

Internet IPv4 Routing Table Analysis Update



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MENOG 15

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Dubai, UAE



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 1 April 2015

BGP routing table entries examined:	539323
Prefixes after maximum aggregation (per Origin AS):	206026
Deaggregation factor:	2.62
Unique aggregates announced (without unneeded subnets):	262749
Total ASes present in the Internet Routing Table:	49828
Prefixes per ASN:	10.82
Origin-only ASes present in the Internet Routing Table:	36532
Origin ASes announcing only one prefix:	16254
Transit ASes present in the Internet Routing Table:	6293
Transit-only ASes present in the Internet Routing Table:	175
Average AS path length visible in the Internet Routing Table:	4.5
Max AS path length visible:	59
Max AS path prepend of ASN (55644)	56
Prefixes from unregistered ASNs in the Routing Table:	1176
Unregistered ASNs in the Routing Table:	419
Number of 32-bit ASNs allocated by the RIRs:	9027
Number of 32-bit ASNs visible in the Routing Table:	7003
Prefixes from 32-bit ASNs in the Routing Table:	25324
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:	371
Number of addresses announced to Internet:	2737260708
Equivalent to 163 /8s, 39 /16s and 72 /24s	
Percentage of available address space announced:	73.9
Percentage of allocated address space announced:	73.9
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:	181860

RIPE NCC Region

Prefixes being announced by RIPE Region ASes:	130738
Total RIPE prefixes after maximum aggregation:	65198
RIPE Deaggregation factor:	2.01
Prefixes being announced from the RIPE address blocks:	137201
Unique aggregates announced from the RIPE address blocks:	84441
RIPE Region origin ASes present in the Internet Routing Table:	17919
RIPE Prefixes per ASN:	7.66
RIPE Region origin ASes announcing only one prefix:	8150
RIPE Region transit ASes present in the Internet Routing Table:	2962
Average RIPE Region AS path length visible:	4.9
Max RIPE Region AS path length visible:	32
Number of RIPE region 32-bit ASNs visible in the Routing Table:	3560
Number of RIPE addresses announced to Internet:	694502276
Equivalent to 41 /8s, 101 /16s and 67 /24s	

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
22773	2144	2931	Cox Communications Inc.
18566	1997	2042	MegaPath Corporation
6389	1671	2891	BellSouth.net Inc.
30036	1368	1523	Mediacom Communications Corp
6147	1329	1786	Telefonica del Peru S.A.A.
6983	1315	1629	EarthLink, Inc.
34984	1237	1933	TELLCOM ILETISIM HIZMETLERI A
11492	1124	1183	CABLE ONE, INC.
8402	1117	1453	OJSC "Vimpelcom"
10620	1092	3057	Telmex Colombia S.A.
22561	1017	1339	CenturyTel Internet Holdings,
31148	964	1045	Freenet Ltd.
13188	851	1037	TOV "Bank-Inform"
7011	834	1047	Frontier Communications of Am
8452	816	1493	TE-AS
13977	777	811	FAIRPOINT COMMUNICATIONS, INC
27738	759	781	Ecuadortelecom S.A.
3356	735	2562	Level 3 Communications, Inc.
4766	723	2912	Korea Telecom
6503	694	1227	Axtel, S.A.B. de C.V.

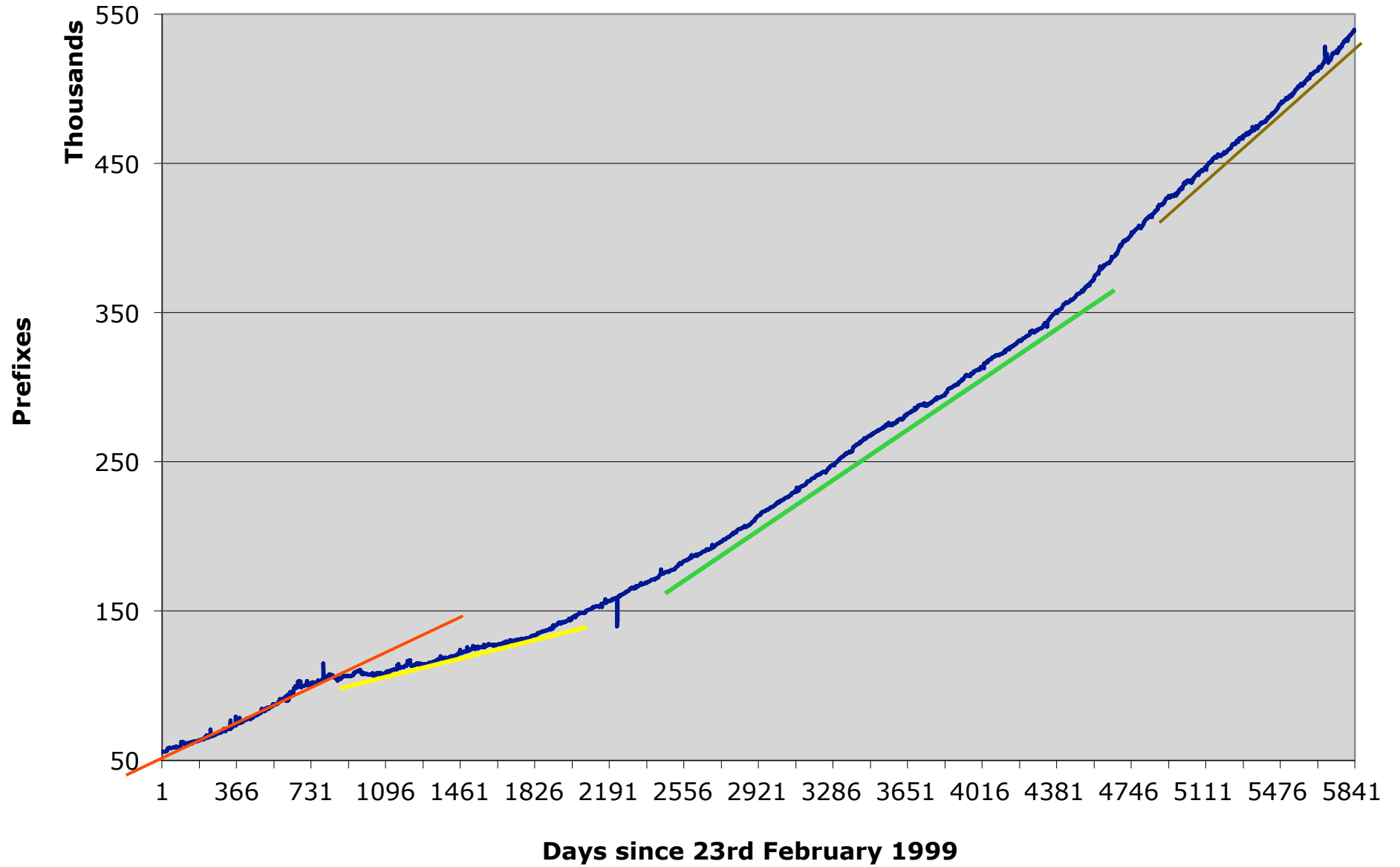
AfriNIC APNIC ARIN LACNIC RIPE NCC

Prefixes Smaller than Registry Allocations

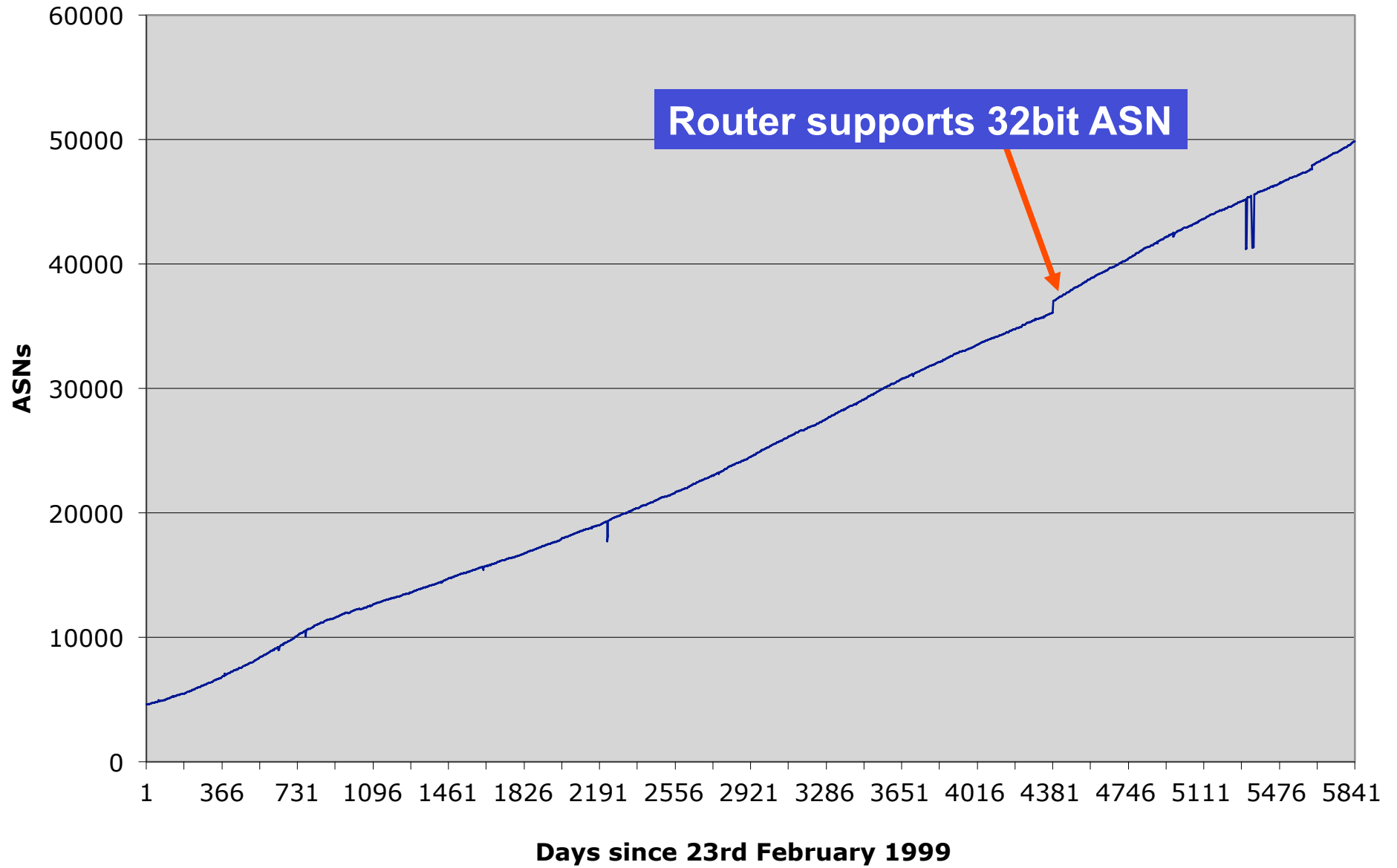
ASN	No of nets	Total ann.	Description
39891	2432	2472	SaudiNet, Saudi Telecom Compa
22773	2230	3018	Cox Communications Inc.
18566	1996	2041	MegaPath Corporation
6389	1671	2881	BellSouth.net Inc.
6983	1371	1724	EarthLink, Inc.
30036	1362	1515	Mediacom Communications Corp
34984	1287	1982	TELLCOM ILETISIM 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

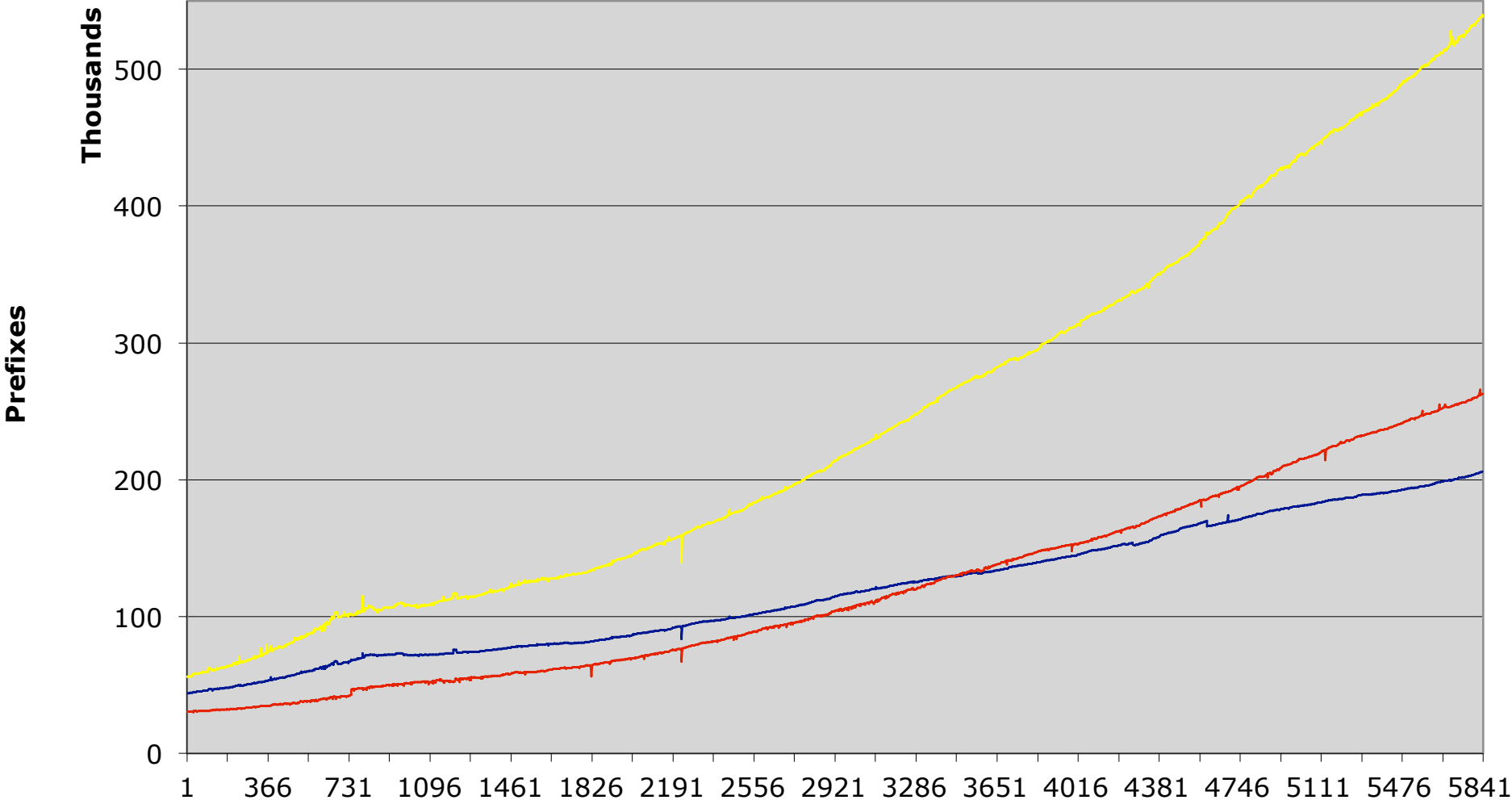
BGP Routing Table



AS Growth

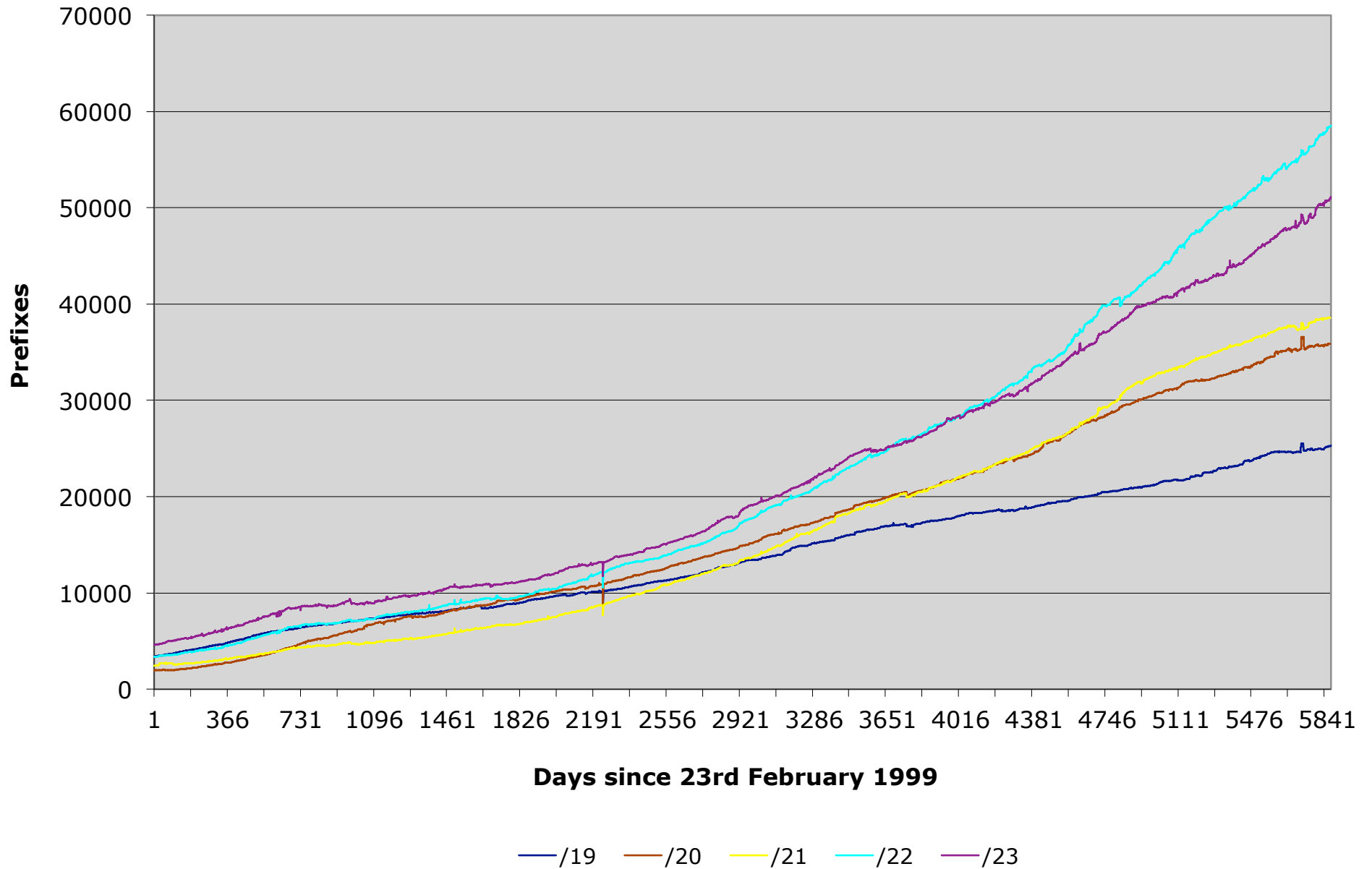


Max Aggregation vs Unique Prefixes

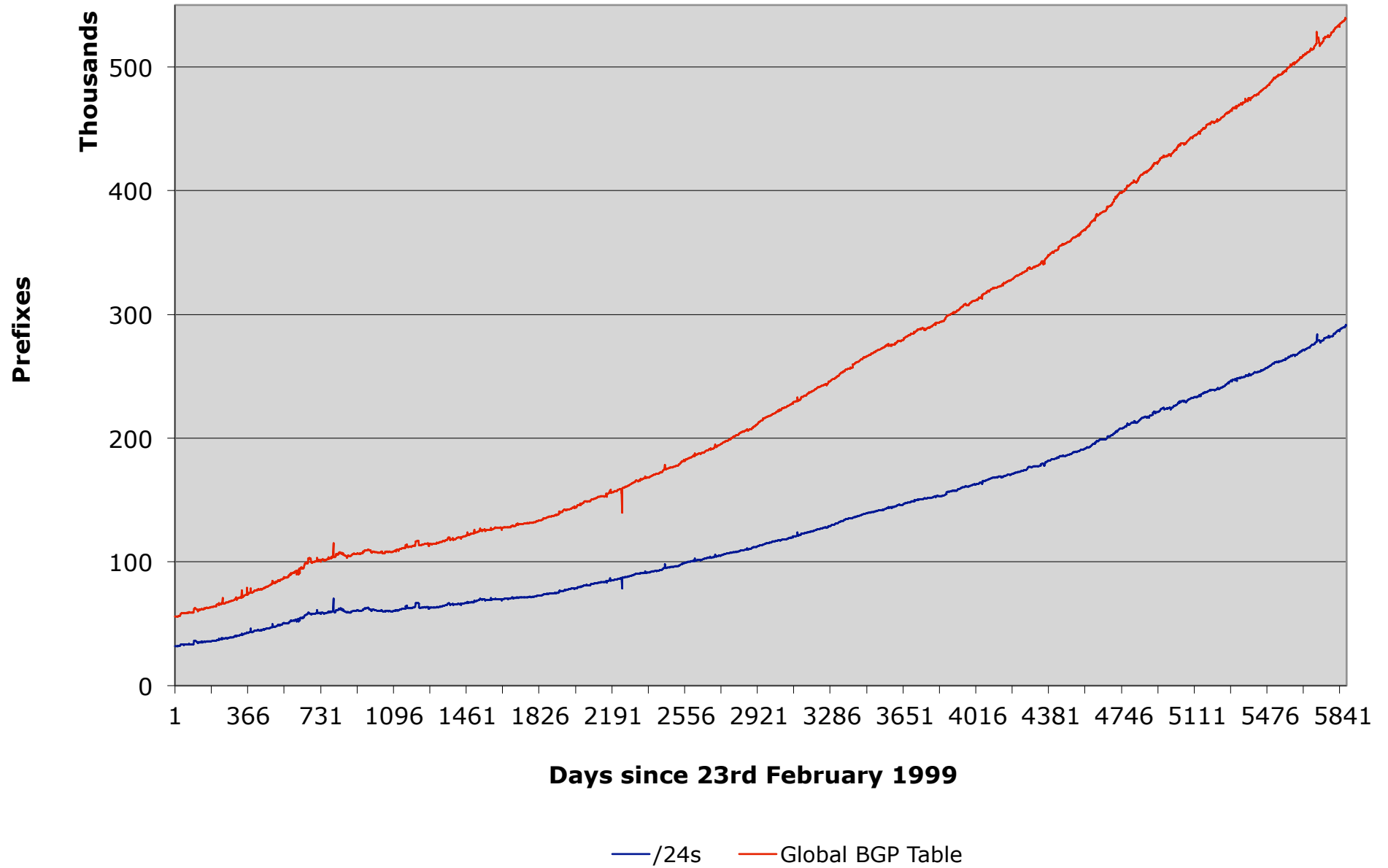


— Max Aggregation — Unique Prefixes — Global BGP Table

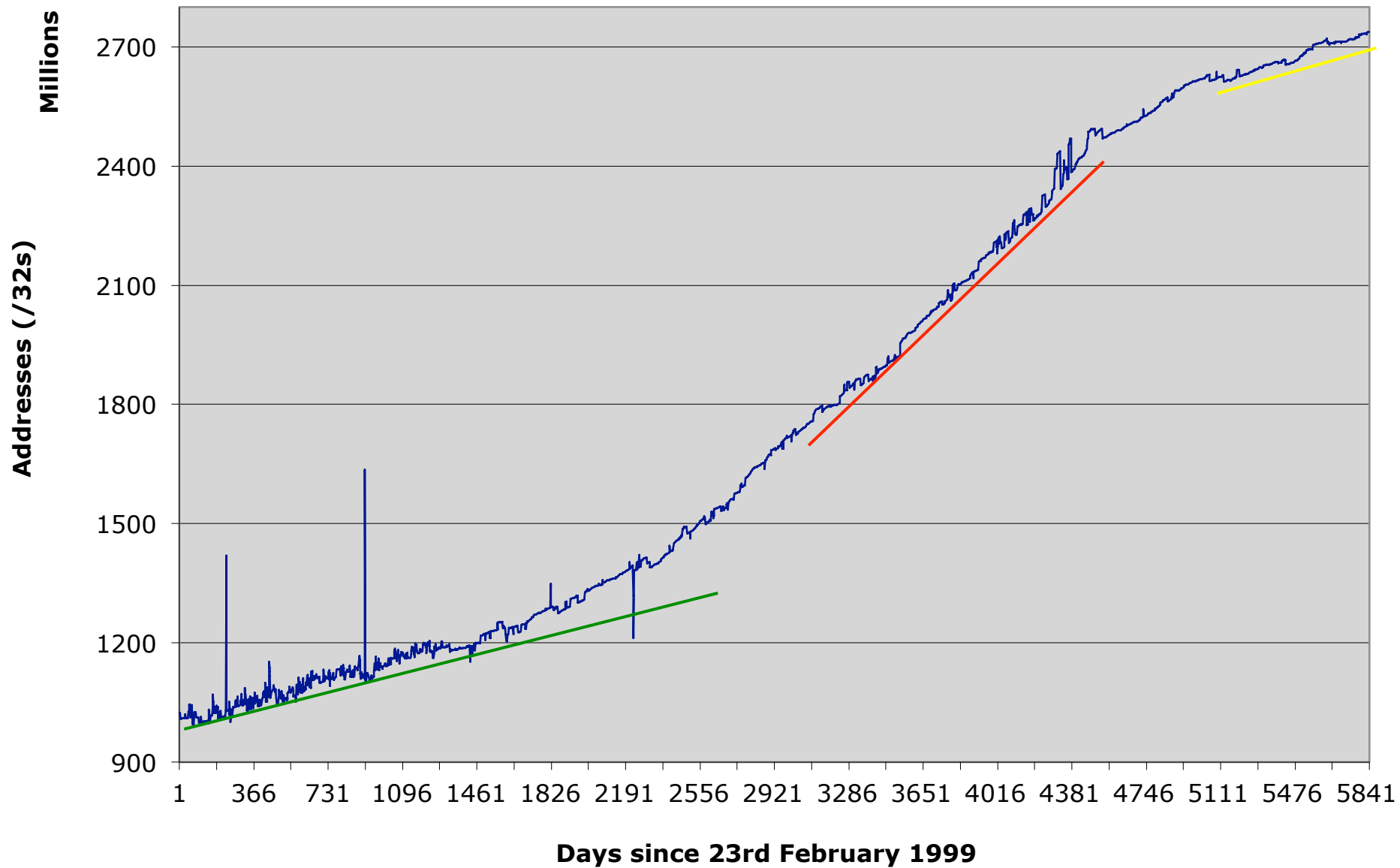
Prefix sizes announced



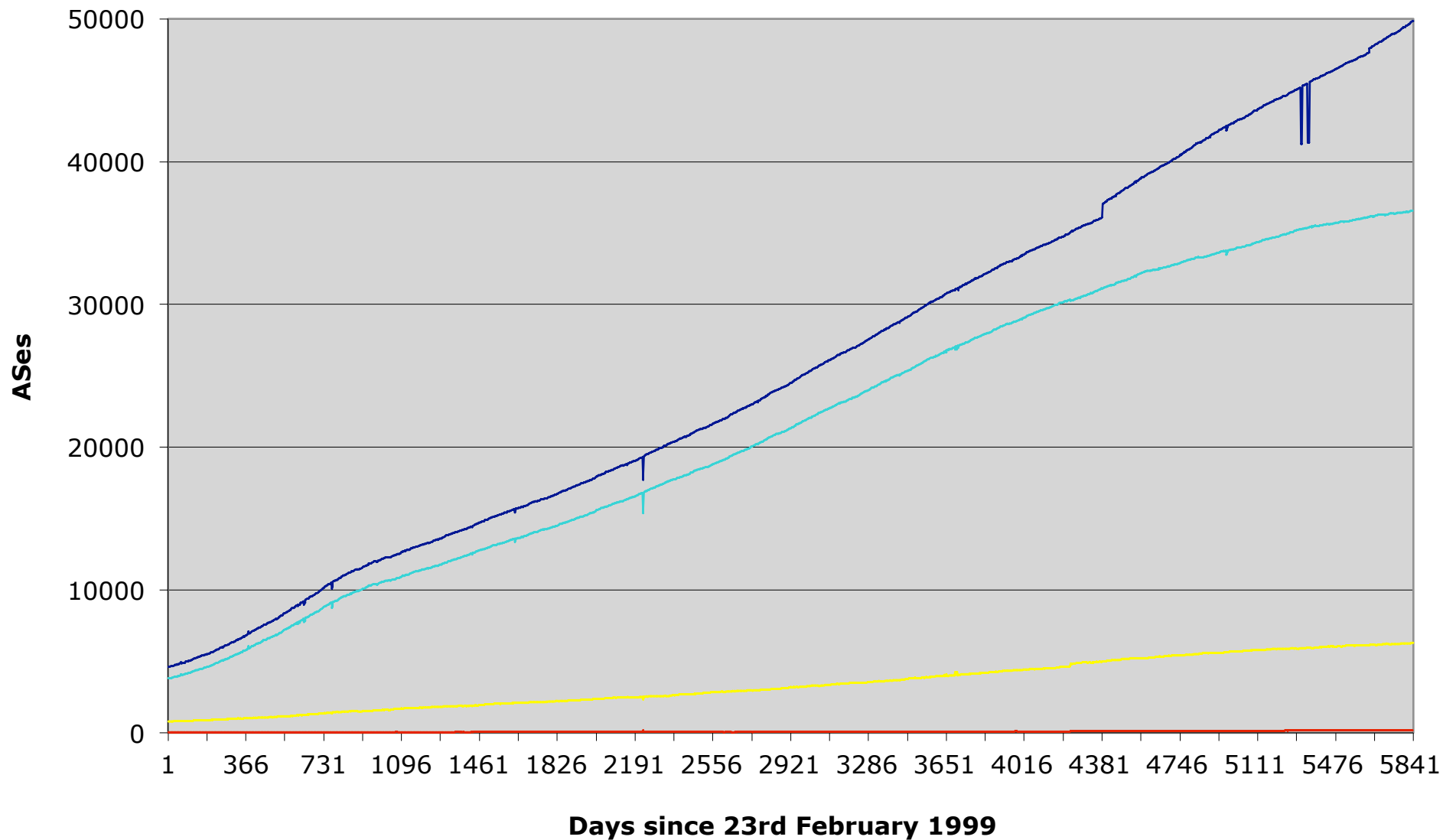
/24s announced



Address Space announced

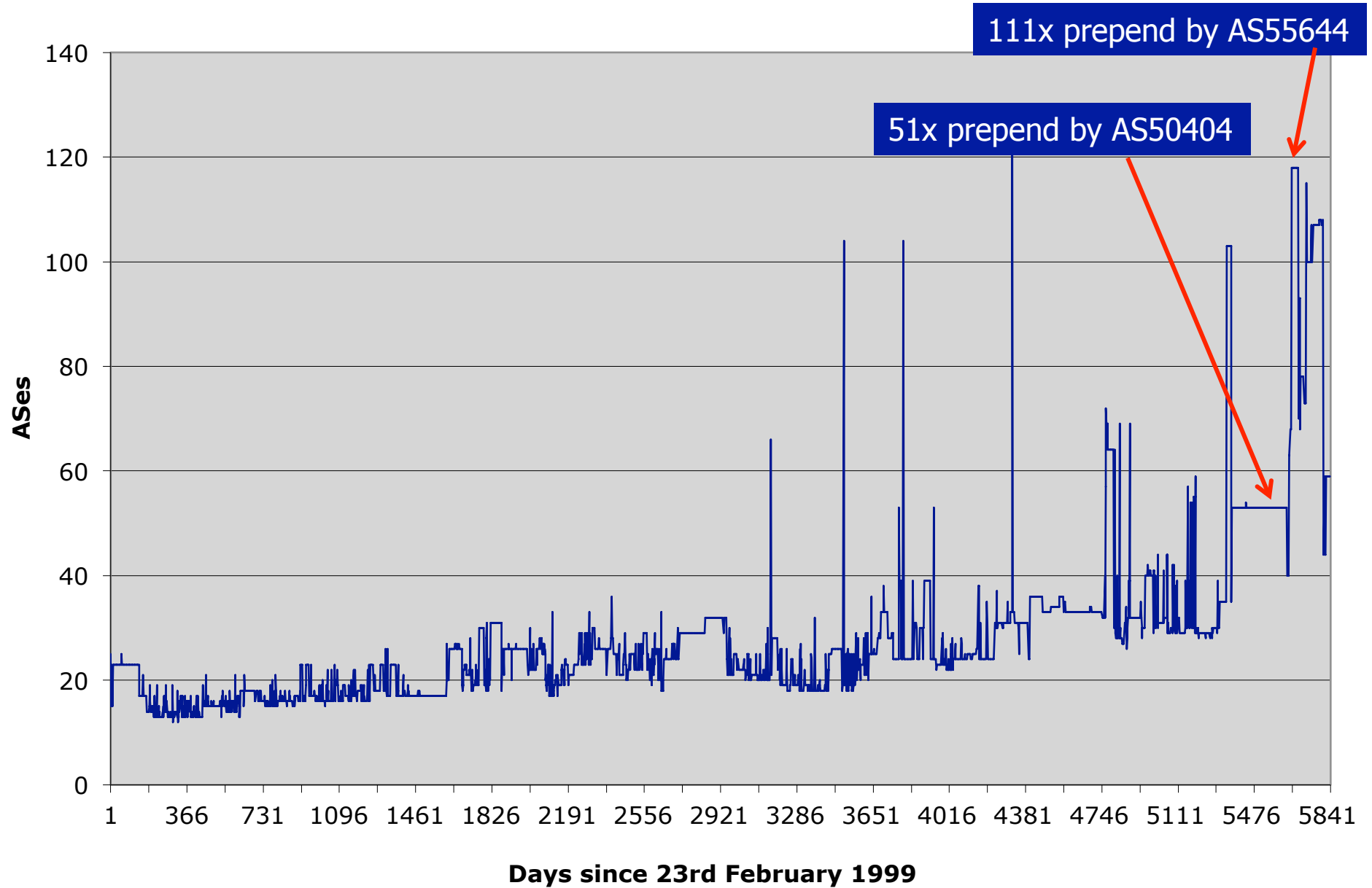


AS Announcements



— Total ASNs — Origin-only ASNs — ASN providing Transit & Origin — Transit-only ASNs

Maximum AS Path Length





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”



April 2015

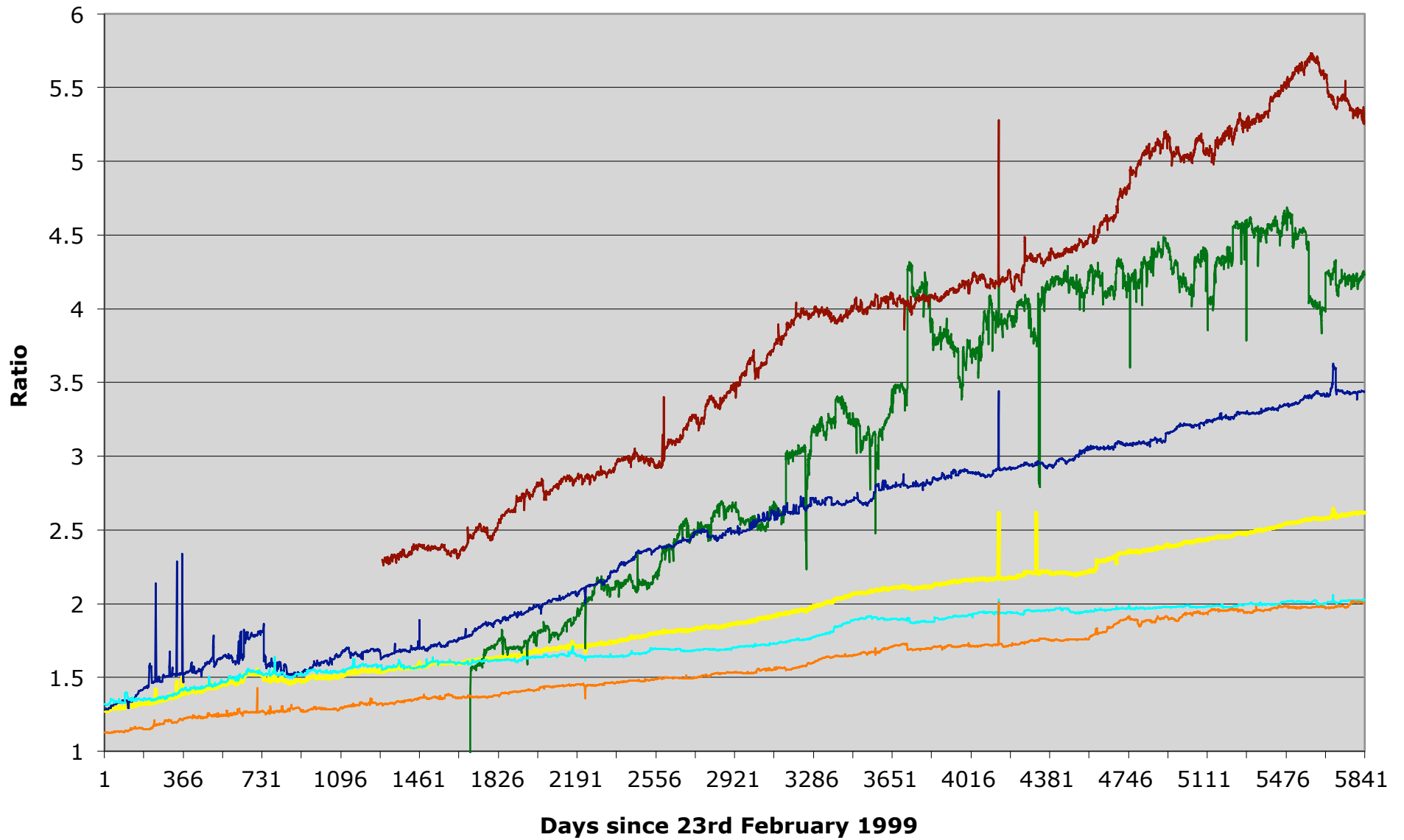
Total Prefixes

- 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



Global AfriNIC APNIC ARIN LACNIC RIPE

RIPE NCC Region Aggregation Savings Summary

ASN	No of Nets	Savings	Description
39891	2472	2466	SaudiNet, Saudi Telecom Compa
34984	1982	1623	TELLCOM ILETISIM HIZMETLERI A
8402	1333	1318	OJSC "Vimpelcom"
6849	1212	1188	JSC "Ukrtelecom"
31148	1046	1025	Freenet Ltd.
13188	1024	952	TOV "Bank-Inform"
8551	886	838	Bezeq International-Ltd
12479	898	819	France Telecom Espana SA
9198	792	767	JSC Kazakhtelecom
25019	574	542	Autonomus System Number for S
9116	544	518	012 Smile Communications Ltd.
8866	522	478	Bulgarian Telecommunication C
9121	500	478	Turk Telekomunikasyon Anonim
20940	1665	432	Akamai International B.V.
9155	431	420	QualityNet General Trading &
6830	823	374	Liberty Global Operations B.V
35819	434	325	Bayanat Al-Oula For Network S
5384	304	278	Emirates Telecommunications C
3215	386	269	Orange S.A.
48161	338	268	NEXTGEN COMMUNICATIONS SRL

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

Middle East Aggregation Savings Summary

ASN	No of Nets	Savings	Description	
39891	2472	2466	SaudiNet, Saudi Telecom Compa	SA
34984	1982	1623	TELLCOM ILETISIM HIZMETLERI A	TR
25019	574	542	Saudi Telecom Company JSC	SA
9121	500	478	Turk Telekomunikasyon Anonim	TR
35819	434	325	Bayanat Al-Oula For Network S	SA
5384	304	278	Emirates Telecommunications C	AE
47524	296	263	Turksat Uydu Haberlesme ve Ka	TR
12735	266	254	TurkNet Iletisim Hizmetleri A	TR
42910	331	246	Hosting Internet Hizmetleri S	TR
8386	255	218	VODAFONE NET ILETISIM HIZMETL	TR
34296	222	210	MILLENI.COM	TR
8376	222	209	Jordan Data Communications Co	JO
12978	207	202	DOGAN TV DIGITAL PLATFORM ISL	TR
31549	189	183	Aria Shatel Company Ltd	IR
50710	182	176	EarthLink Ltd. Communications	IQ
47589	174	172	Kuwait Telecommunication Comp	KW
47442	162	159	Mada Communications	KW
42961	168	158	Mobile Telecommunications Com	KW
42337	164	151	Respina Networks & Beyond PJS	IR
21050	160	149	Fast Telecommunications Compa	KW

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



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	%	Prefixes	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

50 Most active Prefixes for the past 7 days

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 -- MUBEA-FLO - Mubea,US
33	103.225.172.0/24	9081	0.12%	58396 -- DETELNETWORKS-AS-ID PT. DEWATA TELEMATIKA,ID



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?