

Internet Routing Table Analysis Update



Philip Smith

SANOG 20

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Karachi



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 16 July 2012

BGP routing table entries examined:	416436
Prefixes after maximum aggregation:	175960
Deaggregation factor:	2.37
Unique aggregates announced to Internet:	202941
Total ASes present in the Internet Routing Table:	41502
Prefixes per ASN:	10.03
Origin-only ASes present in the Internet Routing Table:	33309
Origin ASes announcing only one prefix:	15677
Transit ASes present in the Internet Routing Table:	5581
Transit-only ASes present in the Internet Routing Table:	134
Average AS path length visible in the Internet Routing Table:	4.5
Max AS path length visible:	30
Max AS path prepend of ASN (51742)	24
Prefixes from unregistered ASNs in the Routing Table:	400
Unregistered ASNs in the Routing Table:	131
Number of 32-bit ASNs allocated by the RIRs:	2990
Number of 32-bit ASNs visible in the Routing Table:	2612
Prefixes from 32-bit ASNs in the Routing Table:	6775
Special use prefixes present in the Routing Table:	1
Prefixes being announced from unallocated address space:	162
Number of addresses announced to Internet:	2565089580
Equivalent to 152 /8s, 228 /16s and 41 /24s	
Percentage of available address space announced:	69.2
Percentage of allocated address space announced:	69.3
Percentage of available address space allocated:	99.9
Percentage of address space in use by end-sites:	93.0
Total number of prefixes smaller than registry allocations:	144209

APNIC Region

Prefixes being announced by APNIC Region ASes:	101972
Total APNIC prefixes after maximum aggregation:	32787
APNIC Deaggregation factor:	3.11
Prefixes being announced from the APNIC address blocks:	102422
Unique aggregates announced from the APNIC address blocks:	42125
APNIC Region origin ASes present in the Internet Routing Table:	4719
APNIC Prefixes per ASN:	21.70
APNIC Region origin ASes announcing only one prefix:	1245
APNIC Region transit ASes present in the Internet Routing Table:	745
Average APNIC Region AS path length visible:	4.6
Max APNIC Region AS path length visible:	26
Number of APNIC region 32-bit ASNs visible in the Routing Table:	245
Number of APNIC addresses announced to Internet:	704264832
Equivalent to 41 /8s, 250 /16s and 58 /24s	
Percentage of available APNIC address space announced:	82.3

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
6389	3388	3773	186	bellsouth.net, inc.
7029	3340	998	177	Windstream Communications Inc
4766	2732	11119	1236	Korea Telecom (KIX)
17974	2217	558	80	PT TELEKOMUNIKASI INDONESIA
18566	2088	382	181	Covad Communications
28573	2007	1214	55	NET Servicios de Comunicacao S.A
10620	1990	346	208	TVCABLE BOGOTA
1785	1935	680	130	PaeTec Communications, Inc.
7545	1691	301	87	TPG Internet Pty Ltd
22773	1664	2911	121	Cox Communications, Inc.
20115	1649	1571	615	Charter Communications
8402	1631	544	16	Corbina telecom
4755	1614	388	162	TATA Communications formerly
4323	1575	1043	384	Time Warner Telecom
6503	1522	418	66	AVANTEL, S.A.
8151	1464	3044	345	UniNet S.A. de C.V.
7303	1454	934	194	Telecom Argentina Stet-France
30036	1390	270	782	Mediacom Communications Corp
9829	1303	1085	28	BSNL National Internet Backbo
7018	1261	10044	825	AT&T WorldNet Services

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	/10:28	/11:82	/12:236
/13:471	/14:843	/15:1520	/16:12288	/17:6364	/18:10783
/19:20870	/20:29725	/21:31551	/22:41196	/23:39211	/24:217392
/25:1235	/26:1486	/27:858	/28:164	/29:61	/30:18
/31:0	/32:23				

July 2012 ↑

July 2011 ↓

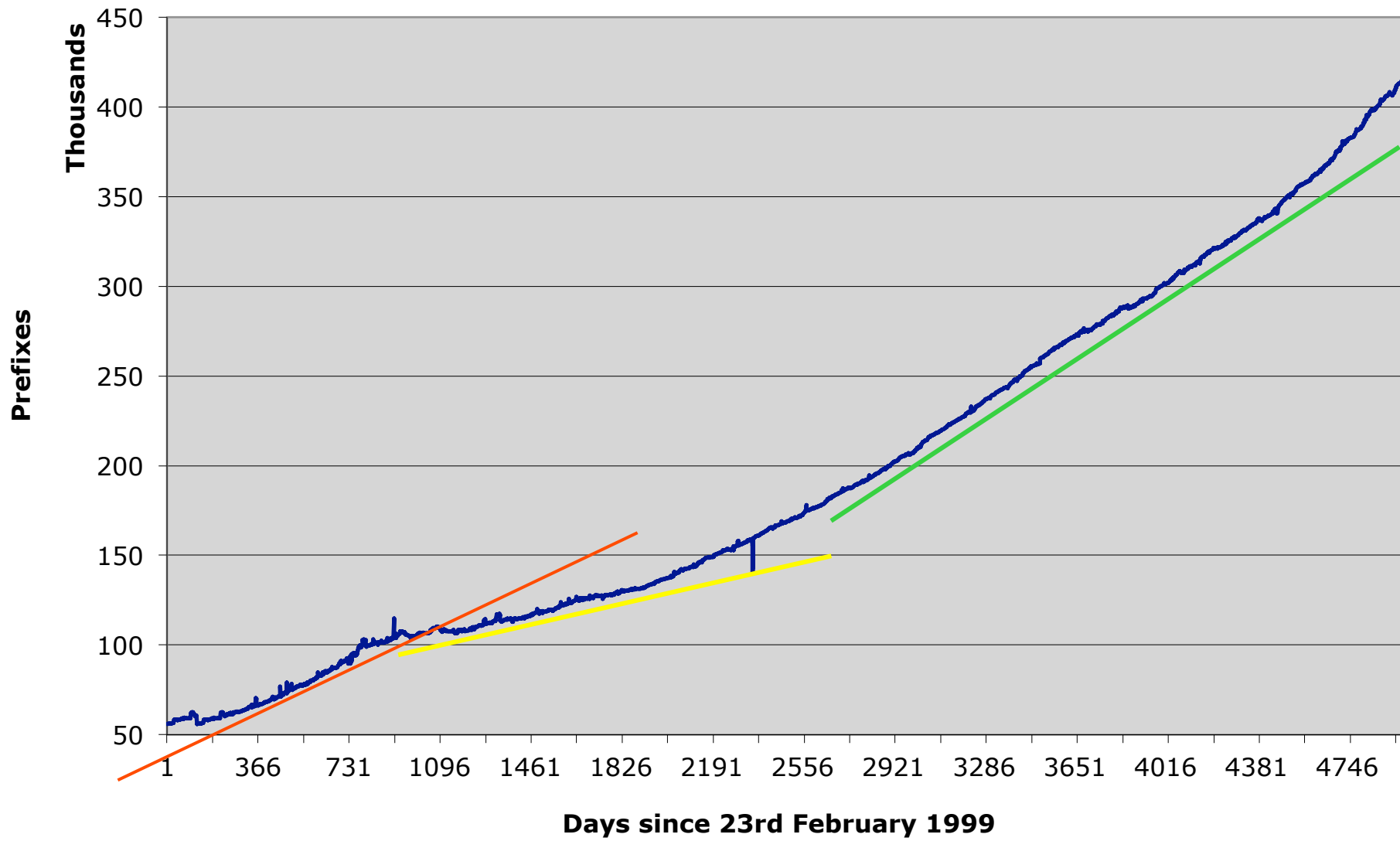
Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:20	/9:12	/10:26	/11:80	/12:232
/13:464	/14:795	/15:1396	/16:12005	/17:5876	/18:9821
/19:19496	/20:26056	/21:26209	/22:34865	/23:33683	/24:189377
/25:1057	/26:1247	/27:720	/28:198	/29:9	/30:2
/31:0	/32:6				

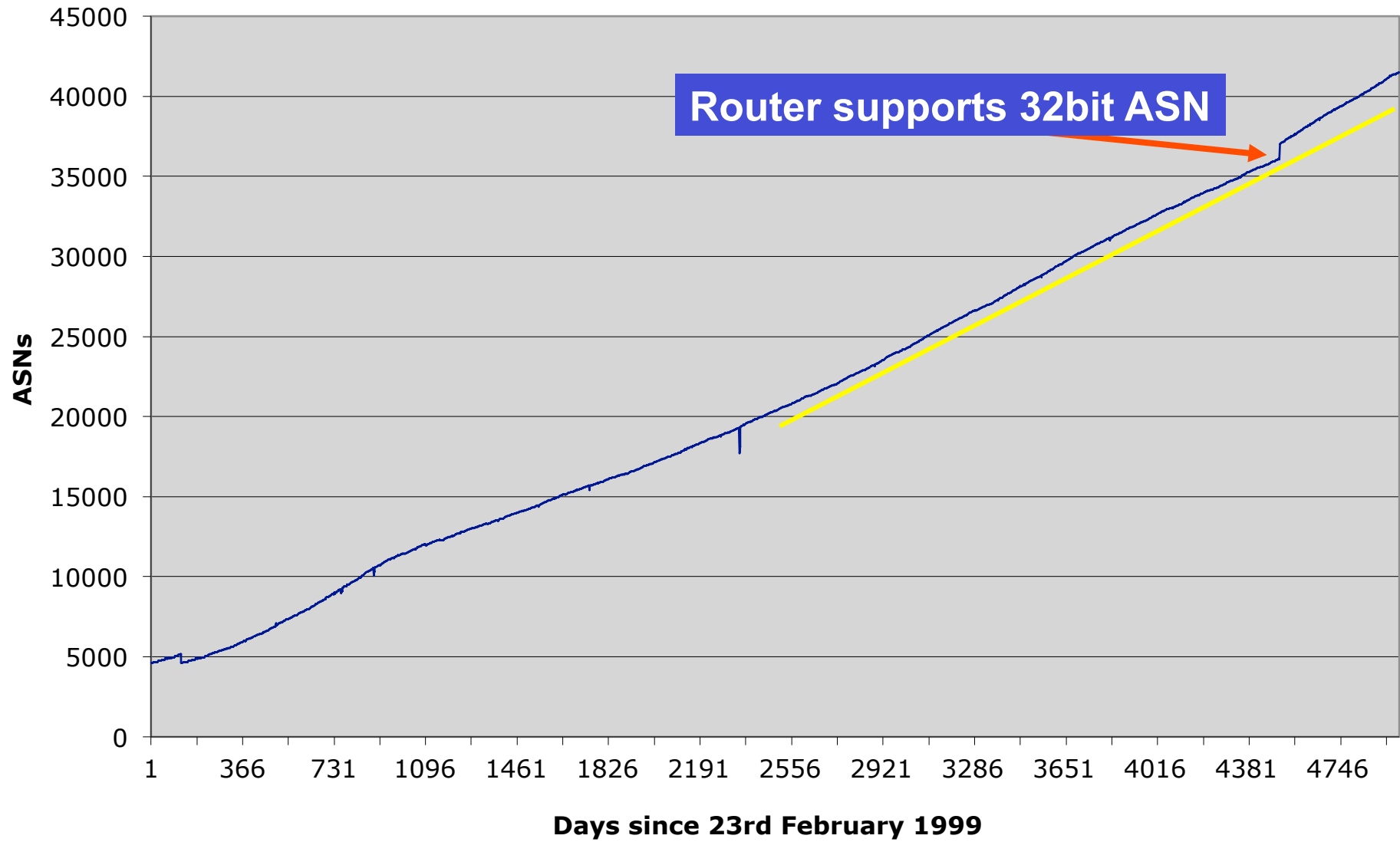
Prefixes Smaller than Registry Allocations

ASN	No of nets	Total ann.	Description
7029	2675	3340	Windstream Communications Inc
18566	2038	2088	Covad Communications
6389	1868	3388	bellsouth.net, inc.
8402	1326	1631	Corbina telecom
30036	1325	1390	Mediacom Communications Corp
11492	1154	1191	Cable One
22773	1095	1664	Cox Communications, Inc.
6503	1051	1522	AVANTEL, S.A.
1785	1043	1935	PaeTec Communications, Inc.
7011	934	1197	Citizens Utilities
8452	865	1106	TEDATA
13977	825	839	FAIRPOINT COMMUNICATIONS, INC
22561	813	1008	Digital Teleport, Inc
4766	730	2732	Korea Telecom (KIX)
6458	700	854	GUATEL
31148	659	704	FreeNet ISP
3356	648	1098	Level 3 Communications, LLC
10620	644	1990	TVCABLE BOGOTA
20115	575	1649	Charter Communications
13407	561	606	Computer Telephone Corp

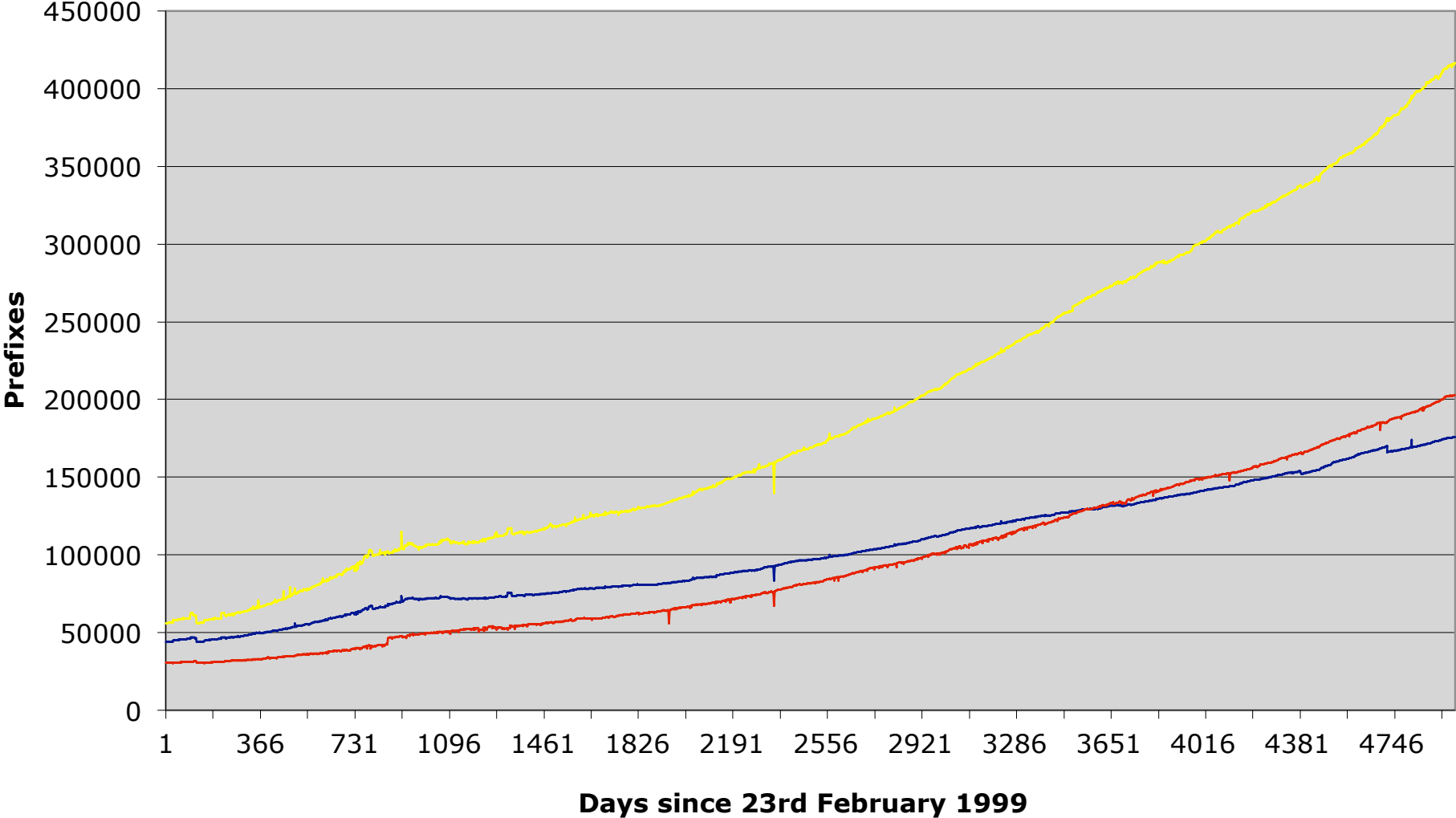
BGP Routing Table



AS Growth

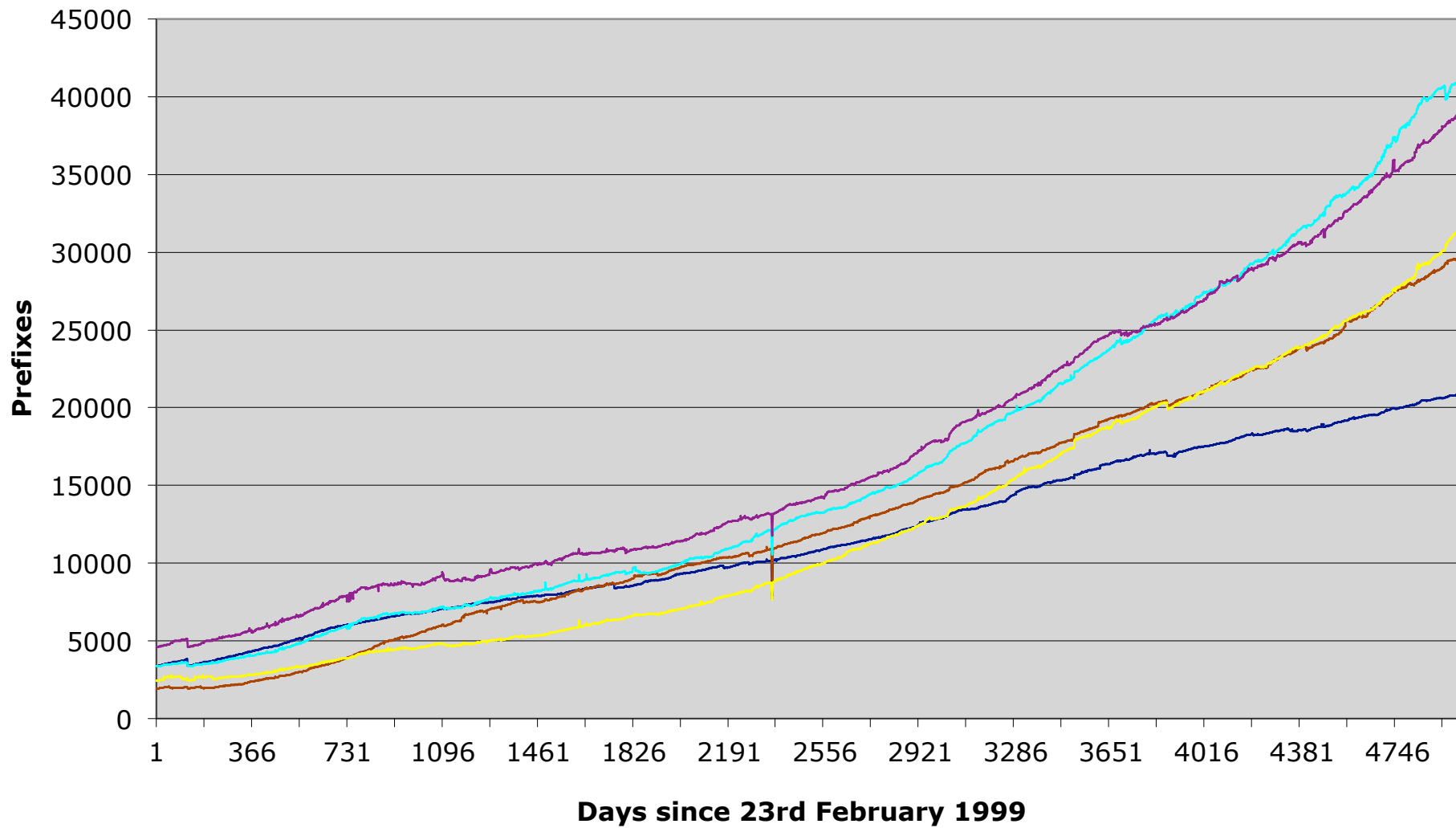


Max Aggregation vs Unique Prefixes



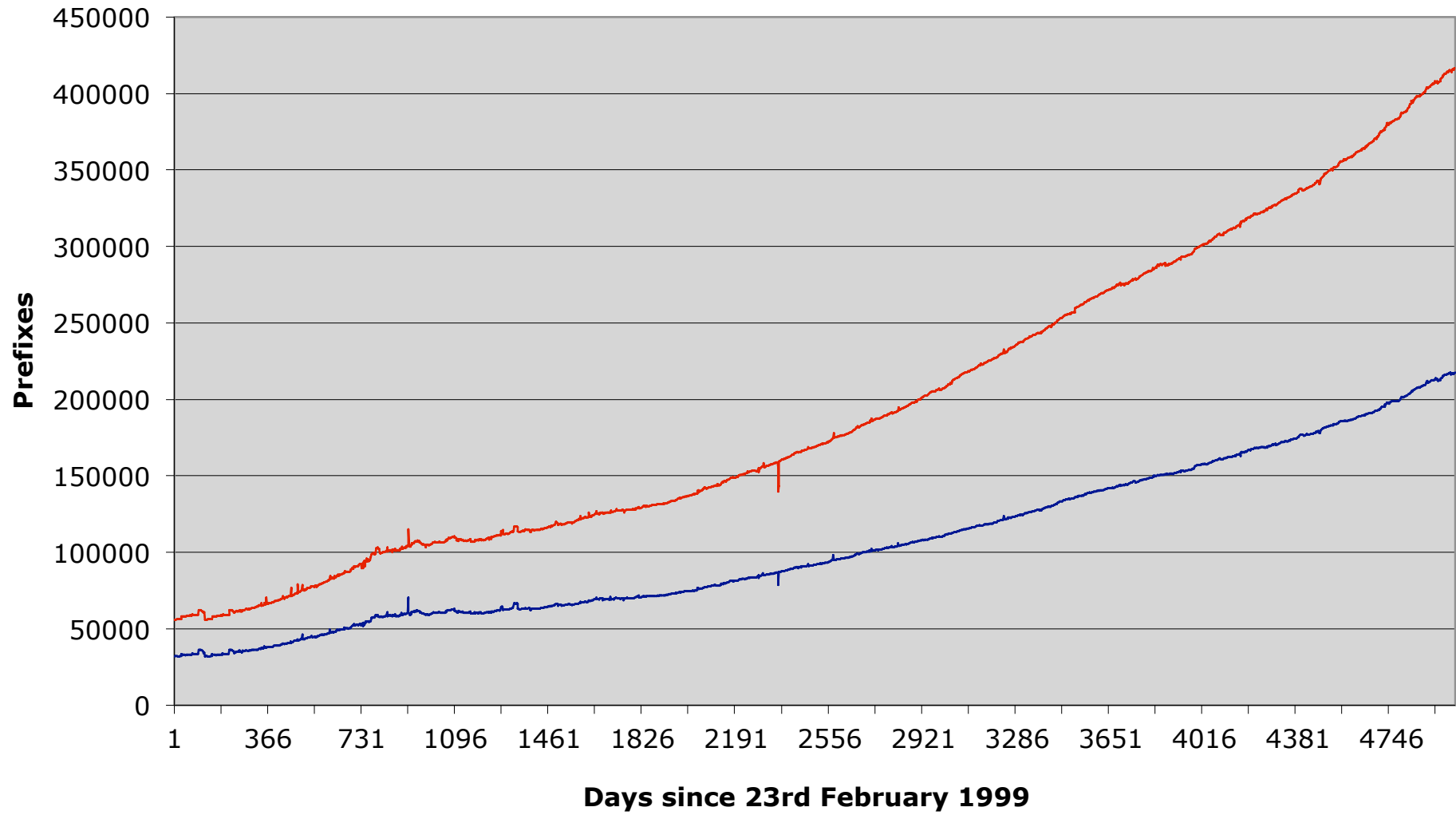
— Max Aggregation — Unique Prefixes — Global BGP Table

Prefix sizes announced



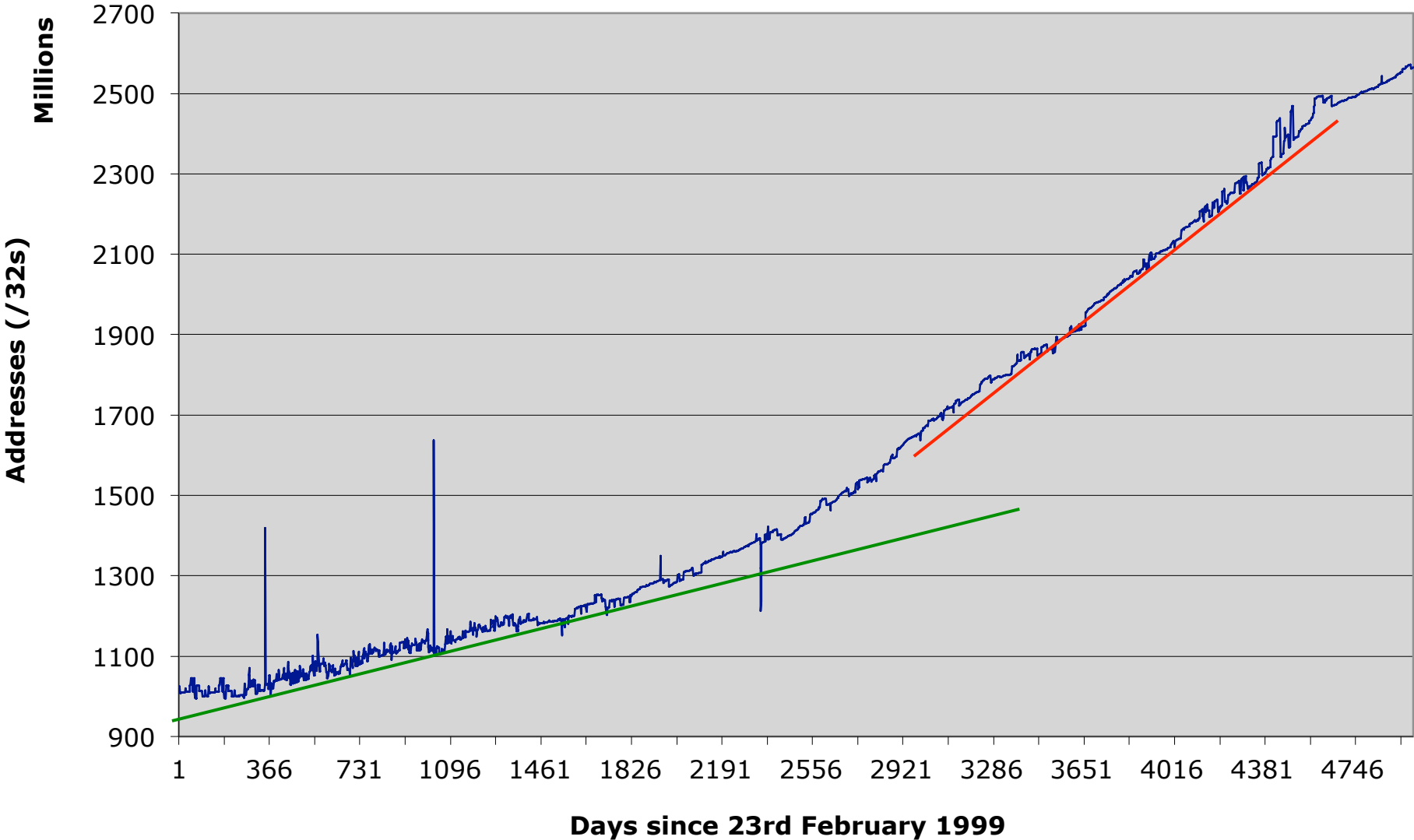
— /19 — /20 — /21 — /22 — /23

/24s announced

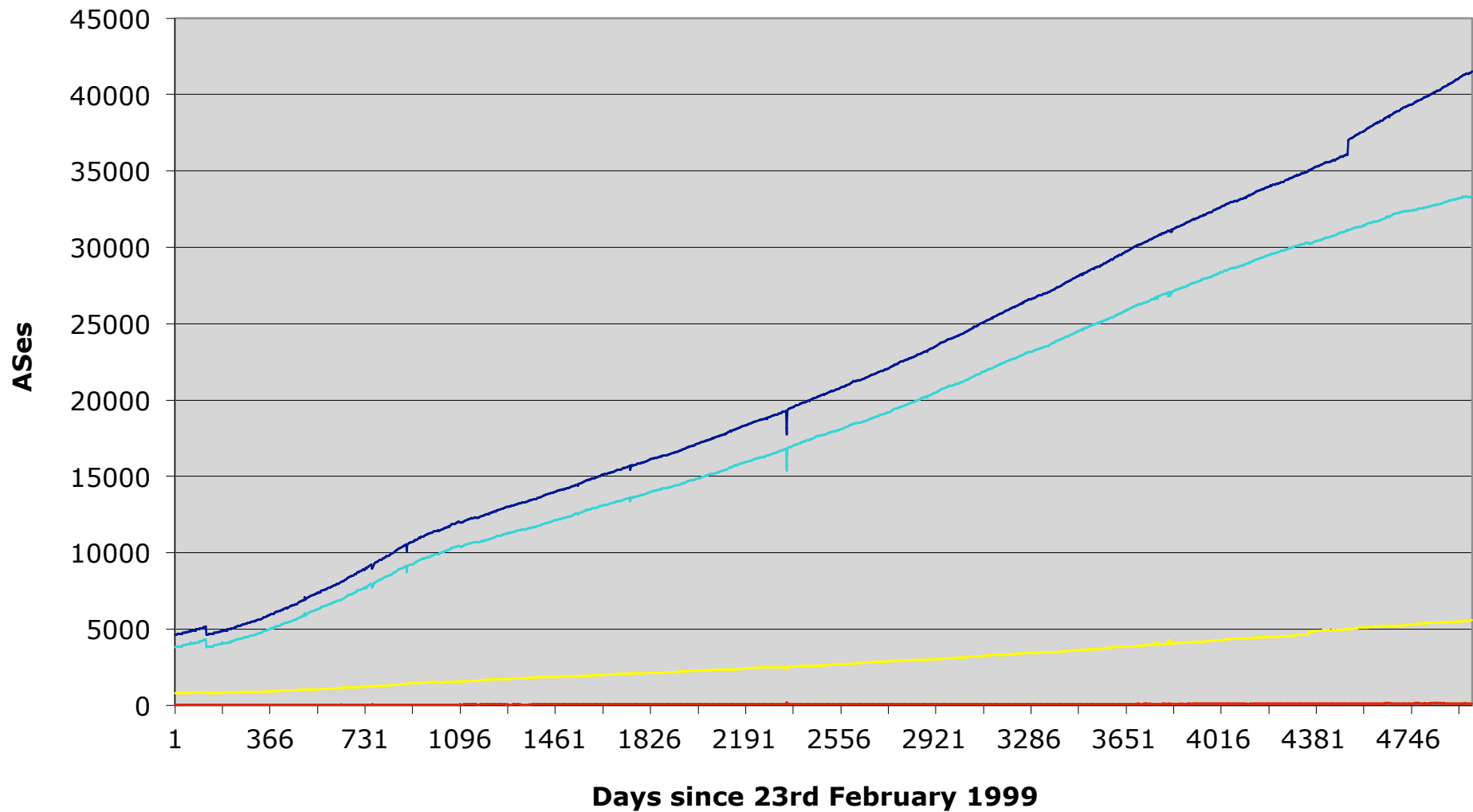


— /24s — Global BGP Table

Address Space announced



AS Announcements



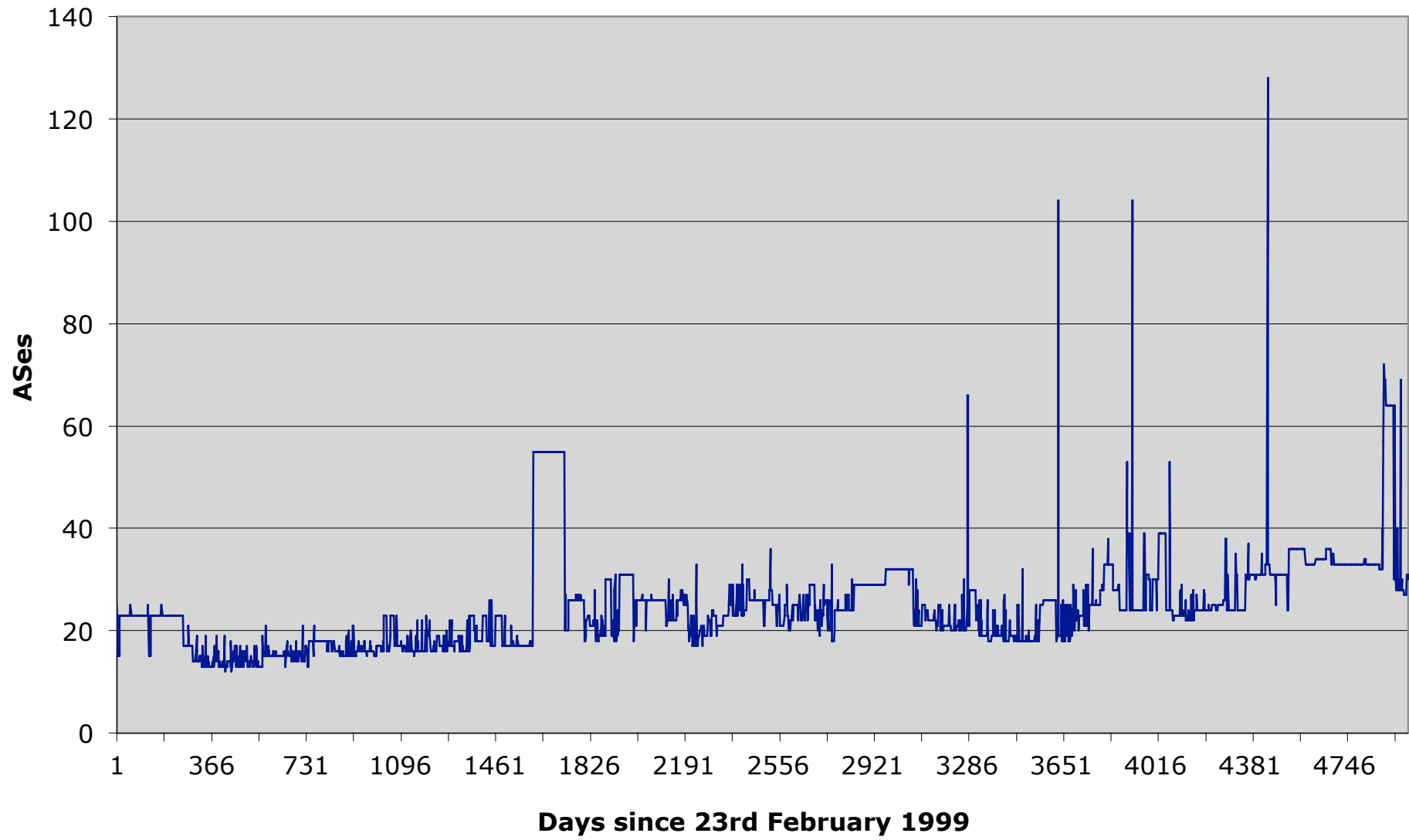
— Total ASNs

— Origin-only ASNs

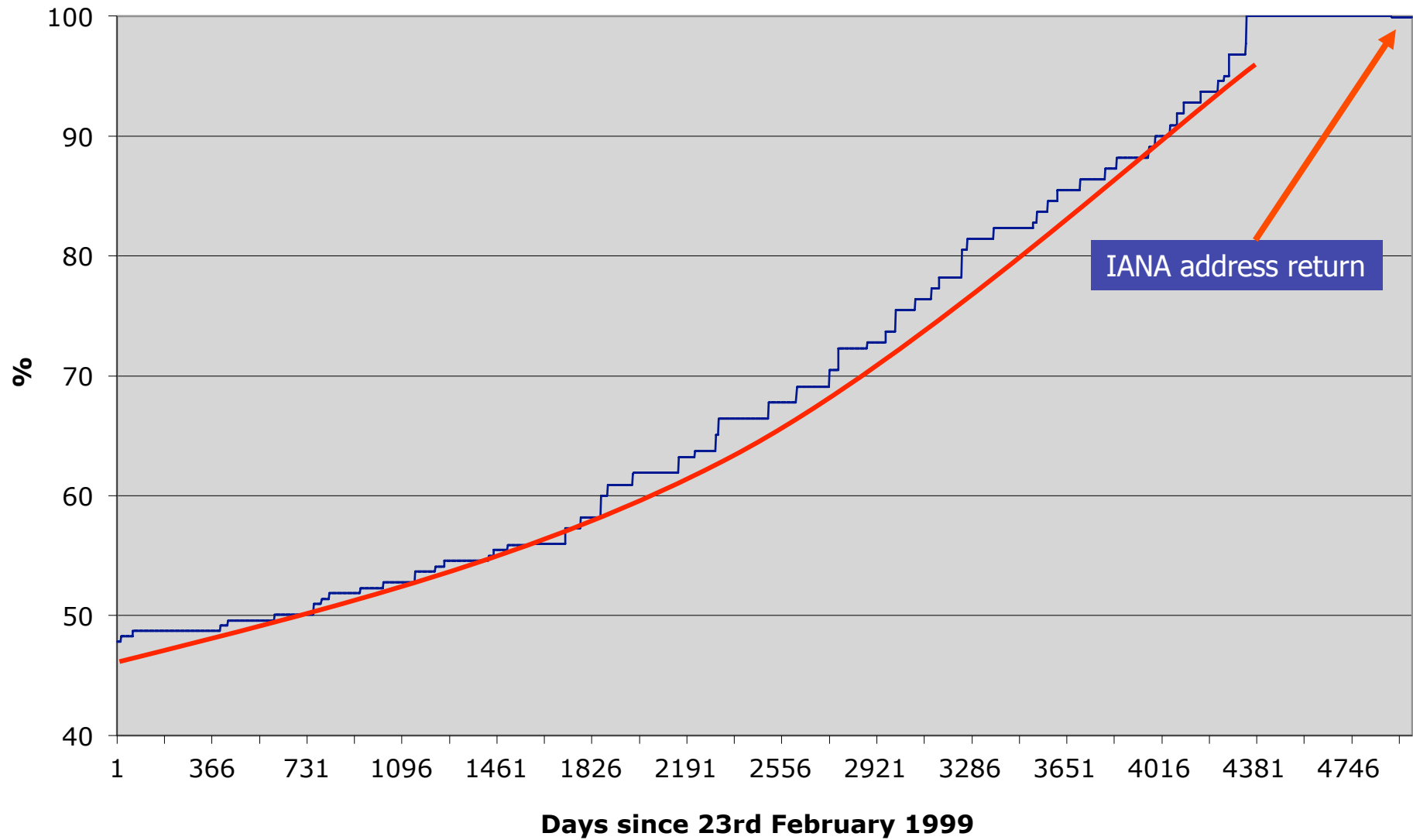
— ASN providing Transit & Origin

— Transit-only ASNs

Maximum AS Path Length



Growth in IPv4 Address Space Allocations





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”



July 2012

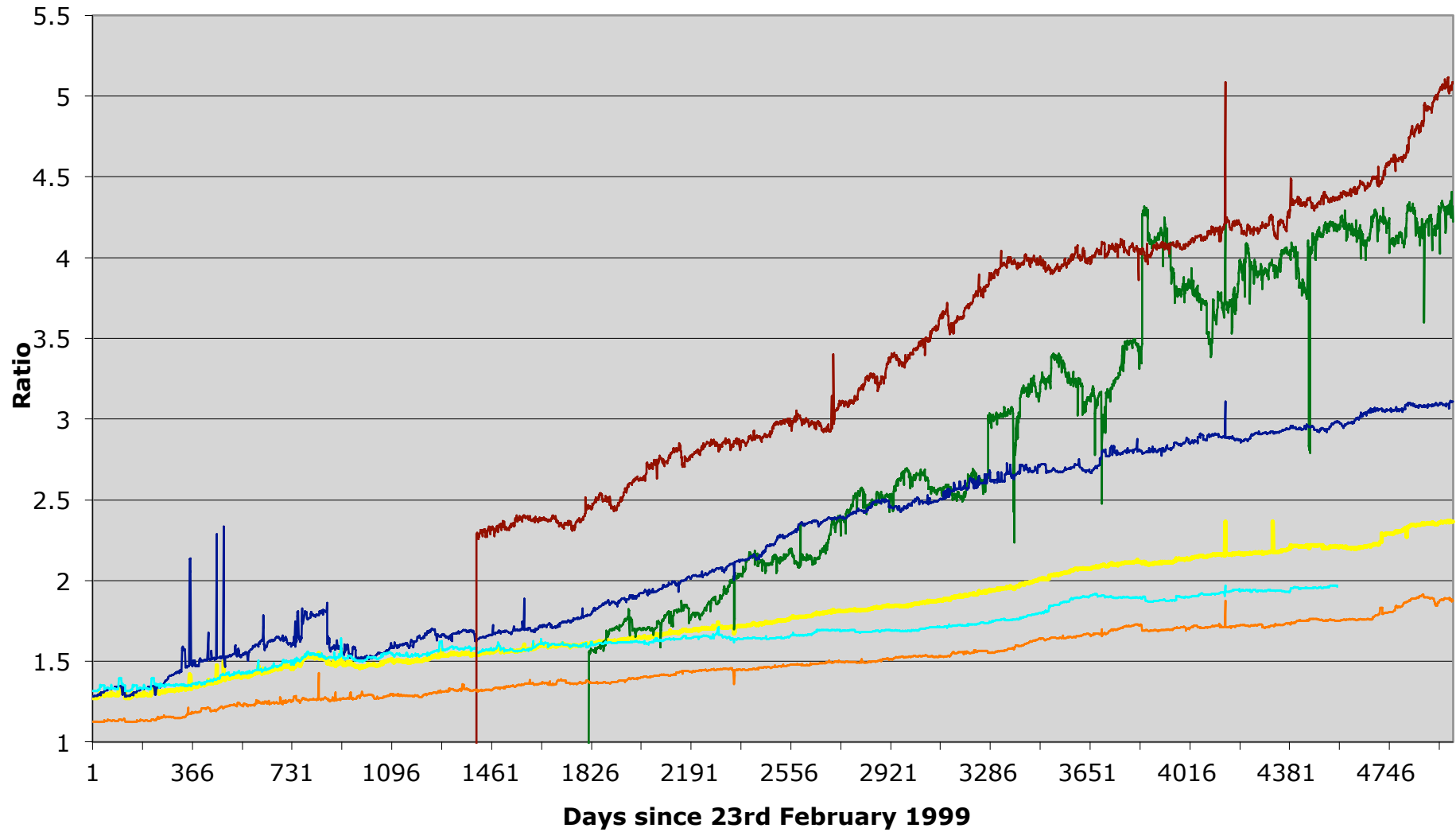
Total Prefixes

- Global BGP Table
 - 416k prefixes
- Europe & Middle East
 - 103k prefixes
- North America
 - 152k prefixes
- Asia & Pacific
 - 102k prefixes
- Africa
 - 9k prefixes
- Latin America & Caribbean
 - 42k prefixes

Deaggregation Factor

- Global Average
 - 2.37
- Europe & Middle East
 - 1.88
- North America
 - 1.97
- Asia & Pacific
 - 3.11
- Africa
 - 4.22
- Latin America & Caribbean
 - 5.09

Deaggregation: RIR Regions vs Global



Global AfriNIC APNIC ARIN LACNIC RIPE

Asia Pacific Aggregation Savings Summary

ASN	No of Nets	Savings	Description
17974	2217	2137	PT TELEKOMUNIKASI INDONESIA
7545	1691	1604	TPG Internet Pty Ltd
4766	2732	1496	Korea Telecom (KIX)
4755	1614	1452	TATA Communications formerly
9829	1303	1275	BSNL National Internet Backbo
7552	1128	1117	Vietel Corporation
9498	981	914	BHARTI Airtel Ltd.
9394	891	874	CHINA RAILWAY Internet (CRNET)
24560	1037	872	Bharti Airtel Ltd., Telemedia
4808	1117	799	CNCGROUP IP network: China169
18101	943	788	Reliance Infocom Ltd Internet
4780	842	774	Digital United Inc.
17908	828	769	Tata Communications
9583	1167	662	Sify Limited
17676	693	617	Softbank BB Corp.
9808	602	589	Guangdong Mobile Communicatio
9443	550	476	Primus Telecommunications
17841	575	471	MIC EGOVERNMENT
17623	521	470	China Netcom Corp.
17803	612	465	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 15 July 2012 06:17 (UTC+1000)

50 Most active ASes for the past 7 days

RANK	ASN	UPDs	%	Prefixes	UPDs/Prefix	AS NAME
1	27738	12569	1.12%	550	22.85	Ecuadortelecom S.A.
2	28306	11414	1.02%	34	335.71	TC Net Informática e Telecomunicações LTDA
3	8402	10868	0.97%	1783	6.10	CORBINA-AS OJSC "Vimpelcom"
4	2697	9883	0.88%	208	47.51	ERX-ERNET-AS Education and Research Network
5	5800	9807	0.87%	250	39.23	DNIC-ASBLK-05800-06055 - DoD Network Information Center
6	24560	9067	0.81%	1037	8.74	AIRTELBROADBAND-AS-AP Bharti Airtel Ltd., Telemedia Services
7	23688	8756	0.78%	46	190.35	LINK3-TECH-AS-BD-AP Link3 Technologies Ltd.
8	17469	8489	0.76%	14	606.36	ACCESSTEL-AS-AP Access Telecom (BD) Ltd.
9	35104	8471	0.75%	78	108.60	KTC-AS AS JSC "KazTransCom"
10	12479	7942	0.71%	801	9.92	UNI2-AS France Telecom Espana SA
11	17813	7187	0.64%	136	52.85	MTNL-AP Mahanagar Telephone Nigam Ltd.
12	6389	6749	0.60%	3393	1.99	BELLSOUTH-NET-BLK - BellSouth.net Inc.
13	38031	6495	0.58%	23	282.39	OPTIMAX-BD-AS-AP OptiMax Communication Ltd.
14	2	6342	0.56%	224	28.31	UDEL-DCN - University of Delaware
15	6503	6180	0.55%	1540	4.01	Axtel, S.A.B. de C.V.
16	56115	5870	0.52%	46	127.61	NGGL-BD Road 27 House 13 Block C2
17	38203	5820	0.52%	14	415.71	ATC-BD-AS-AP Advanced Data Networks System Limited
18	21433	5710	0.51%	216	26.44	ACCENTUREFSSC Accenture UK Limited
19	27096	5517	0.49%	17	324.53	DNIC-ASBLK-27032-27159 - DoD Network Information Center
20	28573	5481	0.49%	2010	2.73	NET Servicos de Comunicacao S.A.
21	13118	5406	0.48%	48	112.62	ASN-YARTELECOM OJSC Rostelecom
22	8151	5262	0.47%	1511	3.48	Uninet S.A. de C.V.
23	7029	5230	0.47%	3342	1.56	WINDSTREAM - Windstream Communications Inc
24	18230	5196	0.46%	10	519.60	ZIPNETBD-DKB-AS-AP Zipnet Limited DKB AS number

50 Most active Prefixes for the past 7 days

RANK	PREFIX	UPDs	%	Origin AS -- AS NAME
1	109.161.64.0/19	5319	0.46%	13118 -- ASN-YARTELECOM OJSC Rostelecom
3	182.64.0.0/16	2791	0.24%	24560 -- AIRTELBROADBAND-AS-AP Bharti Airtel Ltd., Telemedia Services
4	122.161.0.0/16	2630	0.23%	24560 -- AIRTELBROADBAND-AS-AP Bharti Airtel Ltd., Telemedia Services
5	132.254.102.0/23	2257	0.20%	10436 -- Instituto Tecnológico y de Estudios Superiores de Monterrey
6	62.36.252.0/22	2133	0.19%	12479 -- UNI2-AS France Telecom Espana SA
7	59.177.48.0/20	1813	0.16%	17813 -- MTNL-AP Mahanagar Telephone Nigam Ltd.
8	202.56.215.0/24	1732	0.15%	24560 -- AIRTELBROADBAND-AS-AP Bharti Airtel Ltd., Telemedia Services
9	148.208.184.0/24	1722	0.15%	8151 -- Uninet S.A. de C.V.
10	62.36.249.0/24	1721	0.15%	12479 -- UNI2-AS France Telecom Espana SA
11	123.252.208.0/24	1715	0.15%	17762 -- HTIL-TTML-IN-AP Tata Teleservices Maharashtra Ltd
12	62.36.241.0/24	1620	0.14%	12479 -- UNI2-AS France Telecom Espana SA
13	62.36.210.0/24	1567	0.14%	12479 -- UNI2-AS France Telecom Espana SA
14	187.94.82.0/24	1417	0.12%	28306 -- TC Net Informática e Telecomunicações LTDA
15	189.38.15.0/24	1417	0.12%	28306 -- TC Net Informática e Telecomunicações LTDA
16	189.38.13.0/24	1417	0.12%	28306 -- TC Net Informática e Telecomunicações LTDA
17	189.38.5.0/24	1417	0.12%	28306 -- TC Net Informática e Telecomunicações LTDA
18	189.38.10.0/24	1417	0.12%	28306 -- TC Net Informática e Telecomunicações LTDA
19	189.38.8.0/24	1417	0.12%	28306 -- TC Net Informática e Telecomunicações LTDA
20	187.94.83.0/24	1417	0.12%	28306 -- TC Net Informática e Telecomunicações LTDA
21	189.38.9.0/24	1417	0.12%	28306 -- TC Net Informática e Telecomunicações LTDA
22	194.63.9.0/24	1413	0.12%	1273 -- CW Cable and Wireless Worldwide plc
23	67.47.194.0/23	1348	0.12%	16535 -- ECHOS-3 - Echostar Holding Purchasing Corporation
24	69.38.178.0/24	1273	0.11%	19406 -- TWRS-MA - Towerstream I, Inc.
25	144.36.72.0/23	1080	0.09%	21433 -- ACCENTUREFSSC Accenture UK Limited
26	170.251.150.0/23	1080	0.09%	21433 -- ACCENTUREFSSC Accenture UK Limited
27	152.121.181.0/24	1071	0.09%	27030 -- USCG-AS - United States Coast Guard
28	59.177.64.0/18	1014	0.09%	17813 -- MTNL-AP Mahanagar Telephone Nigam Ltd.
29	59.152.0.0/20	862	0.08%	18230 -- ZIPNETBD-DKB-AS-AP Zipnet Limited DKB AS number
30	59.152.88.0/21	862	0.08%	18230 -- ZIPNETBD-DKB-AS-AP Zipnet Limited DKB AS number



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?