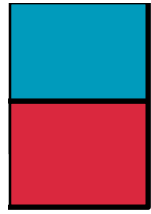# Internet Routing Table Analysis Update

Philip Smith

pfs@cisco.com

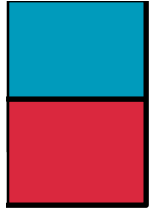**APOPS**

APRICOT 2002, Bangkok, March 2002

Internet Routing Table Analysis

- **New:**

   Count unique prefixes

   Prefixes after maximum aggregation

   IP addresses in use

   Origin only ASes

   Transit only ASes

- **Full Stats on APNIC web page**

   http://www.apnic.net/stats/bgp

New Features

- ## Unique Prefixes

    Eliminate all subnets of prefixes appearing in routing table

    e.g. 158.43.0.0/16 is announced, all subnets are dropped/ignored

    Represents the smallest the Internet Routing Table can be without losing address space

    If used can lead to suboptimal routing, or routing which relies on more detailed routing information existing outside of the viewing AS
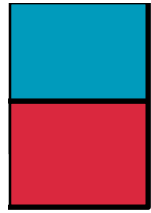
New Features (continued)

- **Prefixes after maximum aggregation**

  Eliminate all subnets of prefixes appearing in routing table and originated by the same AS

  e.g. 158.43.0.0/16 is announced from AS1849, all subnets which also are originated by AS1849 are dropped/ignored

  Represents aggregation effort by the AS (but obviously can not account for traffic engineering)

  Represents the smallest the Internet Routing table can be without losing *any* detailed reachability information

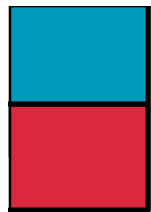# New Features (continued)

- ## IP Addresses in use

  Fixed error in previous analysis which overcounted address space

- ## Origin only ASes

  Counts ASes which only originate prefixes and are not involved in the transit path from this view

- ## Transit only ASes

  Counts Ases which are only in the transit path and are not originating any prefixes from this view

Global summary

```
Routing Report    1 March, 2002

BGP routing table entries examined                            109162
    Prefixes after maximum aggregation                         72088
    Unique aggregates announced to Internet                    51900
Total ASes present in the Internet Routing Table               12652
Origin-only ASes present in the Internet Routing Table         10956
Origin ASes announcing only one prefix                          4794
Transit ASes present in the Internet Routing Table              1696
Transit-only ASes present in the Internet Routing Table           55
Average AS path length visible in the Internet Routing Table     5.4
    Max AS path length visible                                    16
Illegal AS announcements present in the Routing Table              9
Non-routable prefixes present in the Routing Table                 0
Prefixes being announced from the IANA Reserved Address blocks    16
Number of addresses announced to Internet                 1175073960
    Equivalent to 70 /8s, 10 /16s and 52 /24s
    Percentage of available address space announced              31.7
    Percentage of allocated address space announced              60.0
    Percentage of available address space allocated              52.8
Total number of prefixes smaller than registry allocations     72880
```
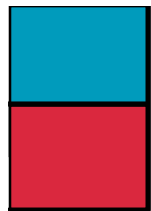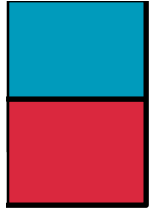
APNIC region summary

```
APNIC region Report     1 March, 2002

Prefixes being announced by APNIC Region ASes                17658
    Total APNIC prefixes after maximum aggregation           10645
Prefixes being announced from the APNIC address blocks       16222
    Unique aggregates announced from the APNIC address blocks  9949
APNIC Region origin ASes present in the Internet Routing Table  1455
APNIC Region origin ASes announcing only one prefix            482
APNIC Region transit ASes present in the Internet Routing Table  252
Average APNIC Region AS path length visible                    5.3
    Max APNIC Region AS path length visible                     15
Number of APNIC addresses announced to Internet           80243520
    Equivalent to 4 /8s, 200 /16s and 107 /24s
    Percentage of available APNIC address space announced     59.3


APNIC AS Blocks         4608 - 4864, 7467 - 7722, 9216 - 10239
                        17408 - 18431, 23552 - 24575
APNIC Address Blocks    61/8, 202/7, 210/7, 218/7 and 220/8
```

ARIN region summary

```
ARIN region Report    1 March, 2002

Prefixes being announced by ARIN Region ASes                73219
    Total ARIN prefixes after maximum aggregation           47359
Prefixes being announced from the ARIN address blocks       51753
    Unique aggregates announced from the ARIN address blocks 16268
ARIN Region origin ASes present in the Internet Routing Table 7491
ARIN Region origin ASes announcing only one prefix          2345
ARIN Region transit ASes present in the Internet Routing Table 767
Average ARIN Region AS path length visible                    5.2
    Max ARIN Region AS path length visible                    16
Number of ARIN addresses announced to Internet          194654788
    Equivalent to 11 /8s, 154 /16s and 50 /24s
    Percentage of available ARIN address space announced    72.5


ARIN AS Blocks            1 - 1876, 1902 - 2042, 2044 - 2046, 2048 - 2106
                          2138 - 2584, 2615 - 2772, 2823 - 2829,
                          2880 - 3153, 3354 - 4607, 4865 - 5119,
                          5632 - 6655, 6912 - 7466, 7723 - 8191,
                          10240 - 12287, 13312 - 15359, 16384 - 17407,
                          18432 - 20479, 21504 - 23551
ARIN Address Blocks       24/8, 63/8, 64/6, 68/8, 199/8, 200/8, 204/6,
                          208/7 and 216/8
```
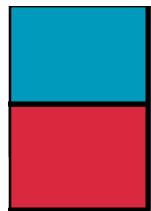
RIPE NCC summary

```
RIPE NCC region Report    1 March, 2002

Prefixes being announced by RIPE Region ASes                      18281
    Total RIPE prefixes after maximum aggregation                 14084
Prefixes being announced from the RIPE address blocks             15010
    Unique aggregates announced from the RIPE address blocks      10012
RIPE Region origin ASes present in the Internet Routing Table      3650
RIPE Region origin ASes announcing only one prefix                 1967
RIPE Region transit ASes present in the Internet Routing Table      661
Average RIPE Region AS path length visible                          5.9
    Max RIPE Region AS path length visible                           15
Number of RIPE addresses announced to Internet                107115936
    Equivalent to 6 /8s, 98 /16s and 117 /24s
    Percentage of available RIPE address space announced           70.9


RIPE AS Blocks           1877 - 1901, 2043, 2047, 2107 - 2136, 2585 - 2614
                         2773 - 2822, 2830 - 2879, 3154 - 3353, 5377 - 5631
                         6656 - 6911, 8192 - 9215, 12288 - 13311,
                         15360 - 16383, 20480 - 21503, 24576 - 25599
RIPE Address Blocks      62/8, 80/7, 193/8, 194/7, 212/7 and 217/8
```

APNIC Region per AS prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
1221	1301	1229	959	Telstra Pty Ltd
4538	456	1162	16	China Education and Research
2907	408	1975	371	SINET Japan
703	397	353	307	UUNET Technologies, Inc.
2764	385	360	361	connect.com.au pty ltd
7474	299	289	203	Optus Communications Pty Ltd
4755	295	111	85	Videsh Sanchar Nigam Ltd. Aut
4134	270	1874	98	Data Communications Bureau
9394	256	112	3	CHINA RAILWAY Internet(CRNET)
17557	231	15	101	Pakistan Telecom
4766	211	1393	147	Korea Internet Exchange for "
9443	163	44	62	Primus Telecommunications
4804	148	84	68	Microplex PTY LTD
9768	147	385	89	Korea Telecom
9583	141	32	5	Satyam Infoway Ltd.,
7539	135	215	132	TANet2, sponsored by NSC, TAI
4713	126	914	104	NTT Communications Corporatio
7657	122	22	85	The Internet Group Limited
4780	120	186	40	Digital United Inc.
17676	115	1840	17	XTAGE CORPORATION

ARIN Region per AS prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
701	2176	8485	1519	UUNET Technologies, Inc.
7018	1204	7492	905	AT&T
3908	851	1661	480	Supernet, Inc.
1	828	8104	602	BBN Planet
1239	800	3364	623	Sprint
4323	643	435	256	Time Warner Communications, I
7046	637	853	420	UUNET Technologies, Inc.
852	617	1119	408	Telus Advanced Communications
209	534	2006	312	Qwest
3549	478	844	242	Global Crossing
7132	456	511	165	Southwestern Bell Internet Se
2914	447	2144	414	Verio, Inc.
690	439	67	285	Merit Network
7843	382	302	48	Adelphia Corp.
705	378	117	268	UUNET Technologies, Inc.
2149	369	208	307	Performance Systems, Inc.
3741	344	731	235	The Internet Solution
3561	335	2172	300	Cable & Wireless USA
2386	333	355	190	AT&T Data Communications Serv
6197	325	214	165	BellSouth Network Solutions

RIPE NCC Region per AS prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
702	1058	2617	853	UUNET Technologies, Inc.
3301	395	924	349	TeliaNet Sweden
3215	260	570	157	France Telecom / &Equant
1257	244	487	240	SWIPnet Swedish IP Network
680	231	2147	230	DFN-IP service G-WiN
5515	217	713	174	Sonera Finland Autonomous Sys
5400	201	82	93	Concert European Core Network
3320	195	1964	171	Deutsche Telekom AG
786	180	1858	180	The JANET IP Service
719	164	289	119	LANLINK autonomous system
8708	162	22	147	Romania Data Systems S.A.
2856	131	790	120	BTnet UK Regional network
3303	123	577	123	Swisscom Ltd
12302	118	7	36	MobiFon S.A.
3269	117	693	71	TELECOM ITALIA
8297	115	40	64	Teleglobe Autonomous System i
517	100	226	98	KPNQwest Germany GmbH
2874	95	100	35	Global One Services AB
5511	89	192	78	France Telecom
5536	89	13	25	Internet Egypt Network
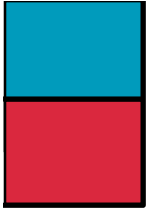
Global per AS prefix count summary

ASN	No of nets	/20 equiv	Max Agg	Description
701	2176	8485	1519	UUNET Technologies, Inc.
1221	1301	1229	959	Telstra Pty Ltd
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852	617	1119	408	Telus Advanced Communications
209	534	2006	312	Qwest
3549	478	844	242	Global Crossing
4538	456	1162	16	China Education and Research
7132	456	511	165	Southwestern Bell Internet Se
2914	447	2144	414	Verio, Inc.
690	439	67	285	Merit Network
2907	408	1975	371	SINET Japan
703	397	353	307	UUNET Technologies, Inc.
3301	395	924	349	TeliaNet Sweden
2764	385	360	361	connect.com.au pty ltd

Global Aggregation Savings Summary

ASN	No of Nets	Net Savings	Description
4538	456	440	China Education and Research
4323	643	387	Time Warner Communications, I
3908	851	371	Supernet, Inc.
1221	1301	342	Telstra Pty Ltd
7843	382	334	Adelphia Corp.
7018	1204	299	AT&T
7132	456	291	Southwestern Bell Internet Se
4151	306	290	USDA
6198	307	274	BellSouth Network Solutions,
11371	278	272	Rhythms NetConnections
9394	256	253	CHINA RAILWAY Internet(CRNET)
6347	315	237	SAVVIS Communications Corpora
3549	478	236	Global Crossing
7029	244	229	Alltel Information Services,
1	828	226	BBN Planet
209	534	222	Qwest
7046	637	217	UUNET Technologies, Inc.
4755	295	210	Videsh Sanchar Nigam Ltd. Aut
852	617	209	Telus Advanced Communications
702	1058	205	UUNET Technologies, Inc.

List of Illegal AS's

Bad AS	Designation	Network	Transit AS	Description
5757	UNALLOCATED	207.19.224.0/24	701	UUNET Technologies,
65534	PRIVATE	209.242.165.32/27	195	San Diego Supercompu
65534	PRIVATE	209.242.166.0/26	195	San Diego Supercompu
65534	PRIVATE	209.242.166.72/29	195	San Diego Supercompu
65534	PRIVATE	209.242.166.80/28	195	San Diego Supercompu

Number of prefixes announced by prefix length

```
 /1:0          /2:0          /3:0          /4:0          /5:0          /6:0
 /7:0          /8:19         /9:6         /10:8         /11:12        /12:37
/13:91        /14:237       /15:408       /16:7175      /17:1437      /18:2571
/19:7406      /20:6828      /21:4834      /22:7374      /23:9036      /24:60737
/25:216       /26:256       /27:123       /28:91        /29:93        /30:127
/31:0         /32:40
```

Advertised IANA Reserved Addresses

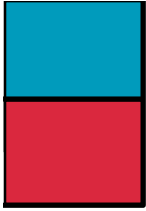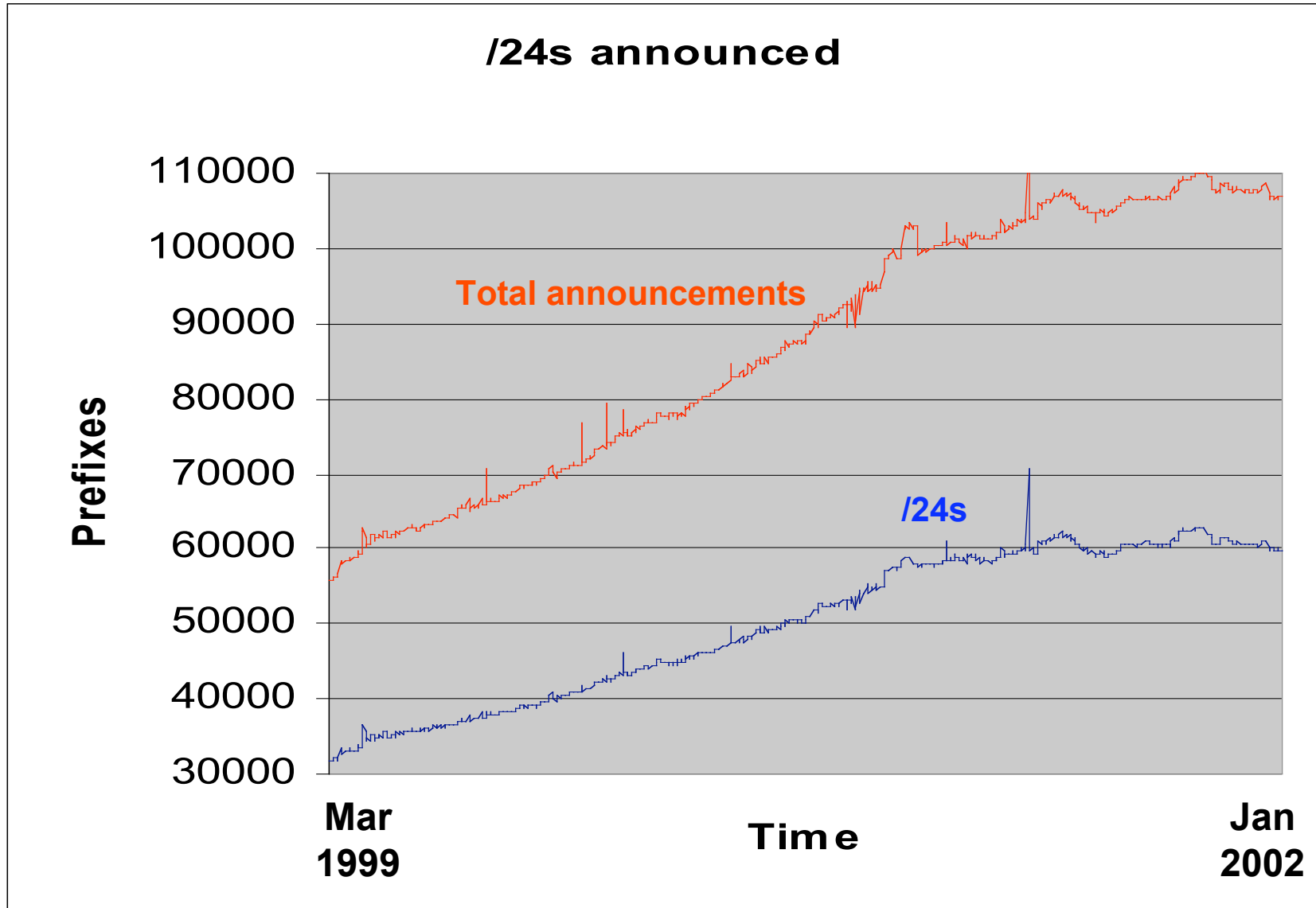| Network	Origin AS	Description
39.0.0.0/8	4554	Exchange Point Blocks
96.0.0.0/20	3549	Global Crossing
132.0.0.0/10	568	DISO-UNRRA
134.137.0.0/16	7170	AT&T Government Markets
135.0.0.0/13	10455	Lucent Technologies
137.0.0.0/13	568	DISO-UNRRA
138.94.0.0/16	1	BBN Planet
144.7.0.0/16	701	UUNET Technologies, Inc.
153.36.0.0/14	701	UUNET Technologies, Inc.
154.150.0.0/16	6494	IDCI
158.0.0.0/13	568	DISO-UNRRA
164.233.0.0/16	6020	DISA NETWORK SERVICES
164.235.0.0/16	6025	US DOD NIC Unregistered
189.186.184.0/24	4471	Michigan Internet Cooperative
201.115.100.0/24	7018	AT&T

BGP Table Growth

Steady size

Nonlinear growth

AS Announcement Growth

Growth slowed down

ASNs

13000
12000
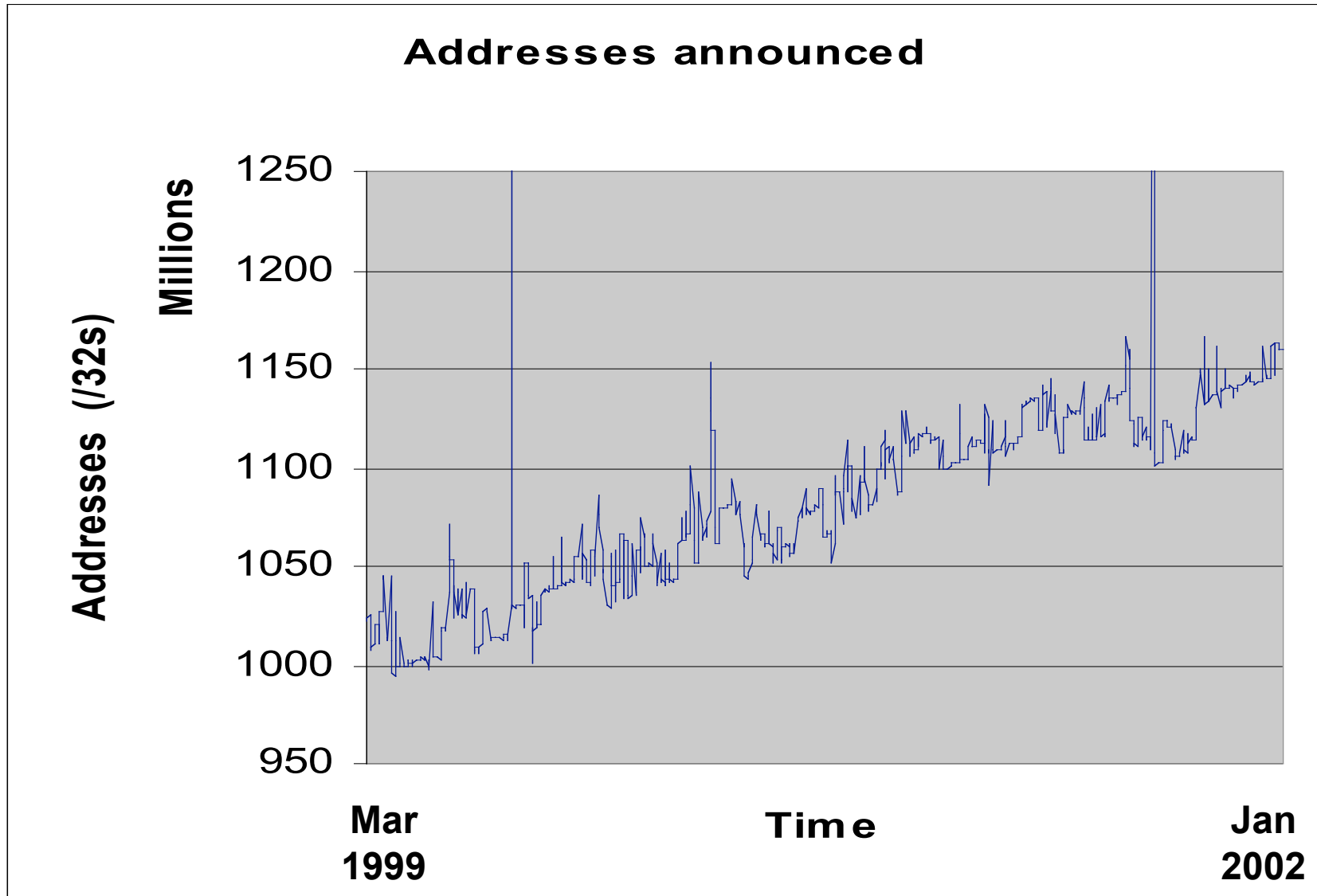11000
10000
9000
8000
7000
6000
5000
4000

Mar
1999

Time

Jan
2002

RIPE vs APNIC Prefixes Announced
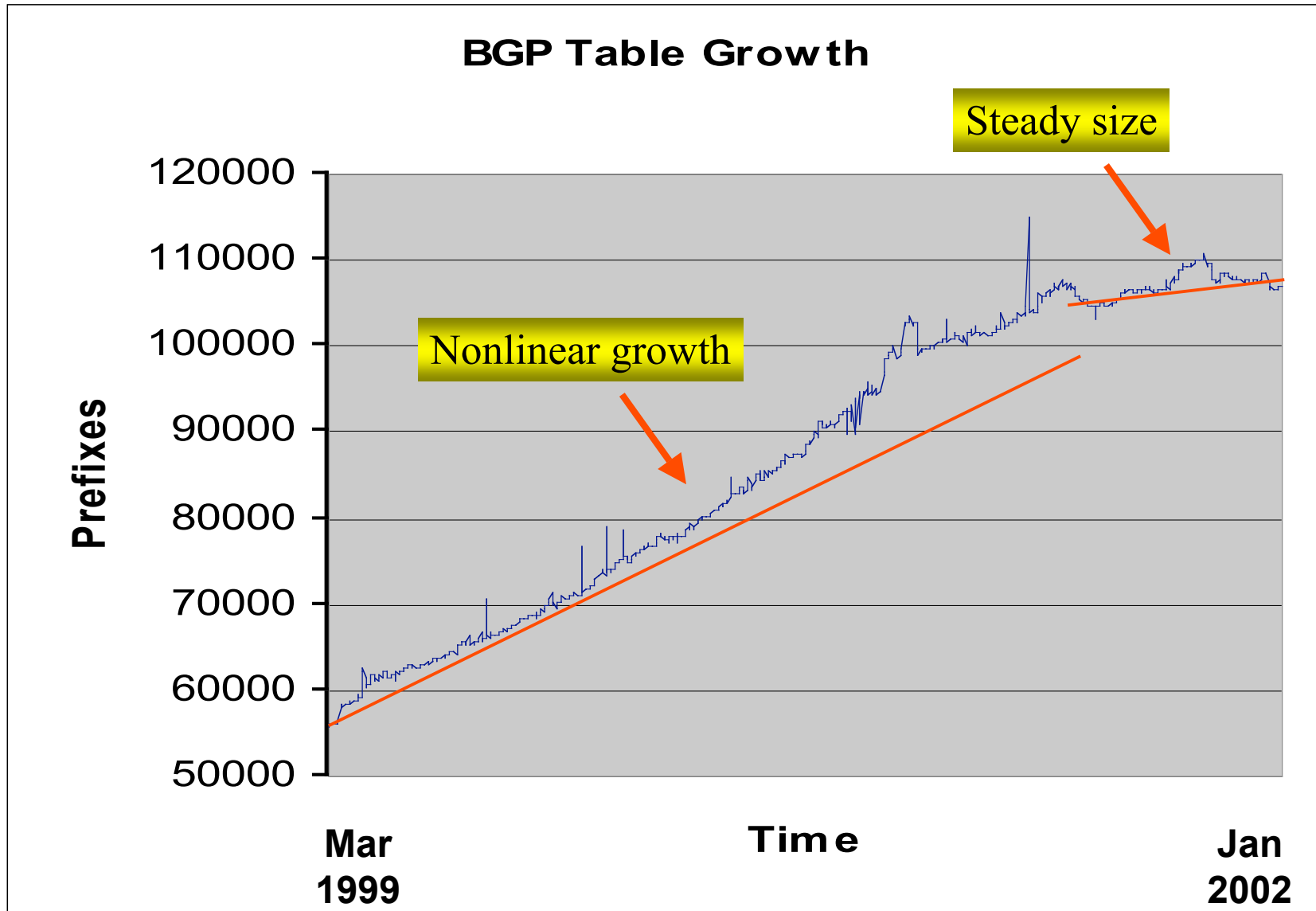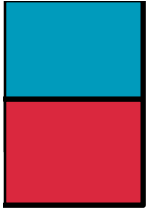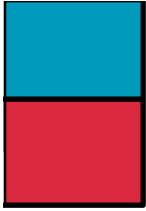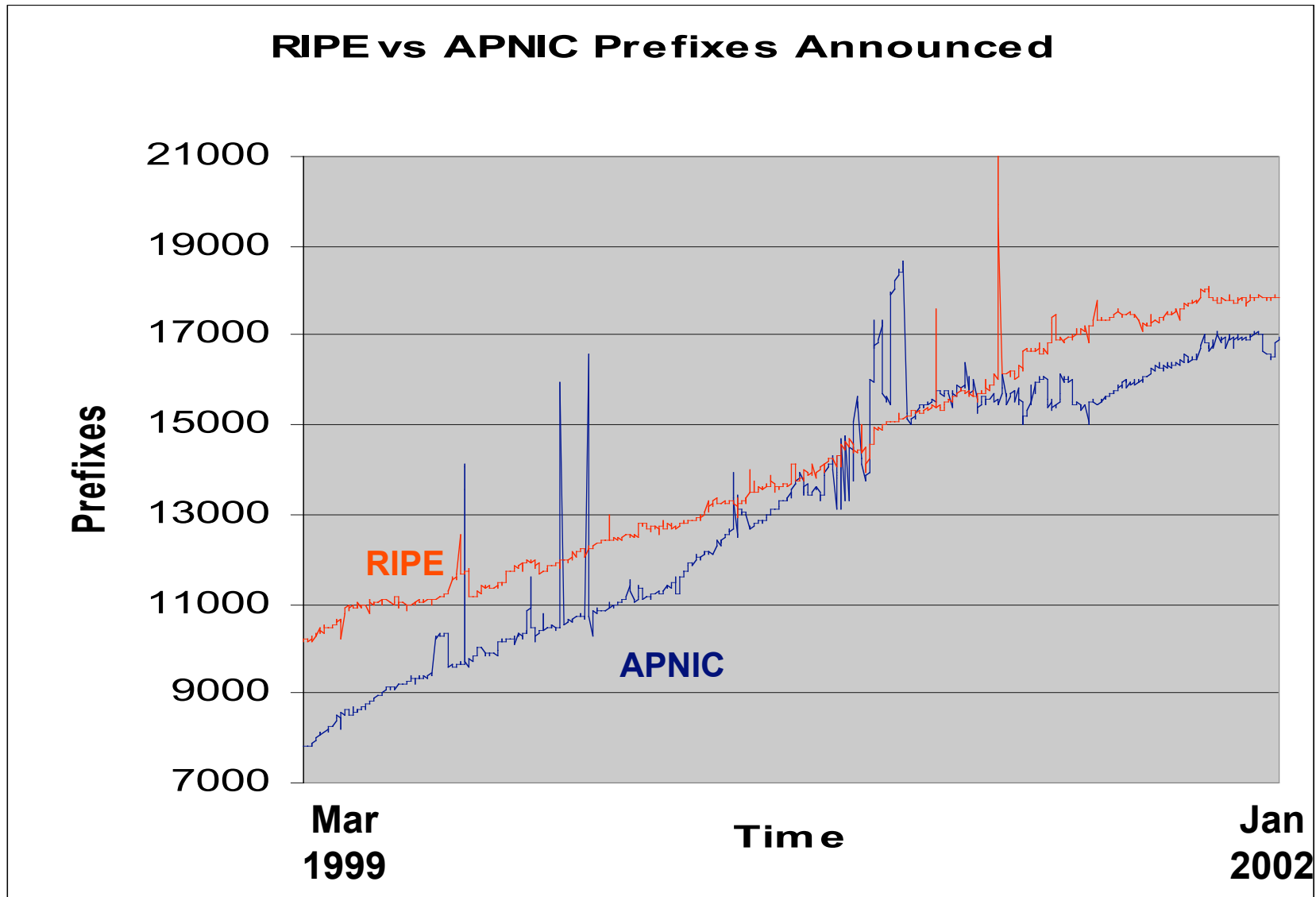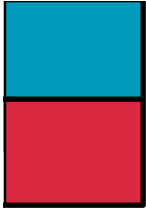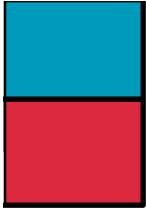
Unique Prefixes vs Max Aggregation

Prefixes sizes announced

Legend: /19s — /20s — /21s — /22s — /23s

Y-axis: Prefixes (2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000)

X-axis: Time (Mar 1999 — Jan 2002)

/24s announced

Addresses announced

AS Announcements

ASes vs Time (Mar 1999 – Jan 2002)

Legend: Total — Origin Only — Transit — Transit Only

Maximum AS Path Length
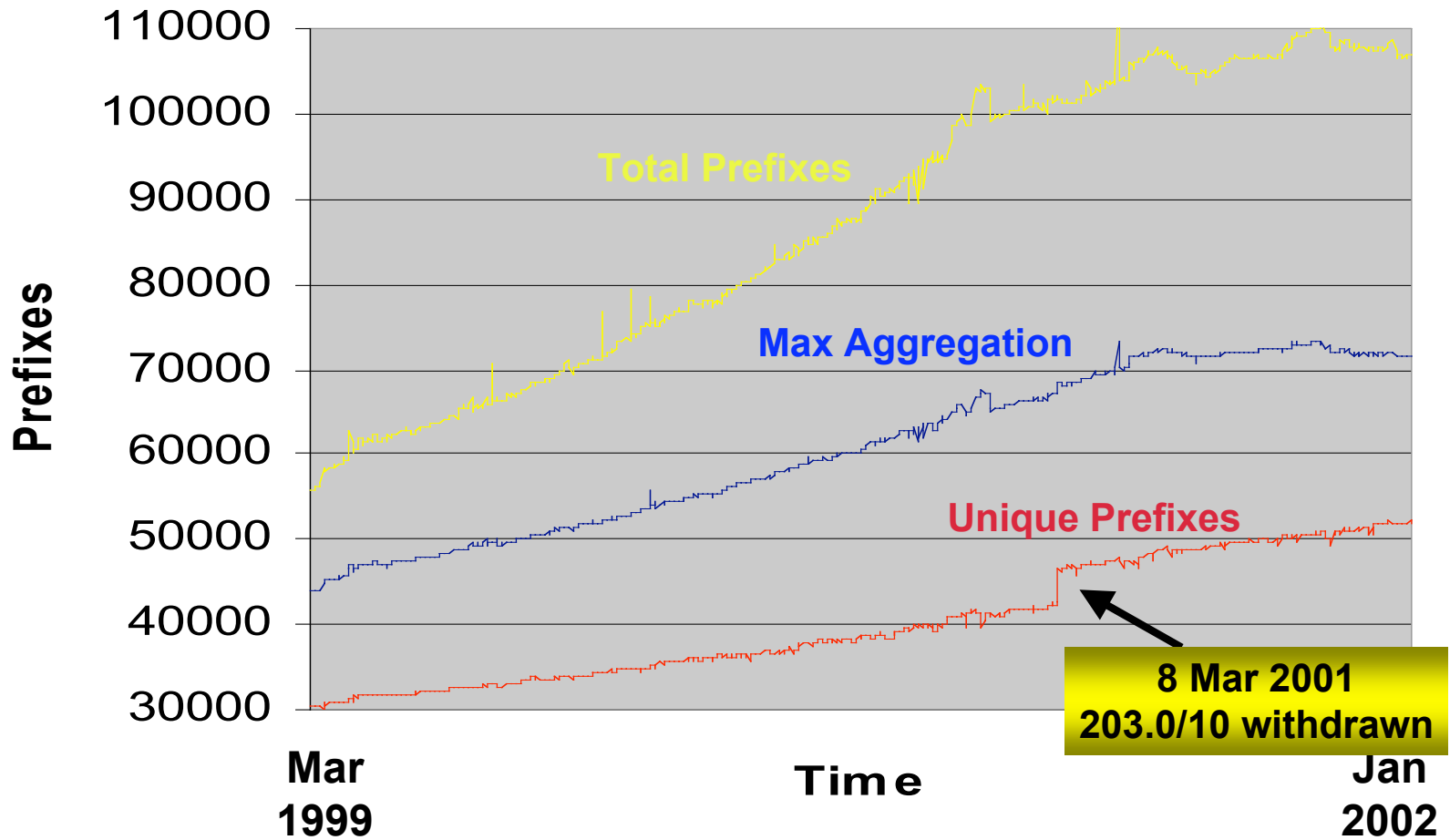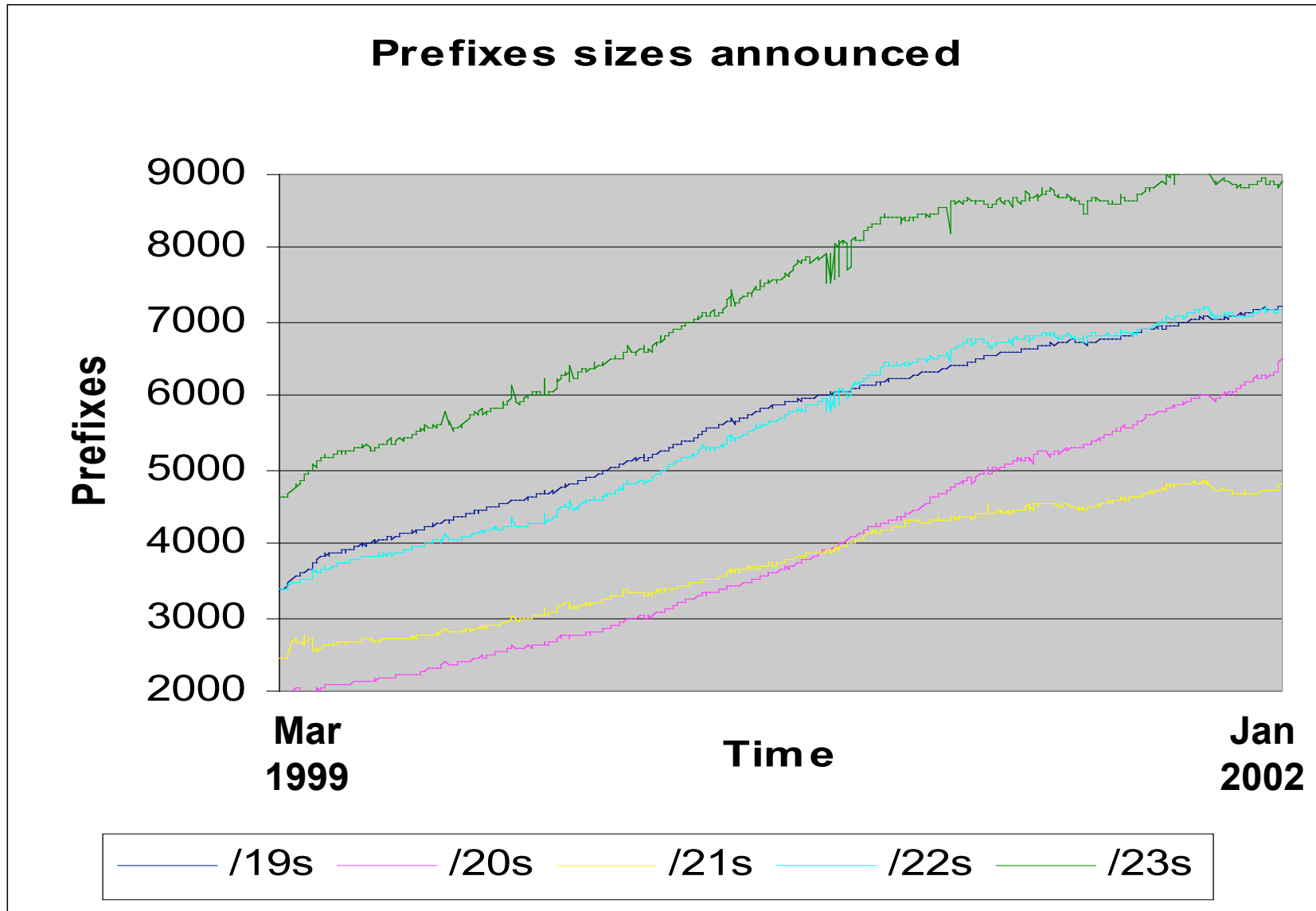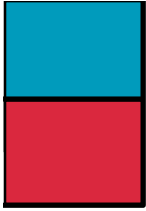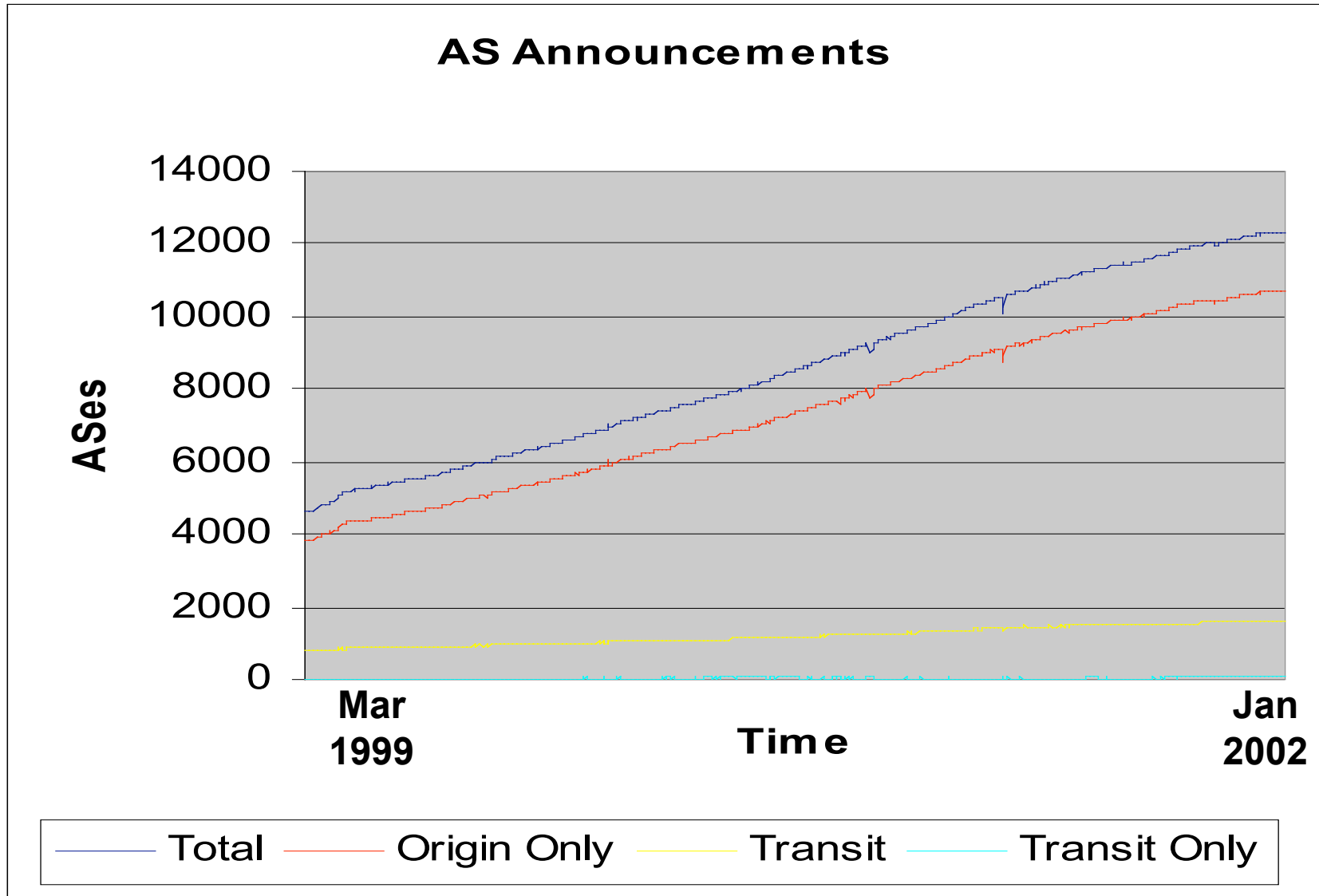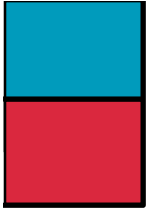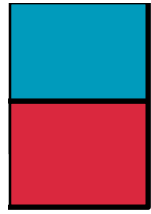
Final Slide...

- **Any comments/discussion?**