Internet Gridlock and WAN Monitoring

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Outline of Talk:

- What's the Problem
- Possible Solutions
- What do we get from Monitoring
- Tools
- Results
- What are People Doing

What's the Problem

Internet Problems ("Gridlock")

Quality of service over Internet has dramatically worsened in last year

- Some metrics whos this worsened by a factor of 2 or more
  - packet loss, response time, host unreachable, hop counts ...

Problem aggravated by explosion in personal use

Also by disappearance of NSFnet (and its coordination) as a network provider to Researchers and Education (R & E)

R & E seriously being impacted

- letter from HEP experimenters sent to FNC
  - "ability to do research severly hampered [by the] disaterous state of the Internet"
  - experiments at particle accelerators depend crucially on computer communications to enable collaborators to work effectively

Possible Solutions

Tail circuits from collaborator sites to Esnet

Peering with NSI, NSF and other government agencies

Develop service quality metrics and perfomance measurements:

- FNC:
  - "expand collaborative development of performance measurements on Federally sponsored segments of the Internet..."
  - "Increase funding / prioritization of research on measurement techniques that can be employed by ISPs and users to quantify Internet QoS"
  - "Identify critical networking metrics and tools which could be run over Federal R&E networks ... [define] tool which could gather data on both end-to-end performance"
- ESSC
  - "develop metrics to measure service quality"
  - "monitor quality at afflicted sites"
  - "make available metrics ans results"
  - "assist in developing proposal to MICS to fund effort"

What do we get from Monitoring

Provides:

1. **Performance Tuning** - Improve service - proactively id & reduce bottlenecks, tune and optimize systems, improve QOS, optimize investments - id under/over utilized resources, balance workloads

2. **Trouble Shooting** - Get out of crisis mode, id probs & start diagnosis/ fixing before end user notices, increase reliability/availability, allow user to accomplish work more effectively and maximize productivity.

3. **Planning** - understand performance trends for planning

4. **Expectations** - set expectations for the *Distributed System* (from network thru applications) and see how well they are met

5. Security

6. Accounting

Challenges compared to LAN Monitoring

WAN monitoring for an end site has different requirements to LAN monitoring

- often outsourced and have limited control
  - e.g. don't have access to router information
- there is much greater variability in results
  - compare response SLAC-Dresden with SLAC-LBL
  - what is prime shift?

However we (users and networkers) still want to have reasonable expectations for planning and problem identification

Tools

The main tools used today are:

- `ping` response time, packet loss and connectivity
- `traceroute` to discover the route to another node
- FTP transfer rates
- traffic measurements from firewall router

Others see:

- http://www.slac.stanford.edu/~cottrell/tcom/nmtf-tools.html

Tools

Ping

- Significant increase in packet loss may indicate overloaded routers/links
- Separate down nodes/links from packet loss
- Since quantitative values vary widely from node to node and even month to month, need automated "expert" help in setting dynamic thresholds

FTP rates depend on many inter-related factors including:

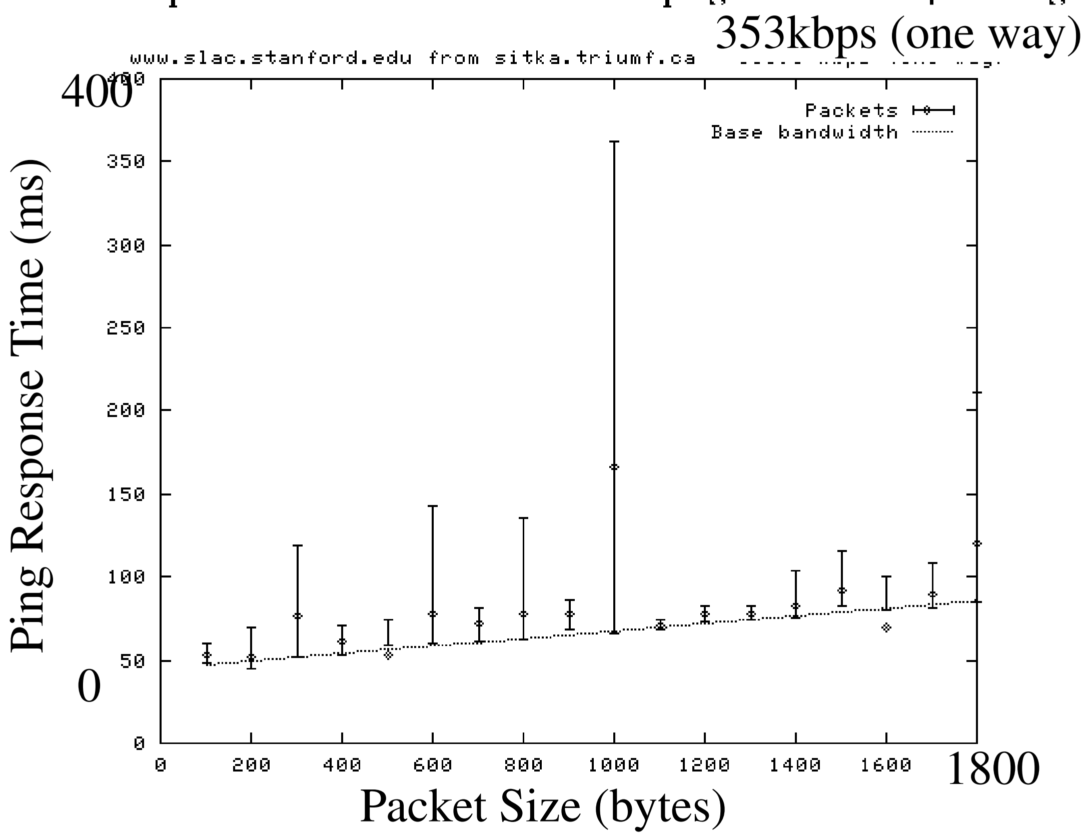
- packet loss
- network response time for end to end
- number of hops and route used
- utilization of links
- speed of links
- capability of end nodes

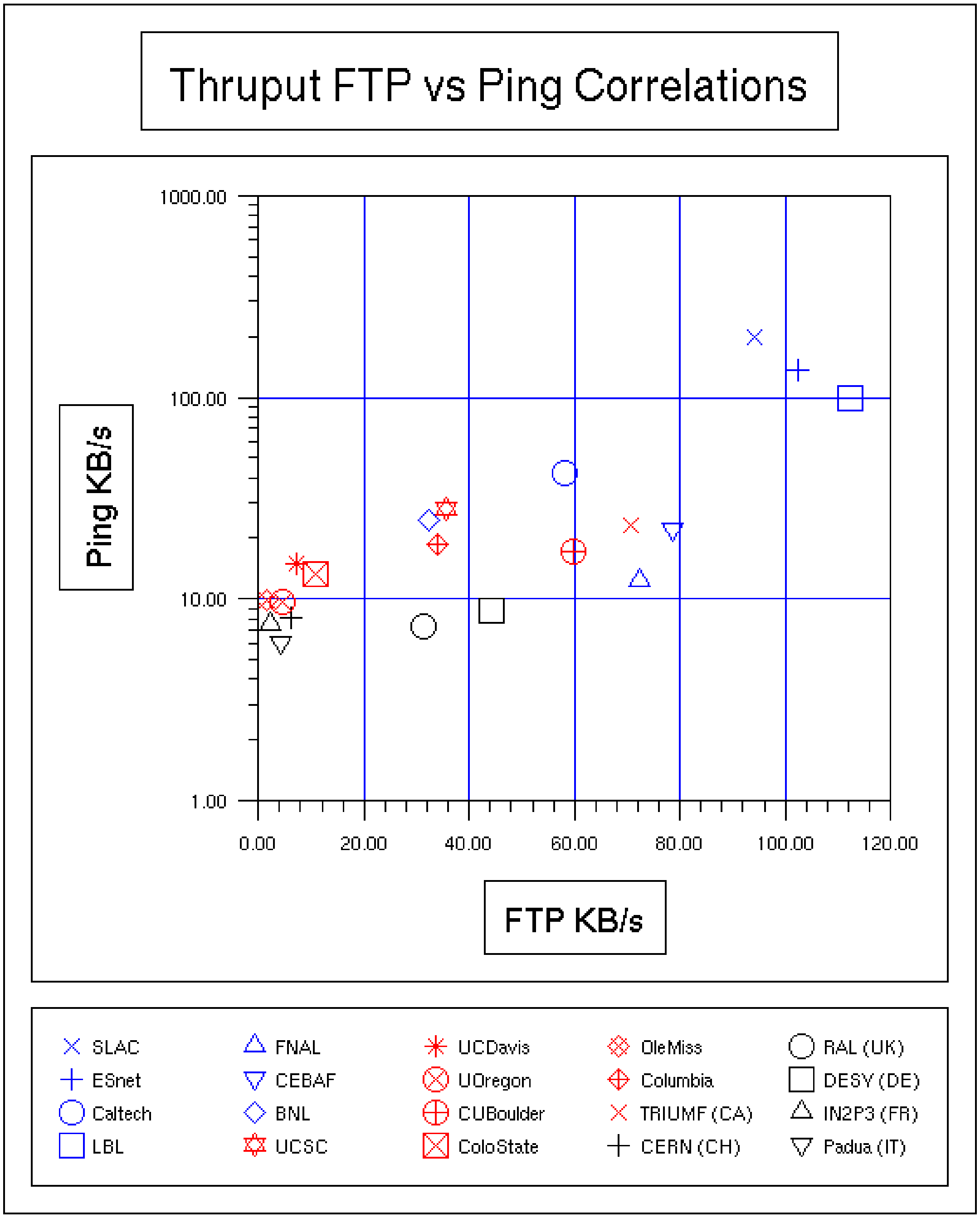
Ping Rate

Visual Ping

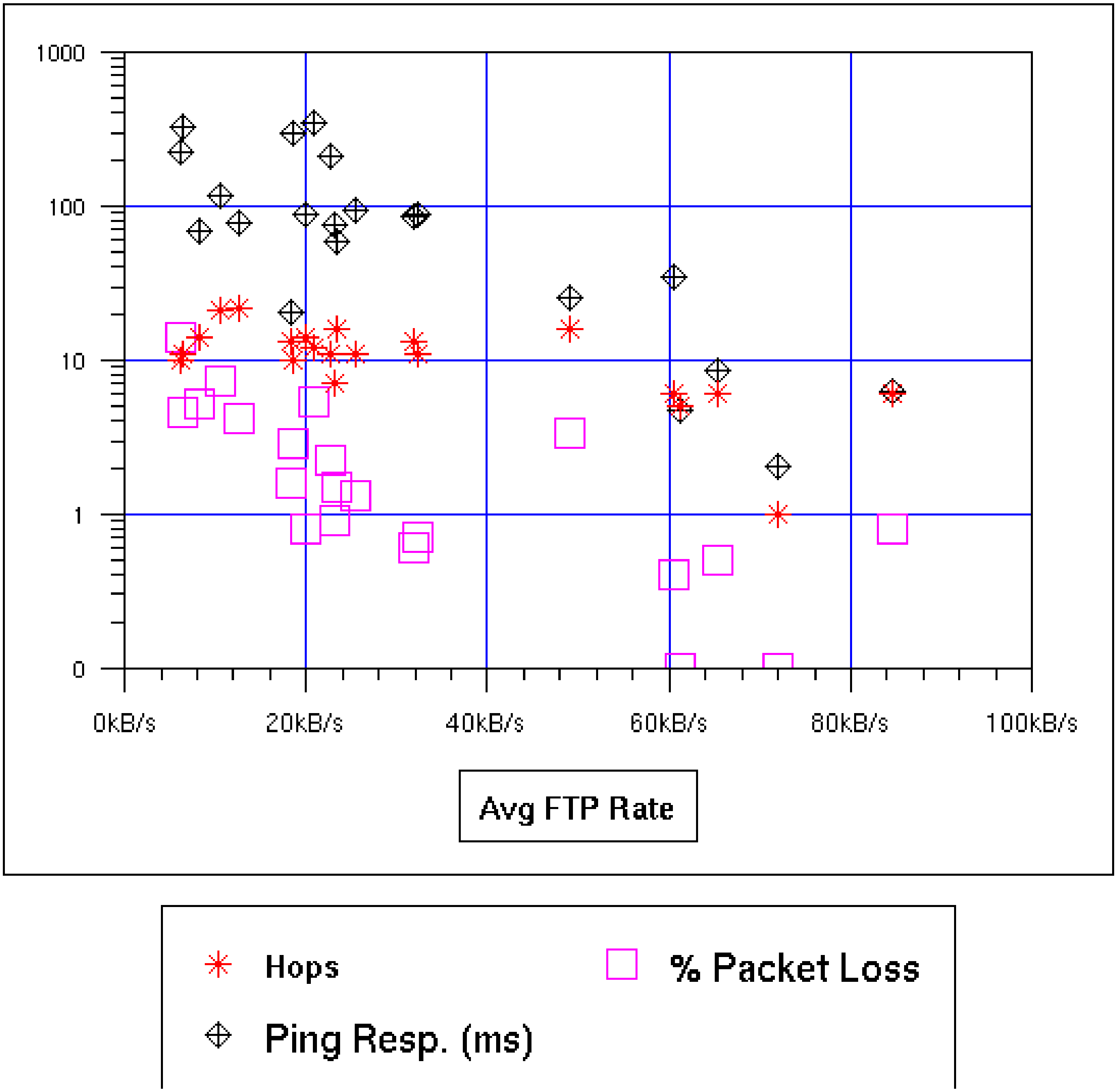
www.slac.stanford.edu from sitka.triumf.ca

Please be patient ... it takes a little while to ping the host and plot the graph

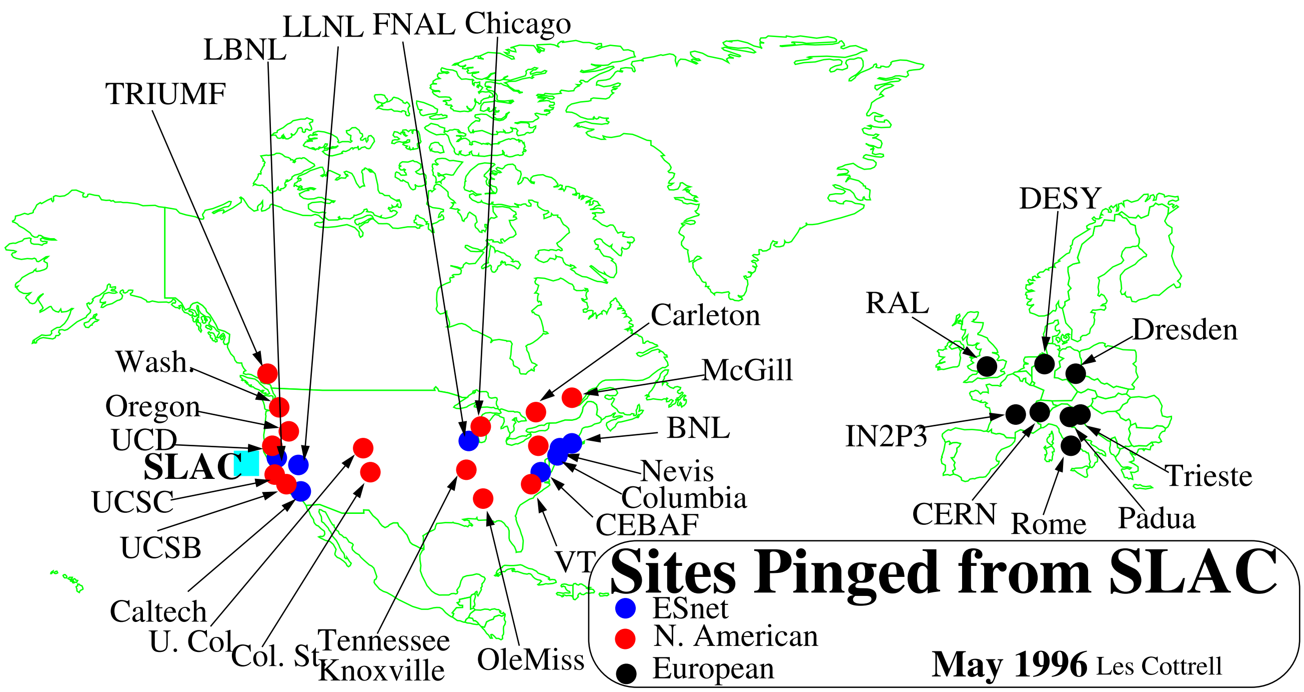



Thruput FTP vs Ping Correlations
Ping KB/s
1000.00
100.00
10.00
1.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
FTP KB/s
SLAC
ESnet
Caltech
LBL
FNAL
CEBAF
BNL
UCSC
UCDavis
UOregon
CUBoulder
ColoState
OleMiss
Columbia
TRIUMF (CA)
CERN (CH)
RAL (UK)
DESY (DE)
IN2P3 (FR)
Padua (IT)

Ping Correlation with Hop Count



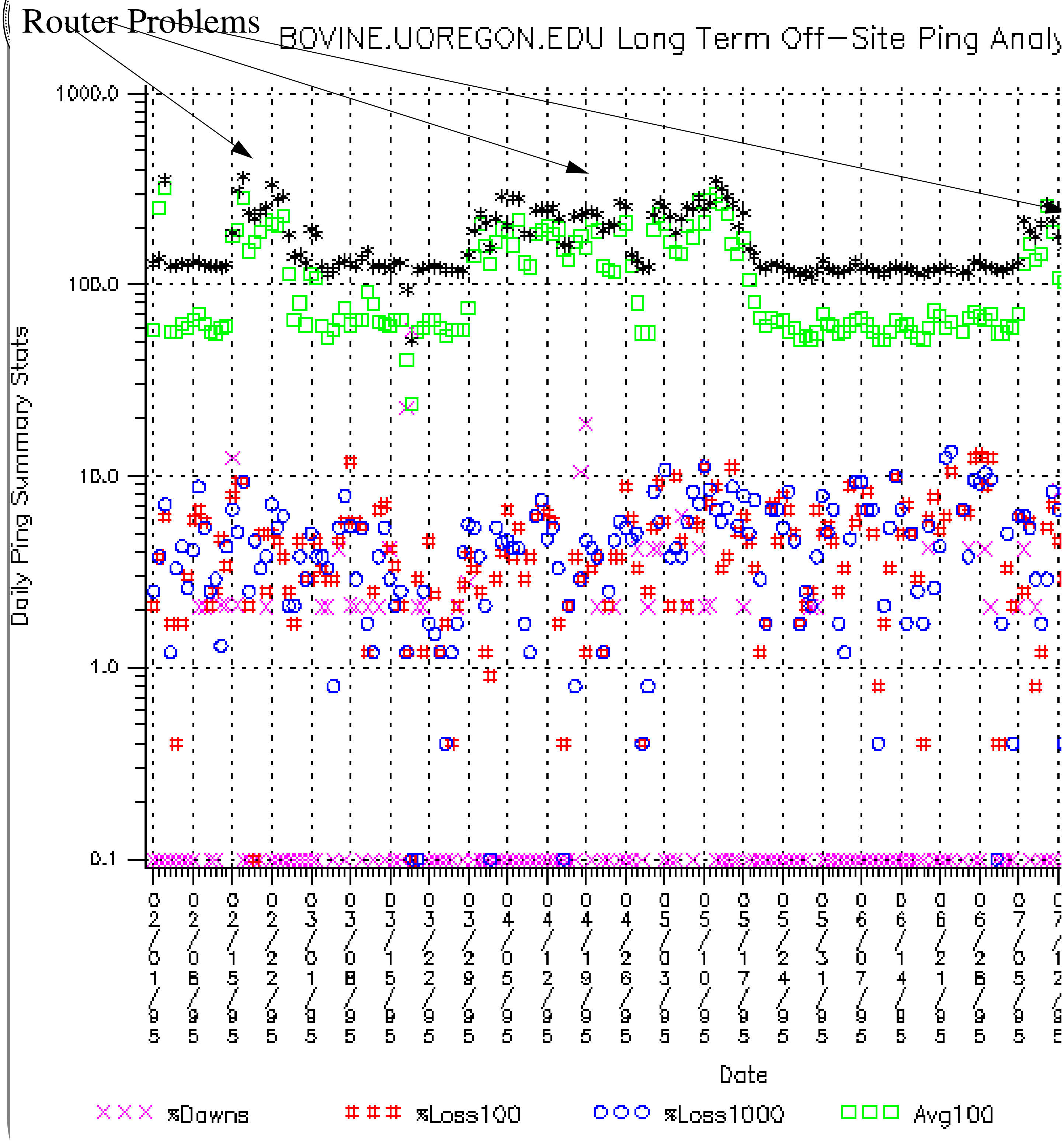
Sites That SLAC Monitors



Requirements for new remote sites:

- Contact person, “public” host to ping, traceroute server, Web page on monitoring
- http://www.slac.stanford.edu/comp/net/wan-req.html
- http://www.slac.stanford.edu/comp/net/mon/offsite.nodes

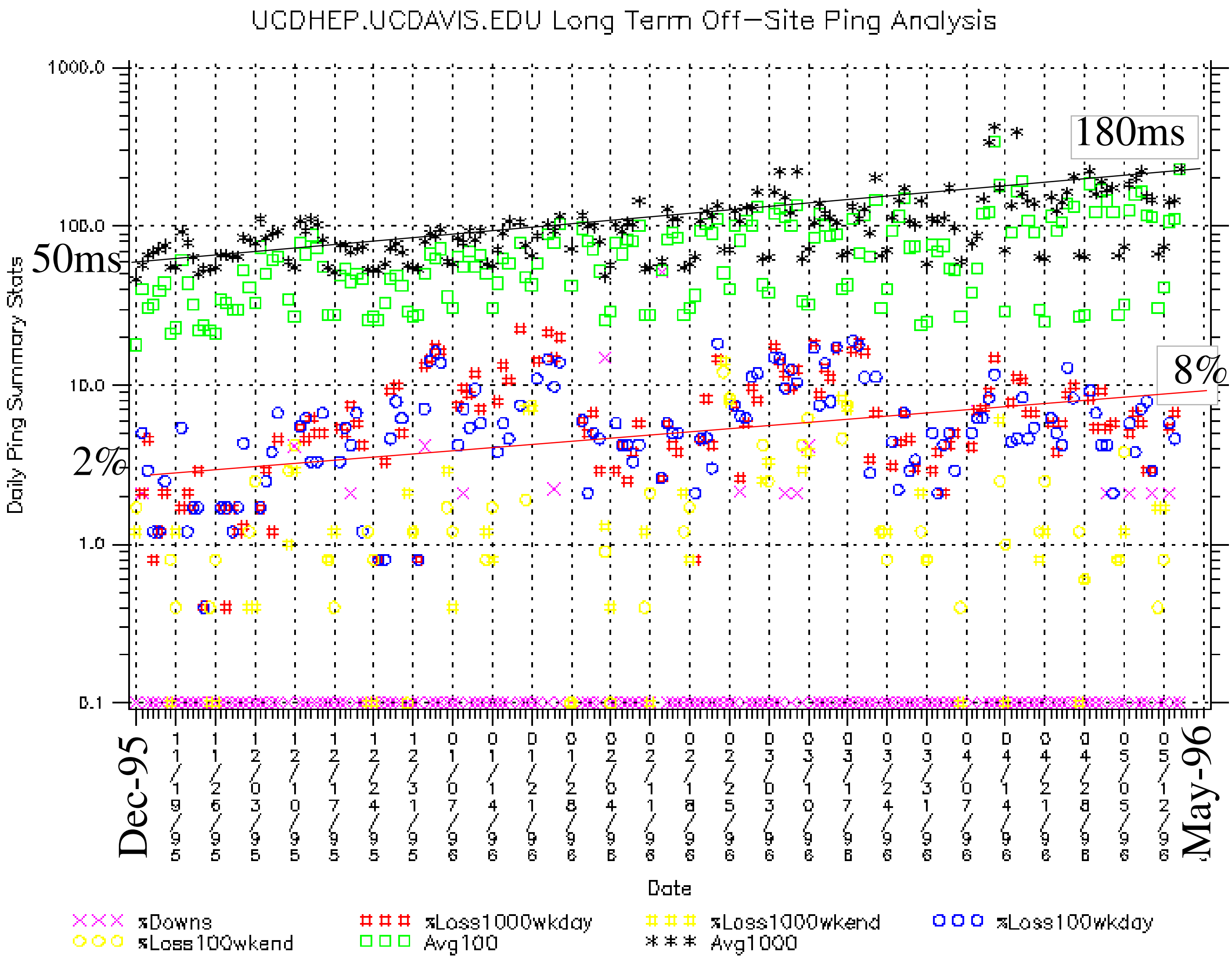
Router Problems



Long Term Degradation

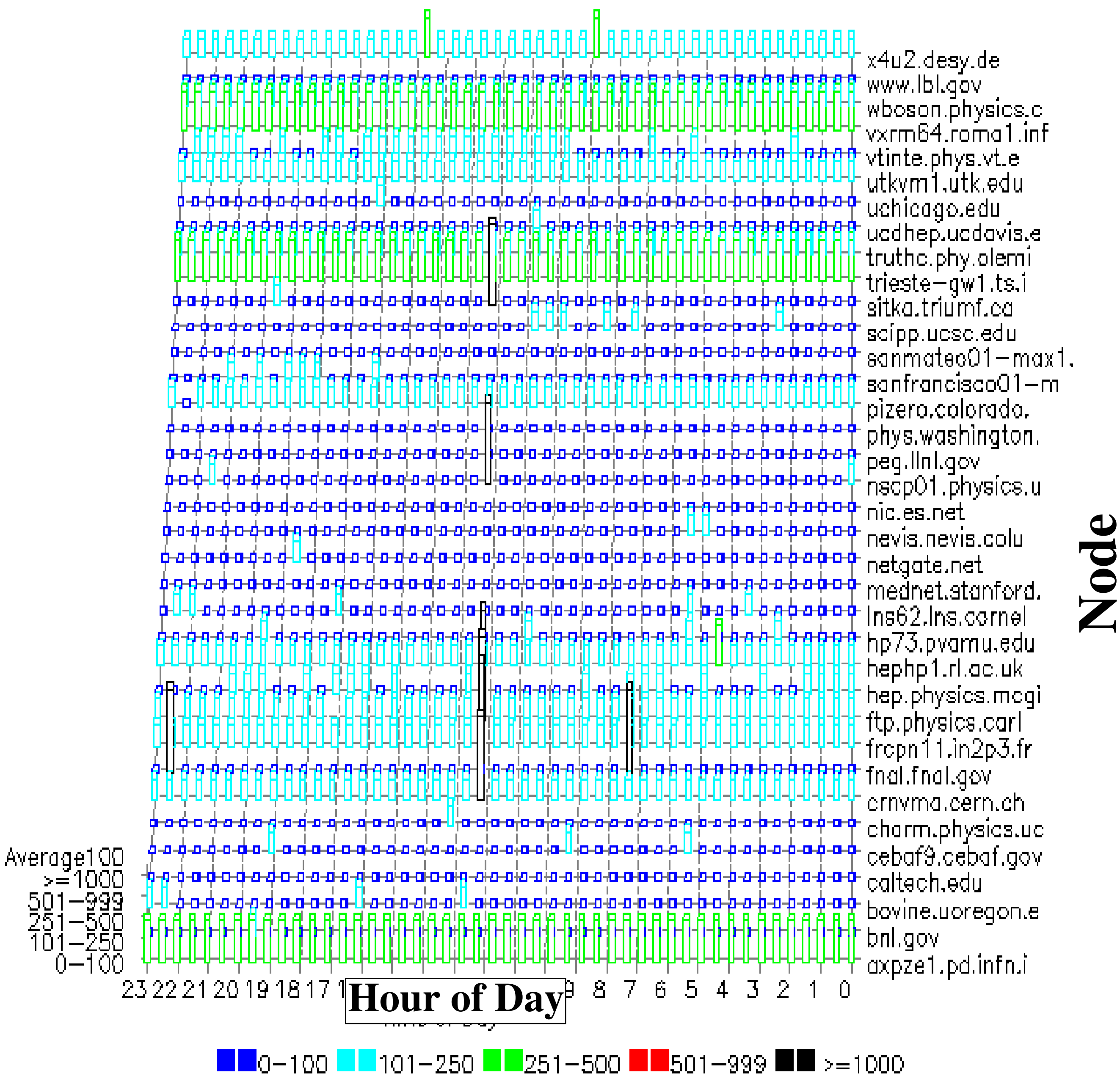
Studies at SLAC, HEPNRC and LBNL show major degradation in quality of service between Universities and ESnet Labs in last year:

180 Day Ping Trends Between UCD & SLAC



Note: difference in weekends vs workdays

3D Plot of Ping Response vs Hour of day & Node



Alerts

For each node being monitored:

- Calculate mean and standard deviation of the weekday packet loss for last 10 weeks.
- If yesterday's value outside 3 standard deviations raise an alert
- Repeat for response time

Report in a table:

```
#                       Mean    Mean    Stdev   #Std     Mean     Mean   Stdev   #Std
#                       10wks   1 wk    10wks   From     10wks    1 wk   10wks   From
#Nodename               %Loss   %Loss   Loss    Mean     Avg      Avg    Avg     Mean
AXPZE1.PD.INFN.IT         2.3     1.3     2.1   -0.5    368.4    156.7   72.1   -2.9
...
```

Hot Links to alerts:

Table 1: Ping Alerts for Sun 5/5/96

Node	#pings	#down	#loss	%loss	min response	max response	avg response
physics.upenn.edu	240	0	17	**7.1%**	89ms	102ms	**92ms**

More Information

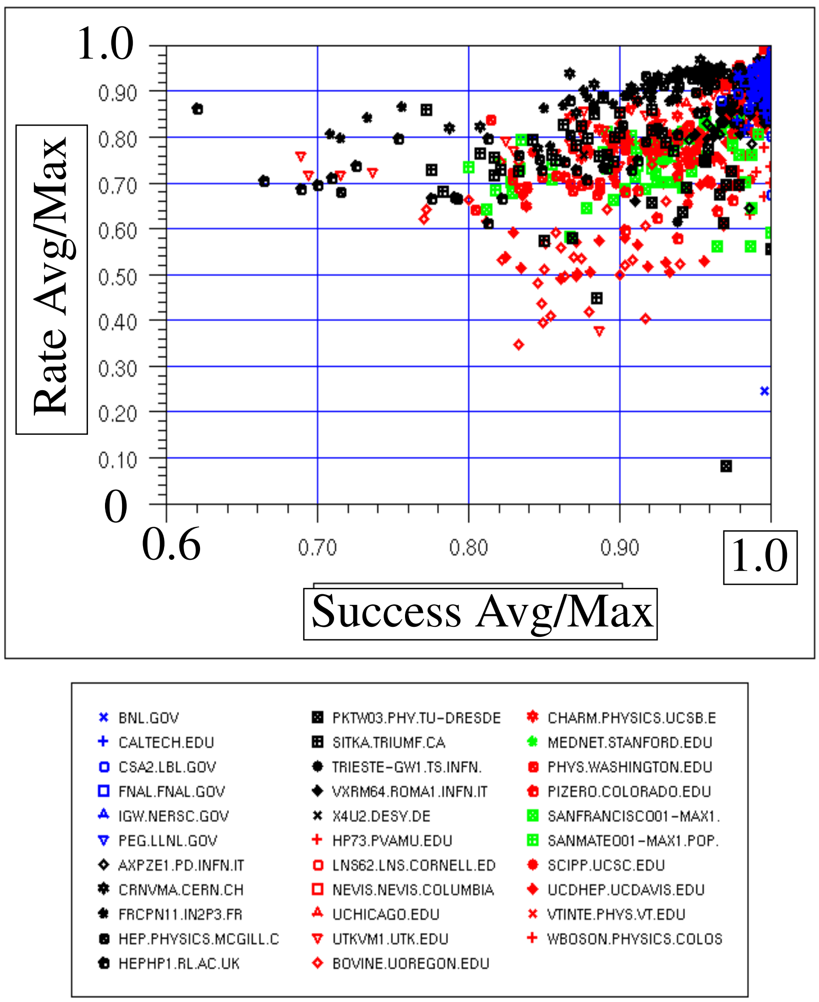
Service Predictability

Scatter plot:

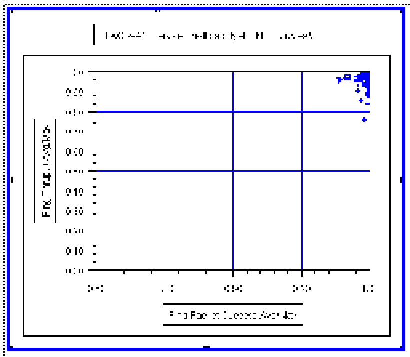
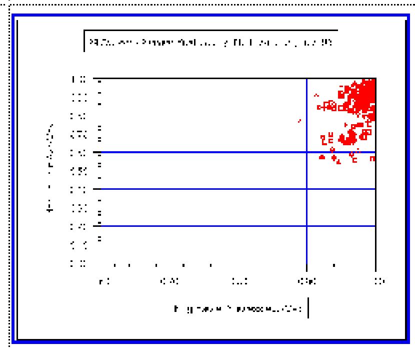
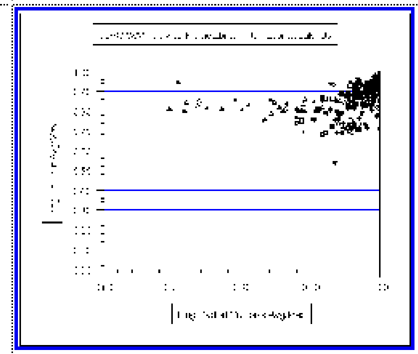
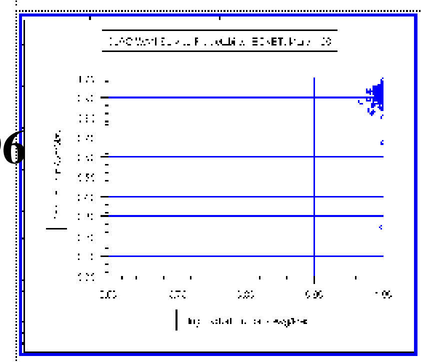
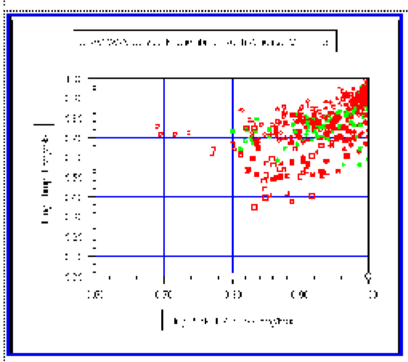
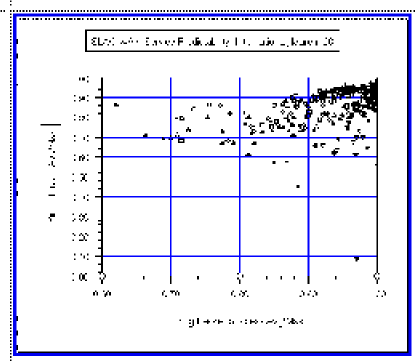
daily average ping / max ping rate versus

daily average packet success / maximum packet success

(where % success = (total packets - packets lost) / Total Packets)

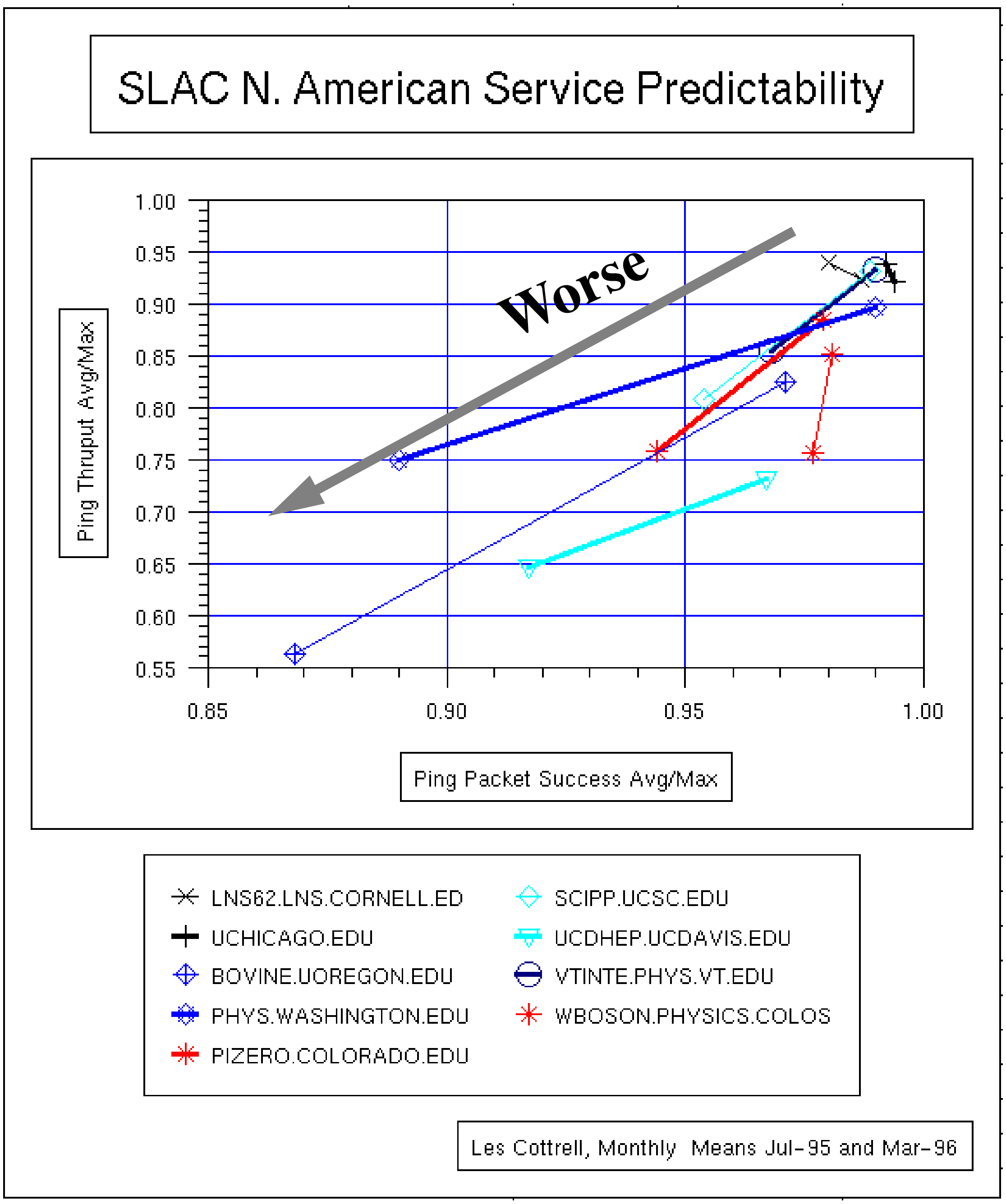


Changes in Service Predictability

	ESnet	N. America	International
Jul ‘95			
Mar ‘96			

By this metric:

- Esnet is predictable and staying that way
- N. American Internet is bad and getting worse
- International bad but not getting worse


SLAC N. American Service Predictability
Ping Thruput Avg/Max
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.85
0.90
0.95
1.00
Worse
Ping Packet Success Avg/Max
LNS62.LNS.CORNELL.ED
UCHICAGO.EDU
BOVINE.UOREGON.EDU
PHYS.WASHINGTON.EDU
PIZERO.COLORADO.EDU
SCIPP.UCSC.EDU
UCDHEP.UCDAVIS.EDU
VTINTE.PHYS.VT.EDU
WBOSON.PHYSICS.COLOS
Les Cottrell, Monthly Means Jul-95 and Mar-96

What are People Doing

ESSC/ESCC/NMTF

Meeting at Berkeley, May 1996 -agreed:

Will monitor end-to-end connections for:

- setting users expectations
- getting trends
- trouble shooting

Find, evaluate, develop & use tools to collect and analyze performance from user viewpoint

Identify and develop metrics and reports to validate and qualify service quality

Extend deployment of monitoring:

- Initially 4 sites (BNL, HEPNRC/FNAL, ORNL, SLAC) act as focal sites. Each site will monitor service quality from it to collaborator sites.
- Develop common recommendations for baseline monitoring for focal sites (what to measure, how often & how)
- Document requirements for hosts being monitored
- Document and share tools for collection, filtering, analysis and report generation
- Where appropriate use a standard format for raw data collected

Spread the word (User groups, TCom-96, Mtgs, DOE, today...)

What are Others Doing

Big concerns about Internet gridlock

"**to a significant extent due to the lack of efficient financial pressure on service providers to strengthen the infrstructure**" from *Metrics for Internet Settlements*, by Brian Carpenter CERN

Much effort therefore to identify critical networking metrics and tools than can be employed by users and ISPs to quantify Internet quality of service

Organizations involved include the Federal Networking Council (FNC) and its Advisory Committee (FNCAC), DARPA, Kansas University, Merit, NSF, ESnet/NMTF, National Laboratory for Applied Network Research (NLANR) working with MCI.

Further Information

ESCC Network Monitoring Task Force (NMTF):

- http://www.slac.stanford.edu/~cottrell/tcom/nmtf/

Tutorial on WAN Monitoring:

- http://www.slac.stanford.edu/comp/net/wan-mon/tutorial.html

Survey of Internet Statistics / Metrics:

- http://www.tomco.net/~tmonk/metrics.htm

Federal Network Council:

- http://www.fnc.gov/metrics.html
- http://www.fnc.gov/fnc_collab1.html

Draft RFC on Metrics for Internet Settlements (Carpenter/CERN):

- ftp://ds.internic.net/internet-drafts/draft-carpenter-metrics-00.txt

National Laboratory for Applied Network Research (NLANR):

- http://www.nlanr.net
- http://www.nlanr.net/INFO/
- http://www.nlanr.net/Viz/End2end

NCSA/NLANR Internet Performance Sampling:

- http://computer.ncsa.uiuc.edu/vwelch/projects/inetperf/

Merit's Network Statistics Collection and Reporting Facility:

- http://home.merit.edu/~wbn/RAC/play.html

SLAC's WAN Monitoring:

- http://www.slac.stanford.edu/comp/net/wan-mon.html