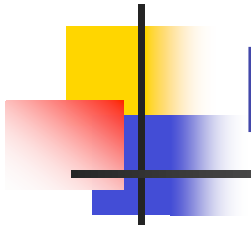
Internet Routing Table Analysis Update

Philip Smith

SANOG 15

27 January 2010

Dhaka



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 27 January 2010

BGP routing table entries examined:	309716
Prefixes after maximum aggregation:	143806
Deaggregation factor:	2.15
Unique aggregates announced to Internet:	152211
Total ASes present in the Internet Routing Table:	33173
Prefixes per ASN:	9.34
Origin-only ASes present in the Internet Routing Table:	28799
Origin ASes announcing only one prefix:	14055
Transit ASes present in the Internet Routing Table:	4374
Transit-only ASes present in the Internet Routing Table:	109
Average AS path length visible in the Internet Routing Table:	3.6
Max AS path length visible:	23
Max AS path prepend of ASN (9503)	21
Prefixes from unregistered ASNs in the Routing Table:	805
Unregistered ASNs in the Routing Table:	134
Number of 32-bit ASNs allocated by the RIRs:	409
Prefixes from 32-bit ASNs in the Routing Table:	362
Special use prefixes present in the Routing Table:	0
Prefixes being announced from unallocated address space:	207
Number of addresses announced to Internet:	2179238688
Equivalent to 129 /8s, 228 /16s and 139 /24s	
Percentage of available address space announced:	58.8
Percentage of allocated address space announced:	66.0
Percentage of available address space allocated:	89.1
Percentage of address space in use by end-sites:	80.9
Total number of prefixes smaller than registry allocations:	149235

APNIC Region

Prefixes being announced by APNIC Region ASes:	74802
Total APNIC prefixes after maximum aggregation:	25837
APNIC Deaggregation factor:	2.90
Prefixes being announced from the APNIC address blocks:	71490
Unique aggregates announced from the APNIC address blocks:	31462
APNIC Region origin ASes present in the Internet Routing Table:	3931
APNIC Prefixes per ASN:	18.19
APNIC Region origin ASes announcing only one prefix:	1075
APNIC Region transit ASes present in the Internet Routing Table:	618
Average APNIC Region AS path length visible:	3.6
Max APNIC Region AS path length visible:	23
Number of APNIC addresses announced to Internet:	490126592
Equivalent to 29 /8s, 54 /16s and 189 /24s	
Percentage of available APNIC address space announced:	76.9

APNIC AS Blocks	4608-4864, 7467-7722, 9216-10239, 17408-18431
(pre-ERX allocations)	23552-24575, 37888-38911, 45056-46079
	55296-56319, 131072-132095
APNIC Address Blocks	1/8, 27/8, 43/8, 58/8 to 61/8, 110/8 to 126/8,
	133/8, 175/8, 180/8, 182/8, 183/8, 202/8, 203/8,
	210/8, 211/8 to 222/8

Global per AS prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
6389	4144	3875	316	bellsouth.net, inc.
4323	3789	1088	395	Time Warner Telecom
4766	1860	7511	472	Korea Telecom (KIX)
1785	1818	699	132	PaeTec Communications, Inc.
7018	1591	5778	1028	AT&T WorldNet Services
8151	1571	2885	240	UniNet S.A. de C.V.
20115	1542	1490	671	Charter Communications
4755	1311	303	136	TATA Communications formerly
2386	1291	616	916	AT&T Data Communications Serv
17488	1278	131	140	Hathway IP Over Cable Interne
3356	1205	10931	427	Level 3 Communications, LLC
11492	1138	222	14	Cable One
22773	1125	2600	66	Cox Communications, Inc.
6478	1106	241	256	AT&T Worldnet Services
18566	1059	296	10	Covad Communications
19262	1056	4364	240	Verizon Global Networks
18101	1044	220	36	Reliance Infocom Ltd Internet
7011	1035	243	629	Citizens Utilities
4134	1019	19605	398	CHINANET-BACKBONE
8452	1019	445	9	TEDATA

Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:21	/9:10	/10:25	/11:66	/12:183
/13:385	/14:660	/15:1244	/16:10889	/17:5101	/18:8689
/19:17844	/20:21731	/21:21793	/22:28068	/23:28177	/24:161916
/25:926	/26:1165	/27:582	/28:217	/29:9	/30:7
/31:0	/32:8				

January 2010 ↑

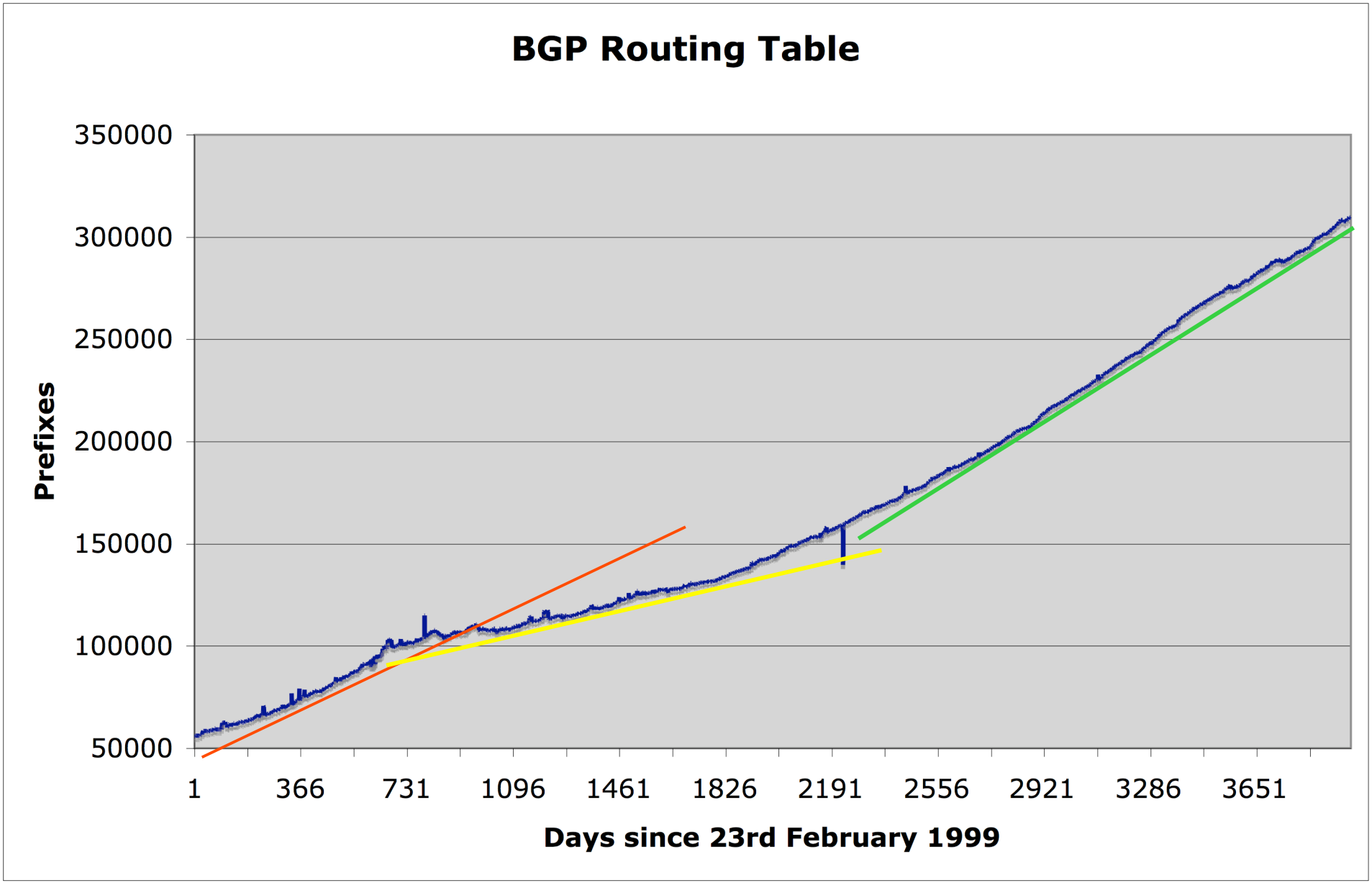
January 2009 ↓

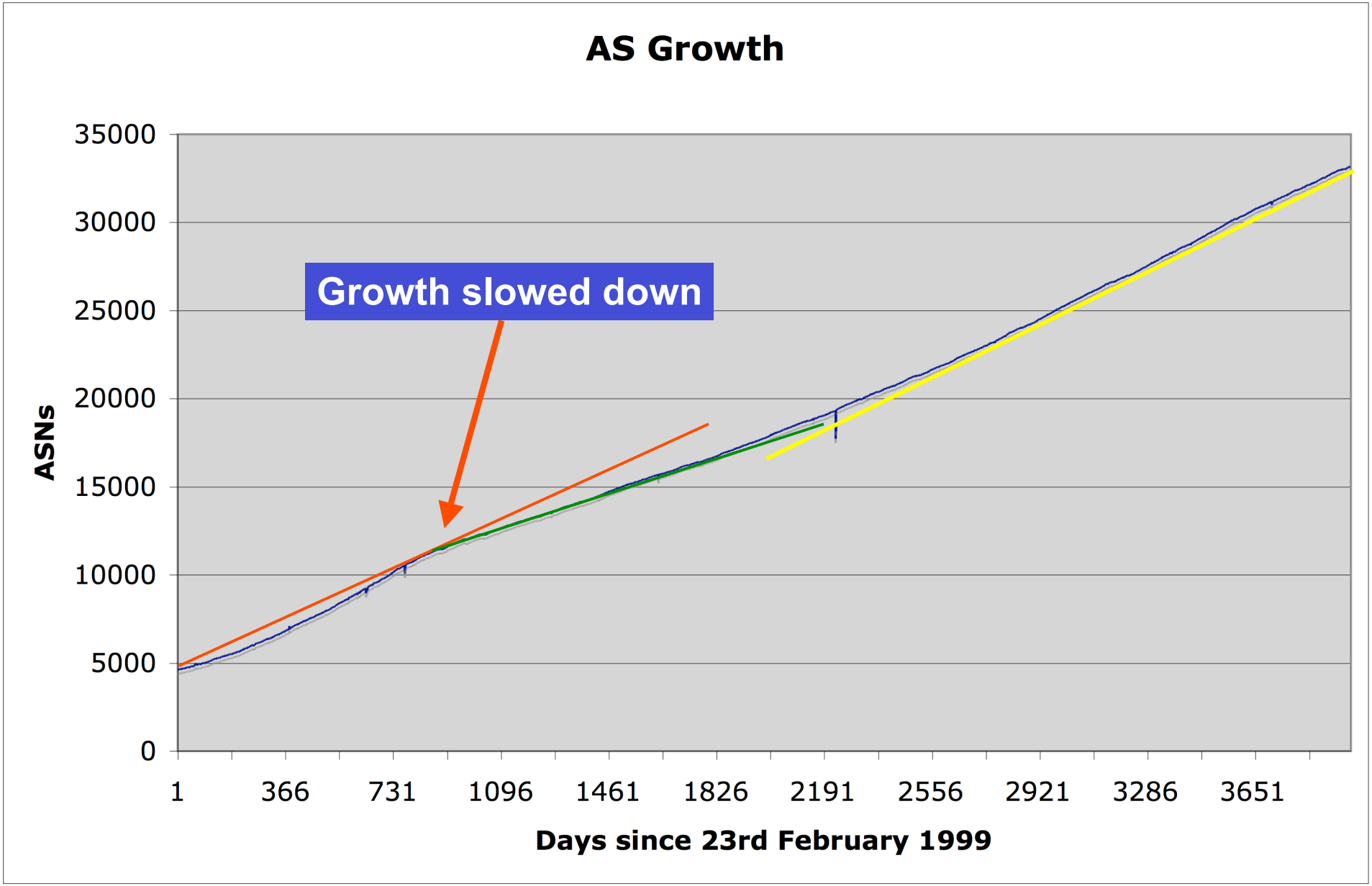
Number of prefixes announced by prefix length

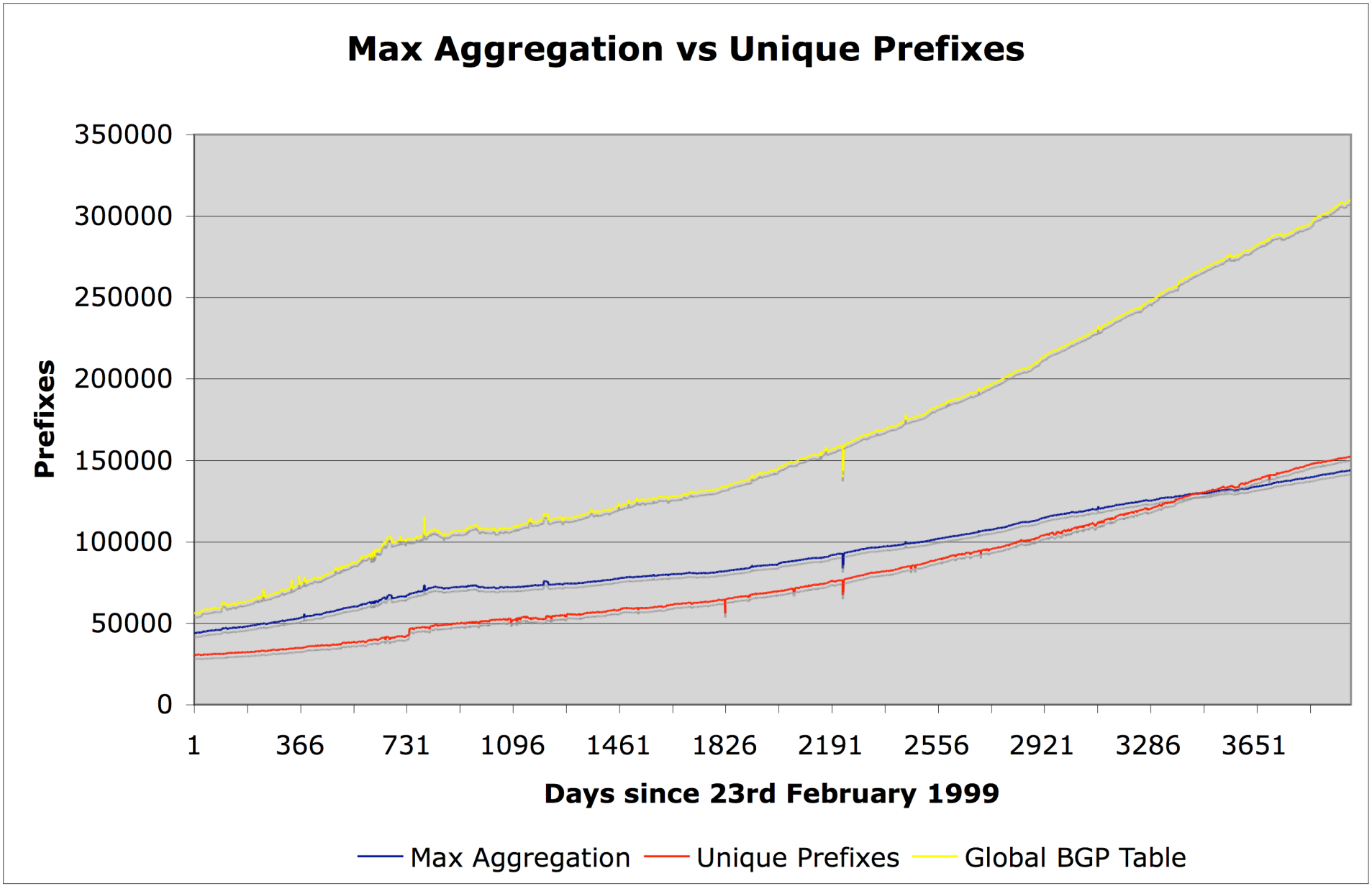
/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:19	/9:9	/10:20	/11:54	/12:159
/13:311	/14:567	/15:1107	/16:10313	/17:4542	/18:7813
/19:16838	/20:19745	/21:19252	/22:24530	/23:24880	/24:146344
/25:654	/26:808	/27:503	/28:92	/29:8	/30:1
/31:0	/32:7				

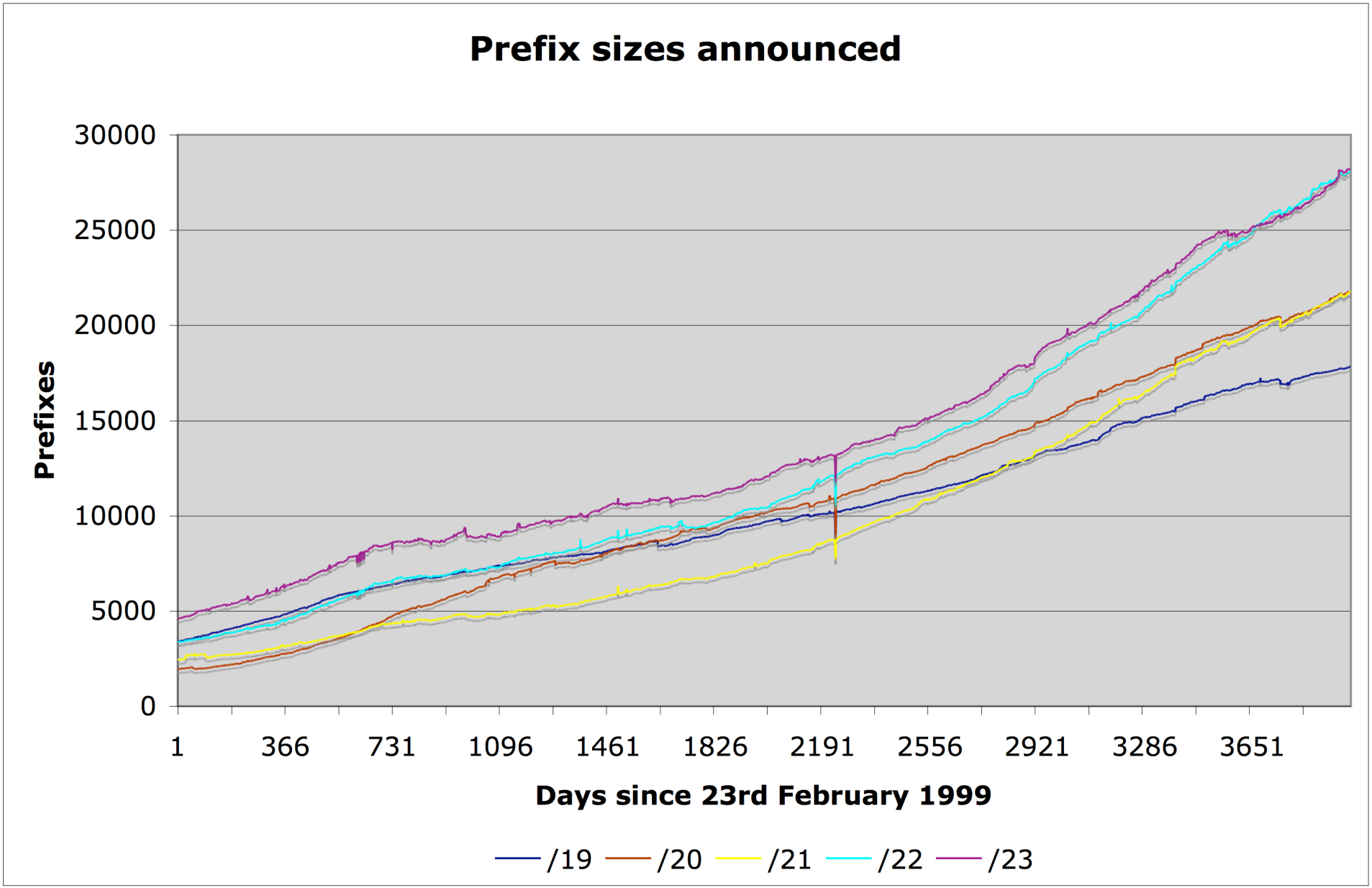
Prefixes Smaller than Registry Allocations

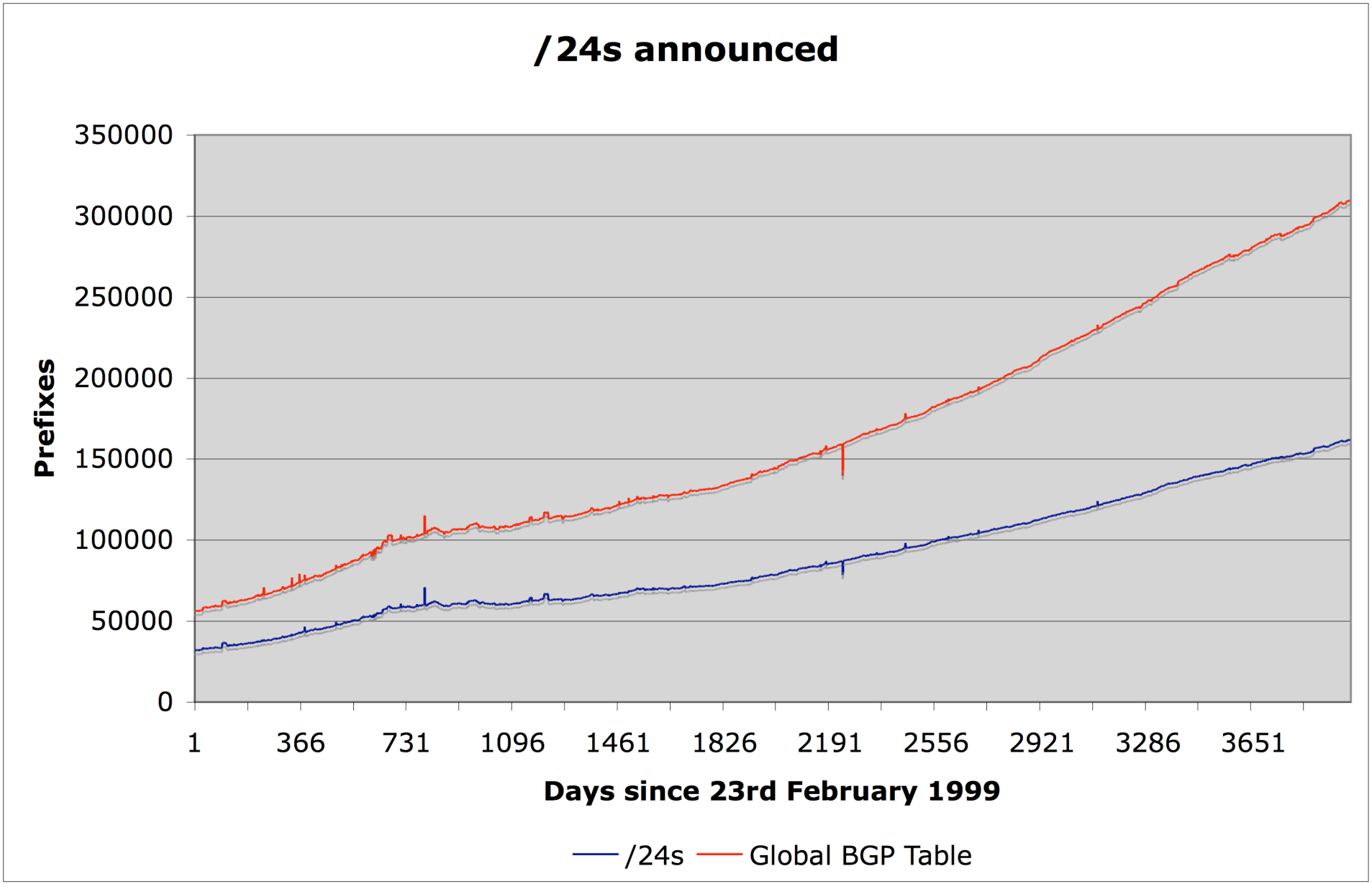
ASN	No of nets	Total ann.	Description
6389	2700	4144	bellsouth.net, inc.
4323	2361	3789	Time Warner Telecom
4766	1478	1860	Korea Telecom (KIX)
1785	1285	1818	PaeTec Communications, Inc.
11492	1058	1138	Cable One
17488	1054	1278	Hathway IP Over Cable Interne
18566	1040	1059	Covad Communications
7018	959	1591	AT&T WorldNet Services
18101	924	1044	Reliance Infocom Ltd Internet
8452	915	1019	TEDATA
10620	913	1007	TVCABLE BOGOTA
9583	838	986	Sify Limited
7011	815	1035	Citizens Utilities
3356	813	1205	Level 3 Communications, LLC
24560	739	839	Bharti Airtel Ltd., Telemedia
22773	685	1125	Cox Communications, Inc.
4755	655	1311	TATA Communications formerly
6517	627	675	Yipes Communications, Inc.
5668	620	789	CenturyTel Internet Holdings,
20115	590	1542	Charter Communications

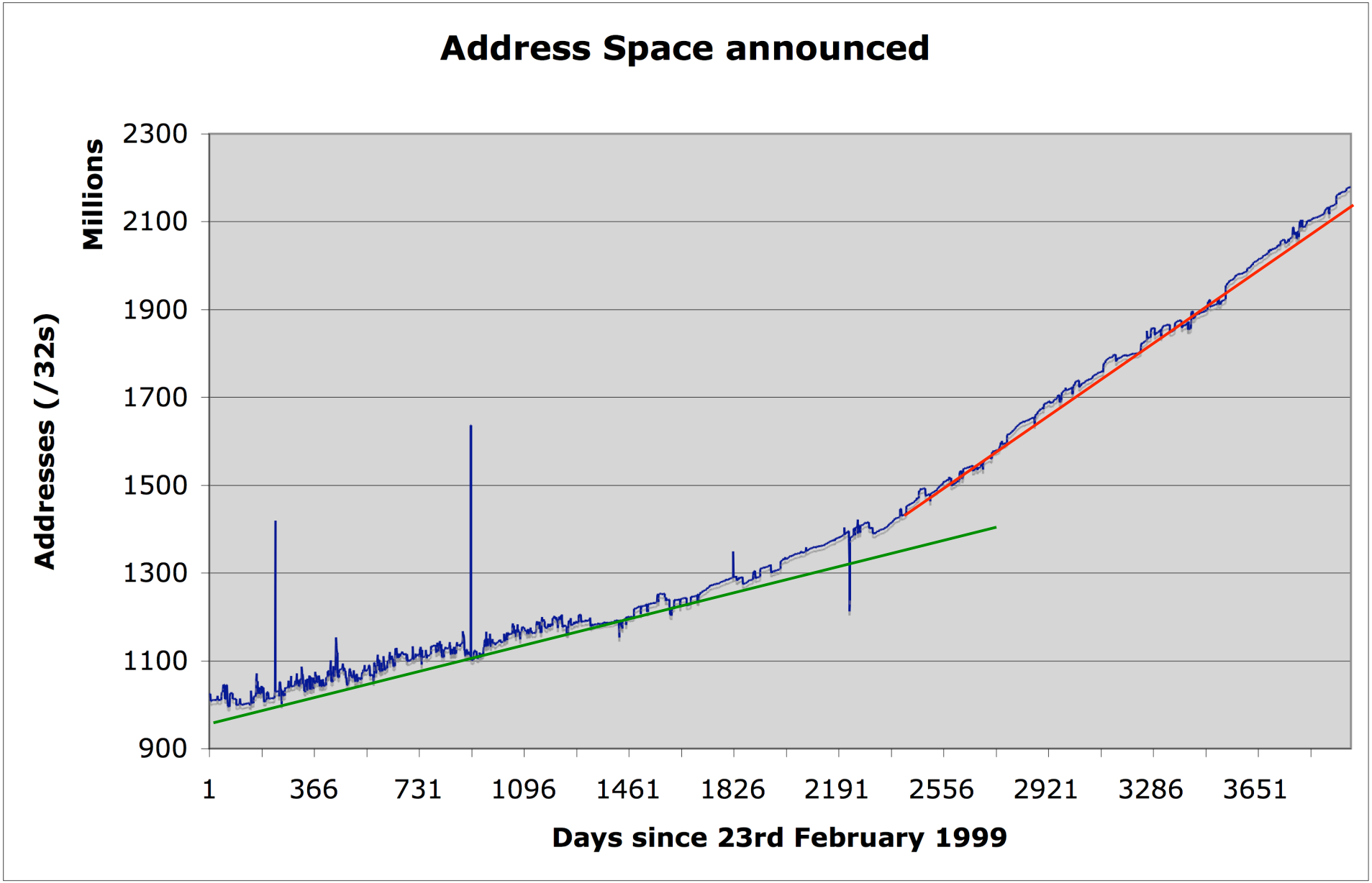

BGP Routing Table
350000
300000
250000
200000
150000
100000
50000
Prefixes
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999

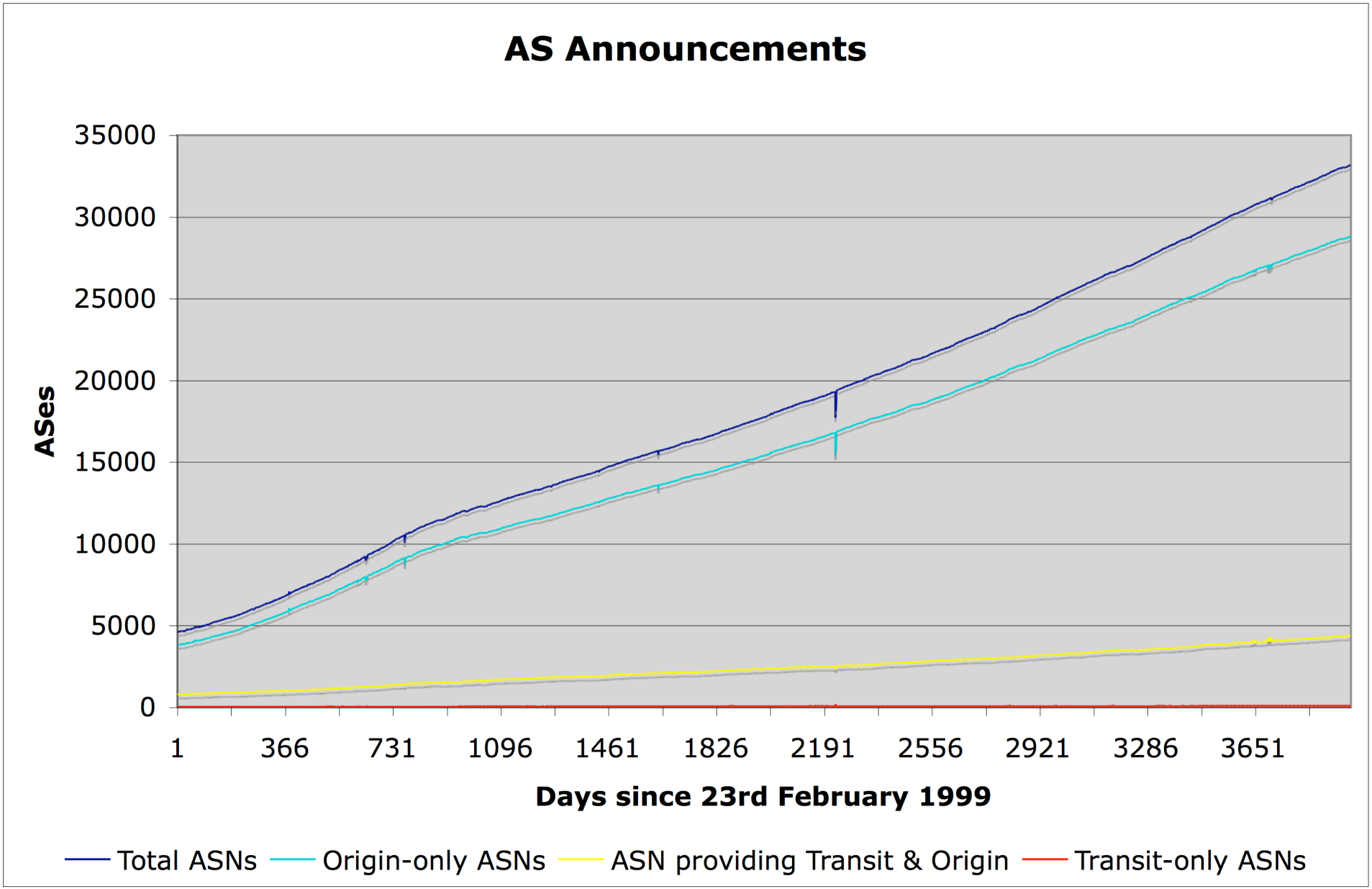

AS Growth
35000
30000
25000
20000
15000
10000
5000
0
ASNs
Growth slowed down
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999

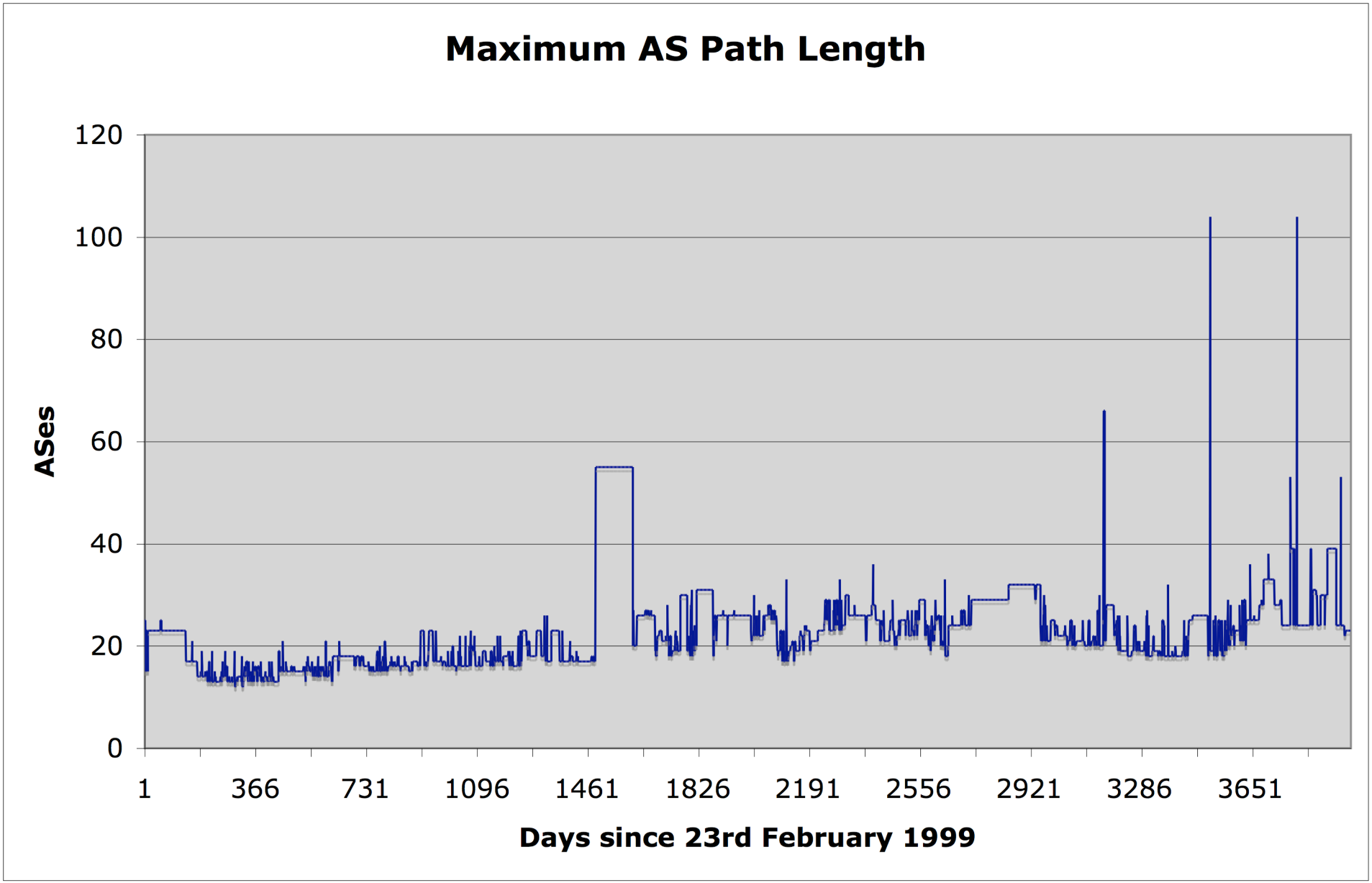

Max Aggregation vs Unique Prefixes
Prefixes
350000
300000
250000
200000
150000
100000
50000
0
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999
Max Aggregation
Unique Prefixes
Global BGP Table

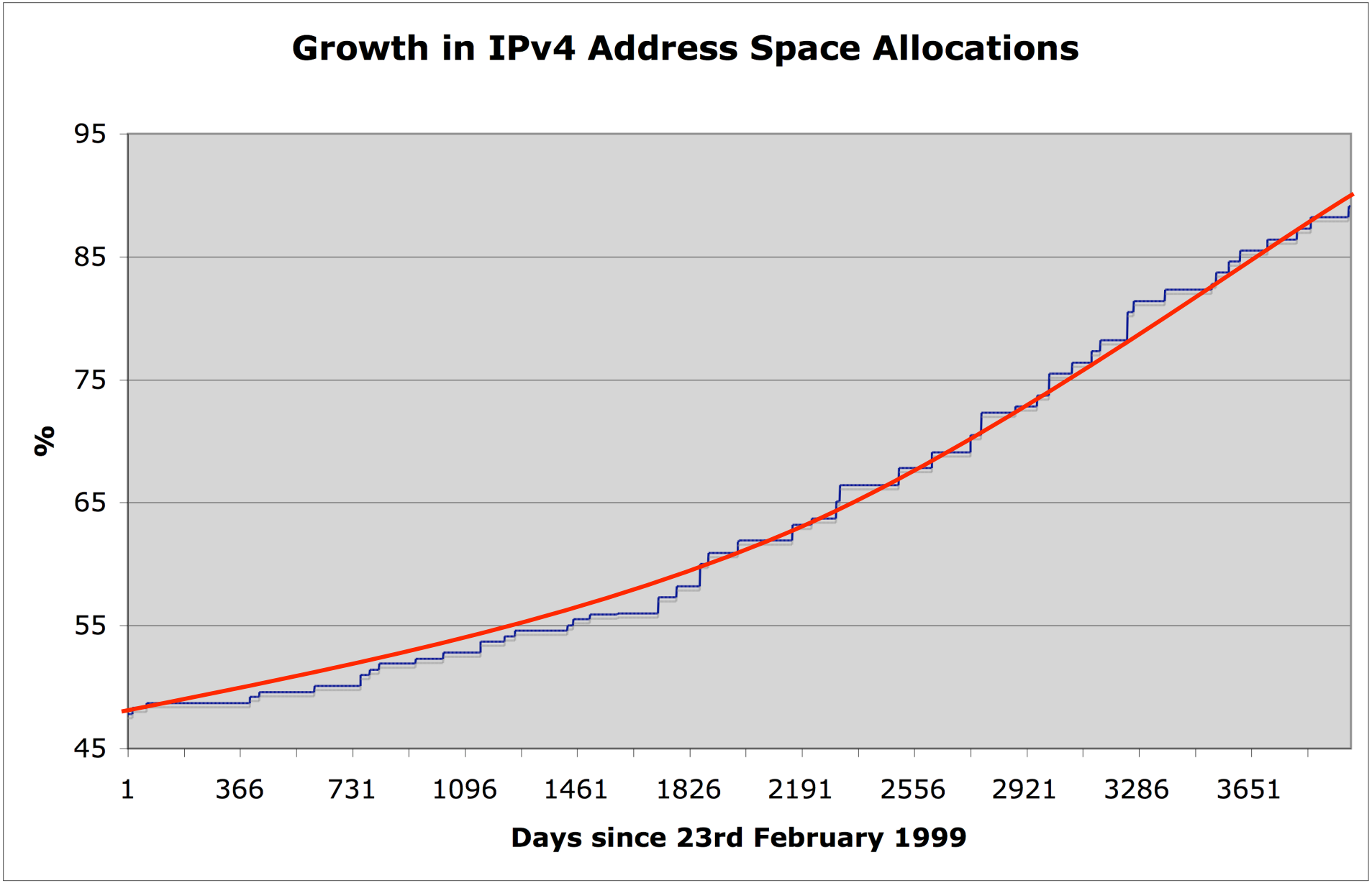

Prefix sizes announced
Prefixes
30000
25000
20000
15000
10000
5000
0
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999
/19
/20
/21
/22
/23

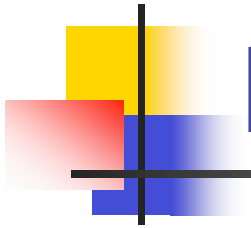

/24s announced
Prefixes
350000
300000
250000
200000
150000
100000
50000
0
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999
/24s
Global BGP Table


Address Space announced
Addresses (/32s)
Millions
2300
2100
1900
1700
1500
1300
1100
900
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999


AS Announcements
35000
30000
25000
20000
15000
10000
5000
0
ASes
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999
Total ASNs
Origin-only ASNs
ASN providing Transit & Origin
Transit-only ASNs

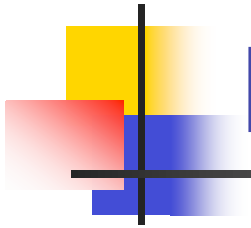

Maximum AS Path Length
ASes
120
100
80
60
40
20
0
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999


Growth in IPv4 Address Space Allocations
95
85
75
65
55
45
%
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999



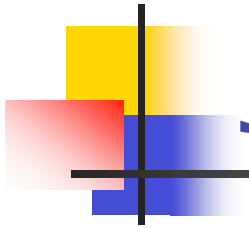
Looking at Deaggregation

- 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"



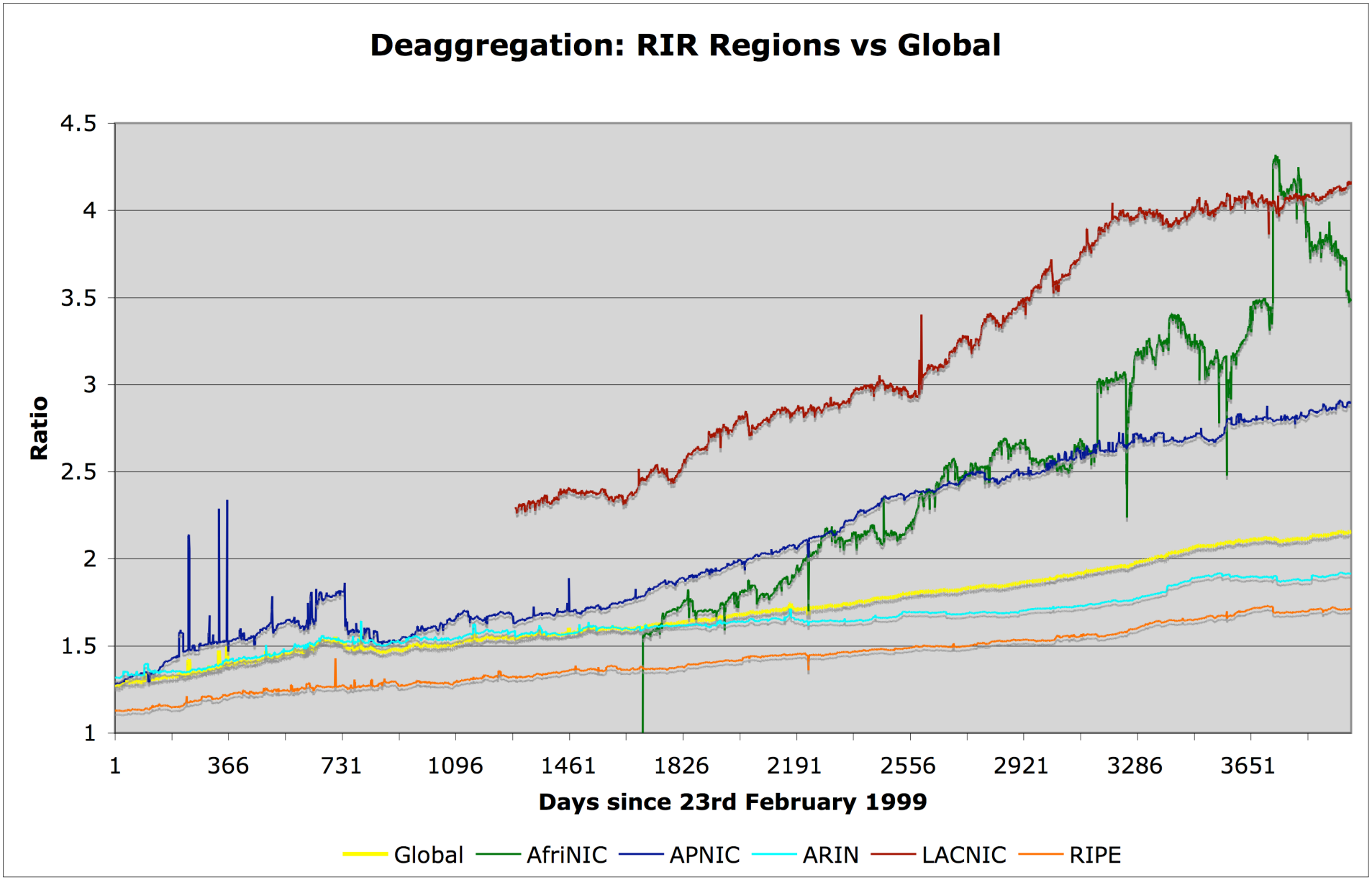
January 2010

Total Prefixes

- Global BGP Table
  - 310k prefixes
- Europe & Middle East
  - 71k prefixes
- North America
  - 129k prefixes
- Asia & Pacific
  - 75k prefixes
- Africa
  - 6k prefixes
- Latin America & Caribbean
  - 27k prefixes

Deaggregation Factor

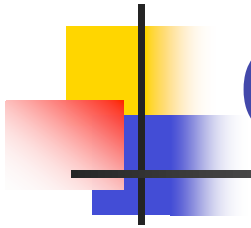
- Global Average
  - 2.15
- Europe & Middle East
  - 1.72
- North America
  - 1.91
- Asia & Pacific
  - 2.90
- Africa
  - 3.48
- Latin America & Caribbean
  - 4.15


Deaggregation: RIR Regions vs Global
Ratio
4.5
4
3.5
3
2.5
2
1.5
1
1
366
731
1096
1461
1826
2191
2556
2921
3286
3651
Days since 23rd February 1999
Global
AfriNIC
APNIC
ARIN
LACNIC
RIPE

Asia Pacific Aggregation Savings Summary

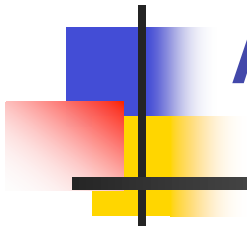
ASN	No of Nets	Savings	Description
4766	1860	1388	Korea Telecom (KIX)
4755	1311	1175	TATA Communications formerly
17488	1278	1138	Hathway IP Over Cable Interne
18101	1044	1008	Reliance Infocom Ltd Internet
17974	881	830	PT TELEKOMUNIKASI INDONESIA
7545	920	822	TPG Internet Pty Ltd
9829	840	819	BSNL National Internet Backbo
17908	764	709	Tata Communications
24560	839	667	Bharti Airtel Ltd., Telemedia
9299	663	642	Philippine Long Distance Tele
4808	836	623	CNCGROUP IP network: China169
4134	1019	621	CHINANET-BACKBONE
9498	663	617	BHARTI Airtel Ltd.
4780	603	531	Digital United Inc.
17676	563	501	Softbank BB Corp.
9583	986	495	Sify Limited
9808	442	432	Guangdong Mobile Communicatio
9443	510	431	Primus Telecommunications
4804	455	387	Microplex PTY LTD
4802	523	360	iiNet Limited

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



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?