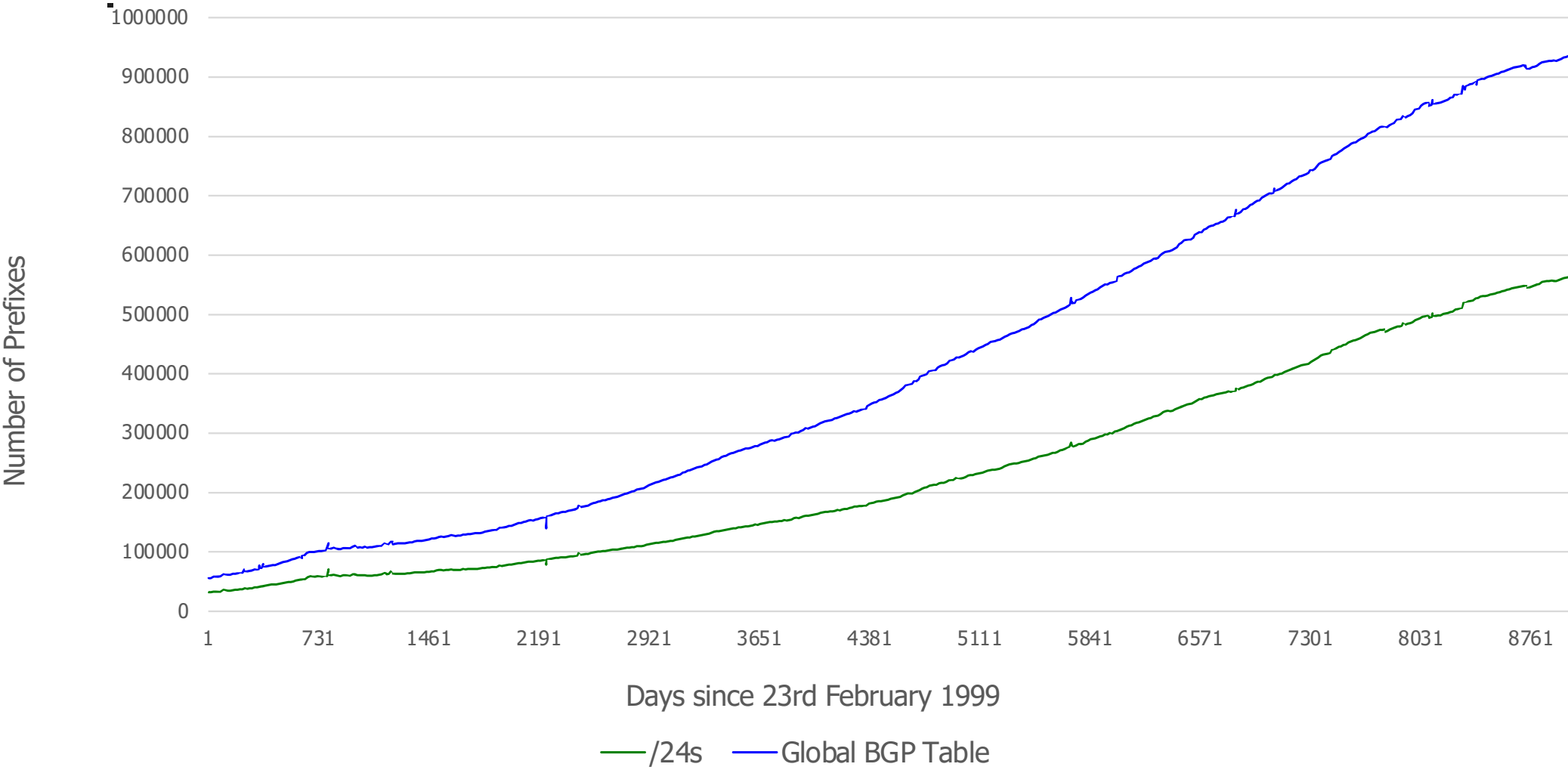
IPv4 Max Aggregation vs Unique Prefixes



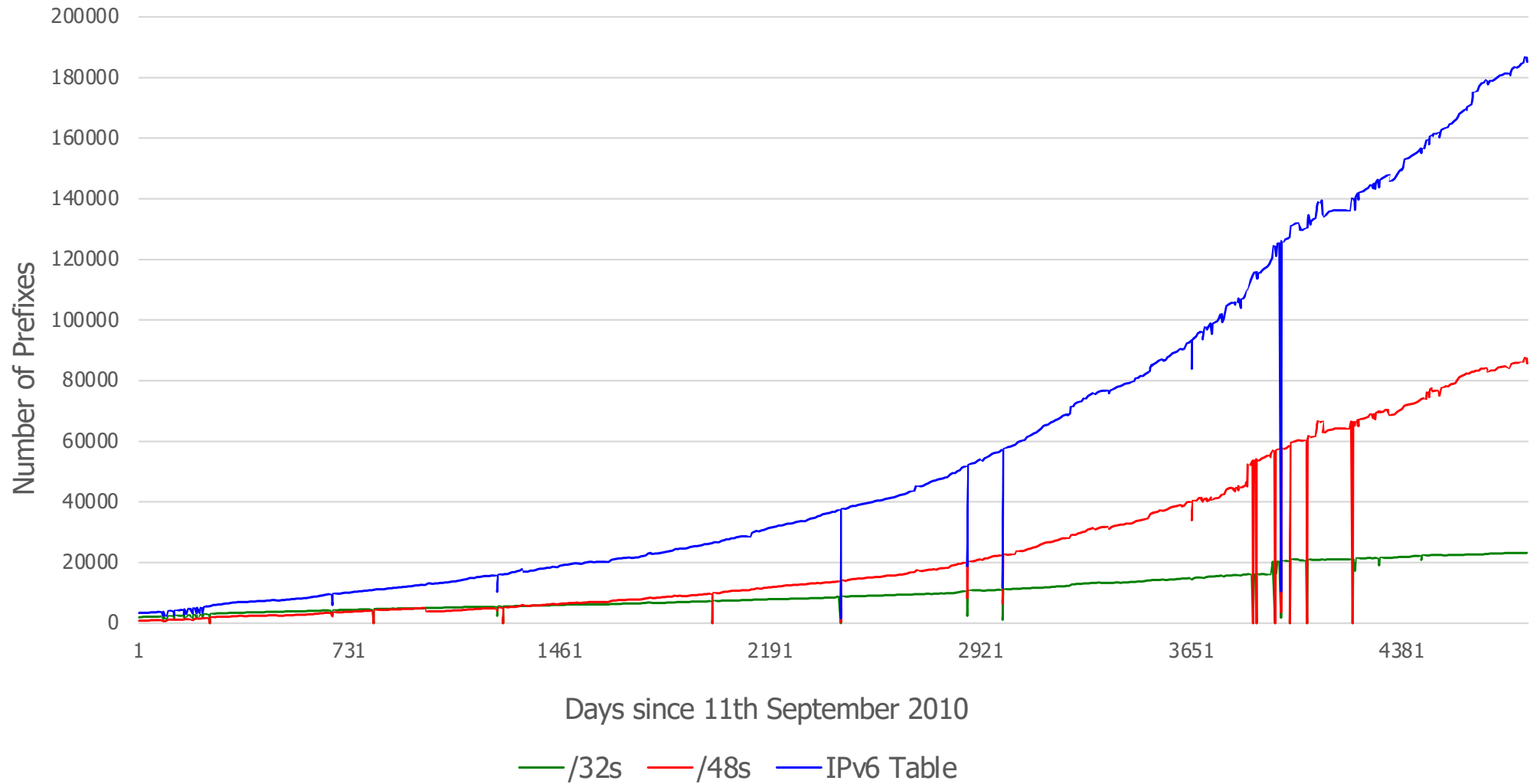
IPv4 Prefix sizes announced



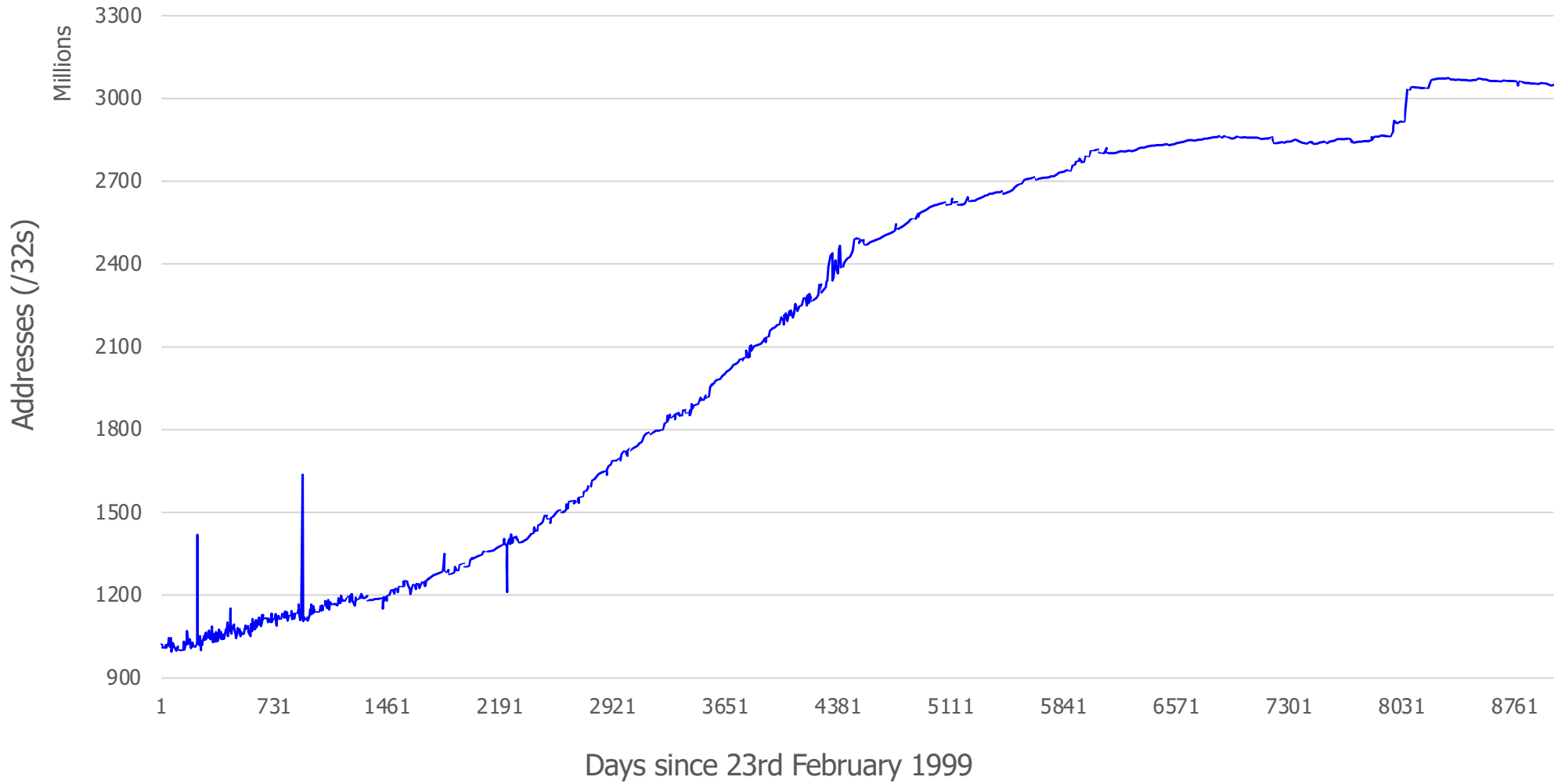
IPv4 /24s announced



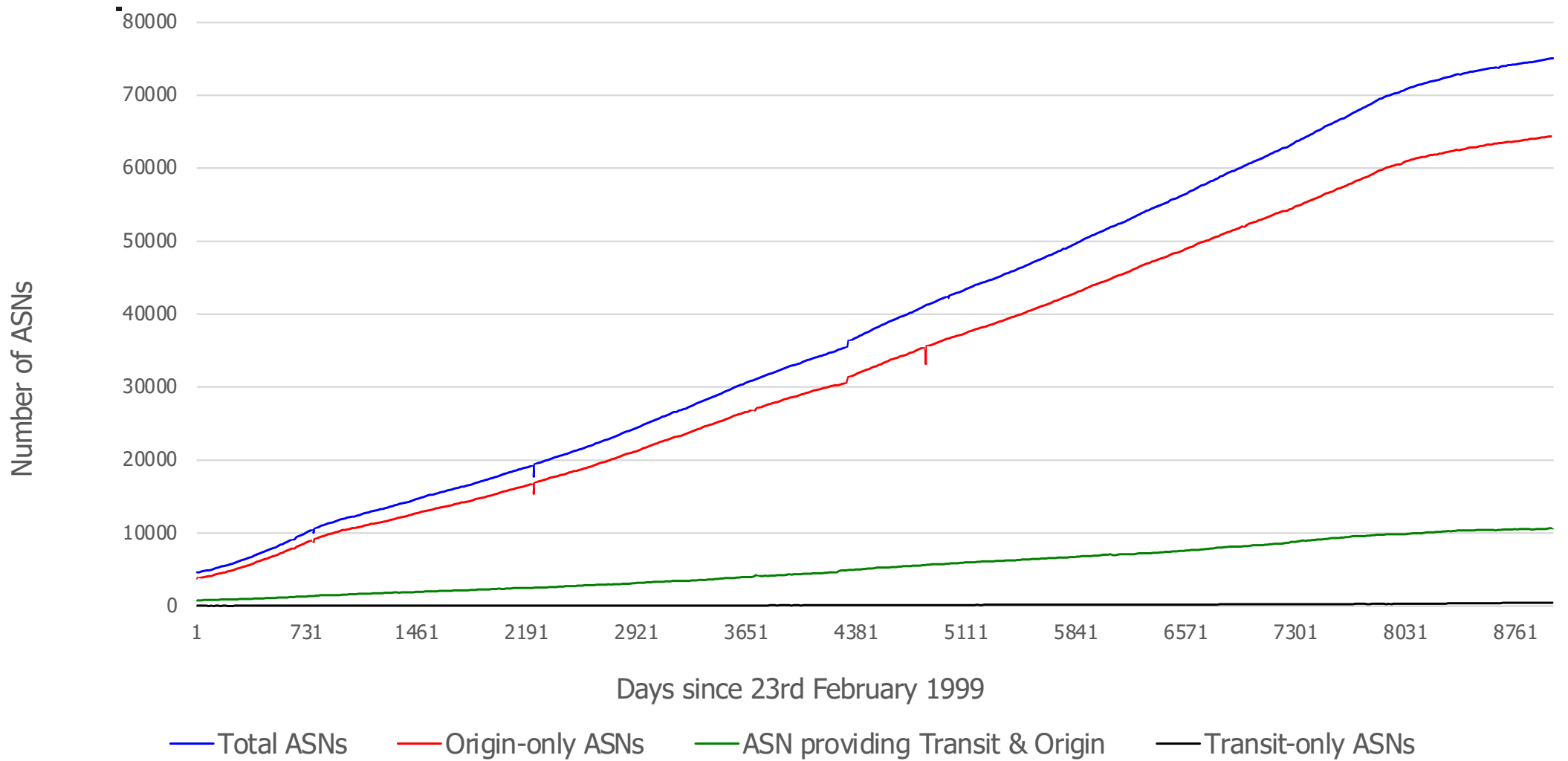
IPv6 /32s vs /48s



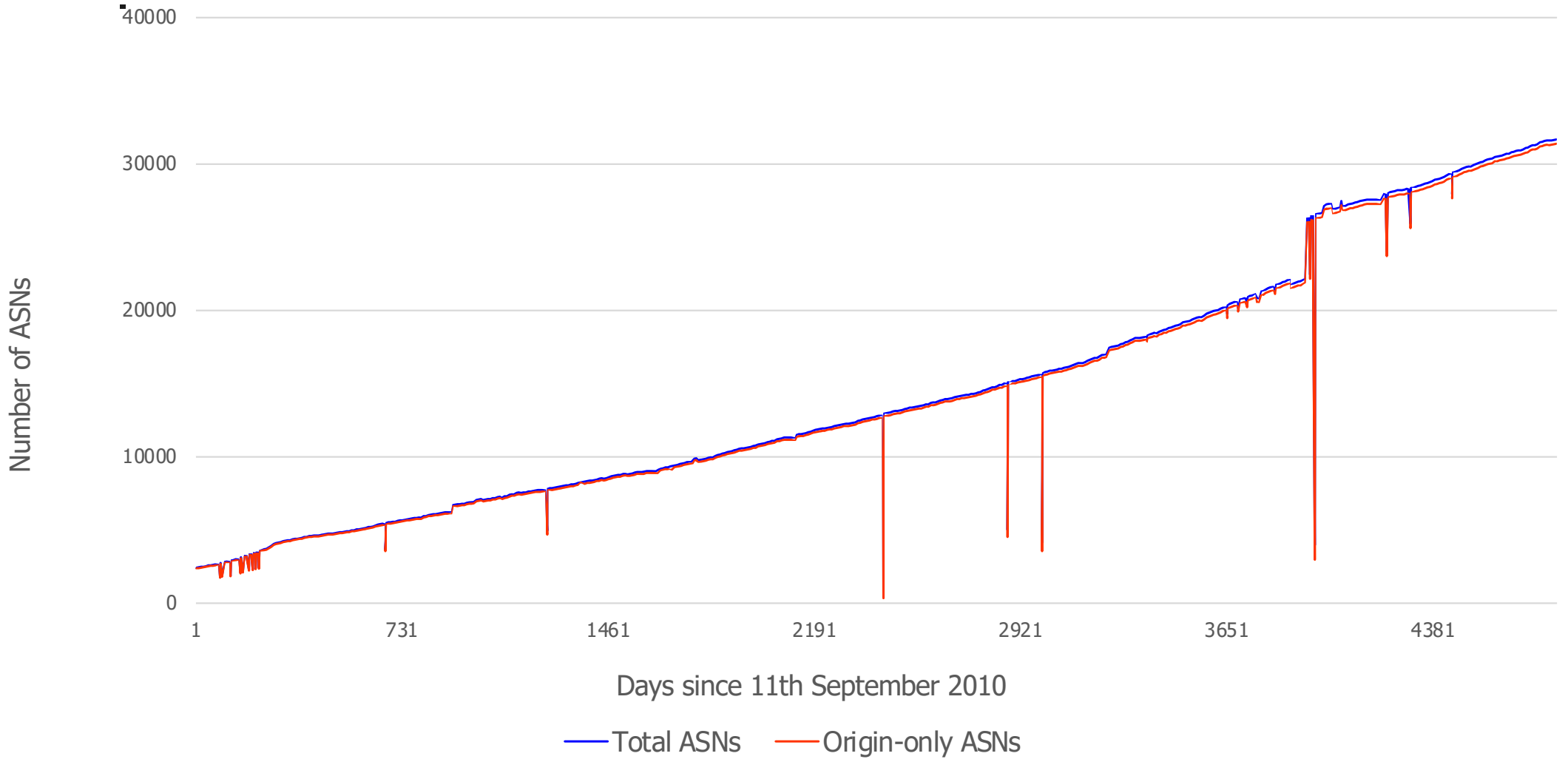
IPv4 Address Space announced



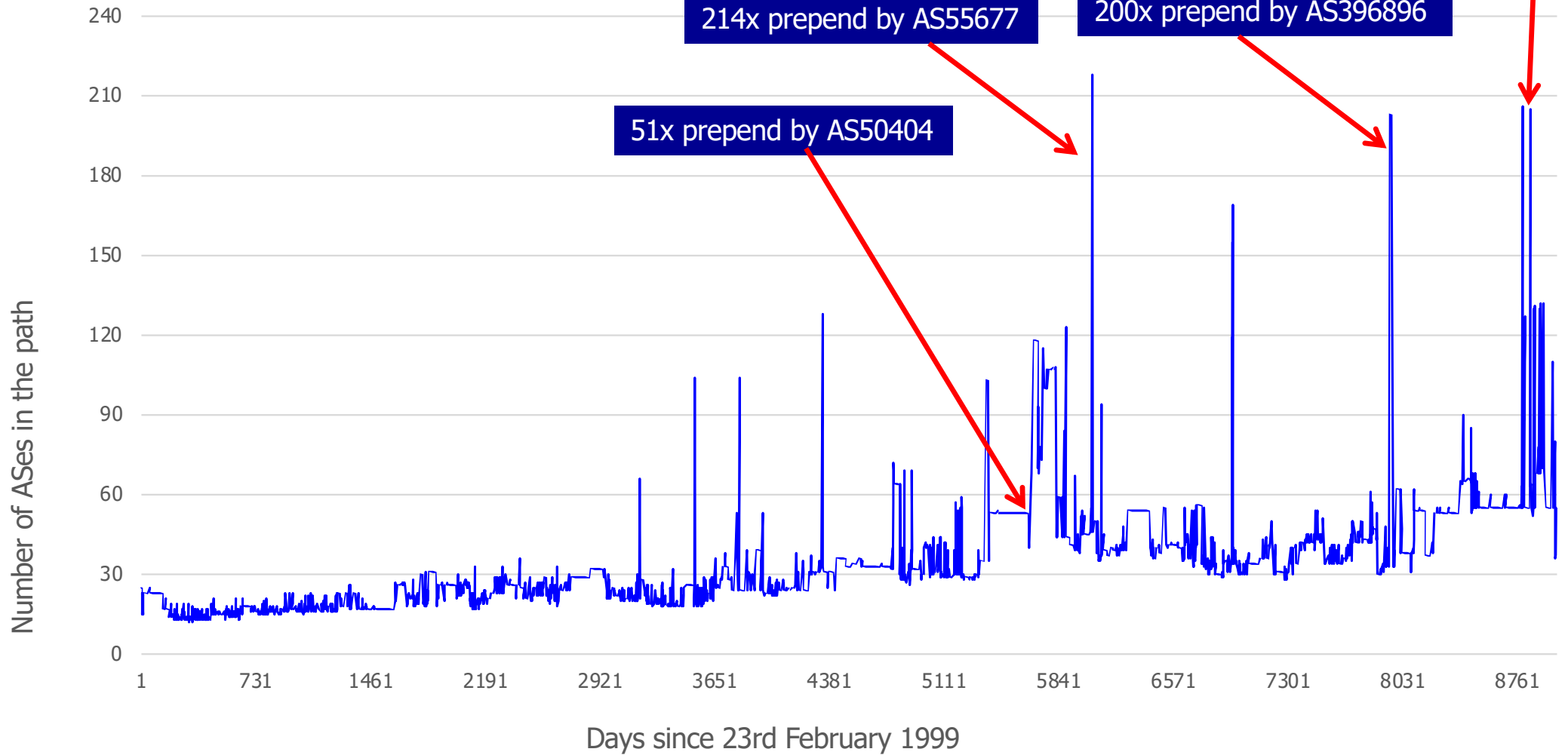
IPv4 AS Announcements



IPv6 AS Announcements



Maximum AS Path Length





Looking at Deaggregation in IPv4

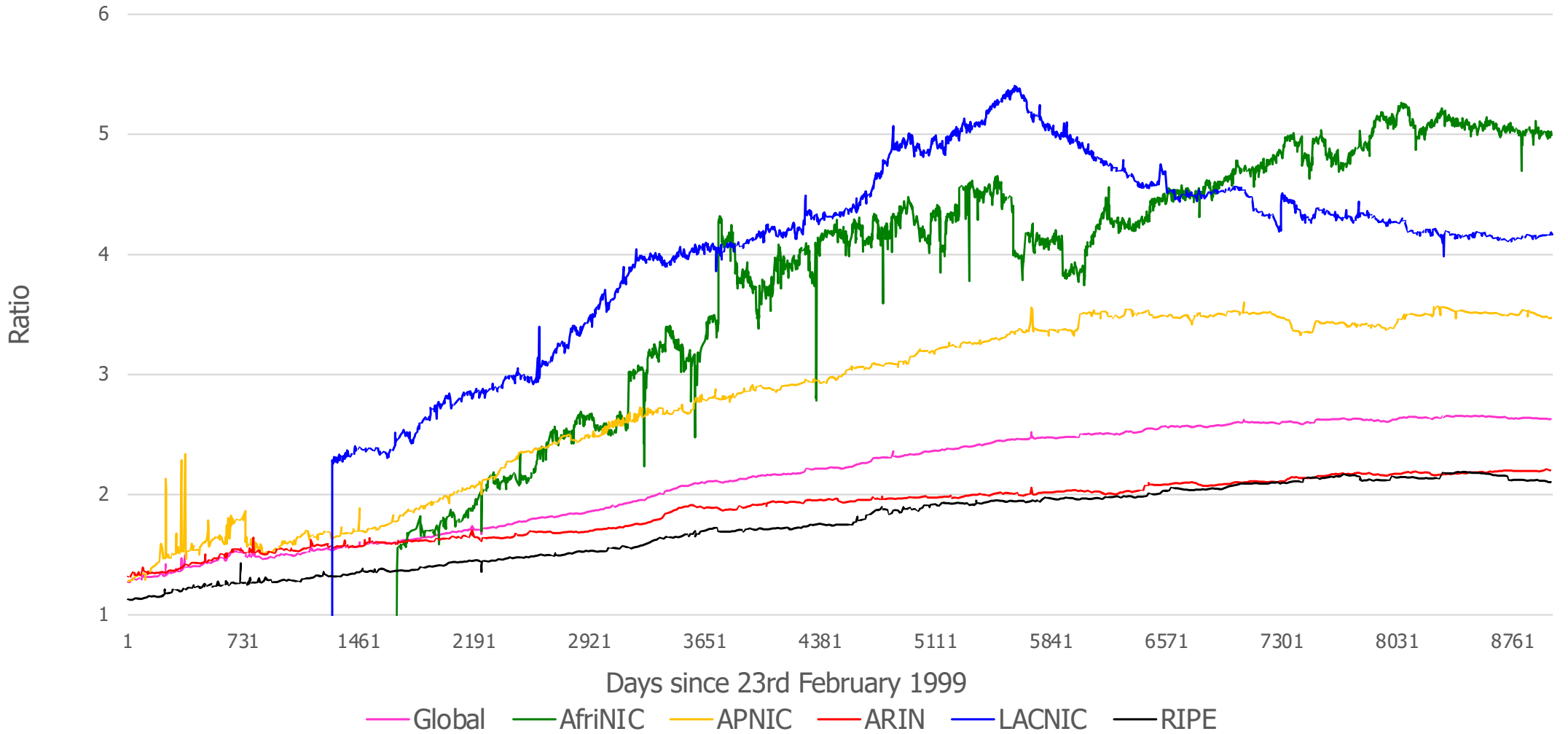
- Routing Report
 - One summary takes BGP table and aggregates prefixes by origin AS
 - Called “Max Aggregation” in report
 - Global and per RIR basis
 - <http://thyme.apnic.net/current/>
- Calculates **Deaggregation** Factor:
 - Measure of Routing Table size/Aggregated Size
 - Global value has been increasing slowly and steadily since “records began”



November 2023

- **Total Prefixes**
- Global BGP Table
 - 936k prefixes
- North America
 - 274k prefixes
- Europe & Middle East
 - 262k prefixes
- Asia & Pacific
 - 249k prefixes
- Latin America & Caribbean
 - 120k prefixes
- Africa
 - 30k prefixes
- **Deaggregation Factor**
- Global Average
 - 2.63
- North America
 - 2.20
- Europe & Middle East
 - 2.10
- Asia & Pacific
 - 3.47
- Latin America & Caribbean
 - 4.16
- Africa
 - 5.00

Deaggregation: RIR Regions vs Global



Asia Pacific Aggregation Savings Summary

ASN	No of Nets	Savings	Description
9808	9751	9707	CHINAMOBILE-CN China Mobile Communications Grou
7545	5686	4989	TPG-INTERNET-AP TPG Telecom Limited, AU
4538	4918	4843	ERX-CERNET-BKB China Education and Research Net
18403	4333	4308	FPT-AS-AP FPT Telecom Company, VN
7713	3600	3530	TELKOMNET-AS-AP PT Telekomunikasi Indonesia, ID
45899	3264	3165	VNPT-AS-VN VNPT Corp, VN
9498	3381	3134	BBIL-AP BHARTI Airtel Ltd., IN
7552	2987	2967	VIETEL-AS-AP Viettel Group, VN
24560	2616	2251	AIRTELBROADBAND-AS-AP Bharti Airtel Ltd., Telem
45090	2185	2106	TENCENT-NET-AP Shenzhen Tencent Computer System
4755	2191	1992	TATACOMM-AS TATA Communications formerly VSNL i
23969	1952	1936	TOT-NET TOT Public Company Limited, TH
9829	1940	1901	BSNL-NIB National Internet Backbone, IN
4766	2484	1899	KIXS-AS-KR Korea Telecom, KR
45609	1899	1554	BHARTI-MOBILITY-AS-AP Bharti Airtel Ltd. AS for
56047	1503	1469	CMNET-HUNAN-AP China Mobile communications corp
56041	1480	1409	CMNET-ZHEJIANG-AP China Mobile communications c
56046	1485	1385	CMNET-JIANGSU-AP China Mobile communications co
9583	1787	1215	SIFY-AS-IN Sify Limited, IN
17557	1244	1211	PKTELECOM-AS-PK Pakistan Telecommunication Comp

<http://thyme.apnic.net/current/data-CIDRnet-APNIC>

Papua New Guinea Aggregation Savings Summary

ASN	No of Nets	Savings	Description
55792	44	41	DATEC-PNG-AS-AP Datec-PNG, PG
58460	50	36	DIGICELPNG-AS-AP Digicel PNG Ltd, PG
38009	21	19	TELIKOM-PNG-AS-AP Telikom PNG Satellite Tier 1
139898	13	8	DCL-AS-AP Digitec Communications Limited, PG
134151	6	5	STC-AS-AP Steamships Ltd, PG
63945	6	4	DIGITECPNG-AS-AP Digitec PNG Limited, PG
133137	4	3	BEMOBILEPNG-AS-AP Bemobile LTD, PG
17828	8	2	PNGDATACOLIMITED-AS-PG PNG DATACO LTD, PG
136239	4	2	CLICKPACIFICLTD-AS-AP CLICK PACIFIC LTD, PG
136587	4	1	PNGDATACOLIMITED-AS-AP PNG DATACO LIMITED, PG
45924	3	1	GLOBAL-AS-AP Global Technologies Limited, PG
136940	2	1	COMSATLTD-AS-AP ComSat Ltd, PG
138519	2	1	EXCITE-AS-AP Excite Limited, PG

New Caledonia Aggregation Savings Summary

ASN	No of Nets	Savings	Description
18200	16	9	OPT-NC-AS-AP Office des Postes et Telecommunica
136402	3	2	NTL-NC-AS-AP Nautile SARL, NC
17480	8	1	CANL CANL, NC
45461	4	1	TELENET-AS-AP TeleNet, NC
134405	3	1	DATASERVICESPACIFIC-AS-AP Data Services Pacific

Fiji Aggregation Savings Summary

ASN	No of Nets	Savings	Description
4638	83	70	IS-FJ-AS Telecom Fiji Limited, FJ
141470	7	6	GOVNET-AS-AP ITC Services, FJ
45355	10	2	DIGICELPACIFIC-1-AP Digicel Fiji Limited, FJ
45349	4	1	TFL-AS-AP Telecom Fiji Ltd, FJ

Solomon Islands Aggregation Savings Summary

ASN	No of Nets	Savings	Description
45891	22	20	SBT-AS-AP Solomon Telekom Co Ltd, SB
132468	9	3	SATSOL-NET-SB SATSOL LIMITED, SB
132462	4	3	BEMOBILESI-AS-AP Bemobile Solomon Islands Ltd,
139609	2	1	SISCC-AS-AP Solomon Islands Submarine Cable Com

Vanuatu Aggregation Savings Summary

ASN	No of Nets	Savings	Description
9249	34	30	VUTELECOM-AS01-VU-AP Telecom Vanuatu Limited, V
45935	11	7	WNL-AS-AP Wantok Network Limited, VU
43357	12	4	OWL Owl Limited, VU
132254	2	1	PRIMADC-AS-AP PRIMA DC LIMITED, VU

Federated States of Micronesia Aggregation Savings Summary

ASN	No of Nets	Savings	Description
38875	5	2	AS38875 FSM Telecommunications Corporation, FM
45193	5	2	AS45193 FSM Telecommunications Corporation, FM
58524	4	2	AS58524 FSM Telecommunications Corporation, FM
139759	4	2	FMTELECOM-AS-AP FSM Telecommunications Corporat

French Polynesia Aggregation Savings Summary

ASN	No of Nets	Savings	Description
9471	207	199	ONATI-AS-AP ONATI, PF
56017	21	18	VITI-AS-PF VITI, PF
138179	12	6	PMT-AS-AP PACIFIC MOBILE TELECOM, PF
55943	9	5	ONATI-AS-AP ONATI, PF

Palau Aggregation Savings Summary

ASN	No of Nets	Savings	Description
17893	5	3	PALAU-AS-AP Palau National Communications Corp.
58932	2	1	PMCI-AS-AP Palau Mobile Communications Inc., PW
133897	2	1	PEACCDPT-AS-AP Palau Equipment Co. Inc., PW

Samoa Aggregation Savings Summary

ASN	No of Nets	Savings	Description
17993	38	35	VODAFONESAMOA-AS-AP Vodafone Samoa Limited, WS
38800	6	1	DIGICELSAMOA-WS-AS-AP Digicel Samoa Ltd, WS
38227	3	1	CSLSAMOA-WS-AS-AP Computer Services Limited CSL

Tonga Aggregation Savings Summary

ASN	No of Nets	Savings	Description
38201	8	1	KALIANET-PUBLIC-AS-AP Tonga Communications Inte
132831	7	2	EZINET-AS-AP EziNET Limited, TO
38198	4	3	DIGICELNET-TO Digicel Tonga Ltd, TO

Guam Aggregation Savings Summary

ASN	No of Nets	Savings	Description
9246	11	3	GTA-AP Teleguam Holdings, LLC, GU
3605	10	1	ERX-KUENTOS-AS Guam Cablevision, LLC., GU
395400	5	3	UNIVERSITY-GUAM, GU

Nauru Aggregation Savings Summary

ASN	No of Nets	Savings	Description
55722	4	3	CENPAC-AS-AP Cenpac Net Inc, NR
141368	3	2	ICT-NR-AS-AP ICT, NR

Tokelau Aggregation Savings Summary

ASN	No of Nets	Savings	Description
57382	2	1	TK1, TK
198147	2	1	TK2, TK

American Samoa Aggregation Savings Summary

ASN	No of Nets	Savings	Description
23657	41	36	BLUESKY-AS-AP Blue Sky Communications, AS
9751	19	6	ASTCA-AS-AP AMERICAN SAMOA TELECOMMUNICATIONS A

Kiribati Aggregation Savings Summary

ASN	No of Nets	Savings	Description
134783	12	9	ATHKL-AS-AP Amalgamated Telecom Holdings Kiriba
132486	3	2	OCEANLINKLTD-AS-AP OCEAN LINK LTD, KI

Tuvalu Aggregation Savings Summary

ASN	No of Nets	Savings	Description
23917	6	1	TUVALU-TELECOM-AS-AP Tuvalu Telecom, TV

Wallis & Fotuna Aggregation Savings Summary

ASN	No of Nets	Savings	Description
45879	14	11	OWF-AS-AP Orange Wallis & Futuna, WF

Northern Marianas Aggregation Savings Summary

ASN	No of Nets	Savings	Description
7131	82	66	PTIPACIFICAINC-AS-AP PTI Pacifica Inc., MP

Cook Islands Aggregation Savings Summary

ASN	No of Nets	Savings	Description
10131	35	34	CKTELECOM-CK-AP Telecom Cook Islands, CK

Niue Aggregation Savings Summary

ASN	No of Nets	Savings	Description
55885	5	4	ISP-NU No. 1 Commercial Center, NU



IPv4 Observations

- Routing table continues to grow
 - Linear growth for last 8 years
 - Even though total address space announced has levelled off over the last 3 years
- /24 announcements continue to grow
 - Clearly many operators are deaggregating down to the smallest prefix size considered routable
 - Do operators still filter prefix sizes smaller than /24?
 - (A few /25s through /32s are visible)
- Overall global deaggregation ratio growth has slowed
 - Significant improvements in Latin America



IPv6 Observations

- Routing table growth has continued in 2023
 - How to interpret this?
- /48 announcements continue to grow rapidly
 - Operators seem to believe that IPv6 /48 needs to be treated like IPv4 /24 🙄😞
- Noticeable increases:
 - According to RIR allocation boundaries
 - Along nibble boundaries



Internet Routing Table Analysis Update

Questions?