Wide-Area Networking at SLAC

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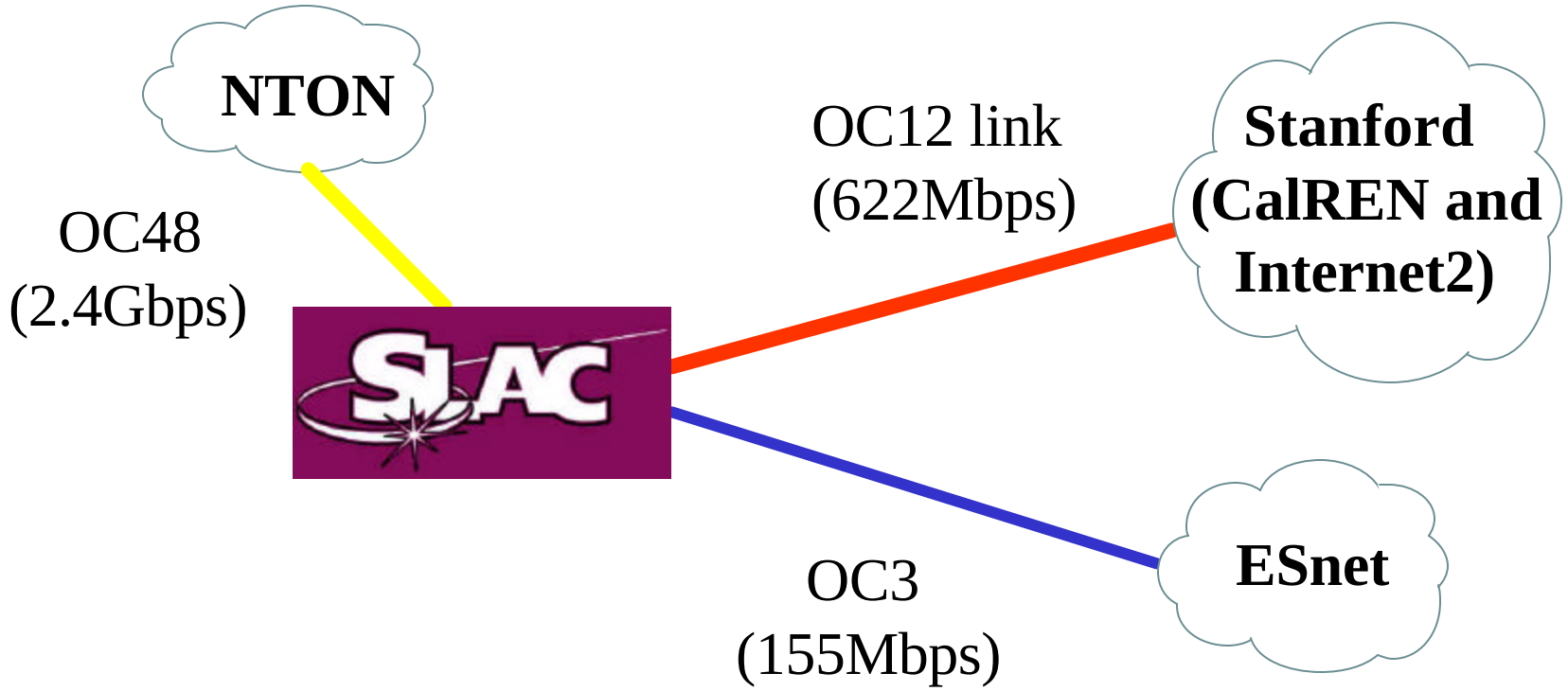
Overview

- SLAC's Connections to WANs
- Utilization
- End-to-end Performance
- The Future
- Note: LANs, MANs, SANs are not discussed

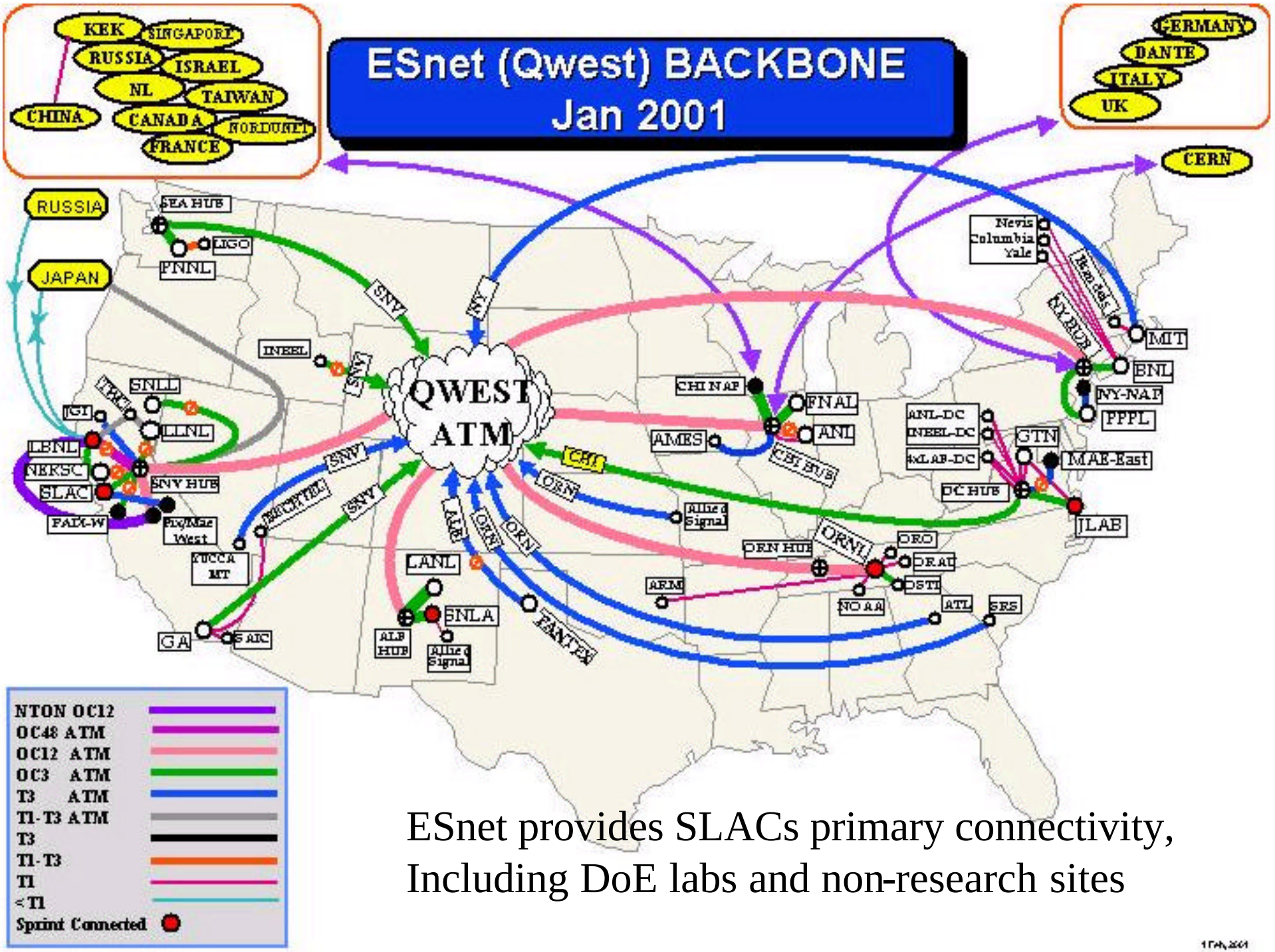
Why

- BaBar will have petabytes (millions of GB) of data
  - Collaborators need access to SLAC resources
  - Much will be exported for processing
- WAN performance is critical to Modern HENP

WAN Connections

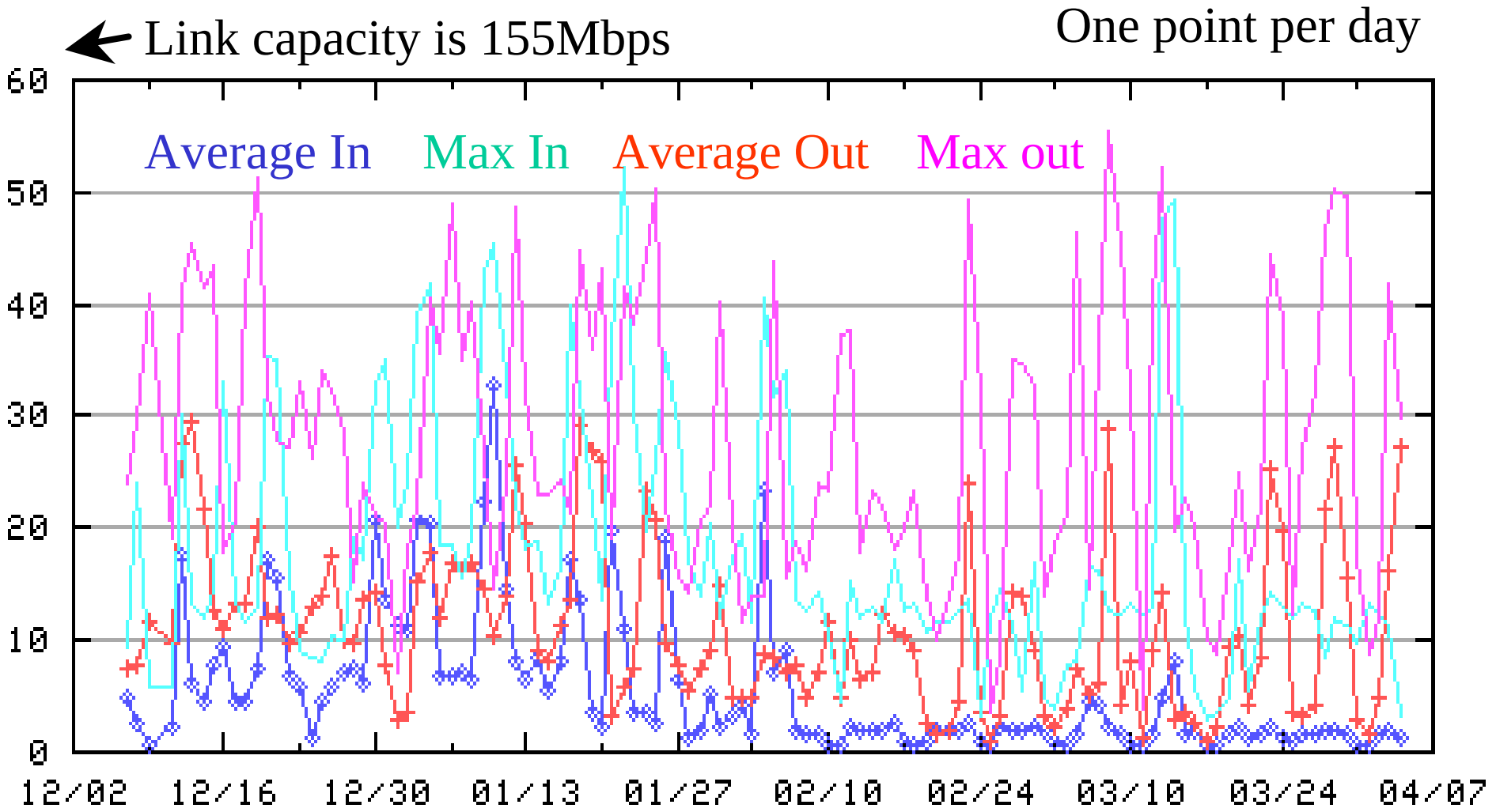


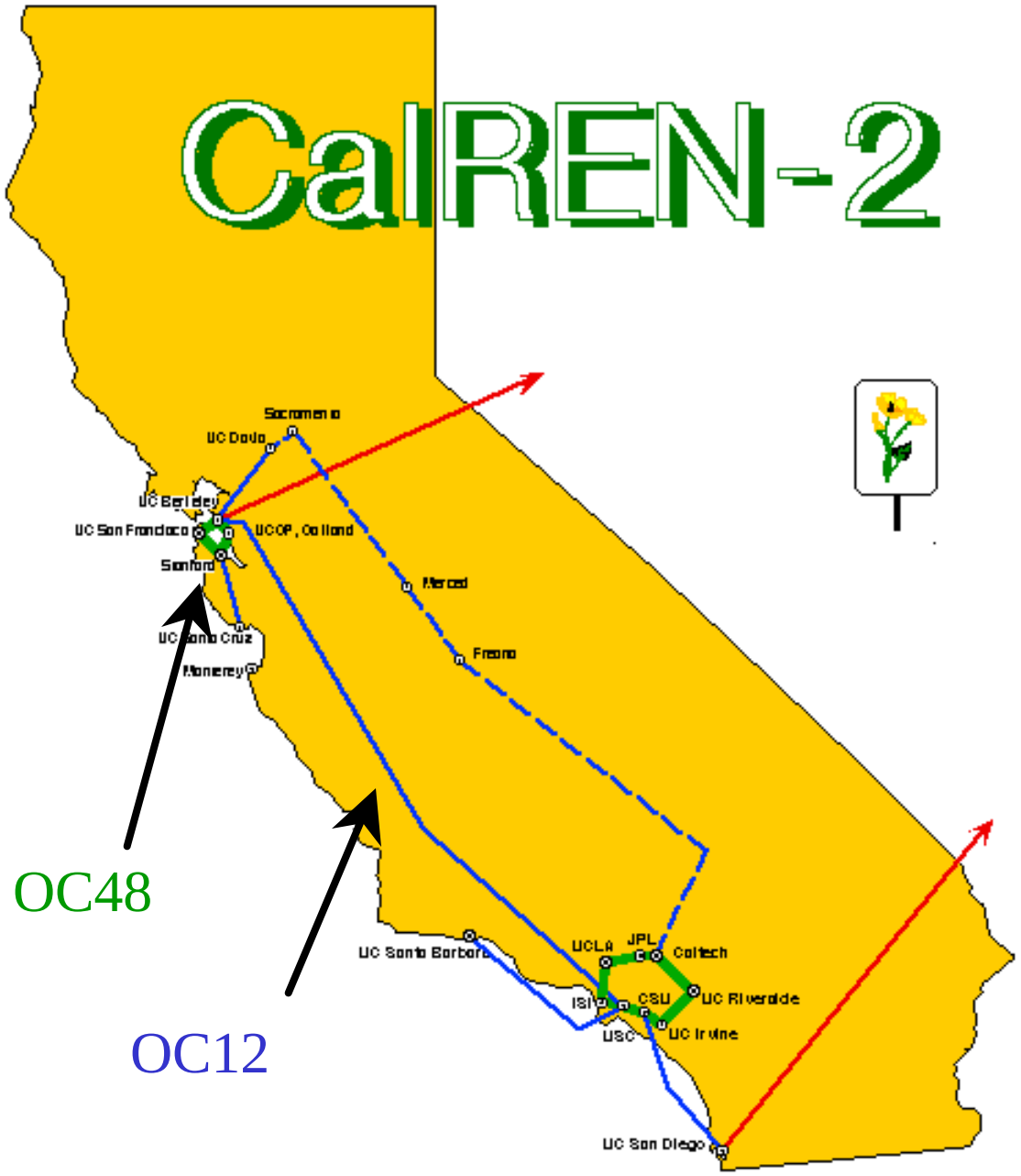
These networks connect (peer) with other networks providing SLAC connectivity to the world.



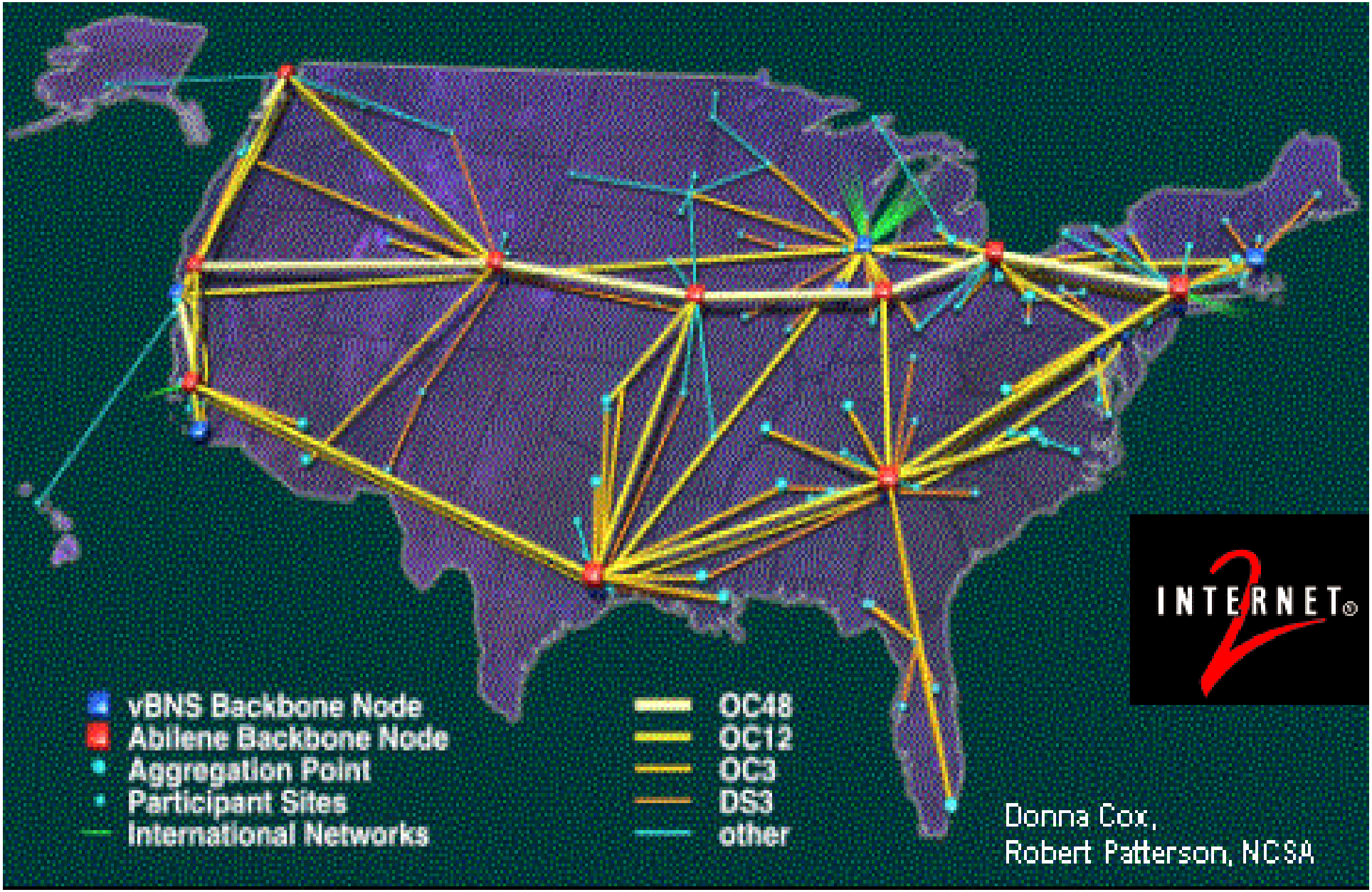
ESnet provides SLACs primary connectivity,
Including DoE labs and non-research sites

Utilization of ESnet link



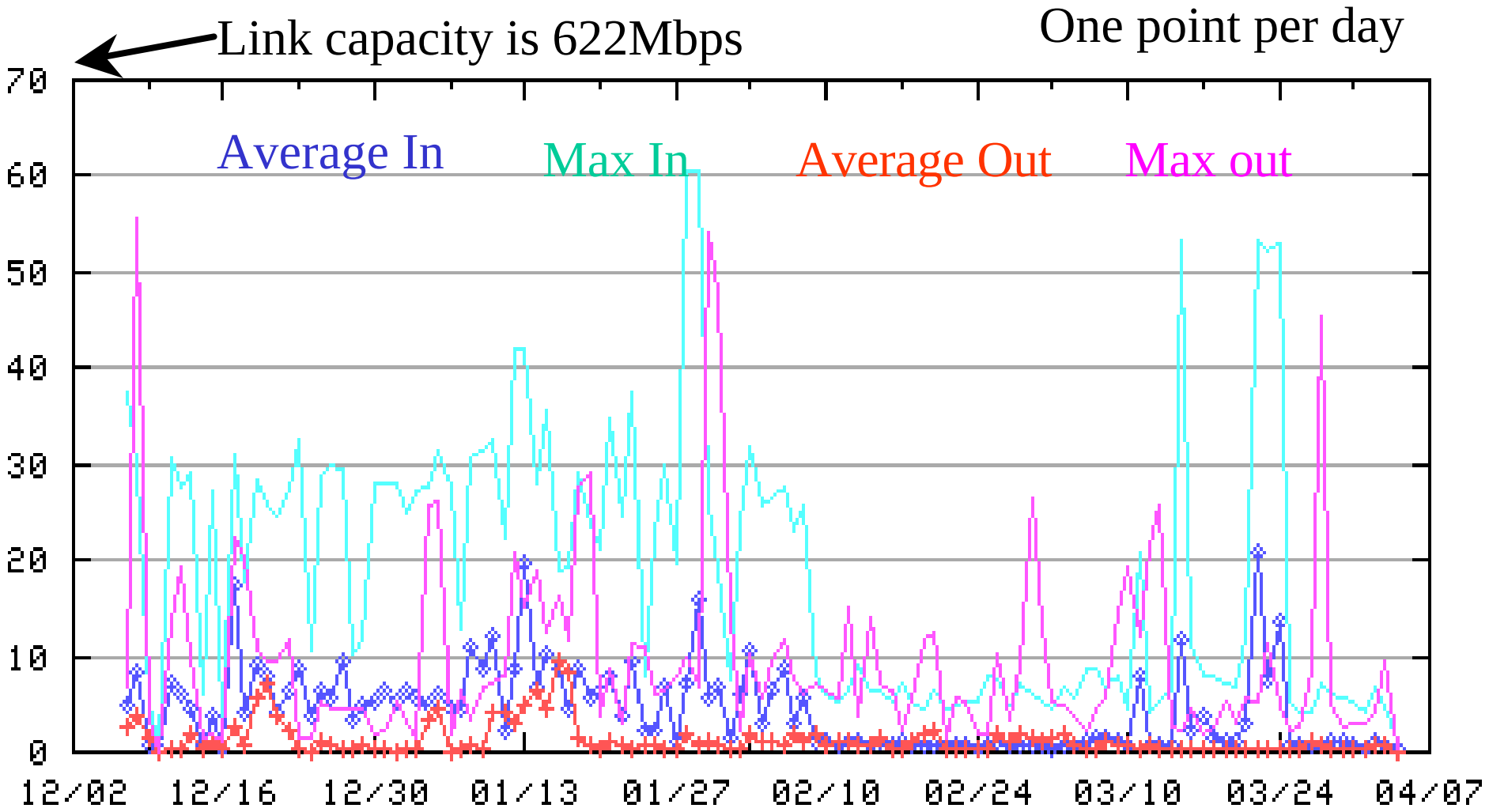


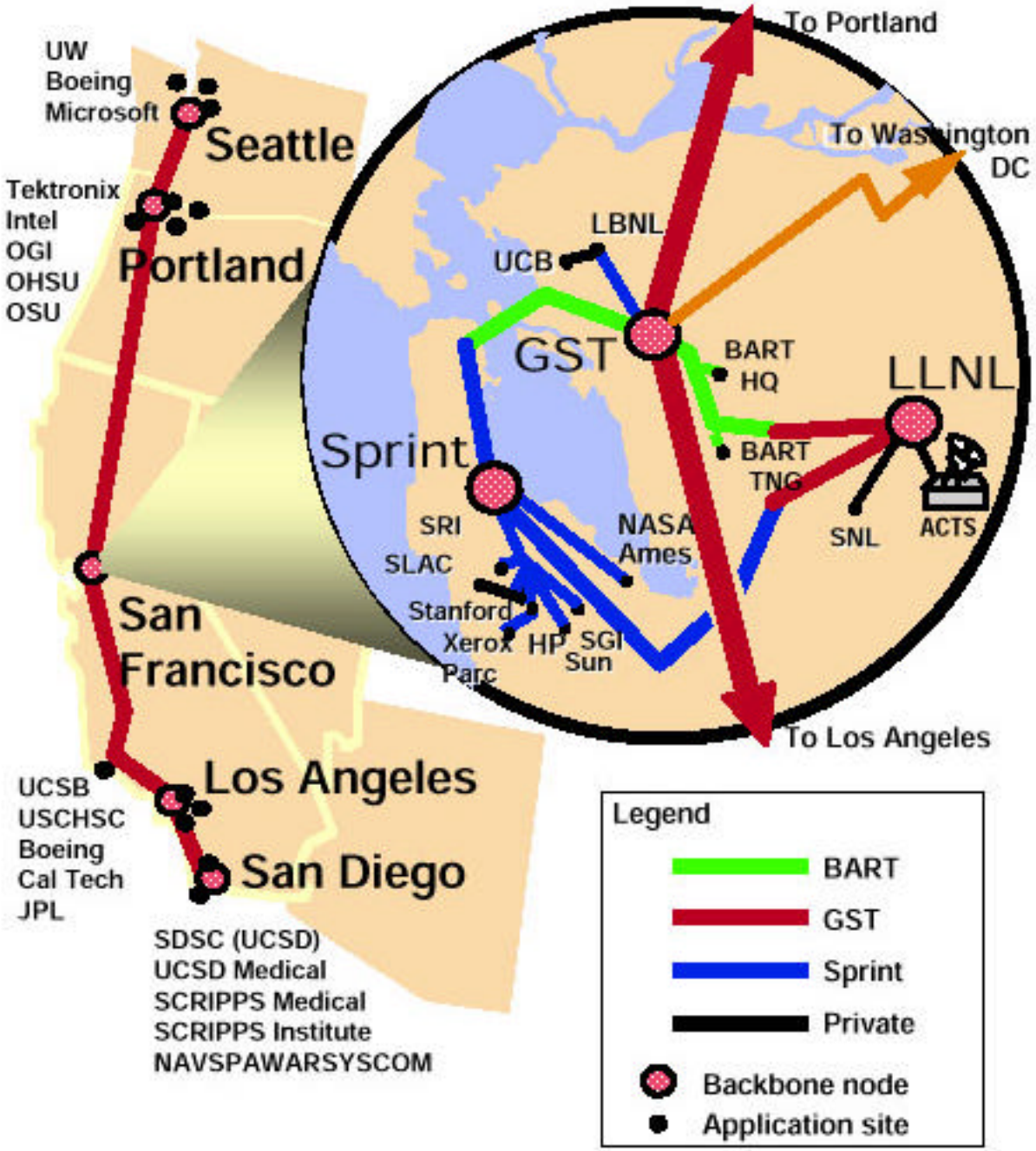
The California Research and Education Network (CalREN) connects Stanford and SLAC to UC sites and provides Connectivity to the Internet2 Networks.



Internet2 is consortium of 180 Universities*. Network is Abilene and vBNS. Connects many research sites including BaBar collaborators.

Utilization of Stanford Link





The National Transparent Optical Network (NTON) Is a testbed for emerging technology.

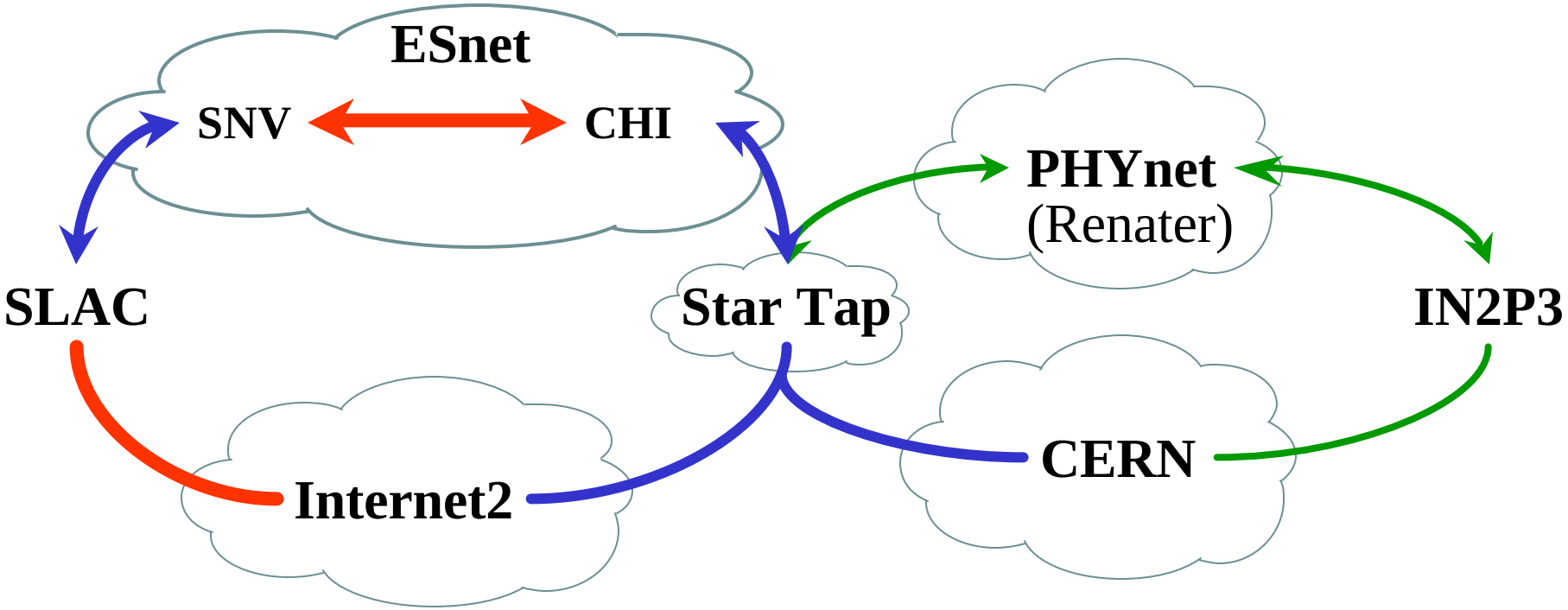
Currently testing with NASA-ARC, Caltech. Want SDSC.

OC48, OC192
Potentially very high throughput.

End-to-end Performance

- Large Data Transfer
  - Bandwidth, Congestion, Latency
- Almost all interesting links cross several networks
  - Peering is critical (avoid public exchange points)
- Some applications also sensitive to variability in latency
- IN2P3, Roma, RAL

Performance Between SLAC and IN2P3

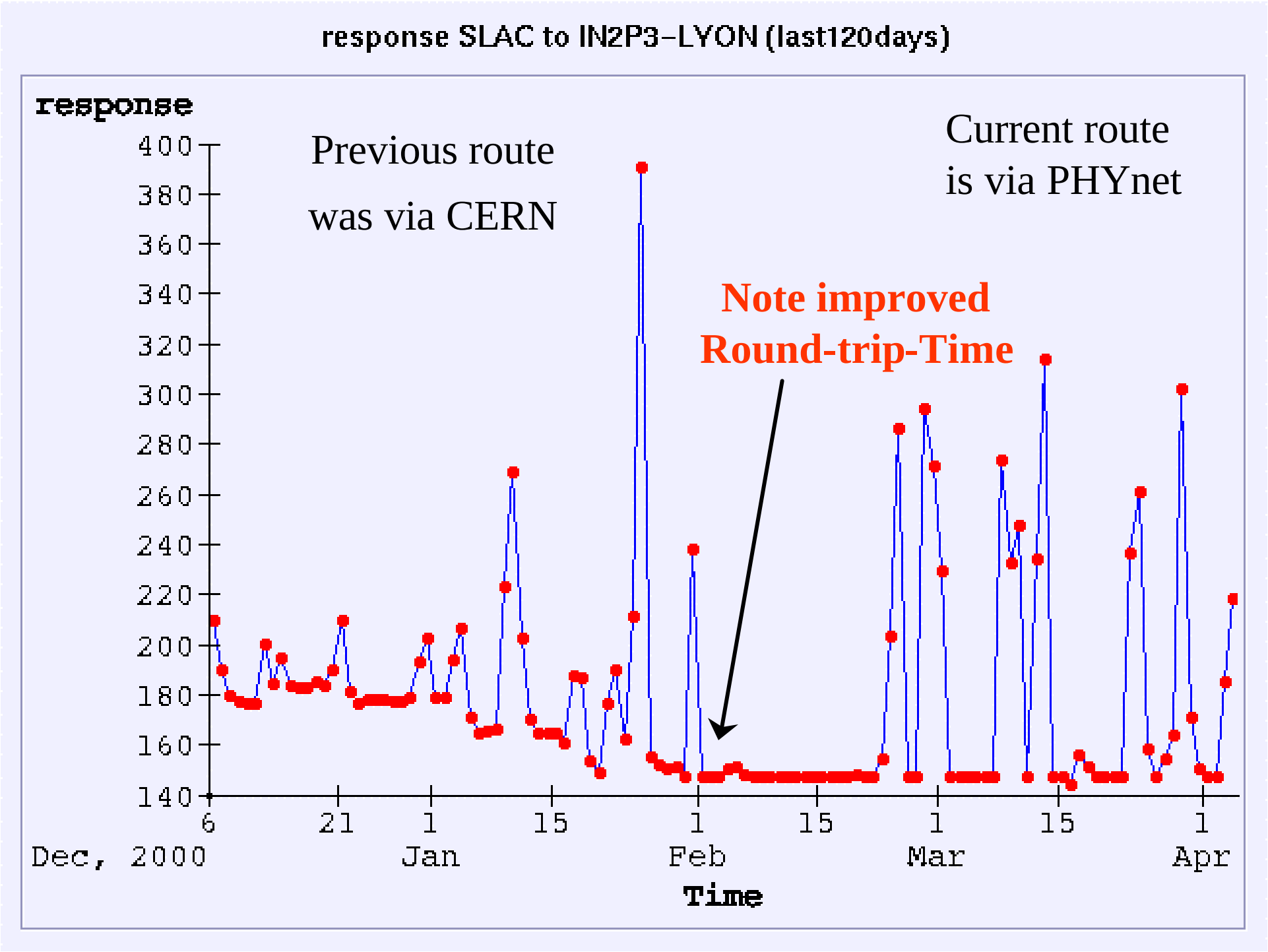


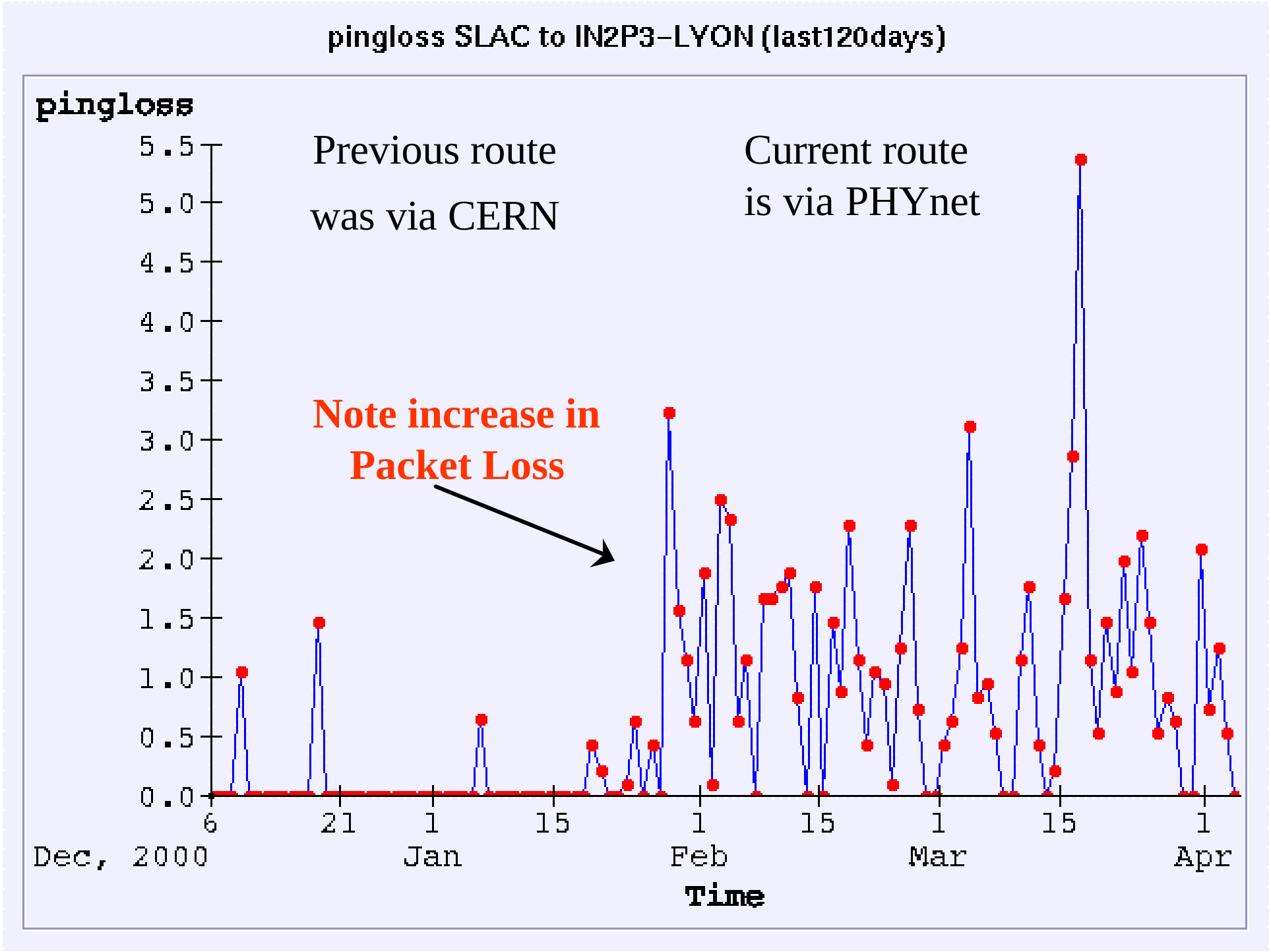
30-40Mbps

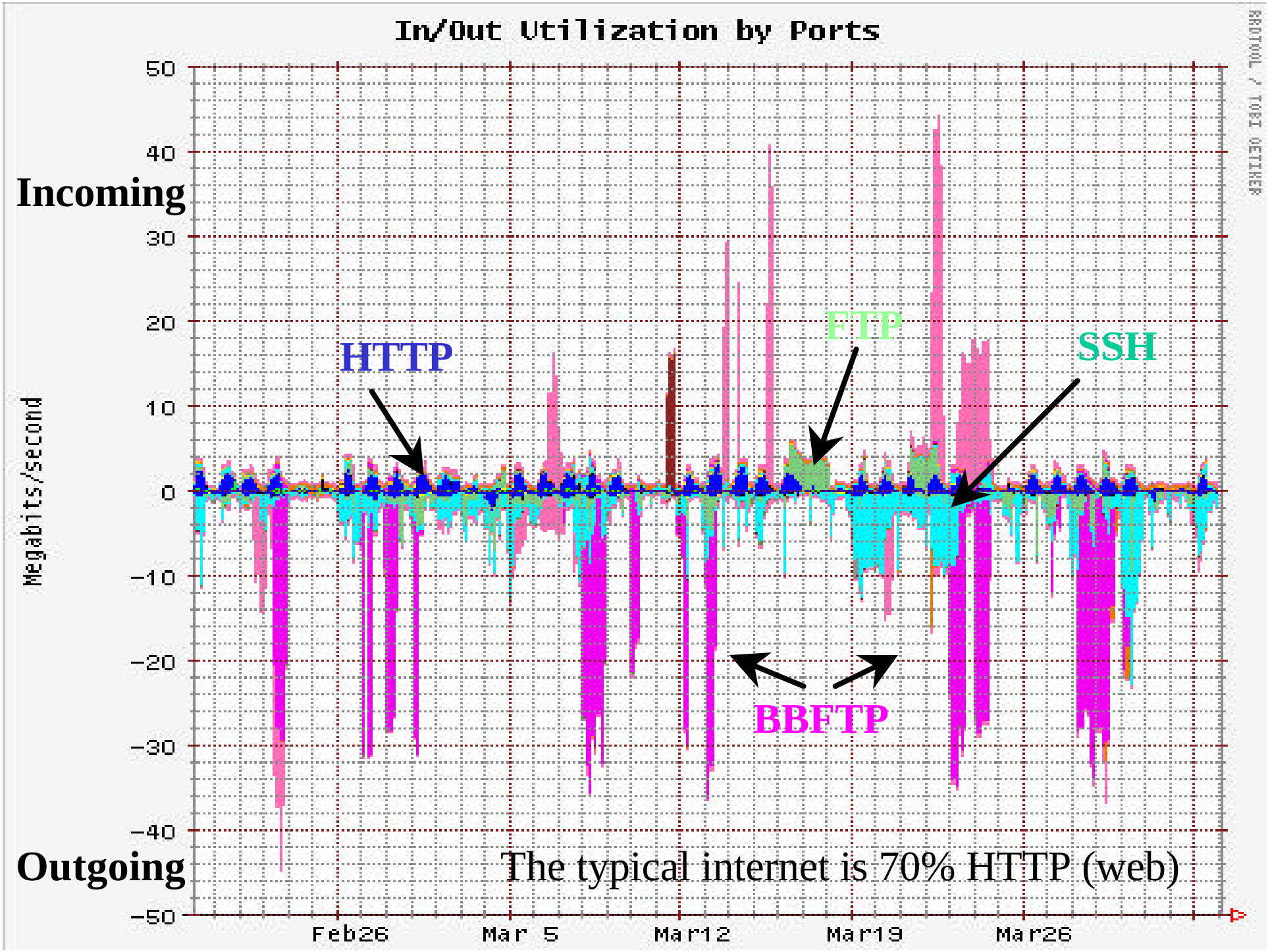
155Mbps

622Mbps

Note:
Current path is Indicated by arrow heads


response SLAC to IN2P3-LYON (last120days)
response
400
380
360
340
320
300
280
260
240
220
200
180
160
140
Previous route
was via CERN
Current route
is via PHYnet
Note improved
Round-trip-Time
6
21
1
15
1
15
1
15
1
Dec, 2000
Jan
Feb
Mar
Apr
Time

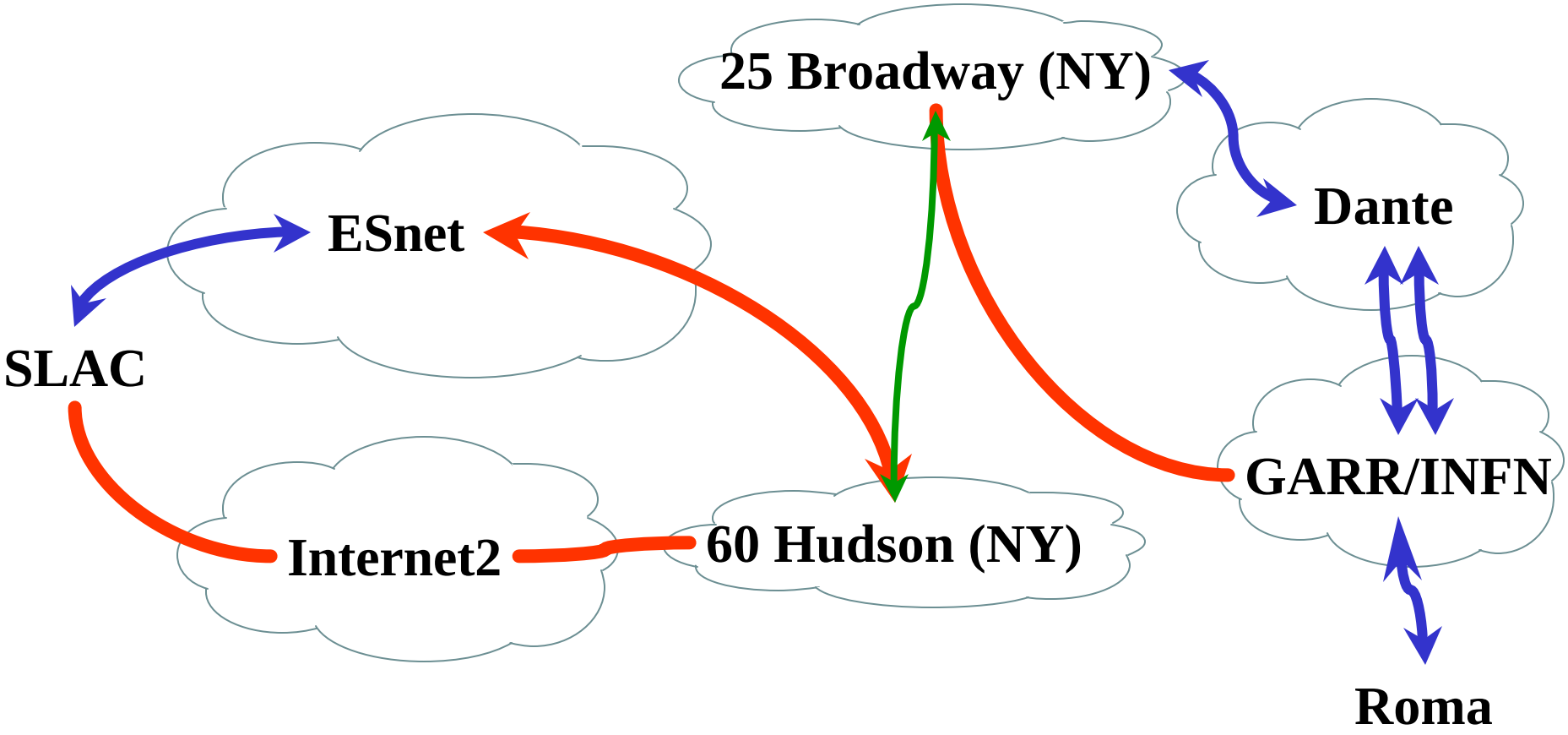

pingloss SLAC to IN2P3-LYON (last120days)
pingloss
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Previous route
was via CERN
Current route
is via PHYnet
Note increase in
Packet Loss
6
21
1
15
1
15
1
15
1
Dec, 2000
Jan
Feb
Mar
Apr
Time


In/Out Utilization by Ports
Incoming
Outgoing
Megabits/second
50
40
30
20
10
0
-10
-20
-30
-40
-50
Feb26
Mar 5
Mar12
Mar19
Mar26
HTTP
FTP
SSH
BBFTP
The typical internet is 70% HTTP (web)
MRTG / TOBI OETIKER

Results and Future Plans

- Sustain 30Mbps*
- CERN-IN2P3 link will be upgraded to 155Mbps this summer
- Further upgraded to 622 Mbps by end of 2002.
- CERNs Transatlantic link and PHYnet will also be upgraded
- Bottleneck will become connection to Star Tap

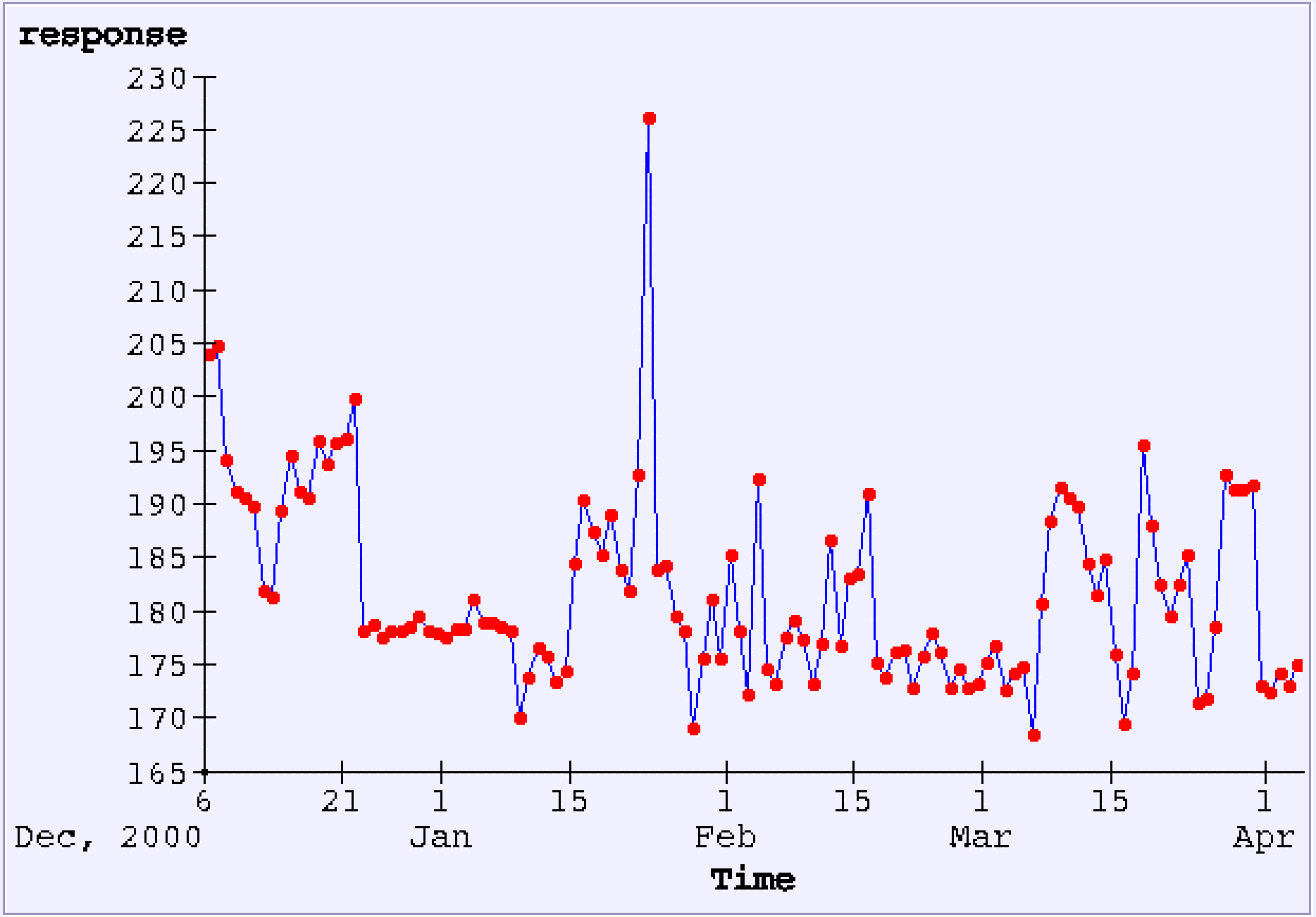
Performance Between SLAC and Roma



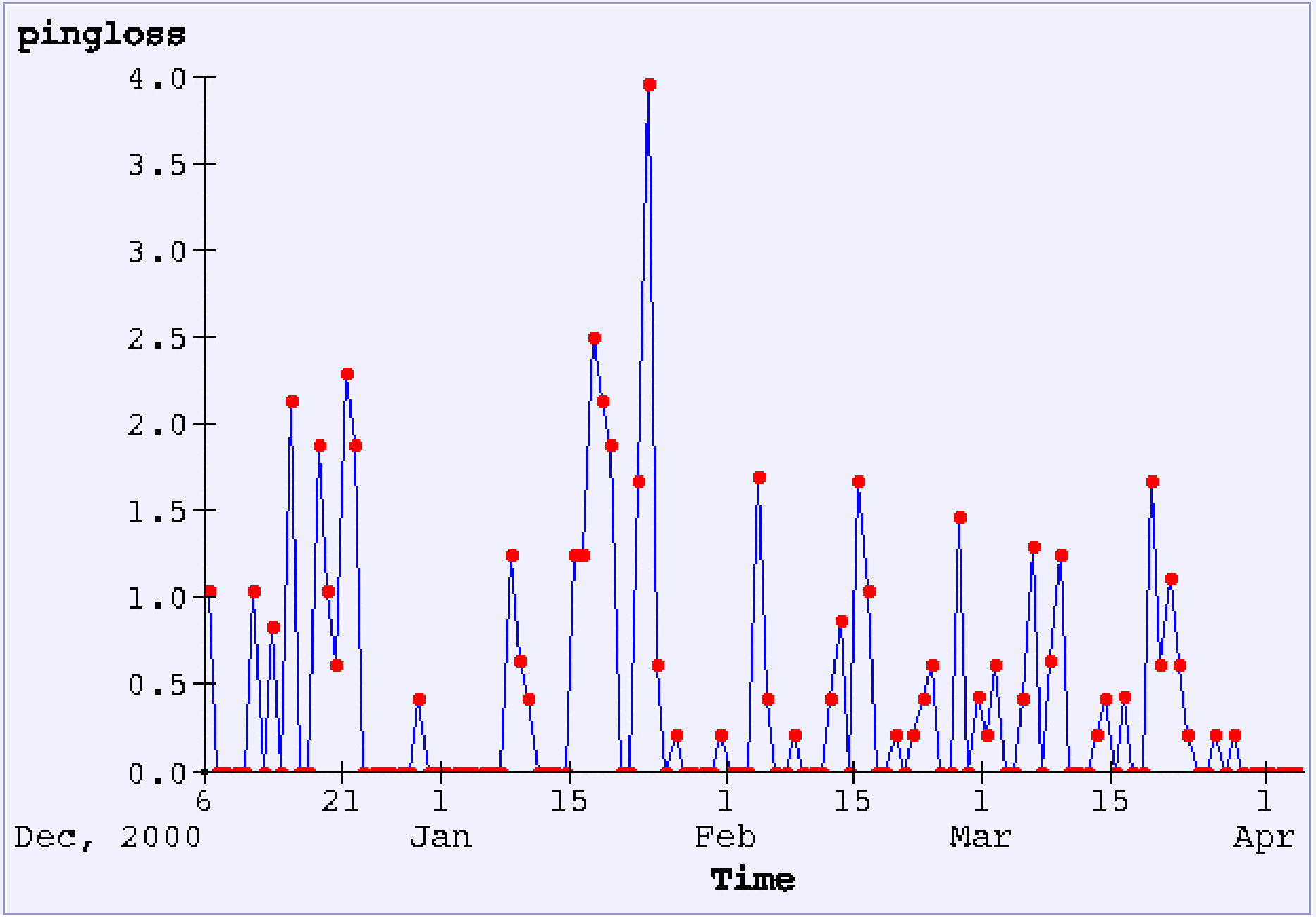
50Mbps
155Mbps
622Mbps

Note:
Current path is Indicated by arrow heads

response SLAC to INFN-ROMA (last120days)



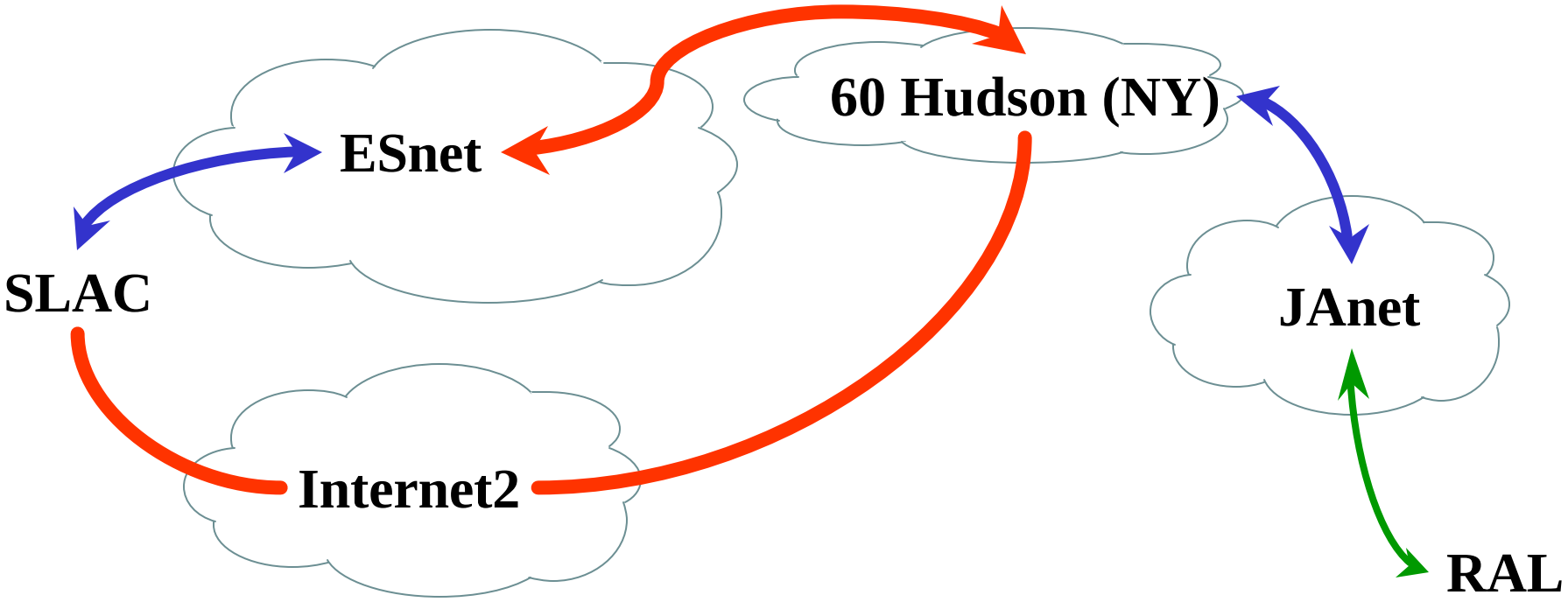
pingloss SLAC to INFN-ROMA (last120days)



Results

- Measured 26Mbps sustained throughput
- Dante upgrading network (Geant)
  - Multi-gigabit
- Bottleneck is crossing New York
  - Notoriously difficult to get fiber across NYC

Performance Between SLAC and RAL



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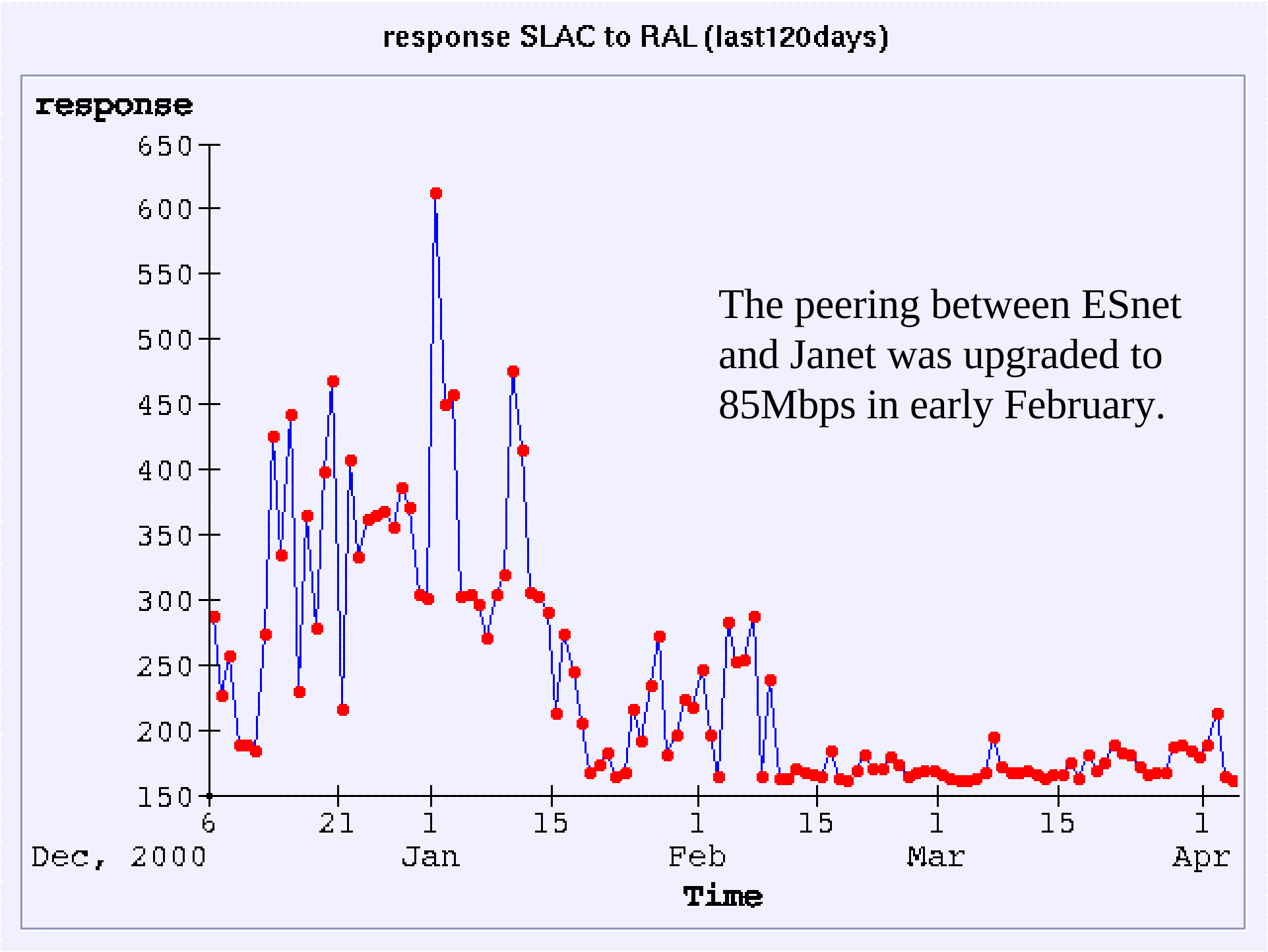
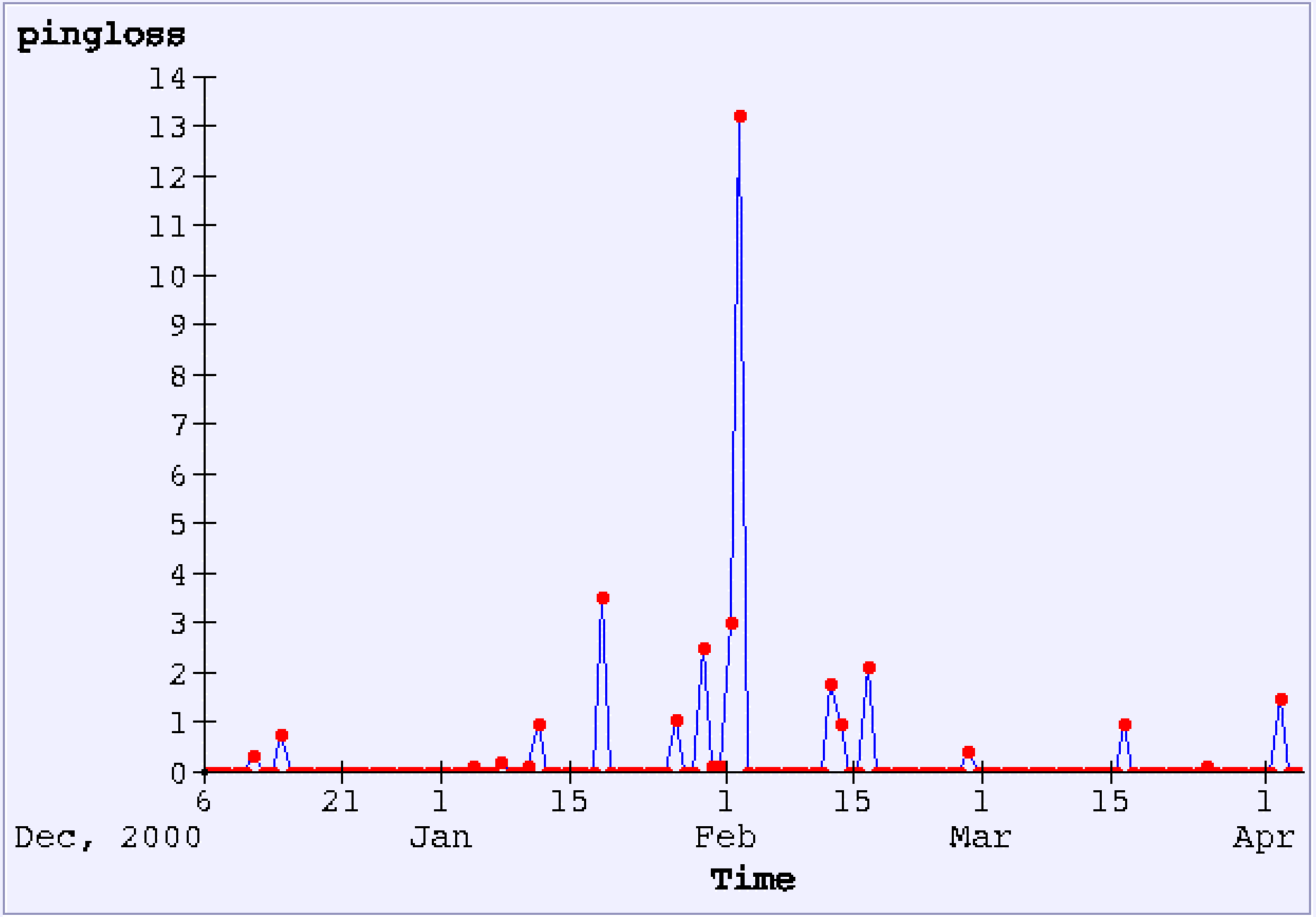

response SLAC to RAL (last120days)
response
650
600
550
500
450
400
350
300
250
200
150
6
21
1
15
1
15
1
15
1
Dec, 2000
Jan
Feb
Mar
Apr
Time
The peering between ESnet and Janet was upgraded to 85Mbps in early February.

pingloss SLAC to RAL (last120days)



Results

- 40Mbps sustained
- UKERNA is in the process of upgrading to SuperJanet4
- Proposed OC12 dedicated path.
- SLAC ESnet connection will be bottleneck

Summary

- Multiple high-speed connections
  - Optimize routing
  - Backup paths
- Well Engineered Networks
  - Negligible packet loss, Good Round Trip Times
  - Traffic doubled on ESnet every year since 1990

Future Networks

- Tremendous infrastructure development
- ESnet
  - Upgrade SLAC Connection to OC12
  - Terabit (1000Gbps) backbone 2003-2005
- NTON
  - Connecting to Chicago, which will give connection to CERN.
- Star Light

Conclusions

- Goals of HENP can be achieved
  - We have the technology
  - Known Goals
- Continued Monitoring and Engineering
- Feed Results back
  - Engineers
  - Users

Further Information

- http://www-iepm.slac.stanford.edu
- http://www.slac.stanford.edu/grp/scs/net/case/international
- http://www.internet2.edu/arena

Any Questions ?