



Measurements on Internet2

Matt Zekauskas

matt@internet2.edu

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Internet2 tends to coordinate

- Work done by members
- Some central support [esp wrt Abilene]
- Focus on end-to-end performance problems underway

Big measurement projects

Campus/gigaPoP coordination

Data from Abilene

End-to-End Performance Initiative

Active

- Measurement within Abilene
- Measurement using entire Internet2 infra.

Passive

- SNMP stats (esp. core Abilene links)
- “IOS” stats (for QoS)
- Characterization of traffic (on the way)
 - Netflow; OCxMON



Measurement Projects

Surveyor (one-way delay, loss, routing)

- www.advanced.org/surveyor
- On many Internet2 campuses (70 sites)
- Abilene presence

AMP (round-trip delay, loss, routing)

- moat.nlanr.net/AMP
- At even more Internet2 campuses (120 sites)

PMA (passive, packet traces)

- moat.nlanr.net/PMA
- 1 min, 8 times a day, ~13 sites



Measurement Projects

PingER (round-trip delay, routing)

- <http://www-iepm.slac.stanford.edu/pinger/>
- Long term data from a few locations to many
- High-energy physics focus

NIMI

- <http://www.ncne.nlanr.net/nimi/>
- Designed to be platform for experiments
- Undergoing some redesign/revitalization
- ~ 60 sites?



An “Application-Level” Example

Pioneer

- <http://pelle.internet2.edu:8080/pioneer/>
- Synthesis of existing infrastructure
- Focus: video conferencing tests

Abilene goal to be an exemplar

- Measurements open
- Tests possible to router nodes
- Web-mediated on-demand measurements
- Throughput tests routinely through backbone
- ...as well as existing utilization, etc.



Active within Abilene

Each Router Node has a PC

Now 10 of 11 are OC3-ATM attached

- missing: Houston

No GPS

- working towards GPS within CDMA solution



Surveyor on Abilene

Definitely not production: experimenting

No GPS $\Rightarrow$ limits clock synch

Experimenting with NTP

- ≈ 250 μ S accuracy on Abilene
- Looks good enough for Operations
(route changes, major congestion)

Experimenting with GPS w/in CDMA

Do have EF and BE traffic flows

Traceroutes not yet exported

<http://hartman.advanced.org/IPPMApplet/abilene/report/Report.html>



Ad-hoc Active on Abilene

With OC-3, can do moderate throughput testing (e.g., iperf UDP & TCP). ~90 Mbps

Adding on-demand tests in support of performance debugging



Passive - Utilization

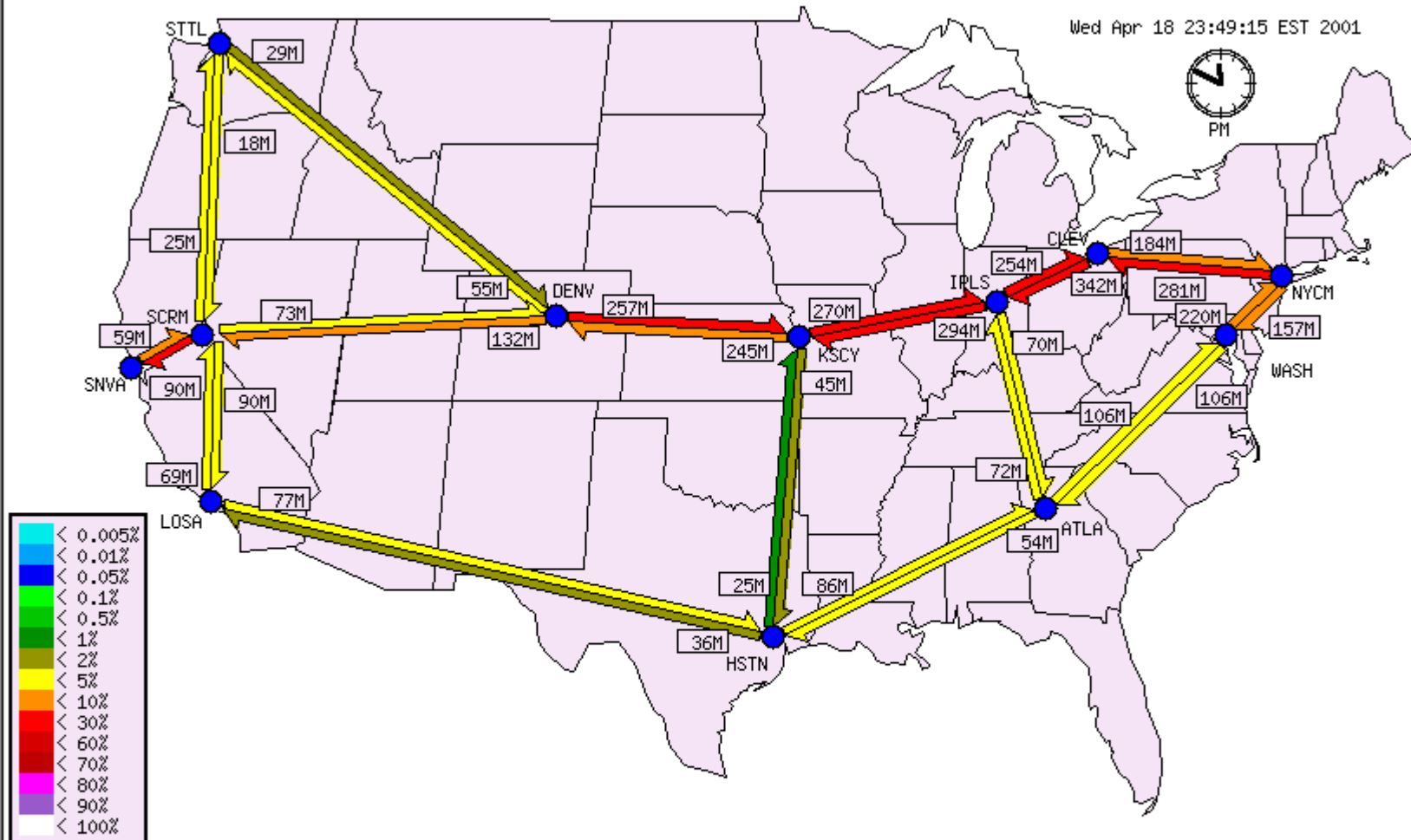
The Abilene NOC takes

- Packets in,out
- Bytes in,out
- Drops/Errors
- ..for all interfaces, publishes internal links & peering points (at 5 min intervals)
- ..via SNMP polling – every 3 sec

<http://hydra.uits.iu.edu/~abilene/traffic/>

INDIANA UNIVERSITY ABILENE NOC WEATHERMAP

Wed Apr 18 23:49:15 EST 2001



FileEditViewFavoritesToolsHelp

Address  http://hydra.uits.iu.edu/~abilene/proxy/ 

Abilene Core Node Router Proxy

A service of the [Abilene NOC](#)

This tool allows you to submit `show` commands to an Abilene core node router. Select a core node, select and complete the command of your choice, and submit the form; the output of the command will be returned in the lower frame.

Core Node:

NYCM [New York, New York]

Command:

show interface

Execute

Reset

Response from Core Node Router NYCM:

show interface

```
POS0/0 is up, line protocol is up
  Hardware is Packet over SONET
  Description: OC48 to CLEV | CORE#:10129914, TBS#1001/OC48/CLEVOHUGH13/NY1001/OC48/CLEVOHUGH13/NYCMNYZF
  Internet address is 198.32.8.30/30
  MTU 4470 bytes, BW 2488000 Kbit, DLY 100 usec, rely 255/255, load 28/255
  Encapsulation HDLC, crc 32, loopback not set
  Keepalive set (10 sec)
  Scramble enabled
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters 1w5d
  Queueing strategy: random early detection (WRED)
  Output queue 0/40, 0 drops; input queue 0/75, 1209 drops
  30 second input rate 188122000 bits/sec, 37205 packets/sec
  30 second output rate 277680000 bits/sec, 43001 packets/sec
    36777413518 packets input, 24409013926095 bytes, 0 no buffer
    Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
      0 parity
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 short
```



Passive – Characterization

gigaPOPs & Universities doing own

Some sparse via NLANR/MOAT

- <http://moat.nlanr.net/PMA/>

Starting some NetFlow measurements

- QoS
- AS-AS information for K-12 & ITN
- Intend to do some characterization



Packet Trace Project

NLANR MOAT/Waikato (New Zealand)

Goal: New backbone traces

Looking to deploy some OC48 monitors

Desire to fully instrument one router

NOT near term, but perhaps in 6 months...



Others via Abilene NOC

BGP Peering

*MSDP (multicast source discovery)
logging*

*See: <http://www.abilene.iu.edu/>
-> Operational Status*

Support of Abilene services

- Abilene Premium Service
- Abilene Scavenger Service

“IOS” stats for QoS metrics not in MIBs

- Think of polling the proxy interface

Some initial results from Netflow (Ben)

*Ability to tag Surveyor measurements
with DSCP value [not routine yet]*



Multicast-specific

Multicast measurements

- Not fully understood
- Debugging is an art

Tools

- Mtrace
- 'sdr' announcements in backbone
- Mhealth, Mantra via UCSB
<http://www.nmsl.cs.ucsb.edu/>
<http://www.cs.ucsb.edu/~almeroth/>

Lots going on

Data available

- from measurement projects
- from Abilene

See also Internet2 Measurement Working Group

- So far, operational focus; research support in charter
- <http://www.internet2.edu/measurement>



End-to-End Performance Initiative



The Problem

Two researchers with a distributed app

Smallest “pipe”: 100Mbps

Run application, get 5Mbps. Loss.

Why?

Can we make large flows routine?



JPL/Caltech – GSFC

The situation

- Using Abilene
- Tuned hosts
- Things work locally

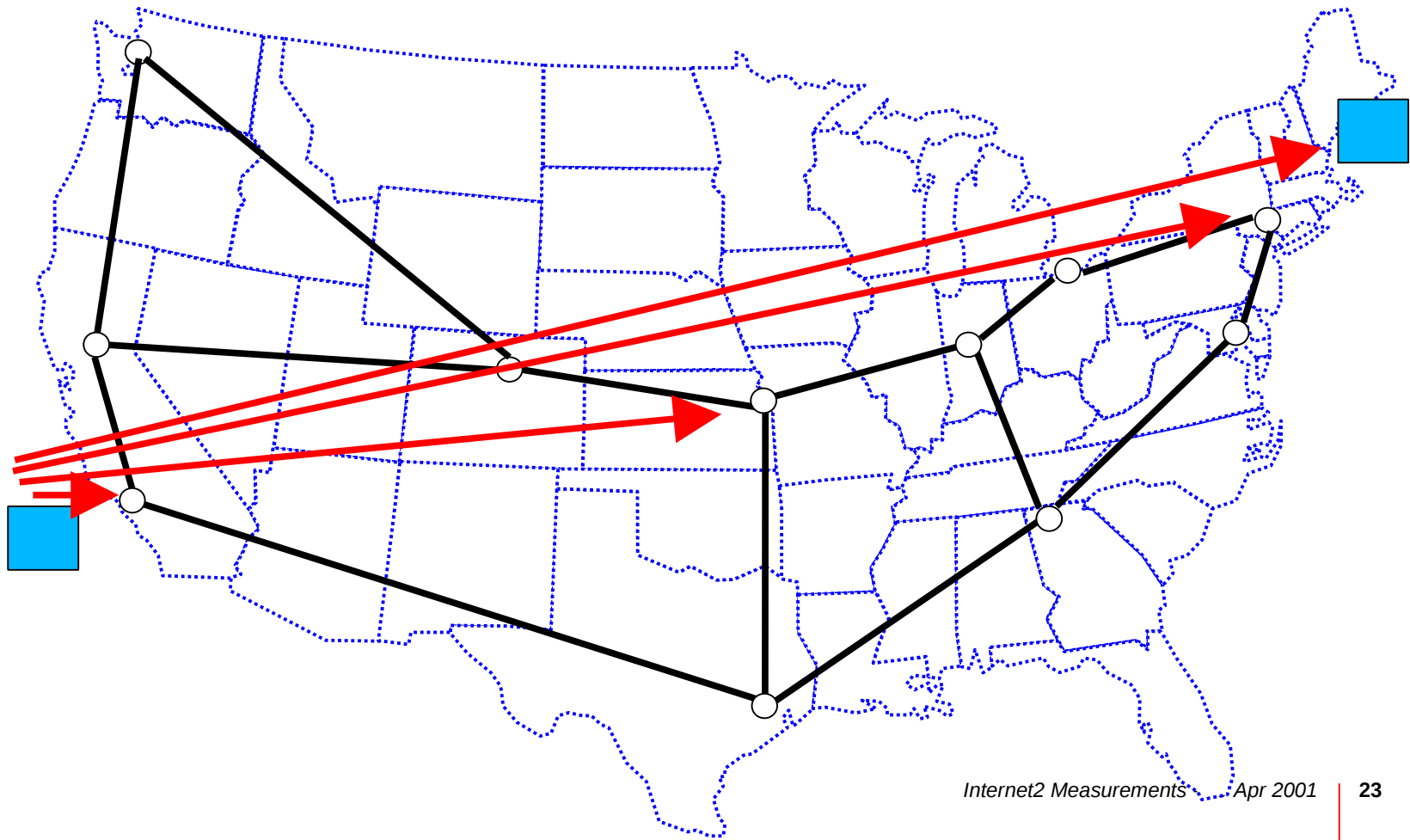
Therefore it MUST be Abilene

- Tests show good flows router-router
- Intermediate tests point towards CA

Bad fiber connection!



One Technique: Problem Isolation via Divide and Conquer





Attacking the Problem

Initiative to focus on the problem

Current leaders

- Steve Corbató
- Laurie Burns

Design document

Upcoming calls for participation to work on problems

<http://www.internet2.edu/e2eperf/>



Attacking the problem

Network

Host computer & operating system

Application

Operational Support

- Performance Evaluation & Review Framework
- Database / Knowledgebase



The Network View

“Wall jack to wall jack”

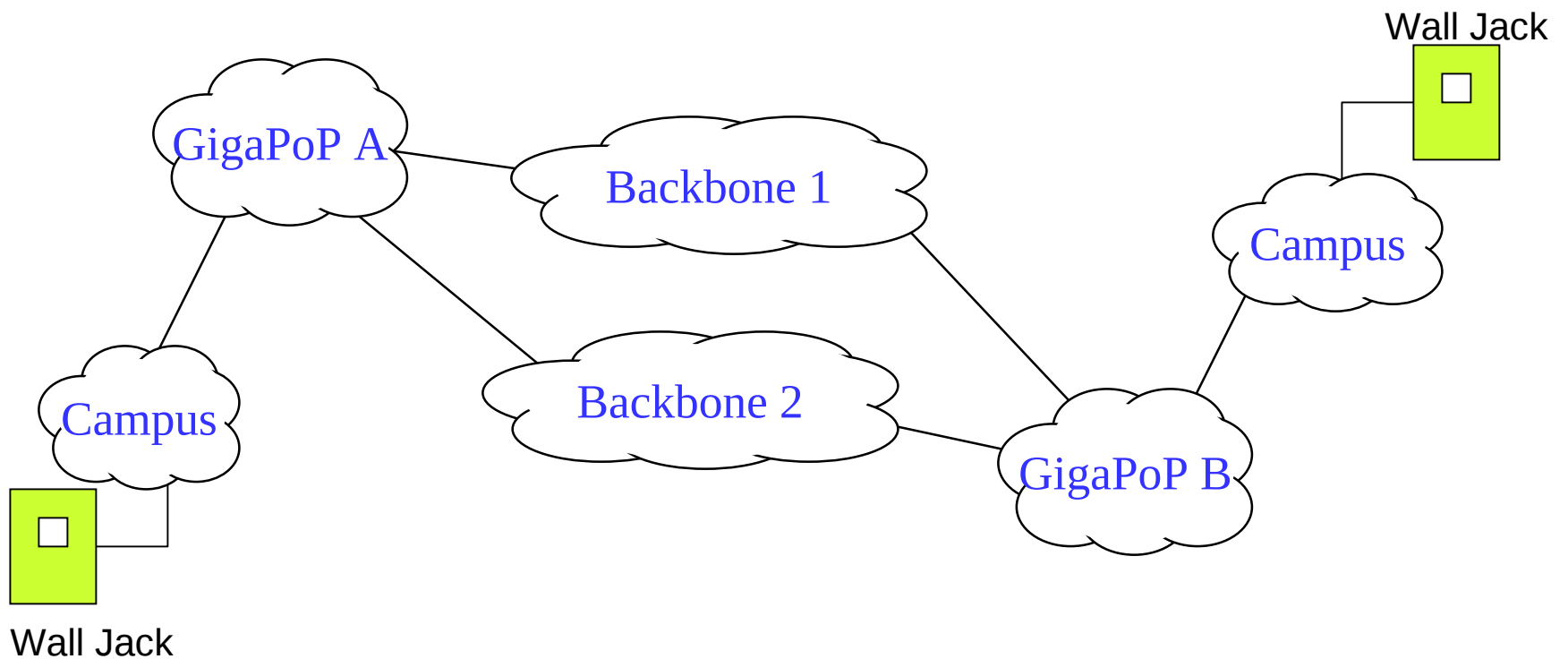
Long term: plug in and it works

Short term:

- Measurement infrastructure
- Analysis tools
- Best Current Practice documents
- $\Rightarrow$ Enable segmental end-to-end measurement, monitoring, analysis

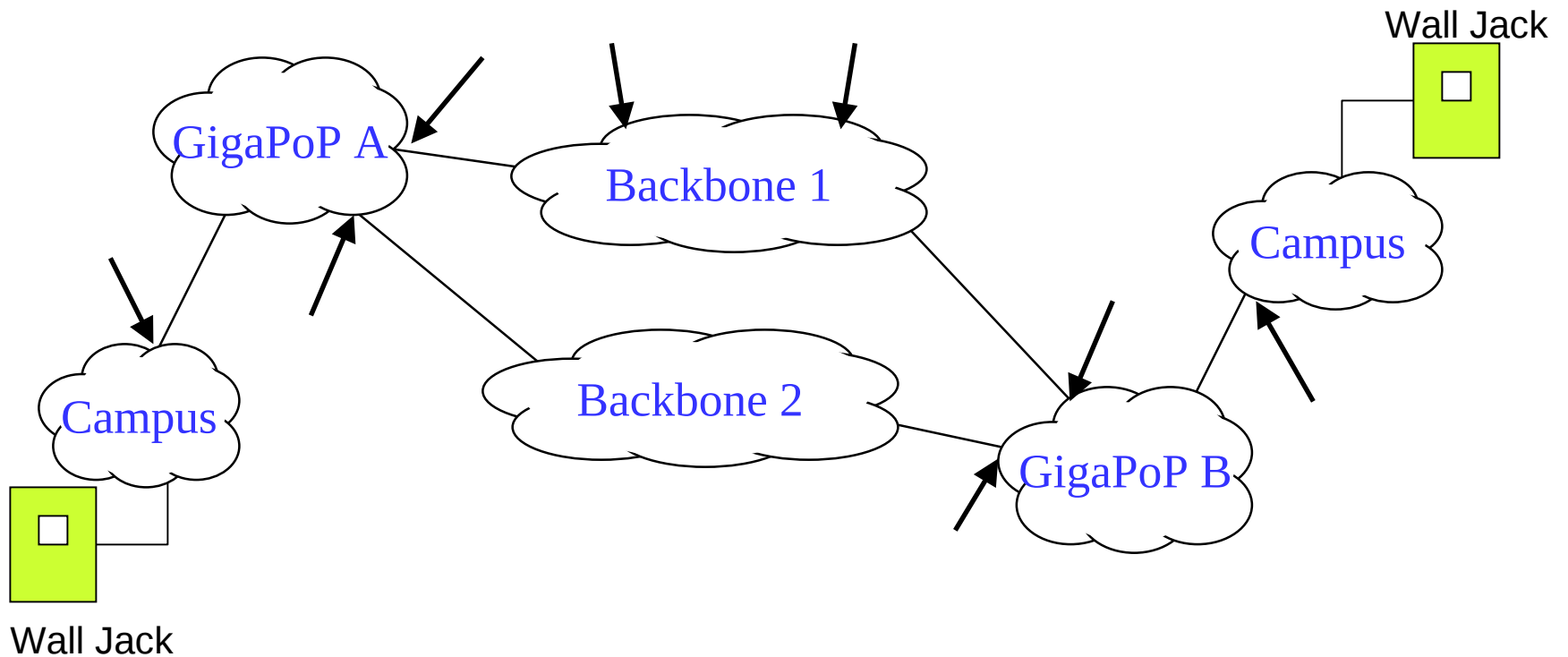


The Network View





The Network View





Measurement Architecture

Permanently installed machines

- Standard measurements on pre-determined basis
- Active measurements
- Diagnostic tools (in conjunction with application reflectors)
- Passive measurements

Portable machines



Measurement Architecture

*Uniform access to schedule tests,
retrieve results*

Results in uniform format

*Authentication, Authorization &
Accounting*

*Synchronization/Scheduling so tests
don't interfere with themselves or
environment*



Measurement Architecture

Security: prevent use as a denial of service platform

Privacy: don't expose user data, especially a concern for passive measurements



Implementation Considerations

Define standard tests

Implementable on range of platforms

Capitalize on existing metrics, tools, infrastructure

Consider commercial products, how to influence vendors (longer-term)

Rigorously document



Other Potential Issues

Identify useful protocol changes

Identify useful changes to hardware

- New counters / measurement support
- New protocol support (like IPMP)
- Different defaults



Phase 0 Measurement

Leverage existing measurement infrastructures

Get something up quickly over perfection

Learn what's missing

Feedback to improve infrastructure