RIPE NCC Measurement Infrastructure Update

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For the RIPE NCC New Projects Group
Lorentz Center, October 25, 2002

Outline

- Test Traffic Measurements Service (TTM)
  - TTM 101
  - New features
  - Some nice results
- Routing Information Service (RIS)
  - RIS 101
  - New features
  - Interesting results

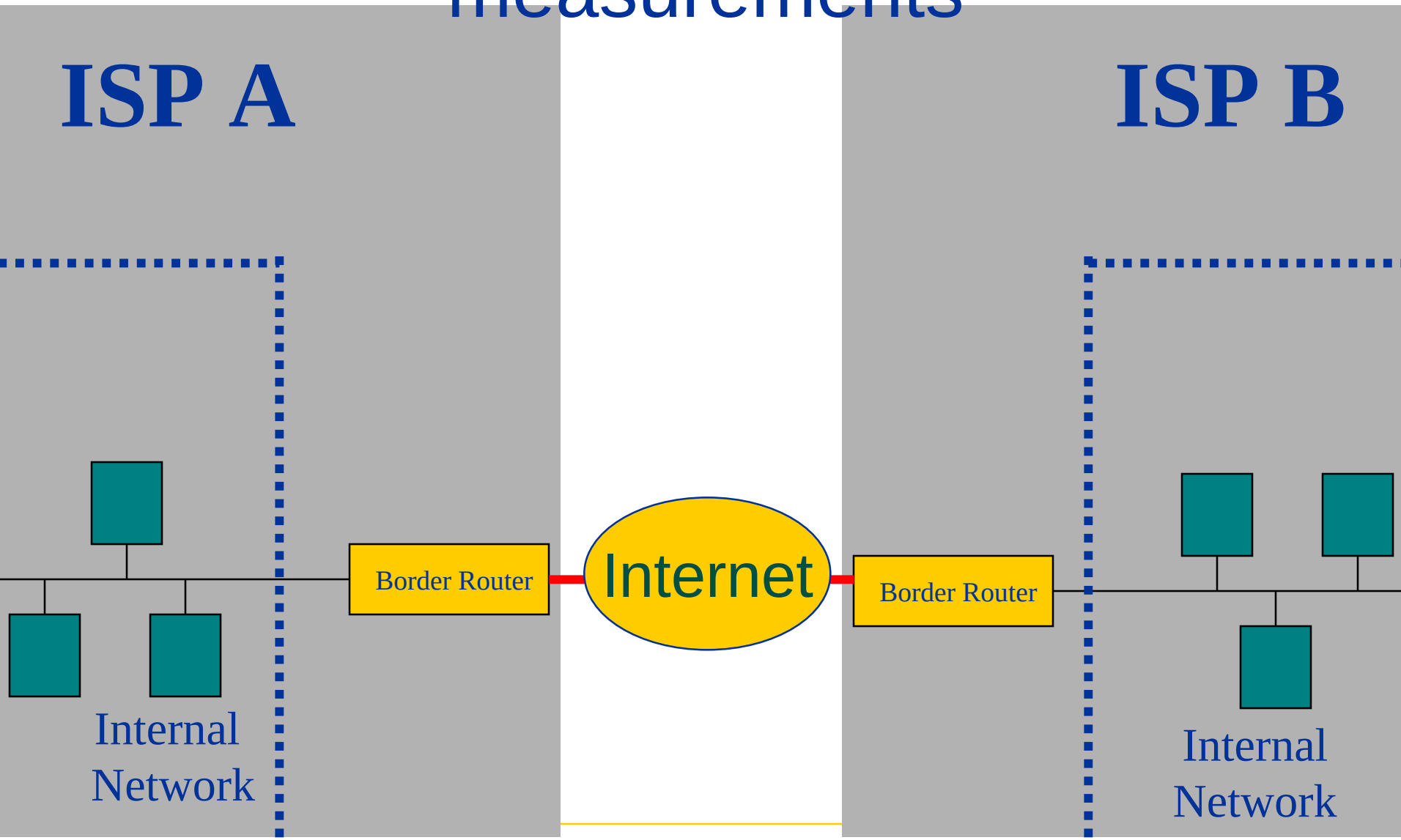
TTM 101

- Project to do measurements on the Internet
- One way measurements
- Dedicated measurement infrastructure
- Active measurements only
- “Real traffic”
- Inter-provider networks only
  - Techniques can be used for internal networks though
- Scientifically defendable, well defined standards
  - IETF IPPM
  - RFC’s: 2330, 2679, 2680, ...

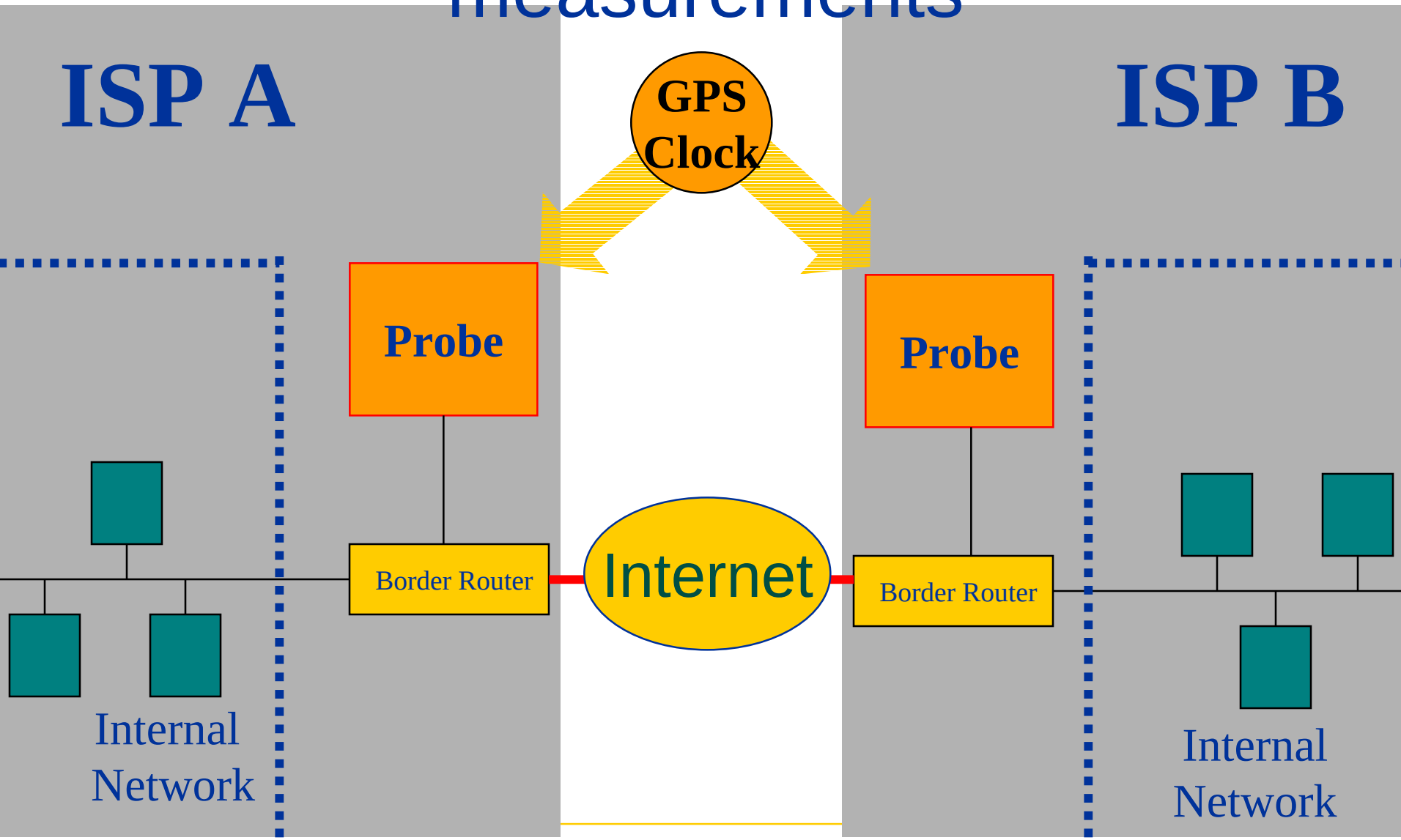
TTM Service Goals

- Black box
  - No configuration by the user
  - No user access
  - Guarantees well-defined environment for the measurements
- Easy to install
- Little maintenance
- Host only has to look at the results

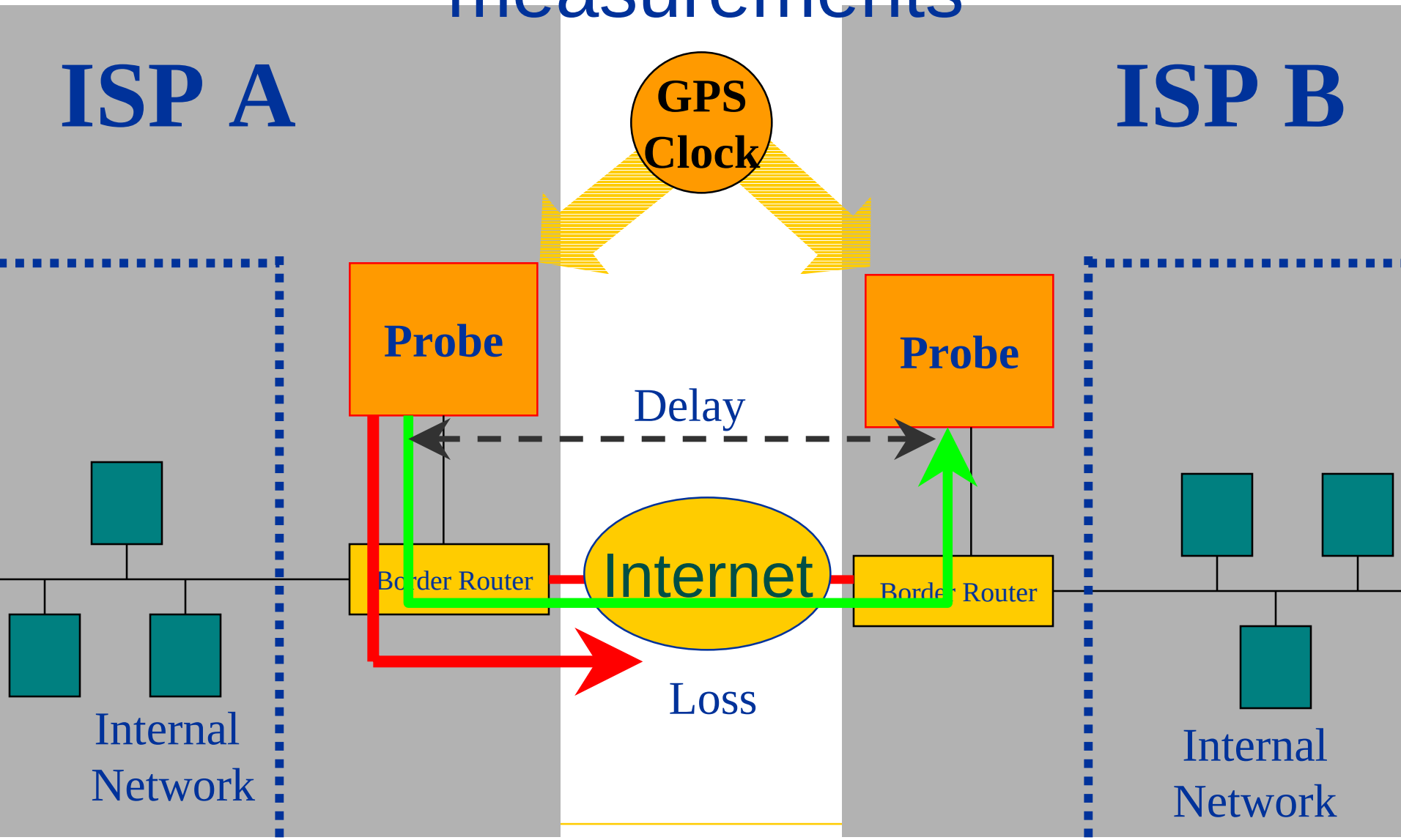
One-way delay and loss measurements



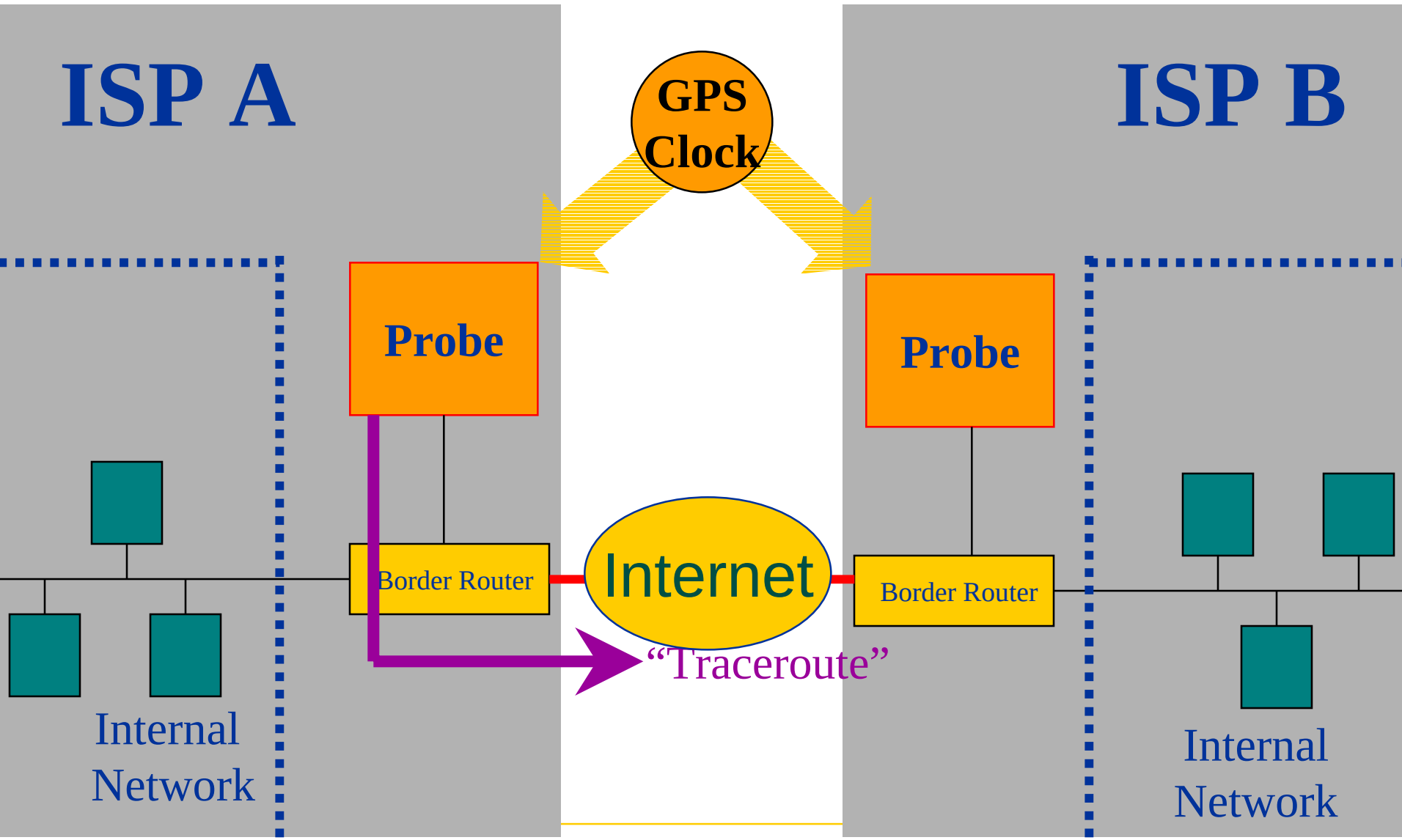
One-way delay and loss measurements



One-way delay and loss measurements



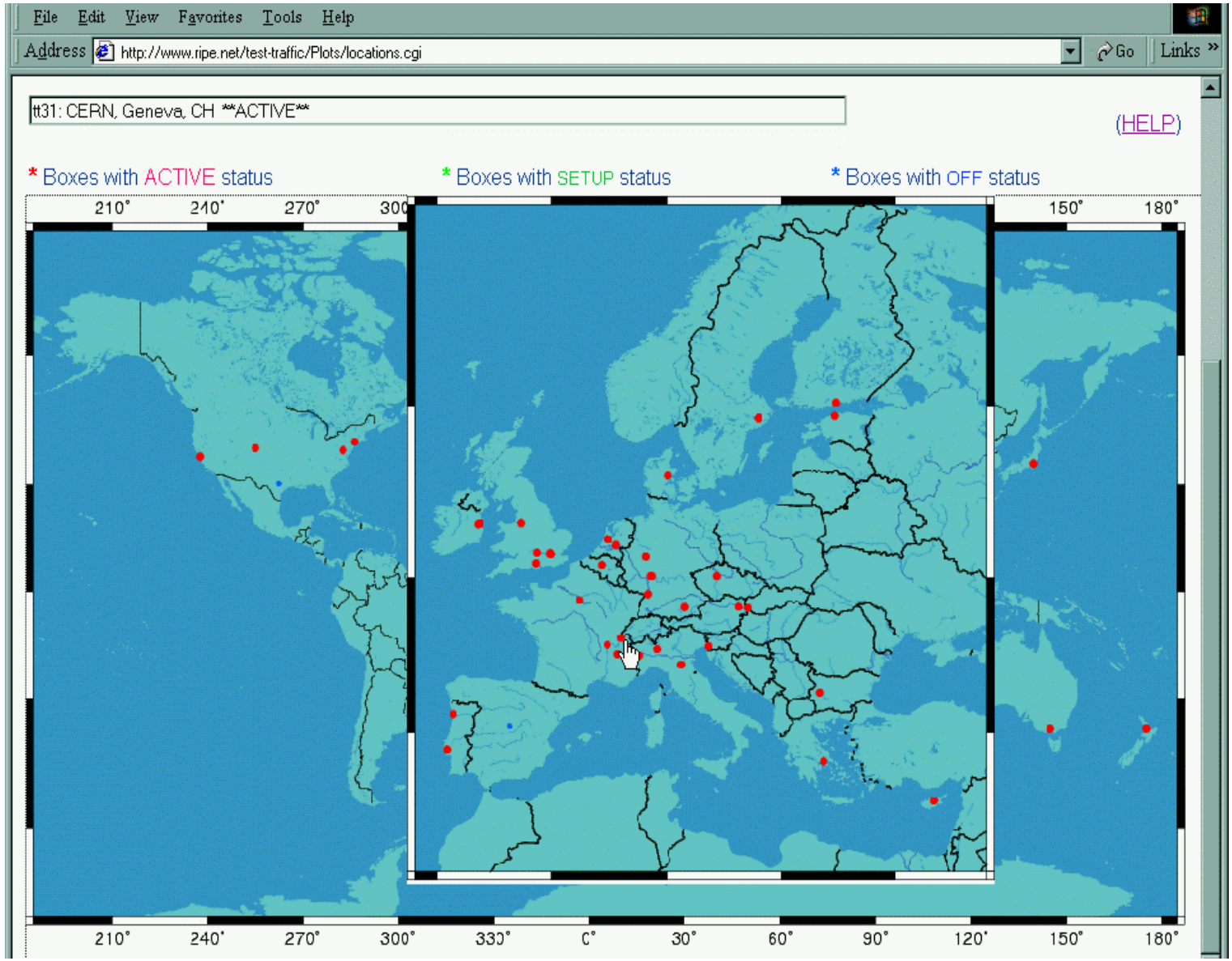
Routing Vectors



Status

- ISP buys a box and a service contract
- About 70 boxes in the field
  - 55 are taking data
  - Need to install another 50 in 2003
- Data set:
  - One way delays between boxes
  - Packet Losses
  - IP-level routing information
  - Alarms
  - Jitter, Trends and other derived metrics
- Raw data available, but also consider buying a box…

Test-box Locations



New Features

- User interface on the box
- CDMA
- Jitter
- Bandwidth
- IPv6 version

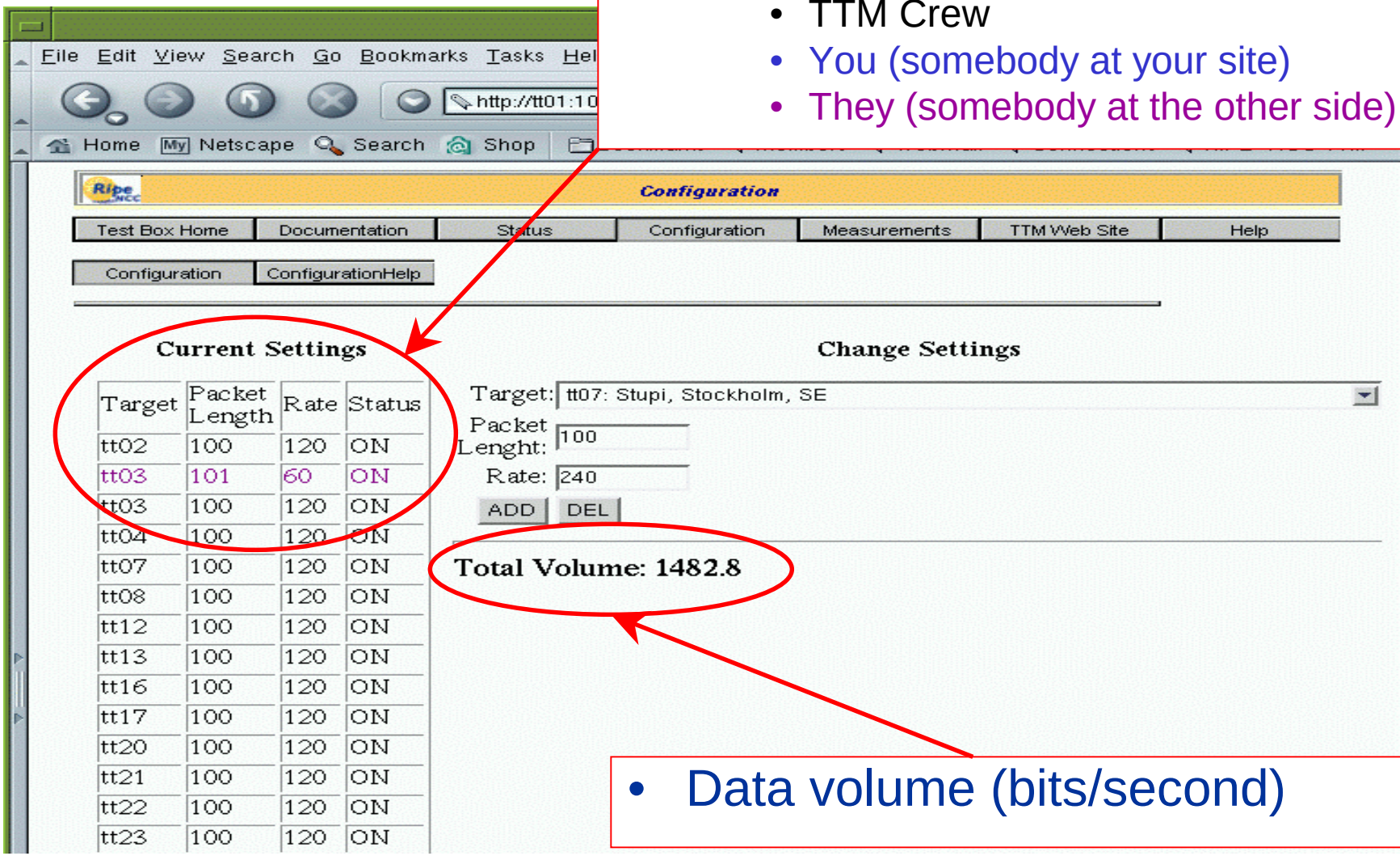
User Interface on the Box

- Configuration: Adjust rates, volumes
- Most recent results

- Public Demo: http://tt01.ripe.net:10259/

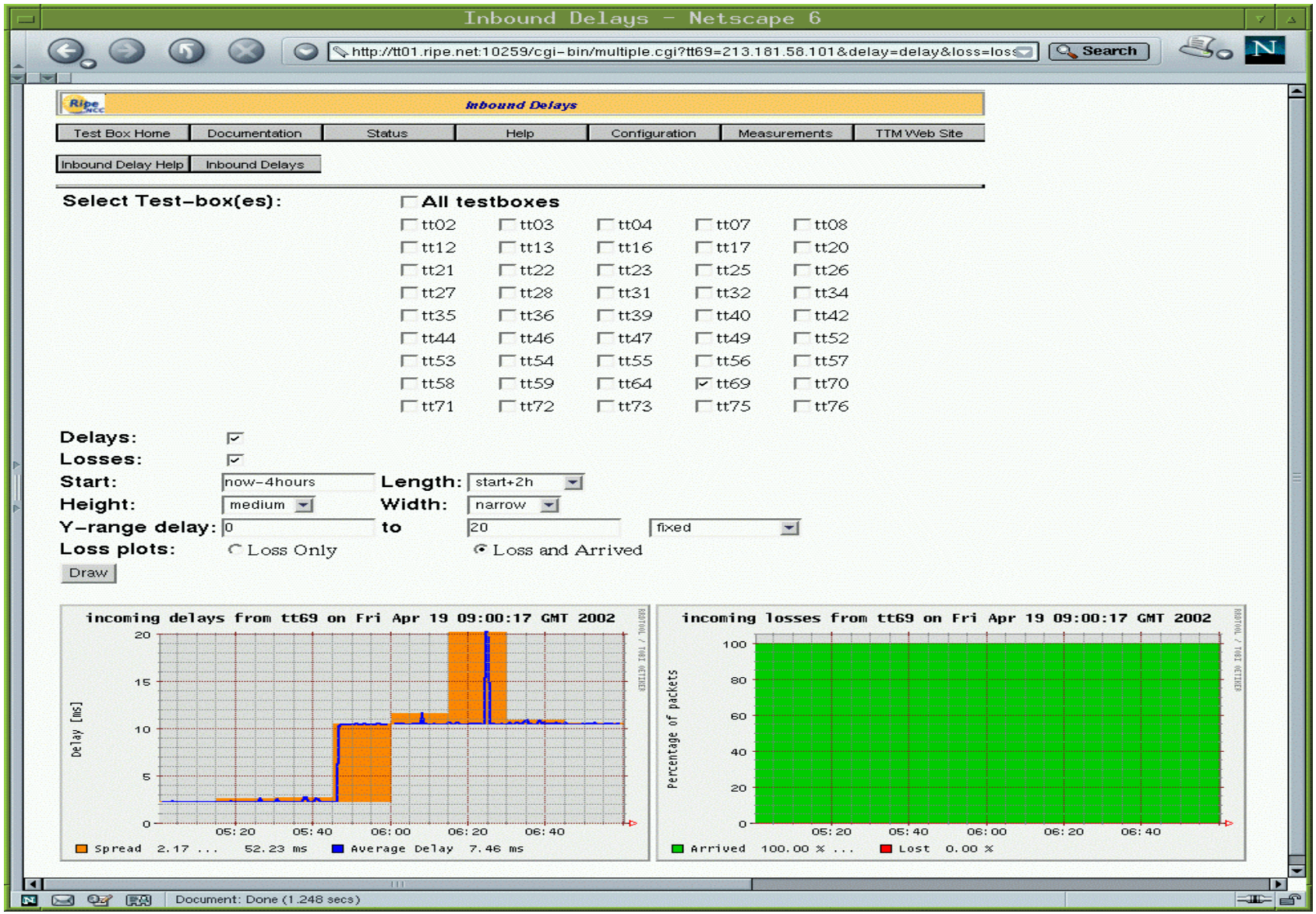
User Interfac

- Current Measurements
  - Rate, target, packet size
  - Status
  - Who set this up:
    - TTM Crew
    - You (somebody at your site)
    - They (somebody at the other side)



- Data volume (bits/second)

User Interface



CDMA Clocks

- We are all aware that installing GPS clocks is not always that easy
- Any alternatives to GPS?

- Recently CDMA became available in North America, Korea, China, Australia
  - Code Division Multiple Access
  - 3rd generation mobile phone standard
- Phones needs a time signal
  - Sync'ed base stations that broadcast a time signal

CDMA vs GPS

GPS	CDMA
• Satellites	• Mobile phone base stations
• Worldwide	• USA, KR, CN, AU only
• Requires view of the sky	• Works everywhere where your mobile phone works
• 100 ns resolution	• Less resolution
• 10µs resolution at the kernel level	• About the same
• Time source are the US DoD atomic clocks	• Same
• Units are cheap	• Same

CDMA Clocks

- CDMA clocks exist
- Praecis CT
  - “Phone without speaker, mike and keypad”
  - http://www.endruntechnologies.com
- X0 communications asked us if our test boxes would work with this unit
- Tried it and…

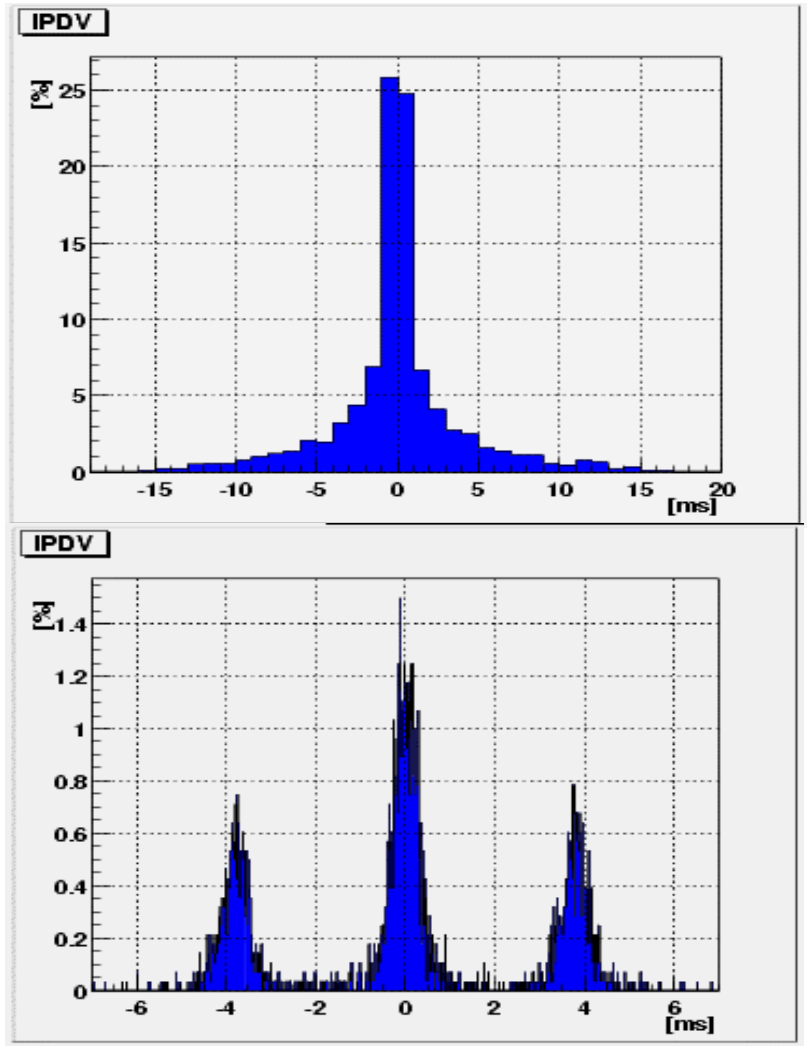
… yes, they do

CDMA version

- Ideal for the US
- UMTS (Europe)? Unclear, investigating
- Contact us if interested

IP-Delay Variations or Jitter

- For some applications, the absolute delay does not really matter
- However, packets should arrive with constant intervals
  - Voice over IP
  - Video on demand
- Metric and Plots



Bandwidth

- The next measurement to be added
- 2 Parameters:
  - C: Total Capacity
  - A: Available Bandwidth
- Method based on packet dispersion
- β-testing

IPv6 version

- IPv6 networks so-far
  - Tunneled over v4
  - Performance monitoring was an afterthought
- 6net project
  - Native IPv6 network
  - Interested in performance measurements from the start
- Use existing products: RIPE NCC TTM
  - Requires an IPv6 version of TTM

Steps

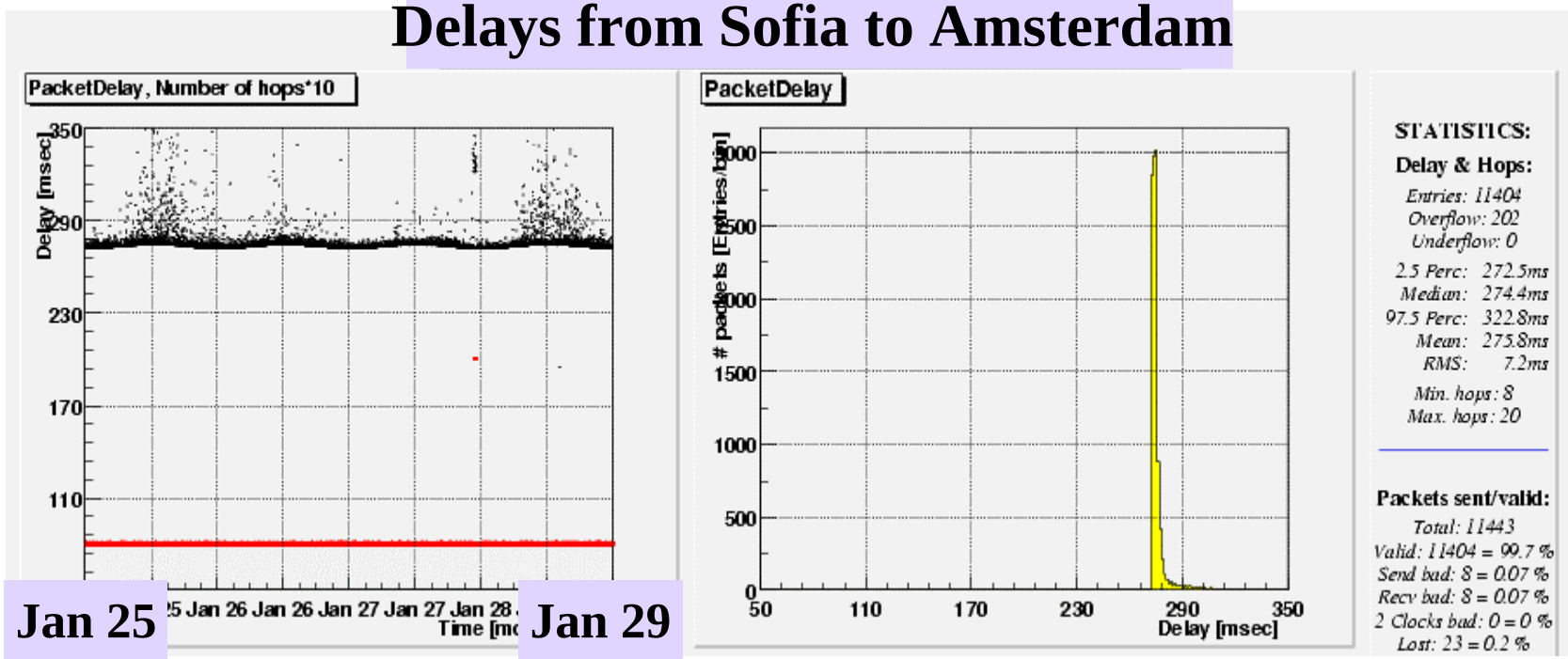
1. Set up IPv6 web server to see the results
   http://2001:610:240:3:2::1
2. Kernel upgrade
   1. FreeBSD 2.2.8 -> FreeBSD 4.6
   2. Dual address Network IF
3. Change send and receive software
   1. 128 bit addresses
   2. Packet format
4. Adapt analysis code.
   1. Formats of addresses
   2. 128 bit addresses
5. Make all supports code v6 compliant
6. Testing and actual measurements

- Done
- Done
- Oct-Dec
- Spring

Some Interesting Results Case #1

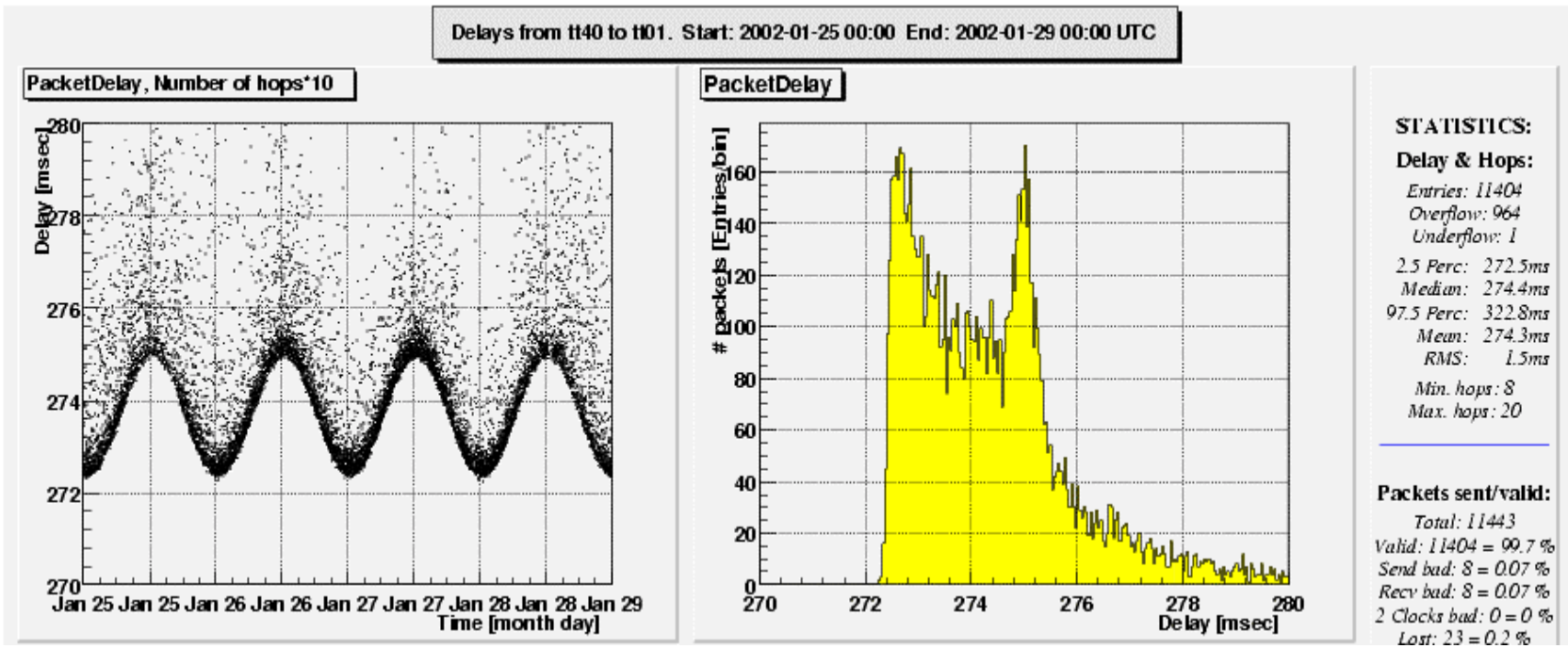
Observation: small variations in minimum delay

Delays from Sofia to Amsterdam



Case Study #1 (cntd)

Zoom in with plots-on-demand:
:



→ Very regular, daily pattern !!

Cause of variations

Minimum delay = delay in routers/switches + transmission delay

Unlikely to be caused by network equipment

- in quiet hours flat baseline expected

→ Variations in transmission delay

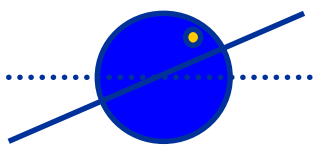
- changes in transmission speed?
- changes in transmission length?
  - 2.65 ms at speed of light (vacuum) = 800 km variation!

Cause of variations (2)

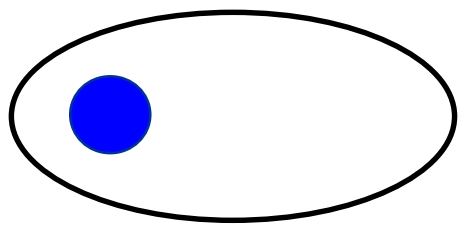
- Traceroutes suggest satellite link:
  - from Sofia up to satellite, down to Vienna, further over terrestrial lines to Amsterdam
- Consistent with absolute delay value (0.27 sec)
  - geostationary satellite 36000 km from Earth center
- Changes in the path of the satellite?
- Search for evidence ...

Satellite orbits

- Geostationary:
  - always same distance, same direction from earth
  - orbital period identical to earth rotational period
- Geosynchronous
  - like stationary orbits, synchronized to earth rotation
  - not necessarily stationary, distance/direction can vary



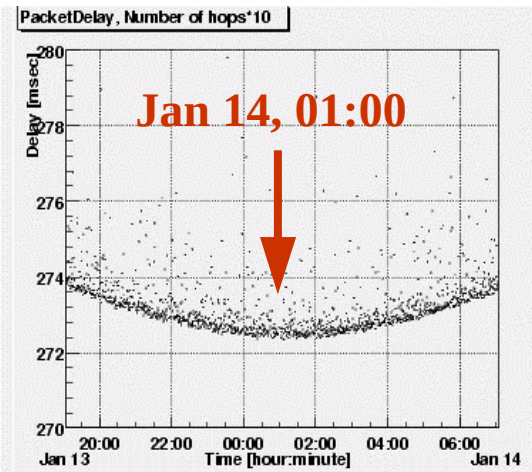
Inclined orbit

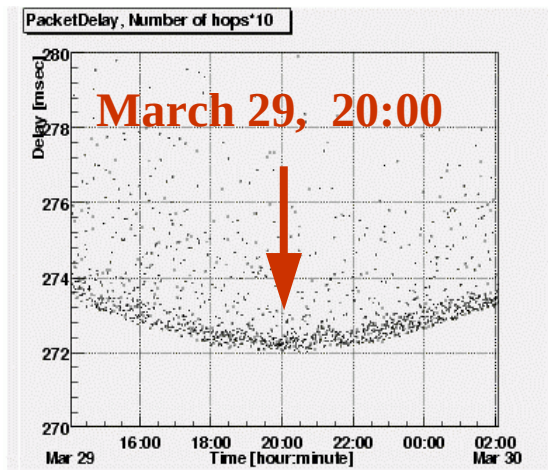


Eccentric orbit

Satellite orbits (2)

- Rotation period of earth in fixed space 23h56m
  - takes 24h before Sun is back at same spot,
    but Earth also orbits Sun, 1 extra day per year
- TTM observes forward shift of 300 min in 75 days
  - low occurs 5 hours earlier, as expected!





Name that Satellite!

- Many geosynchronous satellites deployed
  - catalogue with orbital parameters at `http://hea-www.harvard.edu/~jcm/space/logs/geo.log`
- Can we determine which one is used here?
  - Not from absolute delay values, measurements include both terrestrial and space links, can't break down
  - Approximate location of up and down link are known
  - For each listed satellite compute variation in distance

→ only two close to observed 2.65ms delay variation

- Eutelsat IIF1 at 48 degrees East (2.63ms)
- Eutelsat Hot Bird 4 at 14 degrees East (2.60ms)

Name that Satellite (2)

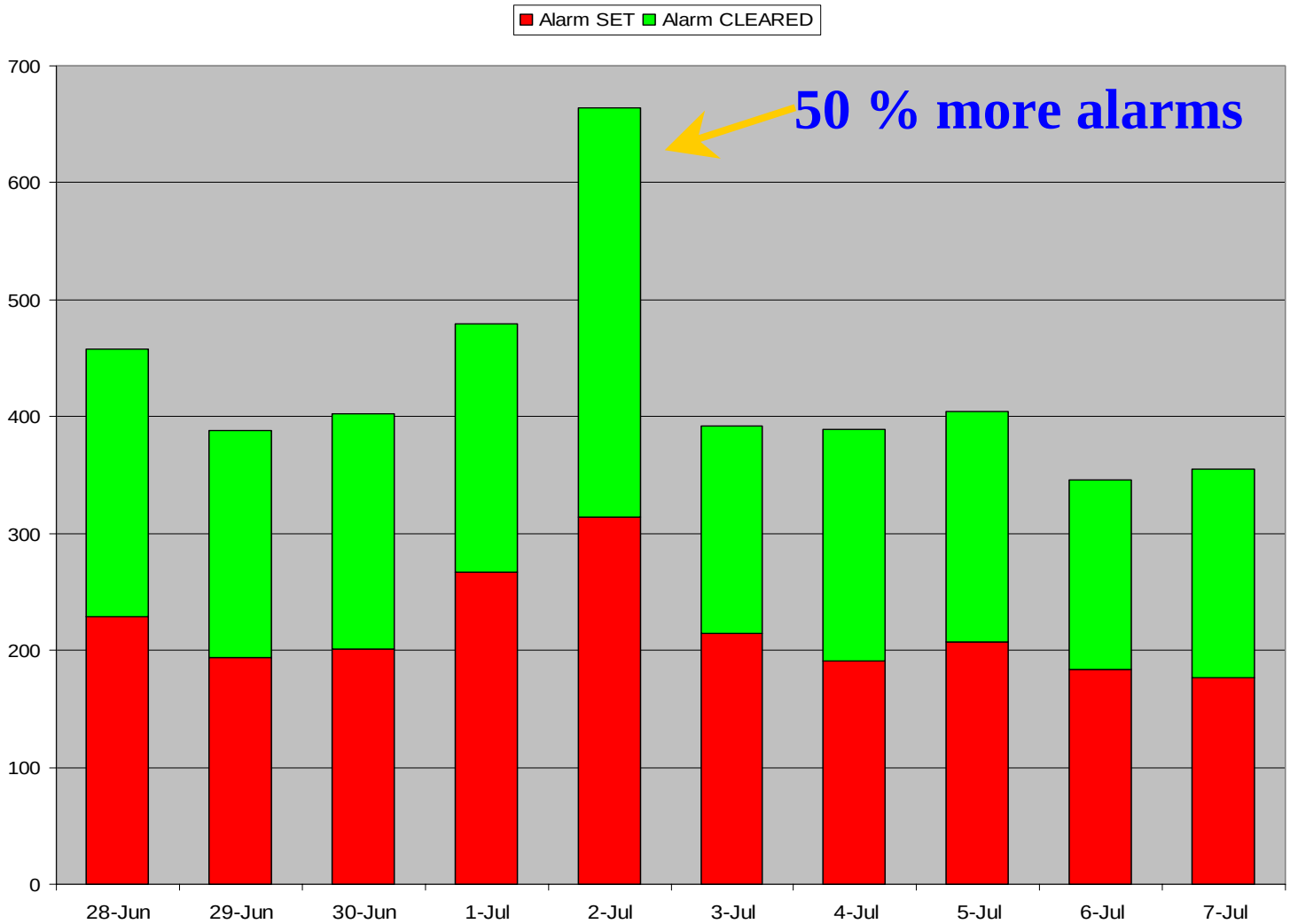
- Eutelsat IIF1
  - old satellite, launched early 1990s, moved from almost stationary to inclined orbit
- HotBird 4
  - part of newer series of Eutelsat satellites, minimal inclination, but eccentric orbit
- Check Eutelsat web site for information
  - Internet backbone links not available from Hot Bird `http://www.eutelsat.com/products/2_2_2_3.html`

→ TTM measurements plus geo catalogue uniquely identify satellite in IP link!

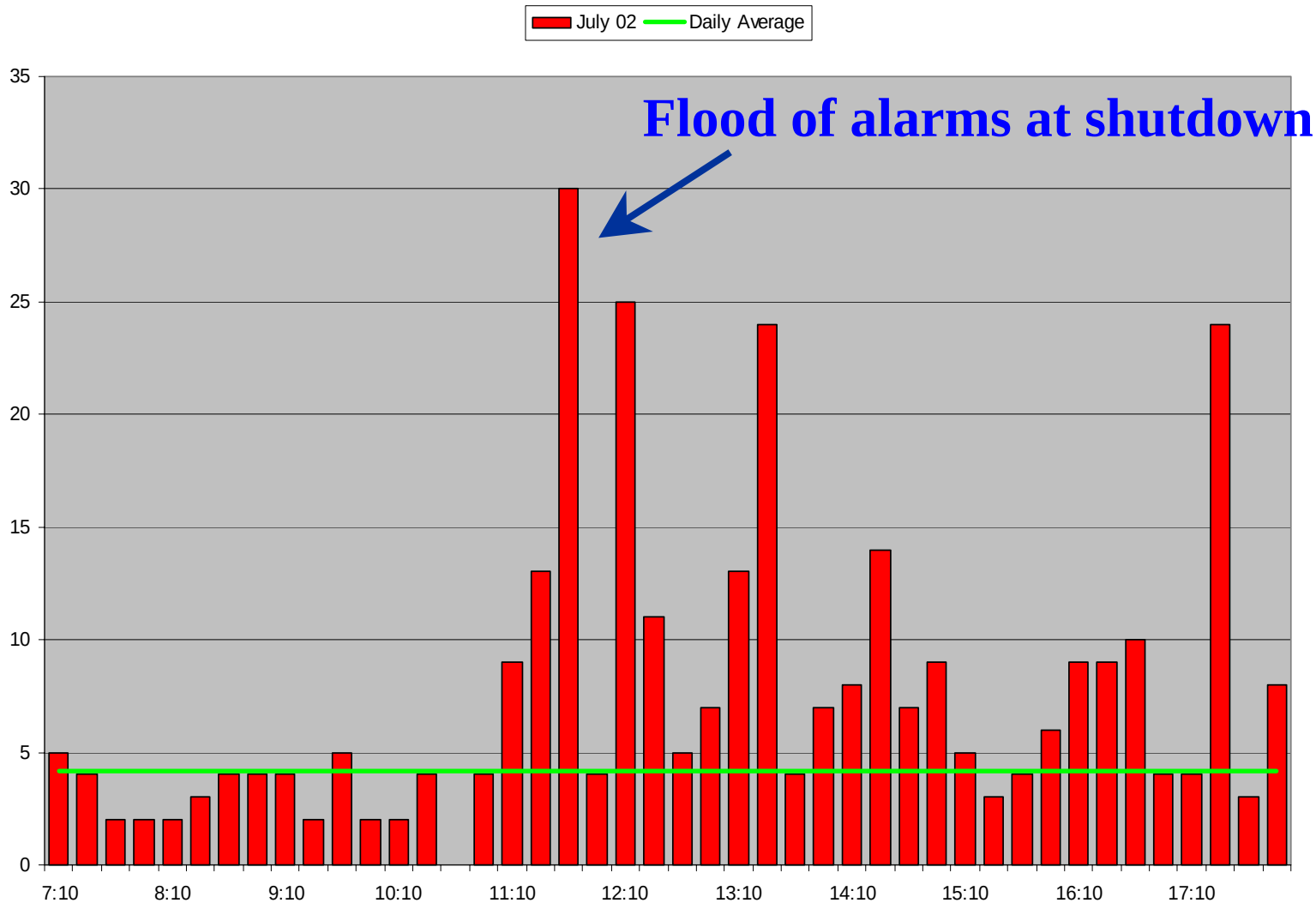
Case Study #2

- On July 2, 2002, shutdown of KPNQwest/Ebone
- Many changes seen by TTM
  - outages, increased delays
  - most short lived, settled later that day
  - some longer lasting effects on traffic
- Highlights of TTM observations in next slides

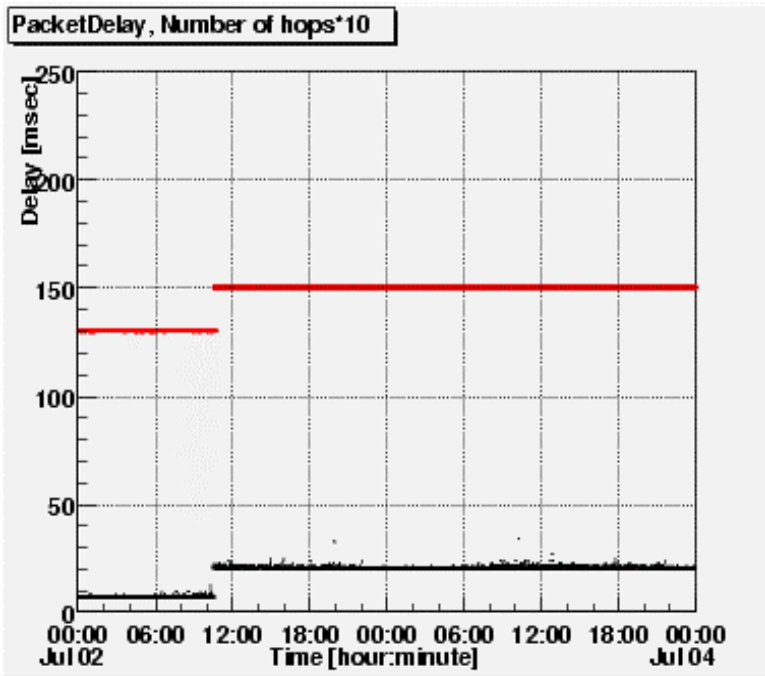
Delay Alarms, daily



Delay Alarms, hourly



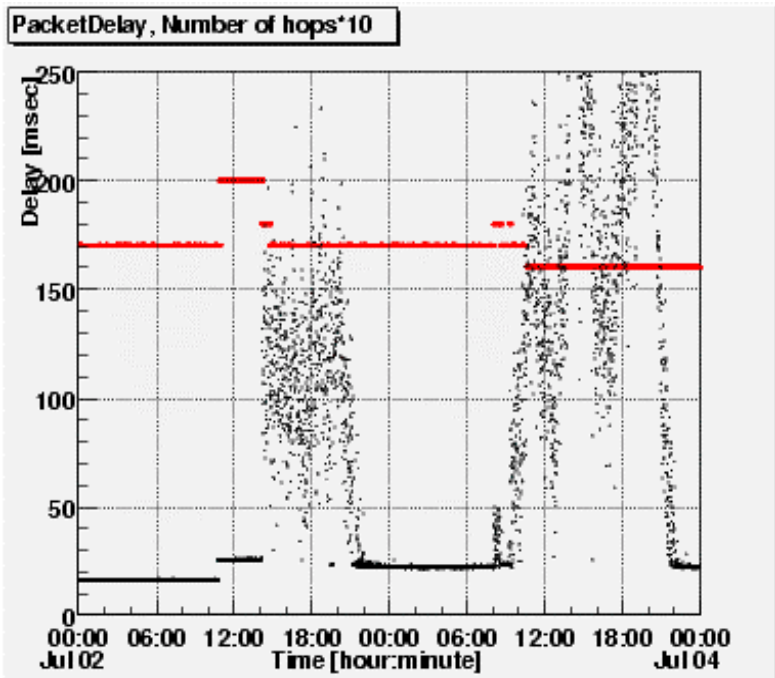
Ebone Shutdown: Connections getting slower



Delays from Karlsruhe to Vienna increased 13ms

- geographically more direct Ebone path replaced by a route through KPNQwest to London and from there with Sprint via Paris to Vienna.

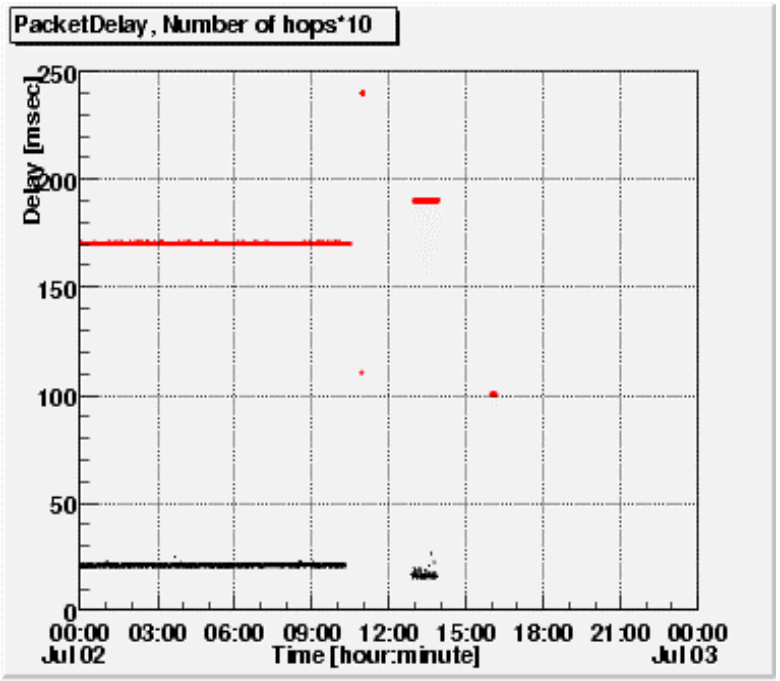
Ebone Shutdown: Overloaded network links



Bratislava - Karlsruhe

- saturated during daytime
- similar pattern seen in traffic to Denmark
- long term data shows a real change in trends, delays between the sites never saturated before

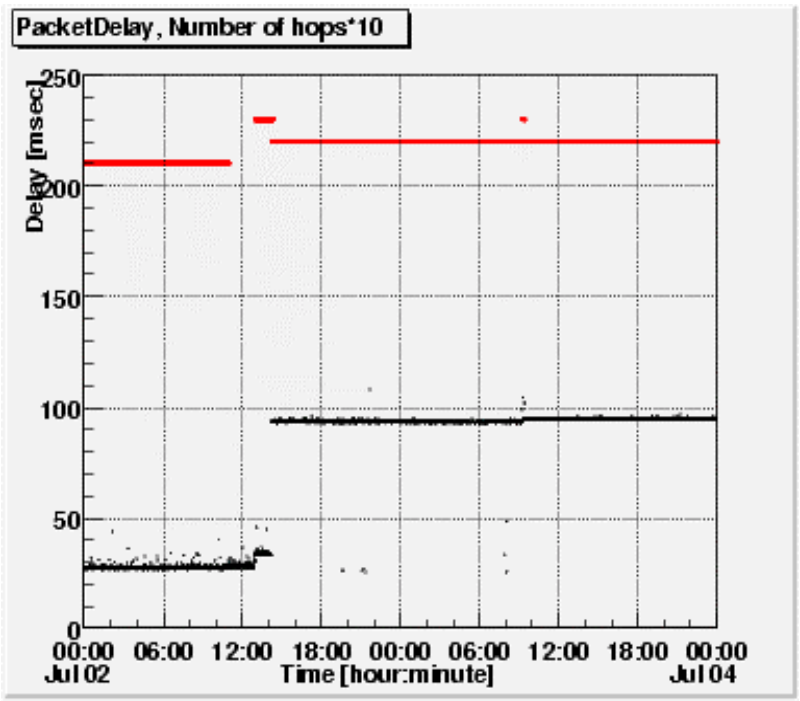
Ebone shutdown
Connection fully broken



Stockholm - Munich

- all packets lost
- site has only one path (ebone)
  to the testbox in Munich
- last Ebone activity between 1300 and 1400 July 2nd

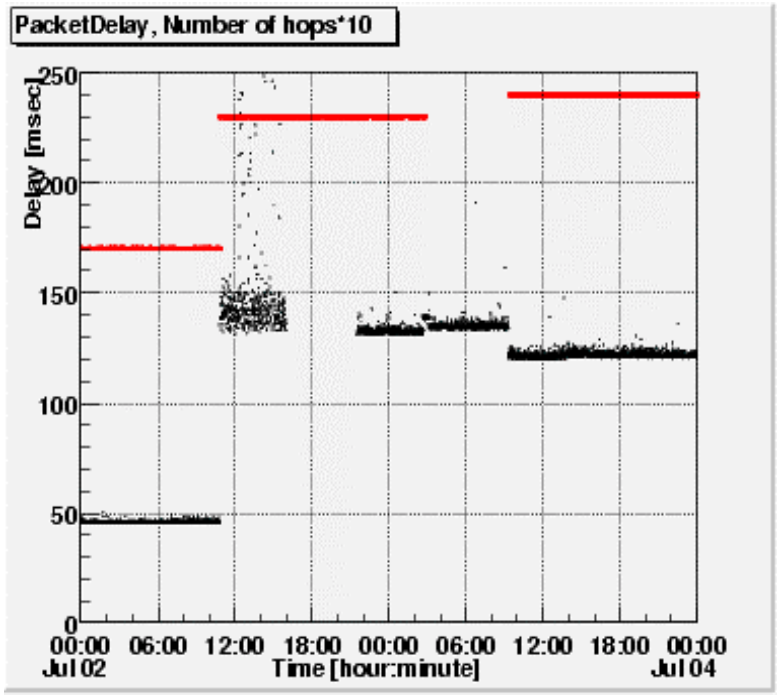
Ebone Shutdown: European traffic routed via USA



Bratislava < > Dublin

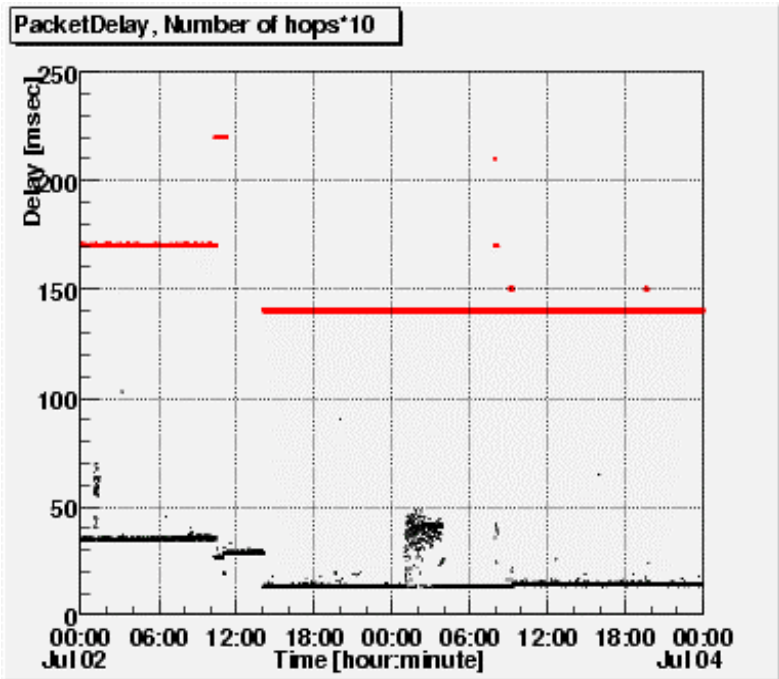
- *both* directions delays 75 ms up
- leaving & entering Bratislava via Sprint/USA
- seen to a Frankfurt site as well

Ebone Shutdown:
US East coast via San Jose



- Munich - Armonk (New York)
  - transatlantic delays up 80ms
  - new backbone provider routes traffic to US West Coast, then via Qwest back to New York

Ebone Shutdown:
Not all changes are bad!



Bratislava - Amsterdam

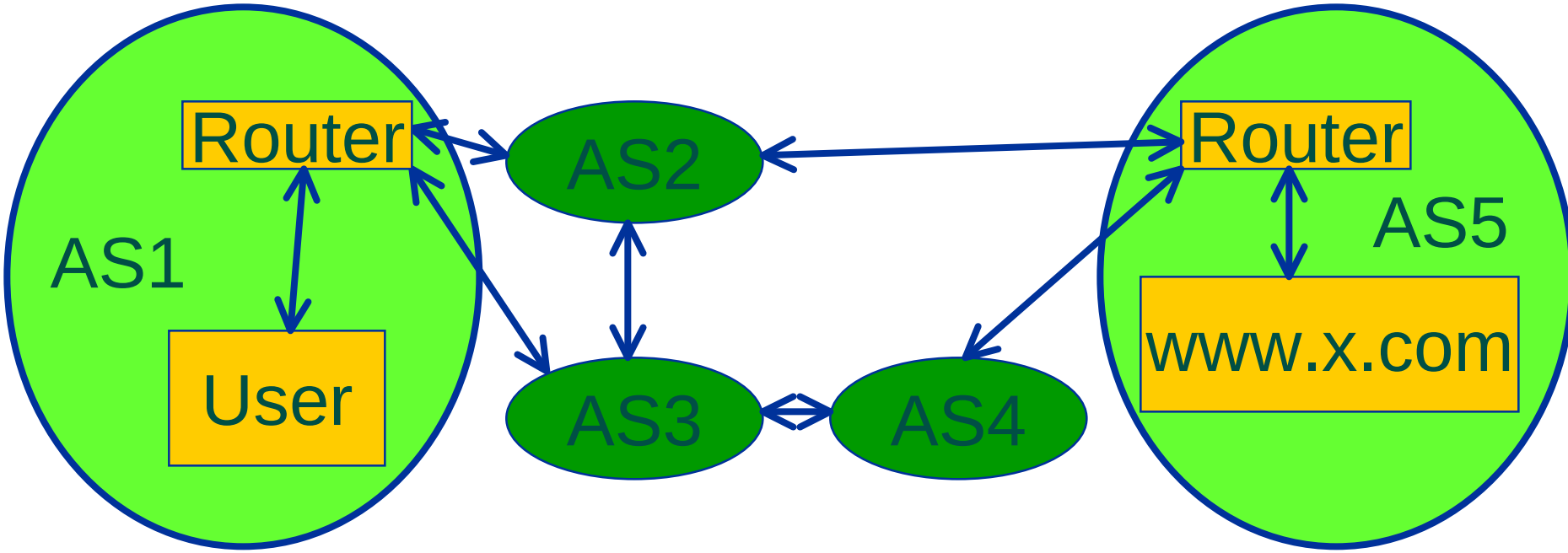
- delays 20ms *down*
- used to be routed via Ebone/UUnet , now via Sprint and Level3

Conclusion

- Impact of Ebone shutdown limited
- A lot of rerouting, backups had been arranged
  - new routes not always optimal, higher delay
  - sometimes really overshooting, via US
  - most settled the same day, rest in following weeks, months
- The internet did not come to a halt
  - of the (then) 2116 measured relations, only one broken, with 100% packet loss

Routing Information Service

RIS 101



- AS1's NOC gets a user complaint:
  - *"Last night, I could not reach www.x.com."*
- AS1's NOC looks at the current routing tables
  - *"Well, it works now"*

Motivation

- Something is wrong with your routing
- Current tools:
  - Log in to your router
  - Use a looking glass on other routers
- Problems:
  - How to find right looking glass?
  - What if the looking glass cannot be reached either?
  - Accessing multiple LG's takes a lot of time
  - No history mechanism
- Solution: Routing Information Service (RIS)

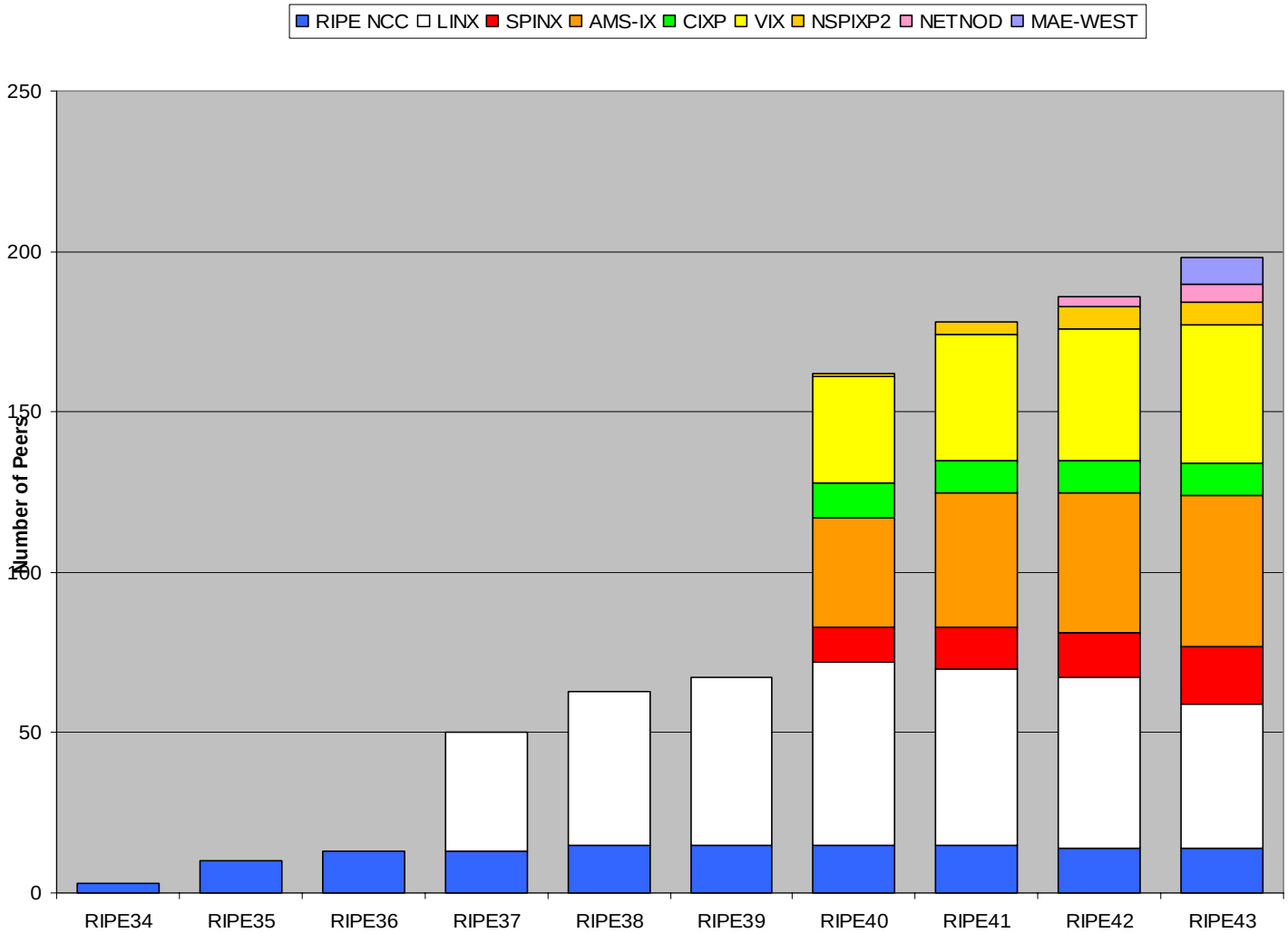
Goals of the RIS

- Collect default-free time-stamped BGP announcements between AS's and store in a data base
  - At several points on the Internet
- Set up interactive queries to database
  - Giant looking glass with history
  - Network reachability from other networks
- Provide raw data
  - for reality checks, RRCC project
  - to generate trend analysis
- Available to the Community

Peering Sessions over Time

Collection Points

- RIPE-NCC
- LINX
- SFINX
- AMS-IX
- CIXP
- VIX
- NSPIXP2
- NETNOD-IX
- MAE-WEST



RIS Total: 199 (+13)

Features

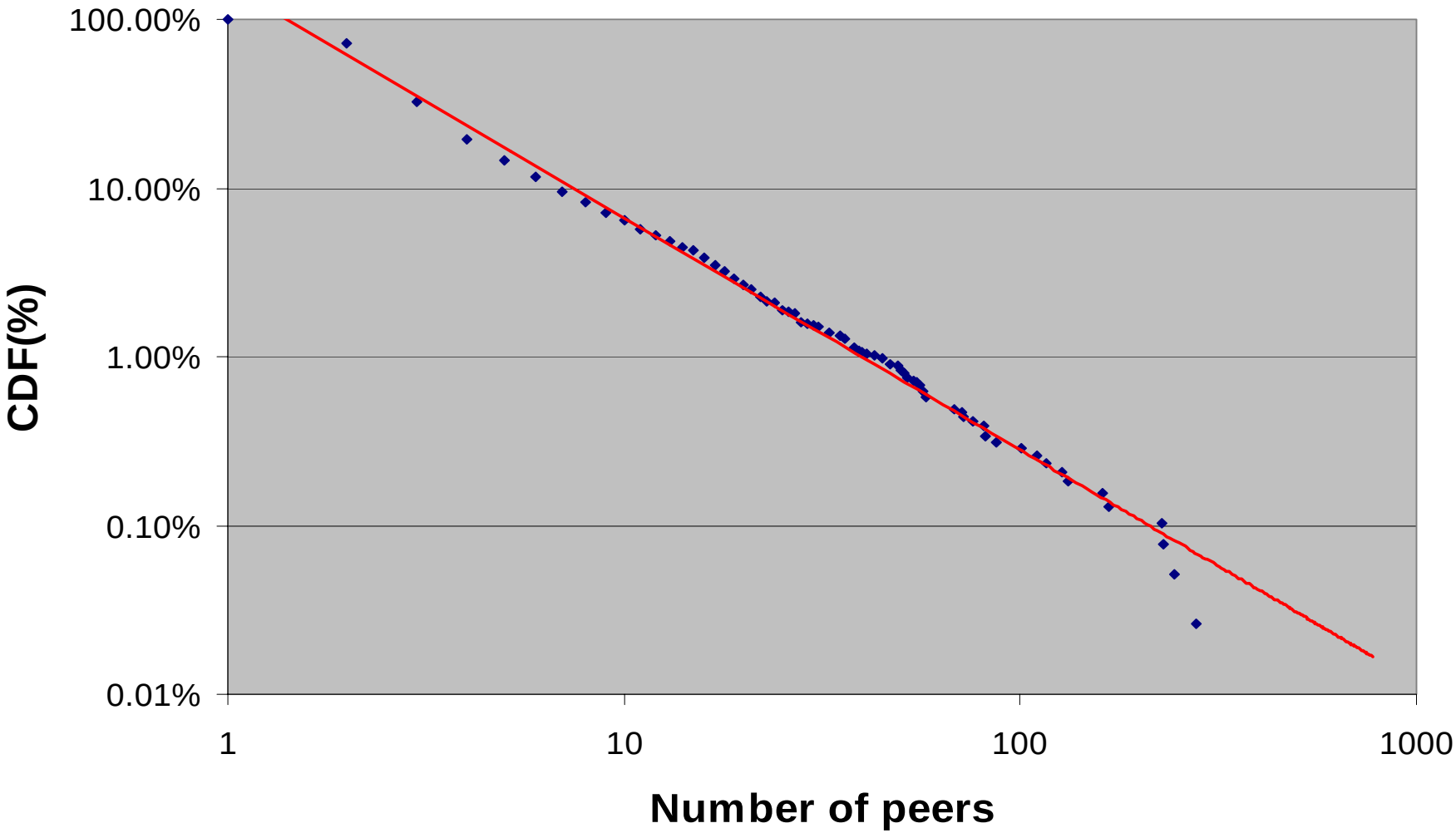
- Raw data
- Queries
  - Search for AS or Prefix
  - Updates for AS
  - AS in use
- Tables and graphs
  - Martians
  - Plots
  - Black holes
  - Hot Spots

Other assorted Results
Number of peers per AS

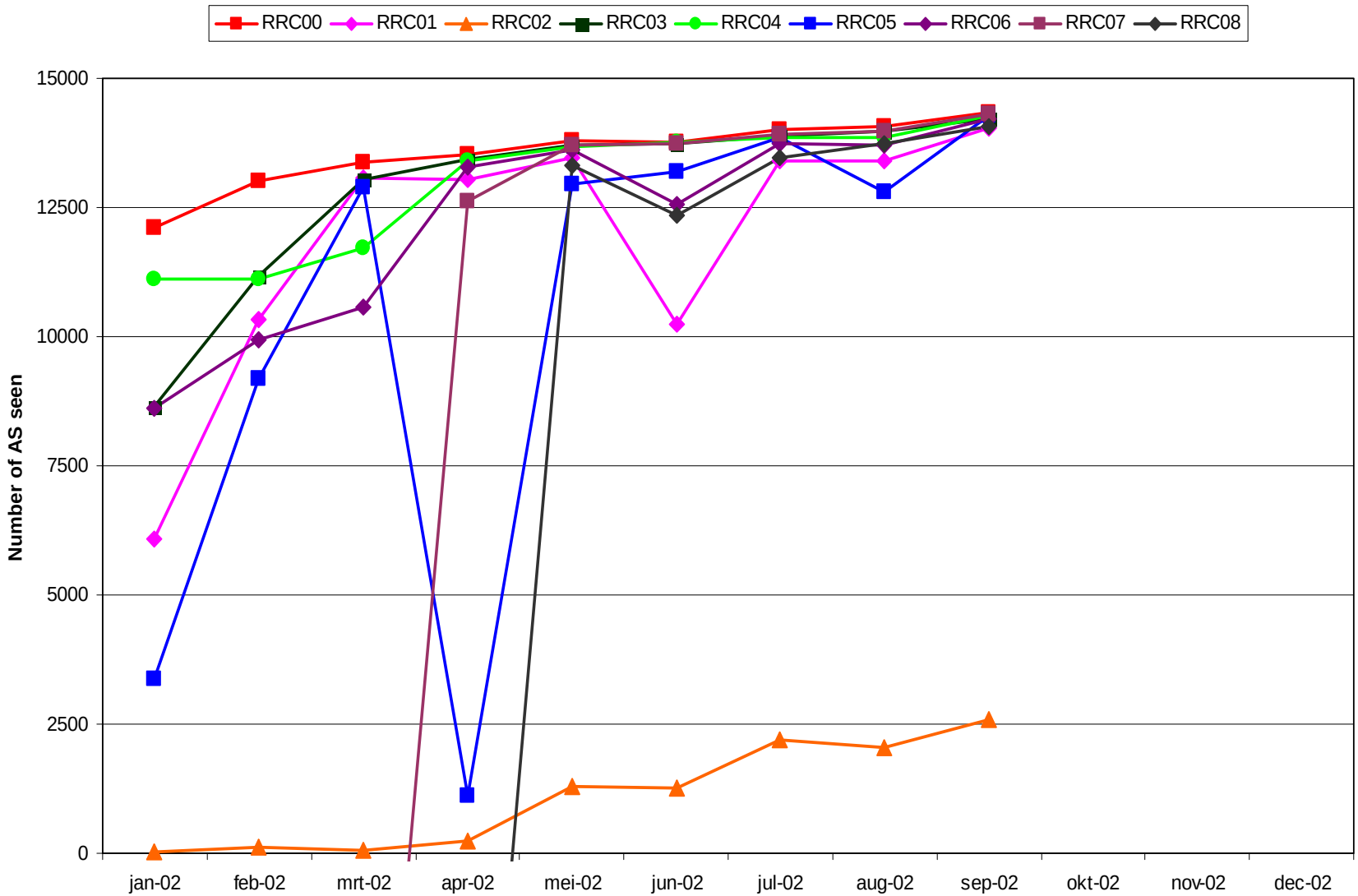
- Number of peers per AS
  - Lots of ASes will peer with 1 or 2 others
  - Few ASes will peer with everybody
- Search number of peers for each AS
- Calculate CDF: Fraction of ASes with $\geq$ n peers
- Graph theory suggests a power law here:

  cumulative distribution function (cdf) = n^a
- This is indeed the case

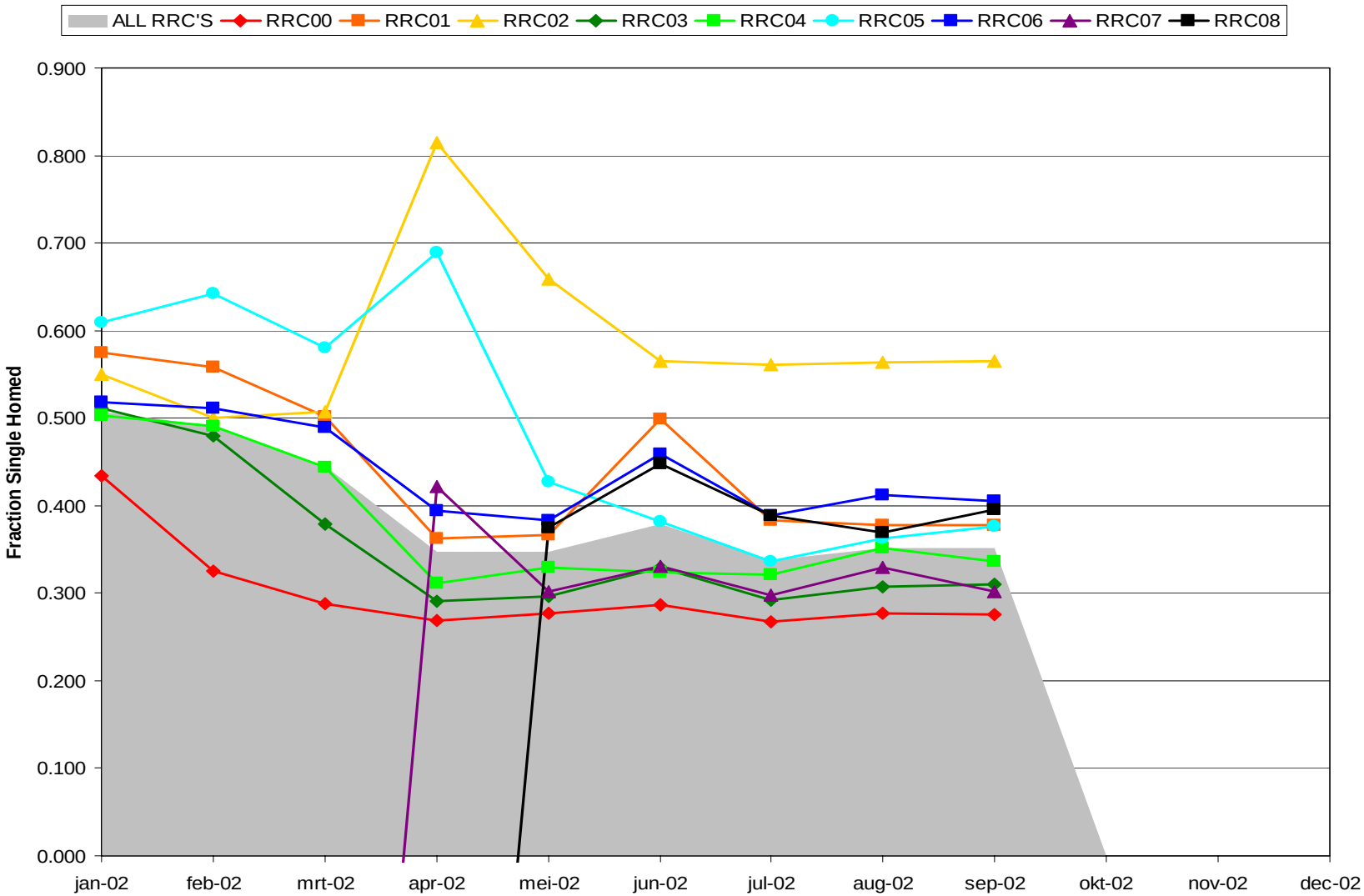
CDF for the number of peers



Number of AS seen



Fraction Single-Homed



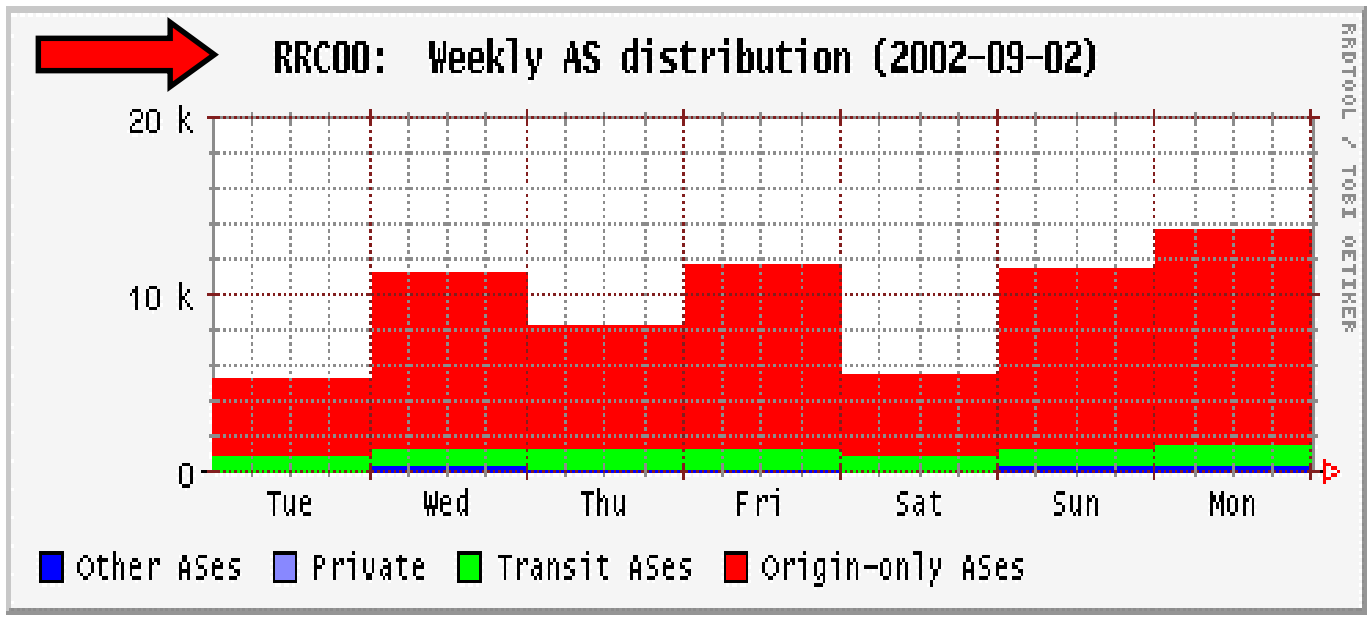
IPv4 Prefixes
RRC00 and the RIS (8/2002)

	RRC00	RIS
– ARIN:	61115	61343
– LACNIC:	4675	4675
– Pre-registry:	31013	31697
– RIPE:	20541	22781
– APNIC:	19959	19968
– IANA:	10	10
– RFC1918:	3	14
– TOTAL:	137316	140488

– URL: http://www.ris.net/ris/query.html (RIS Statistics)

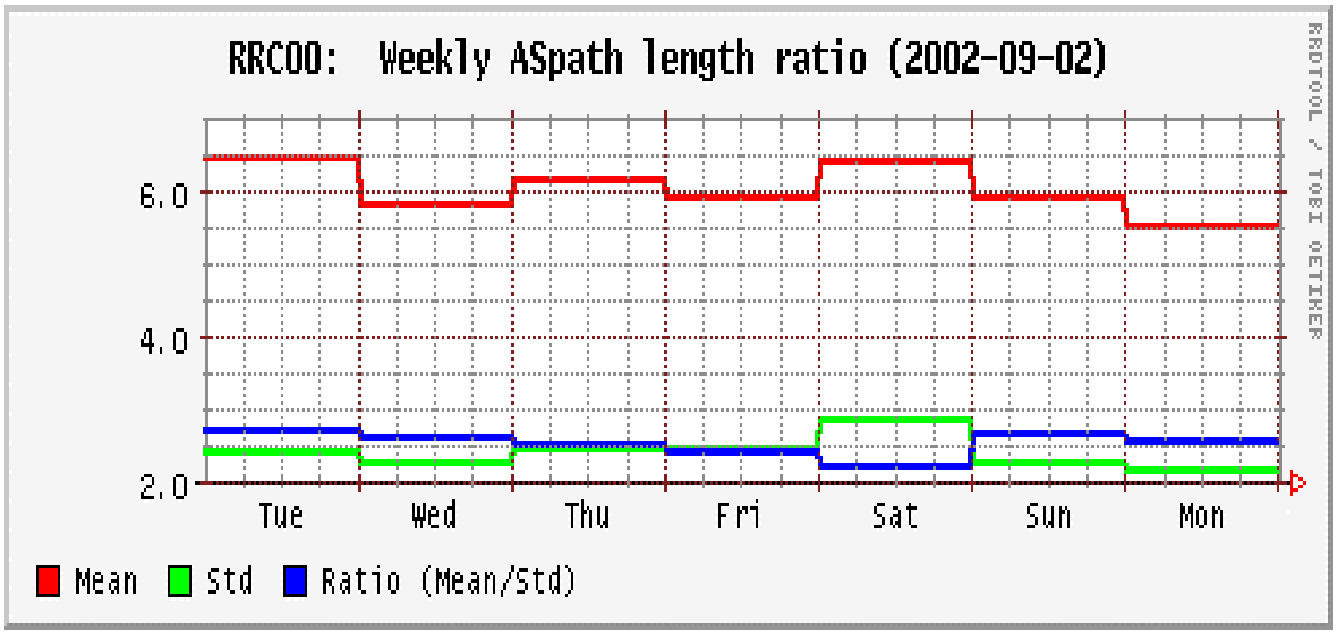
- Single- and multi-homed ASes per RRC
- Prefixes (overall/per RRC)

Types of ASes seen by the RIS



- Long term trends interesting

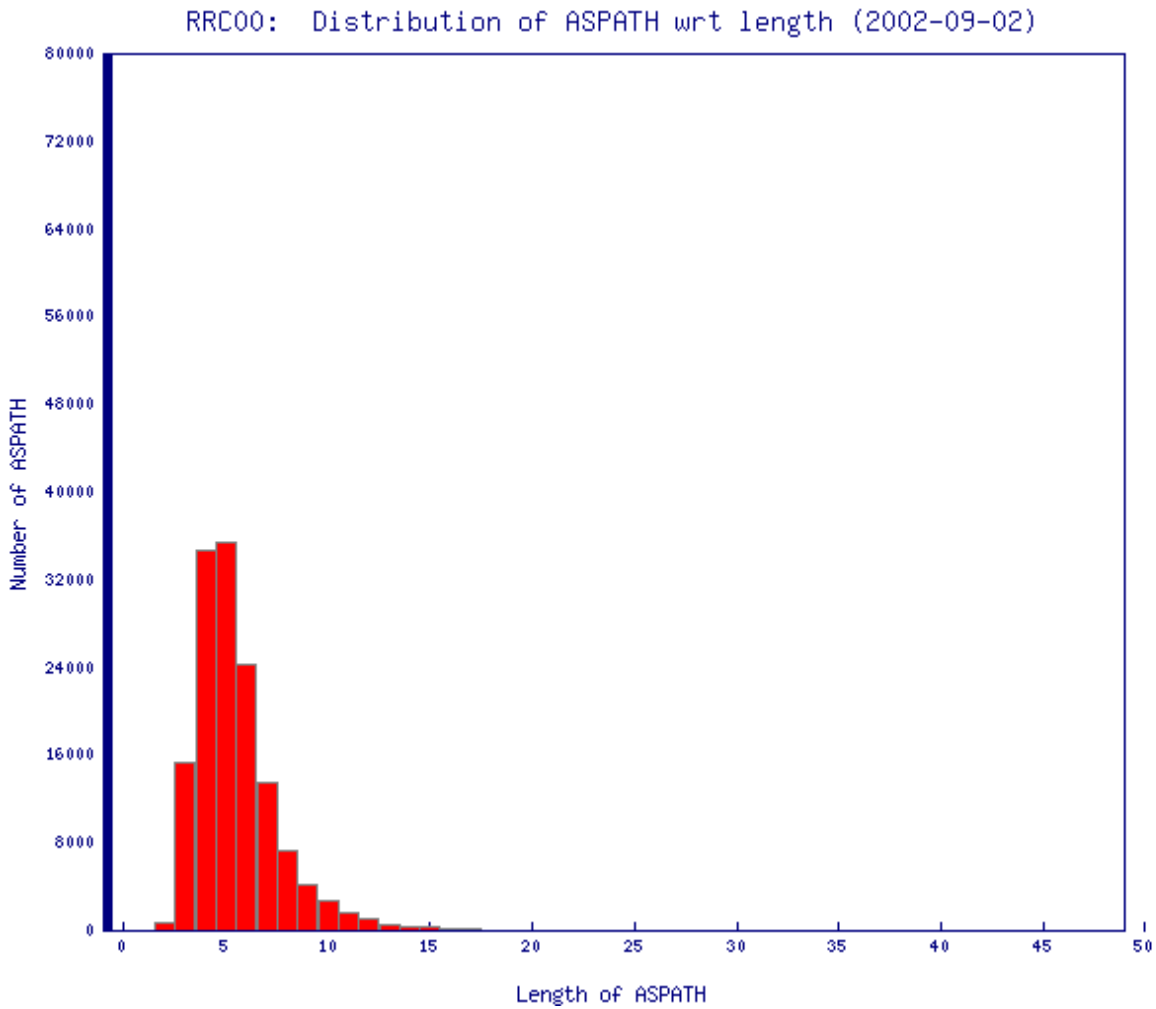
Average AS Path Length



- Mean: around 6
- Std Dev & Ratio: between 2 and 3

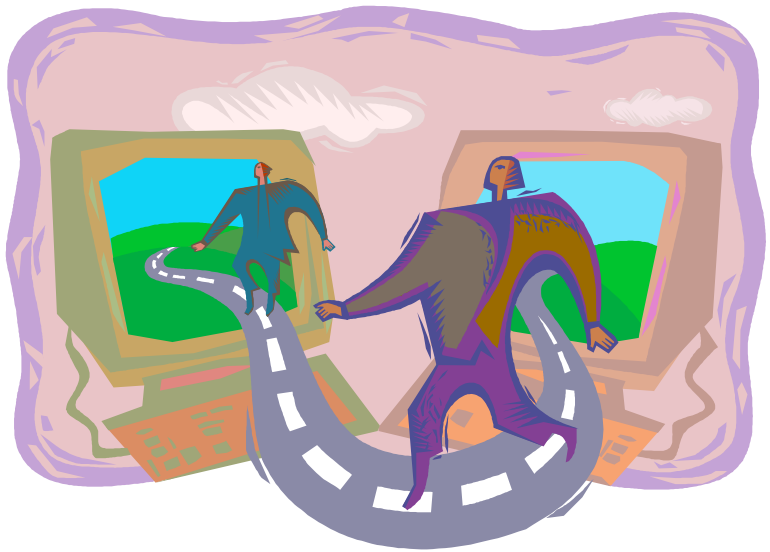
Distribution of AS Path Length

- As was seen previously, mean AS Path length is approx 6



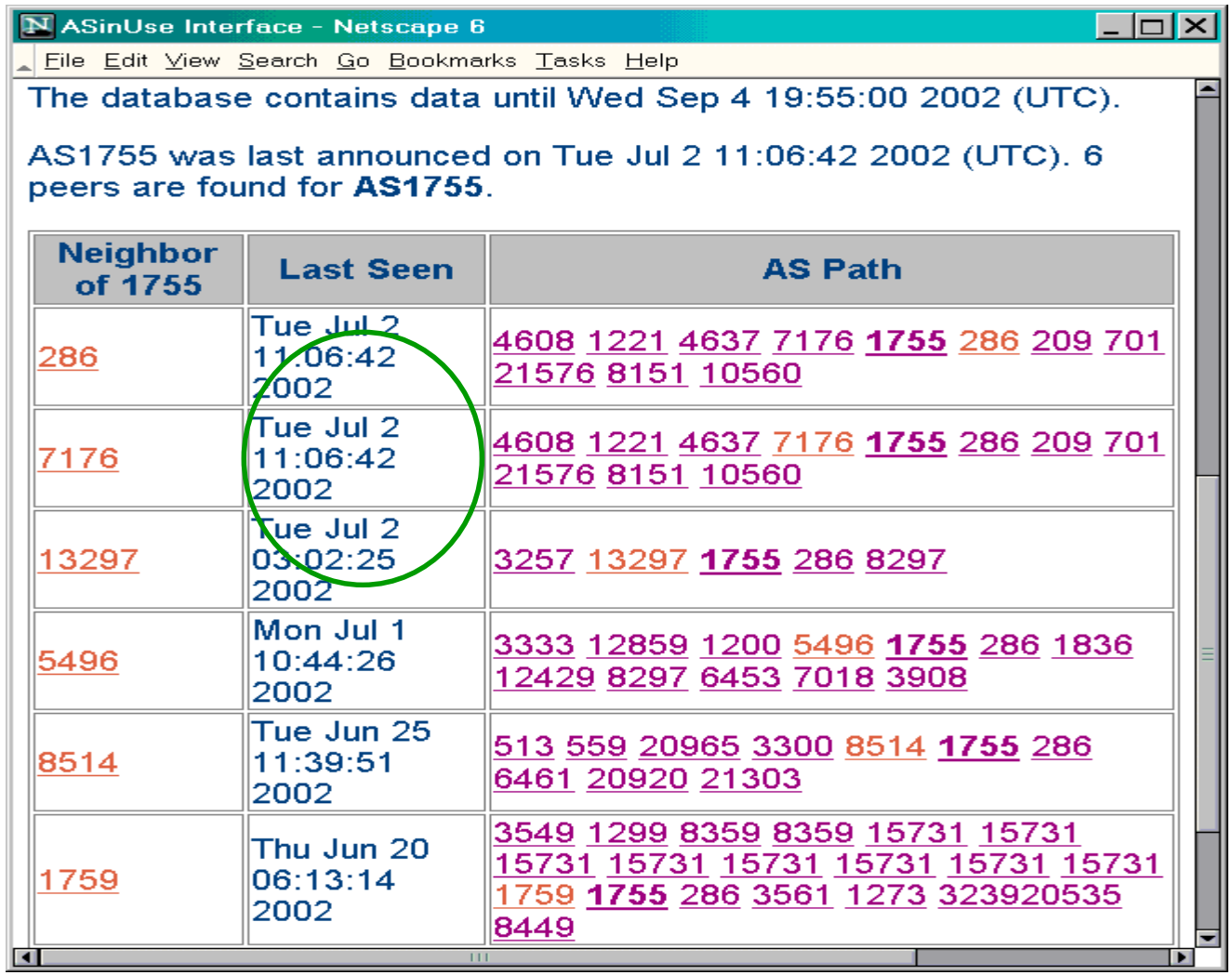
Ebone Shutdown as observed by the RIS

- KPNQwest (AS286) buys Ebone (AS1755) in October, 2001
- Migration of routers and customers to KPNQwest in the beginning of May, 2002



- Ebone shut down on the 2nd of July, 2002

RIS' Last Record of Ebone



ASinUse Interface - Netscape 6

File Edit View Search Go Bookmarks Tasks Help

The database contains data until Wed Sep 4 19:55:00 2002 (UTC).

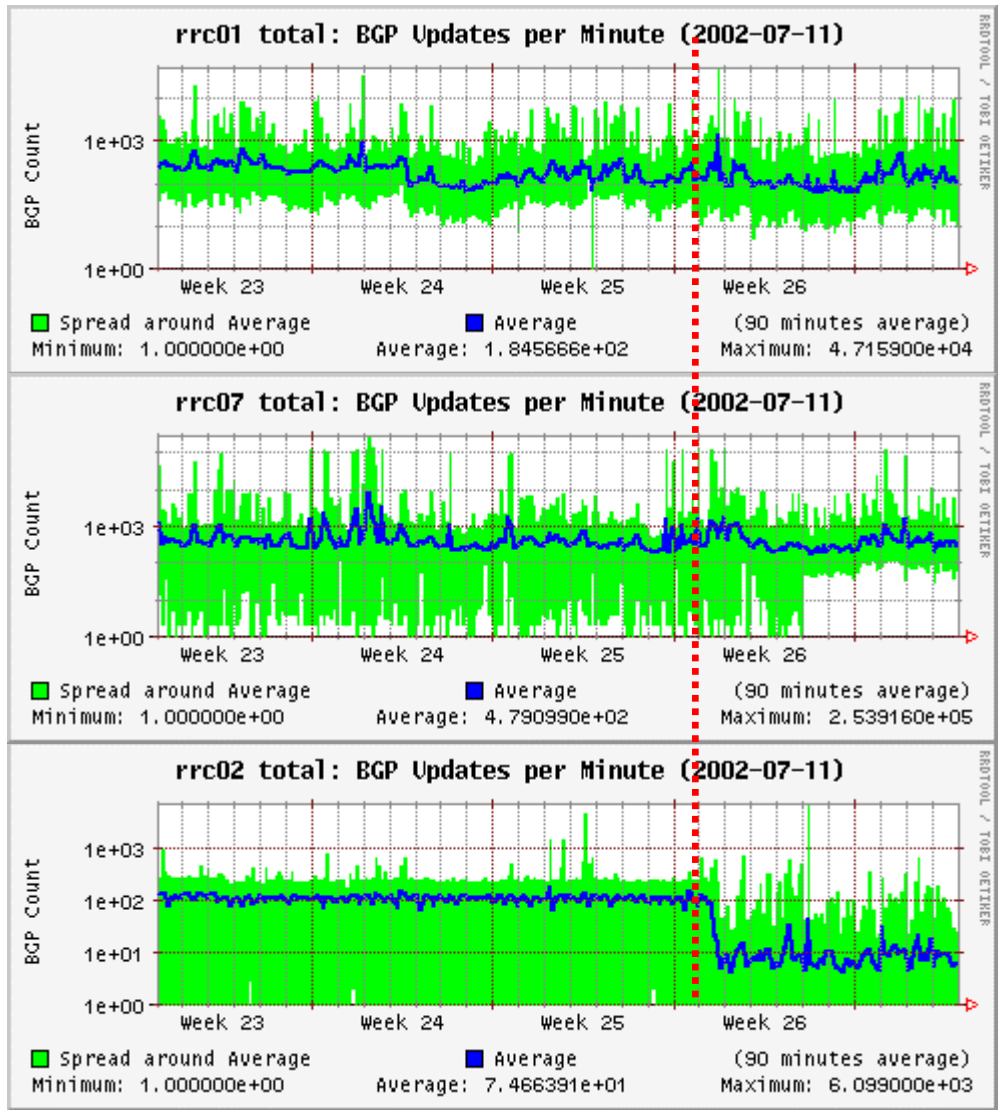
AS1755 was last announced on Tue Jul 2 11:06:42 2002 (UTC). 6 peers are found for **AS1755**.

Neighbor of 1755	Last Seen	AS Path
286	Tue Jul 2 11:06:42 2002	4608 1221 4637 7176 **1755** 286 209 701 21576 8151 10560
7176	Tue Jul 2 11:06:42 2002	4608 1221 4637 7176 **1755** 286 209 701 21576 8151 10560
13297	Tue Jul 2 03:02:25 2002	3257 13297 **1755** 286 8297
5496	Mon Jul 1 10:44:26 2002	3333 12859 1200 5496 **1755** 286 1836 12429 8297 6453 7018 3908
8514	Tue Jun 25 11:39:51 2002	513 559 20965 3300 8514 **1755** 286 6461 20920 21303
1759	Thu Jun 20 06:13:14 2002	3549 1299 8359 8359 15731 15731 15731 15731 15731 15731 15731 15731 15731 1759 **1755** 286 3561 1273 323920535 8449

- AS1755 last observed on Tuesday the 2nd of July, 2002

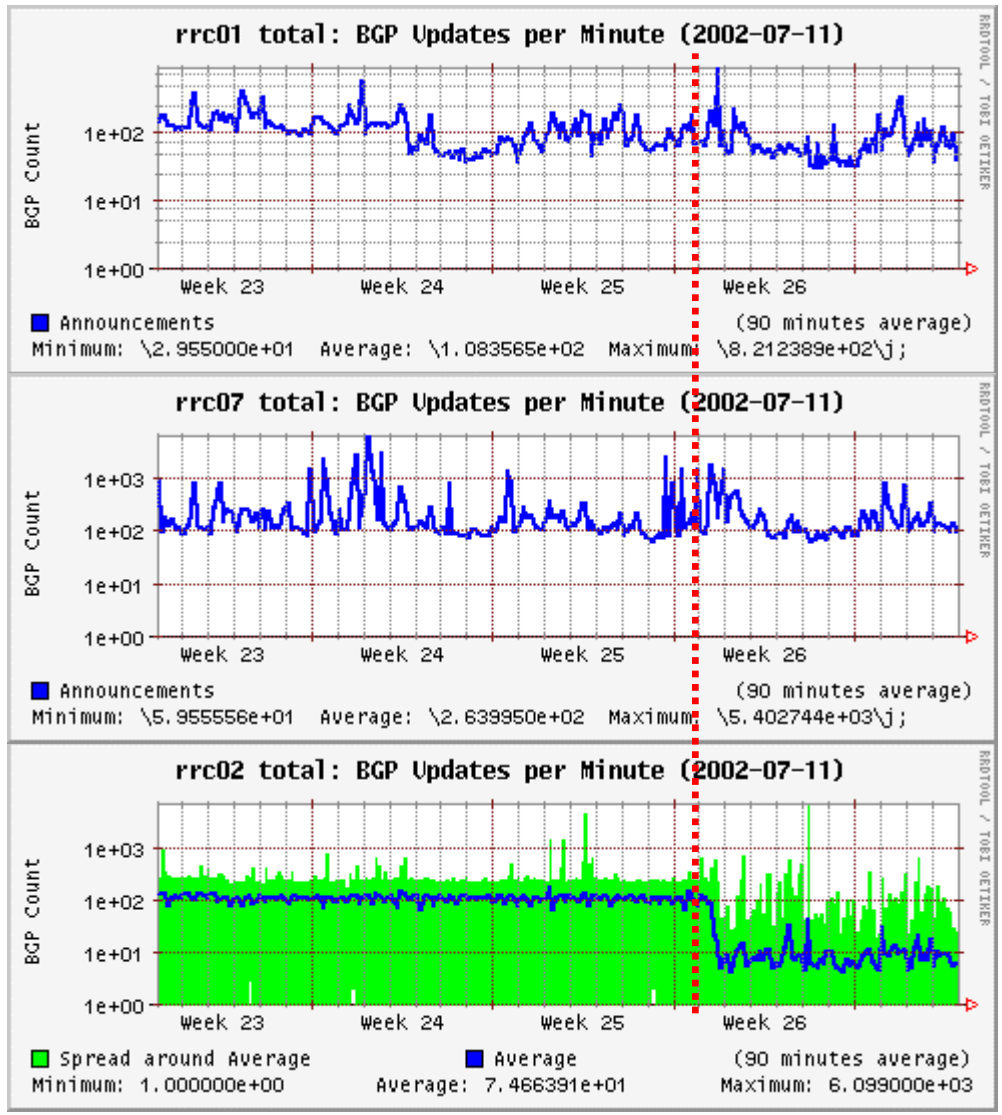
Ebone Shutdown (AS1755)

- Slight increase in BGP update activity on RRC01 (LINX) and RRC07 (Netnod)
- Not very exciting ☹
- Bottom plot indicates when we lost our Ebone peer on RRC02 (SFINX)



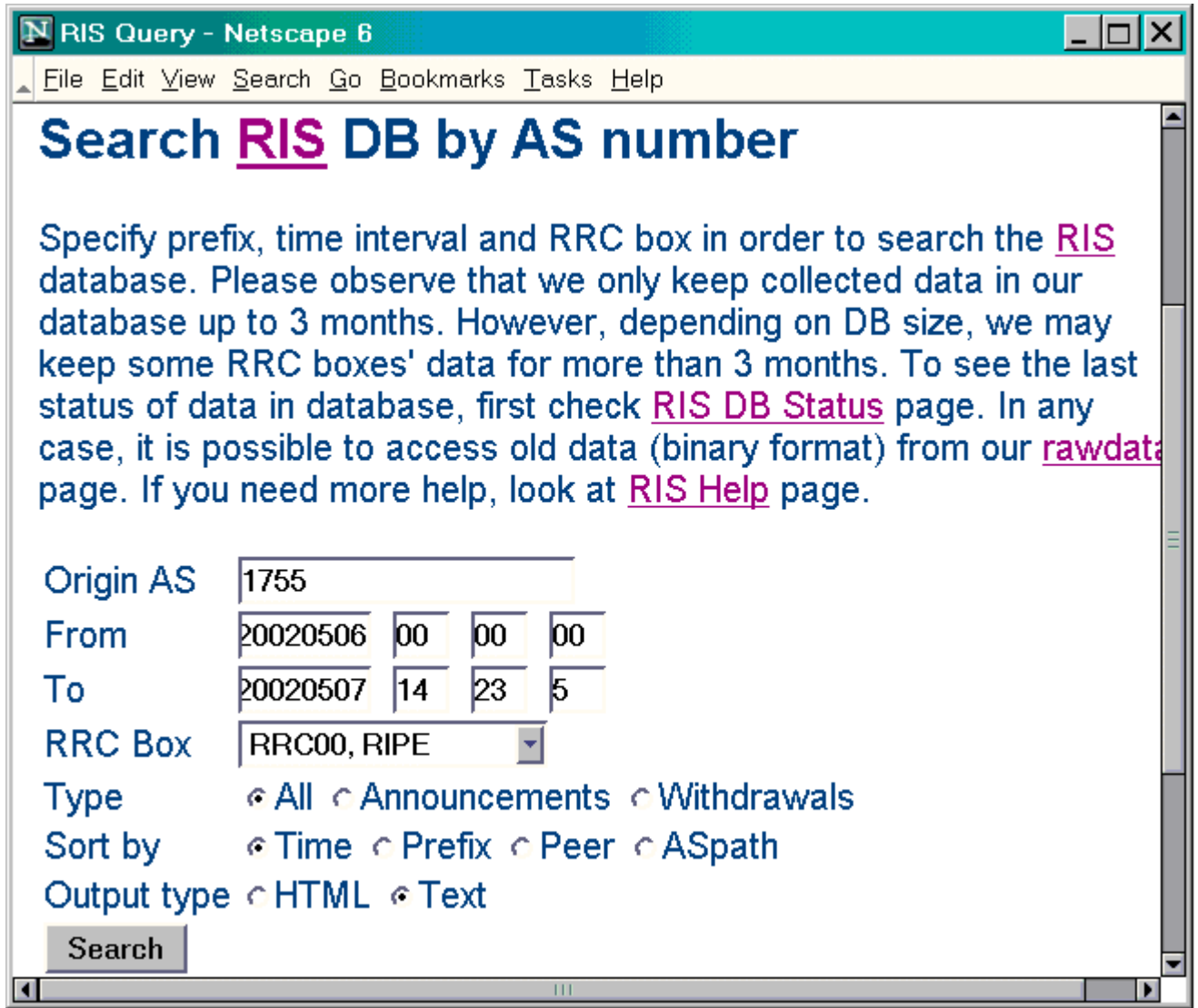
Ebone Shutdown (AS1755)

- More pronouced “peak” in unique announcements plots as “convergence” takes place
- One order-of-magnitude higher UA activity on RRC01 and RRC07
- Not much impact of shutdown due to preventive measures by customers ?
- TTM findings suggest the same



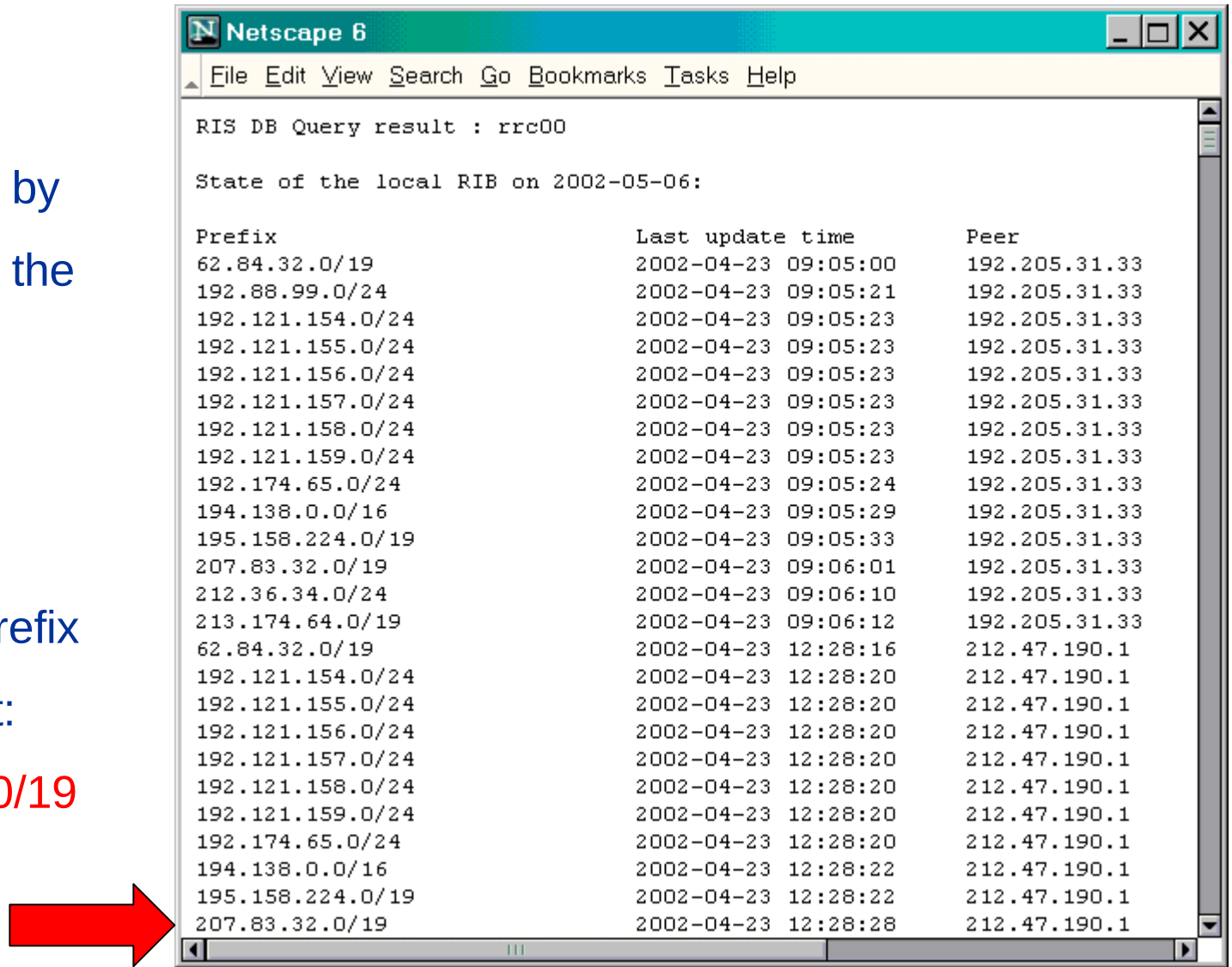
Migration from AS1755 to AS286

- AS Query just prior to the migration of routes from AS1755 to AS286 in the beginning of May, 2002



Migration from AS1755 to AS286

- Prefixes announced by AS1755 on the 6th of May, 2002
- Arbitrary choice of prefix from output: 207.83.32.0/19



Migration from AS1755 to AS286

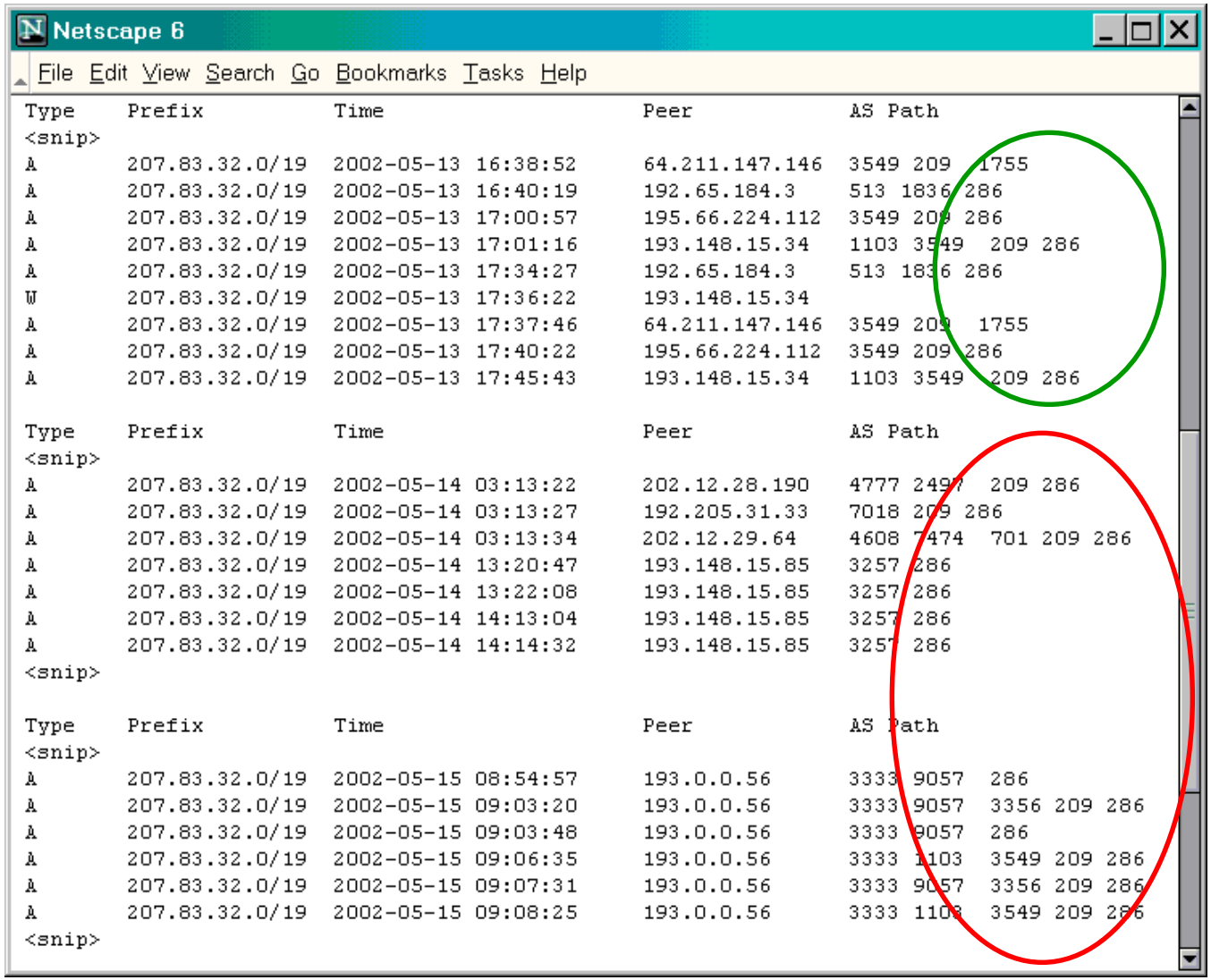
Netscape 6

File Edit View Search Go Bookmarks Tasks Help

```
Type    Prefix          Time                    Peer            AS Path
A       207.83.32.0/19  2002-05-09 00:44:47     193.0.0.56      3333 9057  3356 209 1755
A       207.83.32.0/19  2002-05-09 01:35:29     202.12.28.190   4777 2497  209 1755
A       207.83.32.0/19  2002-05-09 17:48:36     202.12.28.190   4777 2497  209 1755
A       207.83.32.0/19  2002-05-09 21:57:48     192.65.184.3    513 209 1755
A       207.83.32.0/19  2002-05-09 21:58:42     64.211.147.146  3549 209  1755

Type    Prefix          Time                    Peer            AS Path
<snip>
A       207.83.32.0/19  2002-05-10 01:47:20     192.65.184.3    513 1836 286
A       207.83.32.0/19  2002-05-10 01:48:04     195.66.224.112  3549 209 286
A       207.83.32.0/19  2002-05-10 01:48:06     193.148.15.34   1103 3549  209 286
A       207.83.32.0/19  2002-05-10 04:44:11     195.66.224.112  3549 209  1755
A       207.83.32.0/19  2002-05-10 04:44:16     193.148.15.34   1103 3549  209 1755
A       207.83.32.0/19  2002-05-10 05:07:52     193.148.15.34   1103 3549  209 286
A       207.83.32.0/19  2002-05-10 05:07:54     195.66.224.112  3549 209 286
A       207.83.32.0/19  2002-05-10 09:39:04     202.12.28.190   4777 2497  209 1755
<snip>

Type    Prefix          Time                    Peer                    AS Path
A       207.83.32.0/19  2002-05-11 18:31:08     192.65.184.3    513 1836 286
A       207.83.32.0/19  2002-05-11 18:31:37     64.211.147.146  3549 209  1755

Type    Prefix          Time                    Peer                    AS Path
<no updates>            2002-05-12

Type    Prefix          Time                    Peer            AS Path
<snip>
A       207.83.32.0/19  2002-05-13 16:38:52     64.211.147.146  3549 209  1755
A       207.83.32.0/19  2002-05-13 16:40:19     192.65.184.3    513 1836 286
A       207.83.32.0/19  2002-05-13 17:00:57     195.66.224.112  3549 209 286
A       207.83.32.0/19  2002-05-13 17:01:16     193.148.15.34   1103 3549  209 286
```

- Announcements originating from AS1755
- Announcements for 207.83.32.0/19 from both AS1755 and AS286 from the 10th until the 13th of May, 2002

Migration from AS1755 to AS286




```
Type    Prefix           Time                     Peer            AS Path
<snip>
A       207.83.32.0/19   2002-05-13 16:38:52      64.211.147.146  3549 209  1755
A       207.83.32.0/19   2002-05-13 16:40:19      192.65.184.3    513 1836 286
A       207.83.32.0/19   2002-05-13 17:00:57      195.66.224.112  3549 209 286
A       207.83.32.0/19   2002-05-13 17:01:16      193.148.15.34   1103 3549  209 286
A       207.83.32.0/19   2002-05-13 17:34:27      192.65.184.3    513 1836 286
W       207.83.32.0/19   2002-05-13 17:36:22      193.148.15.34
A       207.83.32.0/19   2002-05-13 17:37:46      64.211.147.146  3549 209  1755
A       207.83.32.0/19   2002-05-13 17:40:22      195.66.224.112  3549 209 286
A       207.83.32.0/19   2002-05-13 17:45:43      193.148.15.34   1103 3549  209 286

Type    Prefix           Time                     Peer            AS Path
<snip>
A       207.83.32.0/19   2002-05-14 03:13:22      202.12.28.190   4777 2497  209 286
A       207.83.32.0/19   2002-05-14 03:13:27      192.205.31.33   7018 209 286
A       207.83.32.0/19   2002-05-14 03:13:34      202.12.29.64    4608 7474  701 209 286
A       207.83.32.0/19   2002-05-14 13:20:47      193.148.15.85   3257 286
A       207.83.32.0/19   2002-05-14 13:22:08      193.148.15.85   3257 286
A       207.83.32.0/19   2002-05-14 14:13:04      193.148.15.85   3257 286
A       207.83.32.0/19   2002-05-14 14:14:32      193.148.15.85   3257 286
<snip>

Type    Prefix           Time                     Peer            AS Path
<snip>
A       207.83.32.0/19   2002-05-15 08:54:57      193.0.0.56      3333 9057  286
A       207.83.32.0/19   2002-05-15 09:03:20      193.0.0.56      3333 9057  3356 209 286
A       207.83.32.0/19   2002-05-15 09:03:48      193.0.0.56      3333 9057  286
A       207.83.32.0/19   2002-05-15 09:06:35      193.0.0.56      3333 1103  3549 209 286
A       207.83.32.0/19   2002-05-15 09:07:31      193.0.0.56      3333 9057  3356 209 286
A       207.83.32.0/19   2002-05-15 09:08:25      193.0.0.56      3333 1103  3549 209 286
<snip>
```

- Announcements for 207.83.32.0/19 from both AS1755 and AS286
- Announcements originating from AS286 from the 14th of May, 2002, and onwards

BGP Beacons

- Prefixes announced at known times by each route collector
  - Up at 0, 4, 8, 12, 16, 20 GMT
  - Down at 2, 6, 10, 14, 18, 22 GMT
  - Prefix 195.80.(224+n).0/24
  - N=0…8 for the RRC's
  - Part of the RIS AS 12654
- Flapping Studies
- Active since 30/9/2002

Announce

Type:	Prefix	Time	Peer	AS Path
A	195.80.224.0/24	2002-10-03 00:00:07	193.148.15.85	3257 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:07	64.211.147.146	3549 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:07	64.211.147.146	3549 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:10	195.66.224.112	3549 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:14	212.47.190.1	9177 3320 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:18	193.148.15.34	1103 3549 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:18	192.205.31.33	7018 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:31	202.12.28.190	4777 2497 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:39	193.0.0.56	3333 3356 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:45	193.148.15.34	1103 3356 2914 12654
A	195.80.224.0/24	2002-10-03 00:00:53	202.12.29.64	4608 7474 3561 2914 12654

Withdraw

A 195.80.224.0/24	2002-10-03 02:00:10	193.148.15.85	3257 2914 12654
A 195.80.224.0/24	2002-10-03 02:00:14	193.148.15.85	3257 701 2914 12654
A 195.80.224.0/24	2002-10-03 02:00:14	193.148.15.85	3257 1239 2914 12654
A 195.80.224.0/24	2002-10-03 02:00:14	193.148.15.85	3257 2914 12654
W 195.80.224.0/24	2002-10-03 02:00:14	193.148.15.85	
A 195.80.224.0/24	2002-10-03 02:00:17	193.148.15.85	3257 701 2914 12654
A 195.80.224.0/24	2002-10-03 02:00:18	193.148.15.85	3257 1239 2914 12654
A 195.80.224.0/24	2002-10-03 02:00:18	193.148.15.85	3257 2914 12654
A 195.80.224.0/24	2002-10-03 02:00:35	193.148.15.85	3257 701 2914 12654
W 195.80.224.0/24	2002-10-03 02:00:57	193.148.15.85	
A 195.80.224.0/24	2002-10-03 02:01:31	193.148.15.34	1103 3549 12654 4777 2497 2914 12654
A 195.80.224.0/24	2002-10-03 02:01:59	193.148.15.34	1103 3549 12654 4777 2497 1 2914 12654
A 195.80.224.0/24	2002-10-03 02:02:26	193.148.15.34	1103 3549 12654 4777 2516 701 2914 12654
W 195.80.224.0/24	2002-10-03 02:03:23	193.148.15.34	

URL's, Contact Addresses

- TTM
  - http://www.ripe.net/test-traffic
    - Papers
    - Presentations
    - "For future test-box hosts"
  - ttm@ripe.net : TTM Crew @ NCC
  - tt-wg@ripe.net: RIPE WG on this topic (Majordomo)
- RIS
  - http://www.ripe.net/ris/ris-index.html
    - Presentations
    - Access to the data
  - ris@ripe.net: RIS Crew @ NCC
  - routing-wg@ripe.net: RIPE WG on this topic (Majordomo)

Questions, Discussion