

# Internet Routing Table Analysis Update



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SANOG 18

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# 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 14 September 2011

BGP routing table entries examined:	371760
Prefixes after maximum aggregation:	167812
Deaggregation factor:	2.22
Unique aggregates announced to Internet:	184545
Total ASes present in the Internet Routing Table:	38772
Prefixes per ASN:	9.59
Origin-only ASes present in the Internet Routing Table:	32167
Origin ASes announcing only one prefix:	15466
Transit ASes present in the Internet Routing Table:	5203
Transit-only ASes present in the Internet Routing Table:	139
Average AS path length visible in the Internet Routing Table:	4.3
Max AS path length visible:	36
Max AS path prepend of ASN (22394)	33
Prefixes from unregistered ASNs in the Routing Table:	1228
Unregistered ASNs in the Routing Table:	709
Number of 32-bit ASNs allocated by the RIRs:	1721
Number of 32-bit ASNs visible in the Routing Table:	1402
Prefixes from 32-bit ASNs in the Routing Table:	3224
Special use prefixes present in the Routing Table:	0
Prefixes being announced from unallocated address space:	103
Number of addresses announced to Internet:	2476526336
Equivalent to 147 /8s, 156 /16s and 203 /24s	
Percentage of available address space announced:	66.8
Percentage of allocated address space announced:	66.8
Percentage of available address space allocated:	100.0
Percentage of address space in use by end-sites:	91.2
Total number of prefixes smaller than registry allocations:	154529

## APNIC Region

Prefixes being announced by APNIC Region ASes:	94136
Total APNIC prefixes after maximum aggregation:	30701
APNIC Deaggregation factor:	3.07
Prefixes being announced from the APNIC address blocks:	90649
Unique aggregates announced from the APNIC address blocks:	38137
APNIC Region origin ASes present in the Internet Routing Table:	4561
APNIC Prefixes per ASN:	19.87
APNIC Region origin ASes announcing only one prefix:	1253
APNIC Region transit ASes present in the Internet Routing Table:	711
Average APNIC Region AS path length visible:	4.5
Max APNIC Region AS path length visible:	21
Number of APNIC region 32-bit ASNs visible in the Routing Table:	85
Number of APNIC addresses announced to Internet:	626418016
Equivalent to 37 /8s, 86 /16s and 97 /24s	
Percentage of available APNIC address space announced:	79.4

APNIC AS Blocks	4608-4864, 7467-7722, 9216-10239, 17408-18431
(pre-ERX allocations)	23552-24575, 37888-38911, 45056-46079, 55296-56319, 58368-59391, 131072-132095, 132096-133119
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	3564	3817	226	bellsouth.net, inc.
4766	2508	11047	955	Korea Telecom (KIX)
17974	2006	516	31	PT TELEKOMUNIKASI INDONESIA
18566	1912	364	237	Covad Communications
1785	1822	680	122	PaeTec Communications, Inc.
10620	1661	305	161	TVCABLE BOGOTA
4323	1626	1085	393	Time Warner Telecom
20115	1593	1541	632	Charter Communications
7029	1587	995	230	Windstream Communications Inc
7545	1587	301	82	TPG Internet Pty Ltd
4755	1547	639	170	TATA Communications formerly
22773	1454	2906	99	Cox Communications, Inc.
30036	1426	264	687	Mediacom Communications Corp
8151	1409	2802	355	UniNet S.A. de C.V.
19262	1395	4724	399	Verizon Global Networks
7018	1335	7050	874	AT&T WorldNet Services
28573	1318	1003	69	NET Servicos de Comunicacao S.A
2386	1219	514	877	AT&T Data Communications Serv
7011	1183	325	656	Citizens Utilities
24560	1180	337	193	Bharti Airtel Ltd., Telemedia
9829	1155	989	28	BSNL National Internet Backbo
7303	1153	677	170	Telecom Argentina Stet-France

## 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	/12:234
/13:463	/14:801	/15:1419	/16:11995	/17:5971	/18:10013
/19:19730	/20:26955	/21:27078	/22:36314	/23:34690	/24:192662
/25:1097	/26:1283	/27:742	/28:165	/29:4	/30:0
/31:0	/32:5				

September 2011 ↑

September 2010 ↓

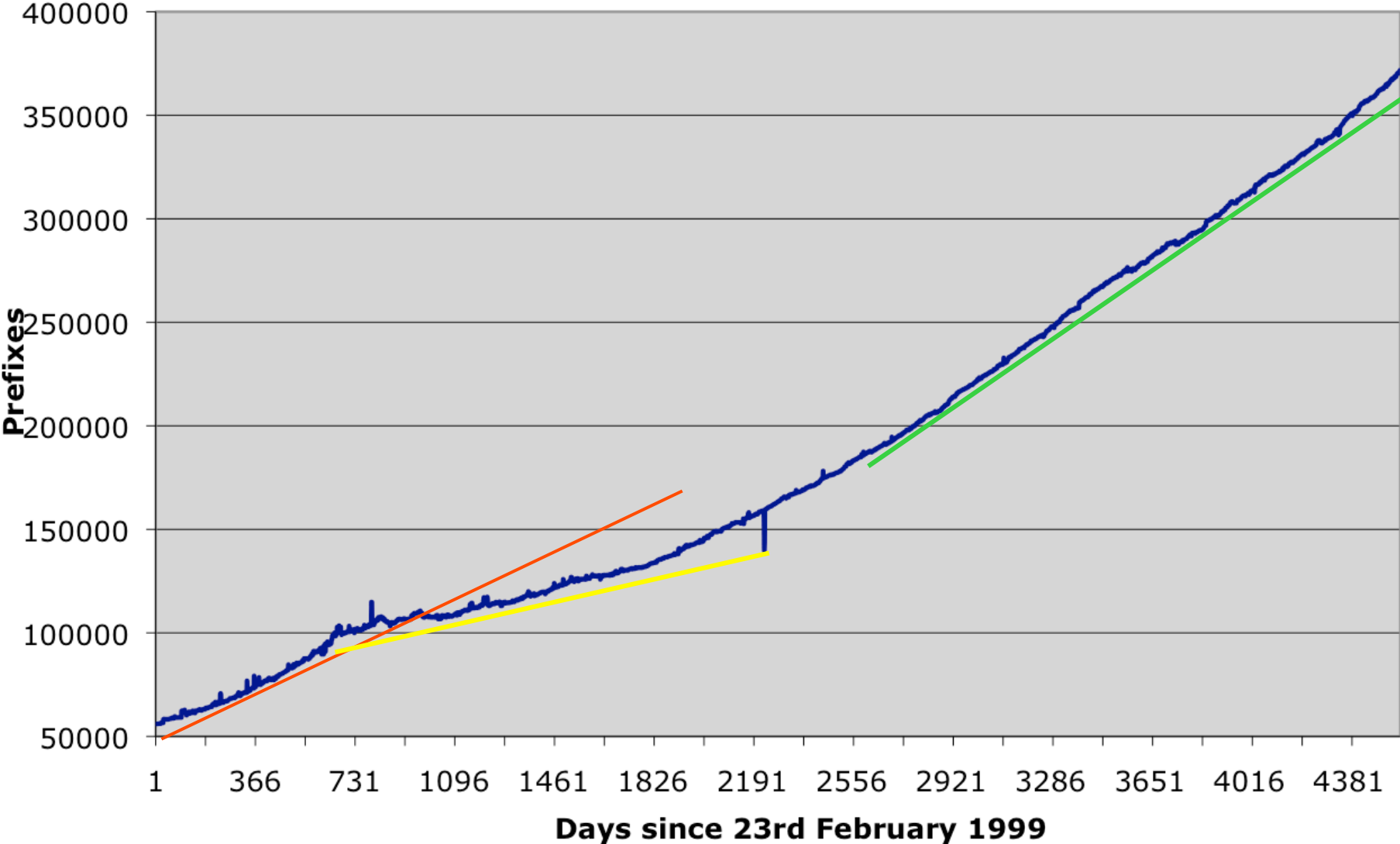
## Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:19	/9:10	/10:25	/11:67	/12:201
/13:419	/14:729	/15:1316	/16:11267	/17:5435	/18:9293
/19:18557	/20:23463	/21:23611	/22:30888	/23:30213	/24:172816
/25:1064	/26:1176	/27:692	/28:166	/29:47	/30:6
/31:0	/32:7				

## Prefixes Smaller than Registry Allocations

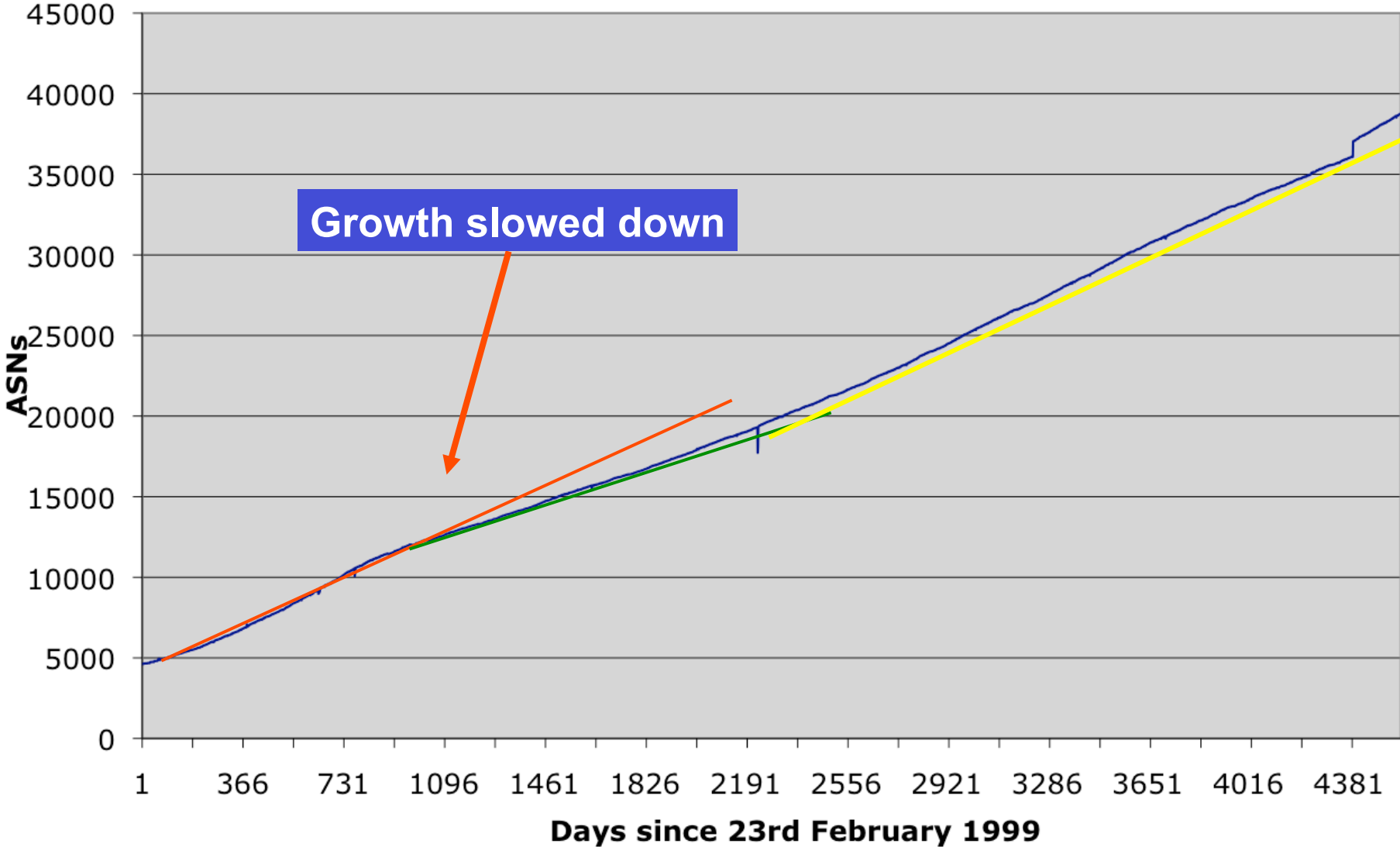
ASN	No of nets	Total ann.	Description
6389	2201	3564	bellsouth.net, inc.
18566	1868	1912	Covad Communications
10620	1556	1661	TVCABLE BOGOTA
30036	1384	1426	Mediacom Communications Corp
7029	1288	1587	Windstream Communications Inc
11492	1104	1142	Cable One
7011	1058	1183	Citizens Utilities
1785	1052	1822	PaeTec Communications, Inc.
22773	944	1454	Cox Communications, Inc.
28573	776	1318	NET Servicos de Comunicacao S.A
22561	769	971	Digital Teleport, Inc
7018	746	1335	AT&T WorldNet Services
13407	733	779	Computer Telephone Corp
7303	714	1153	Telecom Argentina Stet-France
3356	712	1096	Level 3 Communications, LLC
14420	662	718	CORPORACION NACIONAL DE TELEC
4766	633	2508	Korea Telecom (KIX)
19262	597	1395	Verizon Global Networks
3549	576	1046	Global Crossing
20115	555	1593	Charter Communications
8452	551	702	TEDATA
4323	540	1626	Time Warner Telecom

# BGP Routing Table

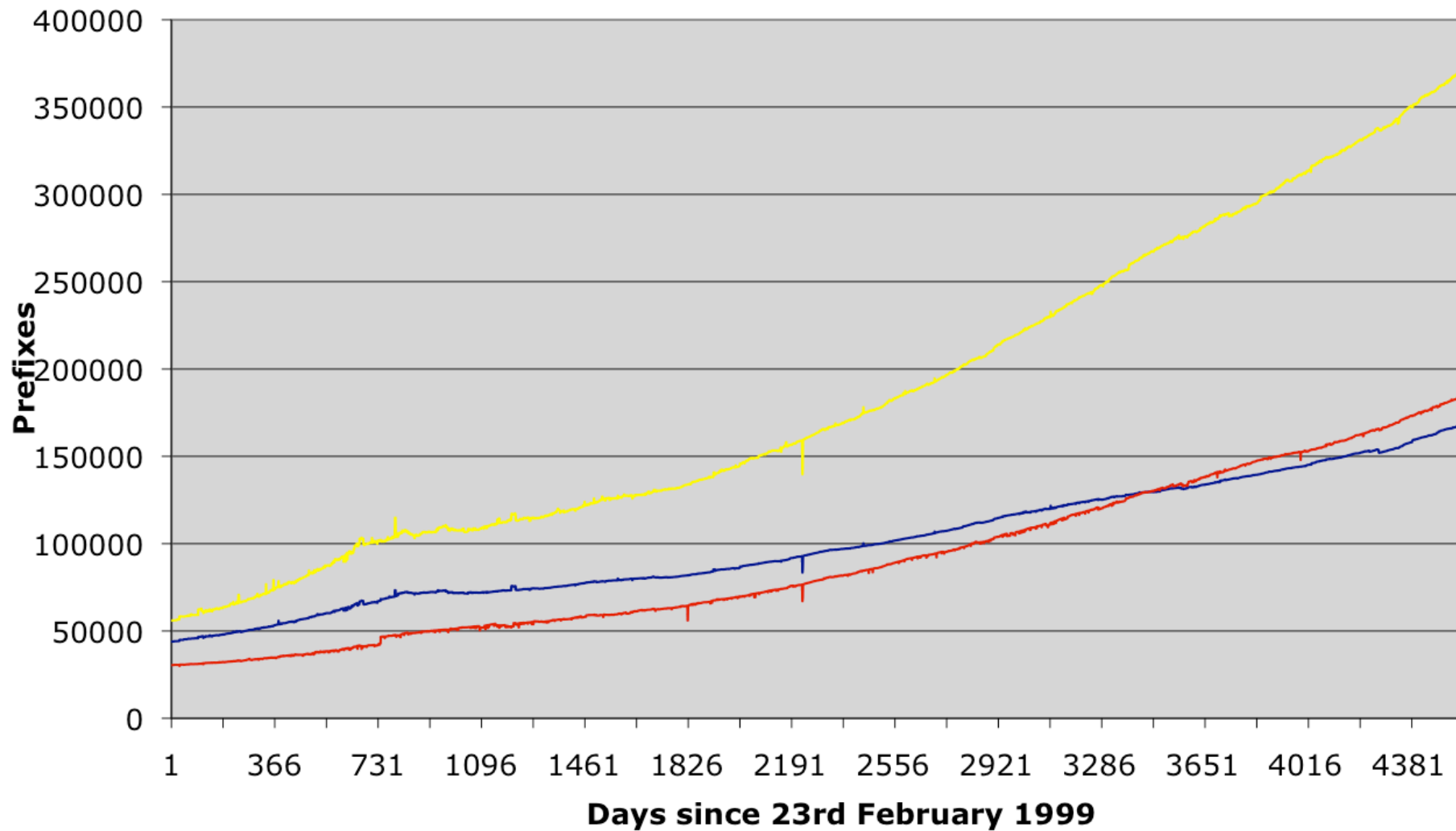




# AS Growth

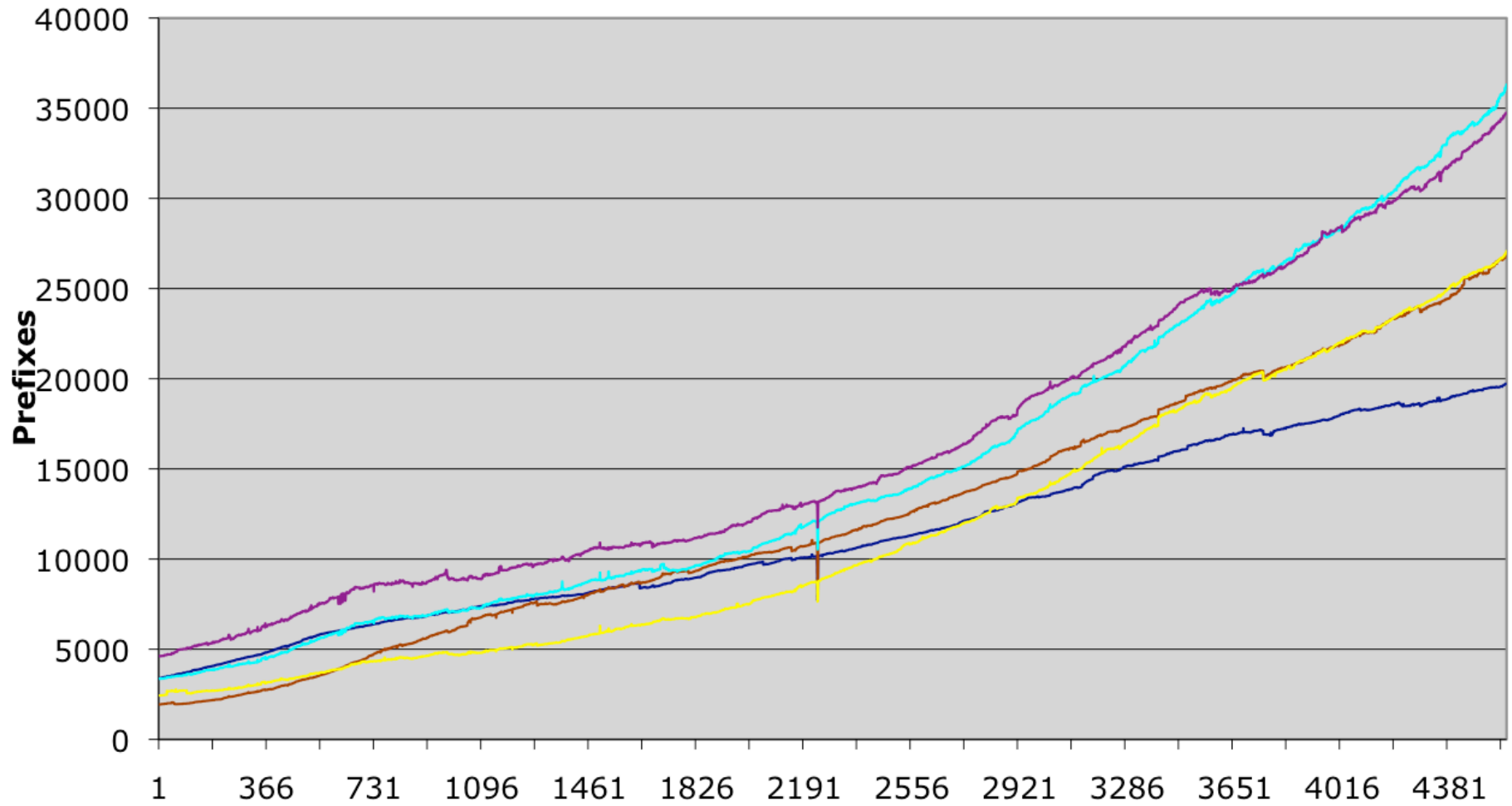


## Max Aggregation vs Unique Prefixes



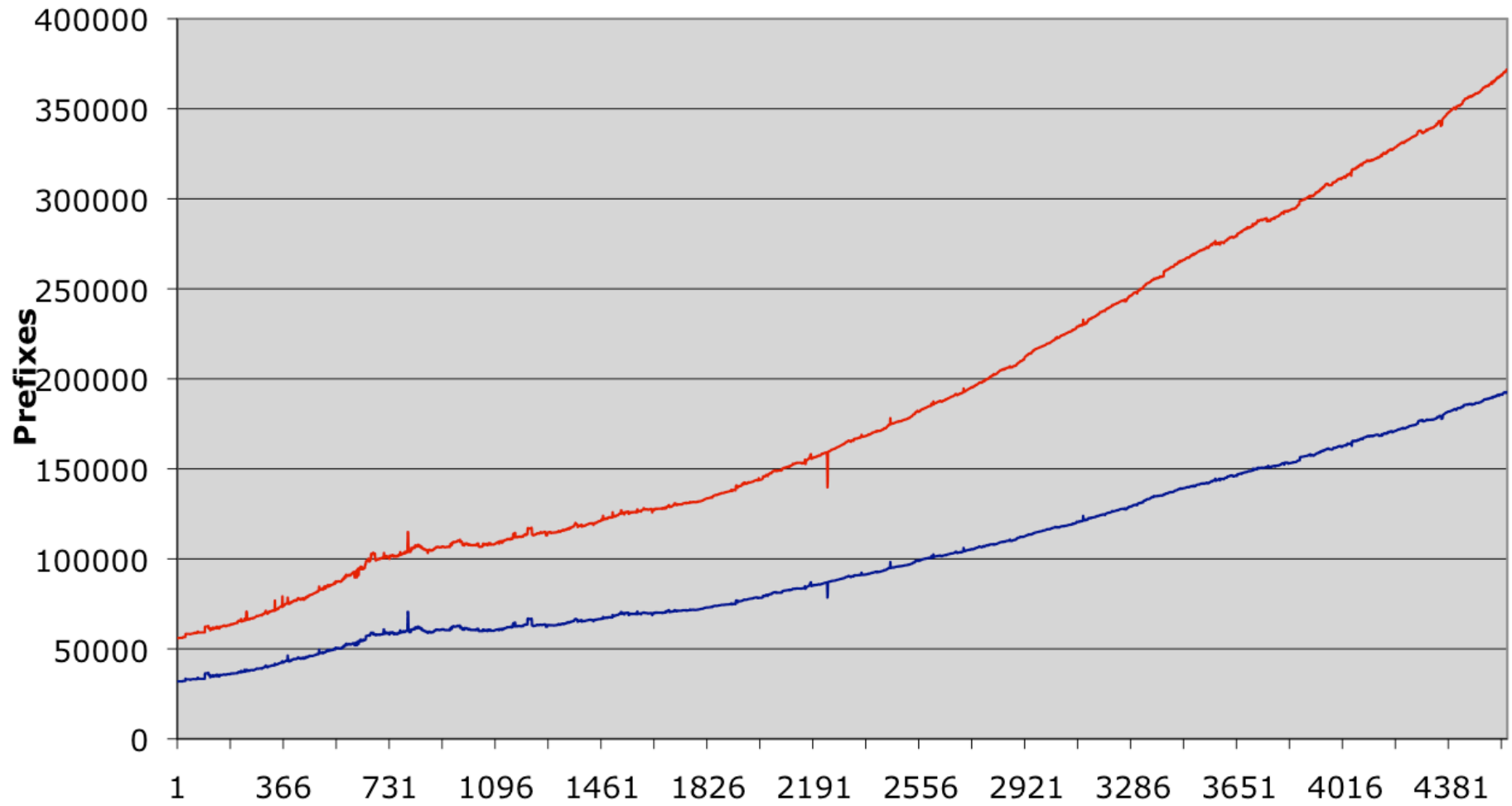
— Max Aggregation — Unique Prefixes — Global BGP Table

# Prefix sizes announced



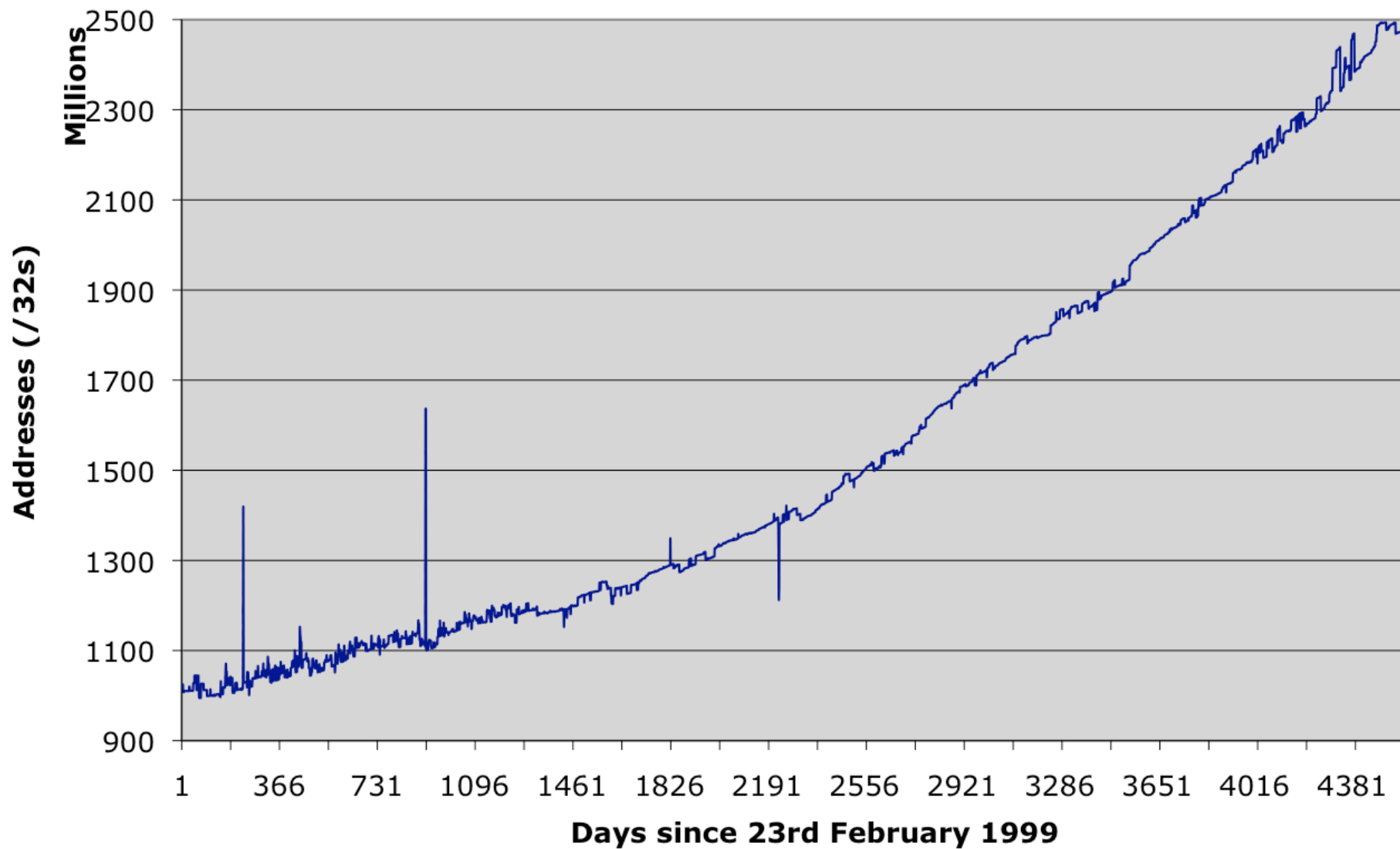
— /19 — /20 — /21 — /22 — /23

## **/24s announced**

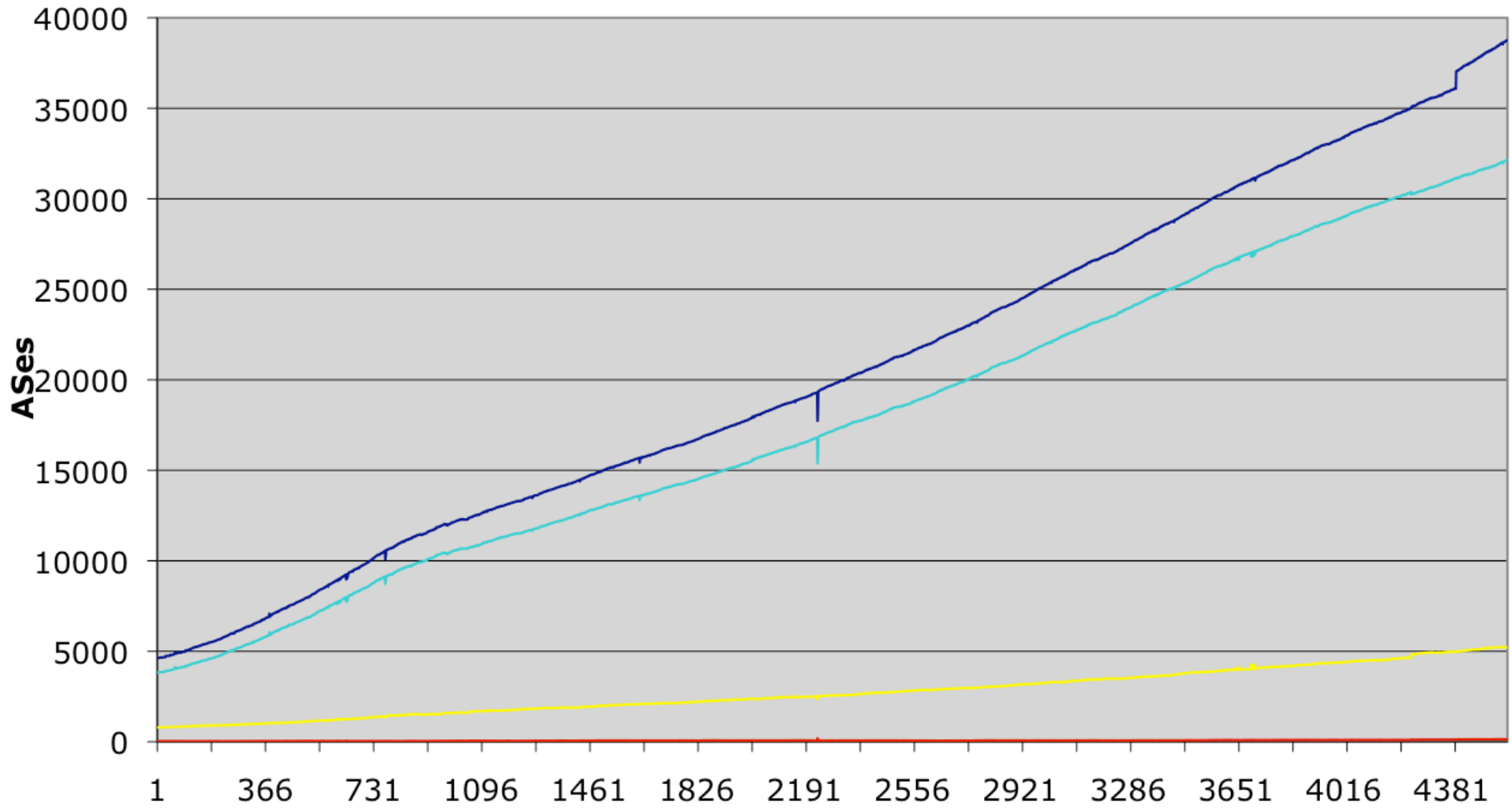


— /24s — Global BGP Table

## Address Space announced

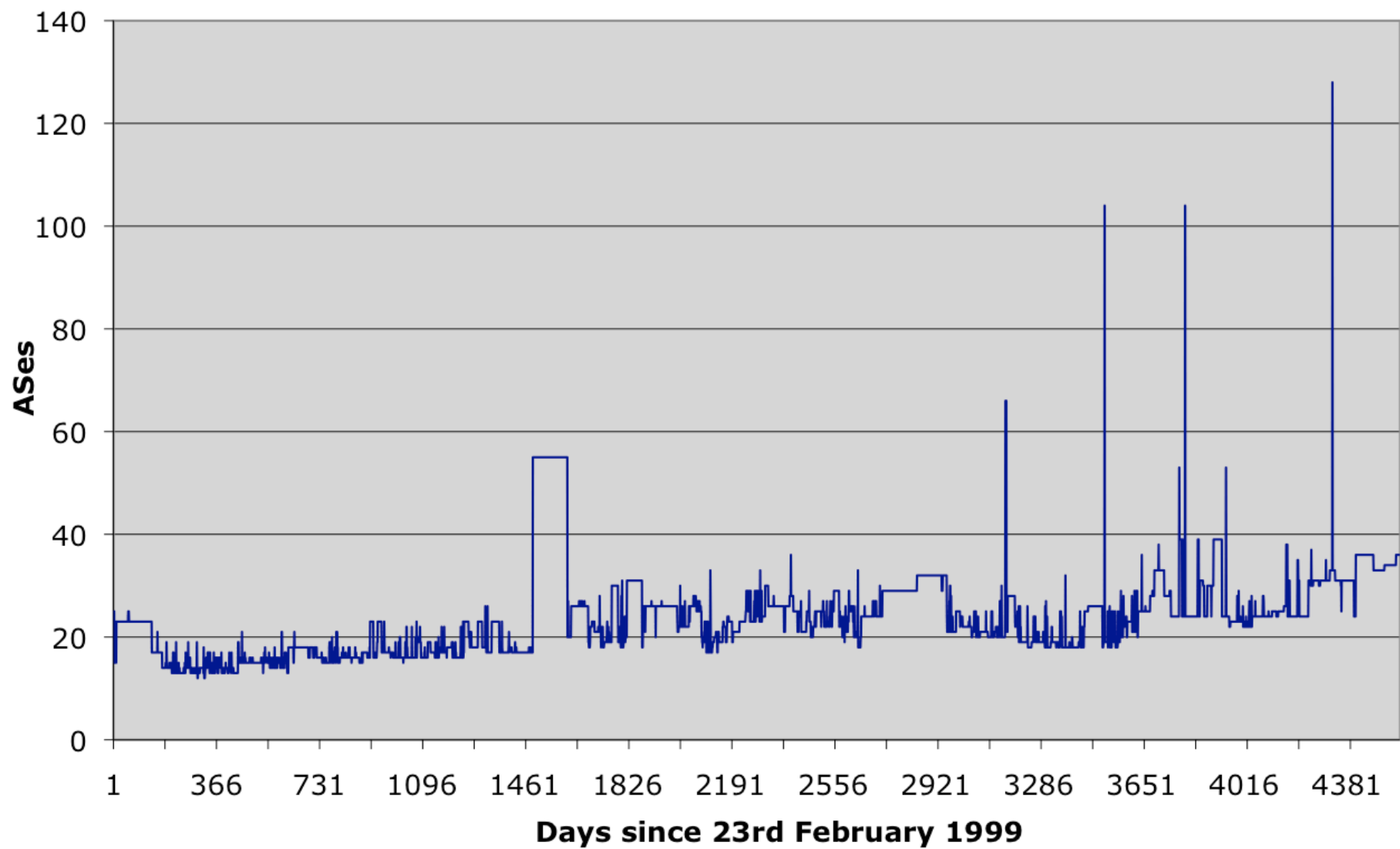


# AS Announcements

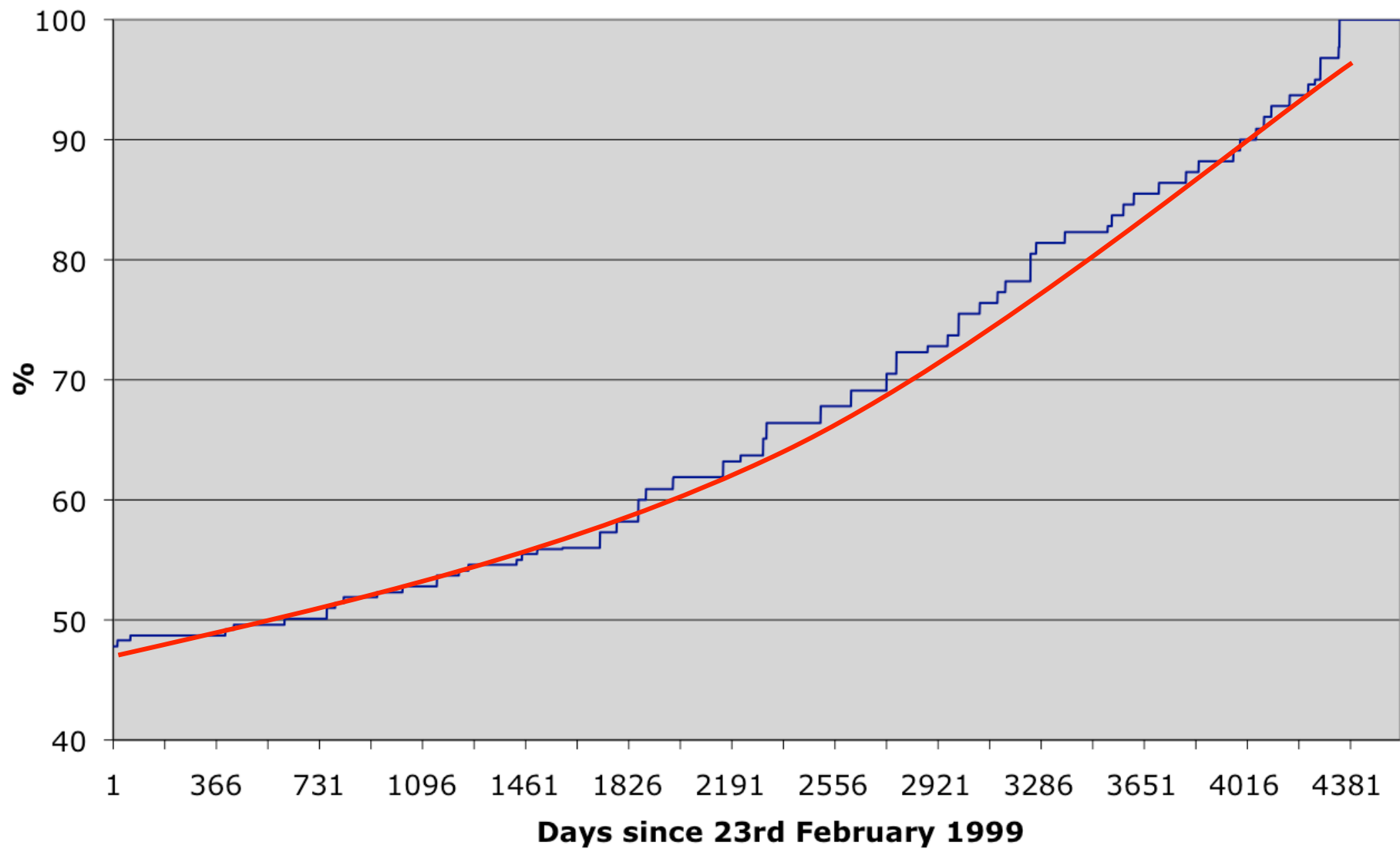


— Total ASNs    — Origin-only ASNs    — ASN providing Transit & Origin    — Transit-only ASNs

# Maximum AS Path Length



## Growth in IPv4 Address Space Allocations







# Looking at Deaggregation

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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”



# September 2011

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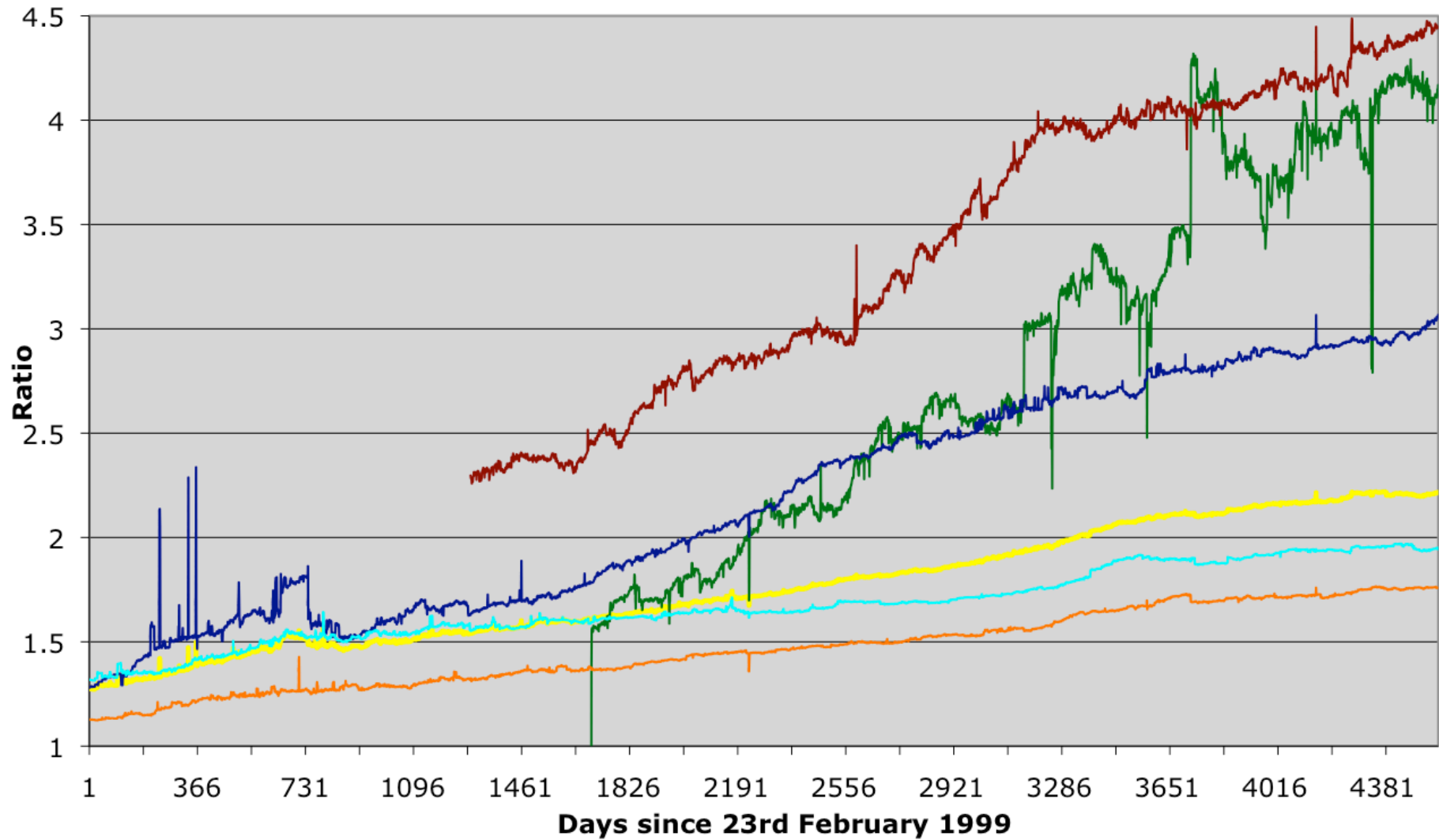
## Total Prefixes

- Global BGP Table
  - 372k prefixes
- Europe & Middle East
  - 88k prefixes
- North America
  - 143k prefixes
- Asia & Pacific
  - 94k prefixes
- Africa
  - 8k prefixes
- Latin America & Caribbean
  - 34k prefixes

## Deaggregation Factor

- Global Average
  - 2.22
- Europe & Middle East
  - 1.76
- North America
  - 1.94
- Asia & Pacific
  - 3.07
- Africa
  - 4.17
- Latin America & Caribbean
  - 4.45

## Deaggregation: RIR Regions vs Global



Global AfriNIC APNIC ARIN LACNIC RIPE

## Asia Pacific Aggregation Savings Summary

ASN	No of Nets	Savings	Description
17974	2006	1975	PT TELEKOMUNIKASI INDONESIA
4766	2508	1553	Korea Telecom (KIX)
7545	1587	1505	TPG Internet Pty Ltd
4755	1547	1377	TATA Communications formerly
9829	1155	1127	BSNL National Internet Backbo
24560	1180	987	Bharti Airtel Ltd., Telemedia
7552	977	966	Vietel Corporation
18101	949	811	Reliance Infocom Ltd Internet
17488	956	792	Hathway IP Over Cable Interne
9498	841	779	BHARTI Airtel Ltd.
4808	1070	767	CNCGROUP IP network: China169
4780	726	670	Digital United Inc.
17676	675	605	Softbank BB Corp.
9583	1077	572	Sify Limited
9443	566	490	Primus Telecommunications
18403	480	471	The Corporation for Financing
4538	527	458	China Education and Research
17841	549	448	MIC EGOVERNMENT
17803	585	441	BSES TeleCom Limited
18207	459	423	IQARA BROADBAND

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



# 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>

[http://bgpupdates.potaroo.net/instability/bgpupd.html](#)
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The BGP Instability Report

# The BGP Instability Report

The BGP Instability Report is updated daily. This report was generated on 14 September 2011 06:15 (UTC+1000)

## 50 Most active ASes for the past 7 days

RANK	ASN	UPDs	%	Prefixes	UPDs/Prefix	AS NAME
1	8447	100481	3.52%	97	1035.89	TELEKOM-AT A1 Telekom Austria AG
2	23966	37274	1.31%	352	105.89	LDN-AS-PK LINKdotNET Telecom Limited
3	7497	32667	1.15%	305	107.10	CSTNET-AS-AP Computer Network Information Center
4	38040	31580	1.11%	14	2255.71	GLOBAL-TRANSIT-TOT-IIG-TH TOT Public Company Limited
5	16212	31094	1.09%	30	1036.47	LORAL-SKYNET-ASN Loral Skynet - Aflenz ES (Telekom Austria)
6	29571	29863	1.05%	198	150.82	CITelecom-AS
7	22566	29051	1.02%	38	764.50	Maxcom Telecomunicaciones, S.A.B. de C.V.
8	9829	28160	0.99%	1156	24.36	BSNL-NIB National Internet Backbone
9	4845	26731	0.94%	27	990.04	SINGTEL-TW Chung Hsiao East Road
10	12486	25794	0.90%	29	889.45	YEMENNET YT - YEMEN NET Autonomous Number
11	8452	25709	0.90%	981	26.21	TE-AS TE-AS
12	6316	25147	0.88%	132	190.51	AS-PAETEC-NET - PaeTec Communications, Inc.
13	32528	25037	0.88%	8	3129.62	ABBOTT Abbot Labs
14	5800	23147	0.81%	181	127.88	DNIC-ASBLK-05800-06055 - DoD Network Information Center
15	7552	22094	0.77%	1415	15.61	VIETEL-AS-AP Vietel Corporation
16	47794	20111	0.71%	74	271.77	ATHEEB-AS Etihad Atheeb Telecom Company
17	16305	19680	0.69%	19	1035.79	mobilkom austria AG
18	1901	19620	0.69%	19	1032.63	EUNETAT-AS eTel Austria Gesmbh u. CO KG
19	9498	19564	0.69%	850	23.02	BBIL-AP BHARTI Airtel Ltd.
20	38543	18025	0.63%	5	3605.00	IBM-TH-AS-AP IBM THAILAND NETWORK
21	8261	17839	0.63%	19	938.89	ARCHWAY-SAT Archway S.r.l
22	47377	17714	0.62%	23	770.17	MES MOBISTAR ENTERPRISE SERVICES SA
23	23700	17508	0.61%	68	257.47	BM-AS-ID PT. Broadband Multimedia, Tbk
24	17885	17281	0.61%	103	167.78	JKTXLNET-AS-AP PT Excelcomindo Pratama

<http://bgpupdates.potaroo.net/instability/bgpupd.html>

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The BGP Instability Report

## 50 Most active Prefixes for the past 7 days

RANK	PREFIX	UPDs	%	Origin AS -- AS NAME
1	91.224.110.0/23	14972	0.50%	56375 -- IKRF Imam Khomeini Relief Foundation IKRF
2	130.36.34.0/24	12511	0.42%	32528 -- ABBOTT Abbot Labs
3	130.36.35.0/24	12511	0.42%	32528 -- ABBOTT Abbot Labs
4	202.92.235.0/24	11975	0.40%	9498 -- BBIL-AP BHARTI Airtel Ltd.
5	66.248.120.0/21	10114	0.34%	6316 -- AS-PAETEC-NET - PaeTec Communications, Inc.
6	66.248.96.0/21	9444	0.32%	6316 -- AS-PAETEC-NET - PaeTec Communications, Inc.
7	200.23.202.0/24	8045	0.27%	3454 -- Universidad Autonoma de Nuevo Leon
8	61.90.164.0/24	6276	0.21%	38543 -- IBM-TH-AS-AP IBM THAILAND NETWORK
9	58.97.61.0/24	6275	0.21%	38543 -- IBM-TH-AS-AP IBM THAILAND NETWORK
10	213.16.48.0/24	5766	0.19%	8866 -- BTC-AS Bulgarian Telecommunication Company Plc.
11	145.36.122.0/24	5760	0.19%	7046 -- RFC2270-UUNET-CUSTOMER - MCI Communications Services, Inc. d/b/a Verizon Business
12	66.248.104.0/21	5509	0.18%	6316 -- AS-PAETEC-NET - PaeTec Communications, Inc.
13	58.137.200.0/24	5472	0.18%	38543 -- IBM-TH-AS-AP IBM THAILAND NETWORK
14	180.180.253.0/24	5338	0.18%	38040 -- GLOBAL-TRANSIT-TOT-IIG-TH TOT Public Company Limited
15	180.180.248.0/24	5337	0.18%	38040 -- GLOBAL-TRANSIT-TOT-IIG-TH TOT Public Company Limited
16	180.180.250.0/24	5334	0.18%	38040 -- GLOBAL-TRANSIT-TOT-IIG-TH TOT Public Company Limited
17	180.180.251.0/24	5333	0.18%	38040 -- GLOBAL-TRANSIT-TOT-IIG-TH TOT Public Company Limited
18	180.180.255.0/24	5170	0.17%	38040 -- GLOBAL-TRANSIT-TOT-IIG-TH TOT Public Company Limited
19	180.180.249.0/24	5060	0.17%	38040 -- GLOBAL-TRANSIT-TOT-IIG-TH TOT Public Company Limited
20	202.41.70.0/24	4021	0.13%	2697 -- ERX-ERNET-AS Education and Research Network
21	202.153.174.0/24	3945	0.13%	17408 -- ABOVE-AS-AP AboveNet Communications Taiwan
22	67.128.69.0/24	3572	0.12%	14321 -- SERVICIO-UNITELLER - Servicio Uniteller, Inc. 14751 -- ONECOM-CVT - One Communications Corporation
23	14.63.21.0/24	3505	0.12%	3976 -- ERX-NURI-ASN I.Net Technologies Inc.
24	206.80.93.0/24	3501	0.12%	16916 -- NETLOGIC-WEST - INFINIPLEX LLC DBA NETLOGIC
25	198.32.6.0/24	2792	0.09%	1239 -- SPRINTLINK - Sprint 4555 -- EP0-BLK-ASNBLOCK-5 - Almond Oil Process, LLC.
26	202.43.176.0/23	2774	0.09%	23947 -- CEPATNET-AS-ID Internet Service Provider PT.Mora Telematika Indonesia
27	202.43.176.0/24	2763	0.09%	23947 -- CEPATNET-AS-ID Internet Service Provider PT.Mora Telematika Indonesia





# 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?