

Internet IPv4 Routing Table Analysis Update



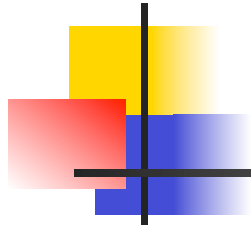
Philip Smith

philip@nsrc.org

SAFNOG 2

7th – 8th April 2015

Mbabane



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 7 April 2015

BGP routing table entries examined:	539369
Prefixes after maximum aggregation (per Origin AS):	206023
Deaggregation factor:	2.62
Unique aggregates announced (without unneeded subnets):	262797
Total ASes present in the Internet Routing Table:	49885
Prefixes per ASN:	10.81
Origin-only ASes present in the Internet Routing Table:	36548
Origin ASes announcing only one prefix:	16283
Transit ASes present in the Internet Routing Table:	6299
Transit-only ASes present in the Internet Routing Table:	174
Average AS path length visible in the Internet Routing Table:	4.4
Max AS path length visible:	44
Max AS path prepend of ASN (55944)	41
Prefixes from unregistered ASNs in the Routing Table:	1132
Unregistered ASNs in the Routing Table:	408
Number of 32-bit ASNs allocated by the RIRs:	9069
Number of 32-bit ASNs visible in the Routing Table:	7038
Prefixes from 32-bit ASNs in the Routing Table:	25405
Number of bogon 32-bit ASNs visible in the Routing Table:	4
Special use prefixes present in the Routing Table:	0
Prefixes being announced from unallocated address space:	362
Number of addresses announced to Internet:	2740633764
Equivalent to 163 /8s, 90 /16s and 192 /24s	
Percentage of available address space announced:	74.0
Percentage of allocated address space announced:	74.0
Percentage of available address space allocated:	100.0
Percentage of address space in use by end-sites:	97.3
Total number of prefixes smaller than registry allocations:	181903

AfriNIC Region

Prefixes being announced by AfriNIC Region ASes:	12715
Total AfriNIC prefixes after maximum aggregation:	3011
AfriNIC Deaggregation factor:	4.22
Prefixes being announced from the AfriNIC address blocks:	13772
Unique aggregates announced from the AfriNIC address blocks:	5106
AfriNIC Region origin ASes present in the Internet Routing Table:	731
AfriNIC Prefixes per ASN:	18.84
AfriNIC Region origin ASes announcing only one prefix:	195
AfriNIC Region transit ASes present in the Internet Routing Table:	159
Average AfriNIC Region AS path length visible:	4.5
Max AfriNIC Region AS path length visible:	25
Number of AfriNIC region 32-bit ASNs visible in the Routing Table:	101
Number of AfriNIC addresses announced to Internet:	64680704
Equivalent to 3 /8s, 218 /16s and 243 /24s	
Percentage of available AfriNIC address space announced:	64.3

AfriNIC AS Blocks 36864-37887, 327680-328703 & ERX transfers
AfriNIC Address Blocks 41/8, 102/8, 105/8, 154/8, 196/8, 197/8 + IANA pool

Global per AS prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
10620	3147	513	234	Telmex Colombia S.A.
22773	3016	2956	142	Cox Communications Inc.
6389	2881	3688	51	BellSouth.net Inc.
4766	2866	11553	914	Korea Telecom
17974	2797	904	78	PT Telekomunikasi Indonesia
7545	2562	336	126	TPG Telecom Limited
3356	2545	10683	474	Level 3 Communications, Inc.
39891	2472	128	6	SaudiNet, Saudi Telecom Compa
28573	2416	2171	123	NET Serviços de Comunicação
18566	2041	379	183	MegaPath Corporation
4755	2002	422	212	TATA Communications formerly
34984	1982	304	359	TELLCOM ILETISIM HIZMETLERI A
20115	1850	1832	430	Charter Communications
4538	1760	4190	71	China Education and Research
6983	1725	866	245	EarthLink, Inc.
7303	1704	1102	241	Telecom Argentina S.A.
8452	1689	958	13	TE-AS
9829	1685	1326	39	BSNL, National Internet Back
20940	1664	640	1232	Akamai International B.V.
4323	1619	1021	408	tw telecom holdings, inc.

AfriNIC APNIC ARIN LACNIC RIPE NCC

Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:16	/9:12	/10:34	/11:92	/12:264
/13:508	/14:999	/15:1721	/16:12953	/17:7205	/18:12229
/19:25339	/20:35844	/21:38612	/22:58518	/23:51134	/24:290854
/25:1111	/26:1174	/27:658	/28:14	/29:11	/30:8
/31:0	/32:13				

April 2015 ↑

April 2014 ↓

Number of prefixes announced by prefix length

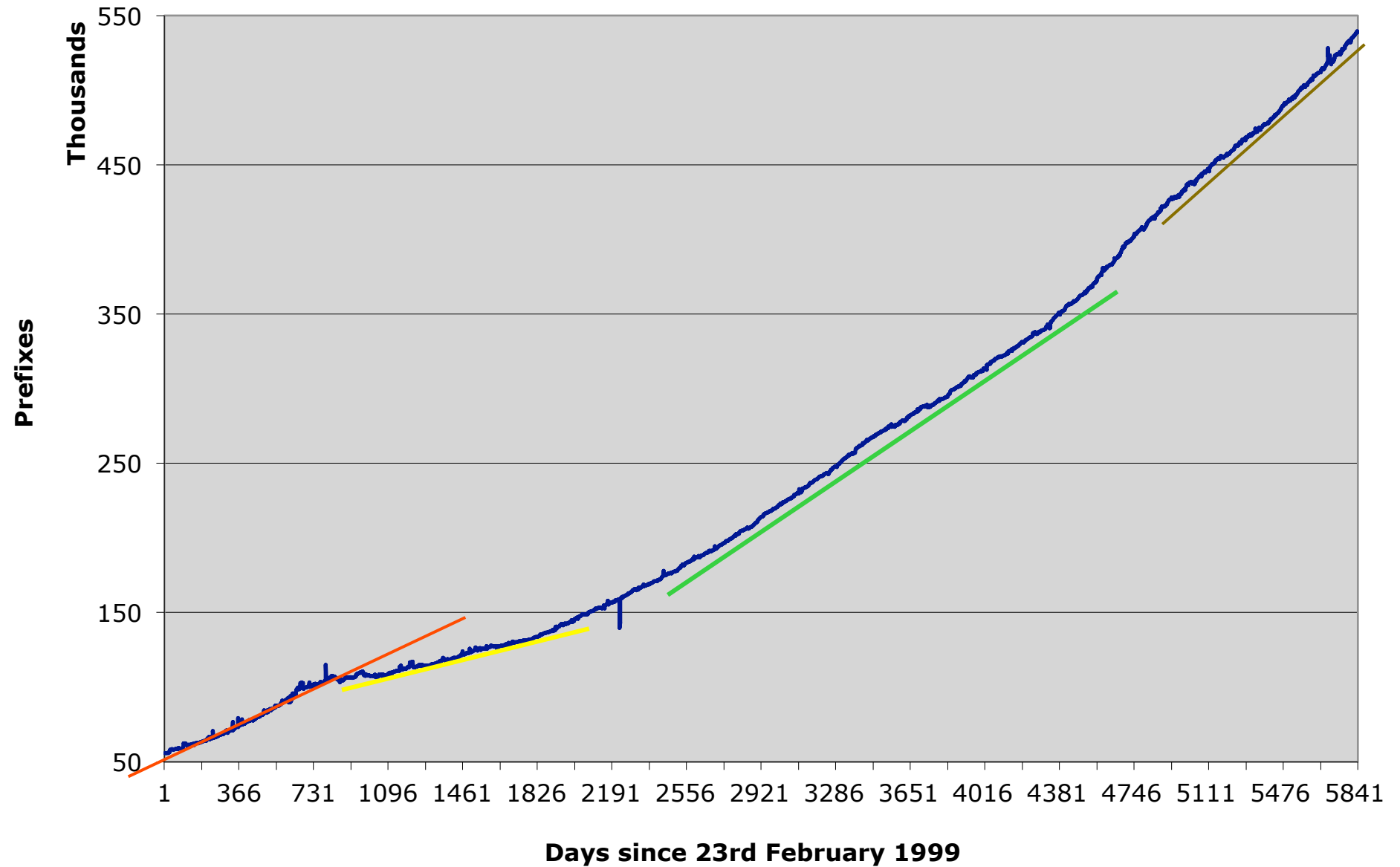
/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:16	/9:12	/10:30	/11:90	/12:256
/13:478	/14:953	/15:1660	/16:12902	/17:6789	/18:11527
/19:24007	/20:33896	/21:36581	/22:52220	/23:45728	/24:260078
/25:813	/26:879	/27:423	/28:13	/29:20	/30:8
/31:1	/32:38				

Prefixes Smaller than Registry Allocations

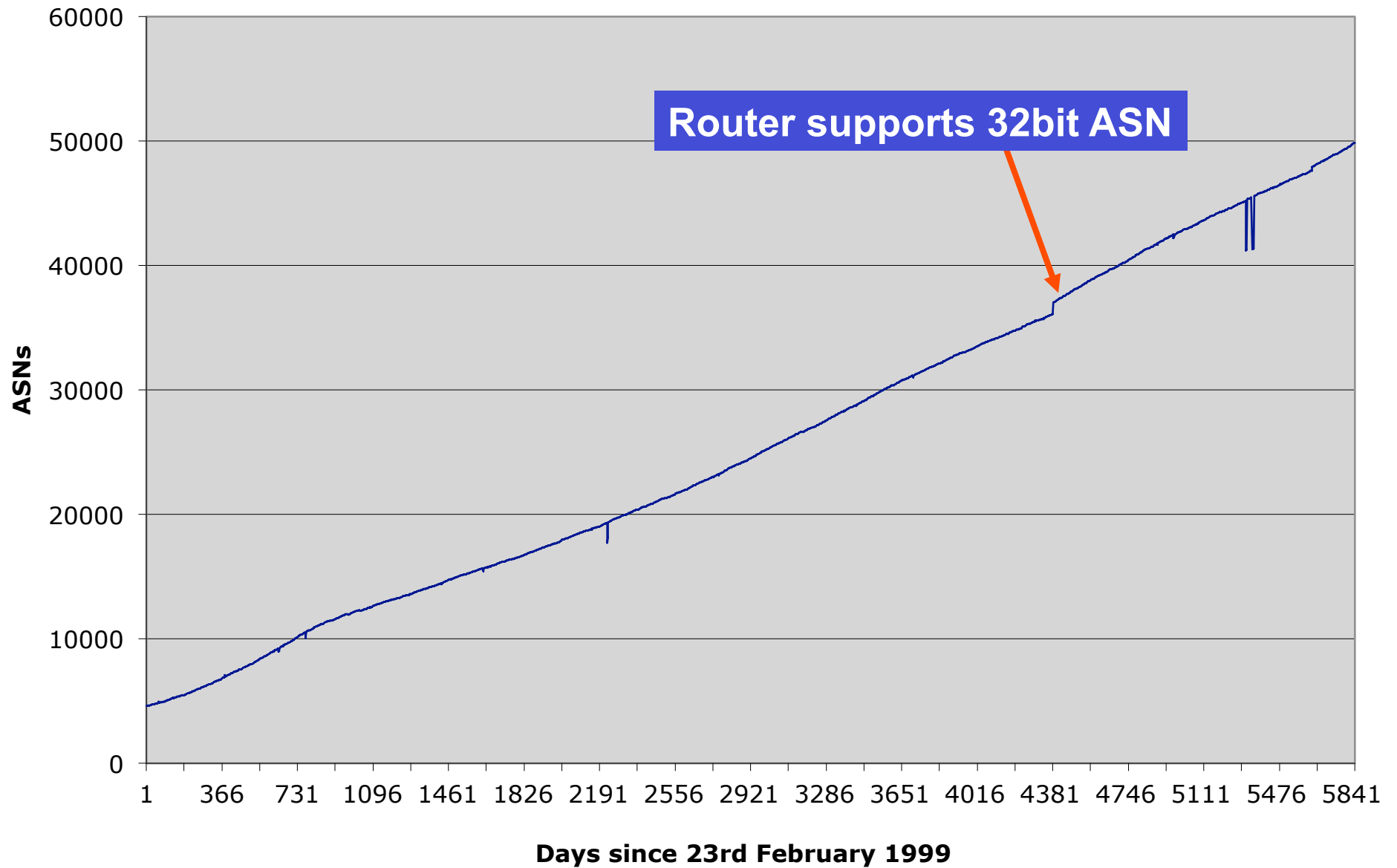
ASN	No of nets	Total ann.	Description
39891	2432	2472	SaudiNet, Saudi Telecom Compa
22773	2230	3018	Cox Communications Inc.
18566	1996	2041	MegaPath Corporation
6389	1671	2881	BellSouth.net Inc.
6983	1371	1724	EarthLink, Inc.
30036	1362	1515	Mediacom Communications Corp
34984	1287	1982	TELLCOM ILETISIM HIZMETLERI A
6147	1145	1597	Telefonica del Peru S.A.A.
10620	1116	3156	Telmex Colombia S.A.
11492	1110	1173	CABLE ONE, INC.
8402	1020	1333	OJSC "Vimpelcom"
22561	1012	1337	CenturyTel Internet Holdings,
6849	994	1212	JSC "Ukrtelecom"
31148	964	1046	Freenet Ltd.
8452	957	1609	TE-AS
13188	848	1024	TOV "Bank-Inform"
7011	811	1030	Frontier Communications of Am
13977	799	826	FAIRPOINT COMMUNICATIONS, INC
27738	759	781	Ecuadortelemcom S.A.
3356	721	2542	Level 3 Communications, Inc.

AfriNIC APNIC ARIN LACNIC RIPE NCC

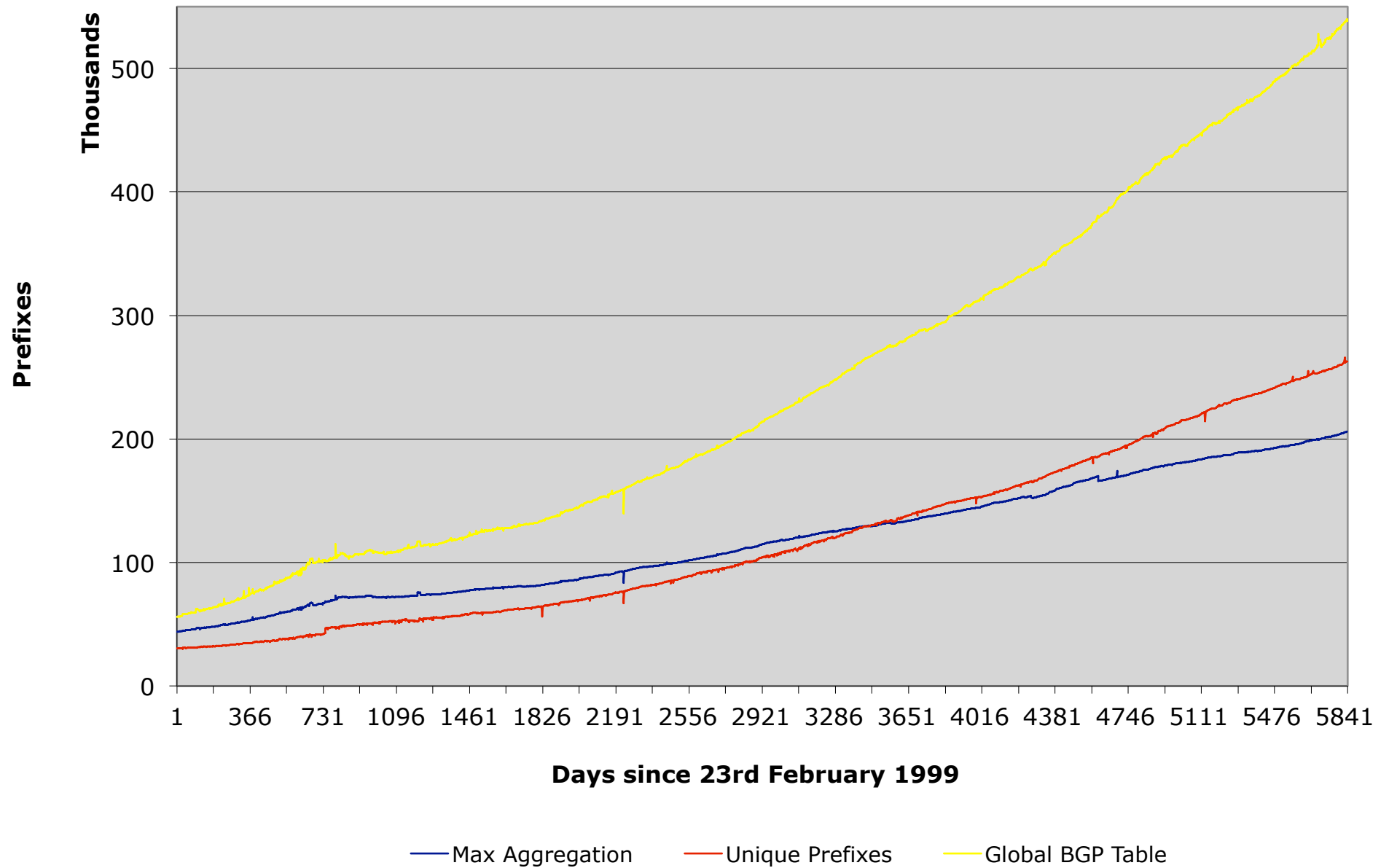
BGP Routing Table



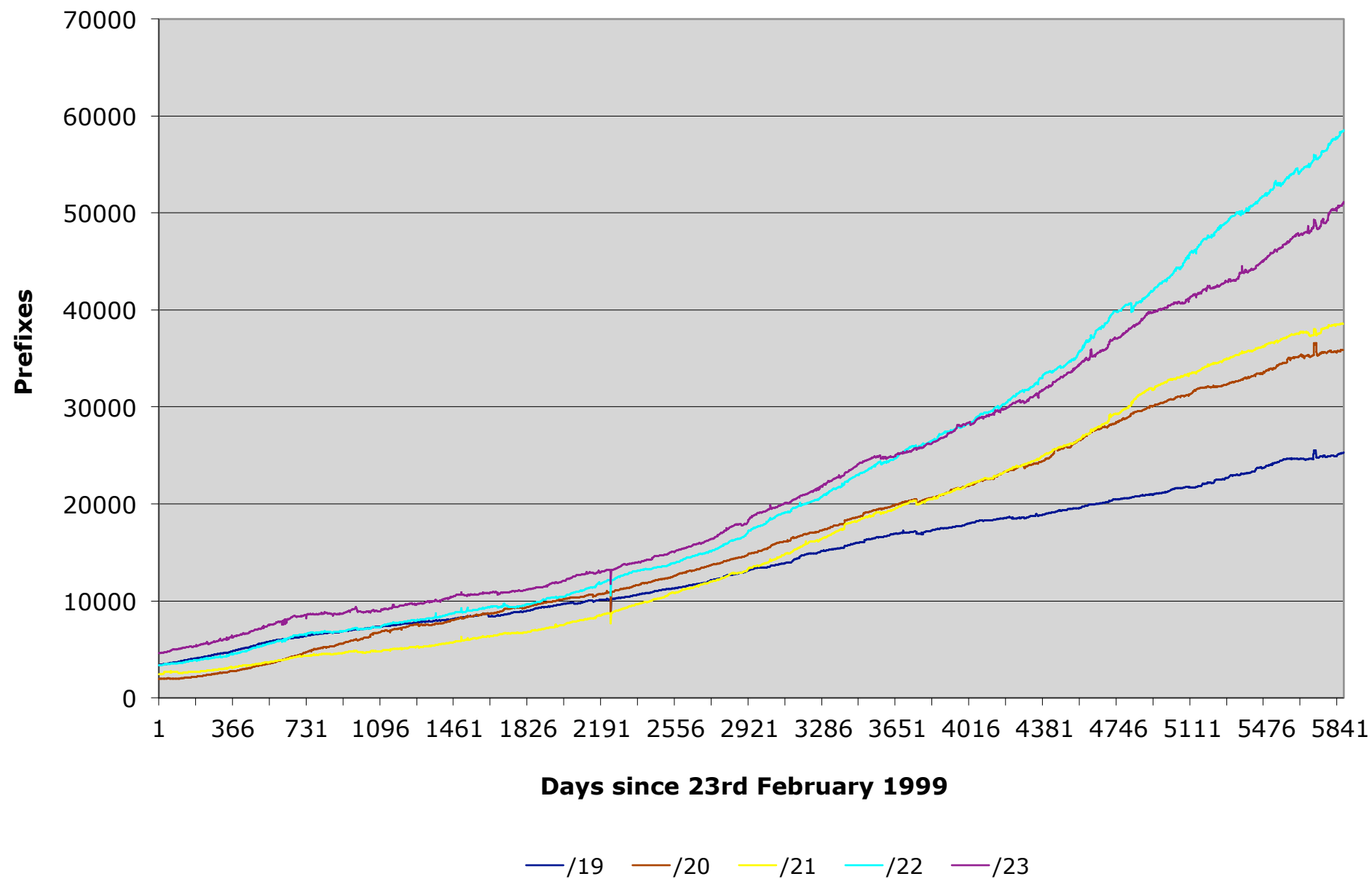
AS Growth



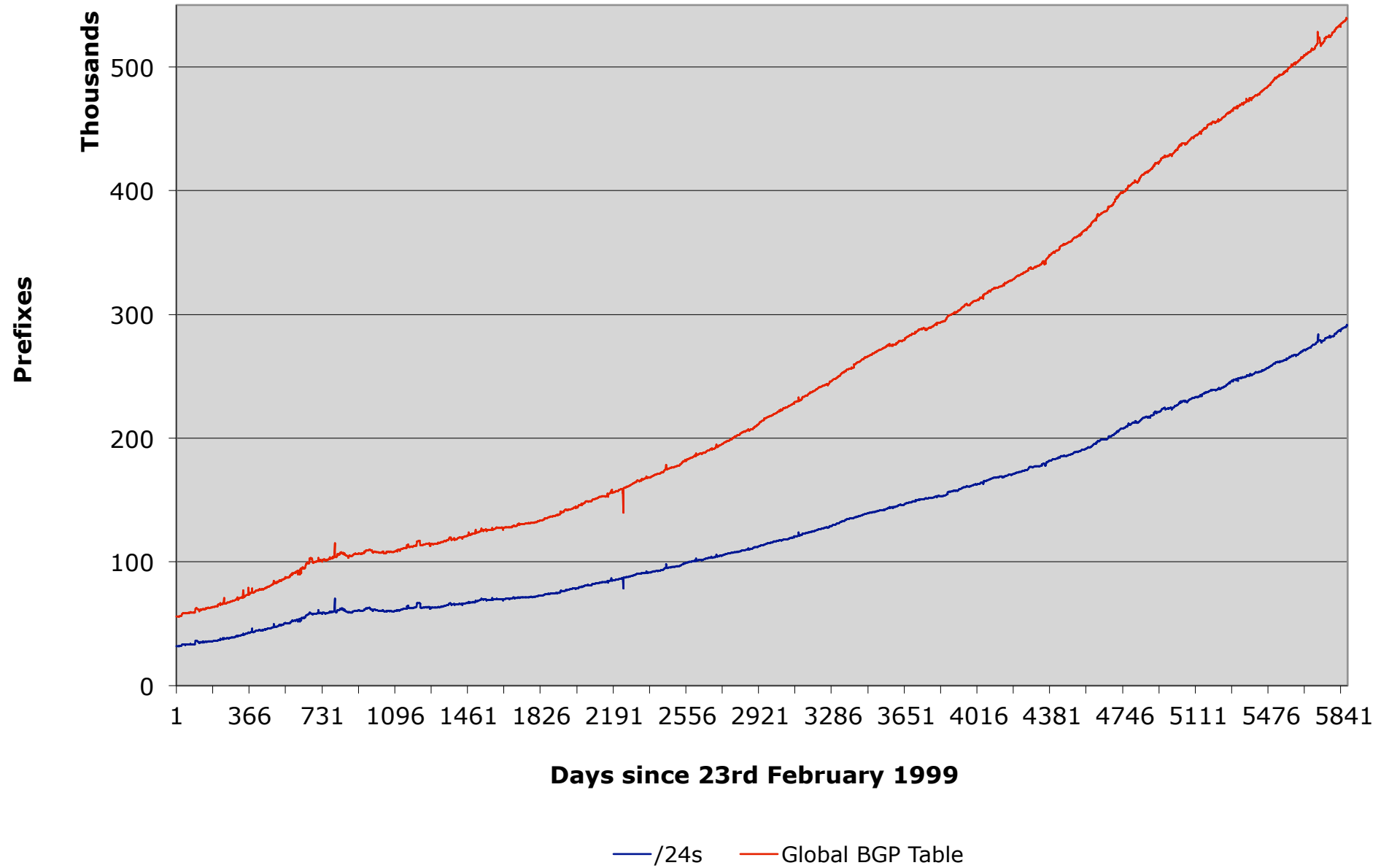
Max Aggregation vs Unique Prefixes



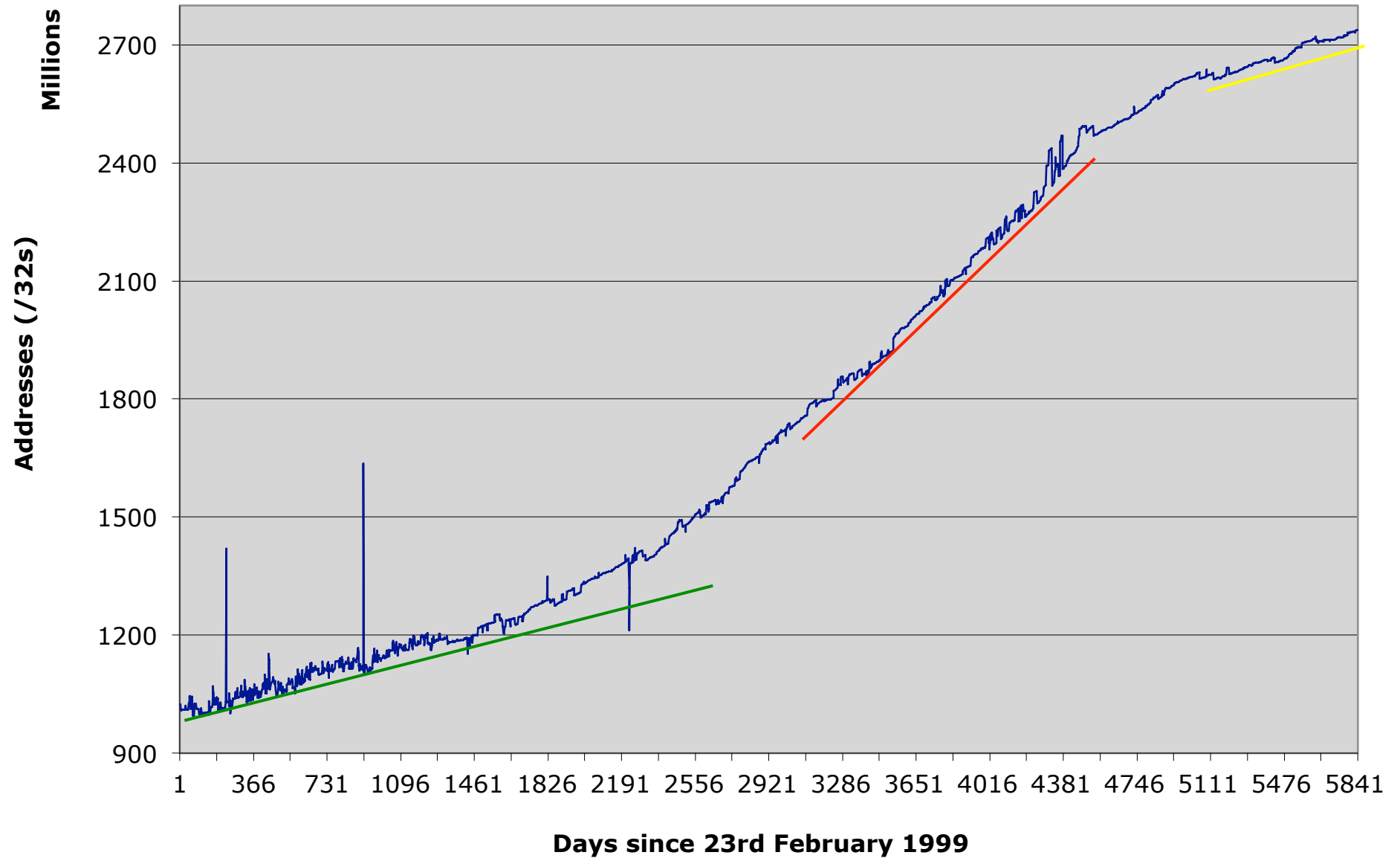
Prefix sizes announced



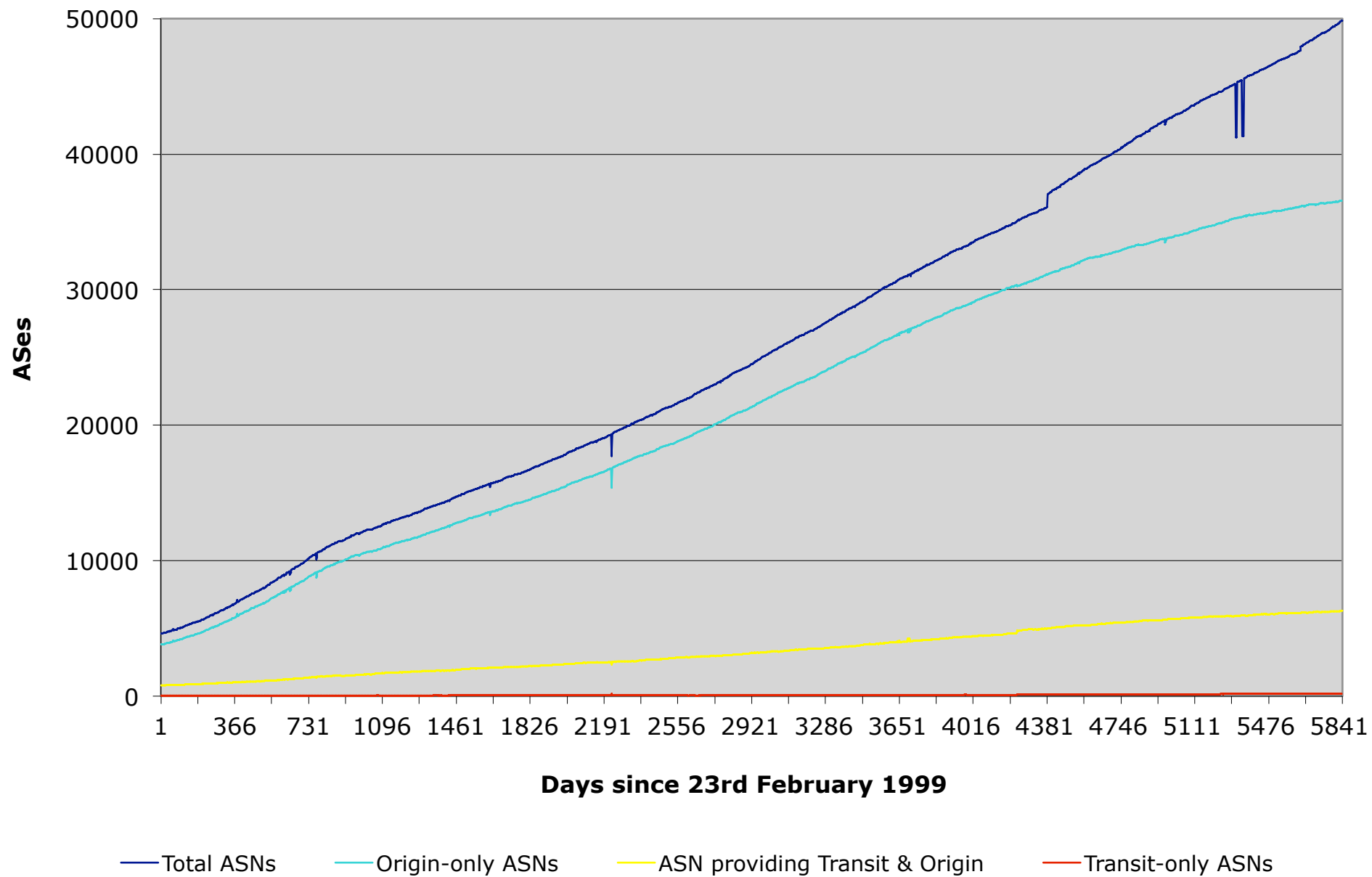
/24s announced



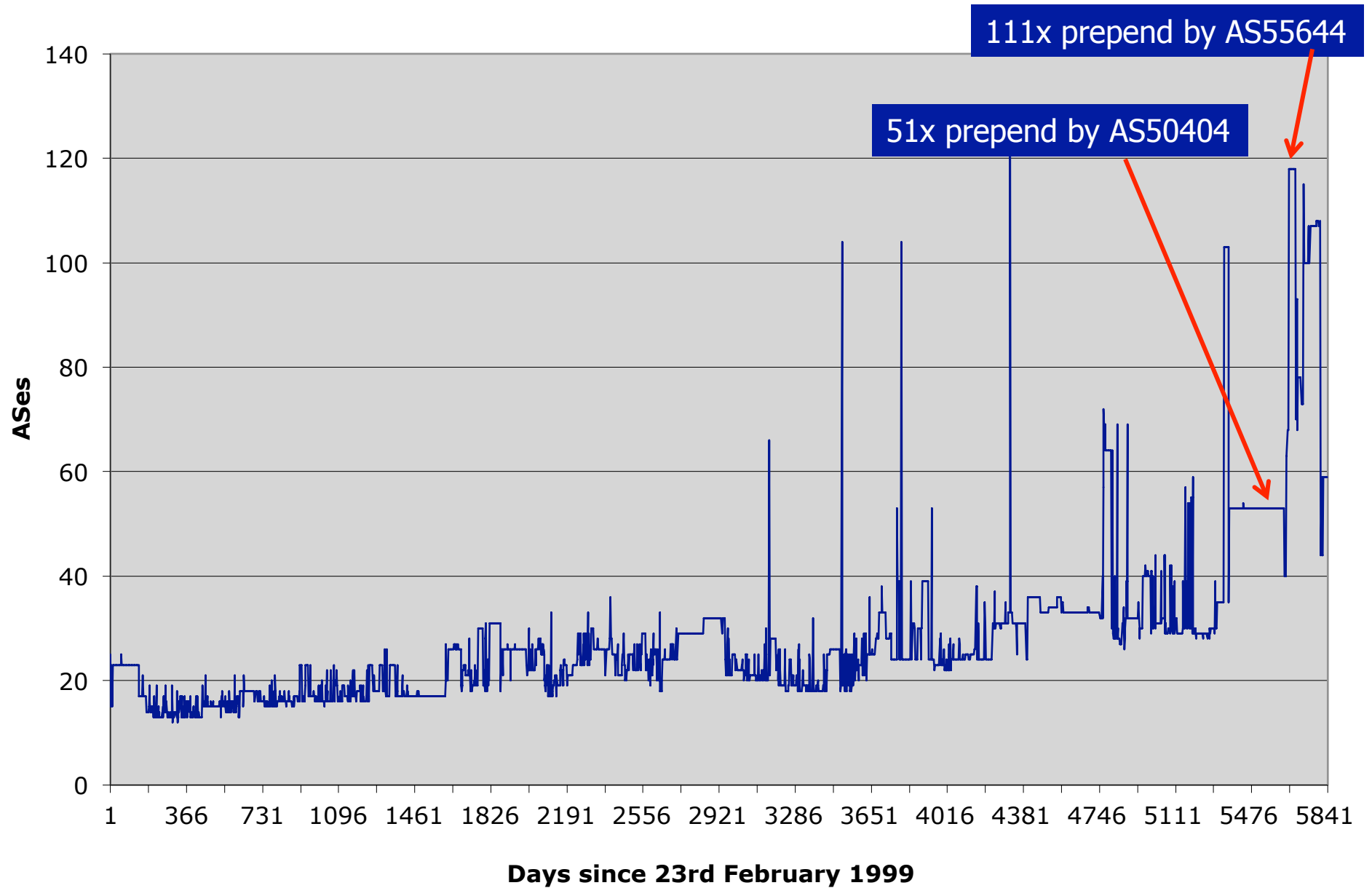
Address Space announced

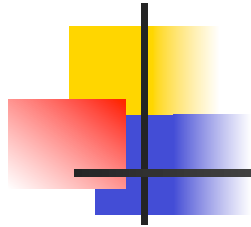


AS Announcements



Maximum AS Path Length





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”



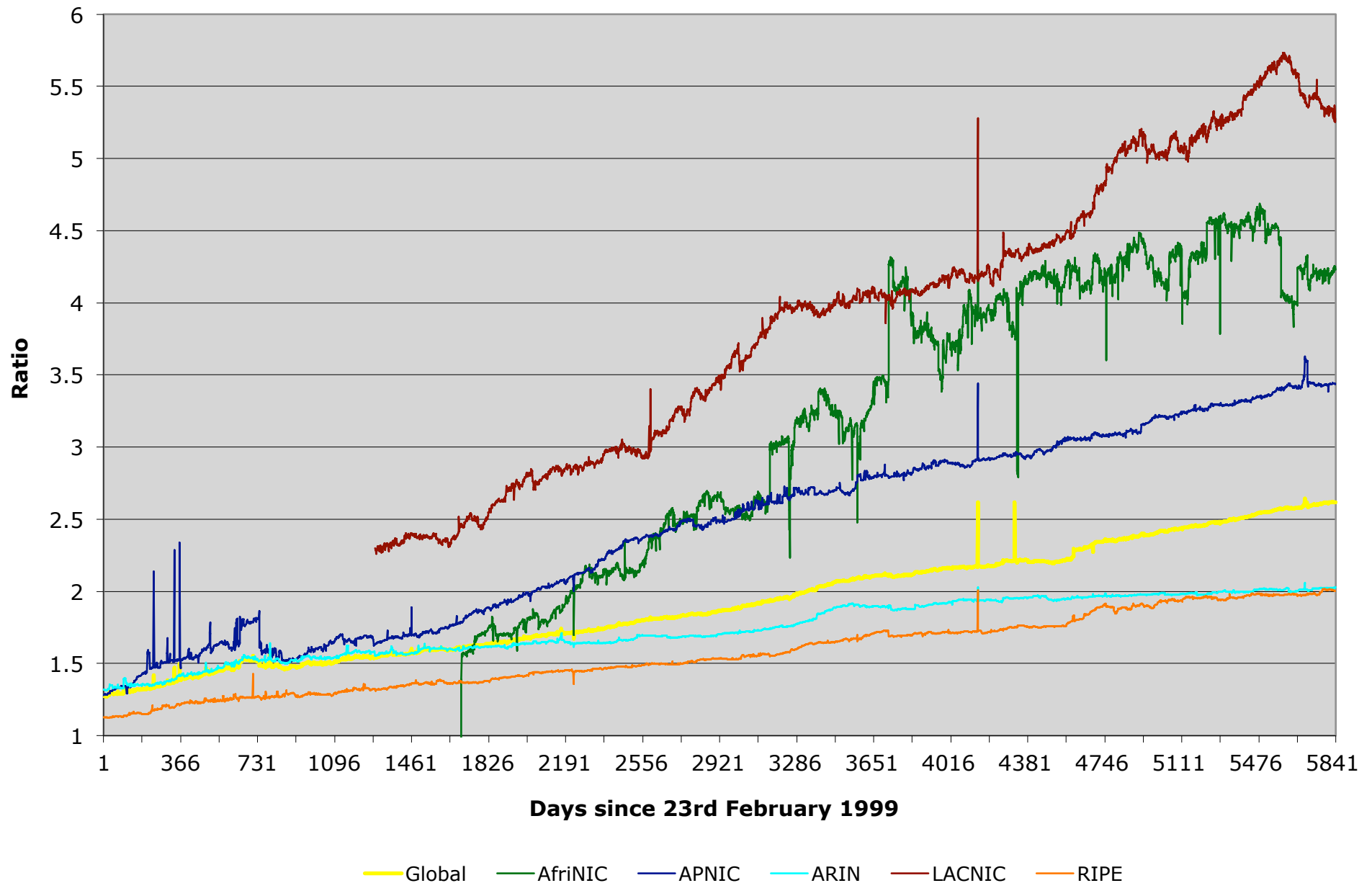
Total Prefixes

- Global BGP Table
 - 539k prefixes
- Europe & Middle East
 - 131k prefixes
- North America
 - 178k prefixes
- Asia & Pacific
 - 133k prefixes
- Africa
 - 13k prefixes
- Latin America & Caribbean
 - 59k prefixes

Deaggregation Factor

- Global Average
 - 2.62
- Europe & Middle East
 - 2.01
- North America
 - 2.03
- Asia & Pacific
 - 3.44
- Africa
 - 4.23
- Latin America & Caribbean
 - 5.28

Deaggregation: RIR Regions vs Global



AfriNIC Region Aggregation Savings Summary

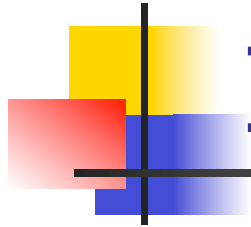
ASN	No of Nets	Savings	Description
8452	1696	1683	Telecom Egypt
24863	964	937	Link Egypt (Link.NET)
36903	479	389	MAROC TELECOM
36992	417	385	ETISALAT MISR
24835	300	291	Vodafone Data Egypt
29571	232	219	Cote d'Ivoire Telecom
37492	277	212	Orange Tunisie
36947	184	171	Telecom Algeria
15706	172	166	Sudatel (Sudan Telecom Co. Ltd)
37054	154	148	TELMA Global Net
29975	160	140	Vodacom ZA
6713	157	135	MAROC TELECOM
23889	120	107	MAURITIUS TELECOM
12258	171	101	MWEB CONNECT (PROPRIETARY) LI
37127	100	93	Visafone Communications Limit
37693	116	85	OOREDOO TUNISIE SA
36935	109	85	Vodafone Data Egypt
37340	89	81	SPECTRANET LIMITED
3067	149	77	Infovan (Pty) Ltd
37061	81	75	One Communications Ltd

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

SAFNOG Countries Aggregation Savings Summary

ASN	No of Nets	Savings	Description	
29975	160	140	Vodacom	ZA
3067	149	77	Infovan (Pty) Ltd	ZA
36994	80	58	Vodacom	ZA
37342	56	55	Movitel, SA	MZ
16637	133	46	MTN SA	ZA
37133	53	46	Airtel Tanzania	TZ
8094	53	45	North West University	ZA
37084	48	45	Simbanet (T) Limited	TZ
3741	249	41	Internet Solutions	ZA
36865	43	41	Teledata Mozambique	MZ
14988	42	35	Botswana Telecommunications C	BW
22750	40	34	BCS Group (BCSNet)	ZA
37238	31	28	IWAY Africa Ltd (a.k.a Multic	ZA
37027	41	23	Simbanet (T) Limited	TZ
37168	28	23	Cell C (Pty) Ltd	ZA
17400	30	22	EBONET	AO
36916	27	22	X-DSL Networking Solutions	ZA
33763	27	19	Paratus-Telecom	NA
30619	25	19	Telecomunicacoes de Mocambiqu	MZ
10474	42	18	MWEB CONNECT (PROPRIETARY) LI	ZA

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



Importance of Aggregation

- Size of routing table
 - Memory is no longer a problem
 - Routers routinely carry over 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 01 April 2015 06:39 (UTC+1000)

50 Most active ASes for the past 7 days

RANK	ASN	UPDs	%	Prefixed	UPDs/Prefix	AS NAME
1	4837	708328	10.75%	4777	148.28	CHINA169-BACKBONE CNCGROUP China169 Backbone,CN
2	7782	468010	7.10%	27	17333.70	ALSK-7782 - Alaska Communications Systems Group, Inc.,US
3	393276	467646	7.10%	6	77941.00	CEA - Chugach Electric Association, Inc.,US
4	23752	237867	3.61%	144	1651.85	NPTELECOM-NP-AS Nepal Telecommunications Corporation, Internet Services,NP
5	9829	190085	2.88%	1702	111.68	BSNL-NIB National Internet Backbone,IN
6	7908	158894	2.41%	160	993.09	BT LATAM Venezuela, S.A.,VE
7	28024	156850	2.38%	1527	102.72	Nuevatel PCS de Bolivia S.A.,BO
8	4134	135125	2.05%	3519	38.40	CHINANET-BACKBONE No.31,Jin-rong Street,CN
9	61894	119170	1.81%	4	29792.50	FreeBSD Brasil LTDA,BR
10	54970	93554	1.42%	1	93554.00	NORTHERN-AIR-CARGO - NORTHERN AIR CARGO,US
11	36947	78960	1.20%	209	377.80	ALGTEL-AS,DZ
12	21669	78110	1.19%	21	3719.52	NJ-STATEWIDE-LIBRARY-NETWORK - New Jersey State Library,US
13	4808	75785	1.15%	1882	40.27	CHINA169-BJ CNCGROUP IP network China169 Beijing Province Network,CN
14	9808	68027	1.03%	1587	42.87	CMNET-GD Guangdong Mobile Communication Co.Ltd.,CN
15	19429	50580	0.77%	1353	37.38	ETB - Colombia,CO
16	53563	48470	0.74%	10	4847.00	XPLUSONE - X Plus One Solutions, Inc.,US
17	8452	46002	0.70%	2137	21.53	TE-AS TE-AS,EG
18	4812	41451	0.63%	740	56.01	CHINANET-SH-AP China Telecom (Group),CN
19	24444	38828	0.59%	653	59.46	CMNET-V4SHANDONG-AS-AP Shandong Mobile Communication Company Limited,CN
20	33529	38255	0.58%	25	1530.20	PEAK-WEB-HOSTING - Peak Web Hosting Inc.,US
21	25563	35256	0.54%	4	8814.00	WEBLAND-AS Webland AG, Autonomous System,CH
22	39891	32374	0.49%	2472	13.10	ALJAWWALSTC-AS Saudi Telecom Company JSC,SA
23	56041	31677	0.48%	539	58.77	CMNET-ZHEJIANG-AP China Mobile communications corporation,CN
24	14287	30958	0.47%	54	573.30	TRIAD-TELECOM - Triad Telecom, Inc.,US
25	13188	27698	0.42%	1024	27.05	BANKINFORM-AS CONTENT DELIVERY NETWORK LTD,UA
26	8402	27175	0.41%	1468	18.51	CORBINA-AS OJSC "Vimpelcom",RU
27	24445	27070	0.41%	169	160.18	CMNET-V4HENAN-AS-AP Henan Mobile Communications Co.,Ltd,CN
28	10620	26897	0.41%	3163	8.50	Telmex Colombia S.A.,CO

—

RANK	PREFIX	UPDs	%	Origin AS -- AS NAME
1	202.70.88.0/21	119183	1.62%	23752 -- NPTELECOM-NP-AS Nepal Telecommunications Corporation, Internet Services,NP
2	177.10.158.0/24	119155	1.62%	61894 -- FreeBSD Brasil LTDA,BR
3	202.70.64.0/21	117864	1.60%	23752 -- NPTELECOM-NP-AS Nepal Telecommunications Corporation, Internet Services,NP
4	192.206.58.0/24	93928	1.28%	7782 -- ALSK-7782 - Alaska Communications Systems Group, Inc.,US
5	198.163.32.0/21	93898	1.28%	7782 -- ALSK-7782 - Alaska Communications Systems Group, Inc.,US
6	192.189.216.0/24	93758	1.28%	393276 -- CEA - Chugach Electric Association, Inc.,US
7	192.189.217.0/24	93712	1.28%	393276 -- CEA - Chugach Electric Association, Inc.,US
8	162.211.56.0/21	93650	1.27%	7782 -- ALSK-7782 - Alaska Communications Systems Group, Inc.,US
9	192.189.218.0/24	93564	1.27%	393276 -- CEA - Chugach Electric Association, Inc.,US
10	198.17.216.0/24	93554	1.27%	54970 -- NORTHERN-AIR-CARGO - NORTHERN AIR CARGO,US
11	192.189.215.0/24	93376	1.27%	393276 -- CEA - Chugach Electric Association, Inc.,US
12	107.152.112.0/20	93364	1.27%	7782 -- ALSK-7782 - Alaska Communications Systems Group, Inc.,US
13	192.189.219.0/24	93232	1.27%	393276 -- CEA - Chugach Electric Association, Inc.,US
14	104.254.224.0/21	93170	1.27%	7782 -- ALSK-7782 - Alaska Communications Systems Group, Inc.,US
15	209.212.8.0/24	78103	1.06%	21669 -- NJ-STATEWIDE-LIBRARY-NETWORK - New Jersey State Library,US
16	105.96.0.0/22	77275	1.05%	36947 -- ALGTEL-AS,DZ
17	199.38.164.0/23	48455	0.66%	53563 -- XPLUSONE - X Plus One Solutions, Inc.,US
18	69.194.4.0/24	38219	0.52%	33529 -- PEAK-WEB-HOSTING - Peak Web Hosting Inc.,US
19	208.73.244.0/22	29745	0.40%	14287 -- TRIAD-TELECOM - Triad Telecom, Inc.,US
20	103.225.173.0/24	17709	0.24%	58396 -- DETELNETWORKS-AS-ID PT. DEWATA TELEMATIKA,ID
21	67.59.81.0/24	16467	0.22%	33356 -- CTWS - Eagle-Tech Systems,US
22	118.98.88.0/24	16042	0.22%	64567 -- -Private Use AS-,ZZ 7713 -- TELKOMNET-AS-AP PT Telekomunikasi Indonesia,ID
23	91.193.202.0/24	14841	0.20%	42081 -- SPEEDY-NET-AS Speedy net EAD,BG
24	42.83.48.0/20	12537	0.17%	18135 -- BTV BTV Cable television,JP
25	92.43.216.0/21	11988	0.16%	25563 -- WEBLAND-AS Webland AG, Autonomous System,CH
26	130.0.192.0/21	11986	0.16%	197914 -- STOCKHO-AS Stockho Hosting SARL,FR
27	185.84.192.0/22	11770	0.16%	25563 -- WEBLAND-AS Webland AG, Autonomous System,CH
28	88.87.160.0/19	11717	0.16%	47680 -- NHCS EOBO Limited,IE
29	95.47.46.0/24	11708	0.16%	61308 -- PVONET-AS PVONET LTD,RU
30	178.174.96.0/19	11498	0.16%	25563 -- WEBLAND-AS Webland AG, Autonomous System,CH
31	192.58.232.0/24	9883	0.13%	6629 -- NOAA-AS - NOAA,US
32	192.58.137.0/24	9153	0.12%	393588 -- MUBEAFLO - Mubea,US
33	103.225.172.0/24	9081	0.12%	58396 -- DETELNETWORKS-AS-ID PT. DEWATA TELEMATIKA,ID

Internet Routing Table Analysis Update



Questions?