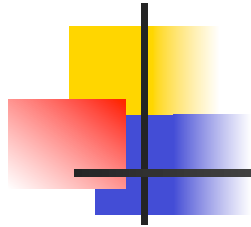


# Internet IPv4 Routing Table Analysis Update



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Philip Smith  
(presented by Frank Habicht)  
AfNOG 2014  
3<sup>rd</sup> June 2014  
Djibouti



# 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 1 June 2014

BGP routing table entries examined:	496629
Prefixes after maximum aggregation:	194234
Deaggregation factor:	2.56
Unique aggregates announced to Internet:	245187
Total ASes present in the Internet Routing Table:	46946
Prefixes per ASN:	10.58
Origin-only ASes present in the Internet Routing Table:	35825
Origin ASes announcing only one prefix:	16321
Transit ASes present in the Internet Routing Table:	6104
Transit-only ASes present in the Internet Routing Table:	172
Average AS path length visible in the Internet Routing Table:	4.6
Max AS path length visible:	53
Max AS path prepend of ASN ( 50404)	51
Prefixes from unregistered ASNs in the Routing Table:	1763
Unregistered ASNs in the Routing Table:	457
Number of 32-bit ASNs allocated by the RIRs:	6753
Number of 32-bit ASNs visible in the Routing Table:	5017
Prefixes from 32-bit ASNs in the Routing Table:	17062
Number of bogon 32-bit ASNs visible in the Routing Table:	183
Special use prefixes present in the Routing Table:	13
Prefixes being announced from unallocated address space:	430
Number of addresses announced to Internet:	2692090112
Equivalent to 160 /8s, 118 /16s and 9 /24s	
Percentage of available address space announced:	72.7
Percentage of allocated address space announced:	72.7
Percentage of available address space allocated:	100.0
Percentage of address space in use by end-sites:	96.5
Total number of prefixes smaller than registry allocations:	172240

## AfriNIC Region

Prefixes being announced by AfriNIC Region ASes:	12007
Total AfriNIC prefixes after maximum aggregation:	2659
AfriNIC Deaggregation factor:	4.52
Prefixes being announced from the AfriNIC address blocks:	12715
Unique aggregates announced from the AfriNIC address blocks:	4382
AfriNIC Region origin ASes present in the Internet Routing Table:	716
AfriNIC Prefixes per ASN:	17.76
AfriNIC Region origin ASes announcing only one prefix:	198
AfriNIC Region transit ASes present in the Internet Routing Table:	153
Average AfriNIC Region AS path length visible:	4.7
Max AfriNIC Region AS path length visible:	25
Number of AfriNIC region 32-bit ASNs visible in the Routing Table:	32
Number of AfriNIC addresses announced to Internet:	56223744
Equivalent to 3 /8s, 89 /16s and 232 /24s	
Percentage of available AfriNIC address space announced:	55.9

AfriNIC AS Blocks           36864-37887, 327680-328703 & ERX transfers

AfriNIC Address Blocks   41/8, 102/8, 105/8, 154/8, 196/7

## Global per AS prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
28573	3410	1837	98	NET Serviços de Comunicação
6389	2959	3688	53	BellSouth.net Inc.
4766	2947	11591	922	Korea Telecom
10620	2853	461	202	Telmex Colombia S.A.
17974	2792	899	72	PT Telekomunikasi Indonesia
22773	2438	2937	133	Cox Communications Inc.
7545	2228	320	117	TPG Telecom Limited
1785	2208	701	137	PaeTec Communications, Inc.
18566	2047	379	178	MegaPath Corporation
18881	1985	972	21	Global Village Telecom
4755	1853	396	199	TATA Communications formerly
7303	1755	1174	229	Telecom Argentina S.A.
34984	1709	265	271	TELLCOM ILETISIM HIZMETLERI A
20115	1707	1691	567	Charter Communications
9829	1649	1307	32	National Internet Backbone
4323	1628	1073	411	tw telecom holdings, inc.
8402	1556	544	16	OJSC "Vimpelcom"
701	1473	11174	747	MCI Communications Services,
30036	1407	306	549	Mediacom Communications Corp
8151	1404	2933	406	Uninet S.A. de C.V.

AfriNIC APNIC ARIN LACNIC RIPE NCC

## Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:16	/9:12	/10:30	/11:91	/12:258
/13:486	/14:965	/15:1700	/16:12972	/17:6882	/18:11705
/19:24377	/20:34394	/21:36777	/22:52908	/23:46310	/24:262908
/25:774	/26:934	/27:389	/28:13	/29:20	/30:7
/31:1	/32:12				

May 2014 ↑

May 2013 ↓

## Number of prefixes announced by prefix length

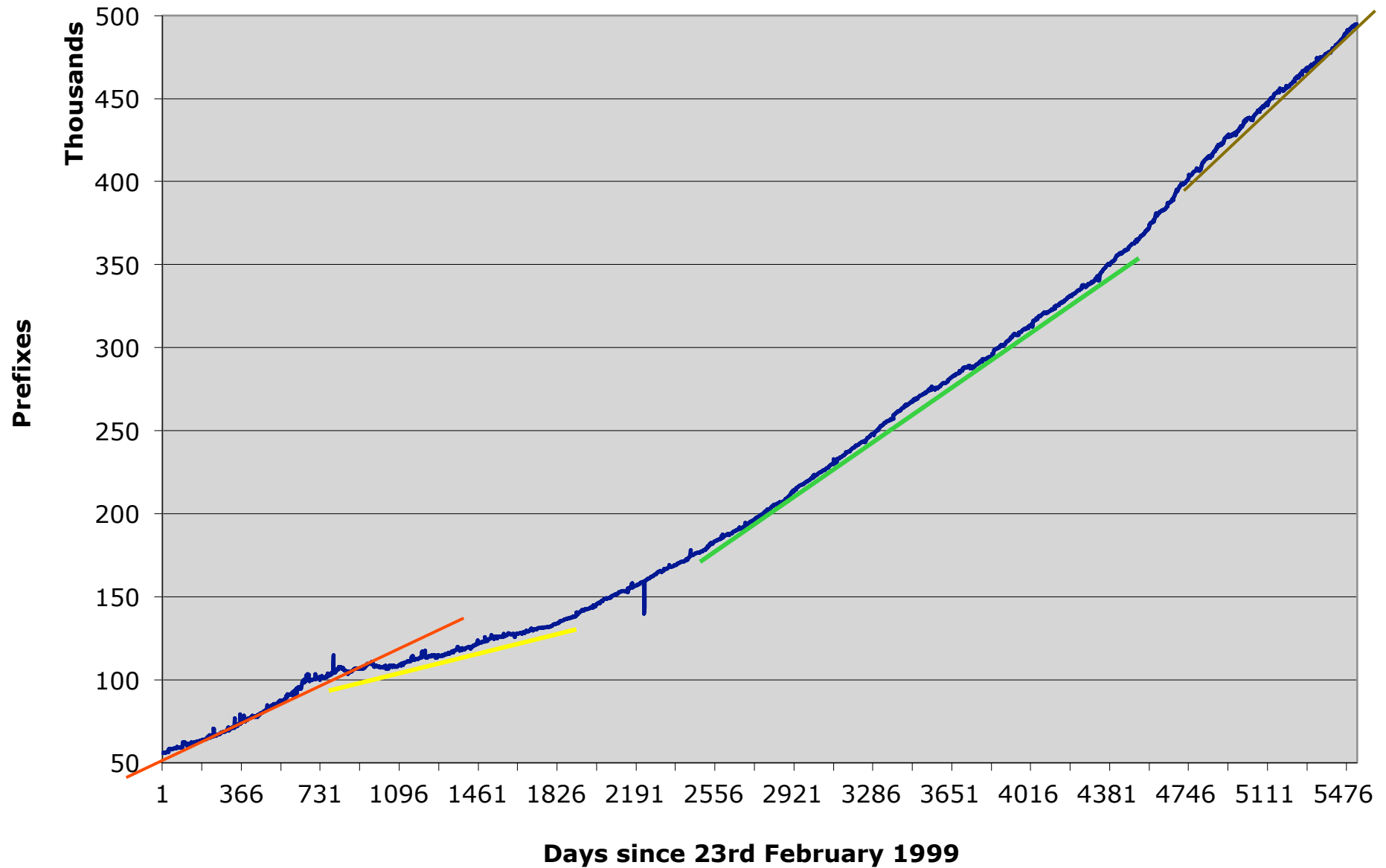
/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:16	/9:13	/10:30	/11:88	/12:248
/13:485	/14:889	/15:1567	/16:12685	/17:6615	/18:11166
/19:22108	/20:31997	/21:34164	/22:47342	/23:42232	/24:239029
/25:1308	/26:1689	/27:867	/28:45	/29:67	/30:18
/31:0	/32:19				

## Prefixes Smaller than Registry Allocations

ASN	No of nets	Total ann.	Description
18566	2002	2047	MegaPath Corporation
6389	1692	2959	BellSouth.net Inc.
22773	1683	2438	Cox Communications Inc.
30036	1245	1407	Mediacom Communications Corp
8402	1230	1556	OJSC "Vimpelcom"
11492	1175	1215	CABLE ONE, INC.
1785	1166	2208	PaeTec Communications, Inc.
36998	1080	1114	Sudanese Mobile Telephone (ZA
6983	1042	1325	ITC^Deltacom
34984	1038	1709	TELLCOM ILETISIM HIZMETLERI A
22561	1004	1306	CenturyTel Internet Holdings,
10620	999	2853	Telmex Colombia S.A.
31148	962	1018	Freenet Ltd.
28573	859	3410	NET Serviços de Comunicação
7011	896	1129	Frontier Communications of Am
13188	857	1049	TOV "Bank-Inform"
13977	750	775	FAIRPOINT COMMUNICATIONS, INC
4766	726	2947	Korea Telecom
27947	707	875	Telconet S.A
6849	641	824	JSC "Ukrtelecom"

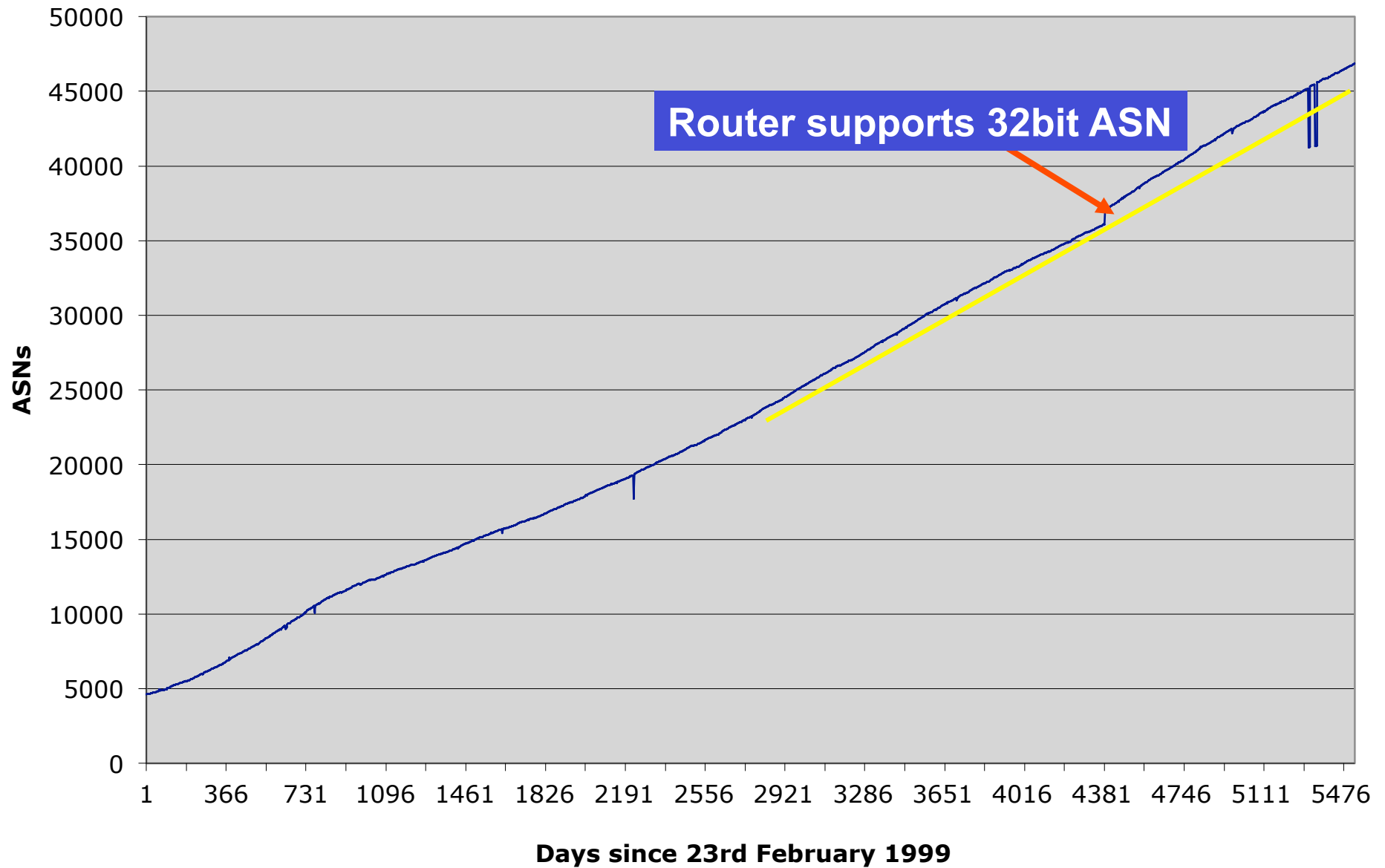
AfriNIC APNIC ARIN LACNIC RIPE NCC

## BGP Routing Table

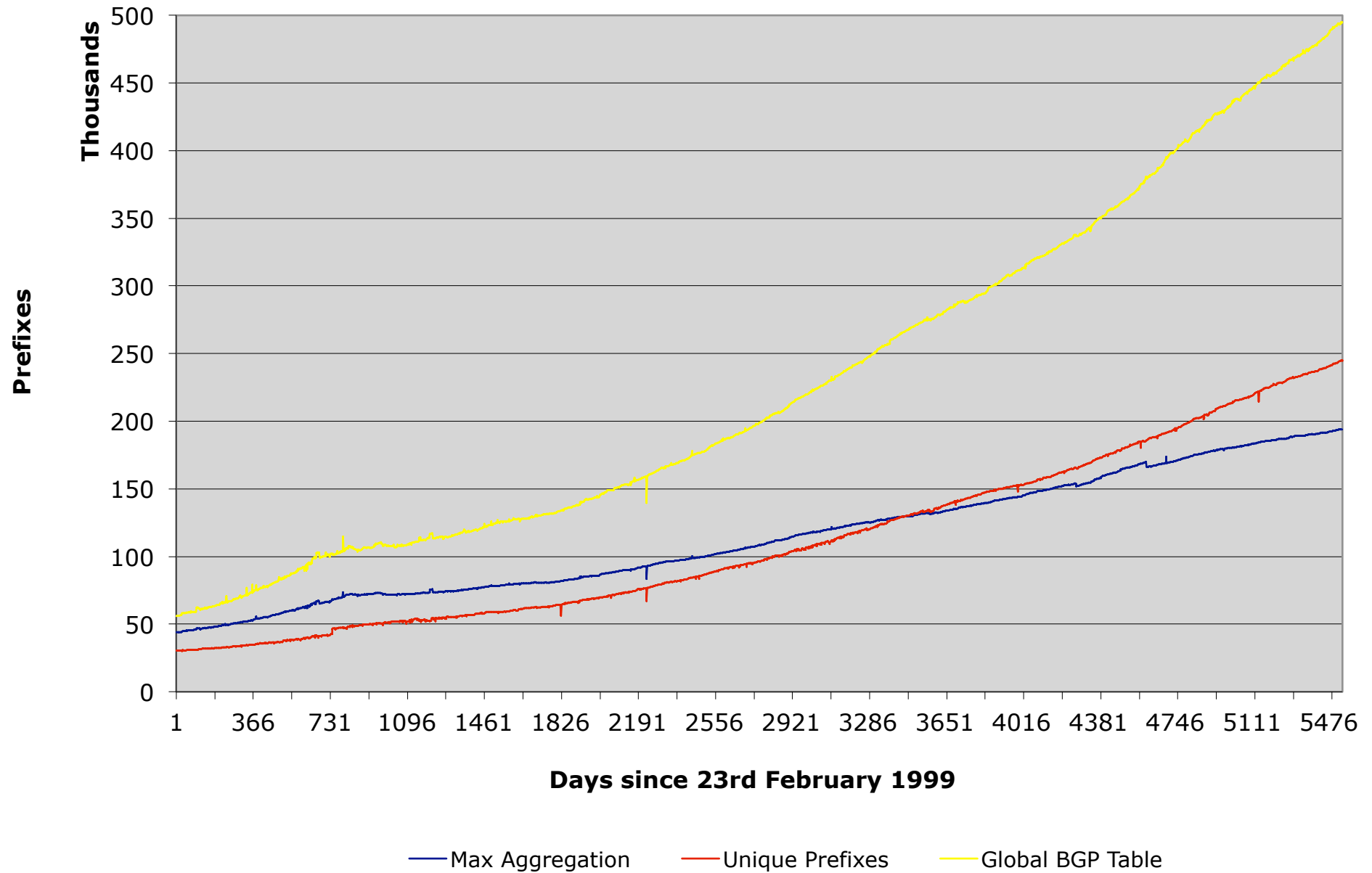




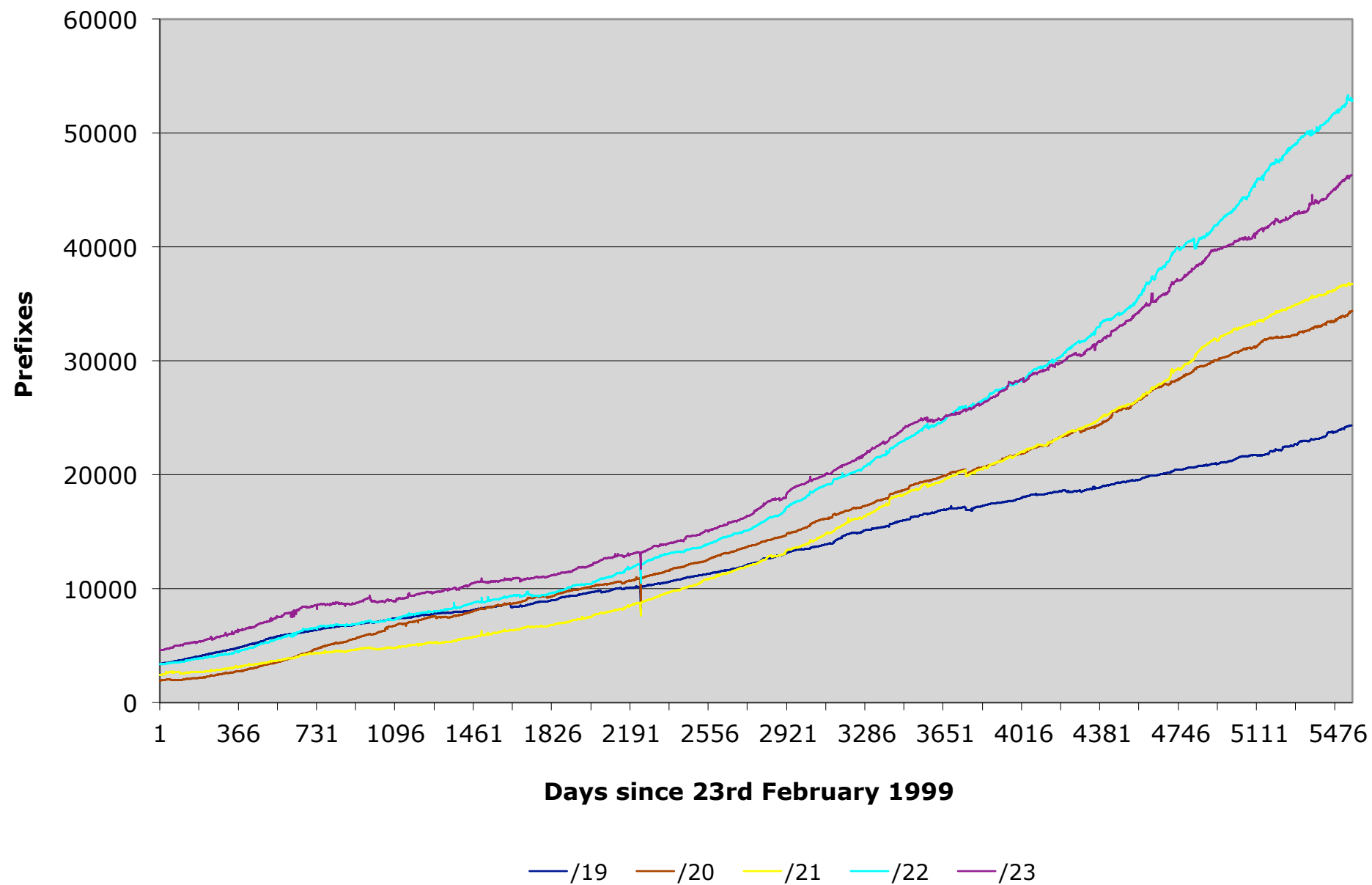
## AS Growth



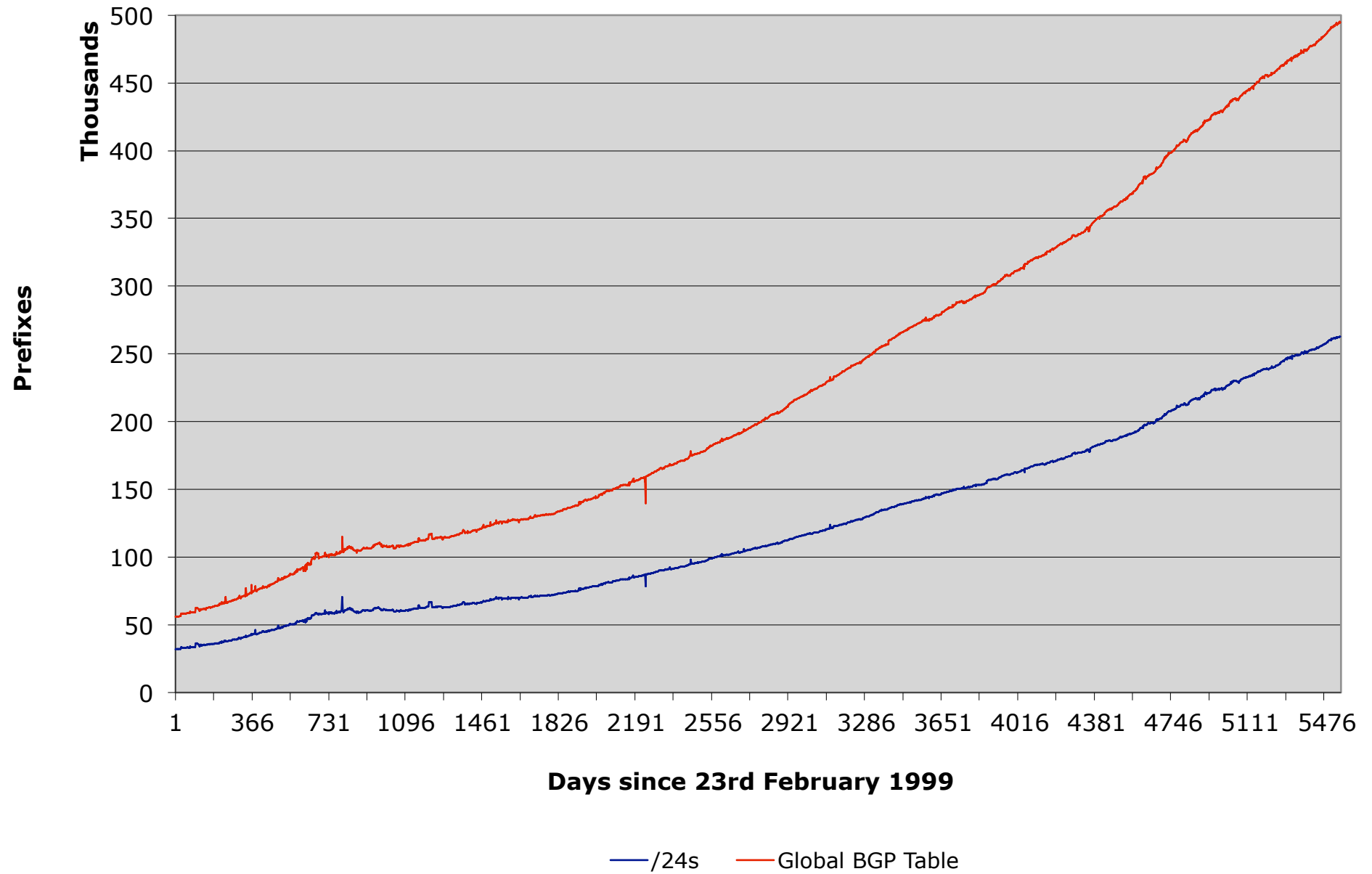
## Max Aggregation vs Unique Prefixes



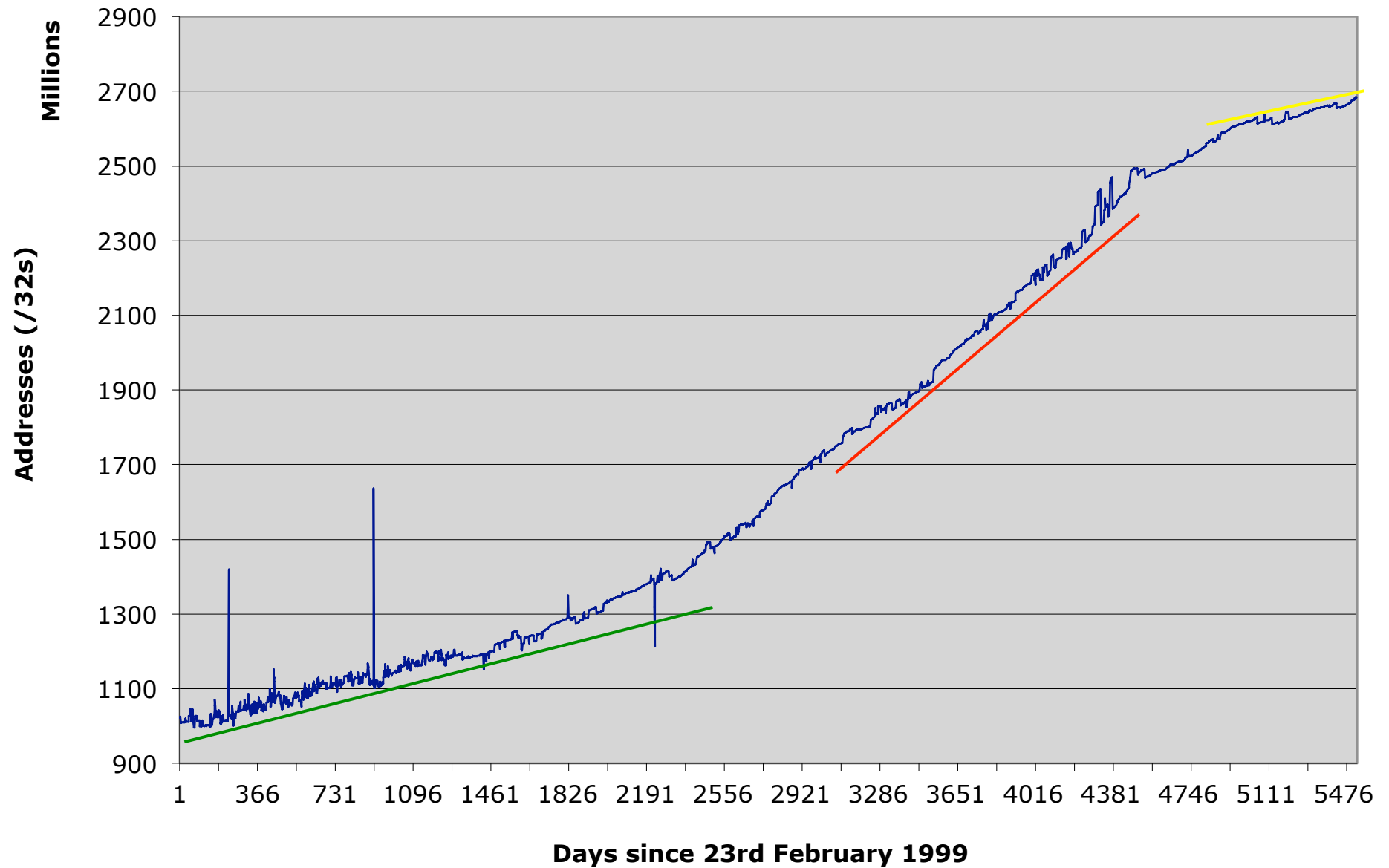
## Prefix sizes announced



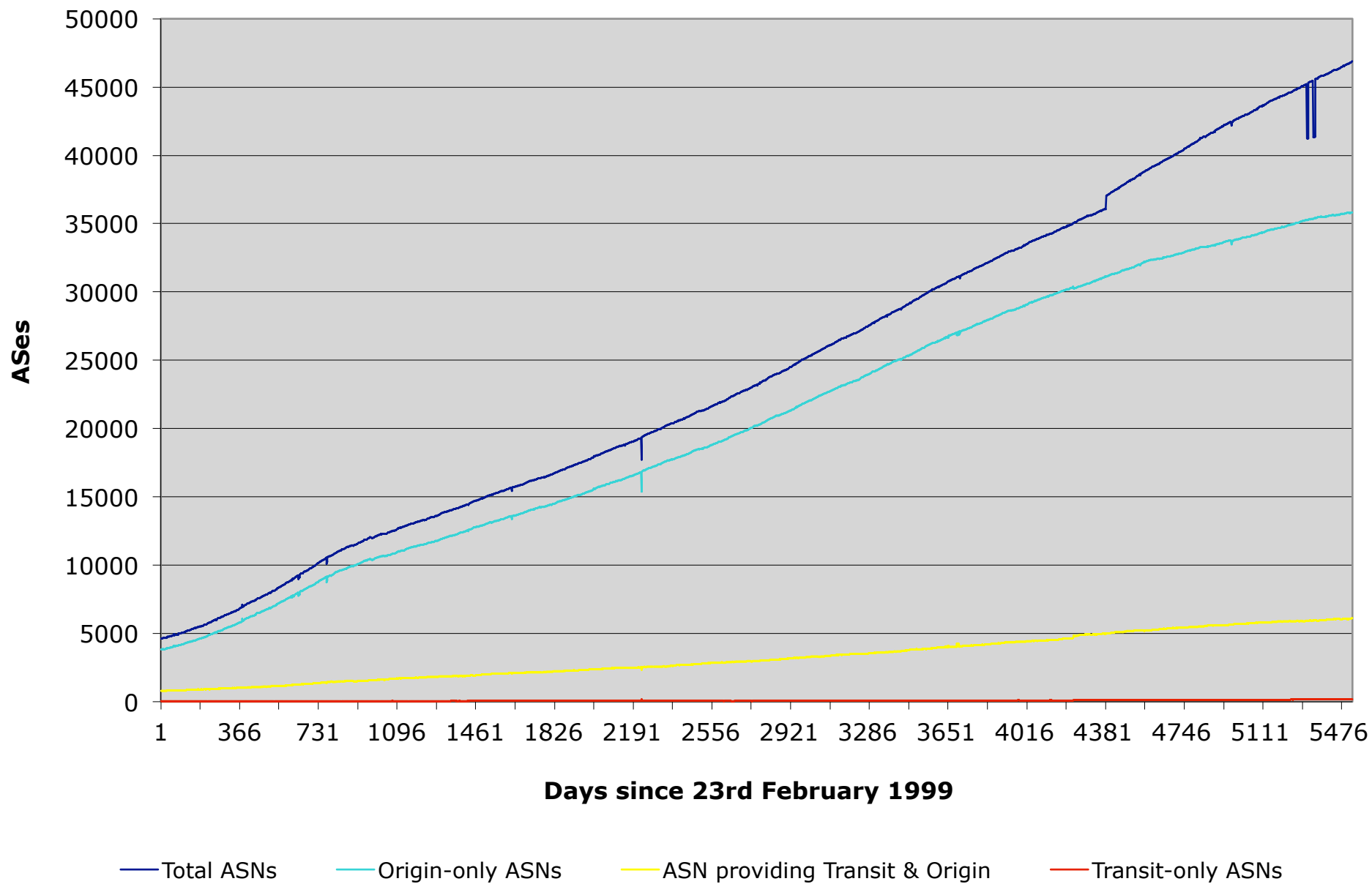
## /24s announced



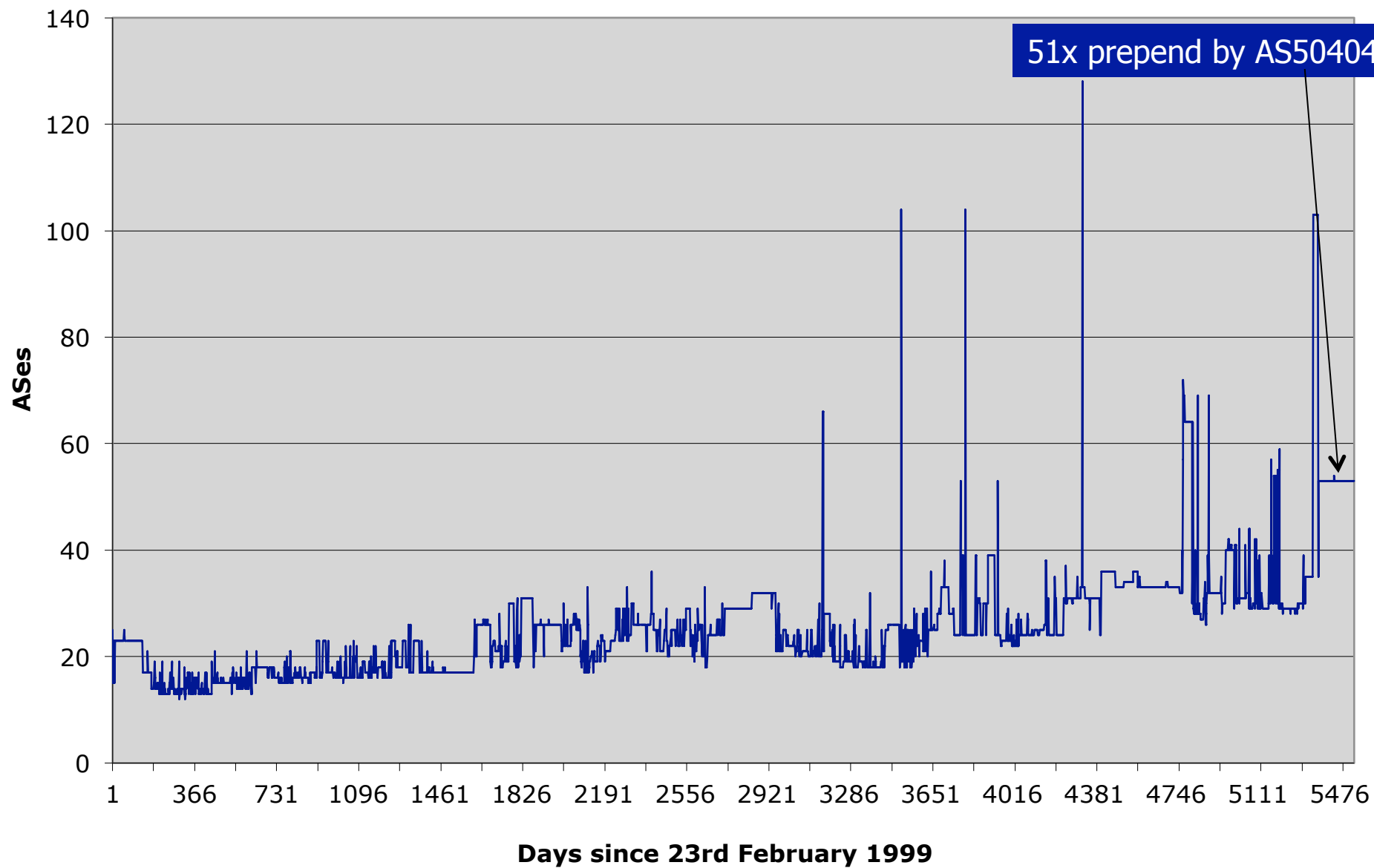
## Address Space announced



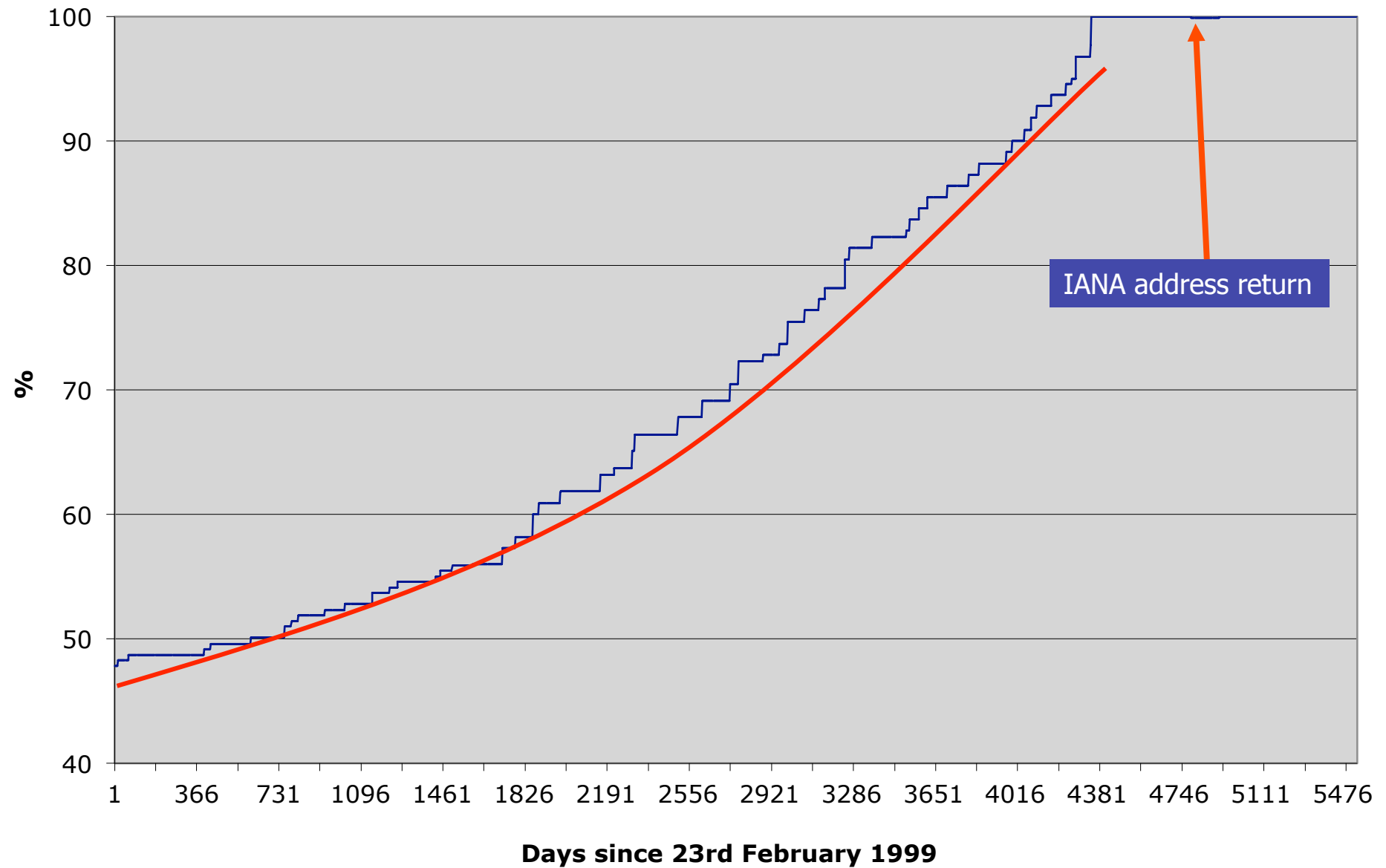
## AS Announcements



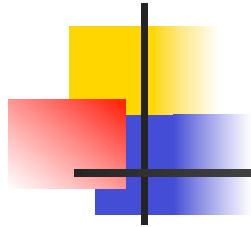
## Maximum AS Path Length



## Growth in IPv4 Address Space Allocations



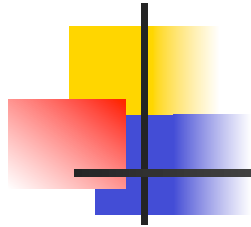




# Looking at Deaggregation

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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”



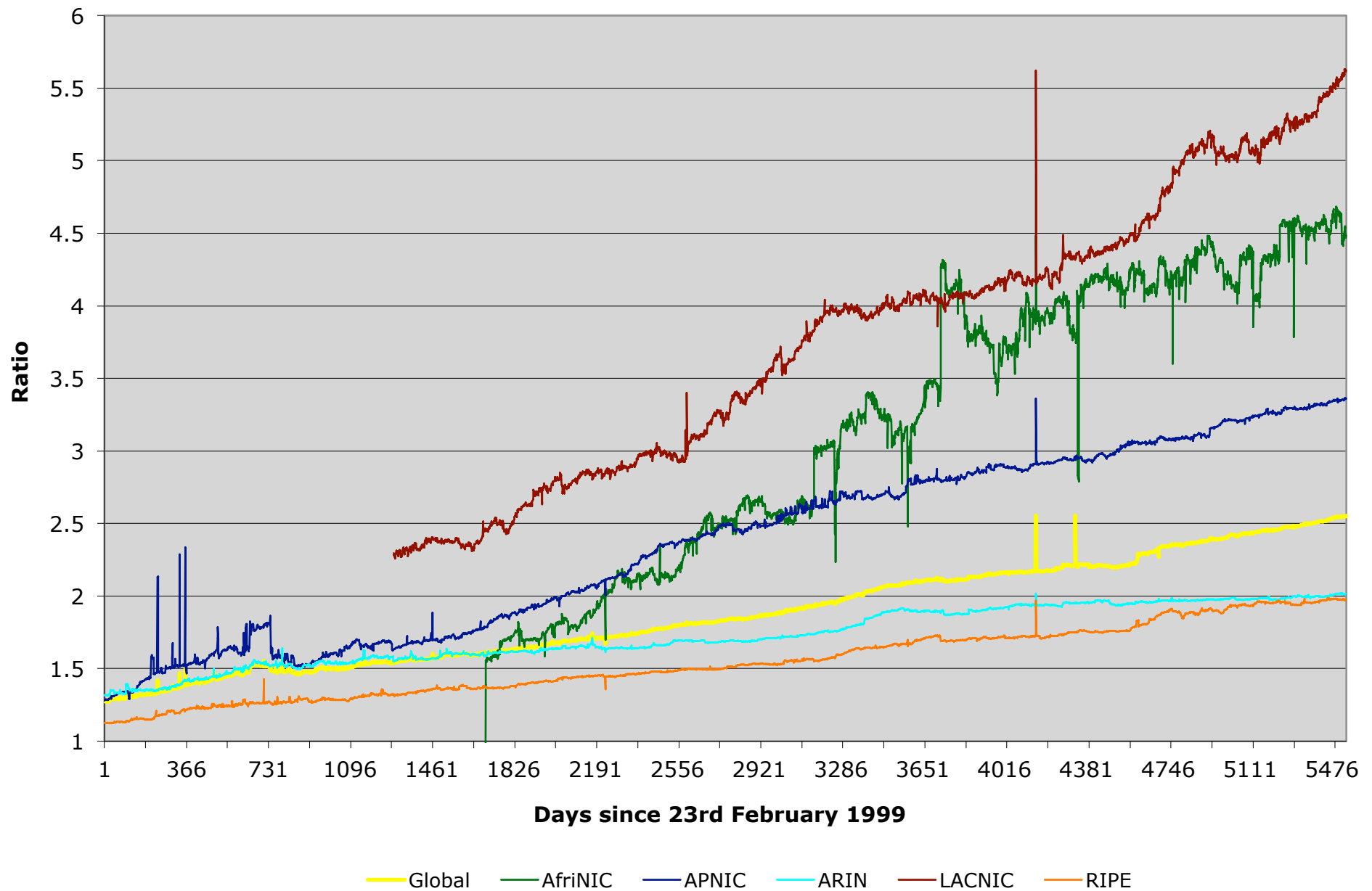
## Total Prefixes

- Global BGP Table
  - 495k prefixes
- Europe & Middle East
  - 123k prefixes
- North America
  - 168k prefixes
- Asia & Pacific
  - 118k prefixes
- Africa
  - 12k prefixes
- Latin America & Caribbean
  - 56k prefixes

## Deaggregation Factor

- Global Average
  - 2.55
- Europe & Middle East
  - 1.97
- North America
  - 2.02
- Asia & Pacific
  - 3.36
- Africa
  - 4.48
- Latin America & Caribbean
  - 5.62

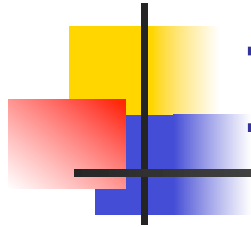
## Deaggregation: RIR Regions vs Global



## Africa Aggregation Savings Summary

ASN	No of Nets	Savings	Description
36998	1114	1108	Sudanese Mobile Telephone (ZA
24863	961	935	Link Egypt (Link.NET)
6713	615	583	Office National des Postes et
8452	587	574	Telecom Egypt
24835	304	295	Vodafone Data
36992	300	276	ETISALAT MISR
37054	248	242	Data Telecom Service
29571	225	209	Cote d'Ivoire Telecom
15706	184	178	Sudatel (Sudan Telecom Co. Lt
29975	192	171	Vodacom
36947	142	129	Telecom Algeria
12258	176	109	MWEB CONNECT (PROPRIETARY) LI
37127	100	93	Visafone Communications Limit
37027	125	90	Simbanet (T) Limited
37061	95	90	One Communications Ltd
3067	100	89	Infovan (Pty) Ltd
37693	102	83	Tunisiana SA
23889	88	76	Asia Pacific Network Informat
36935	92	75	Vodafone Data
12455	78	73	Kenyan Post & Telecommunicati

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



# Importance of Aggregation

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- Size of routing table
  - Memory is no longer a problem
  - Routers routinely carry over 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 20 May 2014 06:28 (UTC+1000)

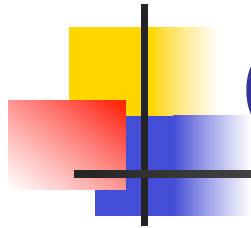
## 50 Most active ASes for the past 7 days

RANK	ASN	UPDs	%	Prefixes	UPDs/Prefix	AS NAME
1	9829	96226	2.77%	1649	58.35	BSNL-NIB National Internet Backbone,IN
2	45514	90625	2.61%	306	296.16	TELEMEDIA-SMB-AS-AP Bharti Airtel Ltd., TELEMEDIA Services, for SMB customers,IN
3	4775	51843	1.49%	127	408.21	GLOBE-TELECOM-AS Globe Telecoms,PH
4	8402	44854	1.29%	1731	25.91	CORBINA-AS OJSC "Vimpelcom",RU
5	28573	43290	1.24%	3951	10.96	NET Serviços de Comunicação S.A.,BR
6	23752	24958	0.72%	140	178.27	NPTELECOM-NP-AS Nepal Telecommunications Corporation, Internet Services,NP
7	27738	21374	0.61%	576	37.11	Ecuadortelecom S.A.,EC
8	10620	19857	0.57%	2860	6.94	Telmex Colombia S.A.,CO
9	41691	19577	0.56%	35	559.34	SUMTEL-AS-RIPE Summa Telecom LLC,RU
10	3816	19337	0.56%	831	23.27	COLOMBIA TELECOMUNICACIONES S.A. ESP,CO
11	31148	18910	0.54%	1018	18.58	FREENET-AS Freenet Ltd.,UA
12	13238	17599	0.51%	284	61.97	YANDEX Yandex LLC,RU
13	35567	16797	0.48%	150	111.98	DASTO-BOSNIA-AS DASTO semtel d.o.o.,BA
14	25184	15924	0.46%	133	119.73	AFRANET AFRANET Co. Tehran, Iran,IR
15	14259	15233	0.44%	268	56.84	Gtd Internet S.A.,CL
16	35819	13367	0.38%	546	24.48	MOBILY-AS Etihad Etisalat Company (Mobily),SA
17	17974	12632	0.36%	2799	4.51	TELKOMNET-AS2-AP PT Telekomunikasi Indonesia,ID
18	4766	12190	0.35%	2947	4.14	KIXS-AS-KR Korea Telecom,KR
19	3475	12117	0.35%	96	126.22	DNIC-AS-03475 - Navy Network Information Center (NNIC),US
20	7552	12041	0.35%	1252	9.62	VIETEL-AS-AP Viettel Corporation,VN
21	6389	11862	0.34%	2965	4.00	BELLSOUTH-NET-BLK - BellSouth.net Inc.,US
22	13489	11424	0.33%	476	24.00	EPM Telecomunicaciones S.A. E.S.P.,CO
23	52879	11223	0.32%	9	1247.00	ABM INFORMATICA E TELECOM,BR

50 Most active Prefixes for the past 7 days

RANK	PREFIX	UPDs	%	Origin AS -- AS NAME
1	89.221.206.0/24	19480	0.53%	41691 -- SUMTEL-AS-RIPE Summa Telecom LLC,RU
2	202.70.88.0/21	11596	0.32%	23752 -- NPTELECOM-NP-AS Nepal Telecommunications Corporation, Internet Services,NP
3	202.70.64.0/21	11287	0.31%	23752 -- NPTELECOM-NP-AS Nepal Telecommunications Corporation, Internet Services,NP
4	78.109.192.0/20	9653	0.26%	25184 -- AFRANET AFRANET Co. Tehran, Iran,IR
5	192.58.232.0/24	9581	0.26%	6629 -- NOAA-AS - NOAA,US
6	120.28.62.0/24	7825	0.21%	4775 -- GLOBE-TELECOM-AS Globe Telecoms,PH
7	205.247.12.0/24	7656	0.21%	6459 -- TRANSBEAM - I-2000, Inc.,US
8	222.127.0.0/24	7343	0.20%	4775 -- GLOBE-TELECOM-AS Globe Telecoms,PH
9	115.170.128.0/17	7229	0.20%	4847 -- CNIX-AP China Networks Inter-Exchange,CN
10	206.152.15.0/24	6984	0.19%	54465 -- QPM-AS-1 - QuickPlay Media Inc.,US
11	42.83.48.0/20	6616	0.18%	18135 -- JPNIC-ASBLOCK-AP JPNIC,JP
13	87.250.97.0/24	3811	0.10%	35567 -- DASTO-BOSNIA-AS DASTO semtel d.o.o.,BA
15	5.160.10.0/24	3478	0.10%	60345 -- NBITI-AS Nahjol Balagheh International Research Institution,IR
16	78.158.184.0/24	3168	0.09%	60345 -- NBITI-AS Nahjol Balagheh International Research Institution,IR
17	121.52.144.0/24	2973	0.08%	17557 -- PKTELECOM-AS-PK Pakistan Telecommunication Company Limited,PK 45773 -- HECPERN-AS-PK PERN AS Content Servie Provider, Islamabad, Pakistan,PK
18	84.205.66.0/24	2634	0.07%	12654 -- RIPE-NCC-RIS-AS Reseaux IP Europeens Network Coordination Centre (RIPE NCC),EU
19	87.250.102.0/24	2590	0.07%	35567 -- DASTO-BOSNIA-AS DASTO semtel d.o.o.,BA
20	87.250.117.0/24	2559	0.07%	35567 -- DASTO-BOSNIA-AS DASTO semtel d.o.o.,BA
21	185.27.8.0/22	2531	0.07%	42525 -- GlobalConnect a/s,DK
22	176.116.240.0/20	2233	0.06%	16321 -- AICONET-AS Aiconet Ltd.,RU
23	91.196.252.0/22	2229	0.06%	16321 -- AICONET-AS Aiconet Ltd.,RU
24	84.204.225.0/24	2229	0.06%	16321 -- AICONET-AS Aiconet Ltd.,RU
25	205.94.160.0/19	1891	0.05%	3475 -- DNIC-AS-03475 - Navy Network Information Center (NNIC),US
26	178.249.103.0/24	1889	0.05%	11054 -- LIVEPERSON - LivePerson, Inc.,US
27	41.200.0.0/15	1877	0.05%	36947 -- ALGTEL-AS,DZ
28	64.16.216.0/22	1858	0.05%	21840 -- SAGONET-TPA - Sago Networks,US
29	207.150.172.0/22	1856	0.05%	21840 -- SAGONET-TPA - Sago Networks,US
30	190.153.168.0/24	1814	0.05%	14259 -- Gtd Internet S A CI





# 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?