Measurements on Internet2

Matt Zekauskas
matt@internet2.edu

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Overview

*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*
Types

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
Continuous measurement
One-way delay and loss
1/sec on Poisson Schedule
12 Byte UDP packets
Ports “random”
Traceroutes at 1/600 sec
72 Machines

- http://ippm-db.advanced.org/plots/ -- static
IPPMDelay Statistics Report
berkeley.csg to advanced

The granularity is 1 minute
Drag to zoom; Shift-drag to translate; Click display to reset

Source: berkeley.csg
Destination: advanced

Delay (ms)

Time (hour UTC)

Start: 06 08 21 00:00:00
End: 06 08 21 24:00:00

Y Scale
 Delay Min: 0
 Delay Max: 300
 Loss (%): 100

Display

- Minimum delay
- 50th percentile delay
- 90th percentile delay
- Any percentile infinite

Packet Loss
IPPM DELAY STATISTICS REPORT
berkeley.csg to advanced

The granularity is 1 minute
Drag to zoom; Shift-drag to translate; Click display to reset

Start: 2000 08 21 00:00:00
End: 2000 08 21 24:00:00

Y Scale:
- Clip
- Auto

Delay Min: 30
Delay Max: 35
Loss (%): 100
Long Term average per day

Round Trip Time (RTT) for amp-columbia

Weekly average

Round Trip Time (RTT) for amp-columbia

- **Minimum (ms):** 69.00
- **Mean (ms):** 72.09
- **Maximum (ms):** 411.00
- **Standard Deviation (ms):** 23.04
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
  • $\approx 250$ $\mu$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

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
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/
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

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/CLEV0HUGH13/NY1001/OC48/CLEV0HUGH13/NYCMNYZEF
Internet address is 198.32.8.30/30
MTU 4470 bytes, BW 2486000 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 (URED)
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
 3677743518 packets input, 24409013926095 bytes, 0 no buffer
Received 0 broadcasts, 0 runs, 0 giants, 0 throttles
 0 parity
 0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
 0 output errors, 0 CRC, 0 interface, 0 throttles, 0 jabber
Passive – Characterization

*gigaPOP*Ps & Universities doing own

Some sparse via NLANR/MOAT

- [http://moat.nlanr.net/PMA/](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
QoS-specific

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/
Summary

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?
Goal: 7 Mbps bi-directional UDP

= Surveyor node
The Duke-Frankfurt Problem

Abilene to Dante Link Utilization

http://monon.uits.iupui.edu/abilene/nycm/dante-bits.html
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
…continue with Network focus for End-to-End performance initiative talk from Spring 2001 member’s meeting…