OARnet Measurement Infrastructure Deployment Experiences

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Topics of Discussion

TFN Measurement Project Overview

- ActiveMon Measurement Infrastructure Software being developed at OARnet
- Two ActiveMon Deployment Casestudies...
- Live TFN-Abilene-ADECnet Monitoring Demo

Conclusion

Background

The **Third Frontier Network (TFN)** funded by the Ohio Board of Regents

A dedicated high-speed fiber-optic network linking Ohio colleges and universities with research facilities to promote research and economic development

Over 1,600 miles of fiber has been purchased to create a network backbone in Ohio to connect colleges and universities, K-12 schools, and communities together

TFN Measurement Project

Funded by Ohio Board of Regents Project started in early 2004 Project Partners OARnet (Project Lead and Co-ordination) University of Cincinnati, Cincinnati State, The Ohio State University, Kent State University, Southern State Community College, University of Toledo, Wright State University

TFN Measurement Project Objectives

- Identify end-to-end performance bottlenecks in the TFN on an ongoing fashion by building a comprehensive Network Measurement Infrastructure (NMI)
- Test new and advanced technologies and equipment before wide-scale adoption in the TFN Higher Education communities
 - Technologies: H.323/SIP based Voice and Videoconferencing, MPEG3, HDTV, Multicast, Bulk FTP
 - Equipment: Video streaming Caches, Firewalls, Intrusion Detection Systems, Traffic shapers
- Bring awareness and train campus-networking professionals to make optimum use of the capabilities of TFN so that their campus network infrastructures can be upgraded suitably

TFN Measurement Project Objectives

This talk's focus!

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"ActiveMon" Open-Source Software ActiveMon http://www.itecohio.org/activemon

- "ActiveMon" is a NMI software Framework being developed for deployment on TFN
- Development Goal of ActiveMon-

"ActiveMon should be an easily customizable and comprehensive NMI software package that a network engineer can setup and use to routinely monitor performance of network-wide paths using active measurements"

ActiveMon Architecture



ActiveMon Framework Features

- Data-Generator Module for an applicationspecific network measurement toolkit
- Central Data-Collector-Sanitizer Module to centrally collect and store sensible measurements data; E.g. this module avoids collecting '-ve' Delay or MOS values, etc.
- Solution Optimized Database Schema to efficiently store massive amounts of measurement data with minimal redundancy; saves disk space and facilities quicker data mining

ActiveMon Measurement Toolkit

Measured Characteristics	ΤοοΙ
Round-trip delay	Ping
High-precision one-way delay	OWAMP
Topology and route changes	Traceroute
Bandwidth capacity: Per-hop	Pathchar
Available bandwidth	Pathload
Bottleneck bandwidth	Pathrate
UDP transfer bandwidth, Jitter and Loss	lperf
Performance of interactive audio/video streams (MOS)	H.323 Beacon

ActiveMon can be easily enhanced to support other tools as well...

ActiveMon Framework Features (2)

- Scalable Scheduler Module for handling networkwide on-going and on-demand measurements; scheduling supports regulation and prevents measurement conflicts due to resource sharing
- Alarm Generator Module digests, analyzes and generates alarms based on an efficient anomaly detection scheme that aims at minimum false-alarms; alarm notification via e-mail is supported
- Easily Customizable Visualization Module with tabular and network health Weather map interfaces; alarm-context sensitive coloring of measurements information is supported
- Security Configurations to avoid compromise of measurement infrastructure resources

Is ActiveMon fully developed and available as open-source?

- An alpha version of the software with several of the above features has been developed and deployed on a measurement testbed
- Based on the deployment experiences, the alpha version is being enhanced to provide better and more consistent functionality
- To obtain the alpha version of ActiveMon, please contact-

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Measurements Testbed

Goal-1:To study end-to-end network performance measurement data reported by various tools to empirically correlate network events and measurement data anomalies in a routine monitoring infrastructure

"Do measurement tools actually detect significant network events?"

Goal-2: To analyze long-term network performance trends via statistical analysis of active and passive measurement data collected at strategic points on an ongoing basis

"What can be understood from long-term network measurements?"

Goal-3: To use findings obtained from fulfilling the above Goals 1 and 2, to comprehensively compare performance at campus, regional and national network backbone levels and hence to quantify end-to-end network performance stability in typical hierarchical network backbones

"How does it matter where I measure the network?"

Testbed spanning Hierarchical Network Backbone Levels – Campus, Regional, National



Case Study - I

(July 2004 – December 2004 Measurements Data)

Delay Variations

- We found that combined one-way delays (A→B+B→A) along a path with ends A and B are comparable to round trip delays (A↔B) in all the three paths
- Significant anomalies due to route changes (each time!)
- Short-lived dips and peaks due to miscellaneous temporal network dynamics; Magnitudes based on hop-count



Case Study - II

(July 2004 – December 2004 Measurements Data)

Bandwidth Variations

- Router mis-configuration anomaly with three distinct trends
- Regional path was the least congested and most provisioned path
- National path traffic spanning multiple-ISPs experiences most congestion events



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ActiveMon Related Publications (2005)

- Prasad Calyam, Dima Krymskiy, Mukundan Sridharan, Paul Schopis, "TBI: End-to-End Network Performance Measurement Testbed for Empirical-bottleneck Detection", IEEE TRIDENTCOM, 2005.
- Prasad Calyam, Chang-Gun Lee, Phani Kumar Arava, Dima Krymskiy, David Lee, "OnTimeMeasure: A Scalable Framework for scheduling active measurements", IEEE E2EMON, 2005.
- Prasad Calyam, Dima Krymskiy, Mukundan Sridharan, Paul Schopis, "Active and Passive Measurements on Campuslevel, Regional-level and National-level Network Backbone Paths", IEEE ICCCN, 2005.
- Prasad Calyam, Chang-Gun Lee, Phani Kumar Arava, Dima Krymskiy, "Enhanced EDF Scheduling Algorithms for Orchestrating Network-wide Active Measurements", IEEE RTSS, 2005.

Above papers are available at - <u>http://www.osc.edu/research/networking/publications.shtml</u>

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Live TFN-Abilene-ADECnet Monitoring Demo

http://activemon.oar.net



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Thanks!

- ActiveMon Scripts Development, Deployment and Data Analysis
 - Prasad Calyam, Phani Kumar Arava, Dima Krymskiy, Peter Jaegerson, Mukundan Sridharan
- Project Management
 - Steve Gordon, Paul Schopis, Pankaj Shah
- OSU Border and Dept. Deployment
 - Prof. David Lee, Dave Kneisly, Arif Khan, Weiping Mandrawa, Mark Fullmer
- UC Border and Dept. Deployment
 - Prof. Jerry Paul, Prof. Fred Annexstein, Bruce Burton, Bill Bohmer, Tom Ridgeway, Michal Kouril, Diana Noelcke
- **TAMU** Deployment
 - Chris Norton
- UToledo Deployment
 - Denis Logan
- SSCC Deployment
 - Dennis Griffith
- NC-ITEC, Abilene Tests
 - John Moore, Jeff Boote

Questions?



TFN Measurement Project Reference: http://tfn.oar.net/measurement

