# Internet Routing Table Analysis Update

**Philip Smith**

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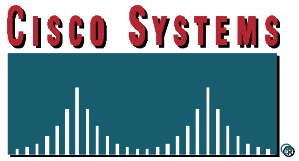
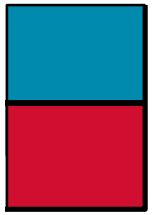
**IEPG, Adelaide, 26 March 2000**





# Internet Routing Table Analysis

- **Thanks to APNIC for support**

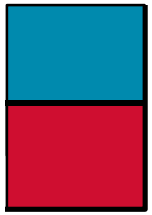
  **especially Bruce Campbell for scripting**

- **Full view taken from NSPIXP2 in Japan**

- **Full BGP table**

  **no filters, no flap dampening**

- **Snapshot at 4am (+10GMT)**



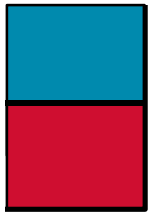
# Internet Routing Table Analysis

- **All three Regional Internet Registry address and AS ranges analysed:**

  `http://www.isi.edu/in-notes/iana/assignments/as-numbers`

  `http://www.isi.edu/in-notes/iana/assignments/ipv4-address-space`

- **Exhaustive search of utilisation of former B space included**
- **NEW: AS space regionalised - historical allocations by InterNIC included**



# Internet Routing Table Analysis

- **Results on APNIC web page**

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

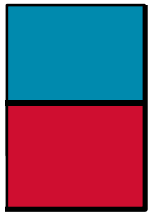
- **Results to mailing lists**

  **bgp-stats@lists.apnic.net (daily)**

  **apops@lists.apnic.net (weekly)**

- **Results to APNIC Routing SIG**

  **sig-routing@lists.apnic.net**



# Some Definitions

- **“available” address space**

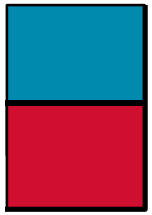
  **everything except draft-manning-dsua-01.txt which lists:**

  **0/8, 10/8, 127/8, 169.254/16, 172.16/12, 192.0.2/24, 192.168/16 and 224/3**

- **“allocated” address space**

  **everything from “available” which isn’t “IANA reserved”**

  **currently this amounts to 49.6% of address space (or 110 /8s)**

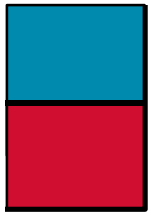


# 25th March summary

## Global summary

**Asia Pacific Report  25 March, 2000**

| | |
|---|---|
| BGP routing table entries examined | 76127 |
| Origin ASes present in the Internet Routing Table | 7049 |
| Origin ASes announcing only one prefix | 2244 |
| Transit ASes present in the Internet Routing Table | 1018 |
| Average AS path length visible in the Internet Routing Table | 5.2 |
| Max AS path length visible | 13 |
| Illegal AS announcements present in the Routing Table | 5 |
| Non-routable prefixes present in the Routing Table | 0 |
| Prefixes being announced from the IANA Reserved Address blocks | 5 |
| Number of addresses announced to Internet | 1119490140 |
| Equivalent to 66 /8s, 186 /16s and 16 /24s | |
| Percentage of available address space announced | 30.2 |
| Percentage of allocated address space announced | 60.9 |
| Percentage of available address space allocated | 49.6 |

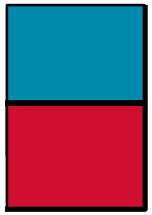


# 25th March summary

## APNIC Region summary

**Asia Pacific Report  25 March, 2000**

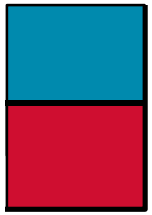
| | |
|---|---|
| Prefixes being announced by APNIC Region ASes | 10932 |
| Prefixes being announced from the APNIC address blocks | 9531 |
| APNIC Region origin ASes present in the Internet Routing Table | 791 |
| APNIC Region origin ASes announcing only one prefix | 267 |
| APNIC Region transit ASes present in the Internet Routing Table | 139 |
| Average APNIC Region AS path length visible | 5.1 |
| Max APNIC Region AS path length visible | 11 |
| Number of APNIC addresses announced to Internet | 42452915 |
| Equivalent to 2 /8s, 135 /16s and 199 /24s | |
| Percentage of available APNIC address space announced | 50.0 |
| | |
| APNIC AS Blocks | 4608 - 4864, 7467 - 7722, 9216 - 10239 |
| APNIC Address Blocks | 61/8, 202/7 and 210/7 |



# 25th March summary

## ARIN region summary

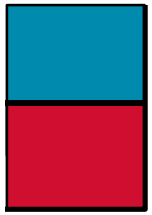
```
ARIN Region Report   25 March, 2000

Prefixes being announced by ARIN Region ASes                    52409
Prefixes being announced from the ARIN address blocks           35665
ARIN Region origin ASes present in the Internet Routing Table    4274
ARIN Region origin ASes announcing only one prefix               1096
ARIN Region transit ASes present in the Internet Routing Table    508
Average ARIN Region AS path length visible                        5.1
    Max ARIN Region AS path length visible                         11
Number of ARIN addresses announced to Internet                143911538
    Equivalent to 8 /8s, 147 /16s and 234 /24s
    Percentage of available ARIN address space announced          78.0

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
ARIN Address Blocks 63/8, 64/8, 199/8, 200/8, 204/6, 208/7 and 216/8
```



# 25th March summary

## RIPE NCC region summary

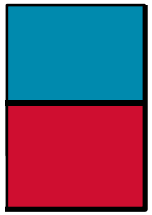
```
RIPE NCC region Report   25 March, 2000

Prefixes being announced by RIPE Region ASes                    12354
Prefixes being announced from the RIPE address blocks            9610
RIPE Region origin ASes present in the Internet Routing Table    1914
RIPE Region origin ASes announcing only one prefix                881
RIPE Region transit ASes present in the Internet Routing Table    367
Average RIPE Region AS path length visible                        5.8
    Max RIPE Region AS path length visible                         13
Number of RIPE addresses announced to Internet                 66838412
    Equivalent to 3 /8s, 251 /16s and 223 /24s
    Percentage of available RIPE address space announced           66.4

RIPE AS Blocks      1877 - 1901, 2042, 2047, 2107 - 2136, 2585 - 2614
                    2773 - 2822, 2830 - 2879, 3154 - 3353, 5377 - 5631
                    6656 - 6911, 8192 - 9215, 12288 - 13311,
                    15360 - 16383
RIPE Address Blocks 62/8, 193/8, 194/7 and 212/7
```



# APNIC Region routing table

**APNIC Region per AS prefix count summary**

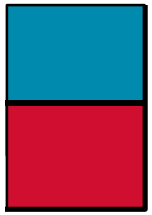
| ASN | No of nets | /19 equiv | Description |
|---|---|---|---|
| 1221 | 932 | 1103 | Telstra |
| 2764 | 434 | 120 | connect.com.au pty ltd |
| 4740 | 393 | 82 | Ozemail |
| 2907 | 383 | 908 | SINET Japan |
| 7657 | 293 | 11 | The Internet Group Limited |
| 4755 | 196 | 67 | VSNL India |
| 4433 | 187 | 141 | Access One Pty Ltd |
| 9269 | 184 | 16 | Hong Kong CTI |
| 7545 | 169 | 6 | TPG Internet Pty Ltd |
| 4618 | 164 | 48 | Internet Thailand |
| 9706 | 151 | 5 | Pusan Metropolitan City Offic |
| 7496 | 128 | 5 | Power Up |
| 7714 | 115 | 49 | Netlink New Zealand |
| 9304 | 112 | 19 | Hutchcity |
| 7474 | 111 | 50 | Optus Communications |
| 4766 | 107 | 217 | KORnet Powered BY Korea Telec |
| 4786 | 106 | 6 | NetConnect Communications Pty |
| 2497 | 97 | 368 | IIJNET |
| 4134 | 97 | 170 | Data Communications Bureau |



# ARIN Region routing table

**ARIN Region per AS prefix count summary**

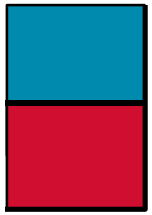
| ASN | No of nets | /19 equiv | Description |
|---|---|---|---|
| 701 | 1966 | 3446 | UUNET Technologies, Inc. |
| 7018 | 994 | 3061 | AT&T |
| 1 | 825 | 4576 | BBN Planet |
| 3561 | 810 | 1687 | Cable & Wireless USA |
| 2914 | 723 | 1173 | Verio, Inc. |
| 1239 | 720 | 1622 | Sprint ICM-Inria |
| 209 | 657 | 712 | Qwest |
| 7046 | 651 | 420 | UUNET Technologies, Inc. |
| 174 | 637 | 2845 | PSINet Inc. |
| 271 | 471 | 411 | BCnet Backbone |
| 1785 | 436 | 880 | Sprint ICM |
| 3602 | 433 | 77 | Sprint Canada |
| 3549 | 410 | 310 | Frontier GlobalCenter |
| 816 | 408 | 180 | UUNET Canada4 |
| 705 | 390 | 21 | UUNET Technologies, Inc. |
| 1740 | 380 | 589 | CERFnet |
| 4293 | 368 | 49 | Cable & Wireless USA |
| 577 | 302 | 218 | Bell Canada |
| 3741 | 272 | 361 | The Internet Solution ZA |



# RIPE NCC Region routing table

**RIPE NCC region per AS prefix count summary**

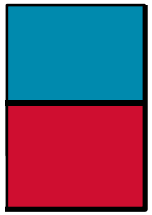
| ASN | No of nets | /19 equiv | Description |
|---|---|---|---|
| 3301 | 442 | 285 | TeliaNet Sweden |
| 1257 | 346 | 249 | Swipnet AB |
| 1270 | 242 | 400 | UUNET Germany |
| 1275 | 234 | 1148 | DFN IP Service |
| 1849 | 227 | 446 | PIPEX |
| 786 | 181 | 959 | JANET IP Service |
| 719 | 180 | 145 | LANLINK |
| 517 | 169 | 200 | Xlink |
| 5515 | 152 | 318 | Sonera Finland |
| 3320 | 126 | 233 | Deutsche Telekom AG |
| 2609 | 121 | 4 | EUnet-TN |
| 2856 | 118 | 239 | BTnet UK Regional network |
| 3303 | 117 | 295 | Swisscom |
| 3215 | 102 | 118 | RAIN |
| 1901 | 89 | 90 | EUnet Austria |
| 2874 | 89 | 84 | Global One Services |
| 1290 | 84 | 195 | PSINet UK Ltd. |
| 8895 | 83 | 28 | Saudi Arabia AS |
| 1890 | 79 | 278 | UUNET NL Autonomous System |



# Global routing table

**Global per AS prefix count summary**

| ASN | No of nets | /19 equiv | Description |
|---|---|---|---|
| 701 | 1966 | 3446 | UUNET Technologies, Inc. |
| 7018 | 994 | 3061 | AT&T |
| 1221 | 932 | 1103 | Telstra |
| 1 | 825 | 4576 | BBN Planet |
| 3561 | 810 | 1687 | Cable & Wireless USA |
| 2914 | 723 | 1173 | Verio, Inc. |
| 1239 | 720 | 1622 | Sprint ICM-Inria |
| 209 | 657 | 712 | Qwest |
| 7046 | 651 | 420 | UUNET Technologies, Inc. |
| 174 | 637 | 2845 | PSINet Inc. |
| 271 | 471 | 411 | BCnet Backbone |
| 3301 | 442 | 285 | TeliaNet Sweden |
| 1785 | 436 | 880 | Sprint ICM |
| 2764 | 434 | 120 | connect.com.au pty ltd |
| 3602 | 433 | 77 | Sprint Canada |
| 3549 | 410 | 310 | Frontier GlobalCenter |
| 816 | 408 | 180 | UUNET Canada4 |
| 4740 | 393 | 82 | Ozemail |
| 705 | 390 | 21 | UUNET Technologies, Inc. |



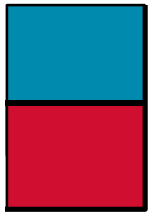
# E-mail output - miscellaneous

**List of Illegal AS's**

| Bad AS | Designation | Network | Transit AS | Description |
|---|---|---|---|---|
| 65209 | PRIVATE | 63.233.132.0/22 | 209 | Qwest |
| 65209 | PRIVATE | 63.233.152.0/24 | 209 | Qwest |
| 65502 | PRIVATE | 159.98.0.0/17 | 3369 | MCI |
| 61100 | RESERVED | 200.27.198.0/24 | 6429 | RdC Internet |
| 65532 | PRIVATE | 208.184.216.128/25 | 6461 | AboveNet |

**Advertised IANA Reserved Addresses**

| Network | Origin AS | Description |
|---|---|---|
| 65.45.0.0/19 | 10585 | NETLIMITED LLC |
| 103.10.0.0/16 | 209 | Qwest |
| 197.138.137.0/24 | 2914 | Verio, Inc. |
| 219.91.160.0/22 | 7742 | InternetNow, Inc. |
| 219.91.164.0/23 | 7742 | InternetNow, Inc. |

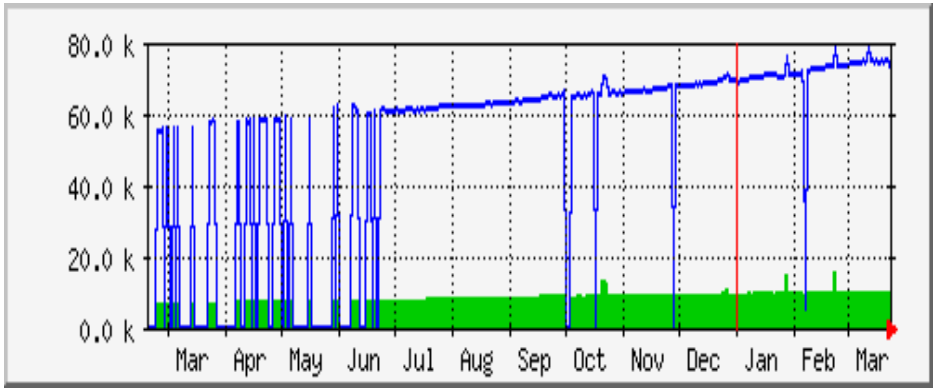


# E-mail output - miscellaneous

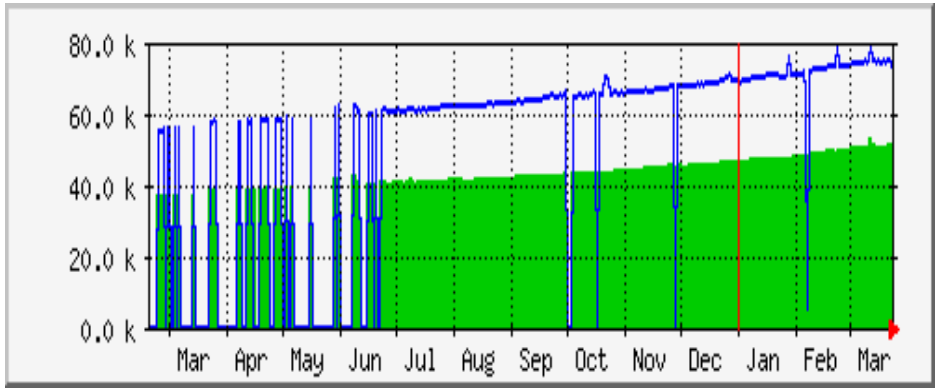
**Number of prefixes announced by prefix length**

| | | | | | |
|---|---|---|---|---|---|
| /1:0 | /2:0 | /3:0 | /4:0 | /5:0 | /6:0 |
| /7:0 | /8:22 | /9:4 | /10:5 | /11:9 | /12:28 |
| /13:45 | /14:157 | /15:270 | /16:6398 | /17:758 | /18:1516 |
| /19:4993 | /20:2834 | /21:3261 | /22:4643 | /23:6433 | /24:43921 |
| /25:141 | /26:171 | /27:124 | /28:65 | /29:55 | /30:150 |
| /31:0 | /32:124 | | | | |

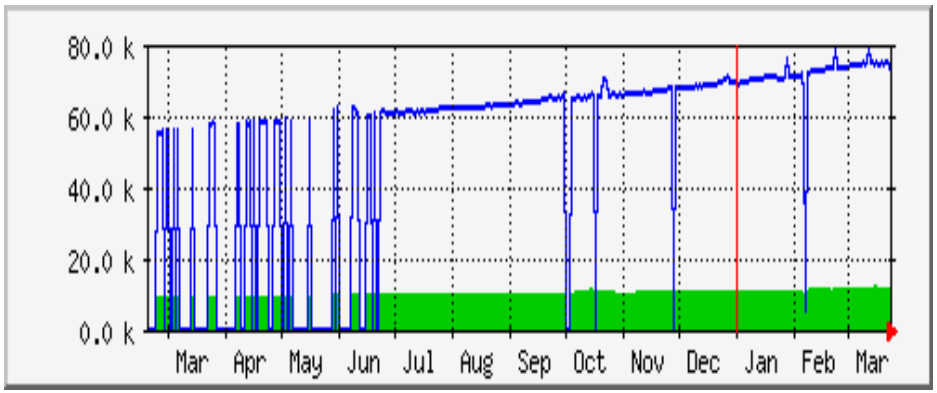
# Internet Routing Table size



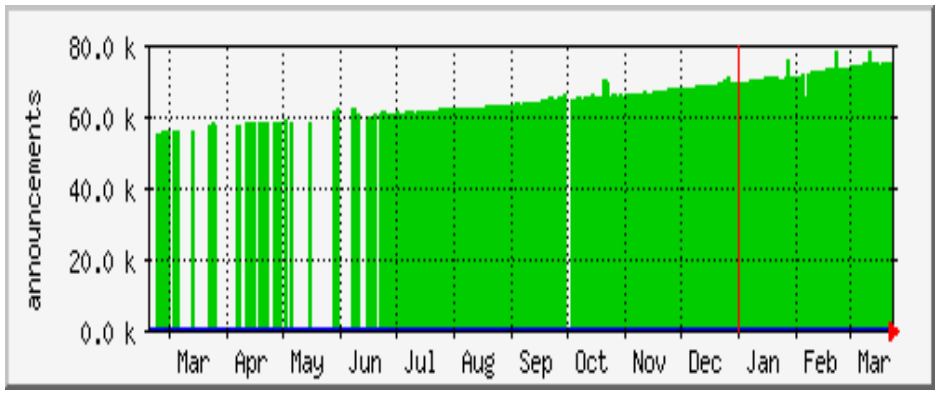

**APNIC**




**ARIN**

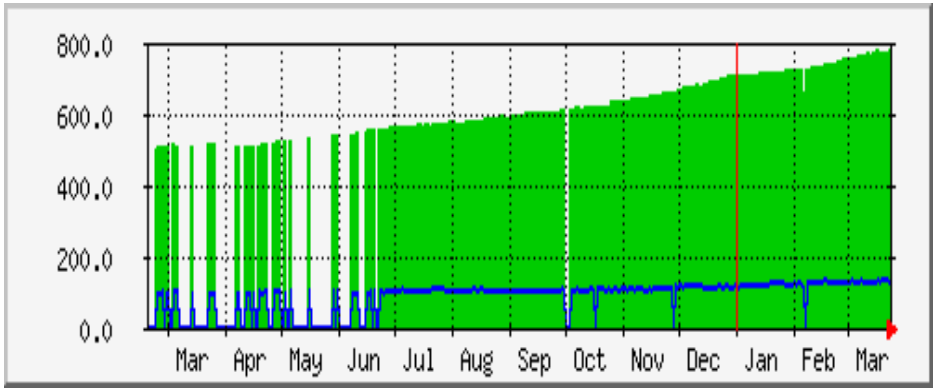



**RIPE NCC**

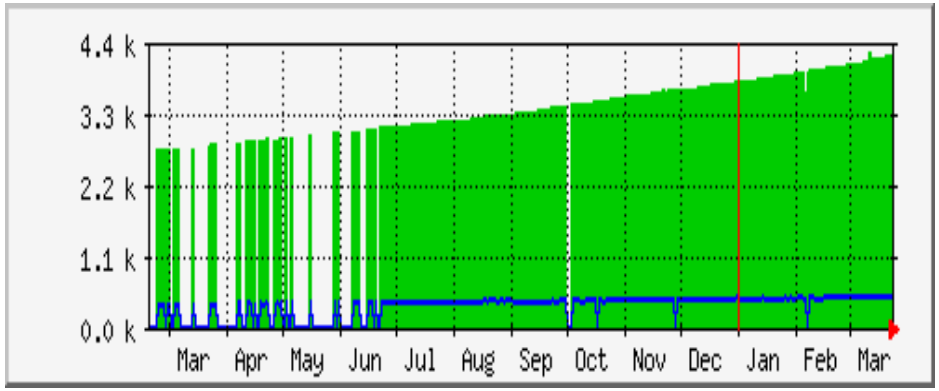



**Global**

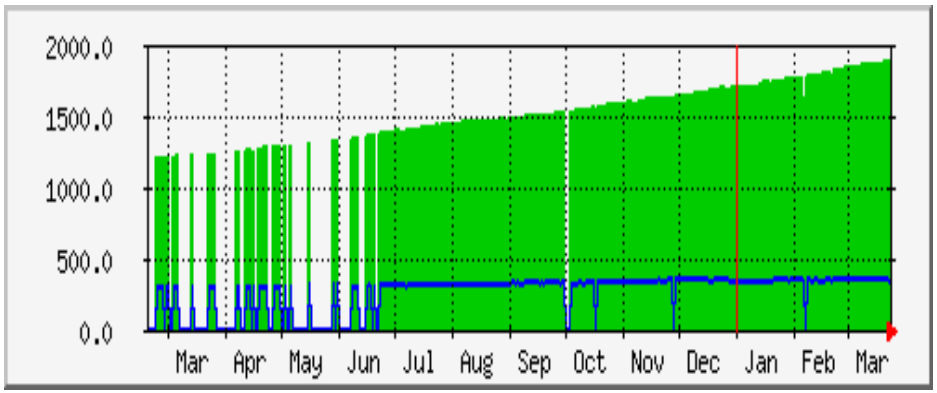
# origin versus transit ASes



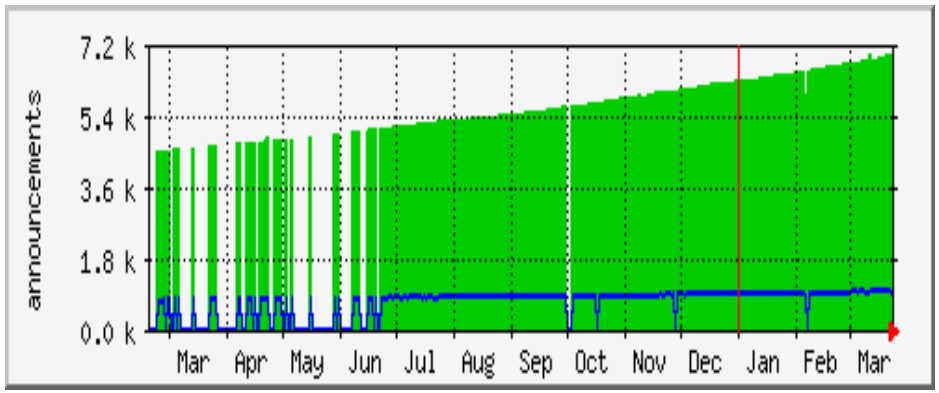

**APNIC**




**ARIN**

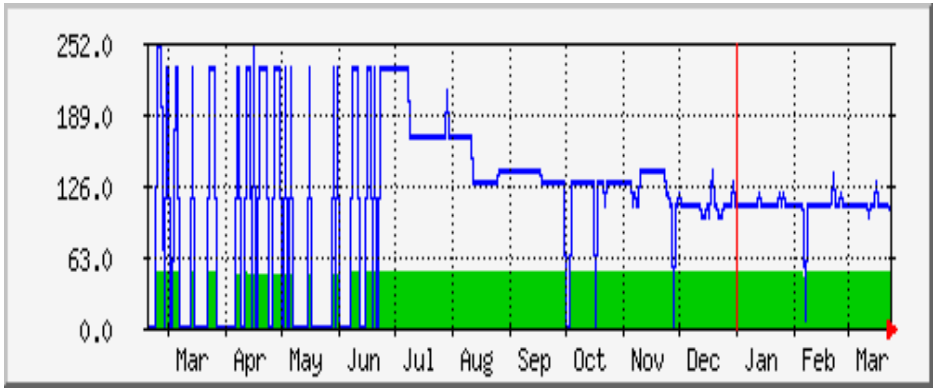



**RIPE NCC**

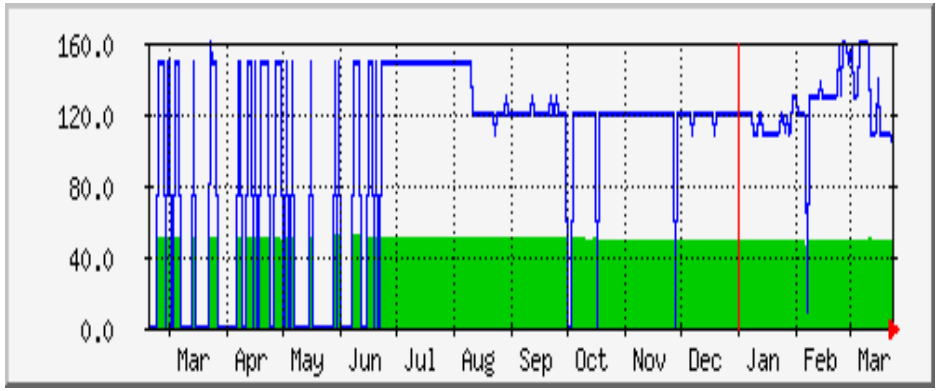



**Global**

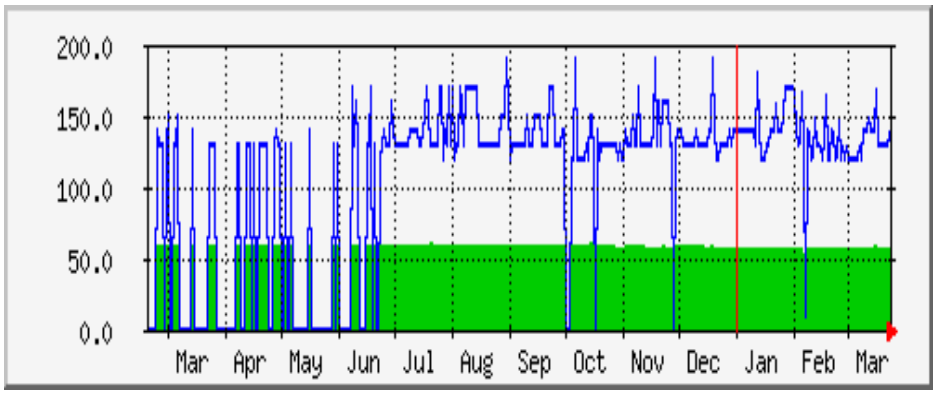
# average versus maximum AS path length



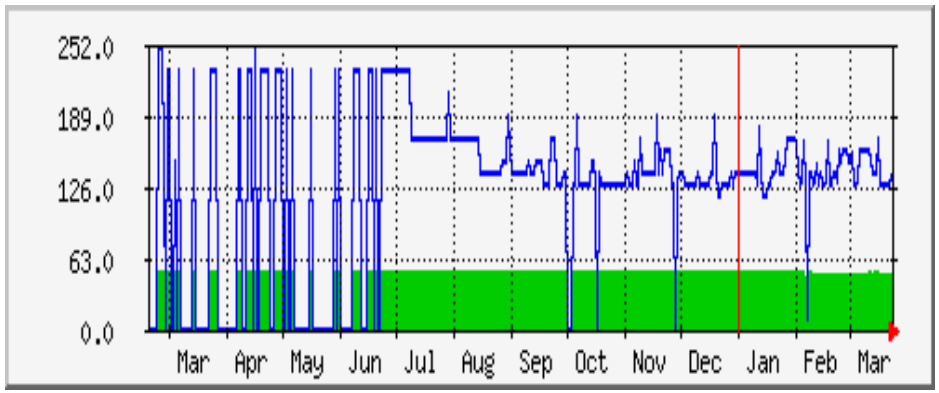

APNIC




ARIN

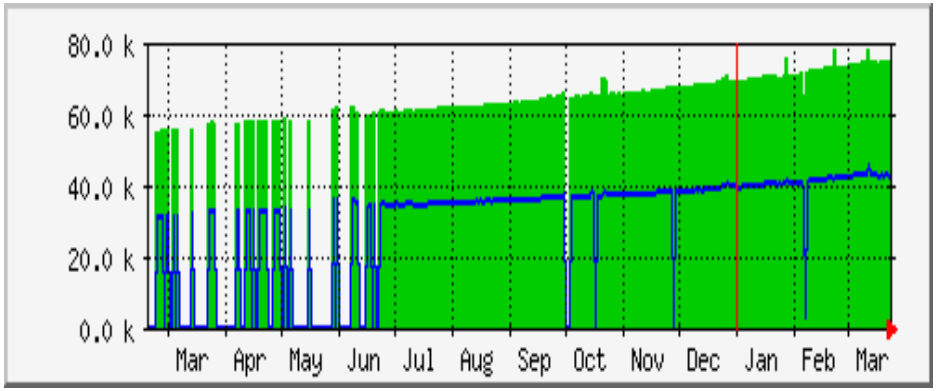



RIPE NCC

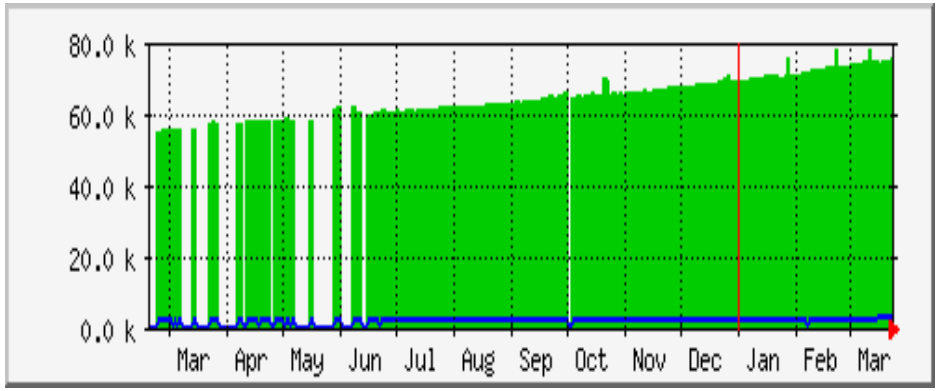



Global

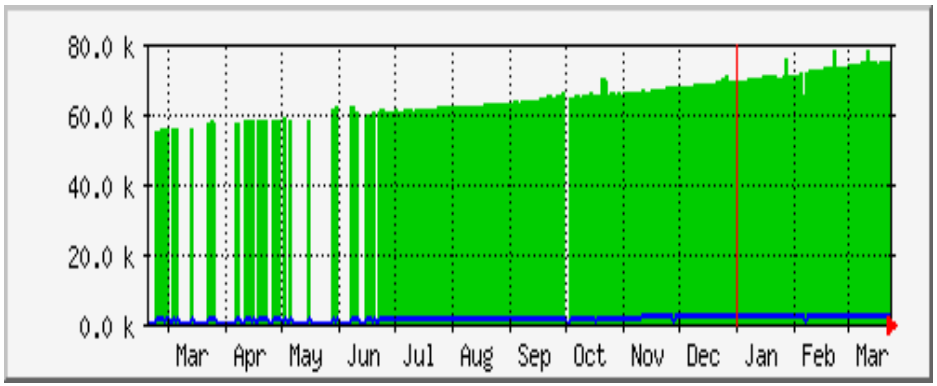
# Relative prefix sizes



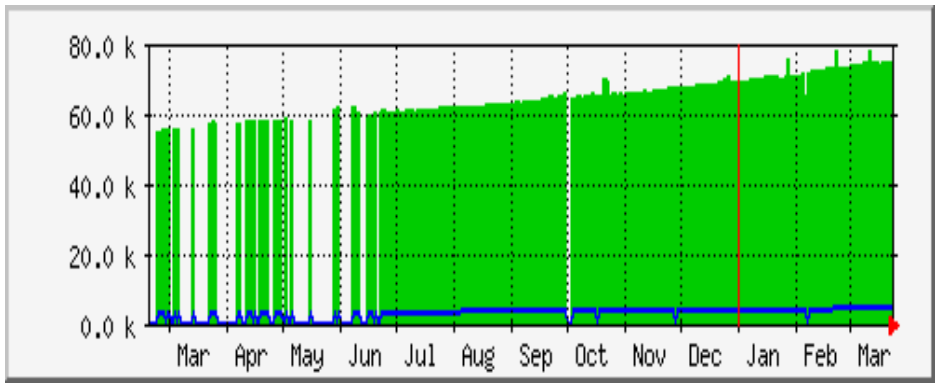

**/24s**



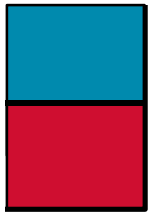

**/21s**




**/20s**




**/19s**



# Observations

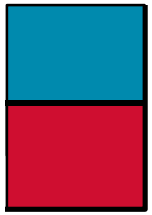
- **Current routing table growth rate**

  **61500 prefixes on 01-07-1999**

  **70300 prefixes on 01-01-2000**

  **at this rate, routing table will reach 100k prefixes by September 2001**

- **Is this a problem?**



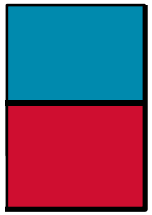
# Observations

- **49.6% of total useable IPv4 address space is allocated**

  **equivalent to ~110 /8s**

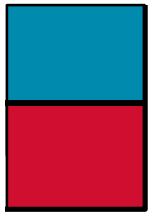
- **Only 61.4% of allocated IPv4 space is announced to the Internet (~68 /8s)**

  **where is the rest???**



# Observations

- **Current AS growth rate**
  - **5200 ASNs on 01-07-1999**
  - **6320 ASNs on 01-01-2000**
  - **will reach 10K ASNs by July 2001**
- **Around 15300 ASNs have been assigned as of 24/03/2000**
  - **7030 are in use on the Internet**
  - **where are the rest???**



# Observations

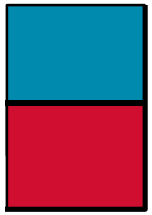
- **/24s announced to Internet**

  **35008 on 01-07-1999**

  **39710 on 01-01-2000**

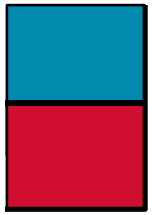
  **4700 new /24s compared with 8800 new prefix announcements in last 6 months**

  **Why? Multihoming? Laziness?**



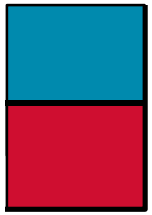
# Observations

- **/21s, /22s and /23s announced**
  - **11480 on 01-07-1999**
  - **13070 on 01-01-2000**
  - **1590 new /21s, /22s and /23s in last 6 months**
- **No obvious impact of ARIN min allocation of /20**
  - **APNIC min allocation will now be /20 also**



# Observations

- **Internet AS Path Length in last 6 months**
  - **average is constant at 5.2 ASNs**
  - **maximum length fluctuated from 11 to 25 ASNs!**

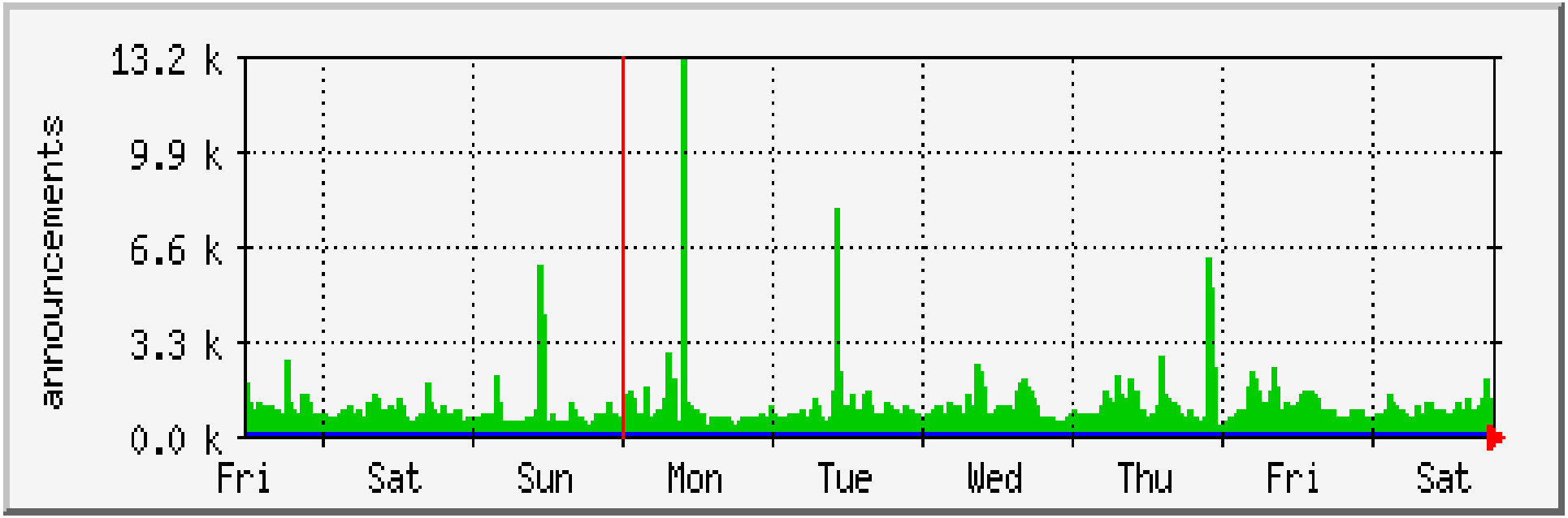


# Route Flaps

- **New work to measure route flaps**
  - **started end of November 1999**
  - **samples taken every 10 minutes**
    - ***sh ip bgp flap* output**
  - **router uses RIPE-178 parameters**

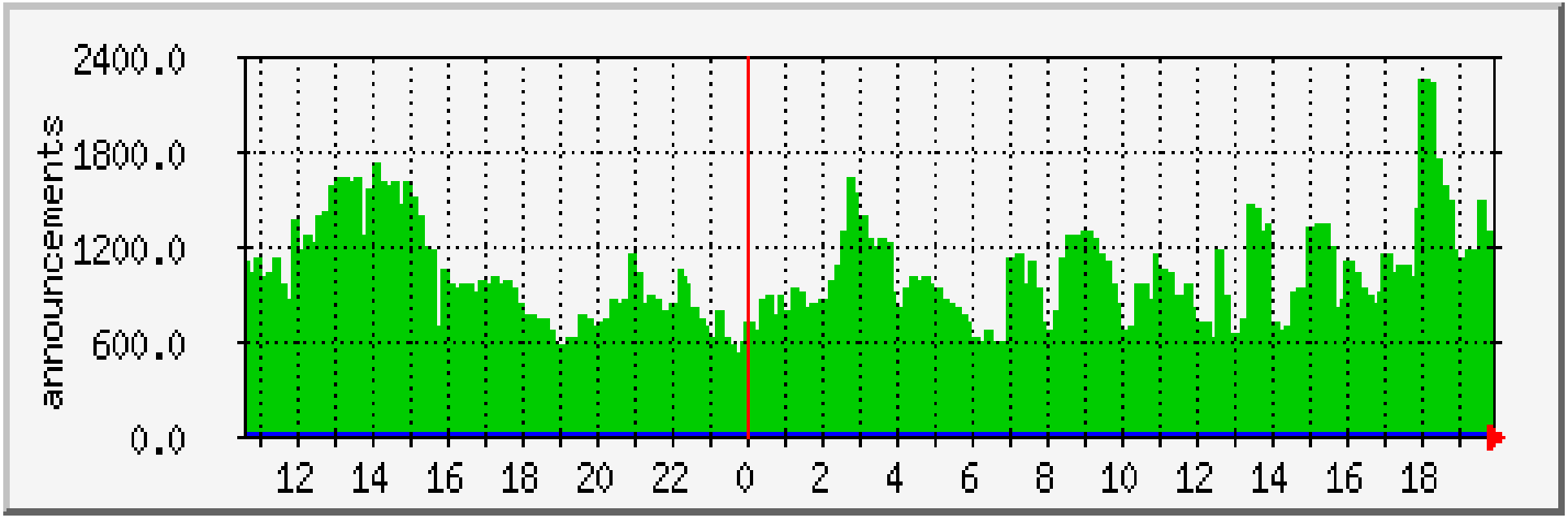
# Global flapping prefixes

**Flapping prefixes 7 days up to 25 March 2000**
**Maximum 13100, average 1100**



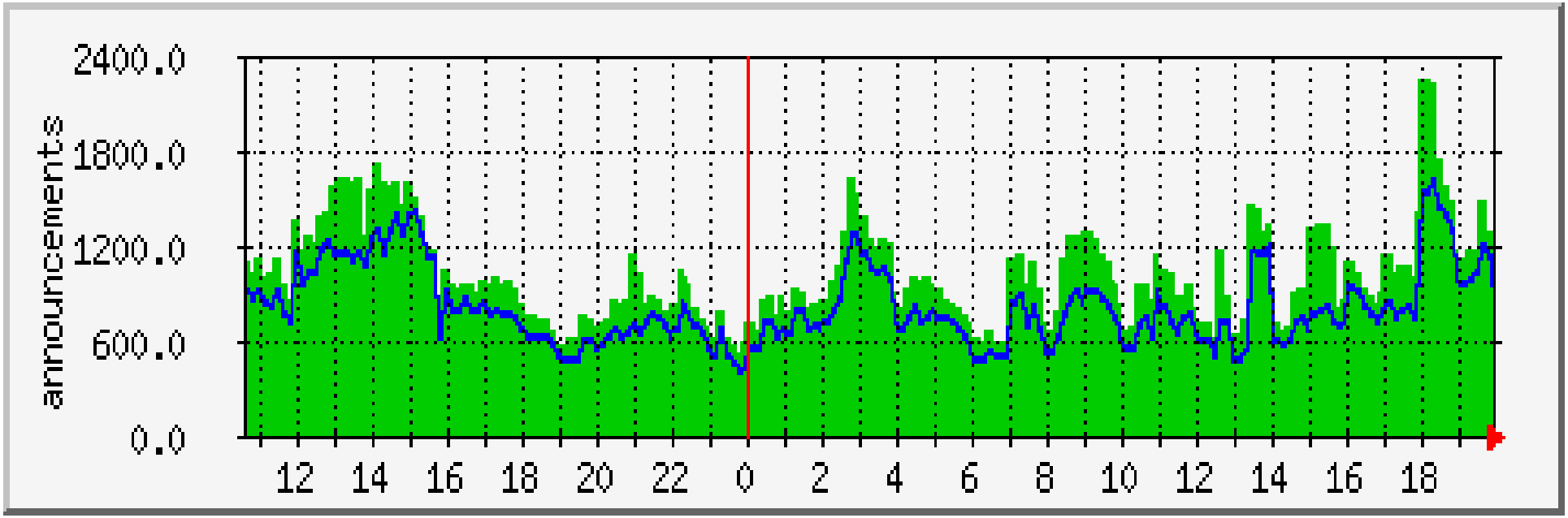
# Global flapping prefixes

**24hours up to 25 March 2000**
**Maximum 2300, average 1100**

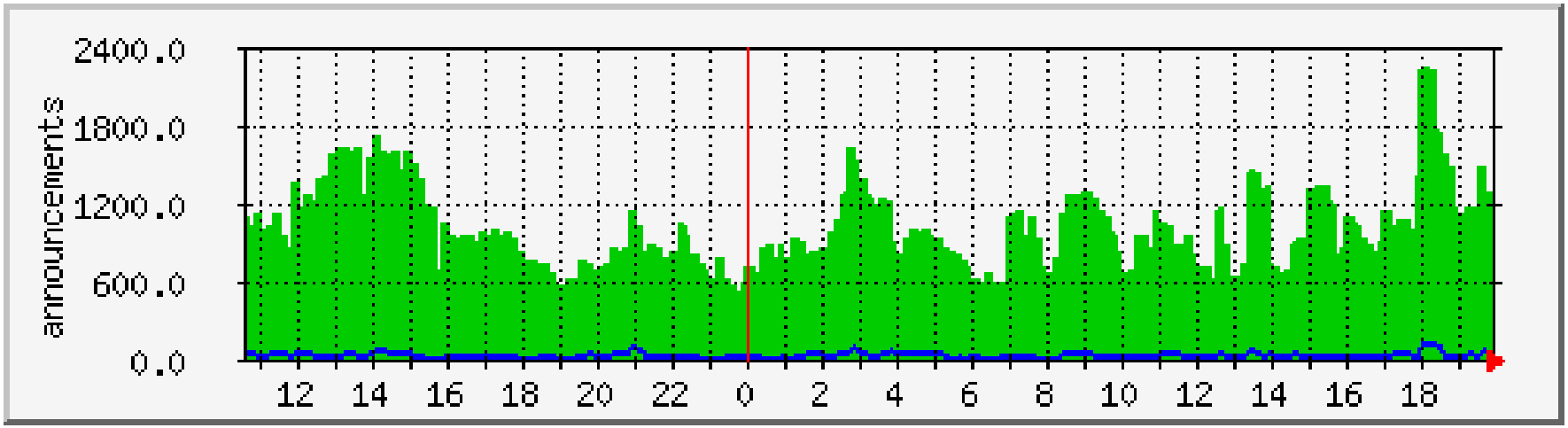


# Flapping /24s

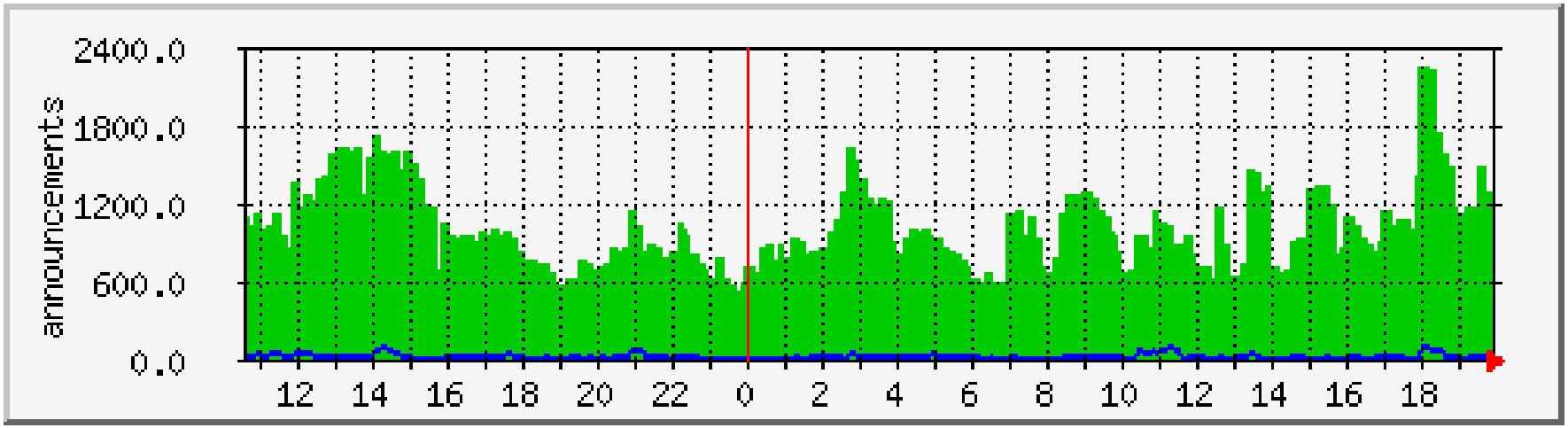
**Total flapping prefixes versus**
***/24* prefixes flapping**
**on 25 March 2000**



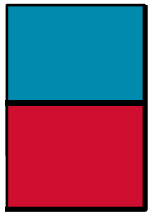
# Trend graphs




***/23*** **prefixes flapping**




***/22*** **prefixes flapping**

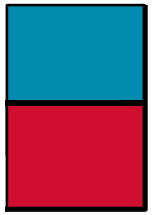


# Comments

- 1100 flapping prefixes on average listed on router
- 80% are /24s!!!

  Only 57% of Internet address space is /24s
- Maybe a review of RIPE-178 is needed?
- Proliferation of /24s in the Internet

  why??



# What else?

- **Per region prefix flaps also computed**

  **will appear on website - no space here**

- **Other interesting flap stats?**
- **Measure dampening stats?**
- **Use fixed dampening rather than RIPE-178?**

  **/22s, /23s and /24s are weighted**