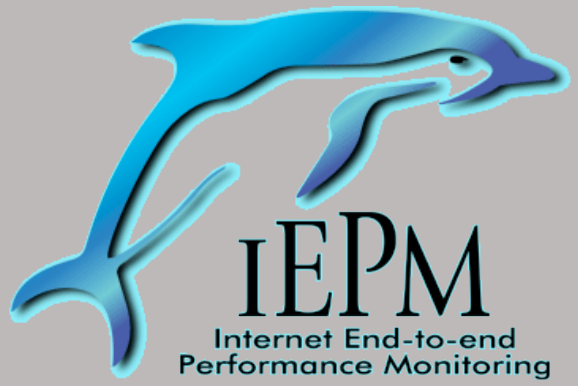
A Step Towards Automated Event Diagnosis

Stanford Linear Accelerator Center



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In this presentation

- Cause of Problems
- Background
- Motivation
- Basic Principles
- Case Study
- Limitations
- Current Status

Cause of problems

- Hardware
  - Network Device failures
  - Communication link failure
  - Fully loaded machines
- Software/Configuration
  - PC configuration
  - Badly designed/configured applications
  - Routing inconsistencies
- Maintenance/Upgrade
- Firewalls

Cause of problems

- Network Device failures
  - Stanford Connectivity Failure (Sat) 10th September 2005 ~14:00
    - CENIC had an unplanned outage of the Stanford 15540 due to a fan failure.
    - Effected SLAC's paths to CENIC (and Internet 2)
- Communication link failure
  - BNL August 2005
    - Event reported from BNL to several sites at 7:45pm
    - BNL's primary ESNet fiber connection (OC-48) to NYC went down on 8/16/05 at around 6:45pm EDT.
    - At that time BNL's only connection to the internet was through its secondary backup connection (T3) through NYSernet. The primary link was restored at around 3:44am EDT.
  - Pakistan July 2005
    - Under water fiber cable (SEAMEWE-III) damaged.
    - Fault was corrected after eight days.

Cause of problems

- Maintenance/Upgrade
  - April 2006 CERN-TENET
    - Anomalously large min-RTT reported between 9 and 10 April 2006
    - TENET shifted to Abilene without prior warning
- Badly designed/configured applications
  - SLAC-CALTECH applet problem
    - November 2005, multiple alerts reported from CALTECH to SLAC and SLAC to CALTECH
    - An applet running on both ends was causing problem, after killing it from both ends every thing was back to normal.
    - The application was opening sockets for communication but not closing them.

Cause of problem

- Routing protocol inconsistencies
  - SLAC to CALTECH factor of 5 drop in performance
    - iperf throughput drop reported on August 27, 2003.
    - a CENIC router in Los Angeles (ASN 2152) was receiving Caltech's prefixes via a Los Nettos route server on a shared connector segment.
    - The Los Nettos route server was preferring paths to Caltech that went through a next hop that was not reachable from the CENIC router (and was then advertising that next-hop to the CENIC router).
    - Because of the unreachable next-hop the CENIC router was re-writing the advertised next-hop to be the direct peering address of the Los Nettos route server.
    - The los nettos route server's unreachable-from-CENIC path traverses a 100 Mb/s ethernet. This was the cause of the bottleneck.
    - Manual change of route, corrected the problem

Motivation

- Audience for performance analysis
  - System Administrators
  - Network Administrators
  - Network Users
  - Researchers
- Analyze events for
  - Event Isolation (finding cause of events)
    - Replace old hardware, reconfiguration, change peerings
  - Event Relationship (between different events)
    - Cascade effects, backup solution identification
  - Confirmation of events (False positives)
    - Seasonal effects etc.

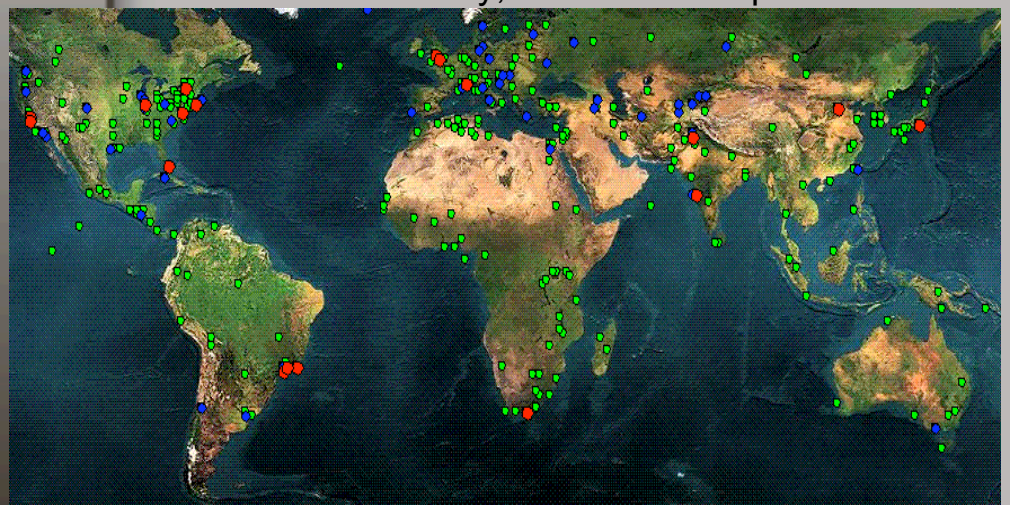
Motivation

- Currently End-to-End Monitoring and Diagnosis very Laborious:
  - Looking at graphs of data
  - Searching for route changes
  - Reconciling data from many different databases manually
  - Occasionally consulting other tools/services
    - Nagios, perfSONAR, maintenance tickets, phone calls etc.
- Analysis is usually conducted late.
  - Have to infer problem scenario and guess at event cause post event
  - Cannot conduct further tests during problem to confirm cause(s)
- The process is ad hoc
  - does not follow any specific procedure so always a chance of missing some important information
  - Need to build a ‘logic database’ to aid diagnostics: heuristics

IEPM-BW Background

- IEPM-BW Deployment
  - Different Network Monitoring tools
    - Ping, IPerf, Thrulay, Pathchirp, Pathload…
  - Variety of Metrics
    - Throughput, RTT, available bandwidth
  - Traceroutes
- Topology
  - 5 Monitoring Hosts
  - Over 25 nodes being monitored by each host
  - Number of Monitoring Host and nodes both increasing
  - Currently, bulk is in Europe and North America

Date/Time	Hop 1	Hop 2	Hop 3	Hop 4
07/08_00:10	SLAC 0.102 ms	SLAC 0.210 ms	(192.68.191.146) 0.286 ms slac-rt4.es.net	(134.5 0.610 n snv-pos
07/08_00:25	SLAC 0.100 ms	SLAC 0.239 ms	(192.68.191.146) 0.273 ms slac-rt4.es.net	(134.5 0.633 n snv-pos
07/08_00:40	SLAC 0.107 ms	SLAC 0.273 ms	(192.68.191.146) 0.309 ms slac-rt4.es.net	(134.5 0.676 n snv-pos
07/08_00:55	SLAC 0.261 ms	SLAC 0.236 ms	(192.68.191.146) 0.315 ms slac-rt4.es.net	(134.5 0.669 n snv-pos



Yesterday's Summary | Reverse Traceroute Summary | Directory of Historical Traceroutes

Checking a box for a node(s) and an hour(s) and pressing SUBMIT will provide topology m

SUBMIT Topology request | RESET FIELDS

NODE \ Hour (Pacific Time)=>	00	01	02	03	04
node1.cacr.caltech.edu* R Sum Log*	202				
node1.cesnet.cz* R Sum Log*	35	68	35		
node1.clrc.ac.uk* R Sum Log*	91	112	91		
node1.dl.ac.uk* R Sum Log*	97	155	97		
node1.ece.rice.edu* R Sum Log*	241				
node1.fnal.gov* R Sum Log*	8	48	8		
node1.in2p3.fr* R Sum Log*	29	131	30		

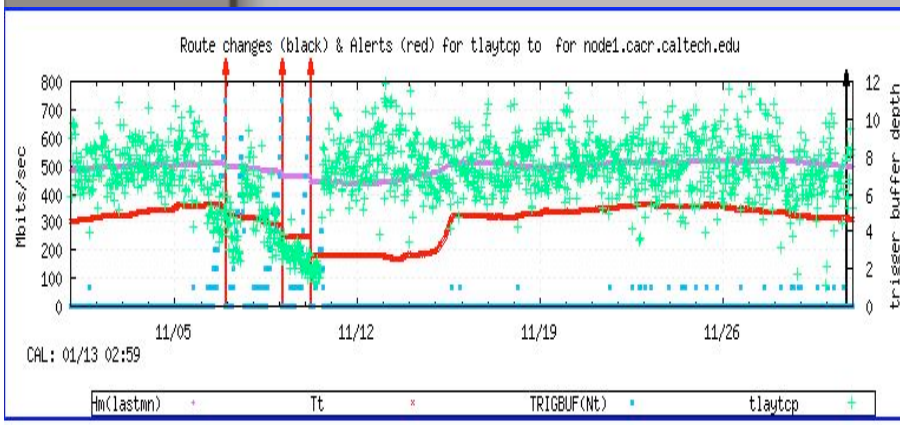
Automated Event Detection

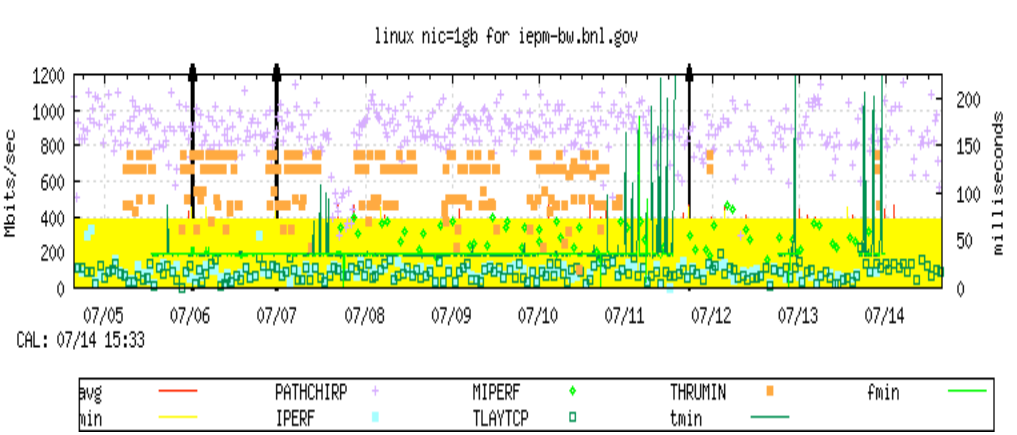
- Different Mechanisms
  - Holt-winters, Plateau
- Alerts are
  - Detected
  - Reported through e-mail
  - Stored in database
  - Made available on web

From: IEPM Account [iepm@socrates.ultralight.org] Sent: Sat 4/29/2006 12
To: Iqbal, Adnan; Logg, Connie A.; Cottrell, Les; Li, Yee-Ting
Cc:
Subject: iepm-bw.cacr.caltech.edu Alert: (node1.nslabs.ufl.edu,pathchirp),
Attachments:

Traceroute Summary Table for Today
http://socrates.ultralight.org/iepm-bw.cacr.caltech.edu/alerts/tracesummaries/today.html

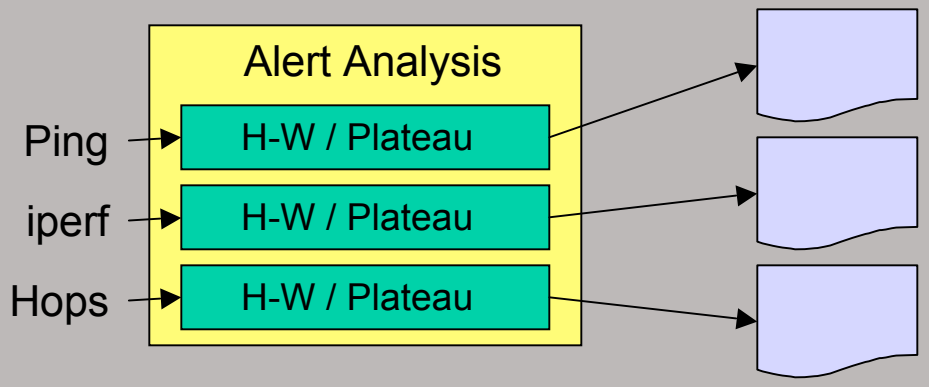
node1.nslabs.ufl.edu BANDWIDTH DROP graph
http://socrates.ultralight.org/iepm-bw.cacr.caltech.edu/alerts/pathchirp/analysis.html#node1.nslabs.ufl.edu
Date: 04/27/2006, Time = 12:57:27, %%drop = 39.7,
Past (mean, stdev) = (370.8, 41.1), Trigger (mean,stdev) = (223.5,29.8), Trigg
start time = (04/27/2006 01:57:36)
Graph of all the data:
http://socrates.ultralight.org/iepm-bw.cacr.caltech.edu/slac_wan_bw_tests.html#node1.nslabs.ufl.edu





IEPM-BW Event Detection Design Overview

- On each machine
  - Measurements taken…
  - Are analysed for events…
  - Stored on local machine in DB



Goals

- We want to find cause of a reported event as soon as possible
- If we keep on doing it manually, we cannot do it quickly
- Automation is not easy
  - Nature of problems varies
  - An apparent cause may not be the actual cause
  - One unified technique may not be applicable
- So what is our approach?
  - Define heuristics which describe relationship between an apparent symptom and a possible cause
  - Use these heuristics to find out actual cause of problem
  - These rules may be complex. One symptom can be due to one of many reasons
  - Use a simple scoring system to determine most probable cause

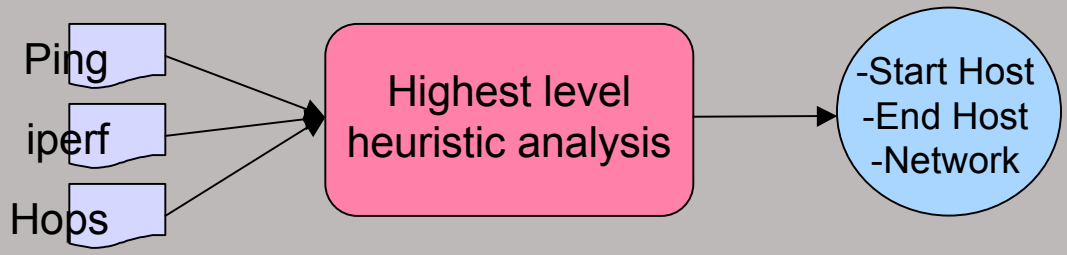
Unified Event Analysis Overview

- Event Notifications are used to initiate analysis of all available results
- Event DB used to cross correlate results between Monitoring Hosts
- Tiered system used to pin-point exact cause of problem.
  - What (extra) reports are needed to help pin-point further?
  - What other tools are available out there to generate these (extra) reports?

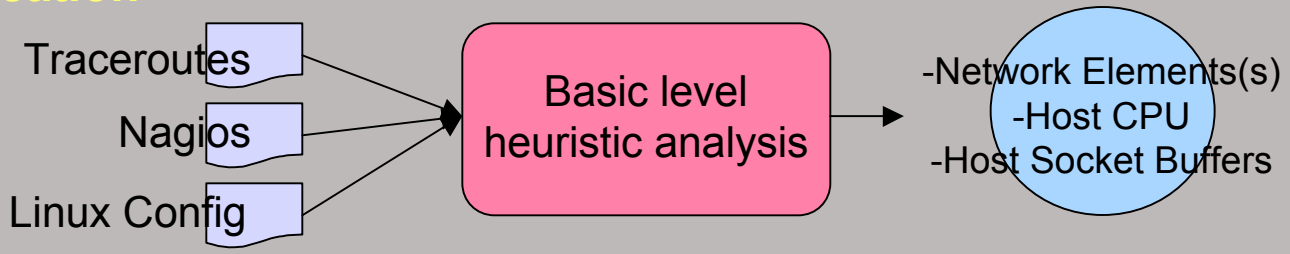
Analysis Overview

Discovery

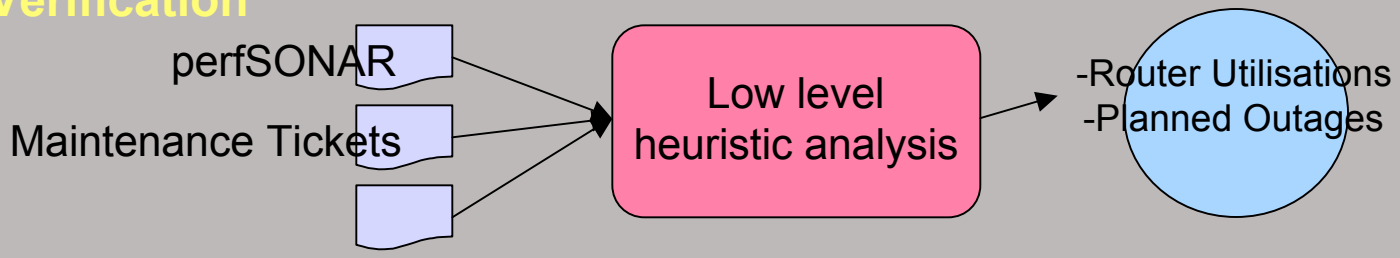
Location



Identification

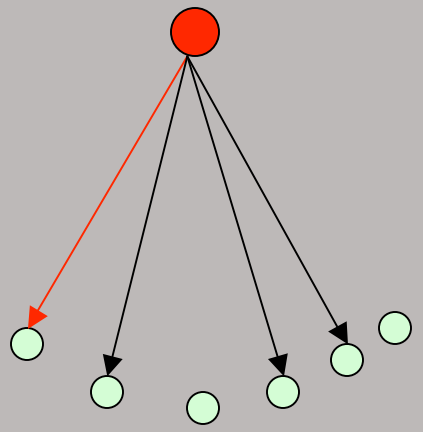


Verification



Heuristics

- If an event E is detected at time T, from monitoring host H for a monitored node M and there exist other events reported by same monitoring host H for monitored nodes other than M, than probability that monitoring host is causing problem increases with every such result



$$S_{smh} = \sum_{i=1}^{n} \alpha$$

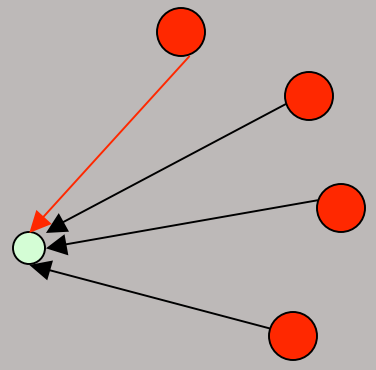
Where i represents only those nodes which reported event and α represents the score each such incident

Heuristics

- If an event E is detected at time T, from monitoring host H for a monitored node M and there exist other events reported by different monitoring hosts for same monitored node, than probability that monitoring node is causing problem increases with every such result

$$S_{node} = \sum_{i=1}^{n} \beta$$

Where i represents only those hosts which reported event and β represents the score each such incident



Heuristics

- If an event E is detected at time T, from monitoring host H for a monitored node M and there exist other events reported by M for H in similar time period than it confirms that event is not a false alarm. However, its cause can be any of the route change, network problem and or any of the end host.

$$S_{node} = \gamma$$

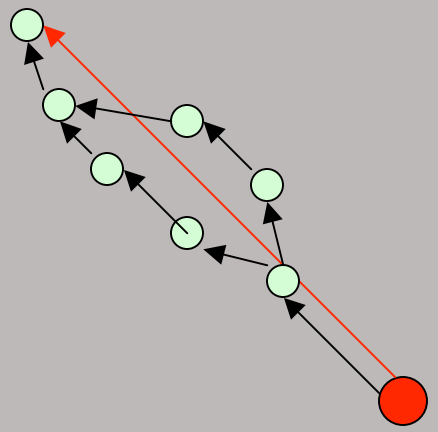
$$S_{host} = \mu$$

$$S_{network} = \lambda$$

Where S_x represents score for each category x.

Heuristics

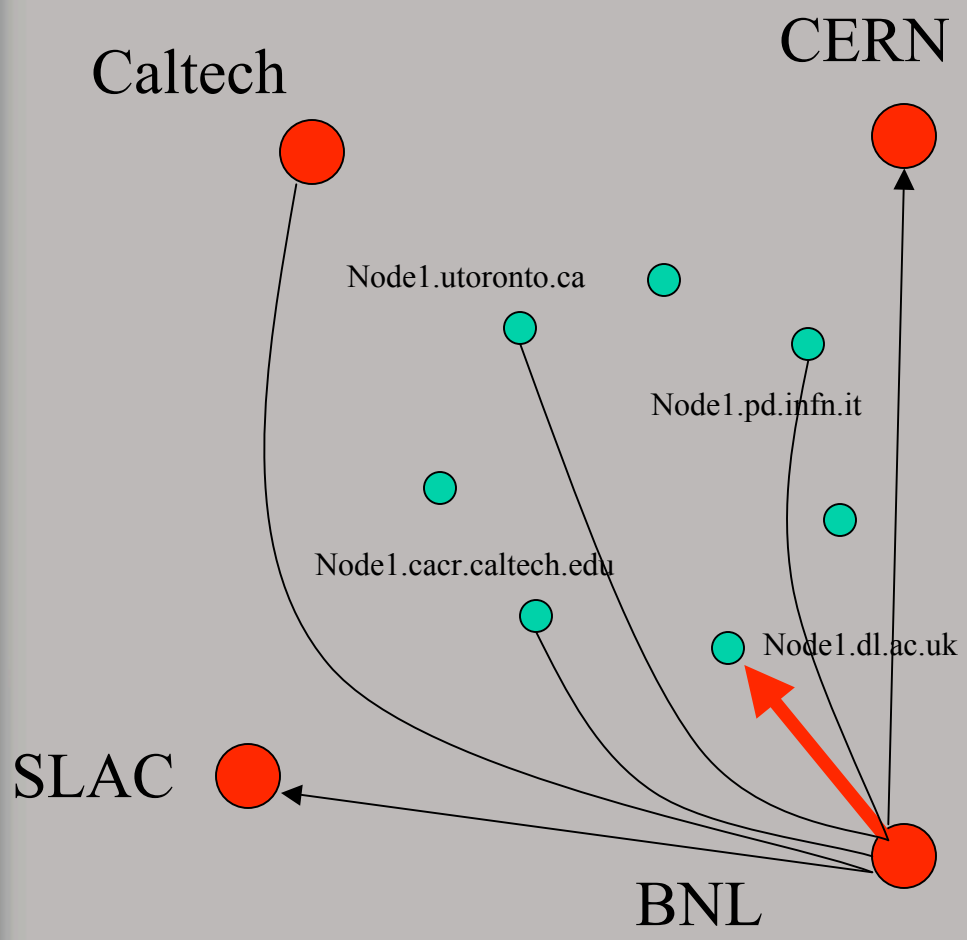
- If an event E is detected at time T, from monitoring host H for a monitored node M and there exist a change in the *number of hops* at the time of event detection than possibility is that performance drop is caused by any network problem.



$$S_{network} = \lambda$$

Where $S_{network}$ represents score for network problem.

BNL problem 12/30/05



Hop # Change No

Reverse Path does not exist

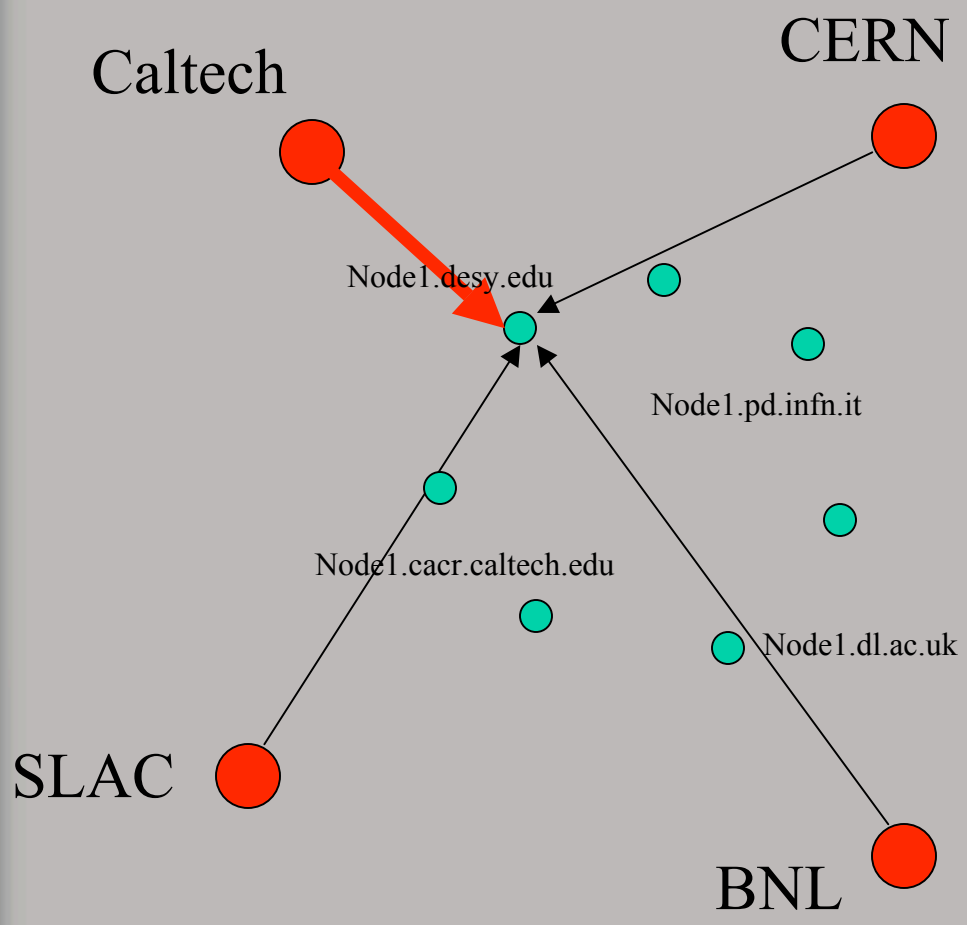
Same Node other Hosts no event reported

Same Host other Nodes Number of events reported

Possible Cause
Monitoring Host (BNL) is not working Fine.

http://www.slac.stanford.edu/grp/scs/net/case/bnl_dec05/

DESY problem 01/30/06



Hop # Change No

Reverse Path does not exist

Same Host other Nodes
No event reported

Same Node other Hosts
every monitoring node reported an event and some reported multiple tools

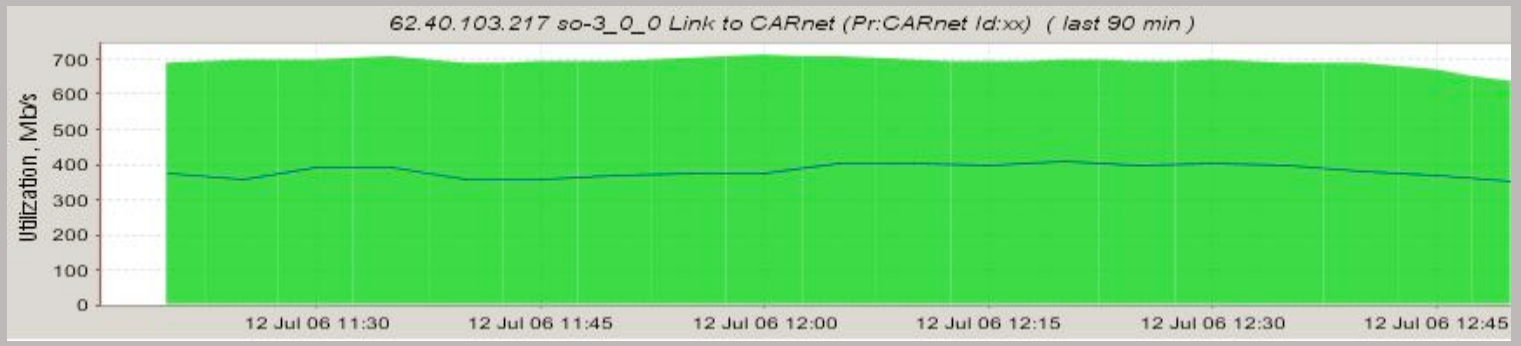
Possible Cause
Monitored Node (DESY) is not working correctly.

Limitations

- Gives a good guess where the problem lies but does not confirm it 100%
  - Use further tests to isolate the identification of specific problem, and then verify the problem.
- To get a final statement, few more things are required
  - Tools that can provide some information about the condition of network at a previous given time
  - Tools that can provide statistics about end hosts at a previous given time

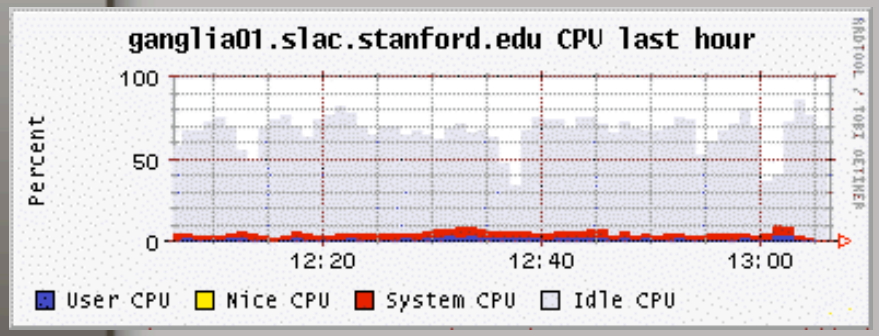
Network Problem Diagnosis

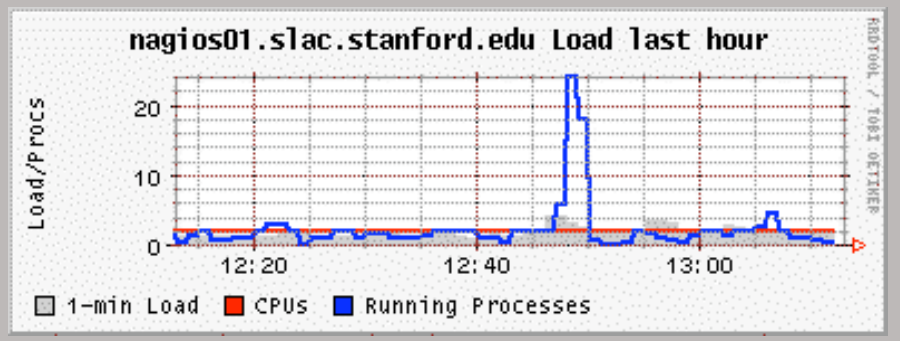
- perfSONAR
  - Router statistics
  - Very helpful to pinpoint the problem
  - Lot of data, making process of analysis slower
    - Therefore use to confirm diagnostics
  - Lot of diagnostic traffic on network



End Host Problem Diagnosis

- Ganglia & Nagios
  - Number of end host statistics, easy installation and configuration
  - Web interface with number of graphs
  - http://ganglia01.slac.stanford.edu:8080/ganglia/monsystems/?r=hour&c=ganglia-monitoring&h=ganglia01.slac.stanford.edu





Current Status

- Includes
  - Initial information about alert
  - Results for each analysis
  - Related links
  - Trace route changes, details and AS traversed
  - Final scores
- Publicly available on web
  - http://www-iepm.slac.stanford.edu/monitoring/event-diagnosis/analysis/case1.html
- Things being worked on
  - Incorporate more related information e.g., plots
  - Incorporate end host information
    - By utilizing Ganglia, Nagios or Liza
  - Incorporate network information
    - By utilizing Network Diagnostic Tool or PerfSonar

Summary

- Many different problems can lead to events
- Identify and categorise events to create heuristics
- Logic of heuristics used to diagnose why event occurred
- Used simple summation of heuristic metrics to determine most likely cause
- Need more detailed reports to help really identify, validate and isolate problems!
  - Need access to public reports!