

Internet Routing Table Status & Deaggregation Update



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MENOG 13

22nd September 2013

Kuwait



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 19 September 2013

BGP routing table entries examined:	467497
Prefixes after maximum aggregation:	188598
Deaggregation factor:	2.48
Unique aggregates announced to Internet:	232248
Total ASes present in the Internet Routing Table:	44999
Prefixes per ASN:	10.39
Origin-only ASes present in the Internet Routing Table:	35148
Origin ASes announcing only one prefix:	16270
Transit ASes present in the Internet Routing Table:	5910
Transit-only ASes present in the Internet Routing Table:	165
Average AS path length visible in the Internet Routing Table:	4.7
Max AS path length visible:	30
Max AS path prepend of ASN (36992)	22
Prefixes from unregistered ASNs in the Routing Table:	5994
Unregistered ASNs in the Routing Table:	1994
Number of 32-bit ASNs allocated by the RIRs:	5048
Number of 32-bit ASNs visible in the Routing Table:	3941
Prefixes from 32-bit ASNs in the Routing Table:	12266
Special use prefixes present in the Routing Table:	1
Prefixes being announced from unallocated address space:	472
Number of addresses announced to Internet:	2643686644
Equivalent to 157 /8s, 147 /16s and 116 /24s	
Percentage of available address space announced:	71.4
Percentage of allocated address space announced:	71.4
Percentage of available address space allocated:	100.0
Percentage of address space in use by end-sites:	95.0
Total number of prefixes smaller than registry allocations:	163807

RIPE NCC Region

Prefixes being announced by RIPE Region ASes:	118673
Total RIPE prefixes after maximum aggregation:	61128
RIPE Deaggregation factor:	1.94
Prefixes being announced from the RIPE address blocks:	122524
Unique aggregates announced from the RIPE address blocks:	79245
RIPE Region origin ASes present in the Internet Routing Table:	17420
RIPE Prefixes per ASN:	7.03
RIPE Region origin ASes announcing only one prefix:	8268
RIPE Region transit ASes present in the Internet Routing Table:	2809
Average RIPE Region AS path length visible:	5.2
Max RIPE Region AS path length visible:	30
Number of RIPE region 32-bit ASNs visible in the Routing Table:	2398
Number of RIPE addresses announced to Internet:	657128164
Equivalent to 39 /8s, 42 /16s and 250 /24s	
Percentage of available RIPE address space announced:	95.5

Global per AS prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
28573	3271	1726	103	NET Servicos de Comunicacao S.A
6389	3067	3689	62	BellSouth.net Inc.
4766	2923	11561	924	Korea Telecom (KIX)
17974	2671	903	91	PT TELEKOMUNIKASI INDONESIA
10620	2560	418	246	TVCABLE BOGOTA
7545	2074	320	111	TPG Internet Pty Ltd
18566	2065	382	184	Covad Communications
22773	2041	2933	124	Cox Communications, Inc.
1785	2013	679	125	PaeTec Communications, Inc.
36998	1864	112	5	Sudanese Mobile Telephone
4755	1771	391	188	TATA Communications formerly
8402	1746	544	16	OJSC "Vimpelcom"
7303	1711	1134	227	Telecom Argentina Stet-France
20115	1679	1650	627	Charter Communications
4323	1616	1103	410	Time Warner Telecom
9829	1535	1238	40	BSNL National Internet Backbo
701	1531	11136	798	UUNET Technologies, Inc.
18881	1432	844	20	Global Village Telecom
30036	1349	304	631	Mediacom Communications Corp
34984	1299	244	221	TELLCOM ILETISIM HIZMETLERI

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	/9:11	/10:31	/11:93	/12:250
/13:479	/14:916	/15:1626	/16:12797	/17:6700	/18:11180
/19:22963	/20:32529	/21:35108	/22:49618	/23:42975	/24:247743
/25:834	/26:988	/27:482	/28:47	/29:79	/30:18
/31:0	/32:14				

September 2013 ↑

September 2011 ↓

Number of prefixes announced by prefix length

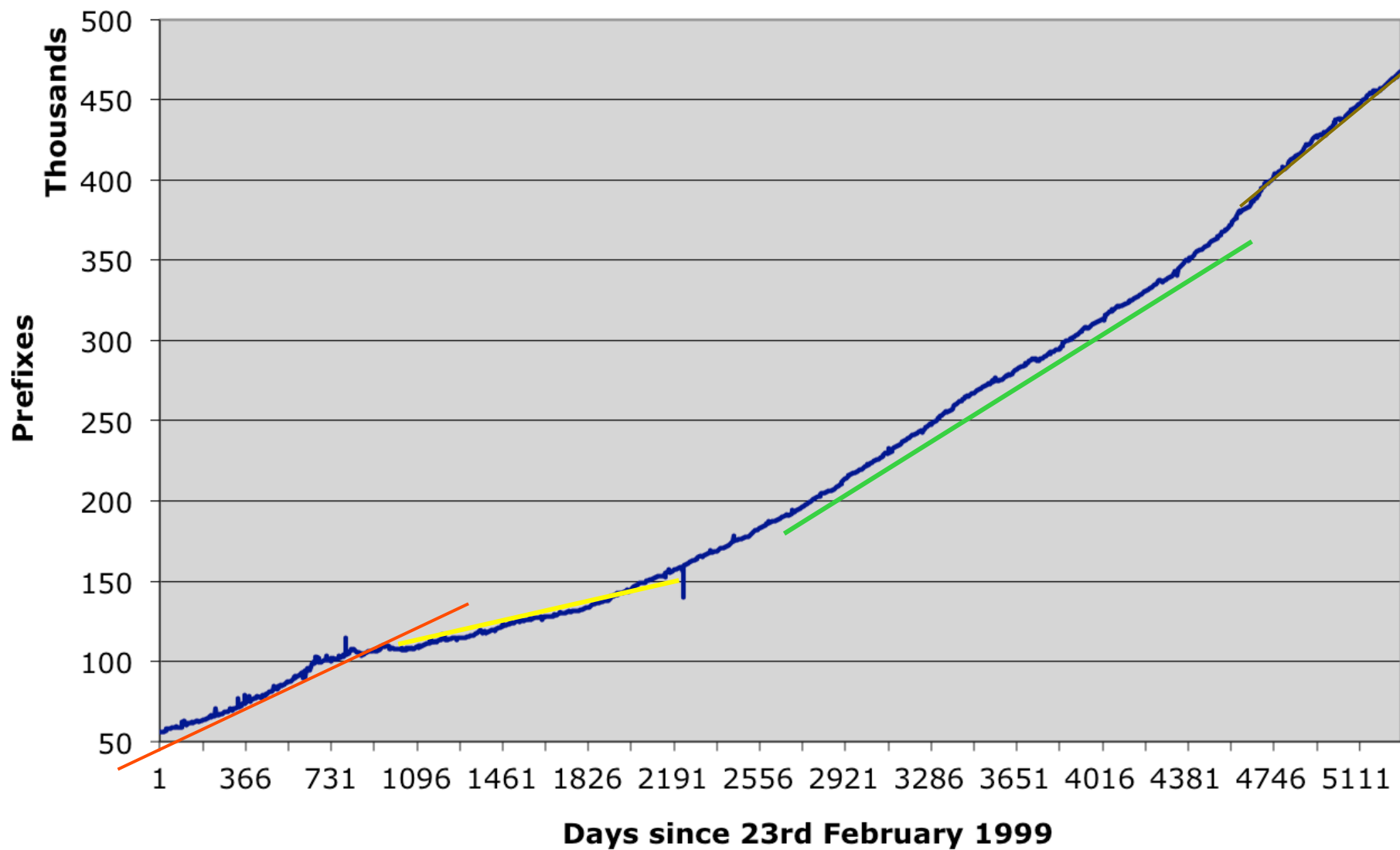
/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:19	/9:12	/10:27	/11:81	/12:235
/13:464	/14:800	/15:1414	/16:11963	/17:5969	/18:10016
/19:19754	/20:27032	/21:27023	/22:36335	/23:34780	/24:192926
/25:1100	/26:1294	/27:743	/28:162	/29:4	/30:0
/31:0	/32:5				

Prefixes Smaller than Registry Allocations

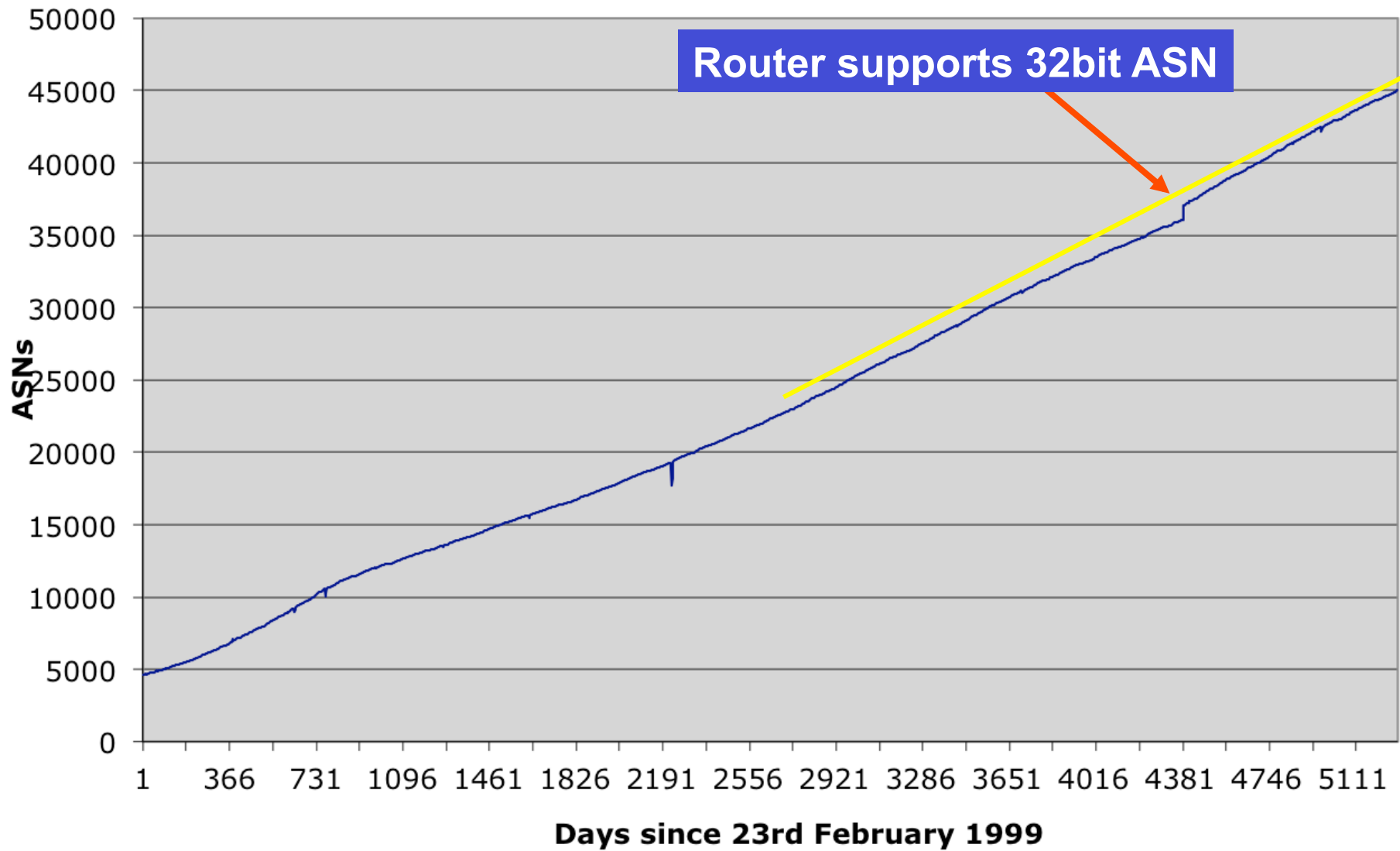
ASN	No of nets	Total ann.	Description
18566	2016	2065	Covad Communications
36998	1829	1864	MOBITEL
6389	1712	3067	bellsouth.net, inc.
8402	1464	1746	OJSC "Vimpelcom"
22773	1328	2041	Cox Communications, Inc.
30036	1210	1349	Mediacom Communications Corp
11492	1187	1228	Cable One
1785	1084	2013	PaeTec Communications, Inc.
6983	1025	1152	ITC^Deltacom
22561	932	1198	Digital Teleport, Inc
31148	931	987	FreeNet ISP
7011	925	1167	Citizens Utilities
10620	893	2560	TVCABLE BOGOTA
34984	892	1331	TELLCOM ILETISIM HIZMETLERI
13977	833	850	FAIRPOINT COMMUNICATIONS, INC
4766	801	2923	Korea Telecom (KIX)
28573	750	3271	NET Servicos de Comunicao S.A
35908	730	866	VPLS Inc.
13188	692	847	TOV "Bank-Inform"
27947	671	836	Telconet S.A

AfriNIC APNIC ARIN LACNIC RIPE NCC

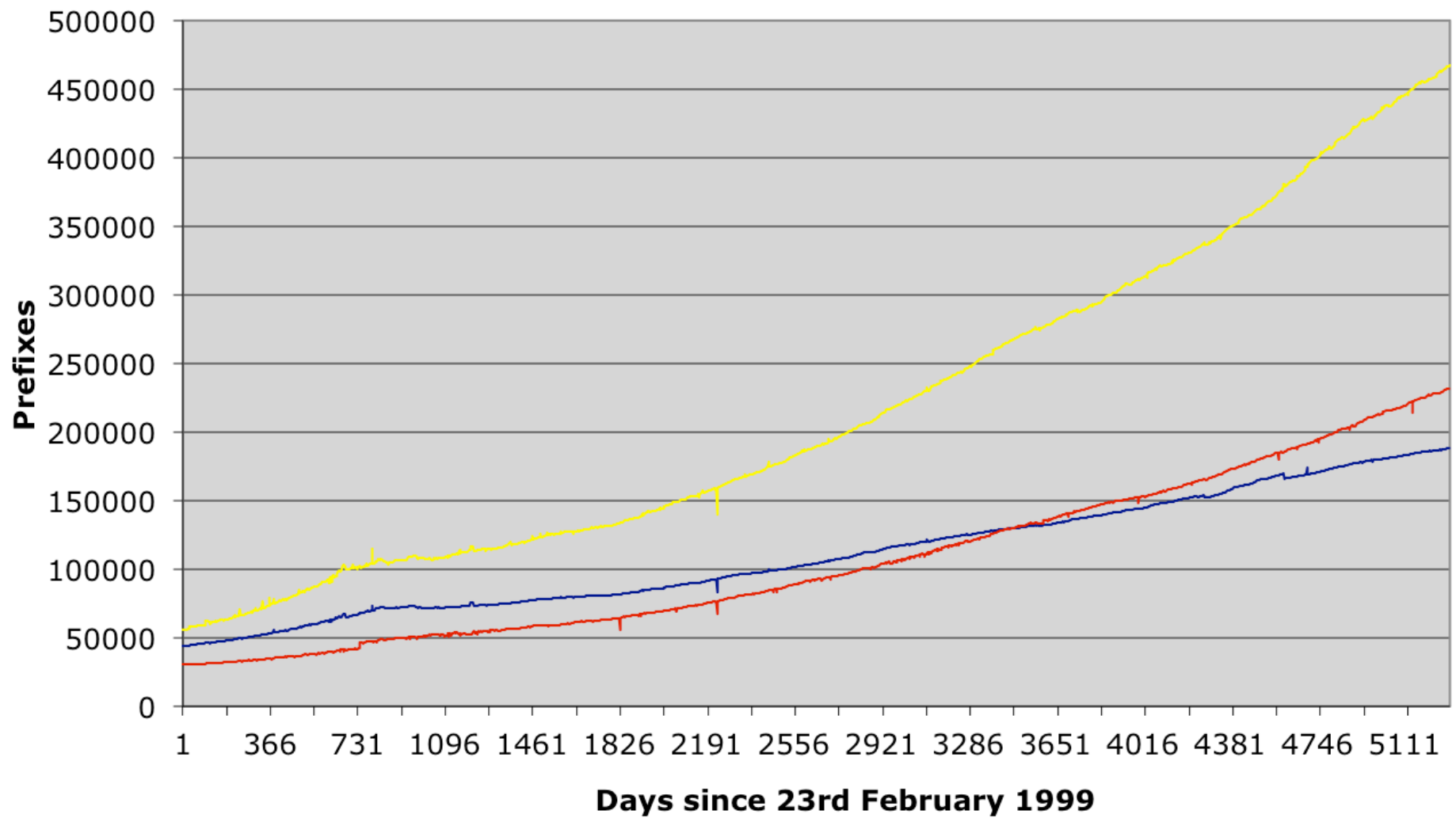
BGP Routing Table



AS Growth

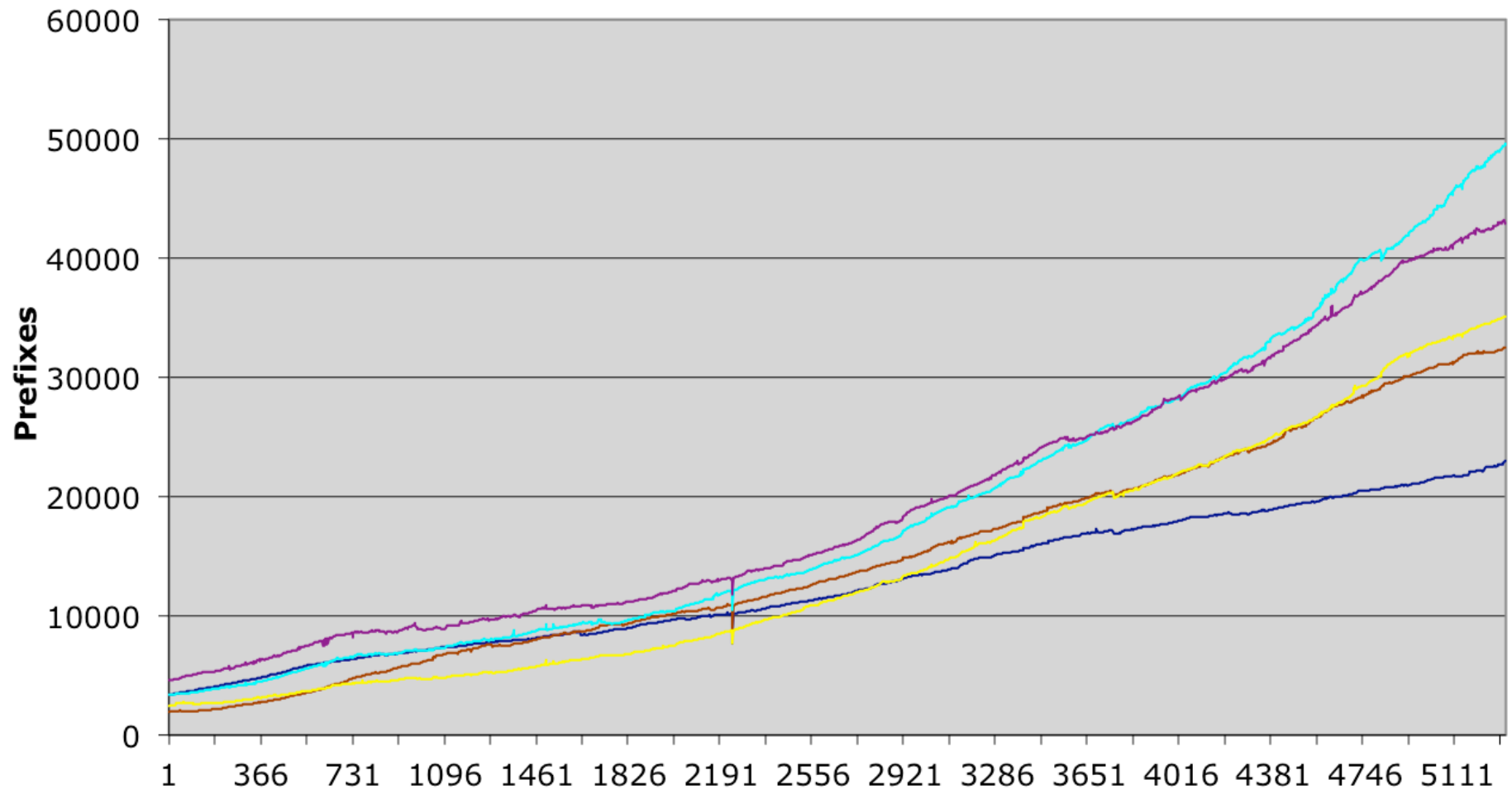


Max Aggregation vs Unique Prefixes



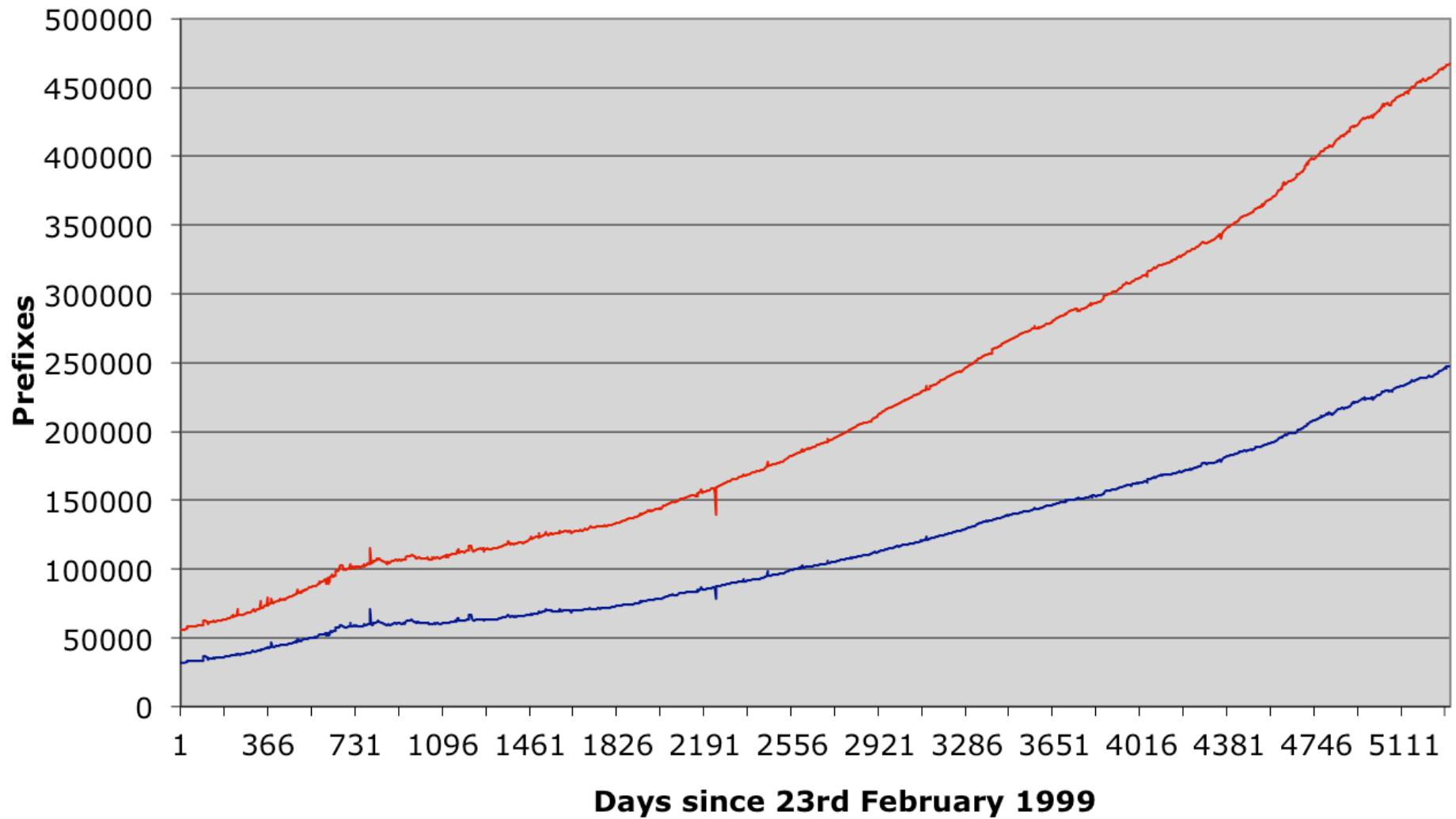
— Max Aggregation — Unique Prefixes — Global BGP Table

Prefix sizes announced



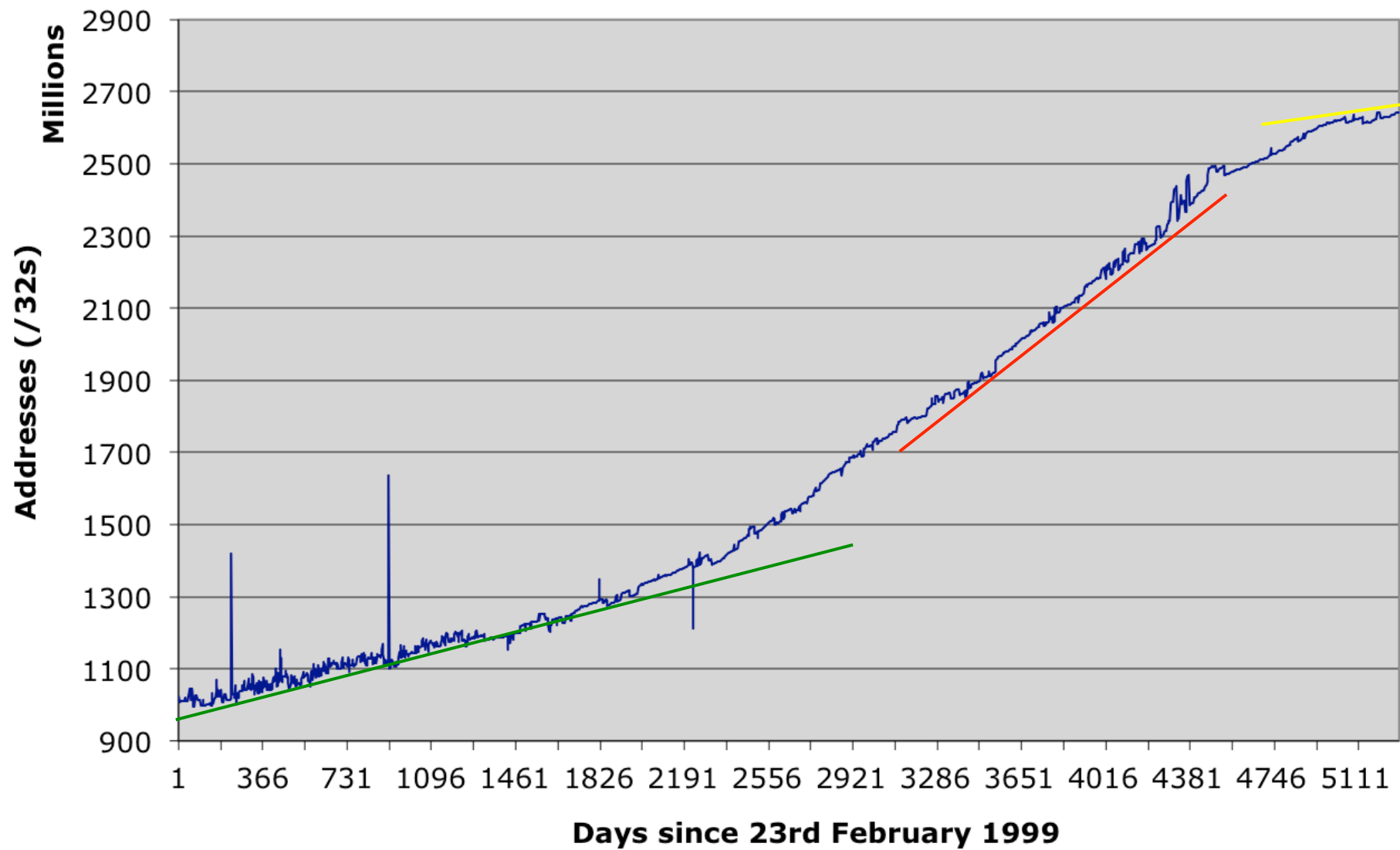
— /19 — /20 — /21 — /22 — /23

/24s announced

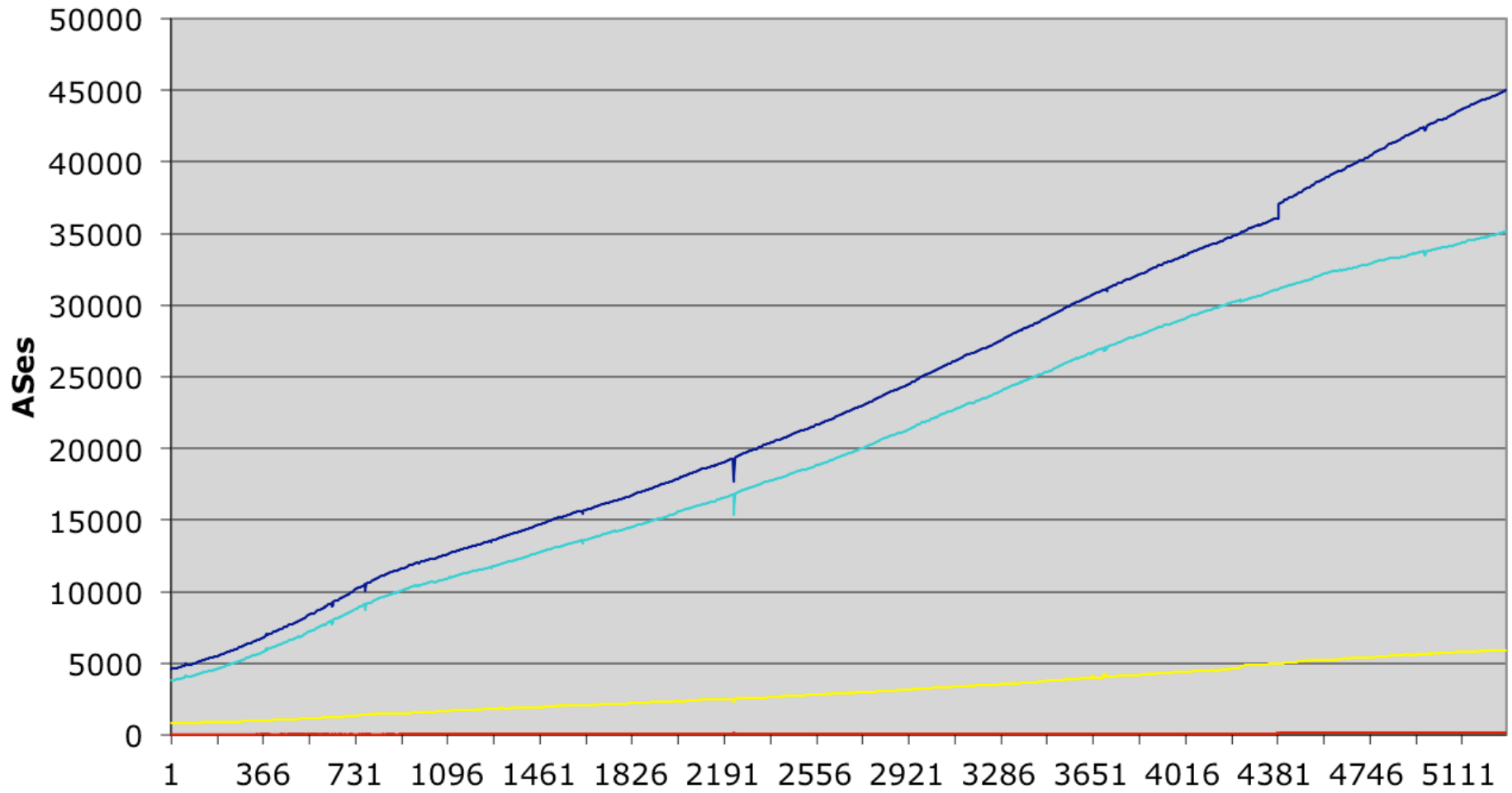


— /24s — Global BGP Table

Address Space announced

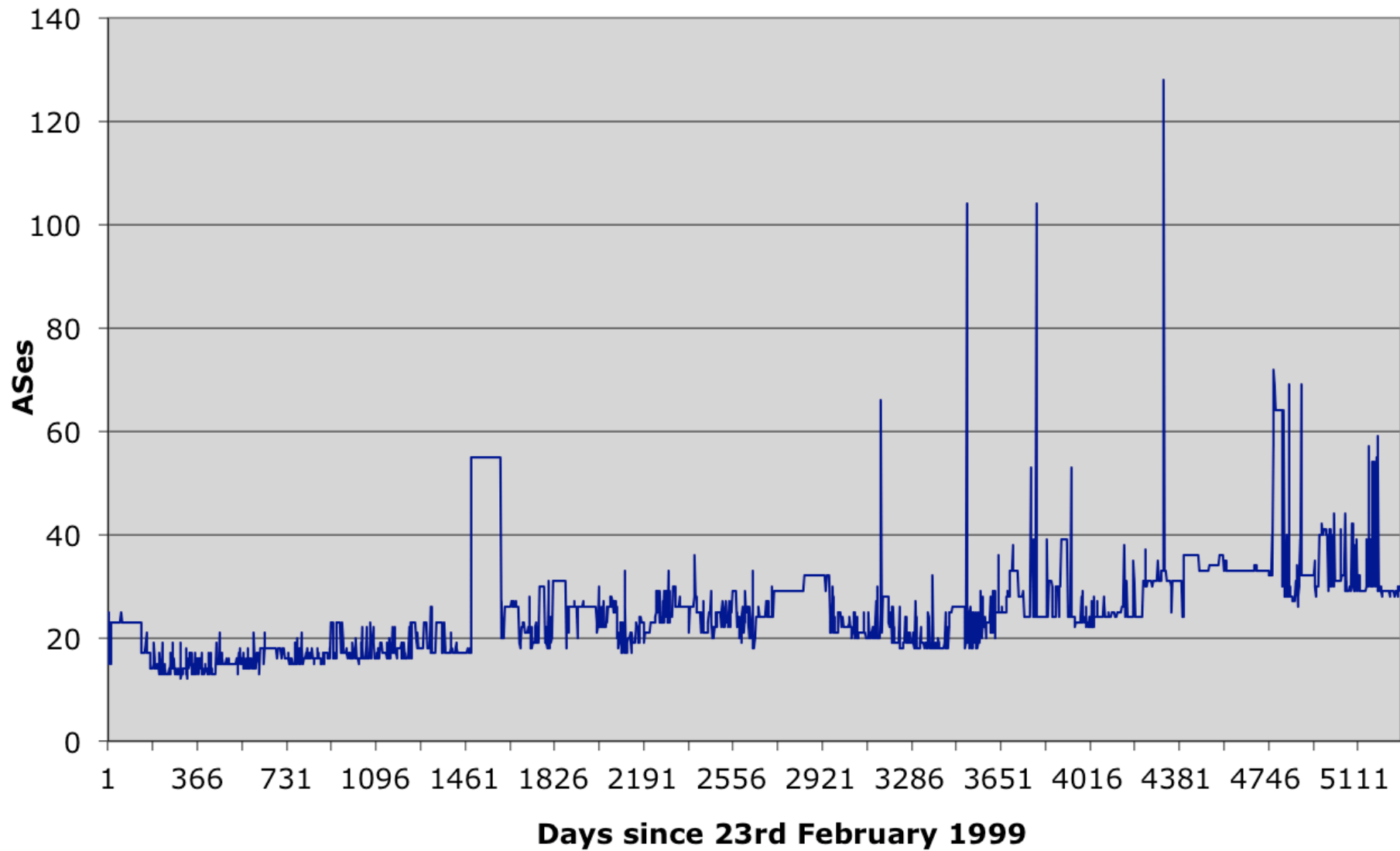


AS Announcements

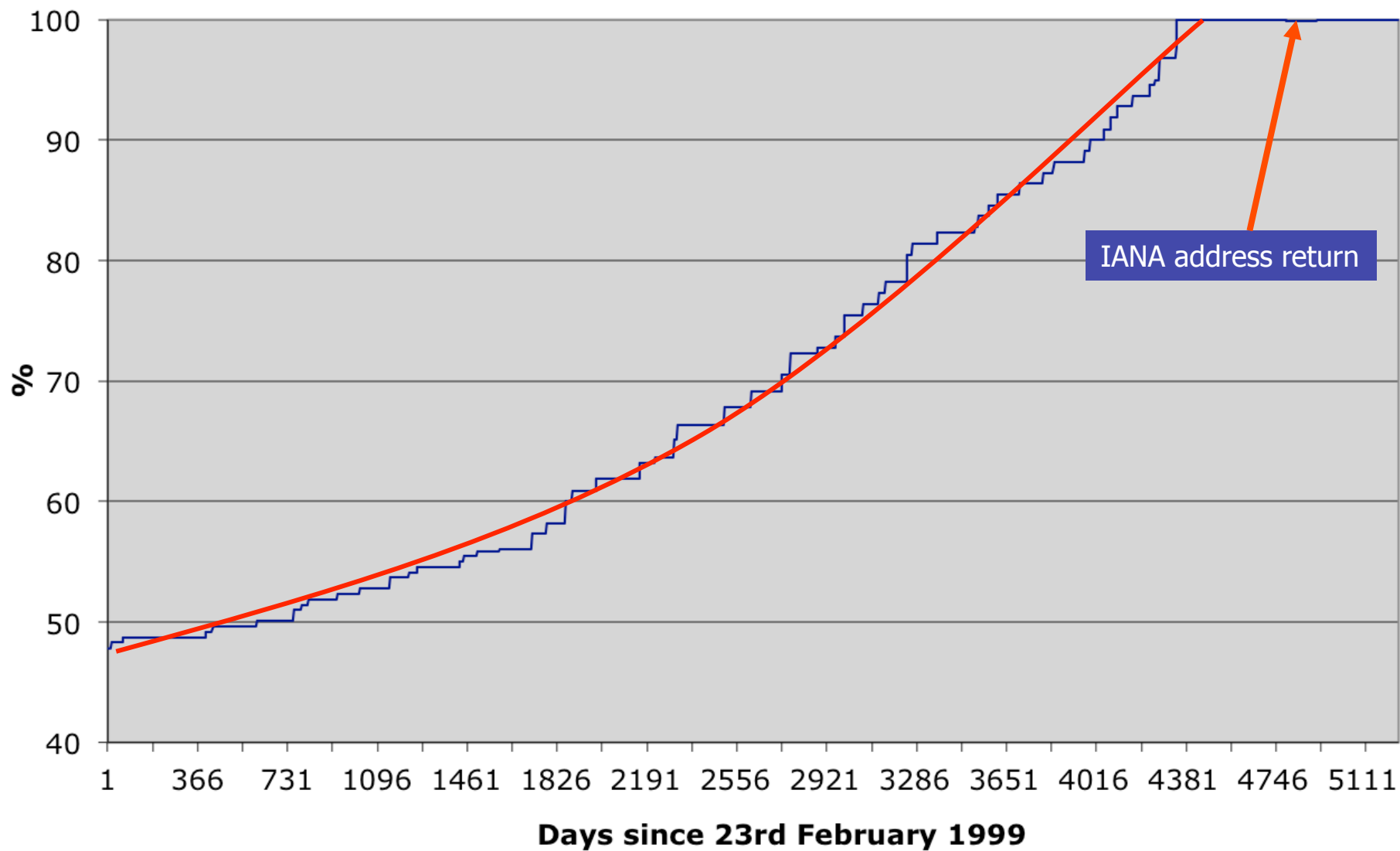


— Total ASNs — Origin-only ASNs — ASN providing Transit & Origin — Transit-only ASNs

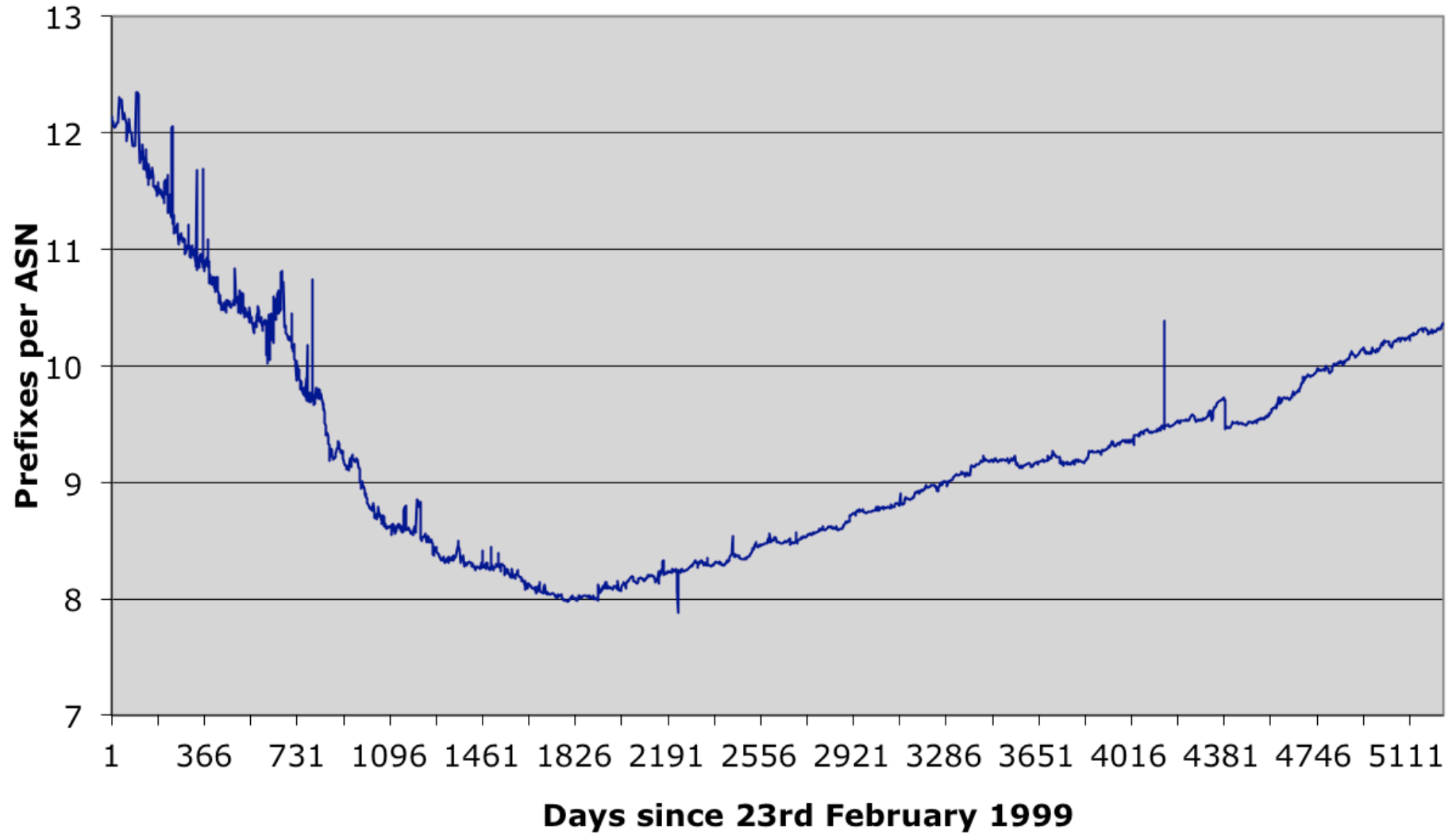
Maximum AS Path Length



Growth in IPv4 Address Space Allocations



Prefixes per ASN





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”



September 2013

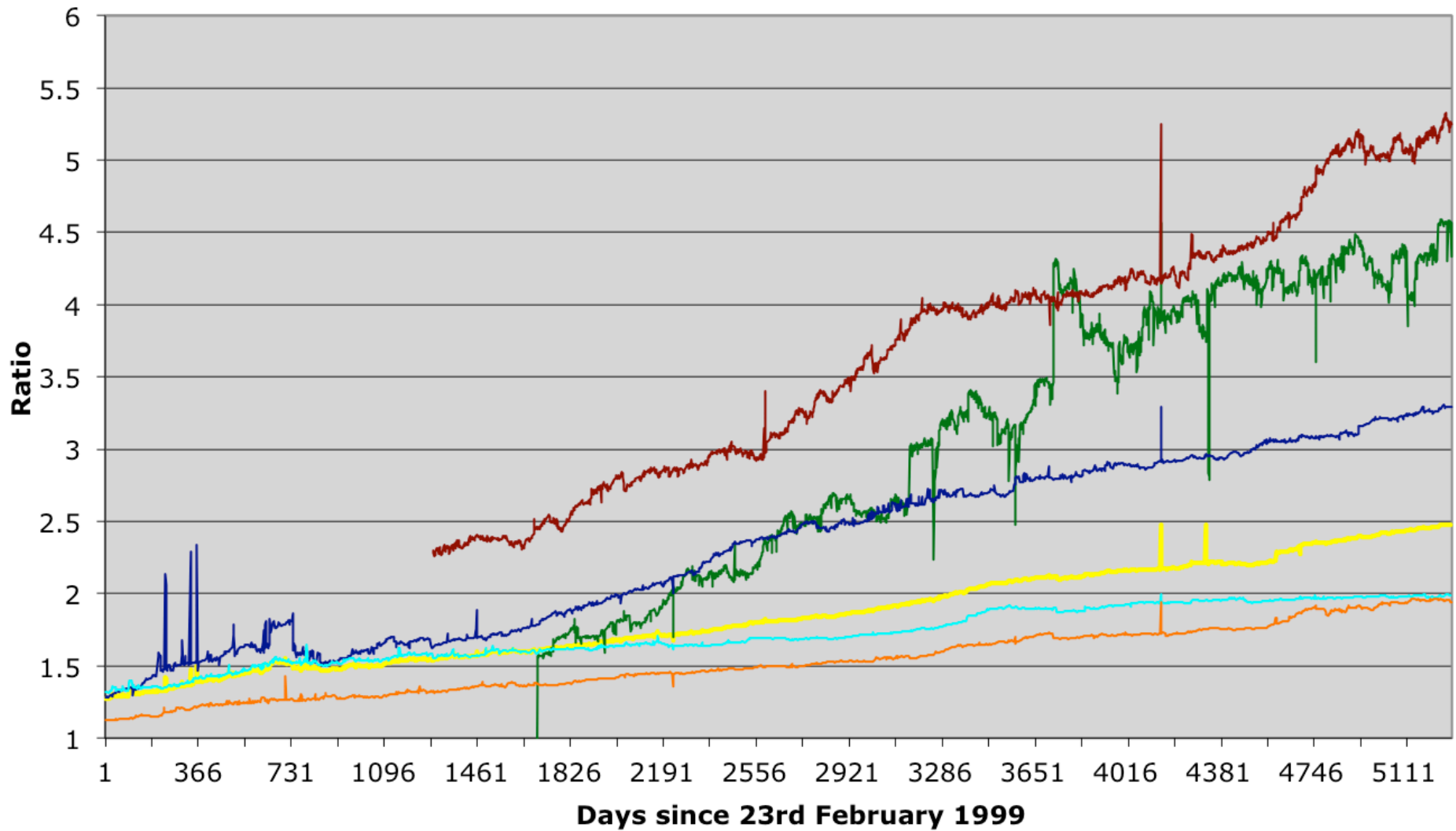
Total Prefixes

- Global BGP Table
 - 468k prefixes
- Europe & Middle East
 - 119k prefixes
- North America
 - 163k prefixes
- Asia & Pacific
 - 111k prefixes
- Africa
 - 12k prefixes
- Latin America & Caribbean
 - 52k prefixes

Deaggregation Factor

- Global Average
 - 2.48
- Europe & Middle East
 - 1.94
- North America
 - 2.00
- Asia & Pacific
 - 3.29
- Africa
 - 4.58
- Latin America & Caribbean
 - 5.27

Deaggregation: RIR Regions vs Global



Global AfriNIC APNIC ARIN LACNIC RIPE

RIPE NCC Region Aggregation Savings Summary

ASN	No of Nets	Savings	Description
8402	1746	1730	OJSC "Vimpelcom"
34984	1331	1110	TELLCOM ILETISIM HIZMETLERI A
31148	987	970	FreeNet ISP
13188	847	777	TOV "Bank-Inform"
8551	749	708	Bezeq International
12479	677	628	Uni2 Autonomous System
35228	528	512	Avatar Broadband Limited
34744	519	475	SC GVM SISTEM 2003 SRL
6830	894	468	UPC Distribution Services
8866	465	449	Bulgarian Telecommunication C
9155	437	429	QualityNet AS number
35819	481	396	Bayanat Al-Oula Autonomous Sy
42910	439	368	Hosting Internet Hizmetleri S
43890	398	364	Netserv Consult SRL
34714	354	331	SC OPTICNET SERV SRL
2118	343	330	OOO "NPO Relcom"
42926	380	321	Radore Veri Merkezi Hizmetler
9121	304	281	TTnet Autonomous System
9198	291	269	Kazakhtelecom Data Network Ad
25019	365	265	SaudiNet (STC ISP)

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

Kuwait Aggregation Savings

ASN	No of Nets	Savings	Description
9155	437	429	QualityNet General Trading &
47442	152	150	Mada Communications
42961	155	145	Mobile Communications Company
47589	133	131	Kuwait Telecommunication Comp
3225	123	110	Gulfnet Kuwait
21050	105	94	Fast Telecommunications Compa
29357	86	82	WATANIYA TELECOM
42781	83	48	Zajil International Telecom C
35181	10	7	Public WareHousing Company
25242	6	5	Computer Information Systems

UAE Aggregation Savings

ASN	No of Nets	Savings	Description
5384	205	182	Emirates Telecommunications C
15802	136	125	Dubai Internet City
47862	13	9	Khalifa University for Scienc
8966	22	7	Emirates Internet Exchange Ro
51182	8	6	United Arab Emirates Universi
47201	4	3	Telecommunication Regulatory
57163	3	2	Zayed University
56479	3	2	Higher Colleges of Technology
5613	3	2	Dubai Mercantile Exchange
44703	8	2	Thuraya Telecommunications Pr

Jordan Aggregation Savings

ASN	No of Nets	Savings	Description
8376	181	170	Jordan Data Communications Co
48832	62	55	Linkdotnet-Jordan
44702	32	31	JORDAN TV CABLE & INTERNET SE
8934	26	24	National Information Center
9038	44	23	Batelco Jordan
44466	27	20	Metrobeam Jordan
57393	19	15	The Blue Zone East / Jordan
50670	9	8	Vtel Holdings Limited /Jordan
42912	13	7	XOL JORDAN
35656	8	7	Jordanian Universities Netwot

KSA Aggregation Savings

ASN	No of Nets	Savings	Description
35819	513	442	Bayanat Al-Oula Autonomous Sy
25019	366	266	SaudiNet (STC ISP)
47794	120	116	Etihad Atheeb Telecom Company
25438	101	88	International Computer Compan
8895	84	80	King Abdul Aziz City for Scie
39891	79	77	SaudiNet, Saudi Telecom Compa
29684	67	52	Nour Communication Co.Ltd - N
35753	53	42	ITC AS number
43775	30	24	Digital Solutions Provider
39919	20	17	Voice & Data Telecommunicatio



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 19 September 2013 06:24 (UTC+1000)

50 Most active ASes for the past 7 days

RANK	ASN	UPDs	%	Prefixes	UPDs/Prefix	AS NAME
1	9829	51501	2.07%	1550	33.23	BSNL-NIB National Internet Backbone
2	8402	40722	1.63%	1910	21.32	CORBINA-AS OJSC "Vimpelcom"
3	15003	34888	1.40%	868	40.19	NOBIS-TECH - Nobis Technology Group, LLC
4	28624	33615	1.35%	231	145.52	Oops Telecom
5	28573	28722	1.15%	3312	8.67	NET Serviços de Comunicação S.A.
6	27738	25300	1.02%	577	43.85	Ecuadortelecom S.A.
7	13118	21068	0.85%	47	448.26	ASN-YARTELECOM OJSC Rostelecom
8	9498	20002	0.80%	1197	16.71	BBIL-AP BHARTI Airtel Ltd.
9	36998	19309	0.77%	1864	10.36	SDN-MOBITEL
10	9416	18447	0.74%	65	283.80	MULTIMEDIA-AS-AP Hoshin Multimedia Center Inc.
11	4766	16820	0.67%	2924	5.75	KIXS-AS-KR Korea Telecom
12	4775	16113	0.65%	129	124.91	GLOBE-TELECOM-AS Globe Telecoms
13	10620	12415	0.50%	2564	4.84	Telmex Colombia S.A.
14	48159	12366	0.50%	918	13.47	TIC-AS Telecommunication Infrastructure Company
15	21341	12292	0.49%	48	256.08	SINET-AS Soroush Rasanheh Company Ltd
16	53229	10773	0.43%	3	3591.00	Industrias Arteb S.A
17	39074	10411	0.42%	39	266.95	IR-SEPANTA-ISP Sepanta Communication Development Co. Ltd
18	50710	10319	0.41%	225	45.86	EARTHLINK-AS EarthLink Ltd. Communications&Internet Services
19	8151	10180	0.41%	1302	7.82	Uninet S.A. de C.V.
20	4434	10132	0.41%	72	140.72	ERX-RADNET1-AS PT Rahajasa Media Internet
21	12880	9764	0.39%	118	82.75	DCI-AS Information Technology Company (ITC)
22	11976	9677	0.39%	203	47.67	FIDN - Fidelity Communication International Inc.
23	48612	9539	0.38%	14	681.36	RTC-ORENBURG-AS CJSC "Comstar-Regions"
24	14287	9334	0.37%	54	172.85	TRIAD-TELECOM - Triad Telecom, Inc.

50 Most active Prefixes for the past 7 days

RANK	PREFIX	UPDs	%	Origin AS -- AS NAME
1	109.161.64.0/20	20470	0.76%	13118 -- ASN-YARTELECOM OJSC Rostelecom
2	61.95.239.0/24	16366	0.61%	9498 -- BBIL-AP BHARTI Airtel Ltd.
3	186.251.232.0/23	10771	0.40%	53229 -- Industrias Ardeb S.A
4	202.154.17.0/24	9983	0.37%	4434 -- ERX-RADNET1-AS PT Rahajasa Media Internet
5	92.246.207.0/24	9436	0.35%	48612 -- RTC-ORENBURG-AS CJSC "Comstar-Regions"
6	203.118.224.0/21	9243	0.34%	9416 -- MULTIMEDIA-AS-AP Hoshin Multimedia Center Inc.
7	192.58.232.0/24	9137	0.34%	6629 -- NOAA-AS - NOAA
8	203.118.232.0/21	9136	0.34%	9416 -- MULTIMEDIA-AS-AP Hoshin Multimedia Center Inc.
9	120.28.62.0/24	7996	0.30%	4775 -- GLOBE-TELECOM-AS Globe Telecoms
11	95.47.176.0/24	6932	0.26%	8359 -- MTS MTS OJSC
12	115.170.128.0/17	6807	0.25%	4847 -- CNIX-AP China Networks Inter-Exchange
13	67.210.190.0/23	5174	0.19%	11976 -- FIDN - Fidelity Communication International Inc.
14	204.29.132.0/23	5073	0.19%	1880 -- STUPI Svensk Teleutveckling & Produktinnovation, STUPI AB
15	69.38.178.0/24	4418	0.16%	19406 -- TWRS-MA - Towerstream I, Inc.
16	201.33.145.0/24	4322	0.16%	11993 -- BANCO DO BRASIL S.A.
17	168.223.200.0/22	4093	0.15%	7202 -- FAMU - Florida A & M University
18	168.223.206.0/23	4065	0.15%	7202 -- FAMU - Florida A & M University
19	67.210.188.0/23	4036	0.15%	11976 -- FIDN - Fidelity Communication International Inc.
20	64.187.64.0/23	3880	0.14%	16608 -- KENTEC - Kentec Communications, Inc.
21	208.16.110.0/24	3539	0.13%	6174 -- SPRINTLINK8 - Sprint
22	206.105.75.0/24	3533	0.13%	6174 -- SPRINTLINK8 - Sprint
23	41.75.40.0/21	3484	0.13%	37367 -- CALLKEY
24	64.187.64.0/24	3154	0.12%	16608 -- KENTEC - Kentec Communications, Inc.
25	72.52.128.0/17	3012	0.11%	32244 -- LIQUID-WEB-INC - Liquid Web, Inc.
26	2.93.235.0/24	3005	0.11%	8402 -- CORBINA-AS OJSC "Vimpelcom"
27	216.194.8.0/21	2727	0.10%	16524 -- METTEL - Metropolitan Telecomm
28	84.205.66.0/24	2581	0.10%	12654 -- RIPE-NCC-RIS-AS Reseaux IP Europeens Network Coordination Centre (RIPE NCC)
29	188.123.160.0/19	2542	0.09%	47887 -- NEU-AS NEU Telecom & Technologies
30	62.84.76.0/24	2448	0.09%	42334 -- BBP-AS Broadband Plus s.a.l.



Observations

- Range of operational “practices” between RIR regions
 - Deaggregation by newer ISPs & developing regions is very significant
 - 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?