

Internet Routing Table Analysis Update

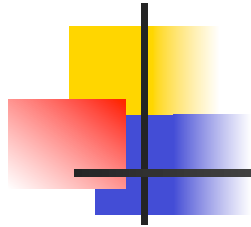


Philip Smith

MyNOG 2

4th & 5th December 2012

Kuala Lumpur



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 reporting report started 23rd February 1999:
 - Routing table size
 - CIDR-Report style reporting on a per-RIR basis
 - ...and many other interesting features

Routing Report 29 November 2012

BGP routing table entries examined:	433432
Prefixes after maximum aggregation:	180342
Deaggregation factor:	2.40
Unique aggregates announced to Internet:	213028
Total ASes present in the Internet Routing Table:	42695
Prefixes per ASN:	10.15
Origin-only ASes present in the Internet Routing Table:	33856
Origin ASes announcing only one prefix:	15805
Transit ASes present in the Internet Routing Table:	5696
Transit-only ASes present in the Internet Routing Table:	141
Average AS path length visible in the Internet Routing Table:	4.6
Max AS path length visible:	41
Max AS path prepend of ASN (22394)	35
Prefixes from unregistered ASNs in the Routing Table:	1087
Unregistered ASNs in the Routing Table:	399
Number of 32-bit ASNs allocated by the RIRs:	3532
Number of 32-bit ASNs visible in the Routing Table:	3143
Prefixes from 32-bit ASNs in the Routing Table:	8526
Special use prefixes present in the Routing Table:	15
Prefixes being announced from unallocated address space:	145
Number of addresses announced to Internet:	2615401924
Equivalent to 155 /8s, 227 /16s and 221 /24s	
Percentage of available address space announced:	70.6
Percentage of allocated address space announced:	70.6
Percentage of available address space allocated:	100.0
Percentage of address space in use by end-sites:	93.9
Total number of prefixes smaller than registry allocations:	152672

APNIC Region

Prefixes being announced by APNIC Region ASes:	104791
Total APNIC prefixes after maximum aggregation:	32667
APNIC Deaggregation factor:	3.21
Prefixes being announced from the APNIC address blocks:	105636
Unique aggregates announced from the APNIC address blocks:	43280
APNIC Region origin ASes present in the Internet Routing Table:	4803
APNIC Prefixes per ASN:	21.99
APNIC Region origin ASes announcing only one prefix:	1246
APNIC Region transit ASes present in the Internet Routing Table:	786
Average APNIC Region AS path length visible:	4.7
Max APNIC Region AS path length visible:	26
Number of APNIC region 32-bit ASNs visible in the Routing Table:	369
Number of APNIC addresses announced to Internet:	715229952
Equivalent to 42 /8s, 161 /16s and 139 /24s	
Percentage of available APNIC address space announced:	83.6

APNIC AS Blocks	4608-4864, 7467-7722, 9216-10239, 17408-18431
(pre-ERX allocations)	23552-24575, 37888-38911, 45056-46079, 55296-56319, 58368-59391, 131072-133119
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 prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
7029	3192	994	215	Windstream Communications Inc
6389	3147	3719	148	bellsouth.net, inc.
4766	2944	11557	900	Korea Telecom (KIX)
17974	2429	826	46	PT TELEKOMUNIKASI INDONESIA
10620	2261	386	206	TVCABLE BOGOTA
28573	2184	1285	66	NET Servicos de Comunicacao S.A
18566	2083	382	180	Covad Communications
22773	1938	2932	131	Cox Communications, Inc.
1785	1931	678	125	PaeTec Communications, Inc.
7545	1807	301	89	TPG Internet Pty Ltd
8402	1793	544	16	Corbina telecom
20115	1684	1607	625	Charter Communications
7303	1668	1138	201	Telecom Argentina Stet-France
4755	1624	374	159	TATA Communications formerly
4323	1587	1153	394	Time Warner Telecom
6503	1536	435	67	AVANTEL, S.A.
8151	1478	3038	354	UniNet S.A. de C.V.
9829	1412	1155	42	BSNL National Internet Backbo
30036	1364	279	745	Mediacom Communications Corp
7018	1283	10276	849	AT&T WorldNet Services

Malaysian per AS Aggregation summary

ASN	No of nets	Net Savings	Description
4788	529	484	Telekom Malaysia
38182	64	62	Extreme Broadband - Total Bro
9534	70	60	Binariang Berhad
23678	67	57	MyKRIS Asia Sdn Bhd
45352	49	41	IP ServerOne Solutions Sdn Bh
24514	62	32	Malaysian Research & Educatio
38199	29	26	Macro Lynx Sdn Bhd, Internet
45668	30	25	AIMS Data Centre Sdn. Bhd.
17971	32	25	Eastgate
24028	26	22	CNX Solutions
10030	24	21	Celcom Internet Service Provi
55720	31	20	THEGIGABIT.com - Dedicated Se
38322	22	17	MIB Comm Sdn Bhd, Internet Se
55761	17	15	Segambut Bahagia
2042	21	14	Malaysian institute of Microe
37997	20	13	Bizsurf (M) Sdn Bhd, Internet
46015	16	12	Exa Bytes Network Sdn.Bhd.
9655	13	12	TPM Corp. Berhad,
38466	14	11	MiTV Networks Sdn Bhd
18206	13	9	Vads MIS dual-homing connecti

Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:18	/9:13	/10:29	/11:88	/12:242
/13:478	/14:858	/15:1553	/16:12452	/17:6556	/18:10881
/19:21474	/20:30781	/21:32814	/22:43570	/23:40538	/24:227036
/25:1363	/26:1731	/27:892	/28:17	/29:22	/30:5
/31:0	/32:21				

November 2012 ↑

November 2011 ↓

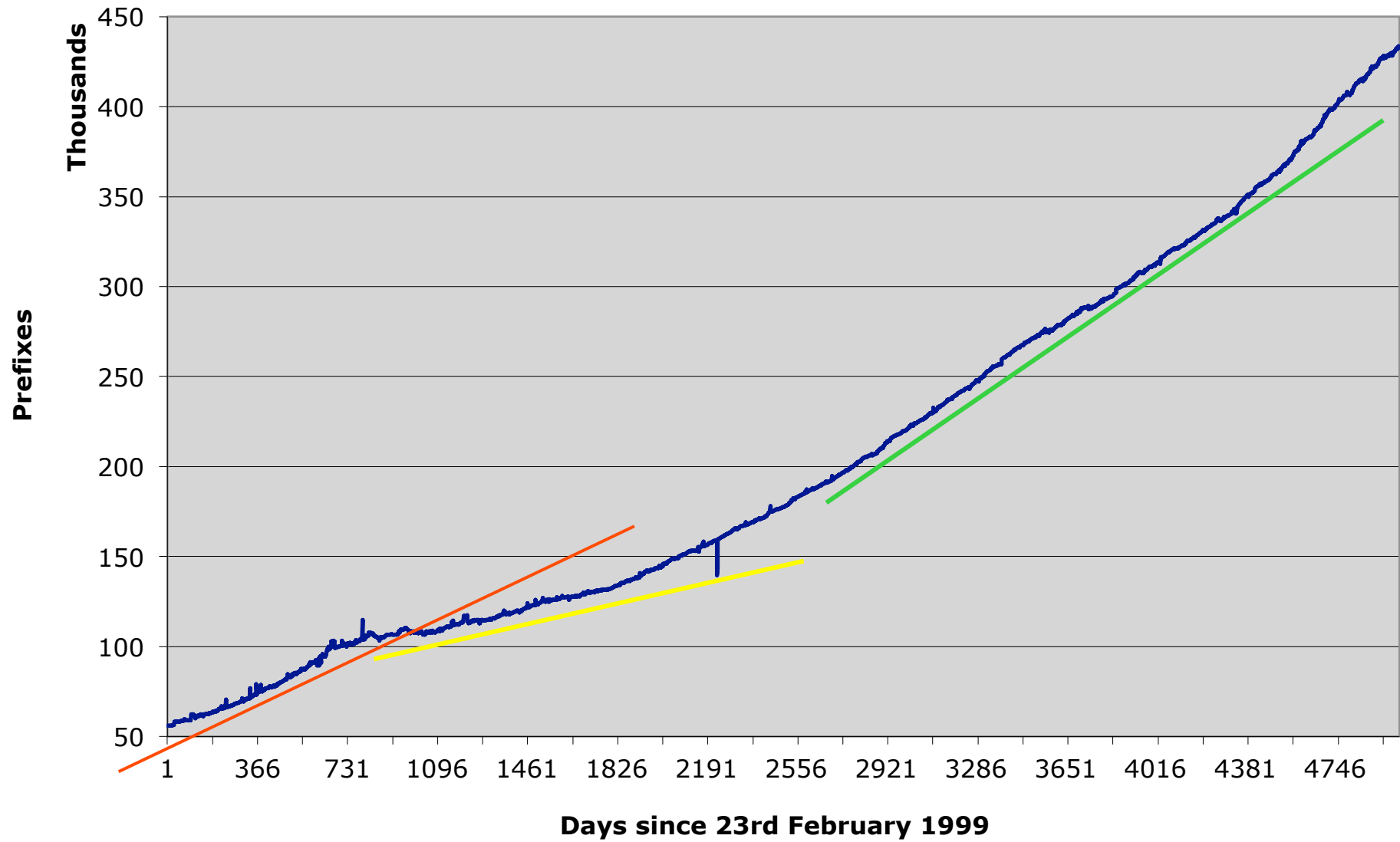
Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:19	/9:12	/10:27	/11:81	/12:236
/13:465	/14:809	/15:1435	/16:12033	/17:6094	/18:10149
/19:20022	/20:27724	/21:27918	/22:38079	/23:35615	/24:198927
/25:1145	/26:1352	/27:772	/28:164	/29:3	/30:0
/31:0	/32:5				

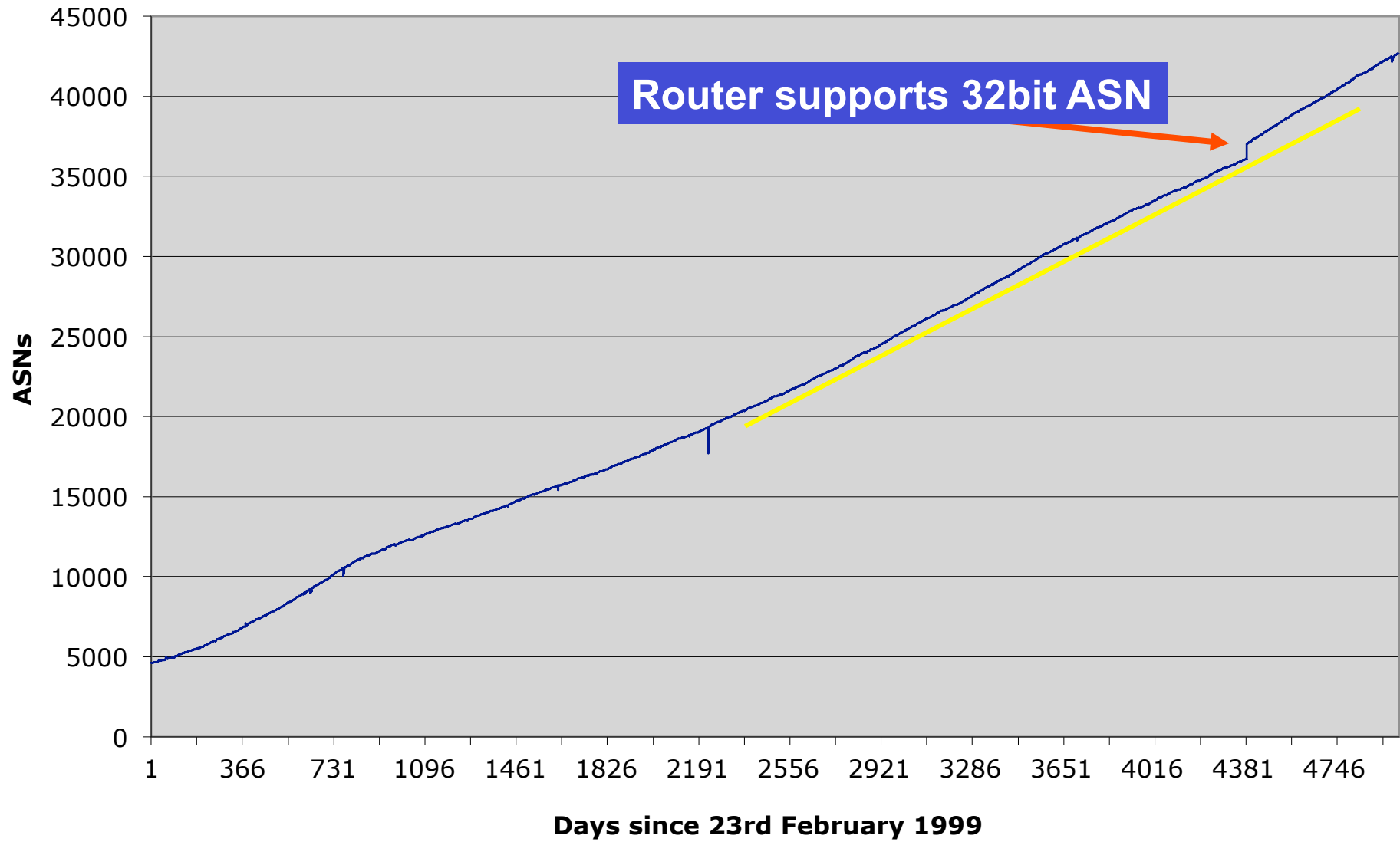
Prefixes Smaller than Registry Allocations

ASN	No of nets	Total ann.	Description
7029	2619	3192	Windstream Communications Inc
18566	2033	2083	Covad Communications
6389	1781	3147	bellsouth.net, inc.
8402	1507	1793	Corbina telecom
30036	1278	1364	Mediacom Communications Corp
22773	1273	1938	Cox Communications, Inc.
11492	1146	1181	Cable One
6503	1054	1536	AVANTEL, S.A.
1785	1017	1931	PaeTec Communications, Inc.
7011	957	1222	Citizens Utilities
6983	879	978	ITC^Deltacom
13977	847	861	FAIRPOINT COMMUNICATIONS, INC
4766	839	2944	Korea Telecom (KIX)
22561	837	1041	Digital Teleport, Inc
10620	767	2261	TVCABLE BOGOTA
36998	767	772	MOBITEL
31148	687	732	FreeNet ISP
3356	651	1105	Level 3 Communications, LLC
34984	629	848	BILISIM TELEKOM
20115	598	1684	Charter Communications

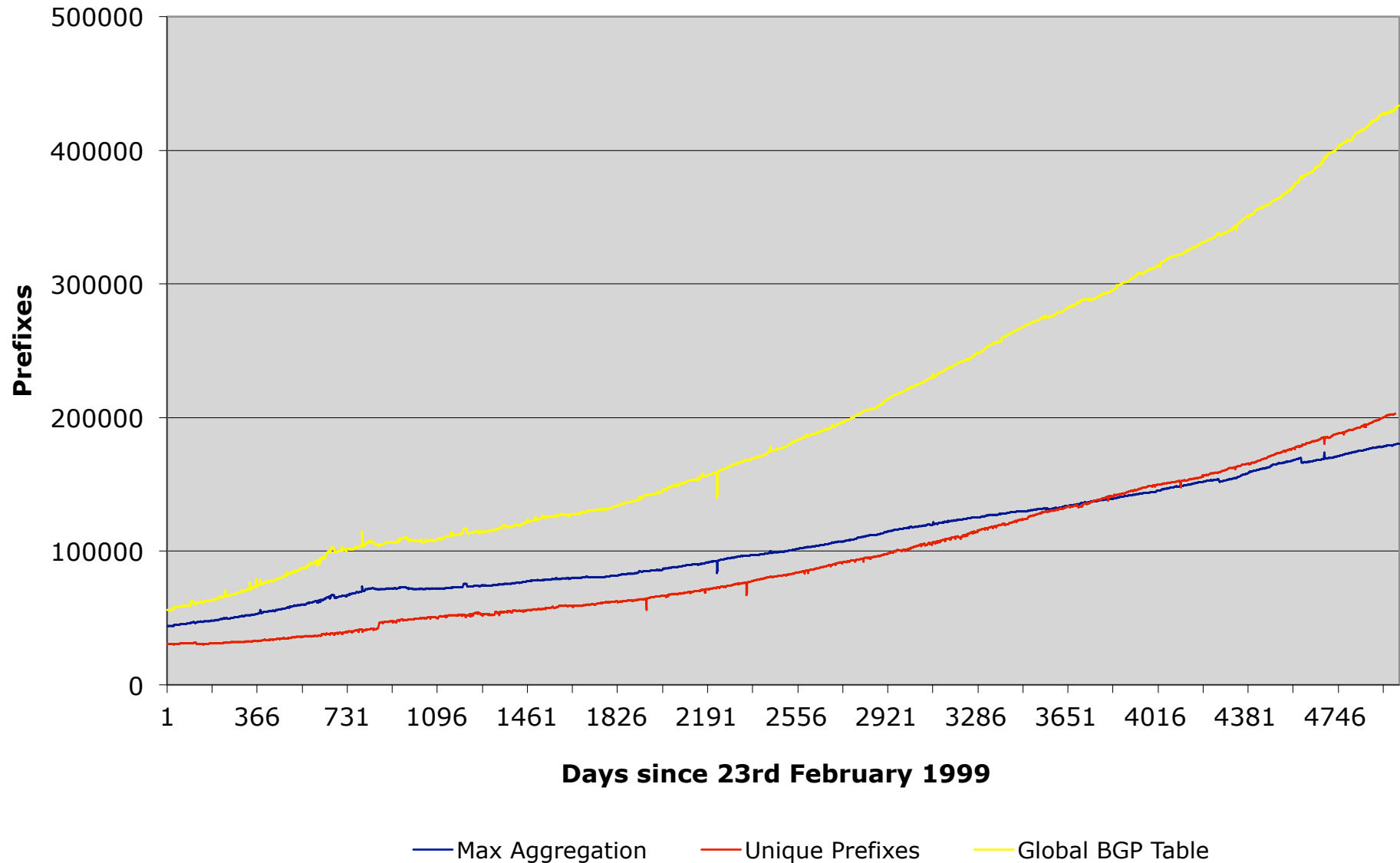
BGP Routing Table



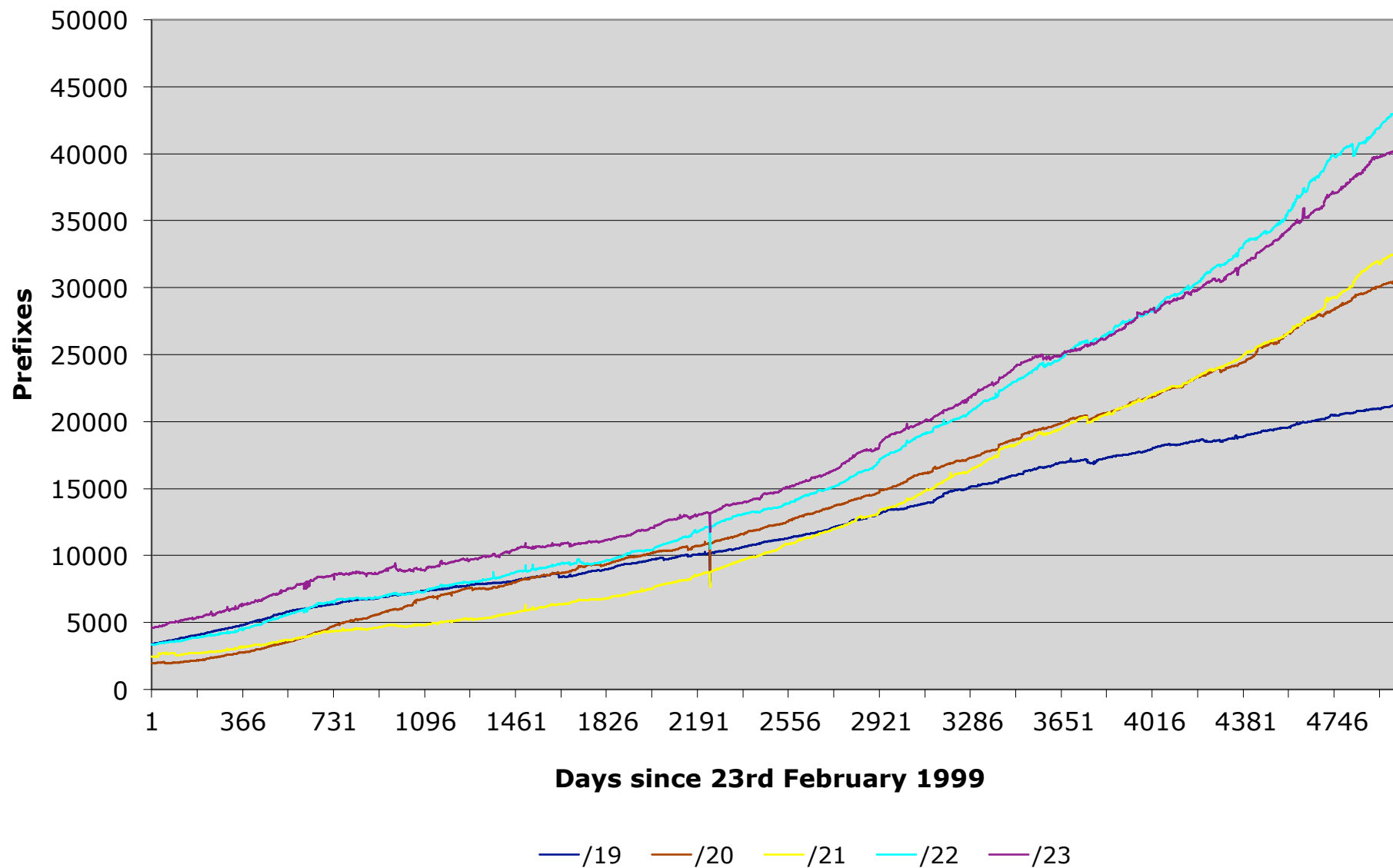
AS Growth



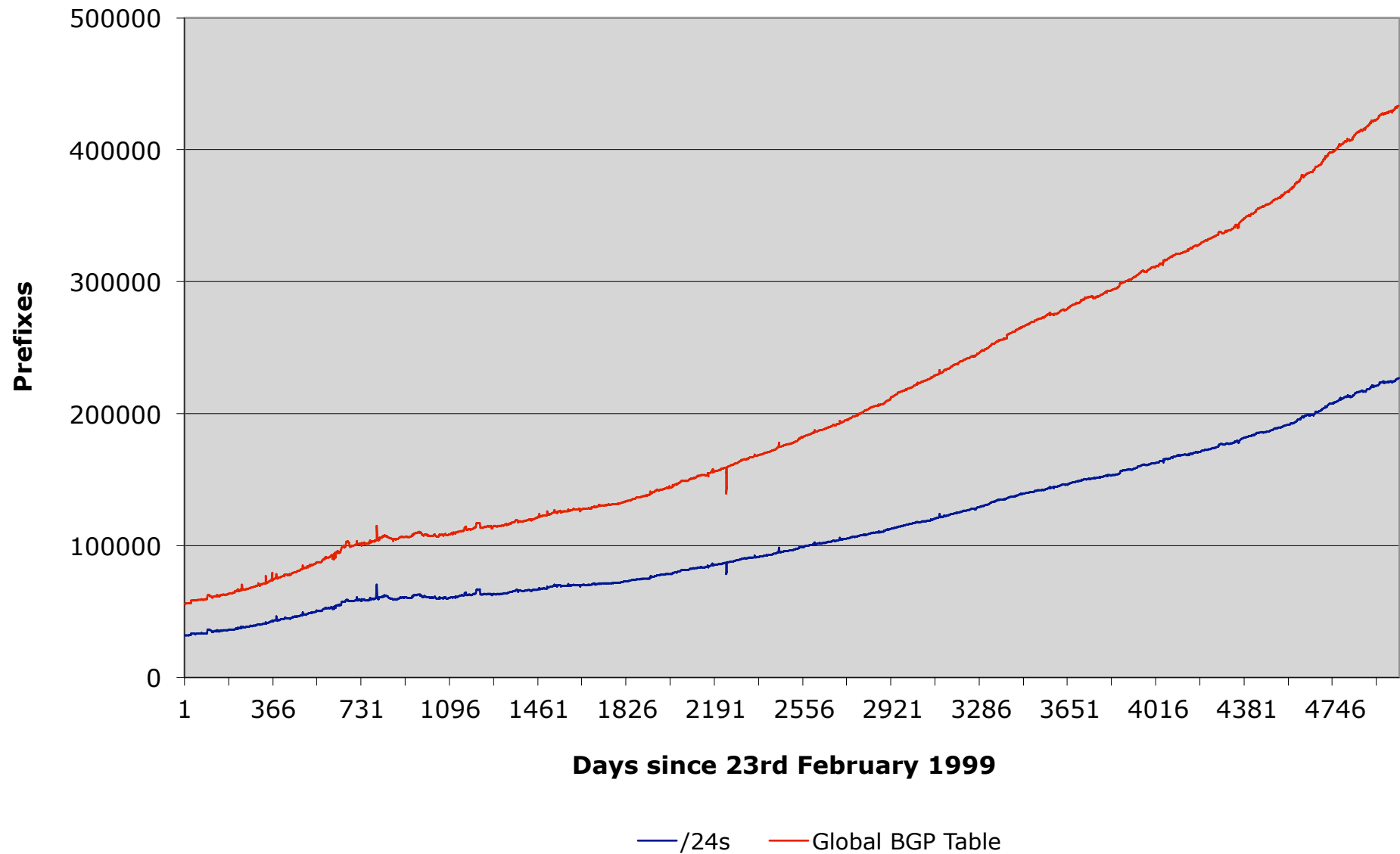
Max Aggregation vs Unique Prefixes



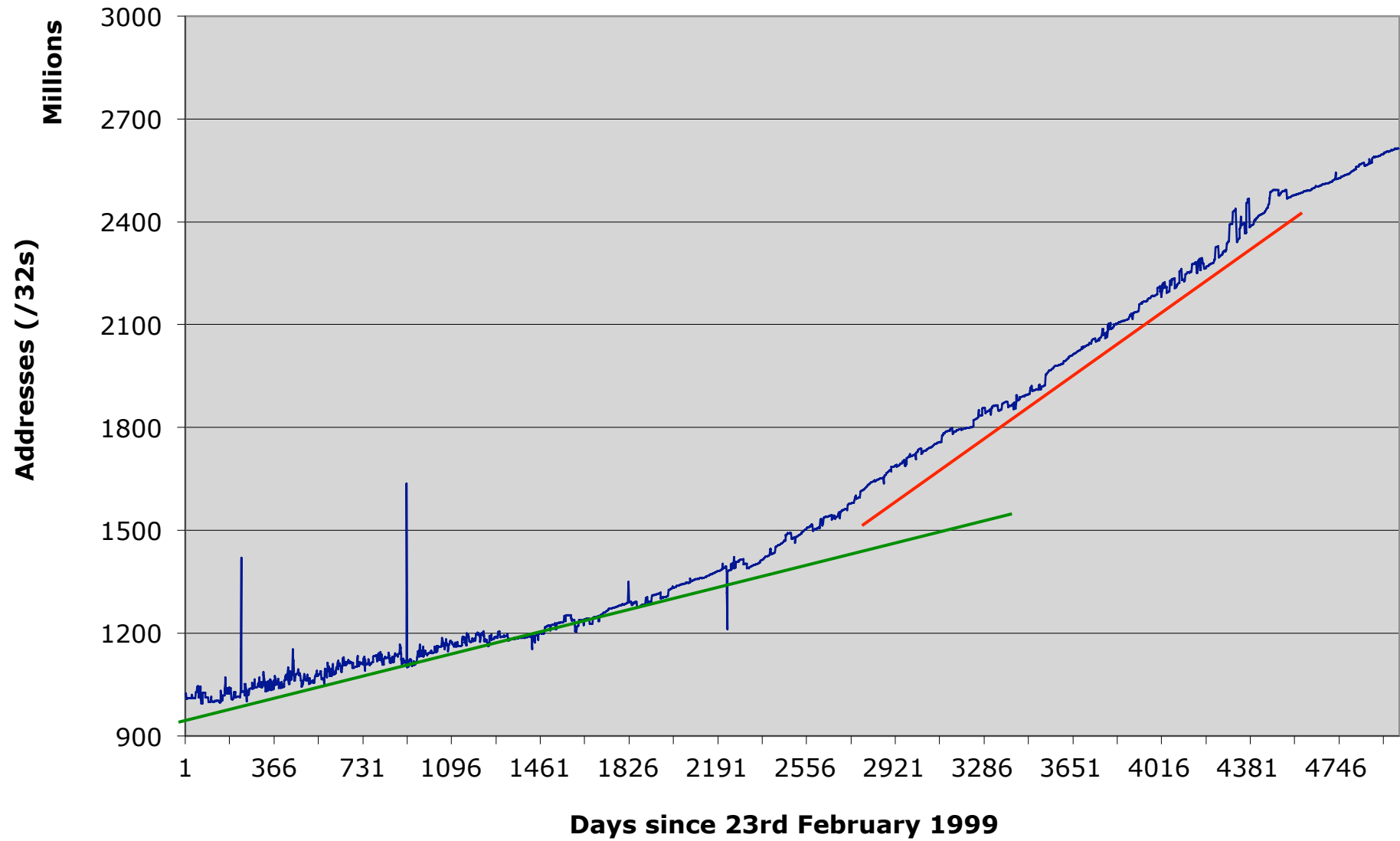
Prefix sizes announced



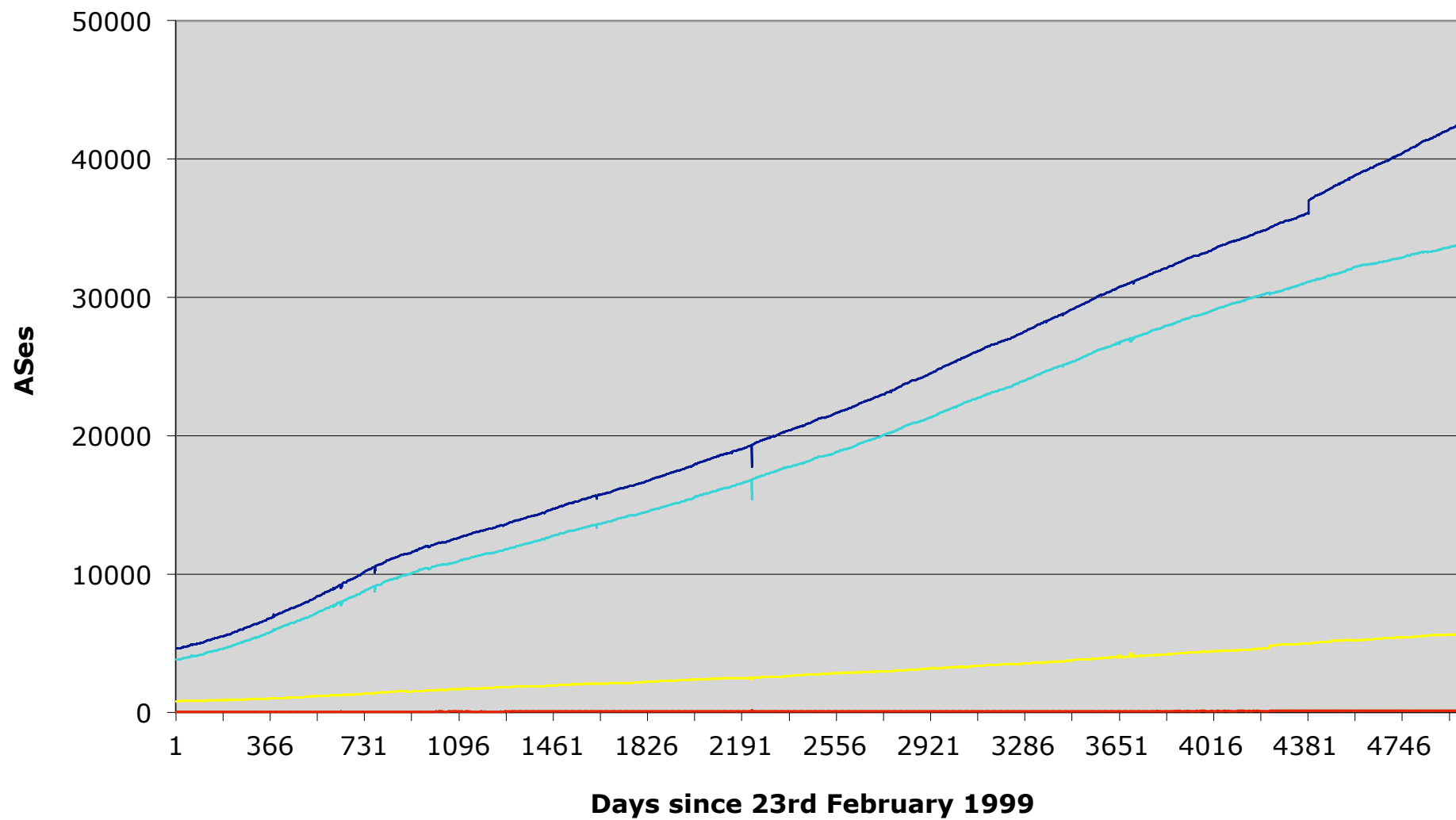
/24s announced



Address Space announced



AS Announcements



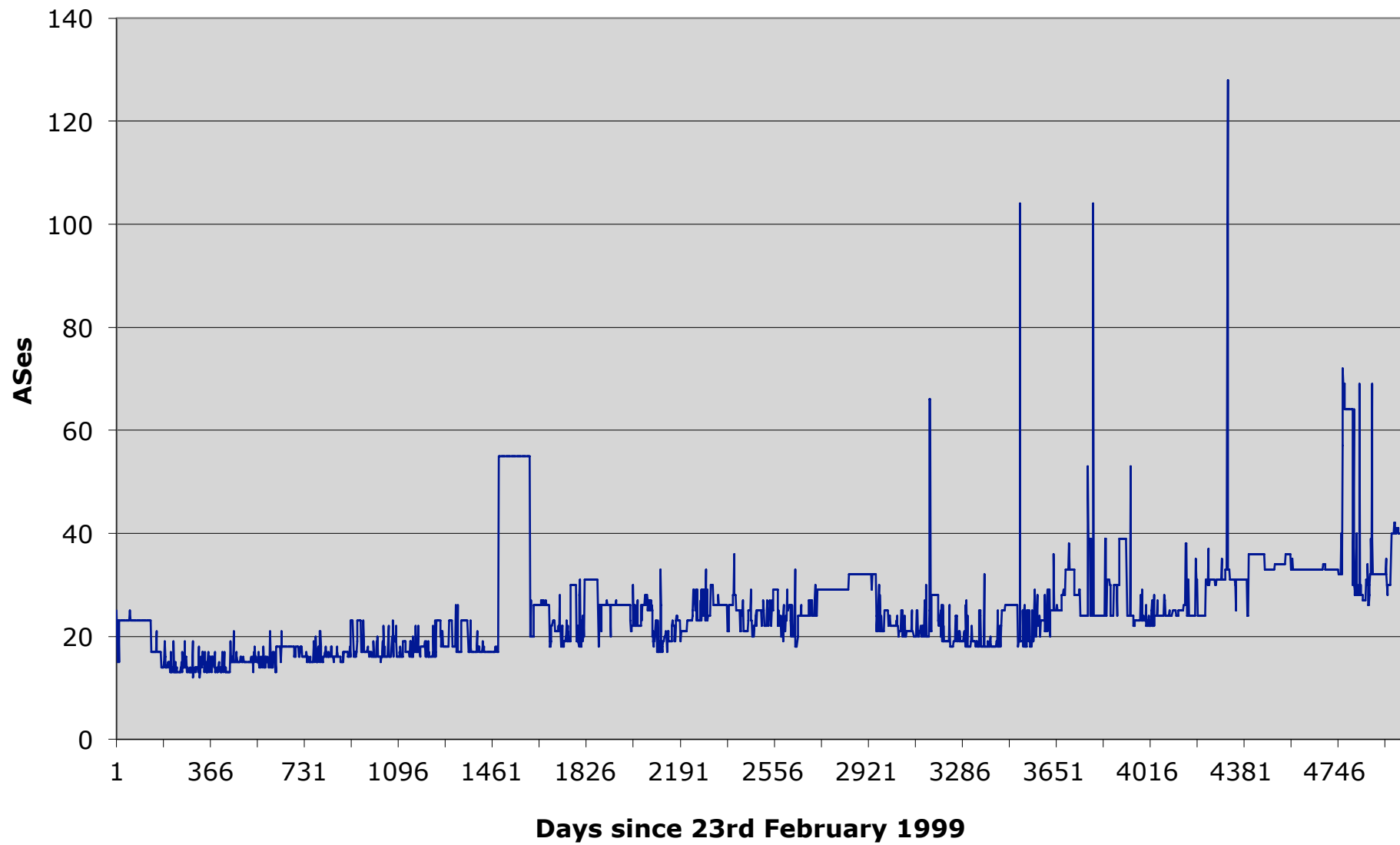
— Total ASNs

— Origin-only ASNs

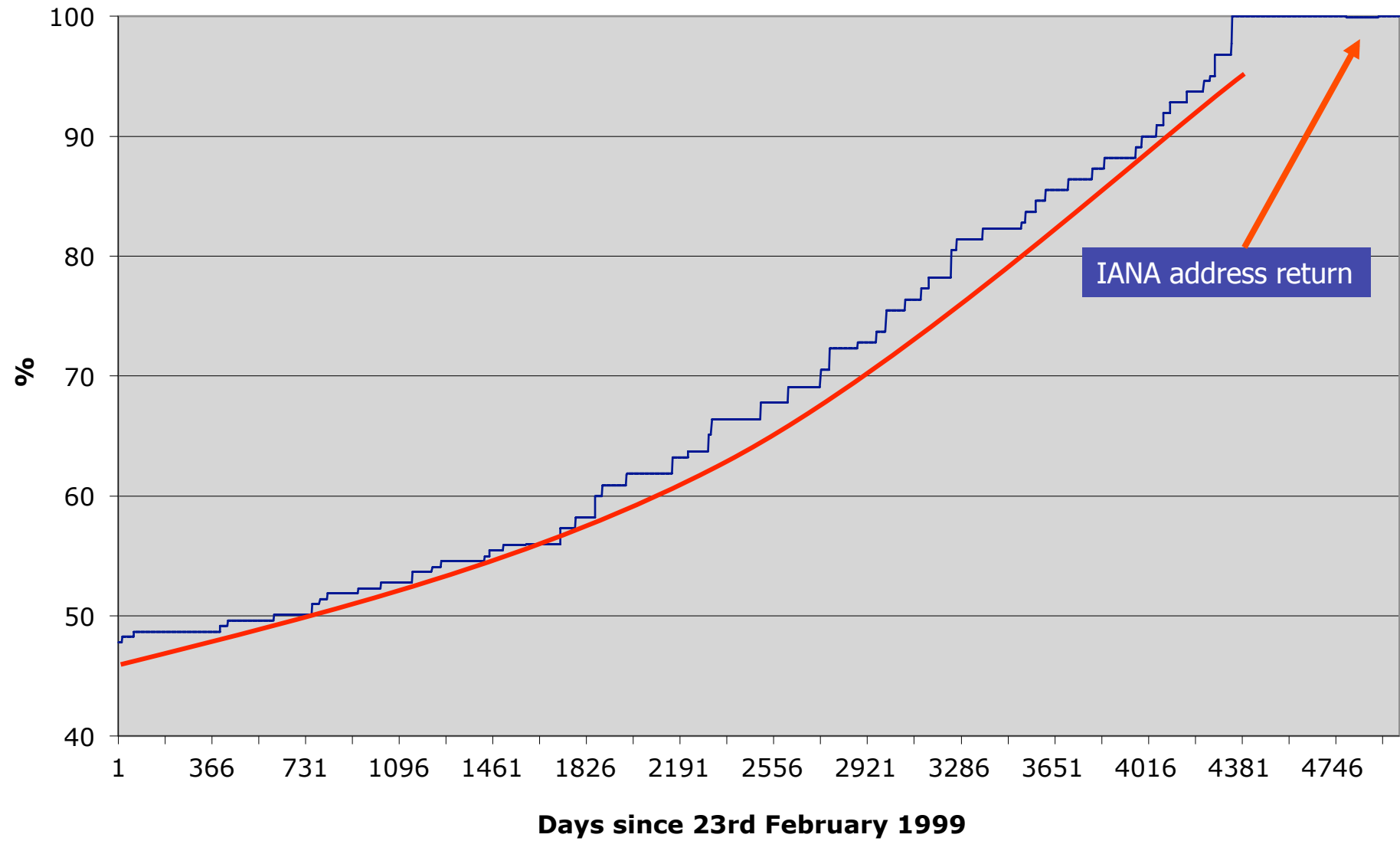
— ASN providing Transit & Origin

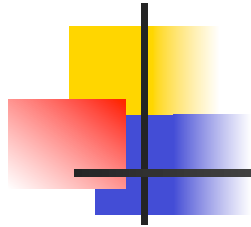
— Transit-only ASNs

Maximum AS Path Length



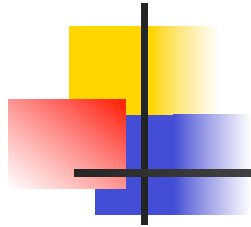
Growth in IPv4 Address Space Allocations





Looking at Deaggregation

- CIDR Report
 - www.cidr-report.org
 - Encourages aggregation following CIDRisation of Internet
 - Today: extensive suite of reports and tools covering state of BGP table
- Routing Report
 - BGP table status on per RIR basis
 - Original CIDR Report and a whole lot more



Deaggregation Factor

- 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 2012

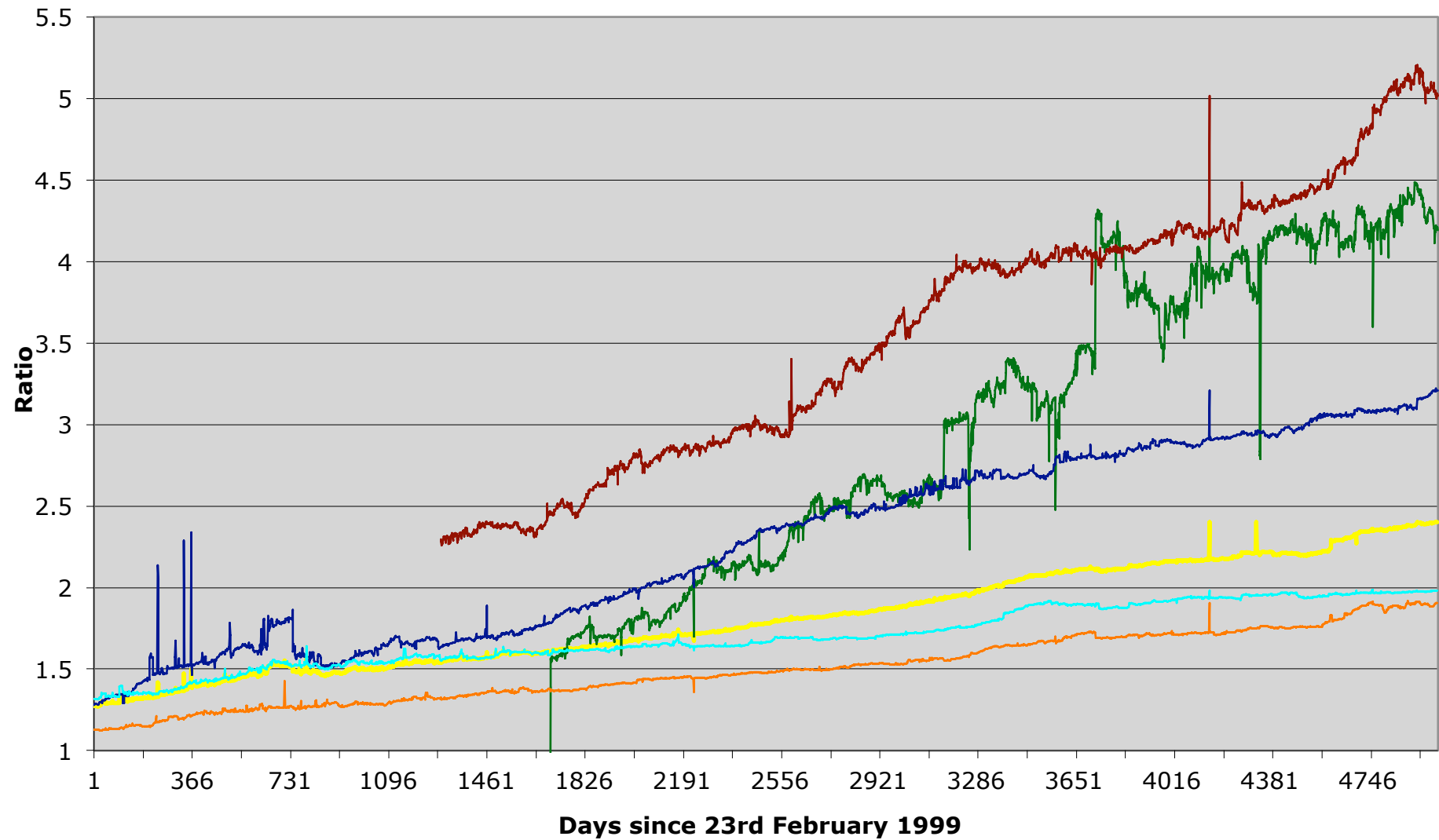
Total Prefixes

- Global BGP Table
 - 433k prefixes
- Europe & Middle East
 - 111k prefixes
- North America
 - 156k prefixes
- Asia & Pacific
 - 105k prefixes
- Africa
 - 9k prefixes
- Latin America & Caribbean
 - 44k prefixes

Deaggregation Factor

- Global Average
 - 2.40
- Europe & Middle East
 - 1.91
- North America
 - 1.98
- Asia & Pacific
 - 3.21
- Africa
 - 4.19
- Latin America & Caribbean
 - 5.02

Deaggregation: RIR Regions vs Global

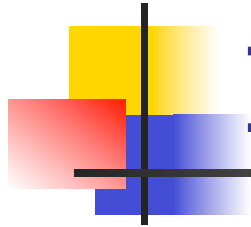


Global AfriNIC APNIC ARIN LACNIC RIPE

Asia Pacific Aggregation Savings Summary

ASN	No of Nets	Savings	Description
17974	2429	2383	PT TELEKOMUNIKASI INDONESIA
4766	2944	2044	Korea Telecom (KIX)
7545	1807	1718	TPG Internet Pty Ltd
4755	1624	1465	TATA Communications formerly
9829	1412	1370	BSNL National Internet Backbo
7552	1141	1130	Vietel Corporation
9498	1031	957	BHARTI Airtel Ltd.
24560	1040	875	Bharti Airtel Ltd., Telemedia
18101	1017	847	Reliance Infocom Ltd Internet
4808	1127	810	CNCGROUP IP network: China169
4780	843	774	Digital United Inc.
9808	756	743	Guangdong Mobile Communicatio
9583	1182	683	Sify Limited
17676	704	616	Softbank BB Corp.
45528	636	556	Tikona Digital Networks,
18207	542	507	IQARA BROADBAND
4788	528	483	Telekom Malaysia
17841	579	476	MIC EGOVERNMENT
17623	522	471	China Netcom Corp.
17803	621	470	BSES TeleCom Limited

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



Importance of Aggregation

- Size of routing table
 - Memory is no longer a problem
 - Routers can be specified to carry 1 million prefixes
- Convergence of the Routing System
 - This is a problem
 - Bigger table takes longer for CPU to process
 - BGP updates take longer to deal with
 - BGP Instability Report tracks routing system update activity
 - <http://bgpupdates.potaroo.net/instability/bgpupd.html>

The BGP Instability Report

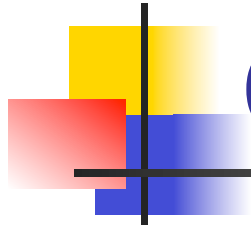
The BGP Instability Report is updated daily. This report was generated on 29 November 2012 06:15 (UTC+1000)

50 Most active ASes for the past 7 days

RANK	ASN	UPDs	%	Prefixes	UPDs/Prefix	AS NAME
1	37113	72331	4.02%	45	1607.36	tangerine-ug-as
2	3909	38512	2.14%	32	1203.50	QWEST-AS-3908 - Qwest Communications Company, LLC
3	36915	37552	2.09%	34	1104.47	AFOL-KE-AS
4	8402	36620	2.03%	2141	17.10	CORBINA-AS OJSC "Vimpelcom"
5	37044	33778	1.88%	20	1688.90	Tangerine-AS
6	9829	30882	1.72%	1412	21.87	BSNL-NIB National Internet Backbone
7	22561	21992	1.22%	1045	21.04	DIGITAL-TELEPORT - Digital Teleport Inc.
8	24757	21890	1.22%	56	390.89	EthioNet-AS
9	29039	17521	0.97%	9	1946.78	AFRICAONLINE-UG Africa Online Uganda
10	13118	15790	0.88%	50	315.80	ASN-YARTELECOM OJSC Rostelecom
11	29032	13655	0.76%	32	426.72	DATANET-UG DATANET LLC
12	29049	13574	0.75%	332	40.89	DELTA-TELECOM-AS Delta Telecom LTD.
13	27738	13148	0.73%	561	23.44	Ecuadortelecom S.A.
14	2708	12321	0.68%	137	89.93	Universidad de Guanajuato
15	7922	11064	0.61%	199	55.60	COMCAST-7922 - Comcast Cable Communications, Inc.
16	34400	10716	0.60%	260	41.22	ASN-ETTIHADETISALAT Etihad Etisalat
17	28885	10470	0.58%	140	74.79	OMANTEL-NAP-AS OmanTel NAP
18	43695	10287	0.57%	1	10287.00	LISNER_AS UNIQ LISNER Sp. z o.o.
19	37048	10140	0.56%	16	633.75	Foris-Uganda
20	9808	10128	0.56%	1124	9.01	CMNET-GD Guangdong Mobile Communication Co.Ltd.
21	21491	9303	0.52%	11	845.73	UGANDA-TELECOM Uganda Telecom
22	28573	9170	0.51%	2189	4.19	NET Servicos de Comunicacao S.A.
23	35819	9044	0.50%	215	42.07	MOBILY-AS Etihad Etisalat Company (Mobily)
24	17762	8622	0.48%	263	32.78	HTIL-TTML-IN-AP Tata Teleservices Maharashtra Ltd

50 Most active Prefixes for the past 7 days

RANK	PREFIX	UPDs	%	Origin AS -- AS NAME
1	151.118.18.0/24	12872	0.67%	3909 -- QWEST-AS-3908 - Qwest Communications Company, LLC
2	151.118.255.0/24	12818	0.67%	3909 -- QWEST-AS-3908 - Qwest Communications Company, LLC
3	151.118.254.0/24	12818	0.67%	3909 -- QWEST-AS-3908 - Qwest Communications Company, LLC
4	184.159.130.0/23	10874	0.57%	22561 -- DIGITAL-TELEPORT - Digital Teleport Inc.
5	184.157.224.0/19	10807	0.56%	22561 -- DIGITAL-TELEPORT - Digital Teleport Inc.
6	91.198.110.0/24	10287	0.54%	43695 -- LISNER_AS UNIQ LISNER Sp. z o.o.
7	93.181.254.0/23	9160	0.48%	13118 -- ASN-YARTELECOM OJSC Rostelecom
8	202.14.255.0/24	5685	0.30%	24057 -- AIGL-AS-AP PT. AIA FINANCIAL, Insurance company, Indonesia
9	12.139.133.0/24	5627	0.29%	14680 -- REALE-6 - Auction.com
10	23.67.247.0/24	5501	0.29%	7922 -- COMCAST-7922 - Comcast Cable Communications, Inc.
11	184.51.102.0/24	5497	0.29%	7922 -- COMCAST-7922 - Comcast Cable Communications, Inc.
12	139.139.19.0/24	5241	0.27%	1562 -- DNIC-ASBLK-01550-01601 - DoD Network Information Center
13	203.28.157.0/24	5167	0.27%	4802 -- ASN-IINET iiNet Limited
14	194.63.9.0/24	4777	0.25%	1273 -- CW Cable and Wireless Worldwide plc
15	123.252.208.0/24	4415	0.23%	17762 -- HTIL-TTML-IN-AP Tata Teleservices Maharashtra Ltd
16	192.58.232.0/24	4304	0.22%	6629 -- NOAA-AS - NOAA
17	192.58.2.0/24	4222	0.22%	6629 -- NOAA-AS - NOAA
18	69.38.178.0/24	4187	0.22%	19406 -- TWRS-MA - Towerstream I, Inc.
19	49.248.72.0/21	4176	0.22%	17762 -- HTIL-TTML-IN-AP Tata Teleservices Maharashtra Ltd
20	175.41.0.0/20	3255	0.17%	36408 -- ASN-PANTHER Panther Express
21	209.48.168.0/24	2749	0.14%	2033 -- PANIX - Panix Network Information Center
22	205.104.48.0/20	2712	0.14%	3475 -- DNIC-AS-03475 - Navy Network Information Center (NNIC)
23	115.170.128.0/17	2473	0.13%	4847 -- CNIX-AP China Networks Inter-Exchange
24	182.19.32.0/19	2271	0.12%	55410 -- VODAFONE-NET-AS-AP C48 Okhla Industrial Estate, New Delhi-110020
25	213.55.92.0/24	2219	0.12%	24757 -- EthioNet-AS
26	213.55.103.0/24	2217	0.12%	24757 -- EthioNet-AS
27	213.55.99.0/24	2217	0.12%	24757 -- EthioNet-AS
28	213.55.73.0/24	2217	0.12%	24757 -- EthioNet-AS
29	213.55.78.0/24	2215	0.12%	24757 -- EthioNet-AS



Observations

- Range of operational “practices” between RIR regions
 - Deaggregation by newer ISPs & developing regions is growing rapidly
 - Is harming the **entire** Internet
- RIPE-399 is only a recommendation
 - Hopefully all the RIRs will include pointers with each address allocation
 - Hopefully more ISPs will pay attention to it
 - Training is there — most ISPs choose to ignore it

Internet Routing Table Analysis Update



Questions?