

# Internet Routing Table Analysis Update



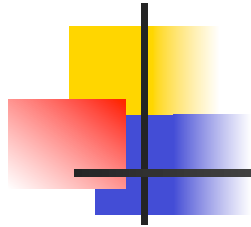
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Philip Smith

CaribNOG 5

24<sup>th</sup> – 26<sup>th</sup> April 2013

Bridgetown, Barbados



# Motivation

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- 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      22 April 2013

BGP routing table entries examined:	450799
Prefixes after maximum aggregation:	184618
Deaggregation factor:	2.44
Unique aggregates announced to Internet:	222597
Total ASes present in the Internet Routing Table:	43891
Prefixes per ASN:	10.27
Origin-only ASes present in the Internet Routing Table:	34510
Origin ASes announcing only one prefix:	16091
Transit ASes present in the Internet Routing Table:	5796
Transit-only ASes present in the Internet Routing Table:	145
Average AS path length visible in the Internet Routing Table:	4.6
Max AS path length visible:	29
Max AS path prepend of ASN ( 19037)	22
Prefixes from unregistered ASNs in the Routing Table:	363
Unregistered ASNs in the Routing Table:	136
Number of 32-bit ASNs allocated by the RIRs:	4730
Number of 32-bit ASNs visible in the Routing Table:	3585
Prefixes from 32-bit ASNs in the Routing Table:	10176
Special use prefixes present in the Routing Table:	22
Prefixes being announced from unallocated address space:	216
Number of addresses announced to Internet:	2613870156
Equivalent to 155 /8s, 204 /16s and 126 /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:	94.4
Total number of prefixes smaller than registry allocations:	158910

## Global per AS prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
6389	3037	3694	87	bellsouth.net, inc.
4766	2953	11557	922	Korea Telecom (KIX)
28573	2632	1452	96	NET Servicos de Comunicacao S.A
17974	2512	839	90	PT TELEKOMUNIKASI INDONESIA
10620	2374	411	217	TVCABLE BOGOTA
7029	2173	1265	212	Windstream Communications Inc
18566	2067	382	184	Covad Communications
22773	1984	2929	125	Cox Communications, Inc.
1785	1974	677	122	PaeTec Communications, Inc.
7545	1887	320	109	TPG Internet Pty Ltd
8402	1871	544	16	Corbina telecom
4755	1735	392	198	TATA Communications formerly
7303	1676	1153	211	Telecom Argentina Stet-France
20115	1668	1610	613	Charter Communications
4323	1609	1139	398	Time Warner Telecom
9829	1512	1205	40	BSNL National Internet Backbo
2118	1430	97	13	EUnet/RELCOM Autonomous Syste
30036	1344	297	657	Mediacom Communications Corp
7018	1316	10807	853	AT&T WorldNet Services
9583	1285	98	538	Sify Limited

## Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:16	/9:13	/10:29	/11:88	/12:249
/13:485	/14:885	/15:1563	/16:12693	/17:6601	/18:10924
/19:21851	/20:31982	/21:33831	/22:46850	/23:41846	/24:236840
/25:1365	/26:1671	/27:864	/28:44	/29:69	/30:22
/31:0	/32:18				

April 2013    ↑

April 2012    ↓

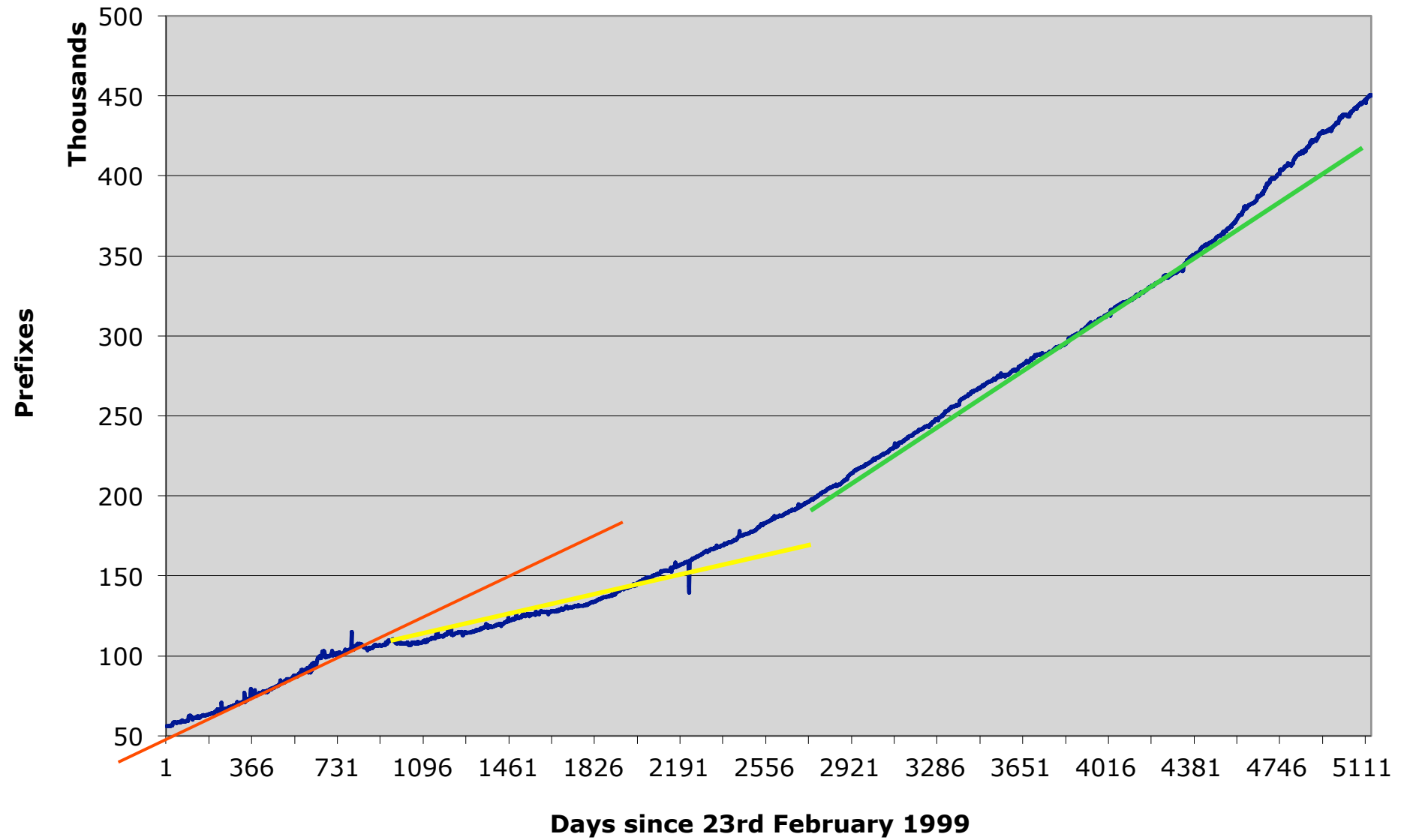
## Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:19	/9:12	/10:28	/11:81	/12:235
/13:459	/14:830	/15:1480	/16:12223	/17:6263	/18:10543
/19:20620	/20:28946	/21:29911	/22:40520	/23:37844	/24:212373
/25:1196	/26:1425	/27:787	/28:157	/29:66	/30:17
/31:0	/32:19				

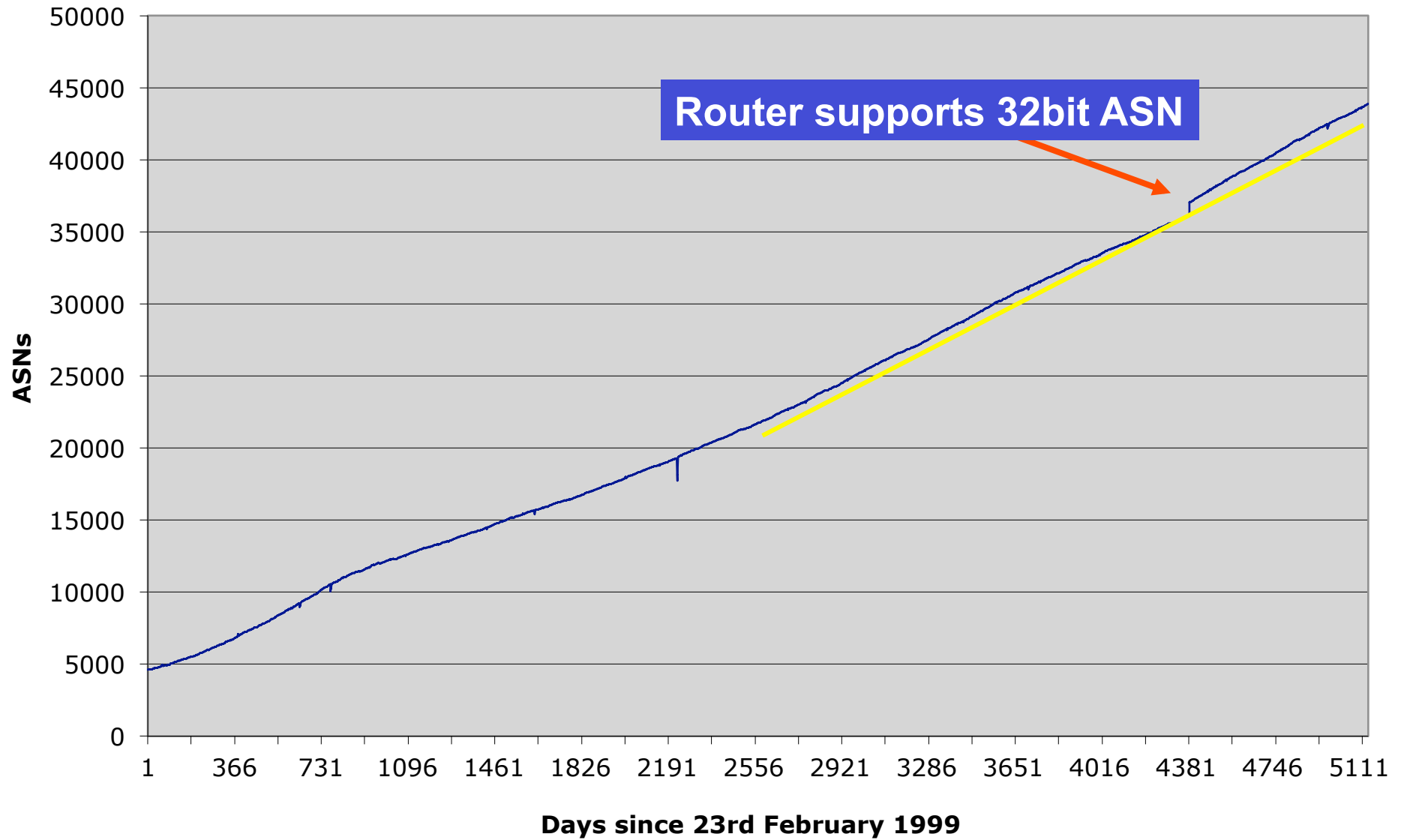
## Prefixes Smaller than Registry Allocations

ASN	No of nets	Total ann.	Description
18566	2018	2067	Covad Communications
6389	1741	3037	bellsouth.net, inc.
7029	1611	2173	Windstream Communications Inc
8402	1572	1871	Corbina telecom
22773	1292	1984	Cox Communications, Inc.
30036	1219	1344	Mediacom Communications Corp
11492	1198	1239	Cable One
36998	1131	1137	MOBITEL
1785	1047	1974	PaeTec Communications, Inc.
6983	1006	1134	ITC^Deltacom
7011	918	1161	Citizens Utilities
22561	861	1085	Digital Teleport, Inc
13977	825	839	FAIRPOINT COMMUNICATIONS, INC
4766	808	2953	Korea Telecom (KIX)
10620	783	2374	TVCABLE BOGOTA
31148	749	794	FreeNet ISP
34984	718	1149	BILISIM TELEKOM
13188	702	862	Educational Network
58113	658	666	LIR DATACENTER TELECOM SRL
34744	637	656	SC GVM SISTEM 2003 SRL

## BGP Routing Table

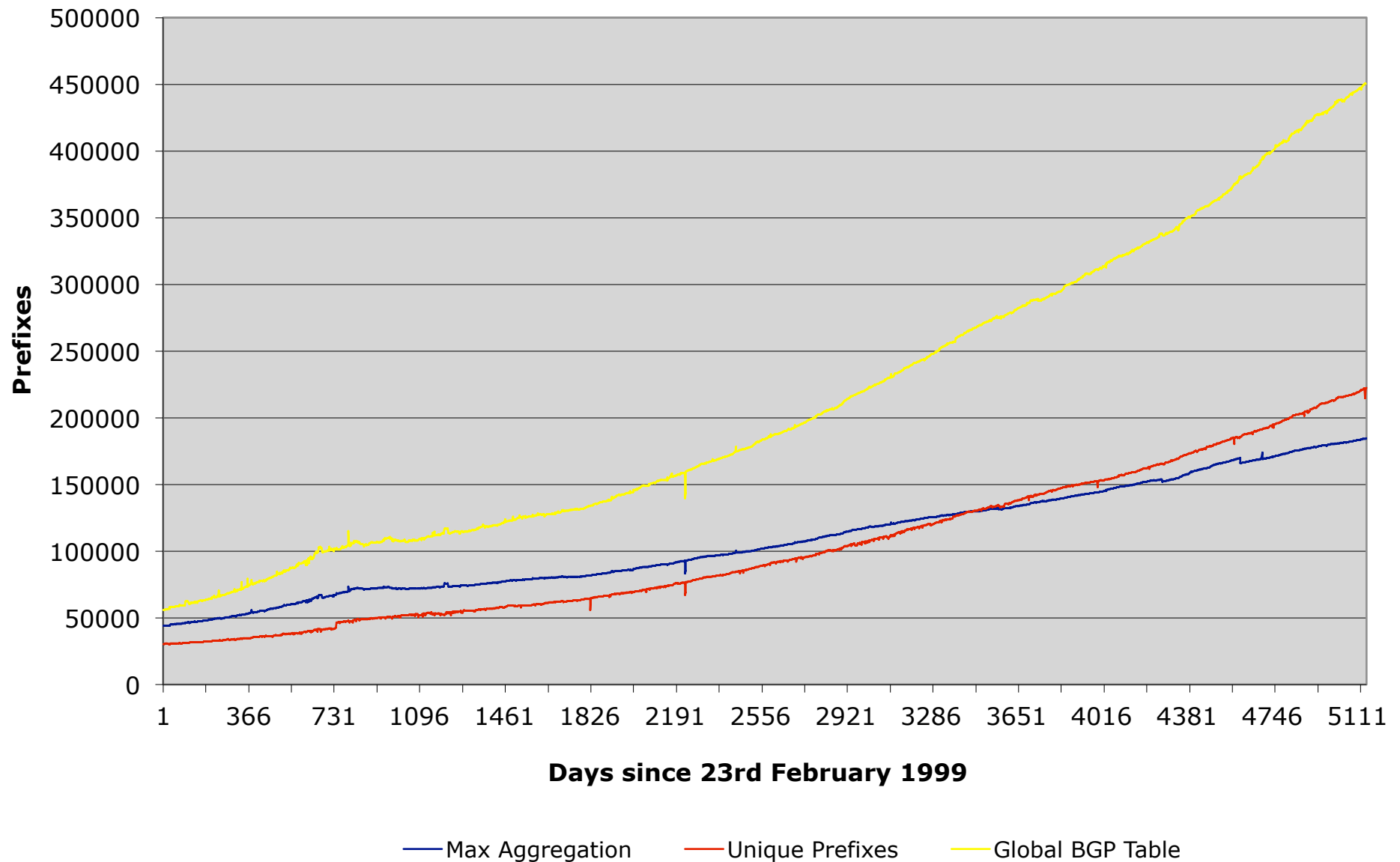


## AS Growth

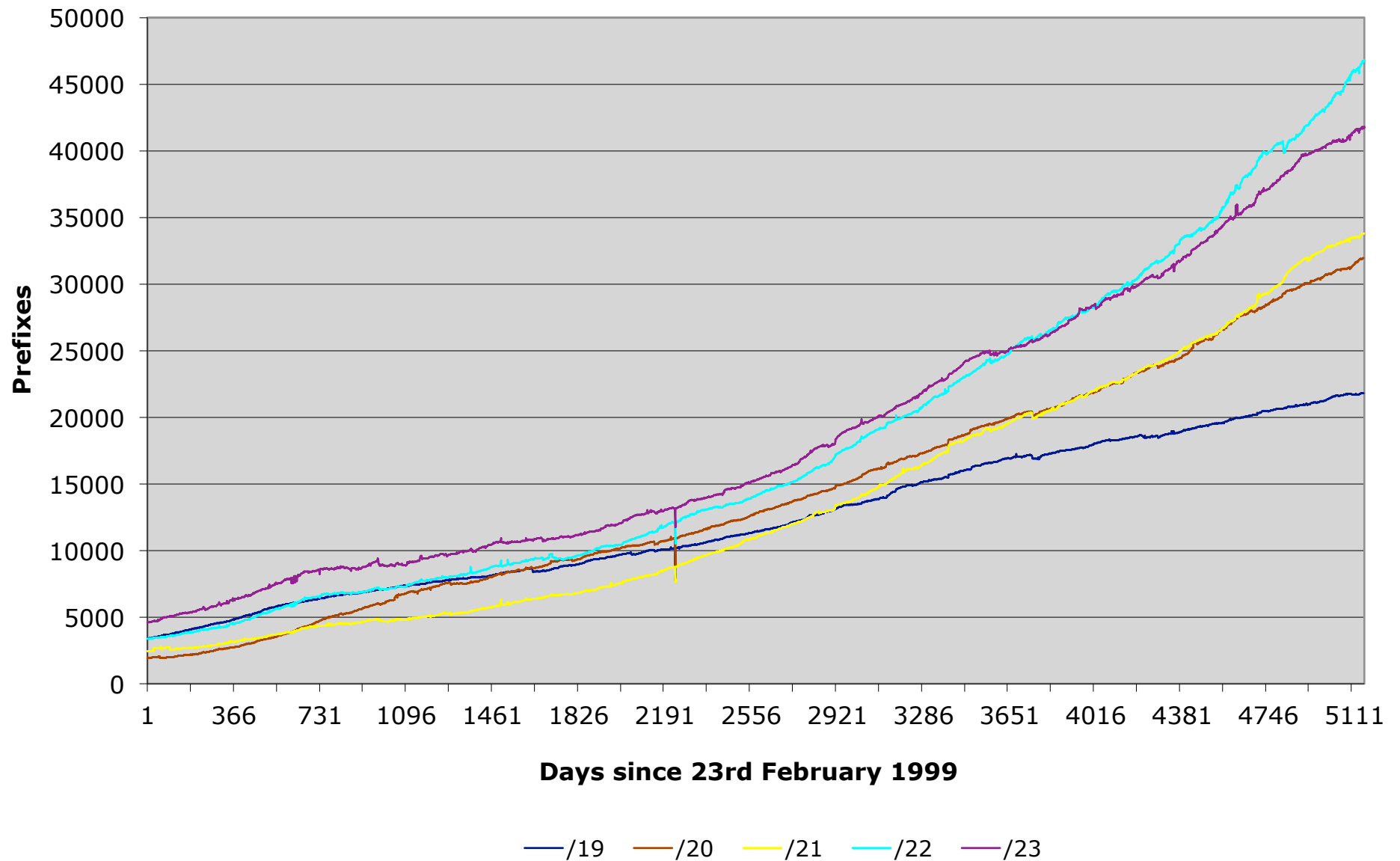




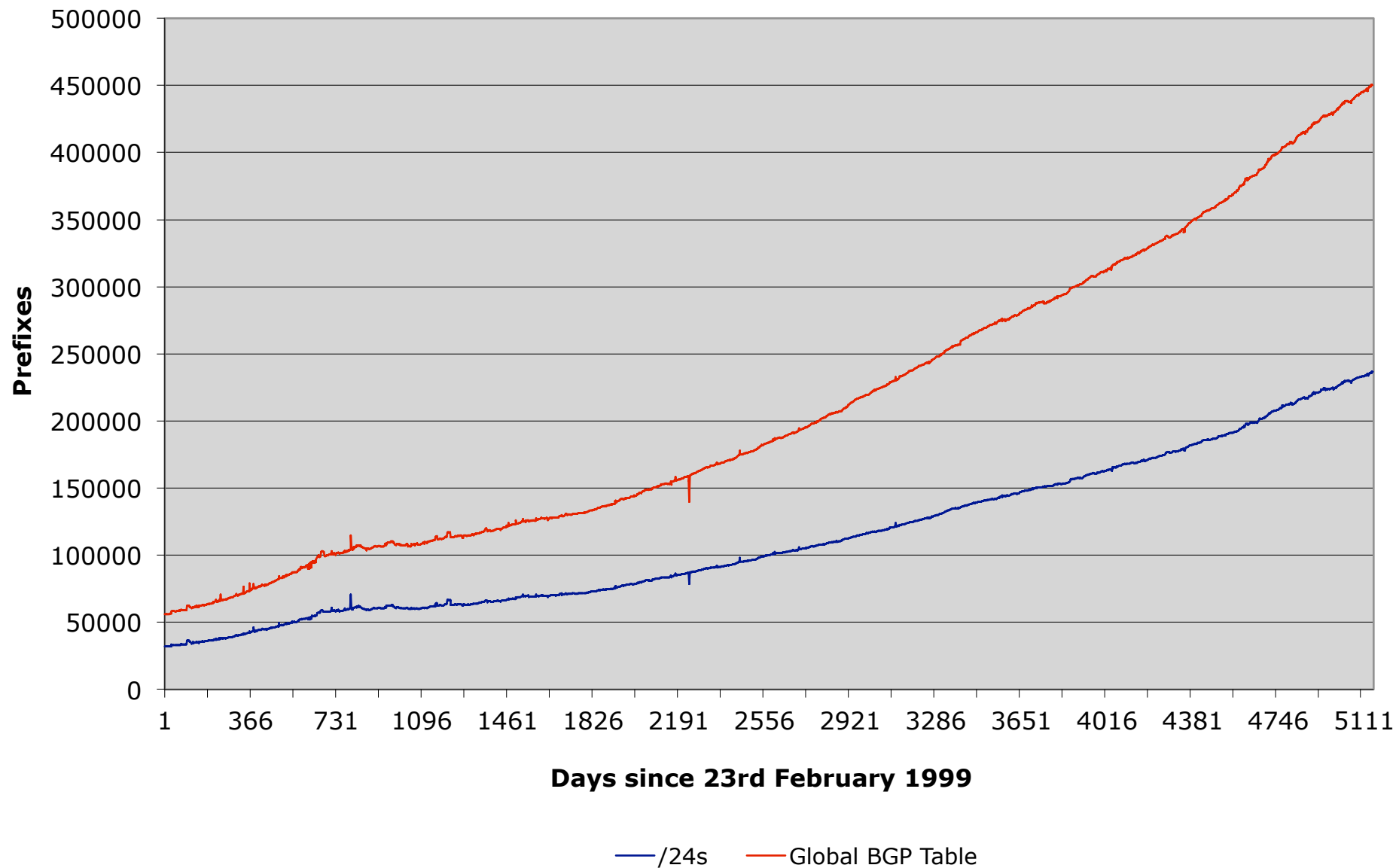
## Max Aggregation vs Unique Prefixes



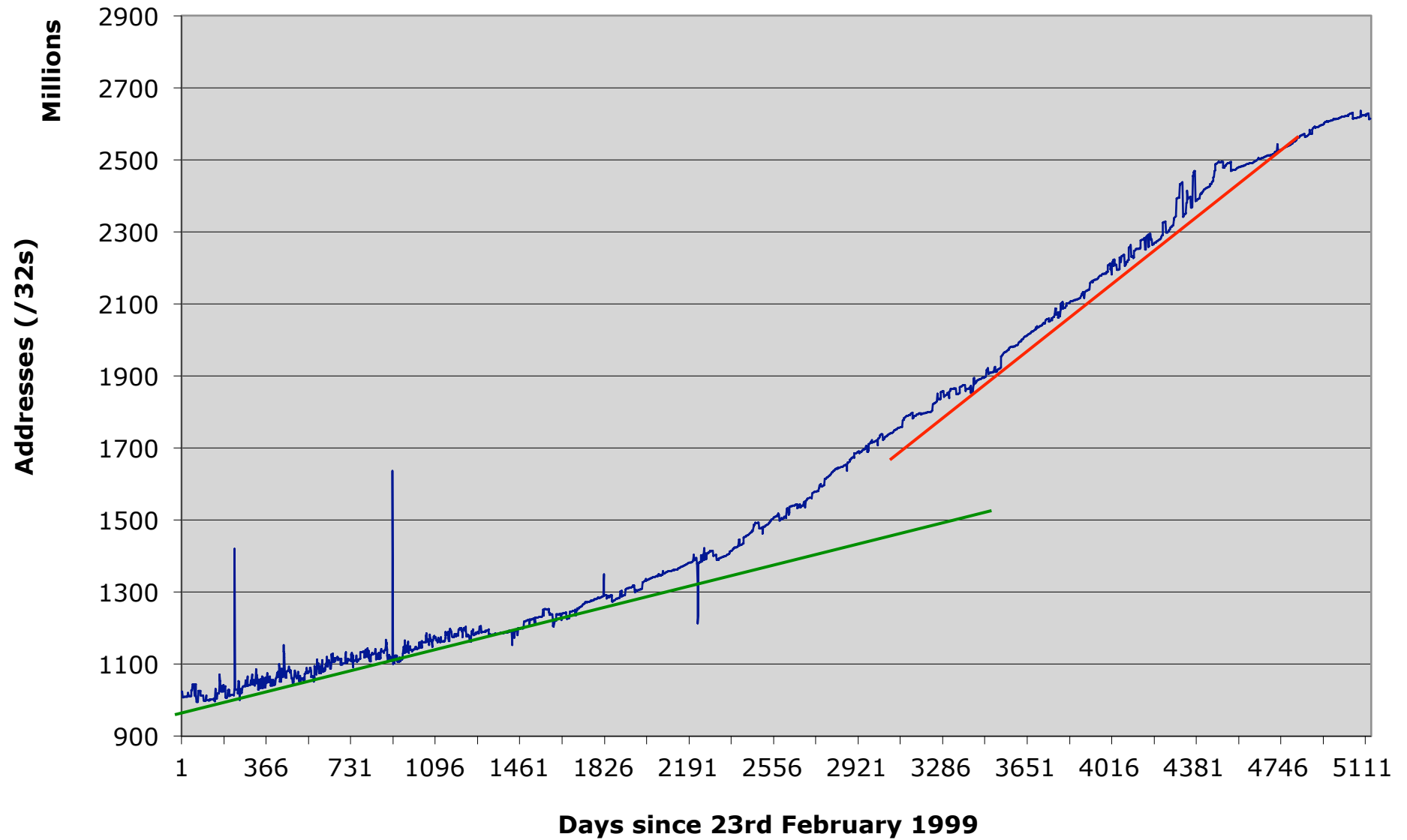
## Prefix sizes announced



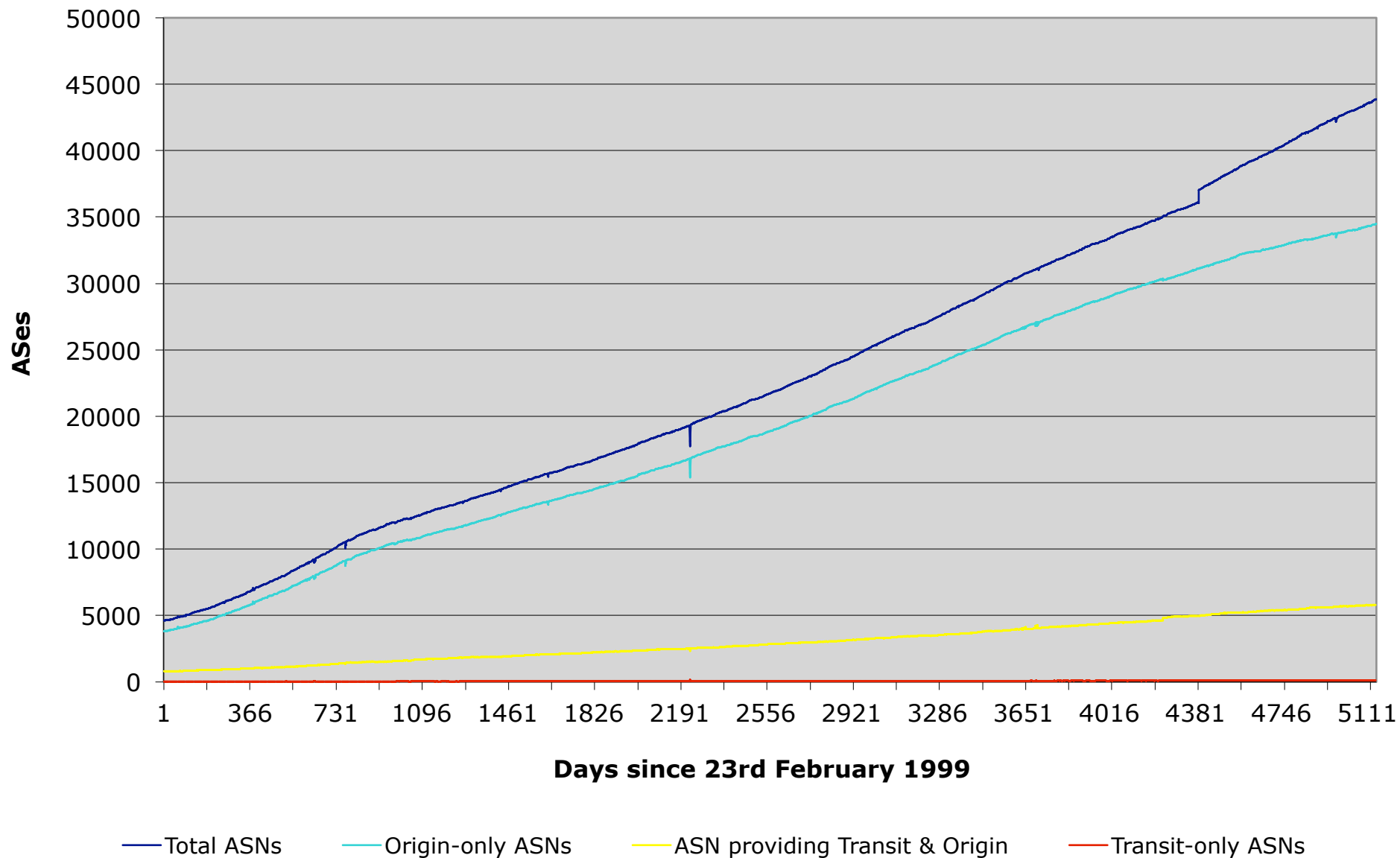
## /24s announced



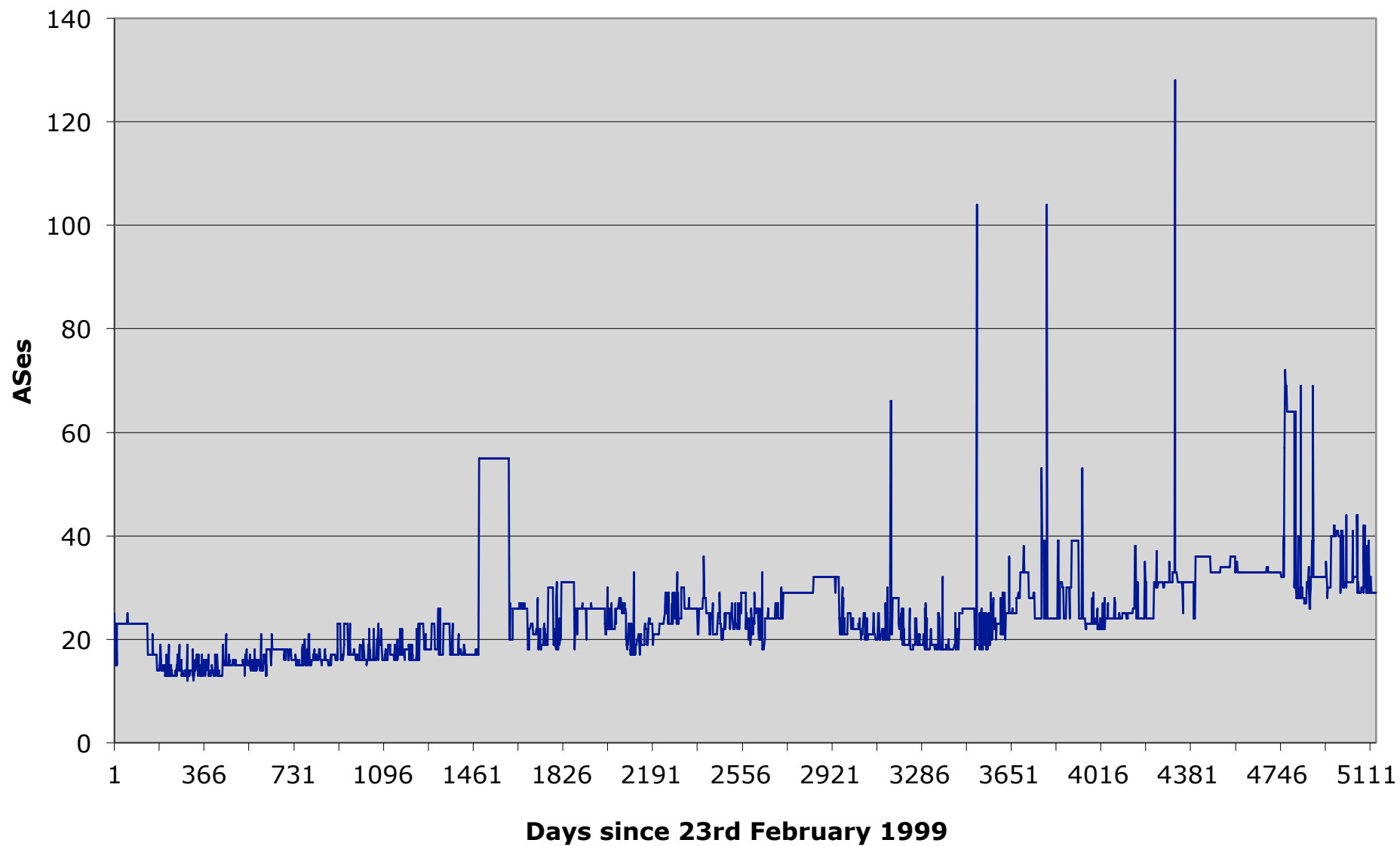
## Address Space announced



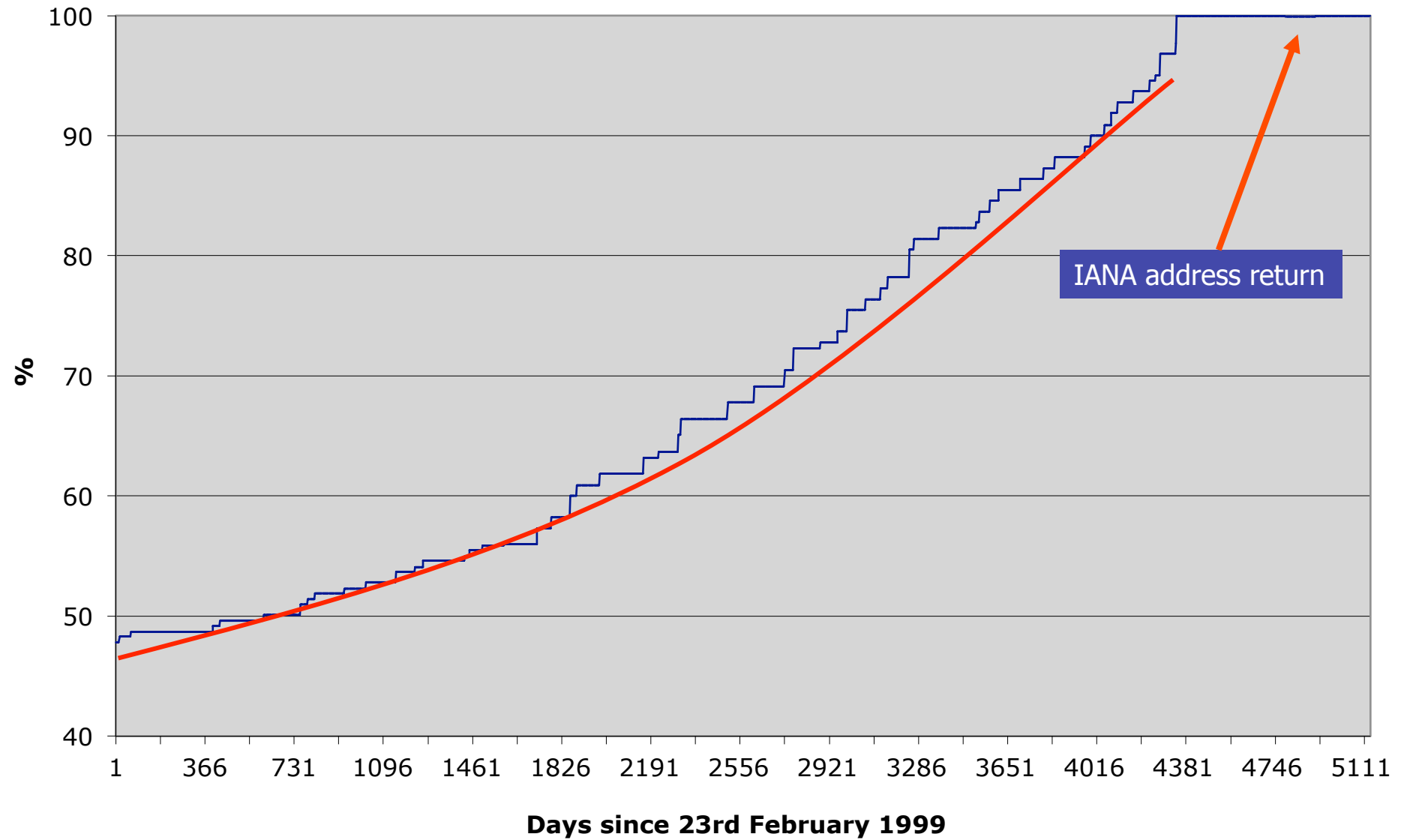
## AS Announcements



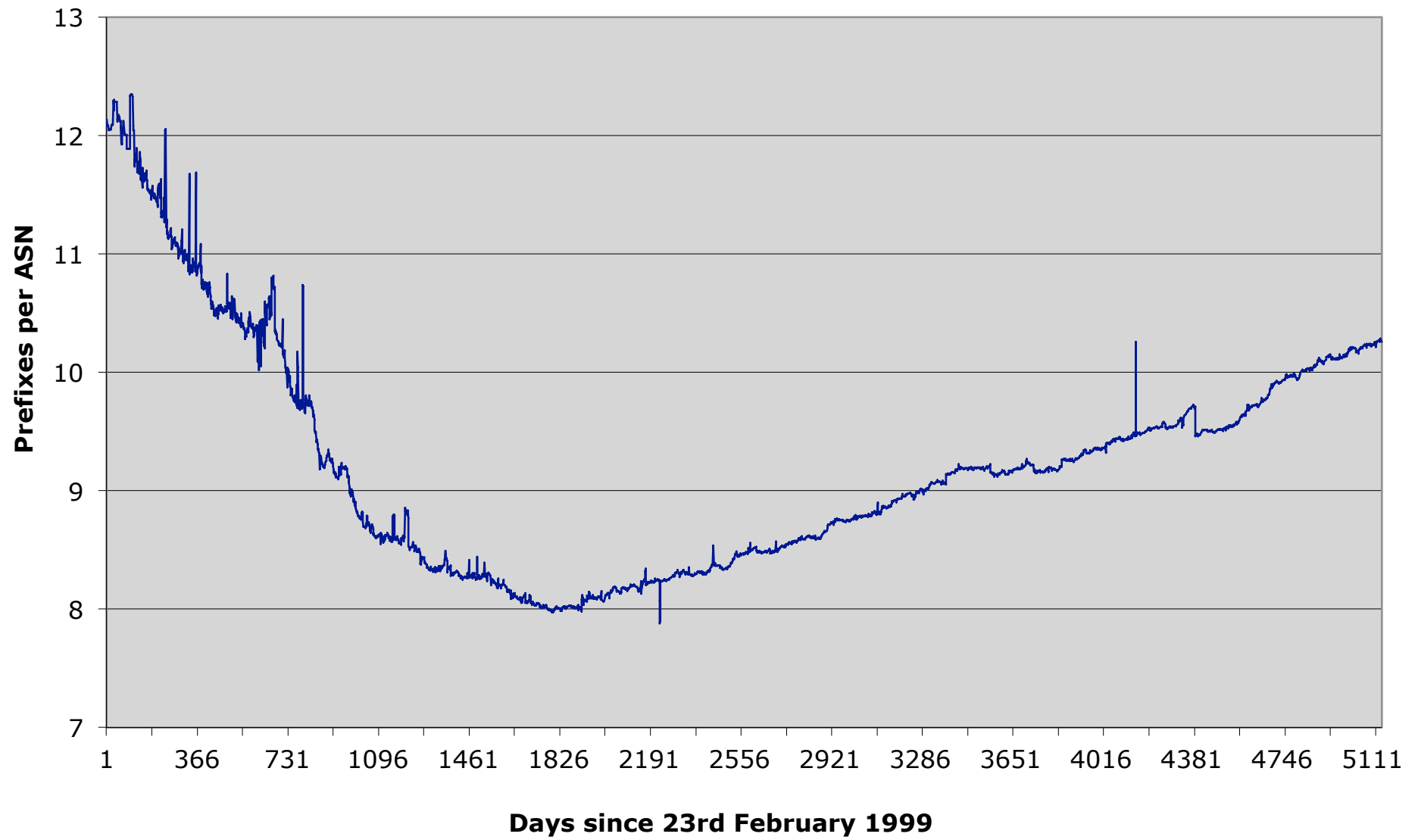
## Maximum AS Path Length



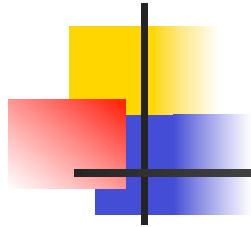
## Growth in IPv4 Address Space Allocations



## Prefixes per ASN



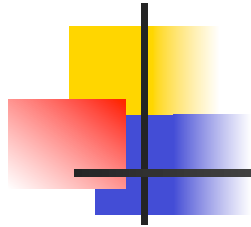




# Looking at Deaggregation

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- CIDR Report
  - [www.cidr-report.org](http://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

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- 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”



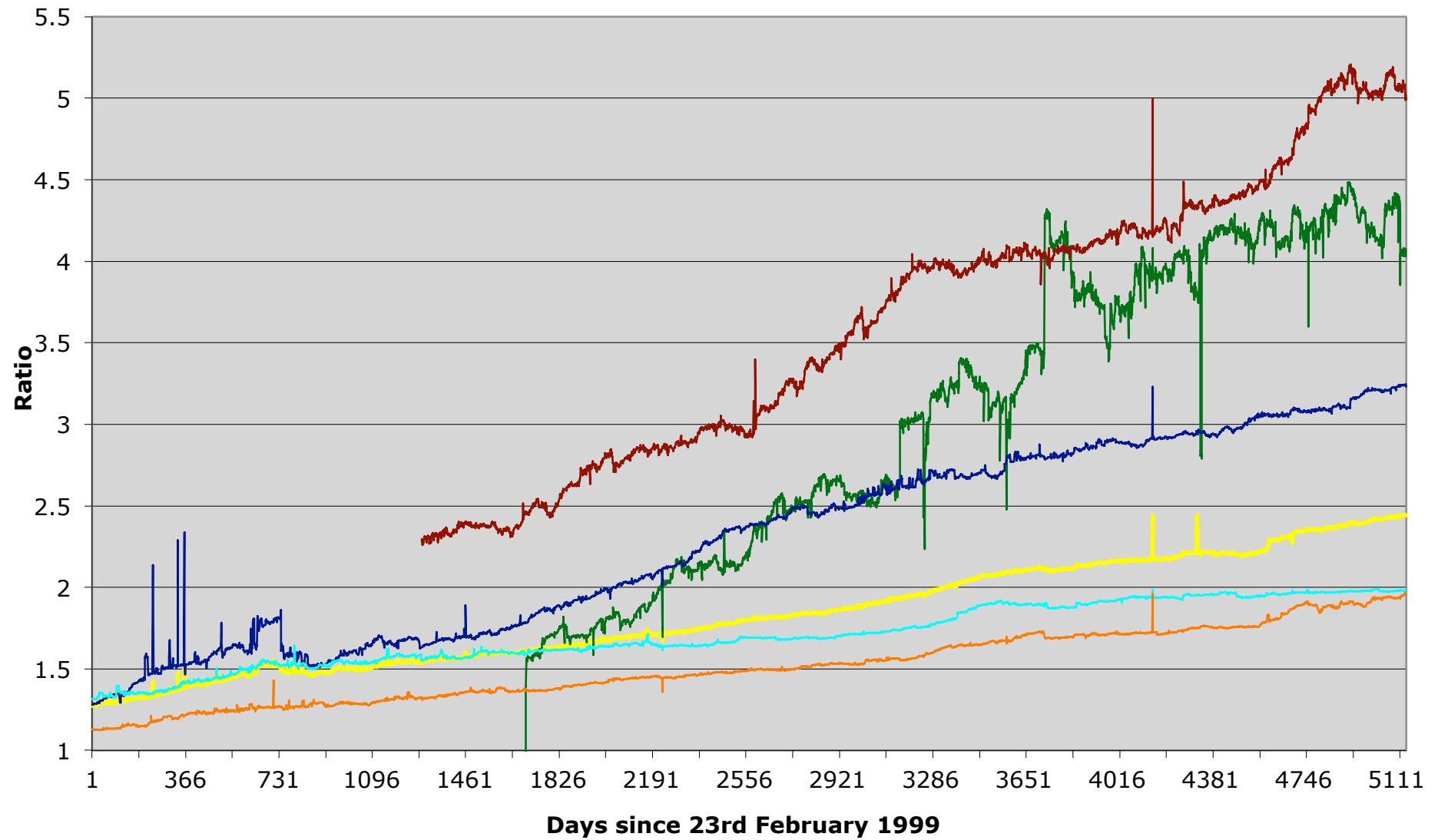
## Total Prefixes

- Global BGP Table
  - 450k prefixes
- Europe & Middle East
  - 116k prefixes
- North America
  - 158k prefixes
- Asia & Pacific
  - 108k prefixes
- Africa
  - 10k prefixes
- Latin America & Caribbean
  - 47k prefixes

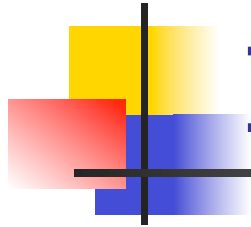
## Deaggregation Factor

- Global Average
  - 2.44
- Europe & Middle East
  - 1.96
- North America
  - 1.98
- Asia & Pacific
  - 3.23
- Africa
  - 4.08
- Latin America & Caribbean
  - 4.99

## Deaggregation: RIR Regions vs Global



Global AfriNIC APNIC ARIN LACNIC RIPE



# Importance of Aggregation

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- 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

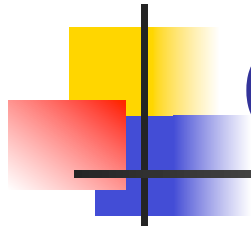
The BGP Instability Report is updated daily. This report was generated on 22 April 2013 06:18 (UTC+1000)

## 50 Most active ASes for the past 7 days

RANK	ASN	UPDs	%	Prefixes	UPDs/Prefix	AS NAME
1	9829	64864	3.24%	1512	42.90	BSNL-NIB National Internet Backbone
2	8402	37774	1.89%	2190	17.25	CORBINA-AS OJSC "Vimpelcom"
3	3909	23030	1.15%	33	697.88	QWEST-AS-3908 - Qwest Communications Company, LLC
4	22216	18025	0.90%	52	346.63	SIEMENS-PLM - Siemens Corporation
5	4538	15422	0.77%	520	29.66	ERX-CERNET-BKB China Education and Research Network Center
6	6713	15257	0.76%	543	28.10	IAM-AS
7	36998	13123	0.66%	1137	11.54	SDN-MOBITEL
8	28573	12772	0.64%	2674	4.78	NET Serviços de Comunicação S.A.
9	33776	12378	0.62%	184	67.27	STARCOMMS-ASN
10	2708	12130	0.61%	147	82.52	Universidad de Guanajuato
11	13188	11878	0.59%	921	12.90	BANKINFORM-AS TOV "Bank-Inform"
12	2118	11858	0.59%	1430	8.29	RELCOM-AS OOO "NPO Relcom"
13	50710	11424	0.57%	201	56.84	EARTHLINK-AS EarthLink Ltd. Communications&Internet Services
14	13999	11187	0.56%	675	16.57	Mega Cable, S.A. de C.V.
15	11664	10994	0.55%	312	35.24	Techtel LMDS Comunicaciones Interactivas S.A.
16	27738	10812	0.54%	567	19.07	Ecuadortelecom S.A.
17	22561	10702	0.53%	1088	9.84	DIGITAL-TELEPORT - Digital Teleport Inc.
18	17974	10596	0.53%	2519	4.21	TELKOMNET-AS2-AP PT Telekomunikasi Indonesia
19	10620	9941	0.50%	2392	4.16	Telmex Colombia S.A.
20	30693	9398	0.47%	263	35.73	EONIX-CORPORATION-AS-WWW-EONIX-NET - Eonix Corporation
21	48612	9000	0.45%	16	562.50	RTC-ORENBURG-AS CJSC "Comstar-Regions"
22	647	8898	0.44%	117	76.05	DNIC-ASBLK-00616-00665 - DoD Network Information Center
23	8551	8858	0.44%	769	11.52	BEZEQ-INTERNATIONAL-AS Bezeqint Internet Backbone
24	24863	8298	0.41%	701	11.84	LINKdotNET-AS

## 50 Most active Prefixes for the past 7 days

RANK	PREFIX	UPDs	%	Origin AS -- AS NAME
1	209.142.140.0/24	9548	0.45%	22561 -- DIGITAL-TELEPORT - Digital Teleport Inc.
2	92.246.207.0/24	8973	0.42%	48612 -- RTC-ORENBURG-AS CJSC "Comstar-Regions"
3	193.19.90.0/23	8372	0.39%	25233 -- AWALNET-ASN Arab Company For Internet & Communications Services (AwalNet)LLC 29684 -- NOURNET-ASN Nour Communication Co.Ltd - Nournet
4	192.58.232.0/24	7593	0.35%	6629 -- NOAA-AS - NOAA
5	151.118.255.0/24	7566	0.35%	3909 -- QWEST-AS-3908 - Qwest Communications Company, LLC
6	151.118.254.0/24	7566	0.35%	3909 -- QWEST-AS-3908 - Qwest Communications Company, LLC
7	151.118.18.0/24	7547	0.35%	3909 -- QWEST-AS-3908 - Qwest Communications Company, LLC
8	12.139.133.0/24	5662	0.26%	14680 -- REALE-6 - Auction.com
9	194.63.9.0/24	4622	0.22%	1273 -- CW Cable and Wireless Worldwide plc
10	69.38.178.0/24	4215	0.20%	19406 -- TWRS-MA - Towerstream I, Inc.
11	209.200.208.0/24	3634	0.17%	21947 -- TRANSARIA - TransAria, Inc.
12	199.0.244.0/22	3607	0.17%	10987 -- PLUMCREEK-AS - Plum Creek Marketing, Inc.
13	134.244.113.0/24	3603	0.17%	22216 -- SIEMENS-PLM - Siemens Corporation
14	134.244.119.0/24	3603	0.17%	22216 -- SIEMENS-PLM - Siemens Corporation
15	134.244.111.0/24	3603	0.17%	22216 -- SIEMENS-PLM - Siemens Corporation
16	134.244.115.0/24	3603	0.17%	22216 -- SIEMENS-PLM - Siemens Corporation
17	134.244.114.0/24	3603	0.17%	22216 -- SIEMENS-PLM - Siemens Corporation
18	58.184.229.0/24	3498	0.16%	9950 -- PUBNETPLUS2-AS-KR DACOM
19	69.165.112.0/20	3460	0.16%	21947 -- TRANSARIA - TransAria, Inc.
20	64.25.130.0/24	3441	0.16%	33521 -- MSLA-SCHOOLS - Missoula County Public Schools
21	206.105.75.0/24	2886	0.13%	6174 -- SPRINTLINK8 - Sprint
22	208.16.110.0/24	2886	0.13%	6174 -- SPRINTLINK8 - Sprint
23	2.93.235.0/24	2715	0.13%	8402 -- CORBINA-AS OJSC "Vimpelcom"
24	115.170.128.0/17	2525	0.12%	4847 -- CNIX-AP China Networks Inter-Exchange
25	84.205.66.0/24	2440	0.11%	12654 -- RIPE-NCC-RIS-AS Reseaux IP Europeens Network Coordination Centre (RIPE NCC)
26	180.249.212.0/22	2420	0.11%	17974 -- TELKOMNET-AS2-AP PT Telekomunikasi Indonesia
27	180.249.208.0/22	2420	0.11%	17974 -- TELKOMNET-AS2-AP PT Telekomunikasi Indonesia
28	41.75.40.0/21	2253	0.11%	37367 -- CALLKEY



# Observations

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- 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



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Questions?