Internet Routing Table Analysis Update

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SANOG 38

22nd July 2022

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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 11th July 2022

BGP routing table entries examined:	902815
Prefixes after maximum aggregation (per Origin AS):	340343
Deaggregation factor:	2.65
Unique aggregates announced (without unneeded subnets):	436338
Total ASes present in the Internet Routing Table:	73378
Prefixes per ASN:	12.30
Origin-only ASes present in the Internet Routing Table:	62965
Origin ASes announcing only one prefix:	25896
Transit ASes present in the Internet Routing Table:	10413
Transit-only ASes present in the Internet Routing Table:	395
Average AS path length visible in the Internet Routing Table:	4.3
Max AS path length visible:	61
Max AS path prepend of ASN (37447)	57
Prefixes from unregistered ASNs in the Routing Table:	995
Number of instances of unregistered ASNs:	1001
Special use prefixes present in the Routing Table:	1
Prefixes being announced from unallocated address space:	514
Number of addresses announced to Internet:	3067942784
Equivalent to 182 /8s, 221 /16s and 23 /24s	
Total number of prefixes smaller than registry allocations:	306700

APNIC Region

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Prefixes being announced by APNIC Region ASes:                    235536
    Total APNIC prefixes after maximum aggregation:                66972
    APNIC Deaggregation factor:                                     3.52
Prefixes being announced from the APNIC address blocks:           230653
    Unique aggregates announced from the APNIC address blocks:     95583
APNIC Region origin ASes present in the Internet Routing Table:    12763
    APNIC Prefixes per ASN:                                        18.07
APNIC Region origin ASes announcing only one prefix:                3686
APNIC Region transit ASes present in the Internet Routing Table:    1741
Average APNIC Region AS path length visible:                         4.7
    Max APNIC Region AS path length visible:                          25
Number of APNIC region 32-bit ASNs visible in the Routing Table:    7977
Number of APNIC addresses announced to Internet:              773037568
                Equivalent to 46 /8s, 19 /16s and 158 /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, 131072-147769

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
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Global per AS IPv4 prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
8151	8535	3443	592	Uninet S.A. de C.V., MX
9808	7570	9000	58	CMNET-GD Guangdong Mobile Communication
12479	6723	1721	140	UNI2-AS, ES
7545	5788	783	678	TPG-INTERNET-AP TPG Telecom Limited, AU
16509	5205	9529	2322	AMAZON-02, US
11492	4791	316	669	CABLEONE, US
4538	4765	4192	74	ERX-CERNET-BKB China Education and Rese
7155	4027	264	32	VIASAT-SP-BACKBONE, US
22773	3961	3013	262	ASN-CXA-ALL-CCI-22773-RDC, US
20940	3662	3347	206	AKAMAI-ASN1, NL
7552	3545	1330	20	VIETEL-AS-AP Viettel Group, VN
7713	3528	1023	56	TELKOMNET-AS-AP PT Telekomunikasi Indon
16625	3505	1811	2442	AKAMAI-AS, US
10620	3406	525	650	Telmex Colombia S.A., CO
6327	3360	1317	69	SHAW, CA
39891	3267	187	22	ALJAWWALSTC-AS, SA
8551	2997	378	40	BEZEQ-INTERNATIONAL-AS Bezeqint Interne
12389	2907	2281	894	ROSTELECOM-AS, RU
45899	2800	1897	55	VNPT-AS-VN VNPT Corp, VN
30036	2579	372	134	MEDIACOM-ENTERPRISE-BUSINESS, US

AfriNIC APNIC ARIN LACNIC RIPE NCC

What about IPv6 ?

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IPv6 Routing Report   10th July 2022 (London)

BGP routing table entries examined:                                147084
    Number of IPv6 prefixes with a valid ROA:                       62542
    Number of IPv6 prefixes with an invalid ROA:                      601
    Number of IPv6 prefixes with no ROA:                            83941
Total ASNs present in the IPv6 Routing Table:                       28447
    Average AS path length:                                           4.2
    Longest AS path:                                                   38
Total Origin ASNs present in the IPv6 Routing Table:                28145
Paths with bogon ASNs present in the IPv6 Routing Table:                4
```

Global IPv6 per AS prefix count summary (London)

ASN	No of Nets	Description
11172	3869	Alestra, S. de R.L. de C.V., MX
17622	2380	CNCGROUP-GZ China Unicom Guangzhou network, CN
16509	2278	AMAZON-02, US
45609	2265	BHARTI-MOBILITY-AS-AP Bharti Airtel Ltd. AS for GPRS Service
7552	2167	VIETEL-AS-AP Viettel Group, VN
45271	1810	ICLNET-AS-AP Idea Cellular Limited, IN
9808	1721	CHINAMOBILE-CN China Mobile Communications Group Co., Ltd.,
24547	1620	CMNET-V4HEBEI-AS-AP Hebei Mobile Communication Company Limit
12479	1607	UNI2-AS, ES
28573	1486	Claro NXT Telecomunicacoes Ltda, BR
17623	1438	CNCGROUP-SZ China Unicom Shenzen network, CN
36183	1341	AKAMAI-AS, US
39891	1272	ALJAWWALSTC-AS, SA
22773	1245	ASN-CXA-ALL-CCI-22773-RDC, US
32098	1129	TRANSTELCO-INC, US
62240	1116	CLOUVIDER Clouvider - Global ASN, GB
56046	1093	CMNET-JIANGSU-AP China Mobile communications corporation, CN
38266	1072	VODAFONE-IN Vodafone India Ltd., IN
13335	1052	CLOUDFLARENET, US
17072	972	TOTAL PLAY TELECOMUNICACIONES SA DE CV, MX

AfriNIC APNIC ARIN LACNIC RIPE NCC

Non-routable ASNs for IPv6

List of Unregistered Origin ASNs

Bad AS	Designation	Net Originated	Transit AS	Transit AS Name
65206	PRIVATE	2001:f40:11::/48	9930	TTNET-MY, MY
65540	DOCUMENT	2a0c:a641::/32	42298	GCC-MPLS-peering, QR

```
    Network            Path
N*> 2001:948::/29      17660 2603 {1653,39590,64530,64540,64541,65002,65003,65004,65005,65006,65007,65008,65009,65010,65430}
I*> 2001:f40:11::/48   17660 9930 65206
N*> 2a0a:bcc0::/29     17660 2603 1653 41001 {64600,65001,65002,65501,65502}
N*> 2a0c:a641::/32     17660 6453 3257 8781 42298 65540
```

Deprecated AS Set

- Use of BGP AS Set is not recommended
  - RFC6472/BCP172 (December 2011)
  - Still some in both IPv4 and IPv6 BGP tables
  - IPv4 has 323 entries
  - IPv6 has 36 entries

IPv4 Prefixes using Deprecated AS_SET

Net Originated	AS Path
15.36.64.0/18	17660 2687 25888 {21326}
20.133.40.0/21	17660 6453 3356 22562 {17916}
20.137.0.0/21	17660 6453 3356 21877 {4237}
20.137.160.0/20	17660 6453 3356 206 {4237}
20.137.176.0/20	17660 6453 3356 21877 {4237}
20.137.240.0/20	17660 6453 3356 21877 {4237}
20.148.32.0/19	17660 6453 3356 21877 {4237}
23.56.208.0/24	17660 2914 20940 {12222}
23.200.20.0/24	17660 6453 3257 20940 20940 {12222}
37.52.0.0/14	17660 1299 6849 {6877}
37.142.0.0/17	17660 1299 8657 12849 {21450}
37.142.128.0/17	17660 1299 8657 12849 {21450}
37.221.128.0/19	17660 1299 25291 3255 {62384}
41.196.34.0/23	17660 6453 5511 24863 {37069}
41.215.160.0/20	17660 6453 174 37613 37030 {37140}
41.215.160.0/21	17660 2914 6453 37282 37030 {37140}
41.215.162.0/24	17660 6453 174 37613 37030 {37140}
41.215.168.0/21	17660 6453 37282 37030 {37140}
45.40.128.0/20	17660 1299 26496 {398101}
45.40.132.0/22	17660 1299 26496 {398101}
45.40.140.0/22	17660 1299 26496 {398101}
45.40.160.0/22	17660 1299 26496 {398101}
45.89.32.0/22	17660 6453 3356 35913 35913 35913 35913 35913 35913 35913 35913 {10912,12189,19437,29791}
46.200.0.0/14	17660 1299 6849 {6877}
49.231.25.0/24	17660 45430 45458 {132681}
50.62.0.0/20	17660 1299 26496 {398101}
50.62.4.0/22	17660 1299 26496 {398101}
...	
216.221.212.0/22	17660 6453 3356 26585 26585 {26585}
216.221.220.0/22	17660 6453 3356 26585 26585 {26585}
217.24.112.0/20	17660 1299 12389 {28860}
217.25.32.0/20	17660 2119 25146 41943 {41943}
217.27.240.0/20	17660 2914 29006 {36483}
217.112.32.0/20	17660 1299 20485 40966 40966 40966 40966 {30943}
217.114.48.0/20	17660 1299 25460 25460 {30847}
217.168.16.0/20	17660 2914 29006 {36483}

IPv6 Prefixes using Deprecated AS_SET

Net Originated	AS Path
2001:410::/32	17660 1299 2603 2603 2603 6509 {271,7860,8111,10972,53904}
2001:510::/32	17660 2914 6453 376 {36786}
2001:6d0:8000::/48	17660 1299 20485 8985 {42385}
2001:948::/29	17660 2603 {1653,39590,64530,64540,64541,65002,65003,65004,65005,65006,65007,65008,65009,65010,65430}
2001:1208::/32	17660 1299 8151 {3905}
2001:4220::/32	17660 6453 1299 1273 24835 {36935}
2001:4220::/33	17660 6453 1299 1273 24835 {36935}
2400:5200:402::/48	17660 6939 4637 55410 {16625}
2402:7500::/32	17660 2914 3491 9924 {24158}
2404:c000::/32	17660 2914 6453 7473 45147 {7713,9002,16625,17727,23693,55818}
2404:c000::/33	17660 2914 6453 7473 45147 {16625,55818}
2600:140f:d400::/48	17660 6939 4637 55410 {16625}
2604:7ac0:e00::/40	17660 2914 3356 12213 {29802}
2606:b400:8814::/48	17660 2914 3356 7160 {7160}
2607:f390::/32	17660 6453 174 32440 {2055,17244}
2607:f7a8:600::/39	17660 2914 3356 46887 {397488}
2607:f7a8:800::/39	17660 2914 3356 46887 {395749}
2607:f7a8:c00::/39	17660 2914 3356 46887 {21687}
2607:f7b8::/32	17660 1299 10490 {2637}
2800:480::/32	17660 1299 14080 14080 14080 14080 14080 14080 14080 14080 14080 14080 14080 14080 {264718}
2800:482::/32	17660 2914 6453 14080 14080 14080 14080 14080 14080 {10620}
2800:484::/32	17660 2914 6453 14080 {10620}
2800:485::/32	17660 2914 6453 14080 {10620}
2800:800:930::/48	17660 2914 3491 14080 {26611}
2800:800:940::/48	17660 2914 3491 14080 {26611}
2800:800:950::/48	17660 1299 14080 14080 14080 14080 14080 14080 14080 14080 14080 {26611}
2800:800:960::/48	17660 2914 3491 14080 {26611}
2803:3b80:4000::/36	17660 6453 6762 263702 263702 263702 {263702}
2806:1030::/32	17660 6453 8151 {20940}
2806:1070::/32	17660 6453 8151 {3905,20940}
2a00:6480::/32	17660 8365 35548 {29018}
2a01:1b0::/32	17660 1299 31477 31477 {51923}
2a01:6480:10::/48	17660 1299 29049 {199524}
2a02:ac00::/29	17660 2914 3356 6717 {6717}
2a03:f600::/32	17660 1299 3301 25146 {41943}
2a0a:bcc0::/29	17660 2603 1653 41001 {64600,65001,65002,65501,65502}

Unassigned resources

- Use of unassigned address space is rampant
  - Currently 512 unassigned prefixes in IPv4 routing table
- Use of unassigned ASNs is also a big problem
  - Currently 377 unassigned ASNs in use
- Many are transited by well known / reputable operators
  - Why??

List of Unregistered Origin ASNs

The complete list in use:

940, 1636, 3577, 4879, 6485, 6565, 7363, 10425, 10926, 10931, 10981, 11011, 11044, 11091, 11223, 11316, 11490, 11610, 11636, 11825, 11945, 11967, 11969, 11974, 12176, 12240, 13224, 13317, 13339, 13342, 13492, 13520, 13717, 13980, 14046, 14076, 14350, 14428, 14439, 14461, 14545, 14552, 14594, 14605, 14651, 14889, 15037, 15115, 15132, 15178, 15182, 15200, 15220, 15329, 15804, 16615, 16769, 16804, 16809, 17341, 18604, 18691, 18781, 18796, 18798, 18805, 18821, 18976, 19023, 19081, 19140, 19142, 19176, 19330, 19359, 19507, 19521, 19533, 19658, 19700, 19708, 20089, 20118, 20190, 20200, 20227, 20421, 20443, 20447, 21584, 21666, 21695, 21714, 21861, 21986, 22063, 22160, 22226, 22272, 22484, 22538, 22539, 22694, 22733, 22736, 22743, 22774, 22830, 23021, 23176, 23190, 23194, 23288, 23357, 23411, 23448, 23507, 23985, 25568, 25600, 25641, 25647, 25800, 25831, 25922, 25978, 26015, 26016, 26018, 26051, 26137, 26140, 26286, 26295, 26341, 26345, 26520, 26643, 26663, 26682, 26701, 26712, 26759, 26861, 26922, 26986, 27174, 27180, 27247, 27289, 27291, 27384, 27426, 27470, 28102, 29763, 29829, 29855, 29987, 30004, 30006, 30037, 30104, 30155, 30265, 30442, 30550, 30654, 30699, 31781, 31813, 32021, 32121, 32187, 32203, 32282, 32346, 32358, 32467, 32497, 32534, 32581, 32596, 32772, 32842, 33017, 33023, 33042, 33123, 33137, 33232, 33394, 33417, 33484, 33625, 33628, 33684, 33732, 35948, 36002, 36267, 36283, 36357, 36465, 36774, 36893, 36900, 36911, 36928, 36979, 37034, 37155, 37169, 37320, 37338, 37442, 37475, 37476, 37544, 37555, 37591, 37703, 38055, 39991, 40186, 40255, 40279, 40340, 40503, 40600, 40687, 40745, 40751, 40779, 40909, 40920, 44428, 45210, 46086, 46123, 46161, 46226, 46228, 46233, 46355, 46472, 46501, 46559, 46614, 46673, 46766, 46772, 46815, 46876, 46916, 47044, 47069, 47086, 50183, 52666, 52761, 53211, 53298, 53367, 53419, 53552, 53657, 53715, 53771, 53775, 53854, 53929, 53947, 54148, 54209, 54218, 54231, 54262, 54278, 54338, 54424, 54427, 54517, 54518, 54590, 54752, 54753, 54776, 54787, 55289, 56096, 62711, 62828, 63092, 63190, 63198, 63305, 63387, 63390, 63401, 64011, 64203, 64257, 64339, 64513, 64612, 65000, 65206, 65379, 65401, 65999, 133617, 134952, 138611, 139692, 140549, 141391, 141730, 227171, 261050, 263092, 264085, 264245, 264379, 264493, 265039, 268652, 269062, 269948, 327869, 327928, 327933, 328007, 328226, 328369, 393266, 393305, 393314, 393320, 393322, 393377, 393446, 393491, 393493, 393588, 393866, 394076, 394156, 394183, 394293, 394376, 394402, 394519, 394607, 394721, 394787, 394788, 394856, 394879, 394936, 394939, 395270, 395281, 395350, 395438, 395514, 395858, 395898, 396015, 396330, 396993, 397096, 397186, 397306, 398083, 398118, 398480

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
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	LIGHTOWER, US
18604	UNALLOCATED	8.25.204.0/24	3356	LEVEL3, US
394936	UNALLOCATED	8.33.224.0/24	22442	HOU-PHONOSCOPE, US
54338	UNALLOCATED	8.33.241.0/24	6461	ZAYO-6461, US
18798	UNALLOCATED	8.40.106.0/24	6461	ZAYO-6461, US
394856	UNALLOCATED	8.40.216.0/24	3356	LEVEL3, US
395438	UNALLOCATED	8.42.206.0/24	3356	LEVEL3, US
395281	UNALLOCATED	12.4.40.0/23	7018	ATT-INTERNET4, US
395281	UNALLOCATED	12.4.42.0/23	7018	ATT-INTERNET4, US
15132	UNALLOCATED	12.9.150.0/24	1239	SPRINTLINK, US
13342	UNALLOCATED	12.17.5.0/24	174	COGENT-174, US
3577	UNALLOCATED	12.19.197.0/24	209	CENTURYLINK-US-LEGACY-QWEST,
26345	UNALLOCATED	12.21.93.0/24	20115	CHARTER-20115, US
26341	UNALLOCATED	12.33.109.0/24	7018	ATT-INTERNET4, US
21861	UNALLOCATED	12.37.59.0/24	7018	ATT-INTERNET4, US
33684	UNALLOCATED	12.37.144.0/24	6461	ZAYO-6461, US
13317	UNALLOCATED	12.44.10.0/24	7018	ATT-INTERNET4, US
397306	UNALLOCATED	12.44.212.0/24	209	CENTURYLINK-US-LEGACY-QWEST,
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
26295	UNALLOCATED	12.110.210.0/23	7018	ATT-INTERNET4, US

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
36928	UNALLOCATED	41.205.237.0/24	327903	MICG, SL
36928	UNALLOCATED	41.205.238.0/24	327903	MICG, SL
36928	UNALLOCATED	41.205.239.0/24	327903	MICG, SL
36928	UNALLOCATED	41.205.240.0/24	327903	MICG, SL
36928	UNALLOCATED	41.205.241.0/24	327903	MICG, SL
36900	UNALLOCATED	41.220.48.0/20	29614	GHANATEL-AS, GH
36979	UNALLOCATED	41.223.146.0/24	29091	IPNXng, NG
327933	UNALLOCATED	41.242.128.0/24	37451	CongoTelecom, CG
327933	UNALLOCATED	41.242.129.0/24	37451	CongoTelecom, CG
327933	UNALLOCATED	41.242.130.0/24	37451	CongoTelecom, CG
327933	UNALLOCATED	41.242.131.0/24	37451	CongoTelecom, CG
133617	UNALLOCATED	43.240.92.0/22	9304	HUTCHISON-AS-AP HGC Global C
133617	UNALLOCATED	43.240.92.0/24	135081	NTRP-AS-AP RP Global, HK
133617	UNALLOCATED	43.240.93.0/24	135081	NTRP-AS-AP RP Global, HK
133617	UNALLOCATED	43.240.94.0/24	135081	NTRP-AS-AP RP Global, HK
133617	UNALLOCATED	43.240.95.0/24	19551	INCAPSULA, US
394183	UNALLOCATED	45.75.202.0/24	49425	DIGITAL-REALTY-UK, GB
268652	UNALLOCATED	45.165.20.0/22	264493	UNASSIGNED
269062	UNALLOCATED	45.179.20.0/24	266233	NEWMASTER TELECOM, BR
269062	UNALLOCATED	45.179.22.0/24	266233	NEWMASTER TELECOM, BR
269062	UNALLOCATED	45.179.23.0/24	266932	UP NET TECNOLOGIA DE REDES L
22271	UNALLOCATED	47.19.86.0/24	17378	AS17378, US
19926	UNALLOCATED	47.19.143.0/24	54004	OPTIMUM-WIFI2, US
14552	UNALLOCATED	50.58.72.0/24	701	UUNET, US
54590	UNALLOCATED	50.58.74.0/24	3356	LEVEL3, US

List of Unassigned addresses

Far too many to list. See http://thyme.apnic.net/current/data-add-IANA:

```
Unassigned Network     ASN Information  AS Name
23.141.0.0/24           Origin:    395350  UNASSIGNED
                       Transit:     11426  TWC-11426-CAROLINAS, US
27.100.7.0/24           Origin:     56096  UNASSIGNED
                       Transit:     45455  TH-2S1N-AP Two S One N Co Ltd, Internet
41.57.124.0/22          Origin:     37442  UNASSIGNED
                       Transit:     37204  TELONE, ZW
41.57.124.0/23          Origin:     37442  UNASSIGNED
                       Transit:     37204  TELONE, ZW
<snip>
41.67.224.0/22          Origin:     15964  CAMNET-AS, CM
                       Transit:     12956  TELXIUS TELXIUS Cable, ES
41.72.0.0/23            Origin:     37155  UNASSIGNED
                       Transit:     17400  EBONET, AO
<snip>
41.74.44.0/24           Origin:     37544  UNASSIGNED
                       Transit:     15964  CAMNET-AS, CM
41.77.64.0/21           Origin:     37320  UNASSIGNED
                       Transit:     29614  GHANATEL-AS, GH
41.77.208.0/22          Origin:     37475  UNASSIGNED
                       Transit:     15964  CAMNET-AS, CM
41.77.240.0/21          Origin:     35251  NETLAB, CA
                       Transit:      8100  ASN-QUADRANET-GLOBAL, US
41.78.60.0/22           Origin:      6762  SEABONE-NET TELECOM ITALIA SPARKLE S.p.A
                       Transit:      2516  KDDI KDDI CORPORATION, JP
41.78.204.0/22          Origin:     37475  UNASSIGNED
                       Transit:     15964  CAMNET-AS, CM
```

List of Unassigned addresses

Far too many to list. See http://thyme.apnic.net/current/data-add-IANA:

Unassigned Network	ASN Information		AS Name
41.242.130.0/24	Origin:	327933	UNASSIGNED
	Transit:	37451	CongoTelecom, CG
41.242.131.0/24	Origin:	327933	UNASSIGNED
	Transit:	37451	CongoTelecom, CG
43.240.92.0/22	Origin:	133617	,
	Transit:	9304	HUTCHISON-AS-AP HGC Global Communication
43.240.92.0/24	Origin:	133617	,
	Transit:	135081	NTRP-AS-AP RP Global, HK
43.240.93.0/24	Origin:	133617	,
	Transit:	135081	NTRP-AS-AP RP Global, HK
43.240.94.0/24	Origin:	133617	,
	Transit:	135081	NTRP-AS-AP RP Global, HK
43.240.95.0/24	Origin:	133617	,
	Transit:	19551	INCAPSULA, US
43.250.235.0/24	Origin:	133948	DIL-AS-AP DONGFONG INC LIMITED, HK
	Transit:	4637	ASN-TELSTRA-GLOBAL Telstra Global, HK
45.252.60.0/22	Origin:	55933	CLOUDIE-AS-AP Cloudie Limited, HK
	Transit:	6939	HURRICANE, US
45.252.60.0/24	Origin:	55933	CLOUDIE-AS-AP Cloudie Limited, HK
	Transit:	400464	VMISS, CA
64.16.112.0/21	Origin:	3561	CENTURYLINK-LEGACY-SAVVIS, US
	Transit:	209	CENTURYLINK-US-LEGACY-QWEST, US
64.85.24.0/23	Origin:	262287	Maxihost LTDA, BR
	Transit:	16735	ALGAR TELECOM SA, BR
66.159.102.0/24	Origin:	17378	AS17378, US
	Transit:	6461	ZAYO-6461, US

List of Unassigned addresses

Far too many to list. See http://thyme.apnic.net/current/data-add-IANA:

Unassigned Network	ASN Information		AS Name
196.195.191.0/24	Origin:	132116	ANINETWORK-IN Ani Network Pvt Ltd, IN
	Transit:	9498	BBIL-AP BHARTI Airtel Ltd., IN
196.195.250.0/24	Origin:	131284	ETISALATAFG-AS-AP Etisalat Afghan, AF
	Transit:	138322	AWCC-AS-AP Afghan Wireless, AF
196.195.251.0/24	Origin:	131284	ETISALATAFG-AS-AP Etisalat Afghan, AF
	Transit:	38193	TWA-AS-AP Transworld Associates Pvt. Ltd
196.195.253.0/24	Origin:	131284	ETISALATAFG-AS-AP Etisalat Afghan, AF
	Transit:	38193	TWA-AS-AP Transworld Associates Pvt. Ltd
196.207.94.0/24	Origin:	137085	ANI89-AS-IN Ani Broadband Service Pvt Lt
	Transit:	4755	TATACOMM-AS TATA Communications formerly
196.207.124.0/24	Origin:	132116	ANINETWORK-IN Ani Network Pvt Ltd, IN
	Transit:	9498	BBIL-AP BHARTI Airtel Ltd., IN
197.255.248.0/23	Origin:	22351	INTELSAT-1, US
	Transit:	3356	LEVEL3, US
198.8.96.0/19	Origin:	17054	AS17054, US
	Transit:	10796	TWC-10796-MIDWEST, US
198.22.236.0/24	Origin:	26854	NYS, US
	Transit:	3356	LEVEL3, US
198.23.26.0/24	Origin:	33052	VZUNET, US
	Transit:	3356	LEVEL3, US
198.32.0.0/22	Origin:	8038	6CONNECT, US
	Transit:	6939	HURRICANE, US
198.32.7.0/24	Origin:	3944	PARTAN-LAB, US
	Transit:	16668	GBPSW-AS, US
198.49.80.0/24	Origin:	62711	UNASSIGNED
	Transit:	3356	LEVEL3, 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
/9:13	/10:40	/11:100	/12:302	/13:592	/14:1207	/15:2060	/16:13539
/17:8322	/18:13884	/19:25099	/20:44394	/21:52282	/22:108861	/23:96690	/24:534623
/25:791	/26:0	/27:0	/28:0	/29:0	/30:0	/31:0	/32:0

11th July 2022↑

11th July 2021↓

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0	/7:0	/8:17
/9:14	/10:41	/11:102	/12:305	/13:589	/14:1194	/15:1995	/16:13465
/17:8324	/18:13968	/19:25403	/20:42308	/21:50361	/22:106957	/23:91548	/24:498787
/25:1400	/26:0	/27:0	/28:0	/29:0	/30:0	/31:0	/32:0

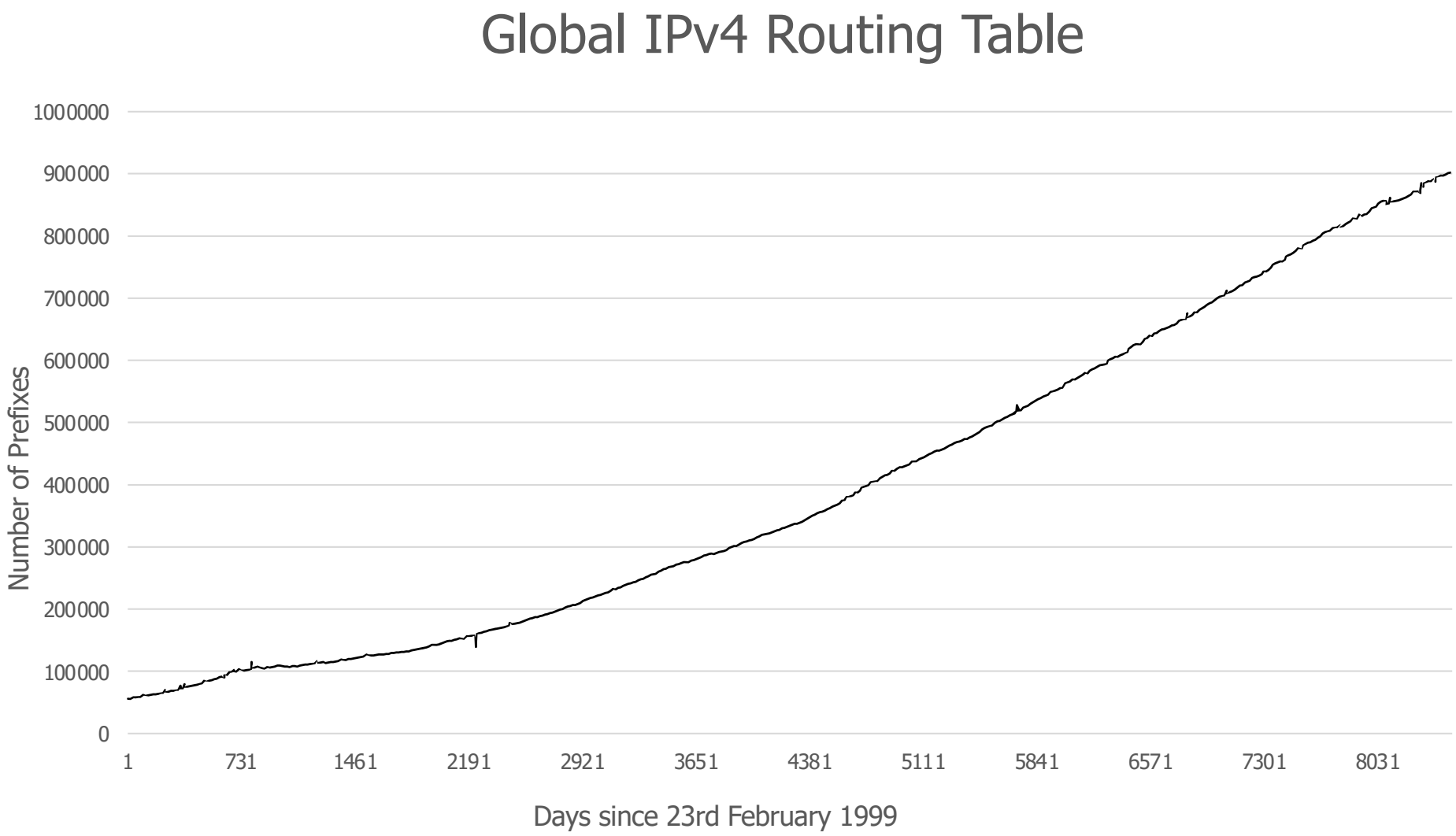
Number of IPv6 prefixes announced by prefix length

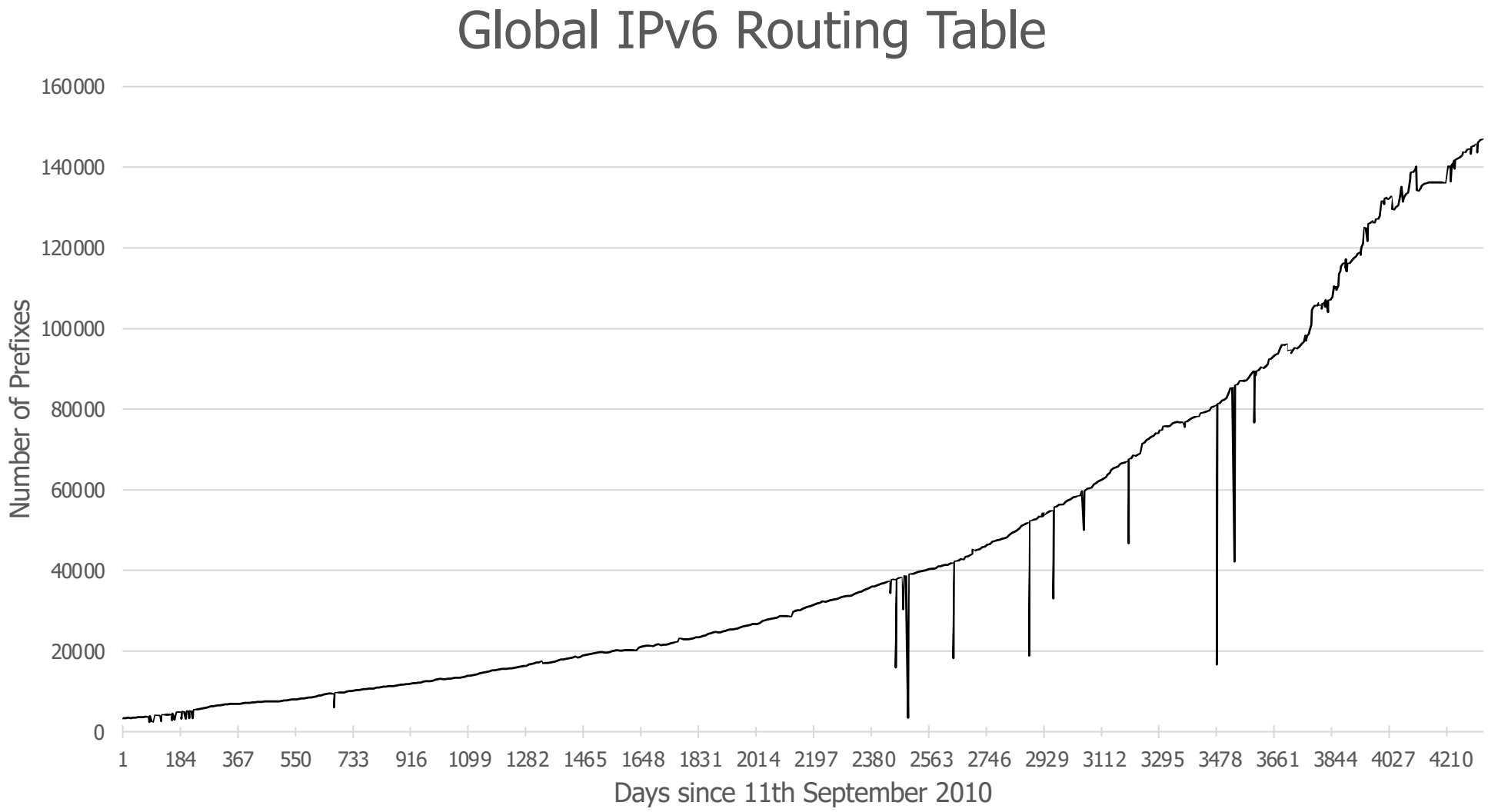
/16:0	/17:0	/18:0	/19:1	/20:15	/21:3	/22:7	/23:7
/24:28	/25:8	/26:15	/27:20	/28:183	/29:4223	/30:518	/31:276
/32:21611	/33:2665	/34:2283	/35:903	/36:5529	/37:798	/38:1445	/39:891
/40:10884	/41:795	/42:2931	/43:1170	/44:12443	/45:1246	/46:3141	/47:2911
/48:70169	/49 → /128: FILTERED by ISP						

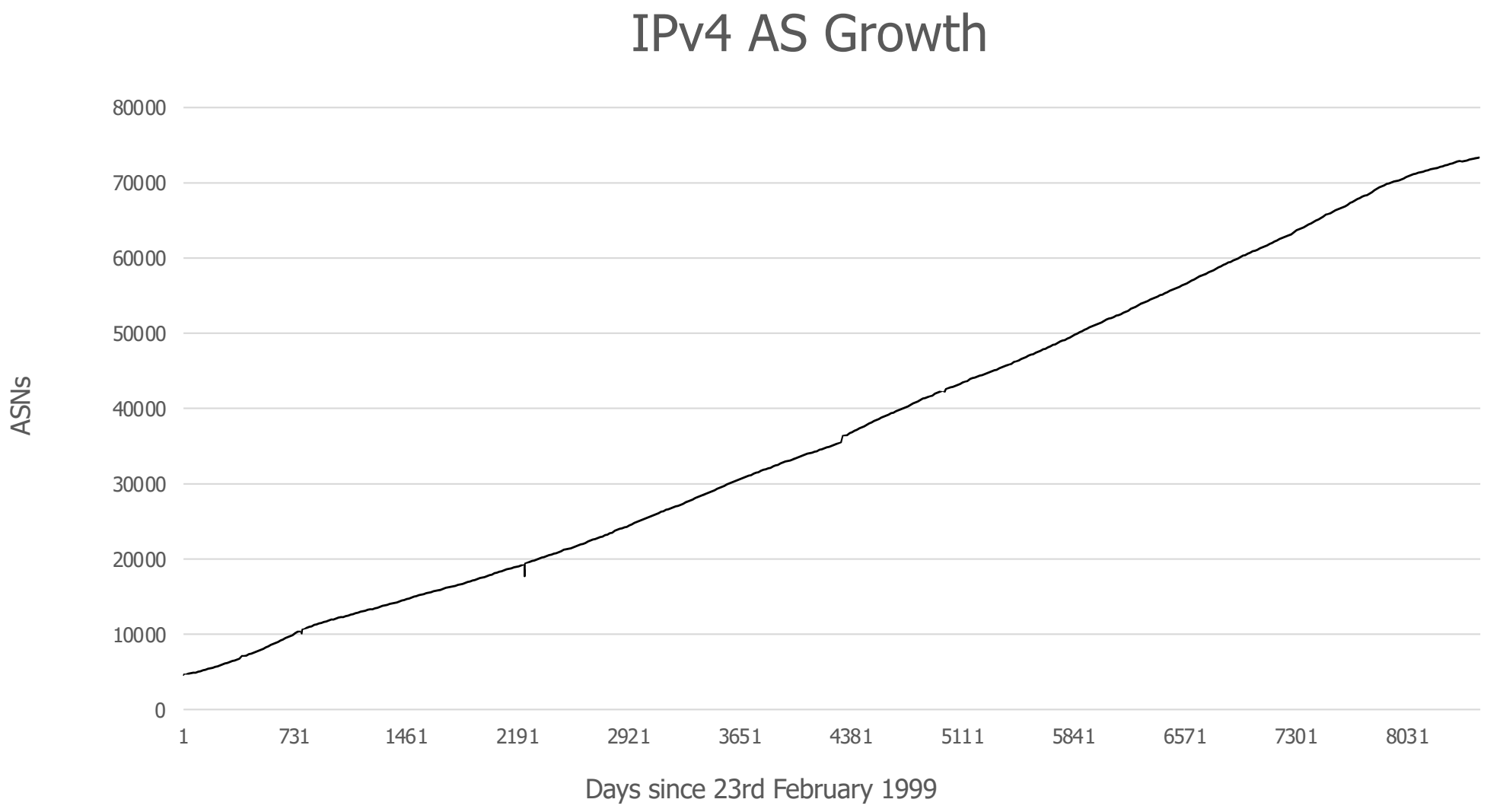
11th July 2022↑

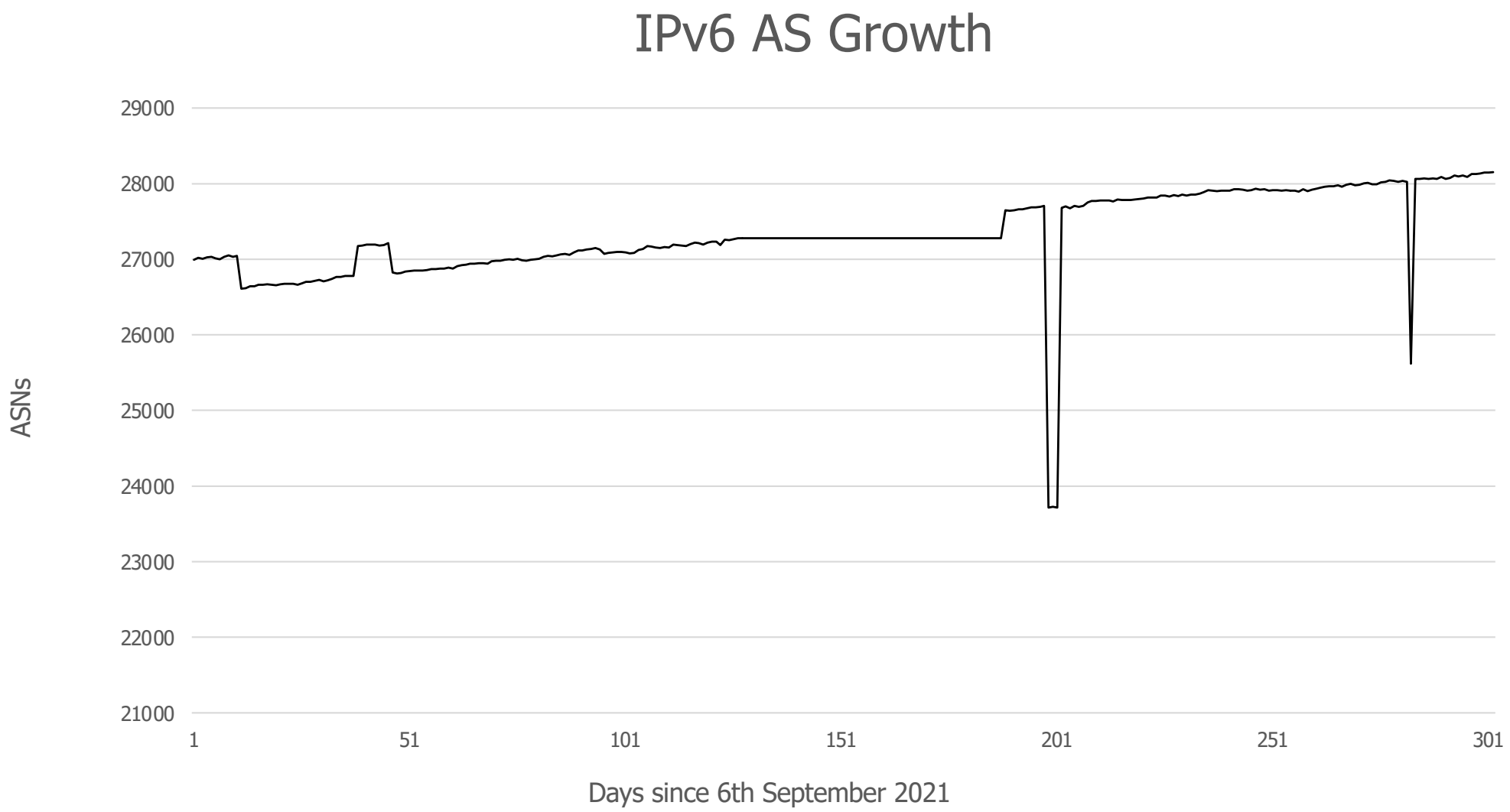
11th July 2021↓

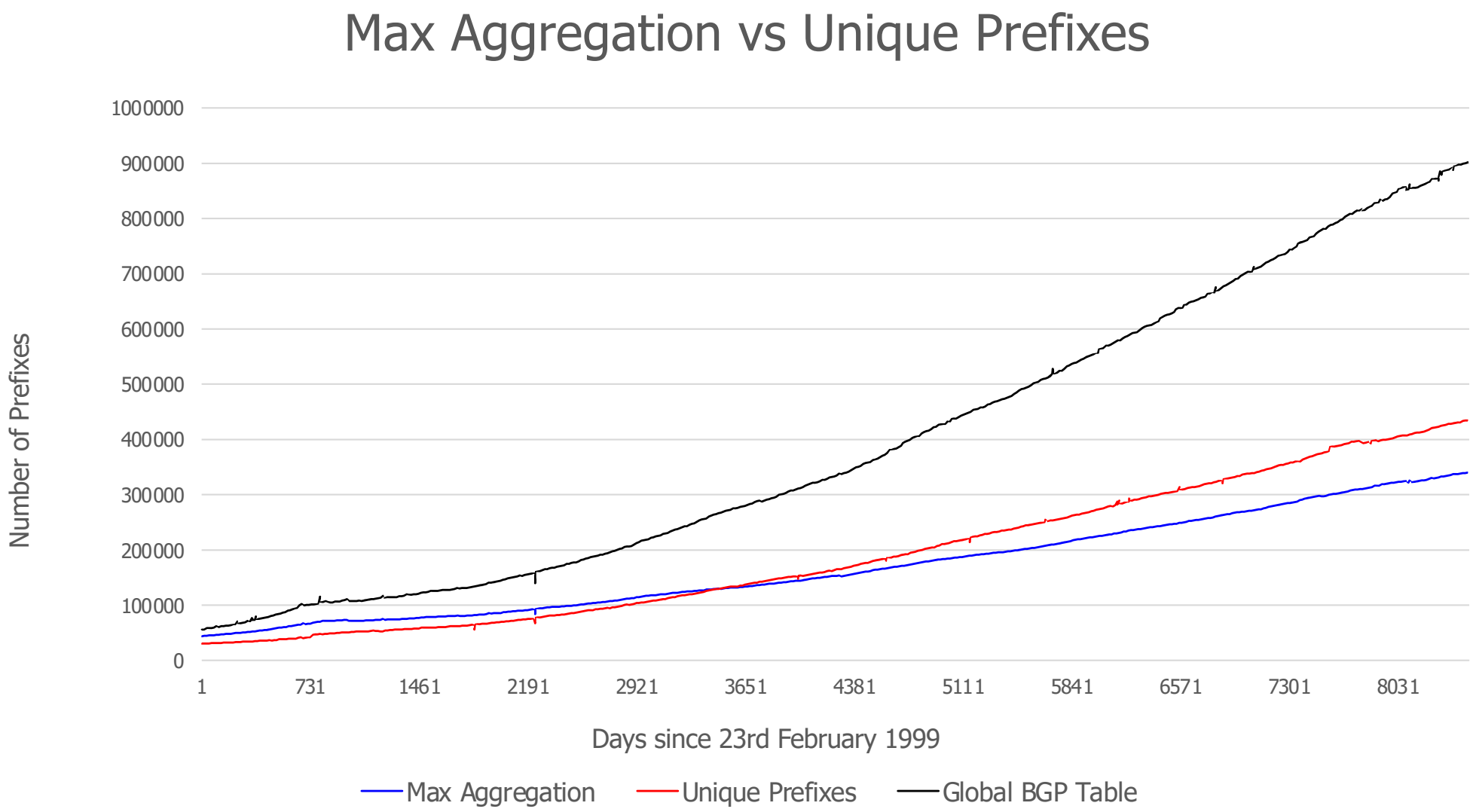
/16:0	/17:0	/18:0	/19:1	/20:14	/21:3	/22:7	/23:7
/24:28	/25:8	/26:15	/27:20	/28:118	/29:3677	/30:526	/31:199
/32:20478	/33:2168	/34:1884	/35:796	/36:4551	/37:815	/38:1408	/39:821
/40:9243	/41:691	/42:2725	/43:626	/44:11494	/45:1018	/46:2476	/47:2171
/48:58182	/49 → /128: FILTERED by ISP						

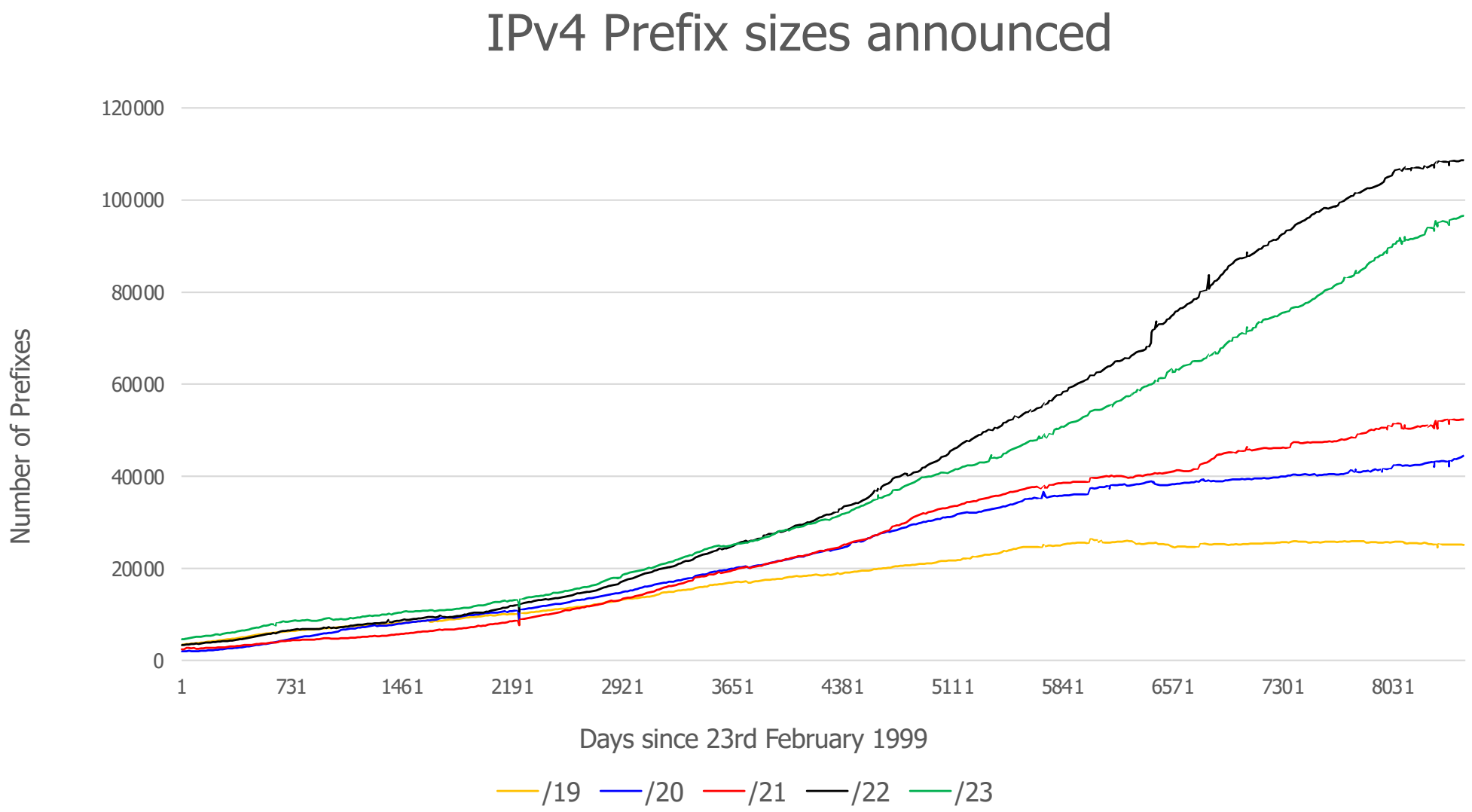

Global IPv4 Routing Table
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
Number of Prefixes
1
731
1461
2191
2921
3651
4381
5111
5841
6571
7301
8031
Days since 23rd February 1999

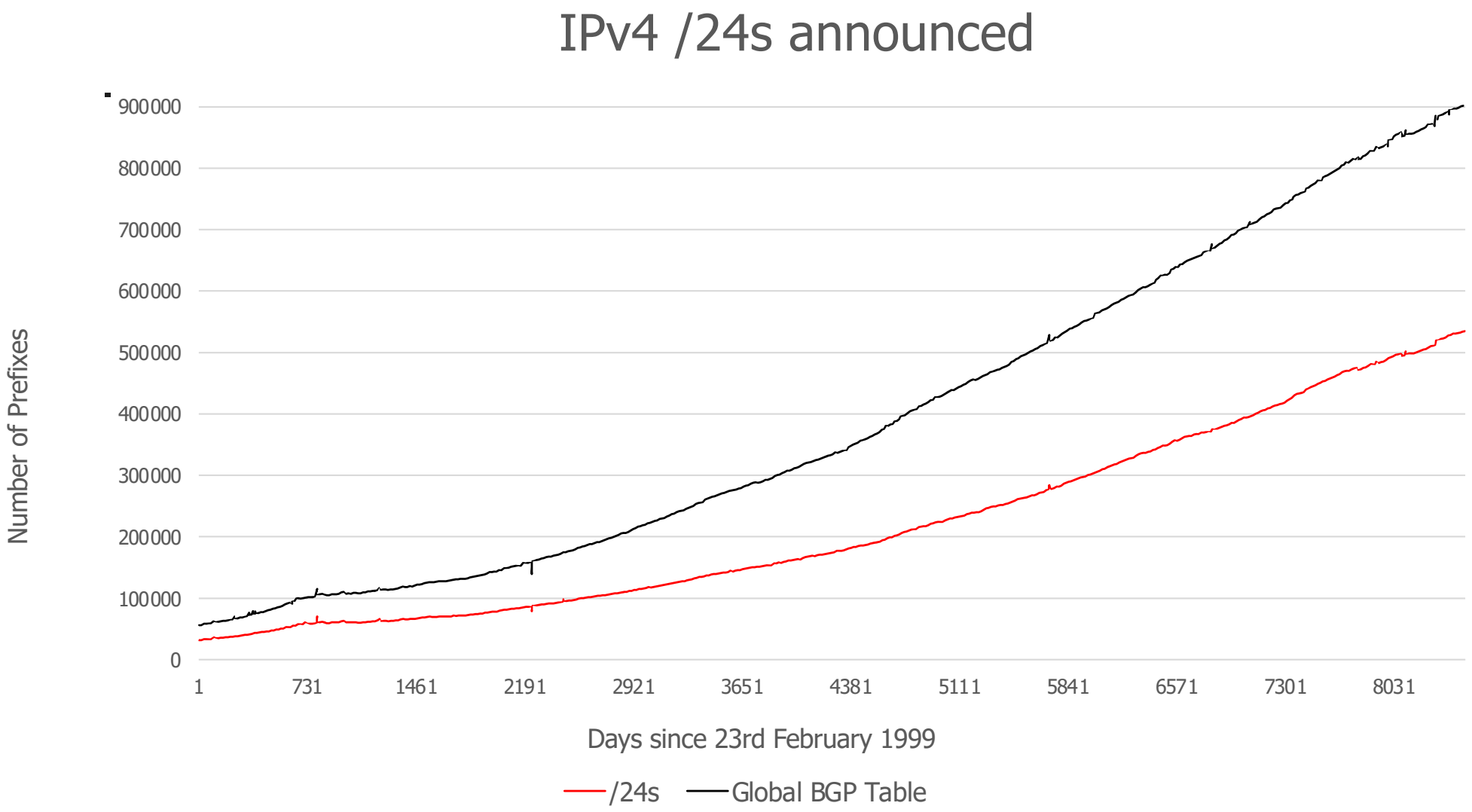

Global IPv6 Routing Table
Number of Prefixes
160000
140000
120000
100000
80000
60000
40000
20000
0
1
184
367
550
733
916
1099
1282
1465
1648
1831
2014
2197
2380
2563
2746
2929
3112
3295
3478
3661
3844
4027
4210
Days since 11th September 2010

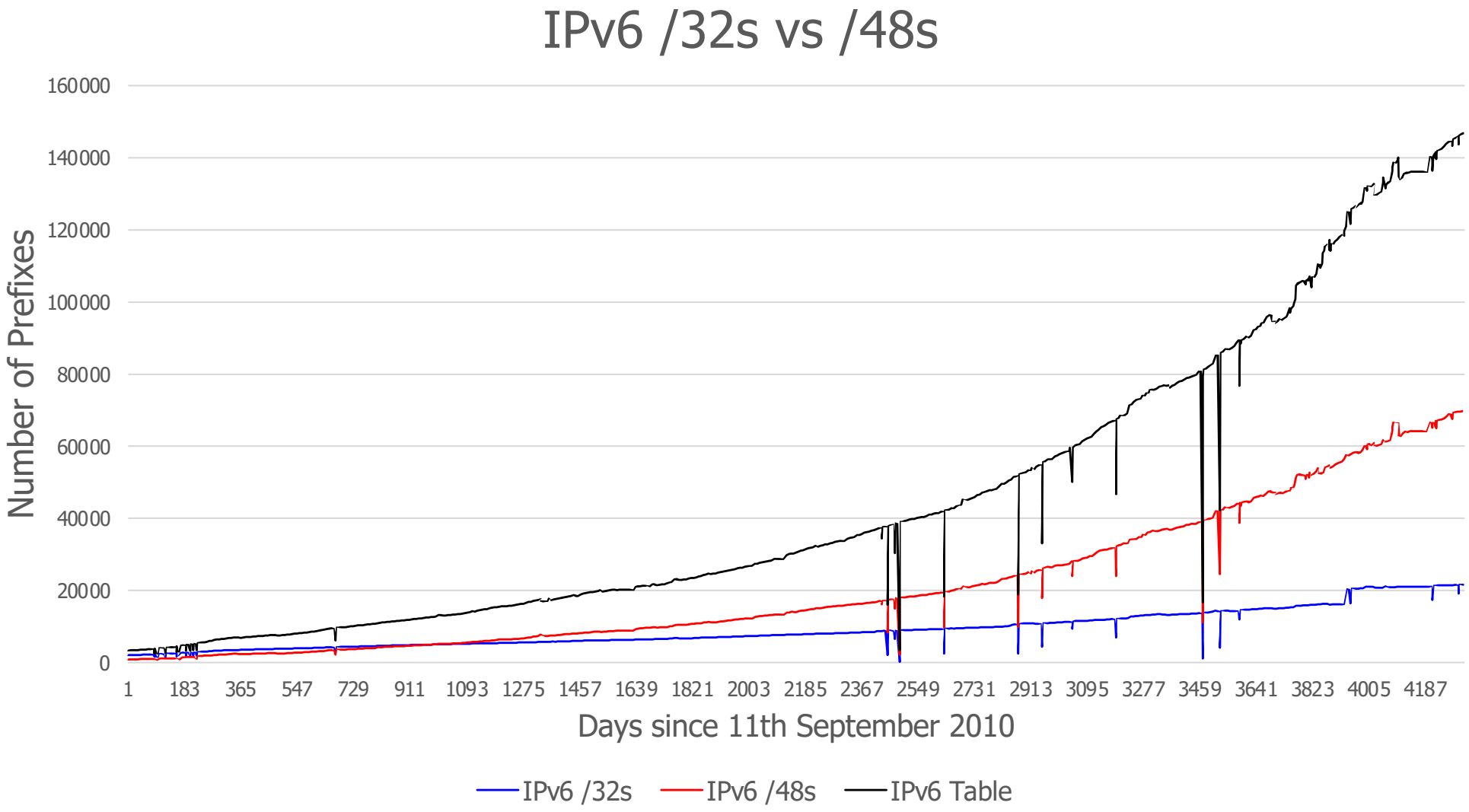

IPv4 AS Growth
ASNs
80000
70000
60000
50000
40000
30000
20000
10000
0
1
731
1461
2191
2921
3651
4381
5111
5841
6571
7301
8031
Days since 23rd February 1999

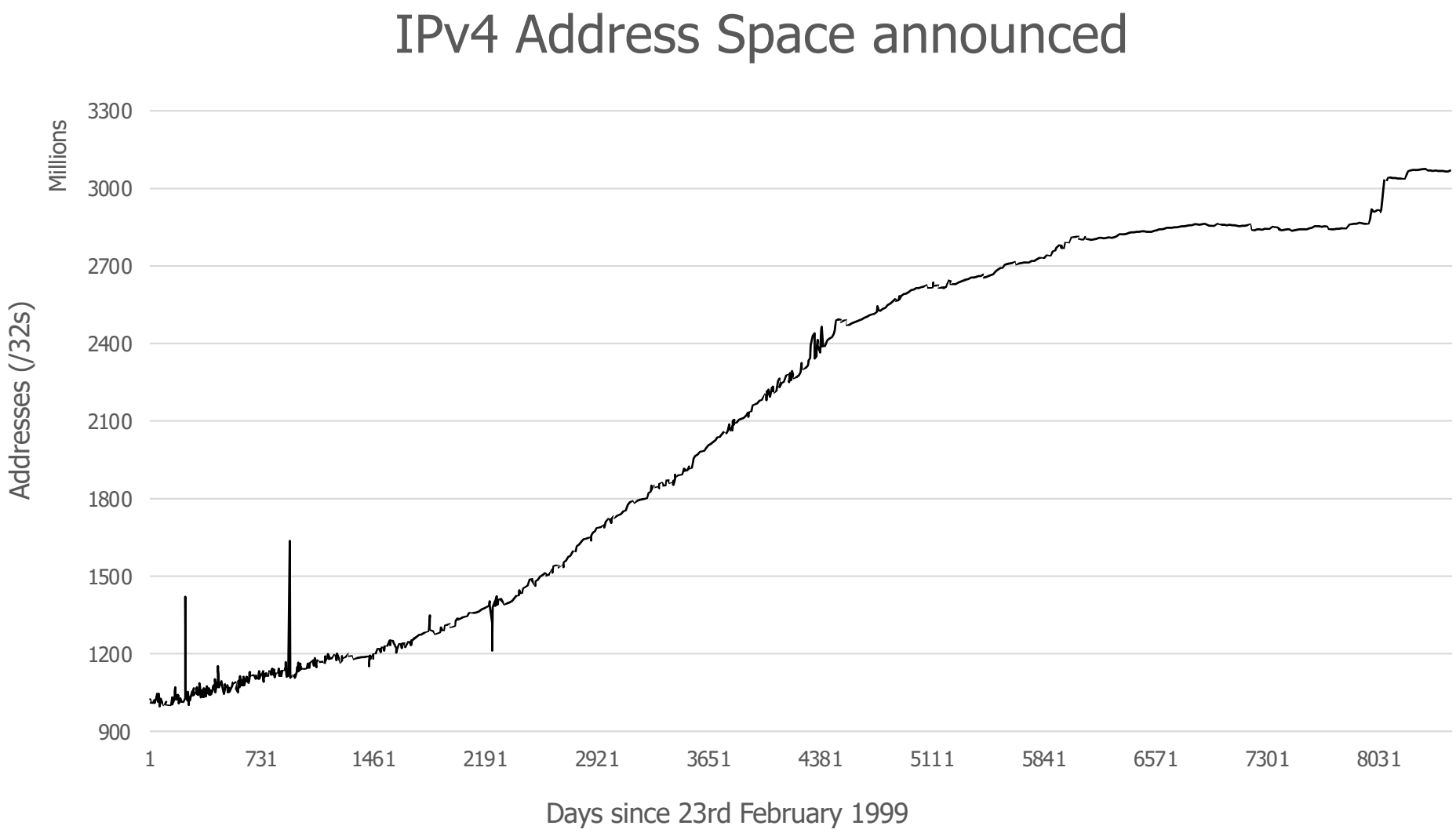

IPv6 AS Growth
29000
28000
27000
26000
25000
24000
23000
22000
21000
ASNs
1
51
101
151
201
251
301
Days since 6th September 2021

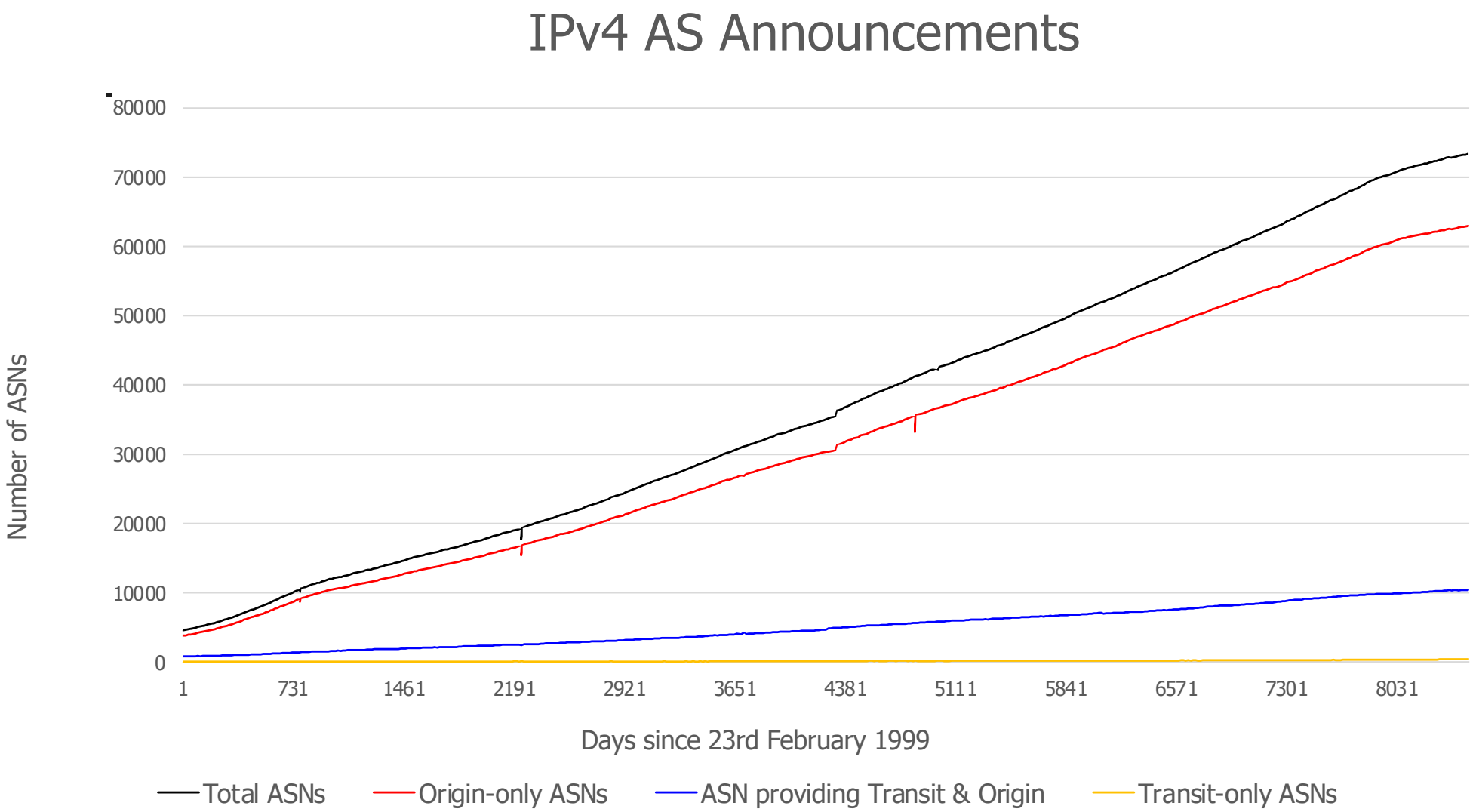

Max Aggregation vs Unique Prefixes
Number of Prefixes
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
1
731
1461
2191
2921
3651
4381
5111
5841
6571
7301
8031
Days since 23rd February 1999
Max Aggregation
Unique Prefixes
Global BGP Table

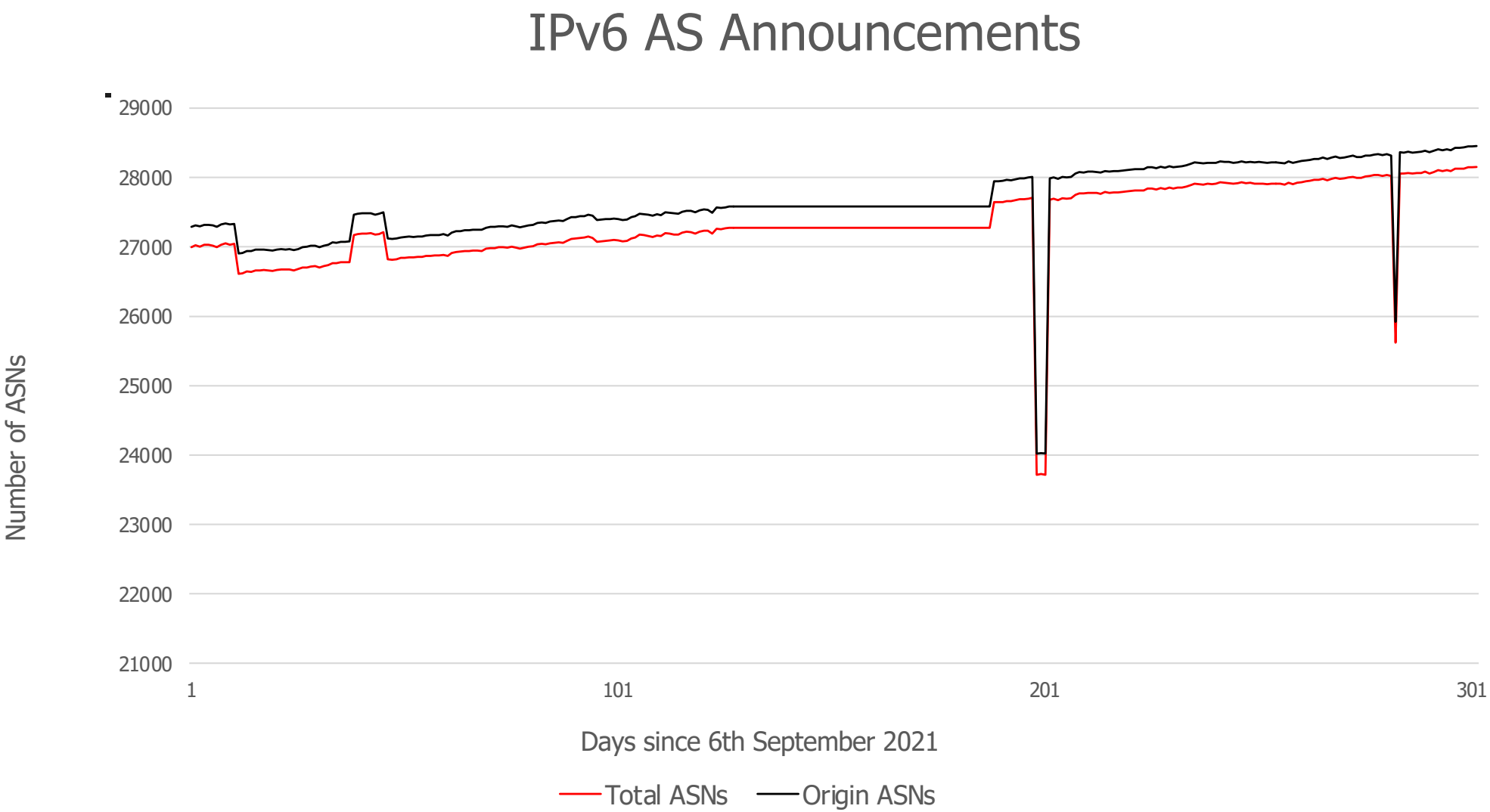

IPv4 Prefix sizes announced
Number of Prefixes
120000
100000
80000
60000
40000
20000
0
1
731
1461
2191
2921
3651
4381
5111
5841
6571
7301
8031
Days since 23rd February 1999
/19
/20
/21
/22
/23

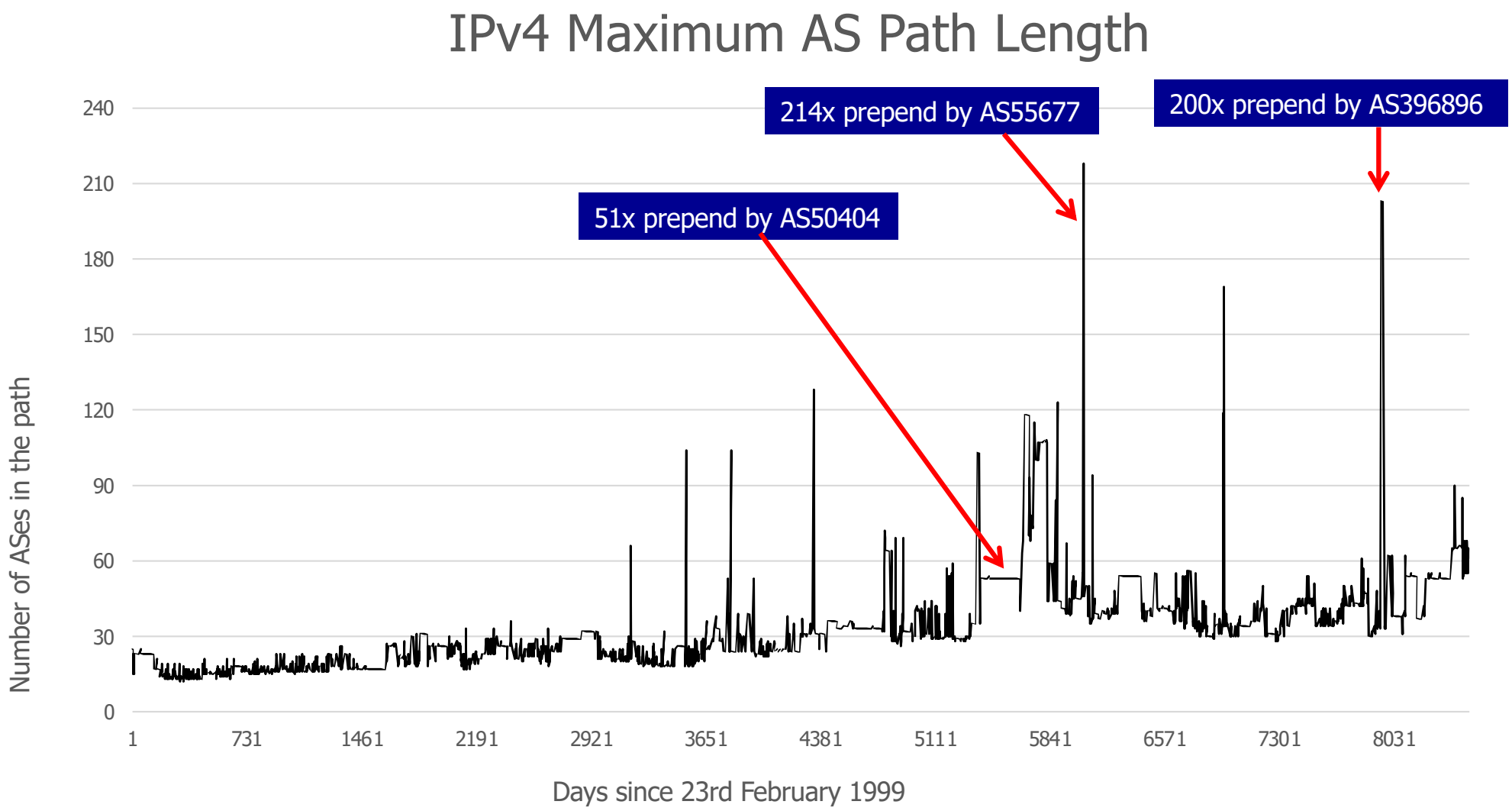

IPv4 /24s announced
Number of Prefixes
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
1
731
1461
2191
2921
3651
4381
5111
5841
6571
7301
8031
Days since 23rd February 1999
/24s
Global BGP Table


IPv6 /32s vs /48s
Number of Prefixes
160000
140000
120000
100000
80000
60000
40000
20000
0
1
183
365
547
729
911
1093
1275
1457
1639
1821
2003
2185
2367
2549
2731
2913
3095
3277
3459
3641
3823
4005
4187
Days since 11th September 2010
IPv6 /32s
IPv6 /48s
IPv6 Table


IPv4 Address Space announced
Millions
Addresses (/32s)
3300
3000
2700
2400
2100
1800
1500
1200
900
1
731
1461
2191
2921
3651
4381
5111
5841
6571
7301
8031
Days since 23rd February 1999


IPv4 AS Announcements
80000
70000
60000
50000
40000
30000
20000
10000
0
Number of ASNs
1
731
1461
2191
2921
3651
4381
5111
5841
6571
7301
8031
Days since 23rd February 1999
Total ASNs
Origin-only ASNs
ASN providing Transit & Origin
Transit-only ASNs


IPv6 AS Announcements
29000
28000
27000
26000
25000
24000
23000
22000
21000
Number of ASNs
1
101
201
301
Days since 6th September 2021
Total ASNs
Origin ASNs


IPv4 Maximum AS Path Length
214x prepend by AS55677
200x prepend by AS396896
51x prepend by AS50404
Number of ASes in the path
240
210
180
150
120
90
60
30
0
1
731
1461
2191
2921
3651
4381
5111
5841
6571
7301
8031
Days since 23rd February 1999

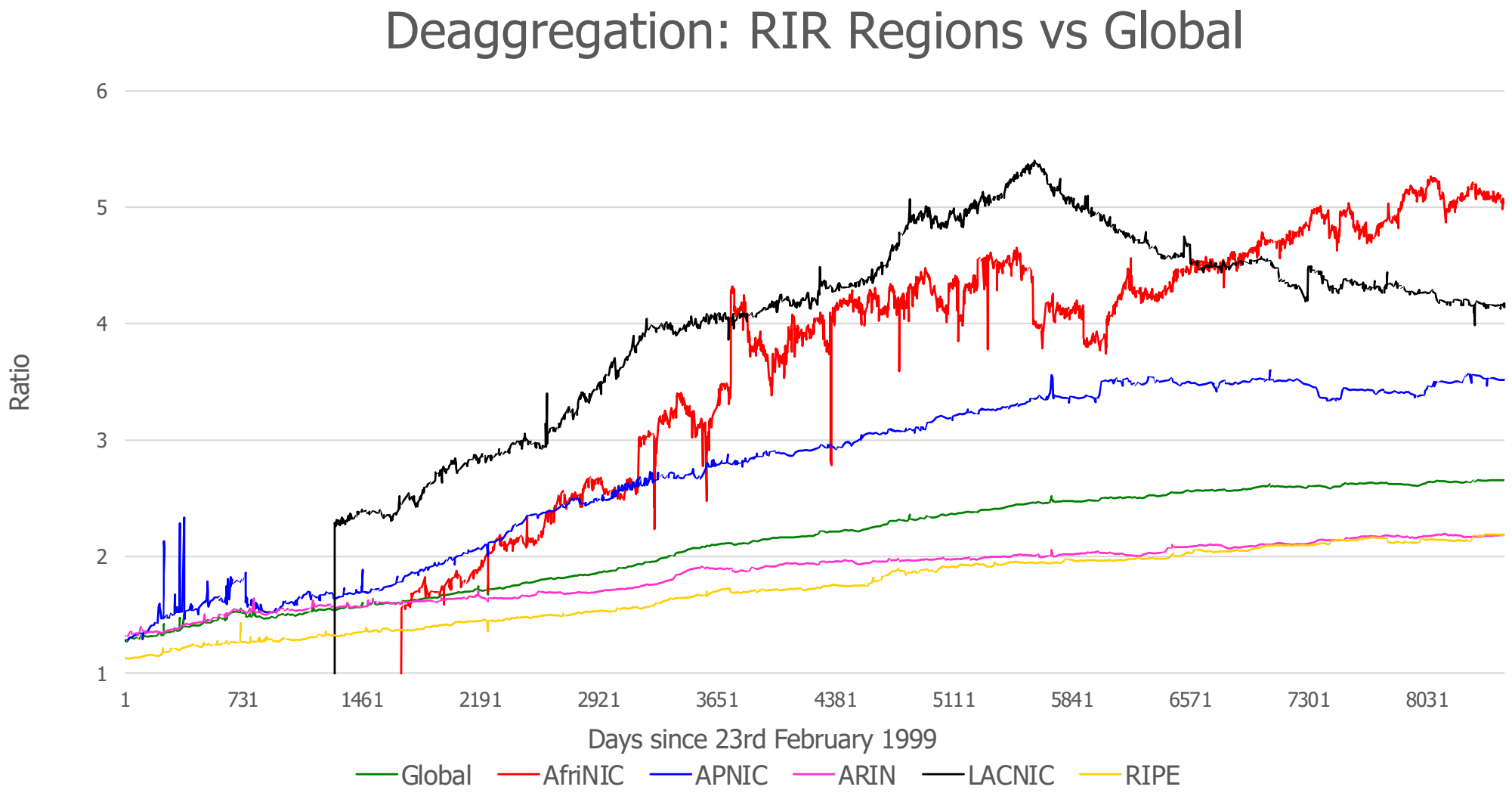
Looking at Deaggregation in IPv4

- 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"

July 2022

- Total Prefixes
- Global BGP Table
  - 856k prefixes
- North America
  - 264k prefixes
- Europe & Middle East
  - 259k prefixes
- Asia & Pacific
  - 236k prefixes
- Latin America & Caribbean
  - 116k prefixes
- Africa
  - 28k prefixes

- Deaggregation Factor
- Global Average
  - 2.65
- North America
  - 2.19
- Europe & Middle East
  - 2.18
- Asia & Pacific
  - 3.52
- Latin America & Caribbean
  - 4.18
- Africa
  - 5.07


Deaggregation: RIR Regions vs Global
Ratio
6
5
4
3
2
1
1
731
1461
2191
2921
3651
4381
5111
5841
6571
7301
8031
Days since 23rd February 1999
Global
AfriNIC
APNIC
ARIN
LACNIC
RIPE

Asia Pacific Aggregation Savings Summary

ASN	No of Nets	Savings	Description
9808	8993	8944	CHINAMOBILE-CN China Mobile Communications Grou
7545	5920	5226	TPG-INTERNET-AP TPG Telecom Limited, AU
4538	4714	4639	ERX-CERNET-BKB China Education and Research Net
7552	3549	3530	VIETEL-AS-AP Viettel Group, VN
7713	3512	3453	TELKOMNET-AS-AP PT Telekomunikasi Indonesia, ID
45899	3426	3370	VNPT-AS-VN VNPT Corp, VN
9498	2426	2189	BBIL-AP BHARTI Airtel Ltd., IN
45090	2172	2093	TENCENT-NET-AP Shenzhen Tencent Computer System
23969	1958	1942	TOT-NET TOT Public Company Limited, TH
4755	2124	1907	TATACOMM-AS TATA Communications formerly VSNL i
4766	2496	1895	KIXS-AS-KR Korea Telecom, KR
9829	1892	1855	BSNL-NIB National Internet Backbone, IN
18403	1871	1830	FPT-AS-AP FPT Telecom Company, VN
24560	2107	1700	AIRTELBROADBAND-AS-AP Bharti Airtel Ltd., Telem
45609	1806	1480	BHARTI-MOBILITY-AS-AP Bharti Airtel Ltd. AS for
56047	1454	1421	CMNET-HUNAN-AP China Mobile communications corp
56041	1470	1403	CMNET-ZHEJIANG-AP China Mobile communications c
56046	1379	1295	CMNET-JIANGSU-AP China Mobile communications co
9583	1756	1229	SIFY-AS-IN Sify Limited, IN
9394	1150	1128	CTTNET China TieTong Telecommunications Corpora

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

India Aggregation Savings Summary

ASN	No of Nets	Savings	Description
9498	2426	2189	BBIL-AP BHARTI Airtel Ltd., IN
4755	2124	1907	TATACOMM-AS TATA Communications formerly VSNL i
9829	1892	1855	BSNL-NIB National Internet Backbone, IN
24560	2107	1700	AIRTELBROADBAND-AS-AP Bharti Airtel Ltd., Telem
45609	1806	1480	BHARTI-MOBILITY-AS-AP Bharti Airtel Ltd. AS for
9583	1756	1229	SIFY-AS-IN Sify Limited, IN
17488	1250	1121	HATHWAY-NET-AP Hathway IP Over Cable Internet,
55410	865	836	VIL-AS-AP Vodafone Idea Ltd, IN
45820	907	813	TTSL-MEISISP Tata Teleservices ISP AS, IN
45271	863	664	ICLNET-AS-AP Idea Cellular Limited, IN

Pakistan Aggregation Savings Summary

ASN	No of Nets	Savings	Description
17557	805	775	PKTELECOM-AS-PK Pakistan Telecommunication Comp
9541	572	461	CYBERNET-AP Cyber Internet Services Pvt Ltd., P
132165	458	415	CONNECT-AS-AP Connect Communications, PK
23674	424	399	NAYATEL-PK Nayatel Pvt Ltd, PK
55714	291	197	APNIC-FIBERLINK-PK Fiberlink Pvt.Ltd, PK
139879	191	178	GALAXY-AS-AP Galaxy Broadband, PK
23966	167	154	LDN-AS-PK LINKdotNET Telecom Limited, PK
38264	200	144	WATEEN-IMS-PK-AS-AP National WiMAXIMS environme
58895	196	139	EBONE1-PK Ebone Network PVT. Limited, PK
136525	136	126	WANCOMPVTLTD-AS-AP Wancom Pvt Ltd., PK

Bangladesh Aggregation Savings Summary

ASN	No of Nets	Savings	Description
23956	185	180	AMBERIT-BD-AS AmberIT Limited, BD
58715	144	128	EARTHTELECOMMUNICATION-AS EARTH TELECOMMUNICATI
24342	132	127	BRAC-BDMAIL-AS-BD BRACNet Limited, BD
23688	115	108	LINK3-TECH-AS-BD-AP Link3 Technologies Ltd., BD
23923	98	94	AGNI-AS Agni Systems Limited, BD
17469	92	83	ACCESSTEL-AS-AP Access Telecom BD Ltd., BD
7565	85	83	BDCOM-BD Rangs Nilu Square, 5th Floor, House 75
24323	93	77	AAMRA-NETWORKS-AS-AP aamra networks limited, BD
24389	81	62	GRAMEENPHONE-AS-AP GrameenPhone Ltd., BD
17471	67	62	CYBERNET-BD-AS Grameen Cybernet Ltd. Bangladesh

Sri Lanka Aggregation Savings Summary

ASN	No of Nets	Savings	Description
9329	131	117	SLTINT-AS-AP Sri Lanka Telecom Internet, LK
18001	75	62	DIALOG-AS Dialog Axiata PLC., LK
5087	81	57	LANKA-COM Lanka Communication Services, LK
45224	60	57	BELLNET-AS-AP Lanka Bell Limited, LK
132045	58	53	AIRTEL-AS-ISP Bharti Airtel Lanka Pvt. Limited,
17904	21	19	SLTASUL-LK Sri Lankan Airlines, LK
45356	22	15	MOBITEL-LK Mobitel Pvt Ltd, LK
17470	16	13	HUTCHISON-LK Hutchison Telecommunications Lanka
132447	9	7	HUTCHISON-LK 234, Galle Road, Colombo 4, LK
38229	8	6	LEARN-LK Lanka Education & Research Network, NR

Nepal Aggregation Savings Summary

ASN	No of Nets	Savings	Description
17501	110	100	WLINK-NEPAL-AS-AP WorldLink Communications Pvt
23752	106	100	NPTELECOM-NP-AS Nepal Telecommunications Corpor
4007	88	76	SUBISU-CABLENET-AS-AP Subisu Cablenet Pvt Ltd,
4613	66	60	MOS-NP Mercantile Office Systems, NP
38565	54	50	NCELL-AS-NP Ncell Pvt. Ltd., NP
24550	55	49	WEBSURFERNP-AS-NP Websurfer Nepal Internet Serv
45650	45	29	VIANET-NP Vianet Communications Pvt. Ltd., NP
55915	32	24	CLASSIC-NP Classic Tech Pvt. Ltd., NP
58504	19	14	TECHMINDS-NP TECHMINDS NETWORKS PVT. LTD., NP
141047	15	12	NDSPL-AS-AP Nepal Digital Service Pvt. Ltd., NP

Afghanistan Aggregation Savings Summary

ASN	No of Nets	Savings	Description
55330	70	49	GCN-DCN-AS AFGHANTELECOM GOVERNMENT COMMUNICATI
38742	63	46	AWCC-AS-AP AWCC, AF
131284	49	37	ETISALATAFG-AS-AP Etisalat Afghan, AF
138322	41	25	AWCC-AS-AP Afghan Wireless, AF
55424	28	22	INSTATELECOM-AS-AP Instatelecom Limited, AF
132471	24	14	MTNAFGHANISTAN-AS-AP MTNAFGHANISTAN, AF
55732	8	7	RANATECHNET-AF RANA Technologies,Kabul, AF
133066	13	5	ANS-AS-AP Ariana Network Services Co, AF
55745	10	4	NEDA-AS-AP Neda Telecommunications, AF
134134	8	4	NORTHTELECOM-AF North Telecom, AF

Maldives Aggregation Savings Summary

ASN	No of Nets	Savings	Description
7642	124	112	DHIRAAGU-MV-AP DHIVEHI RAAJJEYGE GULHUN PLC, MV
55944	48	44	OOREDOO-MV Ooredoo Maldives Plc, MV
136238	6	2	SATLINKPVTLTD-AS-AP SatLink Pvt Ltd, MV

Bhutan Aggregation Savings Summary

ASN	No of Nets	Savings	Description
134715	17	13	DRUKREN-MOIC-AS Ministry of Information & Commu
23955	16	12	TASHICELL-DOMESTIC-AS Tashi InfoComm Limited, B
136039	6	4	NANO-AS-AP NANO, Bhutan, BT
18024	7	3	BTTELECOM-AS-AP Bhutan Telecom Ltd, BT
17660	6	1	DRUKNET-AS DrukNet ISP, BT
135666	5	1	MOIC-AS-AP Government Data Center DITTMoIC, BT
141680	2	1	SUPERNET1-AS-AP SuperNet Infocomm, BT

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 2022
  - 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?