

Internet Routing Table Analysis Update



Philip Smith
SANOG 17
18 January 2011
Colombo



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 17 January 2011

BGP routing table entries examined:	341327
Prefixes after maximum aggregation:	154360
Deaggregation factor:	2.21
Unique aggregates announced to Internet:	168665
Total ASes present in the Internet Routing Table:	35644
Prefixes per ASN:	9.58
Origin-only ASes present in the Internet Routing Table:	30720
Origin ASes announcing only one prefix:	14934
Transit ASes present in the Internet Routing Table:	4924
Transit-only ASes present in the Internet Routing Table:	122
Average AS path length visible in the Internet Routing Table:	4.3
Max AS path length visible:	33
Max AS path prepend of ASN (36992)	29
Prefixes from unregistered ASNs in the Routing Table:	323
Unregistered ASNs in the Routing Table:	131
Number of 32-bit ASNs allocated by the RIRs:	1010
Prefixes from 32-bit ASNs in the Routing Table:	4
Special use prefixes present in the Routing Table:	0
Prefixes being announced from unallocated address space:	214
Number of addresses announced to Internet:	2435008864
Equivalent to 145 /8s, 35 /16s and 73 /24s	
Percentage of available address space announced:	65.7
Percentage of allocated address space announced:	67.8
Percentage of available address space allocated:	96.8
Percentage of address space in use by end-sites:	87.6
Total number of prefixes smaller than registry allocations:	140254

APNIC Region

Prefixes being announced by APNIC Region ASes:	84468
Total APNIC prefixes after maximum aggregation:	28715
APNIC Deaggregation factor:	2.94
Prefixes being announced from the APNIC address blocks:	81317
Unique aggregates announced from the APNIC address blocks:	35426
APNIC Region origin ASes present in the Internet Routing Table:	4293
APNIC Prefixes per ASN:	18.94
APNIC Region origin ASes announcing only one prefix:	1209
APNIC Region transit ASes present in the Internet Routing Table:	690
Average APNIC Region AS path length visible:	4.4
Max APNIC Region AS path length visible:	20
Number of APNIC addresses announced to Internet:	579894304
Equivalent to 34 /8s, 144 /16s and 124 /24s	
Percentage of available APNIC address space announced:	78.6

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, 14/8, 27/8, 36/8, 42/8, 43/8, 49/8,
	58/8 to 61/8, 101/8, 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	3713	3855	266	bellsouth.net, inc.
4323	2647	1077	403	Time Warner Telecom
4766	1909	9484	521	Korea Telecom (KIX)
19262	1838	4941	286	Verizon Global Networks
1785	1786	697	133	PaeTec Communications, Inc.
7545	1564	300	79	TPG Internet Pty Ltd
20115	1508	1530	641	Charter Communications
6478	1451	288	74	AT&T Worldnet Services
17974	1403	459	28	PT TELEKOMUNIKASI INDONESIA
4755	1396	636	159	TATA Communications formerly
7018	1370	5650	882	AT&T WorldNet Services
10620	1349	251	167	TVCABLE BOGOTA
8151	1322	2607	360	UniNet S.A. de C.V.
2386	1298	553	933	AT&T Data Communications Serv
11492	1277	234	71	Cable One
22773	1269	2864	74	Cox Communications, Inc.
28573	1228	951	79	NET Servicos de Comunicacao S.A
7011	1171	289	683	Citizens Utilities
3356	1166	10808	428	Level 3 Communications, LLC
6503	1142	355	79	AVANTEL, S.A.

Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:25	/9:10	/10:25	/11:70	/12:214
/13:437	/14:759	/15:1350	/16:11456	/17:5596	/18:9269
/19:18750	/20:24156	/21:24438	/22:32300	/23:31182	/24:178507
/25:968	/26:1070	/27:569	/28:154	/29:12	/30:2
/31:0	/32:8				

January 2011 ↑

January 2010 ↓

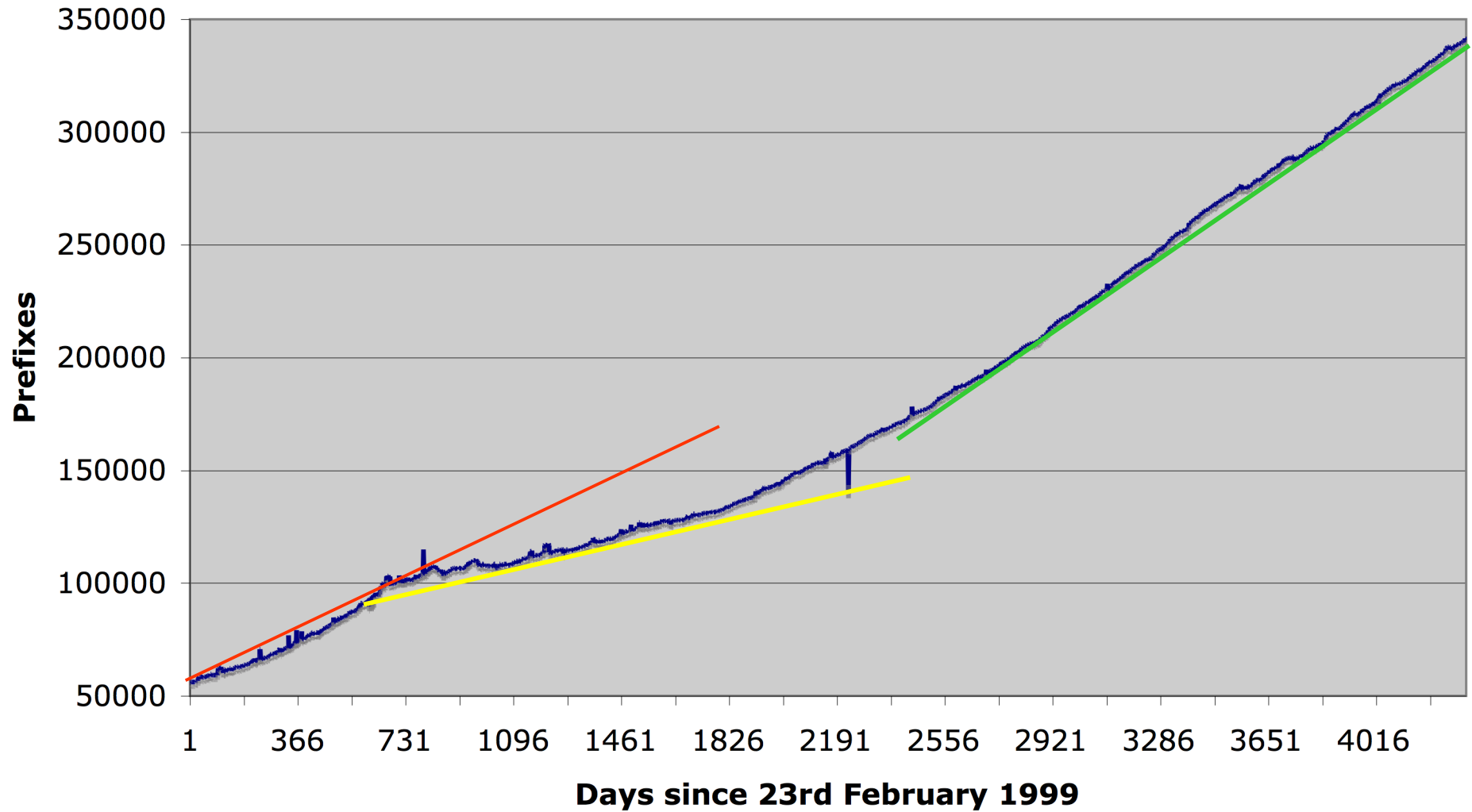
Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:21	/9:10	/10:25	/11:66	/12:183
/13:383	/14:656	/15:1243	/16:10873	/17:5079	/18:8650
/19:17763	/20:21740	/21:21684	/22:28021	/23:28225	/24:161630
/25:924	/26:1153	/27:586	/28:211	/29:9	/30:7
/31:0	/32:8				

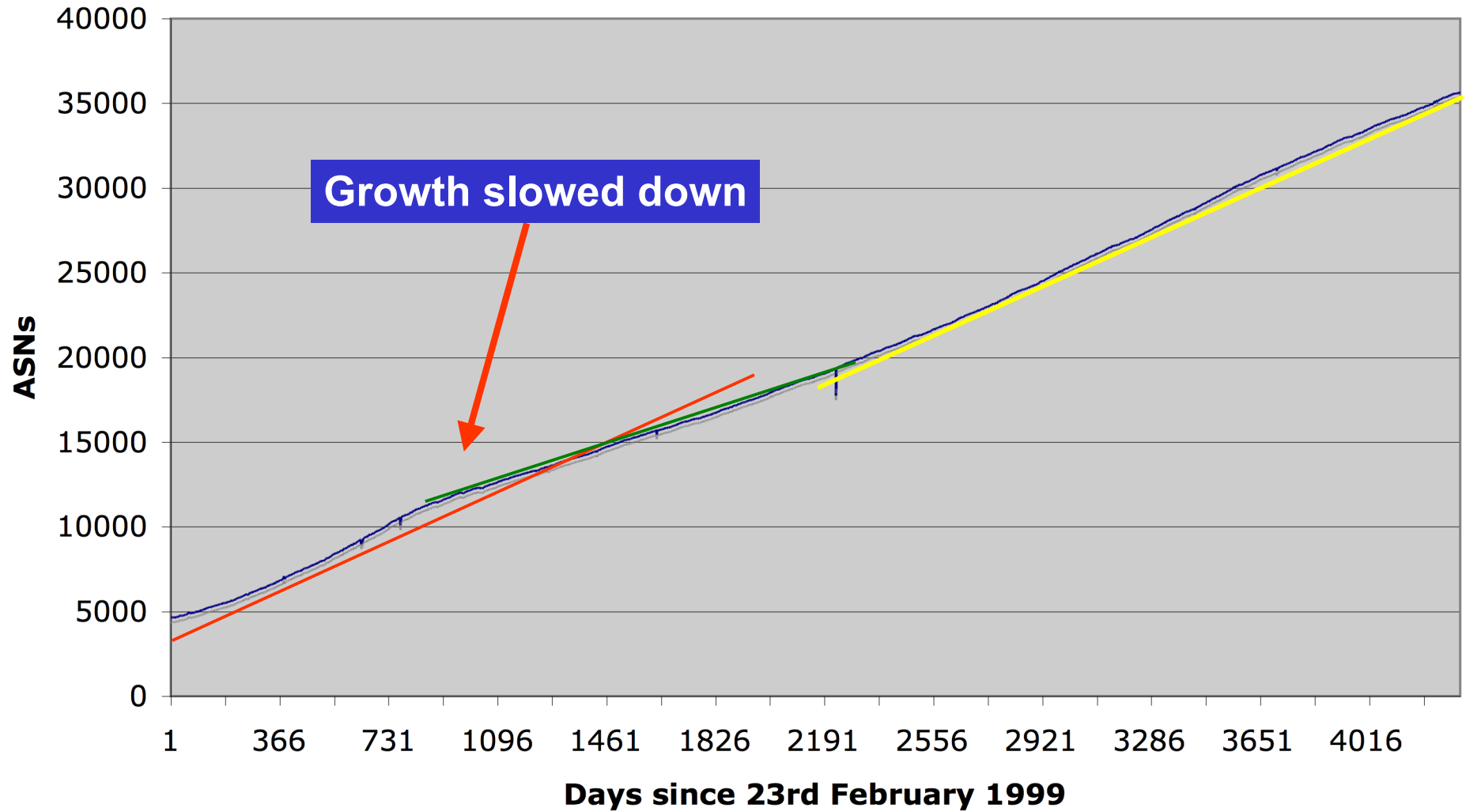
Prefixes Smaller than Registry Allocations

ASN	No of nets	Total ann.	Description
6389	2292	3713	bellsouth.net, inc.
4323	1430	2647	Time Warner Telecom
6478	1407	1451	AT&T Worldnet Services
10620	1240	1349	TVCABLE BOGOTA
11492	1233	1277	Cable One
18566	1098	1117	Covad Communications
7011	1068	1171	Citizens Utilities
1785	1060	1786	PaeTec Communications, Inc.
19262	952	1838	Verizon Global Networks
6503	928	1142	AVANTEL, S.A.
22773	823	1269	Cox Communications, Inc.
7018	784	1370	AT&T WorldNet Services
28573	759	1228	NET Servicios de Comunicacao S.A
3356	744	1166	Level 3 Communications, LLC
7029	705	895	Alltel Information Services,
7303	643	866	Telecom Argentina Stet-France
8452	619	791	TEDATA
36992	563	635	Etisalat MISR
3	556	971	Massachusetts Institute of Te
14420	545	603	CORPORACION NACIONAL DE TELEC

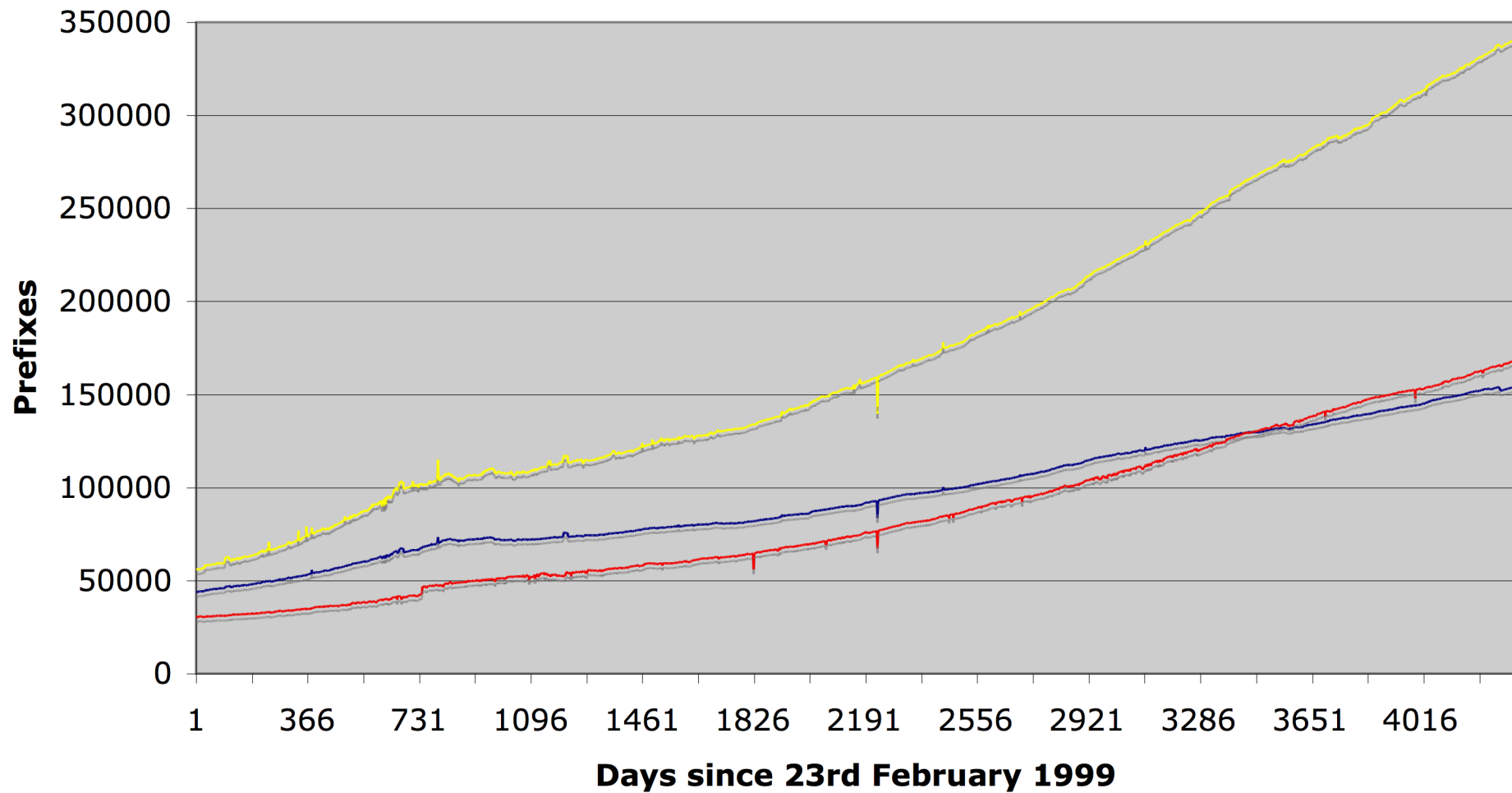
BGP Routing Table



AS Growth

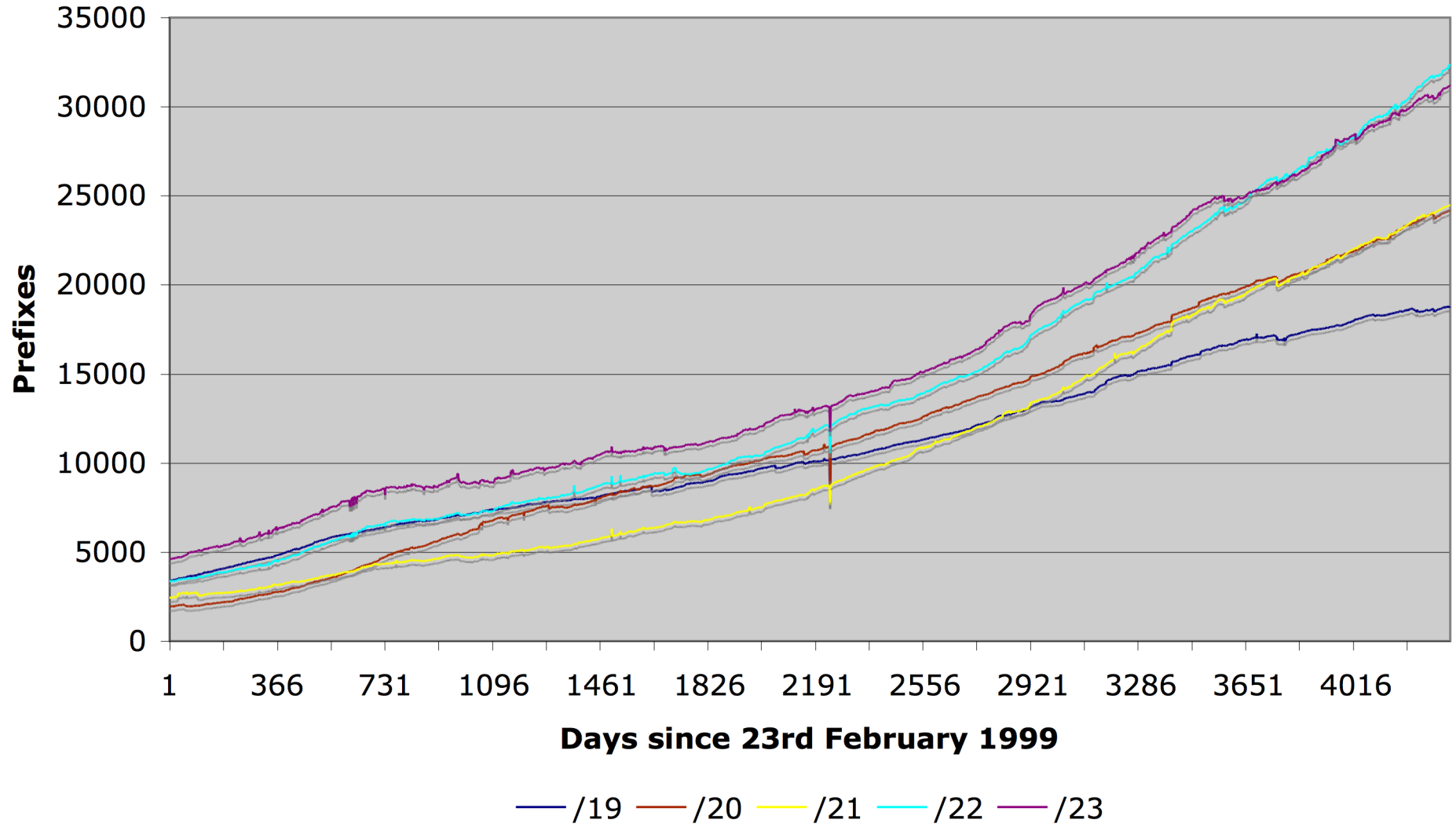


Max Aggregation vs Unique Prefixes

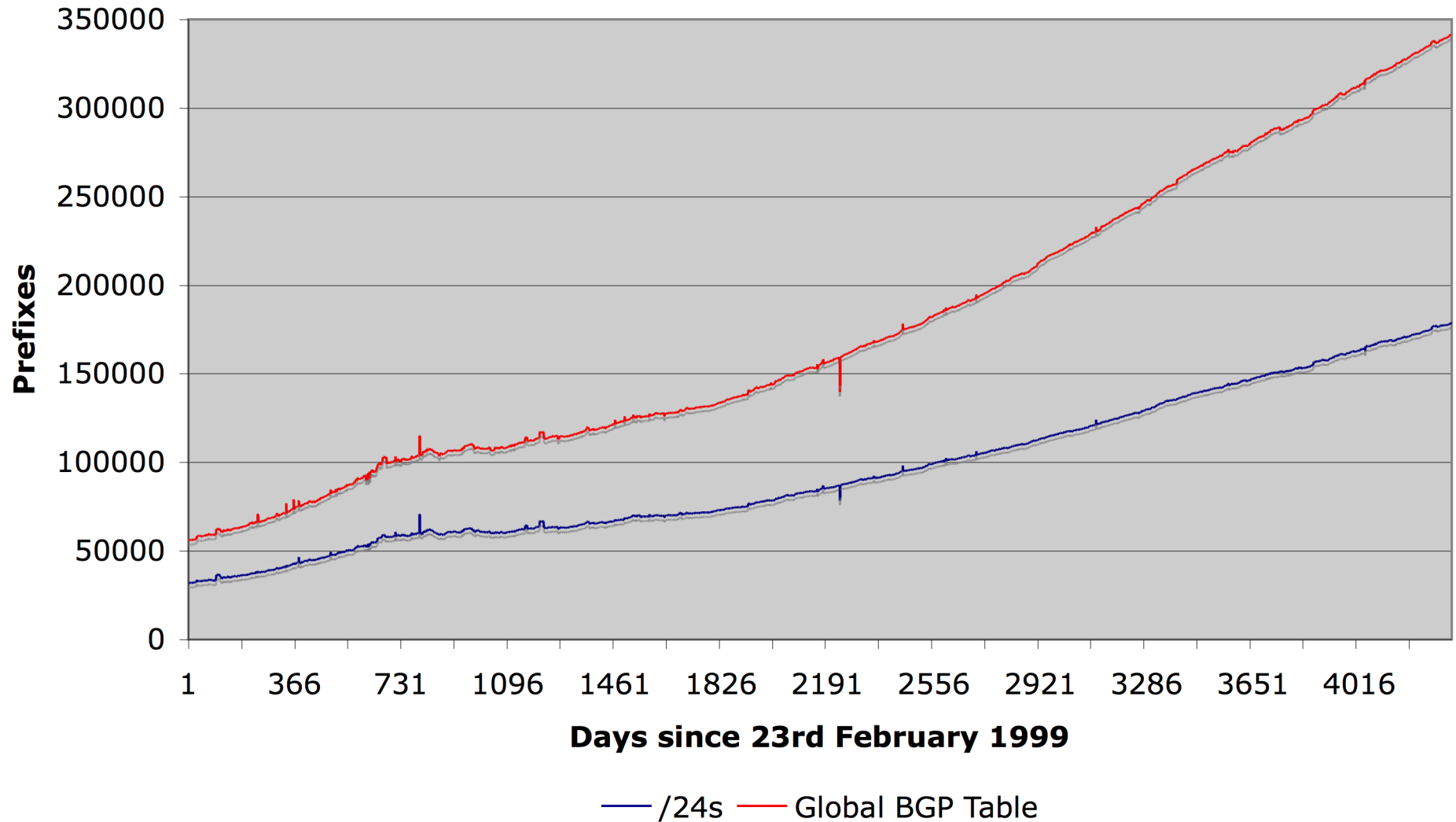


— Max Aggregation — Unique Prefixes — Global BGP Table

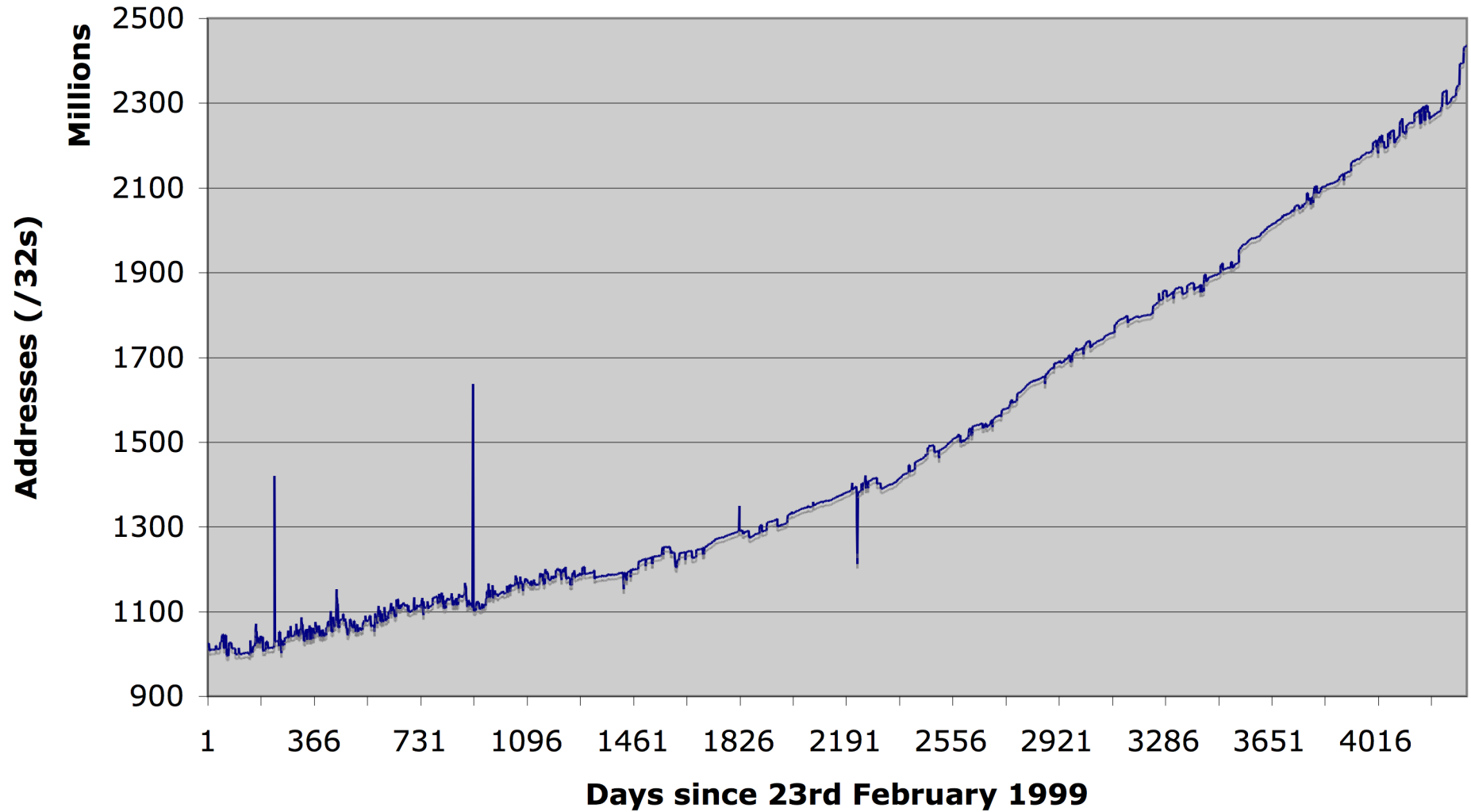
Prefix sizes announced



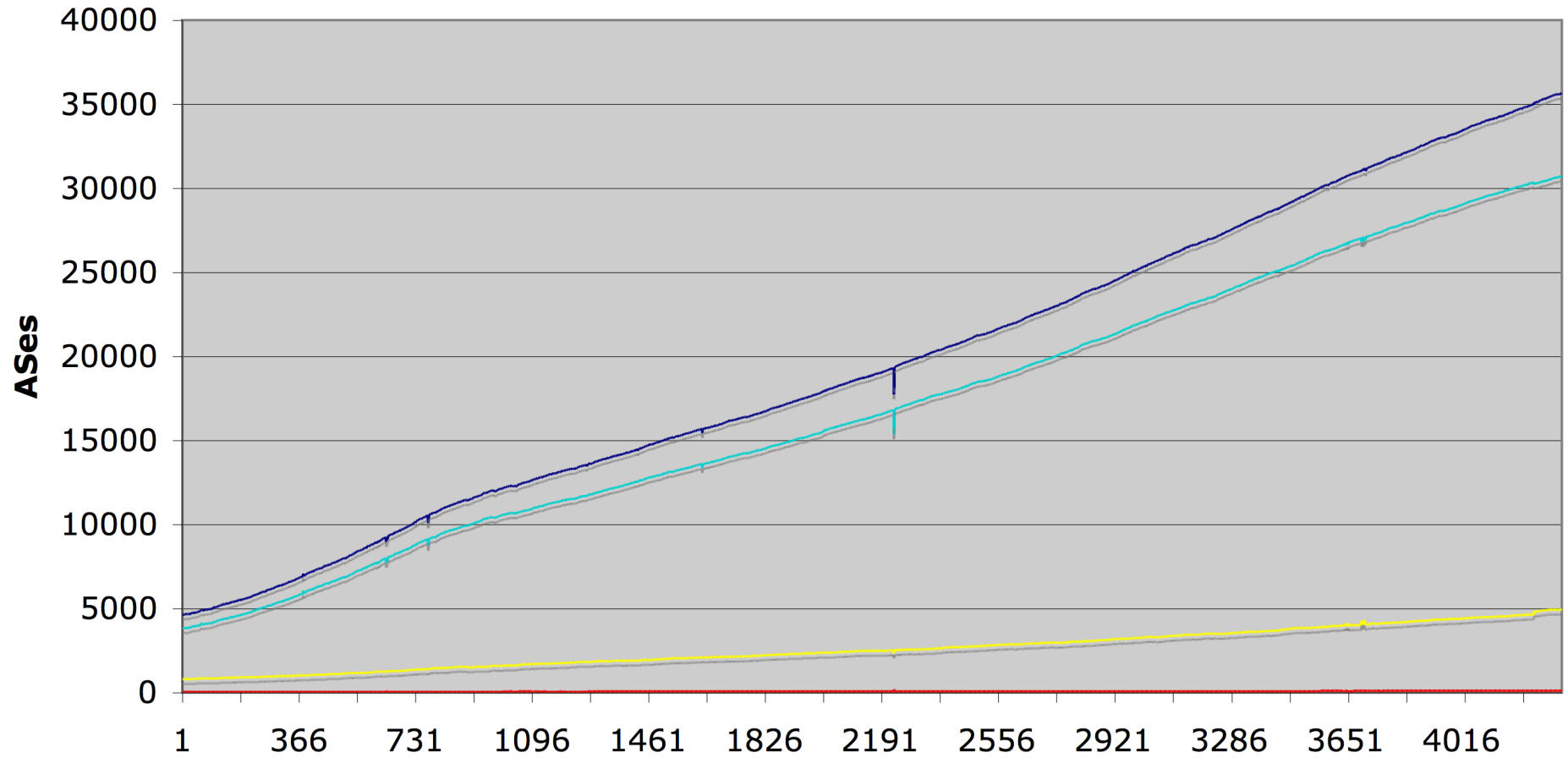
/24s announced



Address Space announced

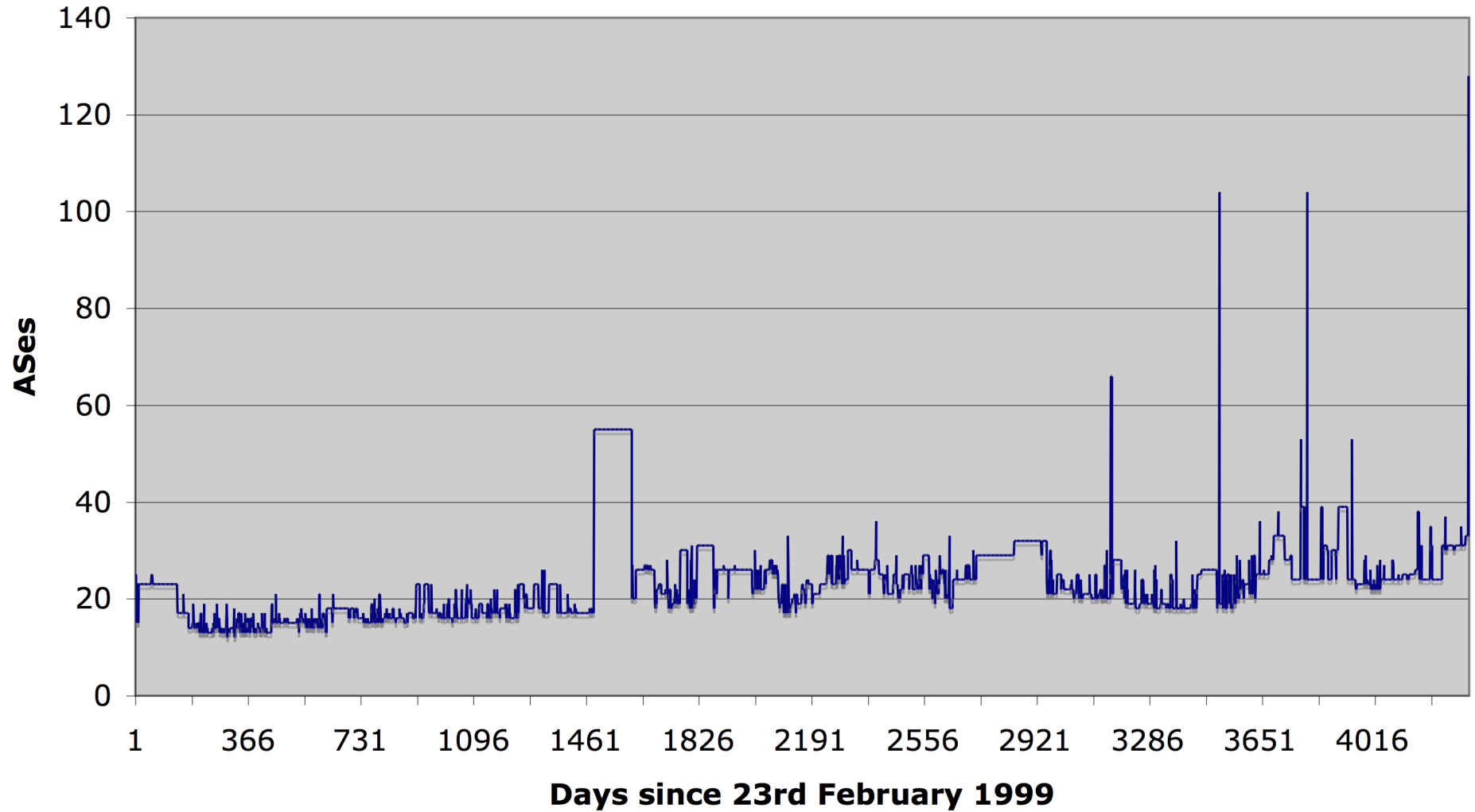


AS Announcements

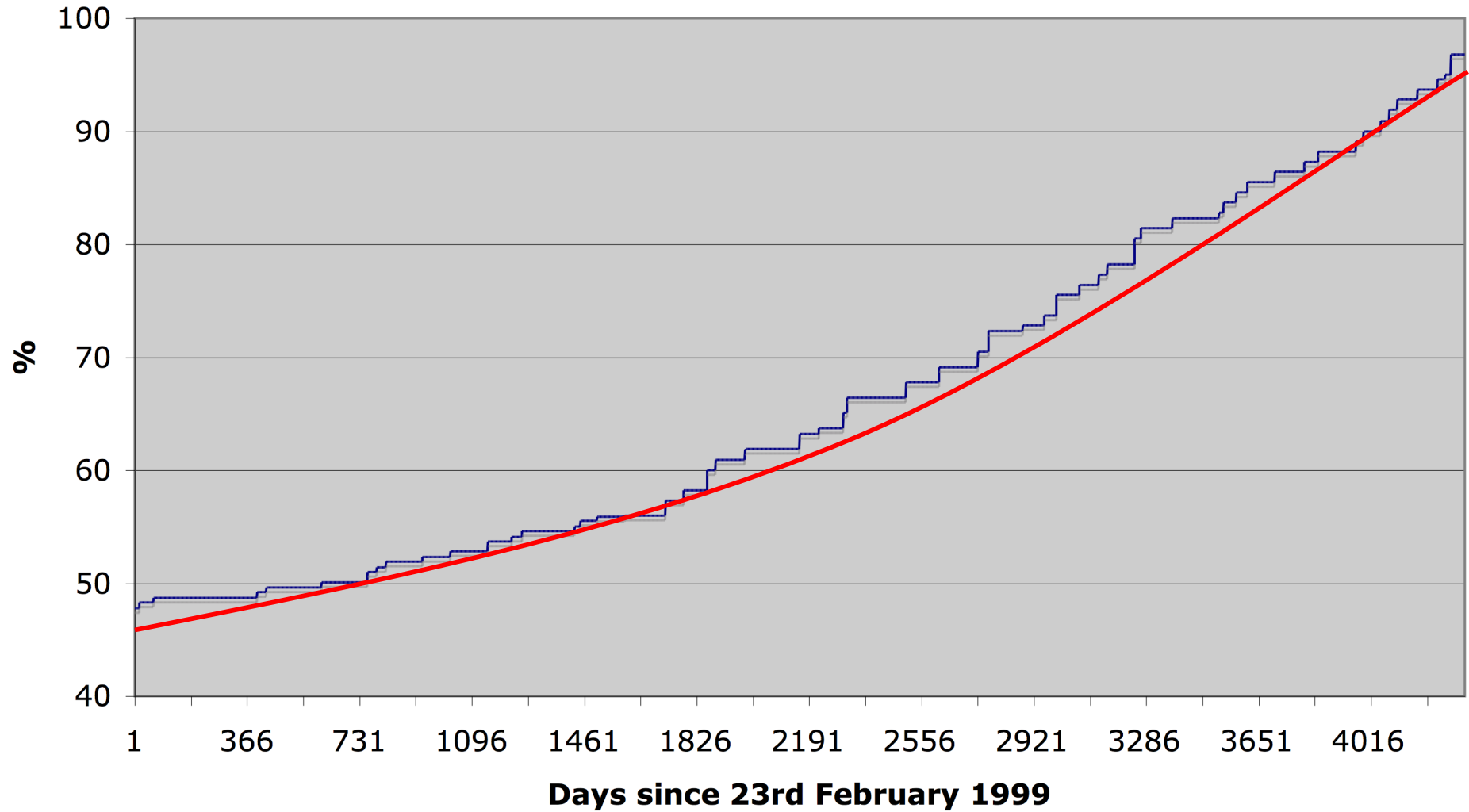


— Total ASNs — Origin-only ASNs — ASN providing Transit & Origin — Transit-only ASNs

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”



January 2011

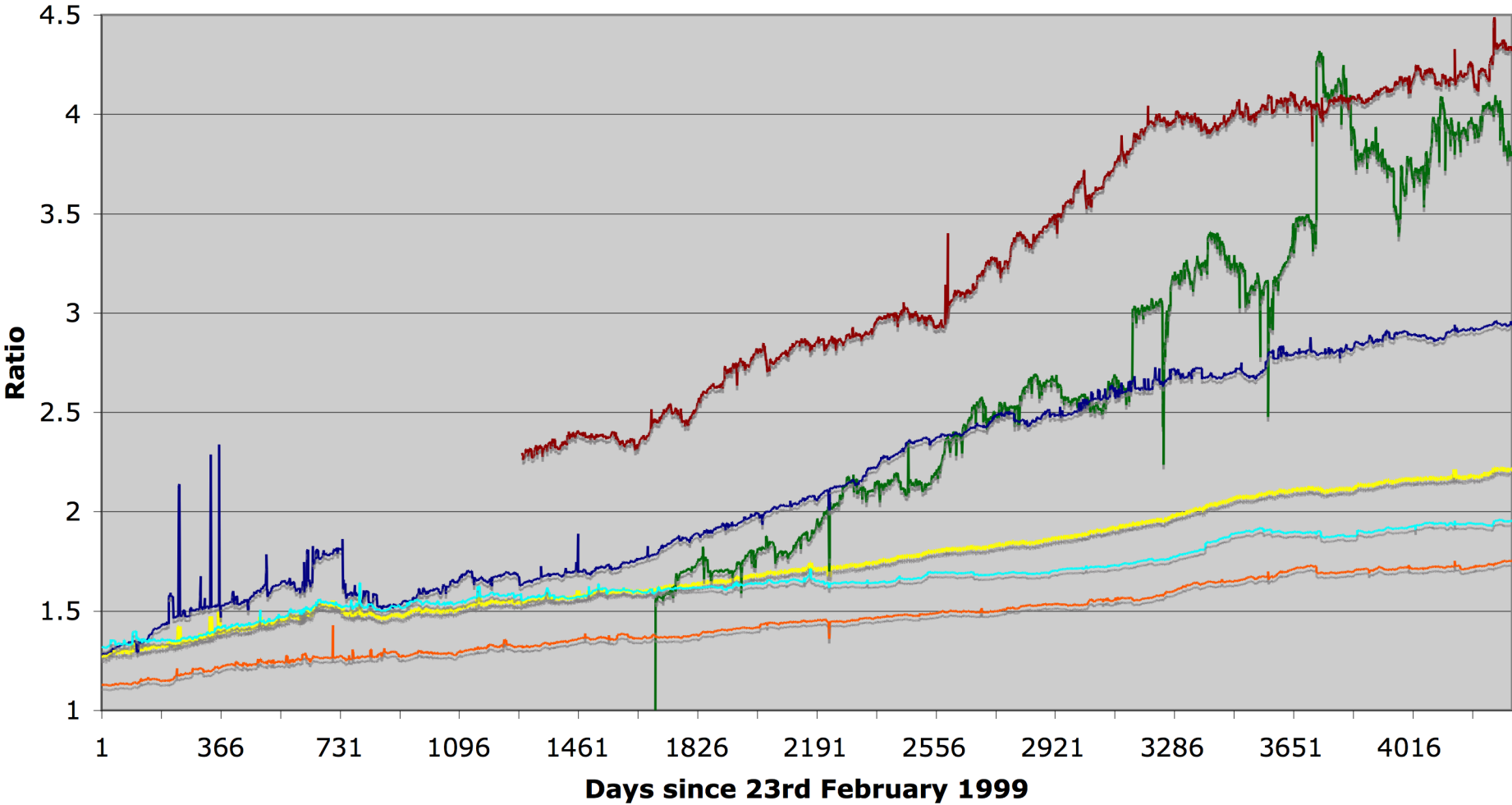
Total Prefixes

- Global BGP Table
 - 341k prefixes
- Europe & Middle East
 - 80k prefixes
- North America
 - 138k prefixes
- Asia & Pacific
 - 84k prefixes
- Africa
 - 7k prefixes
- Latin America & Caribbean
 - 31k prefixes

Deaggregation Factor

- Global Average
 - 2.21
- Europe & Middle East
 - 1.75
- North America
 - 1.95
- Asia & Pacific
 - 2.94
- Africa
 - 3.80
- Latin America & Caribbean
 - 4.33

Deaggregation: RIR Regions vs Global



Global AfriNIC APNIC ARIN LACNIC RIPE

Asia Pacific Aggregation Savings Summary

ASN	No of Nets	Savings	Description
7545	1564	1485	TPG Internet Pty Ltd
4766	1909	1388	Korea Telecom (KIX)
17974	1403	1375	PT TELEKOMUNIKASI INDONESIA
4755	1396	1237	TATA Communications formerly
24560	1093	912	Bharti Airtel Ltd., Telemedia
17488	949	846	Hathway IP Over Cable Interne
9829	861	814	BSNL National Internet Backbo
18101	916	775	Reliance Infocom Ltd Internet
4808	1014	727	CNCGROUP IP network: China169
9498	739	684	BHARTI Airtel Ltd.
4780	756	681	Digital United Inc.
7552	630	621	Vietel Corporation
17676	645	577	Softbank BB Corp.
9583	1042	553	Sify Limited
9443	543	469	Primus Telecommunications
17803	573	432	BSES TeleCom Limited
4134	814	382	CHINANET-BACKBONE
17908	441	381	Tata Communications
9808	387	374	Guangdong Mobile Communicatio
4802	567	366	iiNet 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 17 January 2011 06:11 (UTC+1000)

50 Most active ASes for the past 7 days

RANK	ASN	UPDs	%	Prefixes	UPDs/Prefix	AS NAME
1	18025	25200	1.95%	36	700.00	ACE-1-WIFI-AS-AP Ace-1 Wifi Network
2	32528	19110	1.48%	8	2388.75	ABBOTT Abbot Labs
3	33475	17776	1.37%	215	82.68	RSN-1 - RockSolid Network, Inc.
4	14420	17316	1.34%	603	28.72	CORPORACION NACIONAL DE TELECOMUNICACIONES - CNT EP
5	17974	13777	1.06%	1426	9.66	TELKOMNET-AS2-AP PT Telekomunikasi Indonesia
6	35931	13356	1.03%	6	2226.00	ARCHIPELAGO - ARCHIPELAGO HOLDINGS INC
7	4761	13025	1.01%	5107	2.55	INDOSAT-INP-AP INDOSAT Internet Network Provider
8	24923	11846	0.91%	9	1316.22	SETTC South-East Transtelecom Joint Stock Co.
9	9829	10627	0.82%	861	12.34	BSNL-NIB National Internet Backbone
10	45194	10522	0.81%	64	164.41	SIPL-AS Syscon Infoway Pvt. Ltd., Internet Service Provider, India
11	8151	10391	0.80%	1398	7.43	Uninet S.A. de C.V.
12	10113	10144	0.78%	198	51.23	DATAFAST-AP DATAFAST TELECOMMUNICATIONS LTD
13	45474	10071	0.78%	49	205.53	NEXUSGUARD-AS-AP Tower 1 Millennium City 1
14	24554	9847	0.76%	114	86.38	FIVE-NET-AS-IN Fivenetwork Solution India Pvt Ltd Internet
15	5800	8987	0.69%	233	38.57	DNIC-ASBLK-05800-06055 - DoD Network Information Center
16	16322	8648	0.67%	72	120.11	PARSONLINE PARSONLINE Autonomous System
17	17803	8407	0.65%	574	14.65	BSES-AS-AP BSES TeleCom Limited
18	11492	7864	0.61%	1285	6.12	CABLEONE - CABLE ONE, INC.
19	2386	7831	0.60%	1301	6.02	INS-AS - AT&T Data Communications Services
20	9238	6916	0.53%	79	87.54	TATA-AS TATA ISP
21	9498	6823	0.53%	747	9.13	BBIL-AP BHARTI Airtel Ltd.
22	7552	6801	0.53%	634	10.73	VIETEL-AS-AP Viettel Corporation
23	28573	6764	0.52%	1249	5.42	NET Servicos de Comunicacao S.A.
24	45595	6654	0.51%	445	14.95	PKTELECOM-AS-PK Pakistan Telecom Company Limited

50 Most active Prefixes for the past 7 days

RANK	PREFIX	UPDs	%	Origin AS -- AS NAME
1	213.129.96.0/19	11846	0.86%	24923 -- SETTC South-East Transtelecom Joint Stock Co.
2	180.233.173.0/24	10045	0.73%	45474 -- NEXUSGUARD-AS-AP Tower 1 Millennium City 1
3	202.182.78.0/23	9554	0.69%	10113 -- DATAFAST-AP DATAFAST TELECOMMUNICATIONS LTD
4	130.36.34.0/24	9550	0.69%	32528 -- ABBOTT Abbot Labs
5	130.36.35.0/24	9548	0.69%	32528 -- ABBOTT Abbot Labs
6	63.211.68.0/22	8699	0.63%	35931 -- ARCHIPELAGO - ARCHIPELAGO HOLDINGS INC
7	27.123.248.0/22	5066	0.37%	18025 -- ACE-1-WIFI-AS-AP Ace-1 Wifi Network
8	182.54.140.0/22	5053	0.37%	18025 -- ACE-1-WIFI-AS-AP Ace-1 Wifi Network
9	182.54.148.0/22	5052	0.37%	18025 -- ACE-1-WIFI-AS-AP Ace-1 Wifi Network
10	189.1.173.0/24	5006	0.36%	28666 -- HOSTLOCATION LTDA
11	101.78.24.0/22	4980	0.36%	18025 -- ACE-1-WIFI-AS-AP Ace-1 Wifi Network
12	101.78.20.0/22	4979	0.36%	18025 -- ACE-1-WIFI-AS-AP Ace-1 Wifi Network
13	202.92.235.0/24	4923	0.36%	9498 -- BBIL-AP BHARTI Airtel Ltd.
14	216.126.136.0/22	4919	0.36%	6316 -- AS-PAETEC-NET - PaeTec Communications, Inc.
15	198.140.43.0/24	4554	0.33%	35931 -- ARCHIPELAGO - ARCHIPELAGO HOLDINGS INC
16	68.65.152.0/22	3579	0.26%	11915 -- TELWEST-NETWORK-SVCS-STATIC - TEL WEST COMMUNICATIONS LLC
17	206.184.16.0/24	3333	0.24%	174 -- COGENT Cogent/PSI
18	202.153.174.0/24	3249	0.24%	17408 -- ABOVE-AS-AP AboveNet Communications Taiwan
19	91.197.95.0/24	2993	0.22%	43534 -- CREDITCALL CreditCall Ltd
20	170.141.231.0/24	2956	0.21%	4454 -- TNET-AS - State of Tennessee
21	189.85.51.0/24	2542	0.18%	28175 --
22	212.215.128.0/18	2397	0.17%	25019 -- SAUDINETSTC-AS Autonomus System Number for SaudiNet 8866 -- BTC-AS Bulgarian Telecommunication Company Plc.
23	213.108.216.0/21	2319	0.17%	49776 -- GORSET-AS Gorodskaya Set Ltd.
24	95.32.128.0/18	1998	0.14%	21017 -- VSI-AS VSI AS
25	95.32.192.0/18	1909	0.14%	21017 -- VSI-AS VSI AS
26	202.83.96.0/20	1890	0.14%	18106 -- VIEWQWEST-SG-AP Viewqwest Pte Ltd 4761 -- INDOSAT-INP-AP INDOSAT Internet Network Provider 9255 -- CONNECTPLUS-AS Singapore Telecom
27	199.154.73.0/24	1814	0.13%	4858 -- DMCLADNET - D-D Network Information Center



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?