NETWORKERS 2003

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Suddenly…

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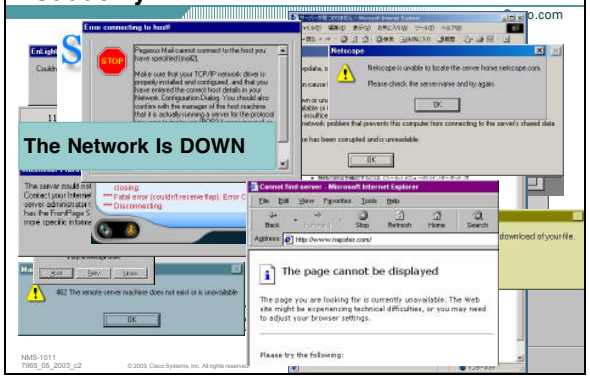

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Understanding Fault Management

Session NMS-1011

Do You Know What Went Wrong?

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- Did a router fail?
- Did several routers fail?
- Was there a fiber cut?
- Did the path to the network management station fail?

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A Few Things to Remember

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- Faults happen
- Redundancy only works if you notice the first failure
- It's easier to resolve problems before they affect your customers
- You won't know what went wrong unless you have appropriate instrumentation AND documentation

Sources

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- Routers, switches, wires, fiber, PDUs, DNS servers, HVACs, power companies, squirrels, floods, soft drinks, clumsy people, nuclear accelerators

What Is a Fault?

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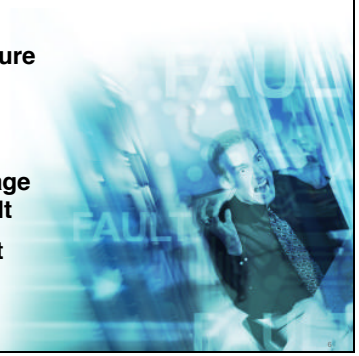
- A fault is an unplanned failure of software, hardware, or wetware
- Not every outage is due to a fault
- Not every fault results in an outage



Agenda

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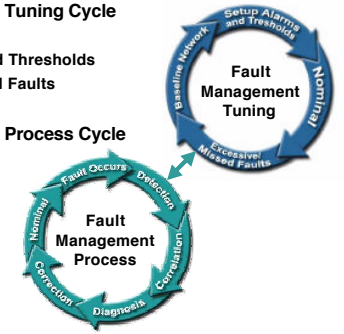
- Fault Management Tuning Cycle
  - Baseline Network
  - Setup Alarms and Thresholds
  - Excessive/Missed Faults
  - Nominal
- Fault Management Process Cycle
  - Fault Occurs
  - Detection
  - Correlation
  - Diagnosis
  - Correction
  - Nominal
- Tools



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Fault Management Tuning Cycle

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IP Connectivity and Fault Management

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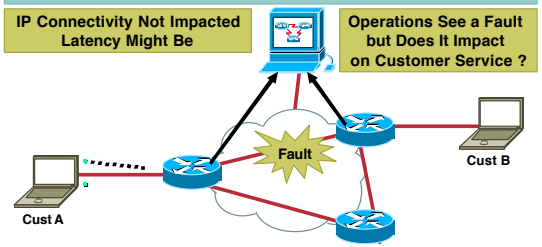
IP Connectivity Identifies Issues Fault Management May Not See and Directs Operators at Service Impacting Faults

IP Connectivity Not Impacted Latency Might Be

Operations See a Fault but Does It Impact on Customer Service ?



Baselining—What's Nominal?

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- **Take a baseline of your network when times are good**
- **Include:**
  - **Network and wiring diagrams**
  - **Device configurations**
  - **Performance metrics**
  - **Service level agreements (SLAs)**

NMS Placement

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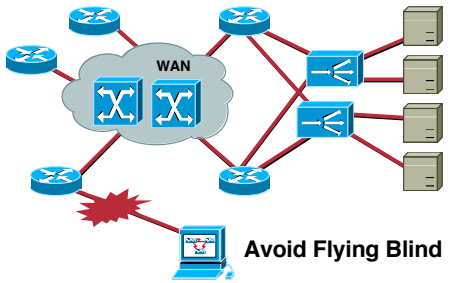

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NMS Placement

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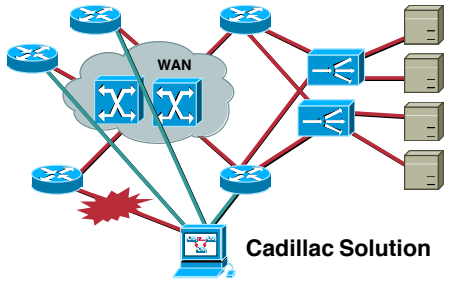

Use High-Availability Principles for Network Management!

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- Have redundant connectivity all the way to the NMS
- Have multiple DNS servers near by
- Ditto for NTP servers
- Have sufficient bandwidth to poll (when needed)
- Have reliable AAA and a backup—if you can't get in, you can't fix the problem

Fault Management Tuning Cycle

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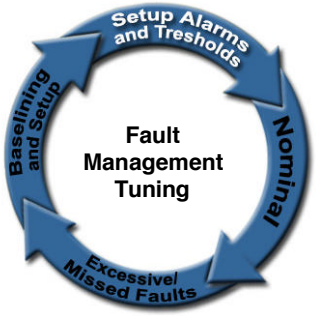

Setup Alarms and Thresholds

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- Alarms may be SNMP notifications, Syslog events, or events triggered from polling
- Many applications include default thresholds
  - Defaults may not be the best for your network—Each network is unique
- Check which alarms are covered by built-in notifications or events
- Some polling may be necessary to check other thresholds

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Management Domain

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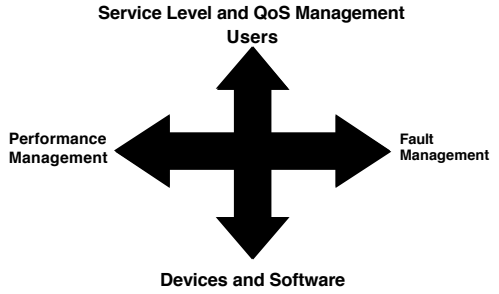

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SNMP Trap Notification

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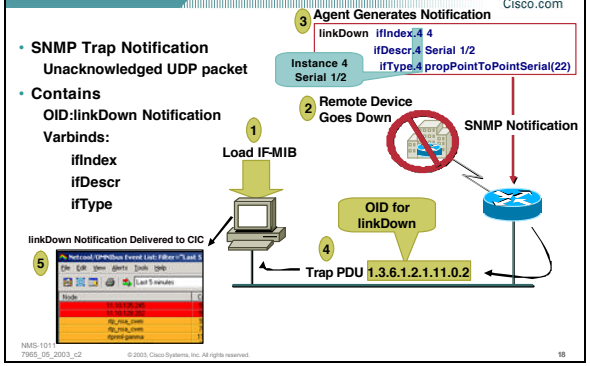
- SNMP Trap Notification
  - Unacknowledged UDP packet
- Contains
  - OID:linkDown Notification
  - Varbinds:
    - ifIndex
    - ifDescr
    - ifType



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SNMP Inform Notification

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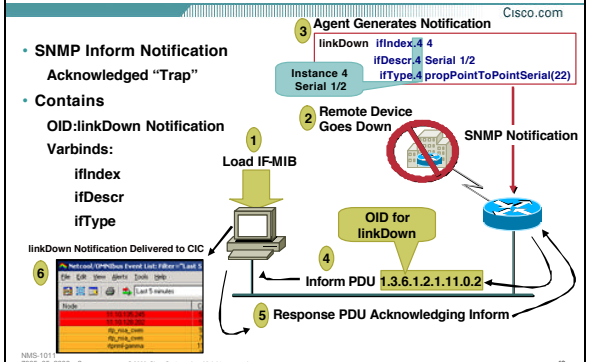
- SNMP Inform Notification
  - Acknowledged "Trap"
- Contains
  - OID:linkDown Notification
  - Varbinds:
    - ifIndex
    - ifDescr
    - ifType



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SNMP Version Differences

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	Version 1	Version 2c	Version 3
Informs	No	Yes	Yes
RMON/Event	Yes	Yes	Yes
Authentication	Community	Community	Users
Privacy	No	No	Yes
IOS/CATOS	Supported	Supported	Supported
NMS Support	Ubiquitous	Pretty Good	Limited

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Which Objects Does Cisco Support?

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Mandatory: MIB-II and IF-MIB

- **http://www.cisco.com/go/mibs**
  - **For all OSes and MIBs**
  - **Describes which products support which MIBs**
  - **Also has the MIBs themselves**

Downloading MIBs and Related Files in Bulk

- **ftp://ftp.cisco.com/pub/mibs**
  - **Consider downloading the whole OID directory for quick searches**

How Useful Is Notification-Based Polling?

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"There Are So Few SNMP Notifications!"

There Are as Many Notifications as There Are MIB Variables!

Notifications

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How to Make your own Notifications

- **RMON Events/Alarms**
  - **Available in Cisco IOS® since 11.1**
  - **Available in CatOS always**
- **Event MIB**
  - **Available in Cisco IOS since 12.1(3)T**

Customize objects for use in Notifications

- **Expression MIB**
  - **Available in Cisco IOS since 12.0(5)T**

Set a Threshold

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RMON alarms

- **Command line accessible**

EVENT-MIB

- **Has wildcards, better variety of tests**

EXPRESSION-MIB

- **Create new objects that can be tested**

System Polls Itself!

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Example MIB to Create Notification from

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- **CISCO-PROCESS-MIB**
  - SNMP version of "show process"
  - Provides total CPU usage as well as per-process usage
- **Now, to create a new notification based upon total CPU utilization**

Device Checks CPU Utilization Using RMON

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- Define the alarm:

```
RMON alarm 1 cpmCPUTotalTable.1.4.1 60 absolute
rising-threshold 90 1
falling-threshold 70
```

  - Tests the OID (1 min CPU utilization (cpmCPUTotal1min) found in CISCO-PROCESS-MIB) every 60 seconds
  - If the absolute value exceeds 90% fire event 1
  - Reset the alarm when the value falls below 70%
- Define the event:

```
rmon event 1 description "CPU Notification" owner
chelliot@cisco.com log trap public
```

  - When triggered will both create a log entry and send a SNMP notification

Equivalent of HPOV Threshold Events—but no Polling!

Event MIB

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- **More flexible than RMON events/alarms**
  - RMON is tailored for use with Counter objects
- **Can be used to test objects on other devices**
- **No CLI yet—need to use SNMP directly or through tool**

Event MIB

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- **Based on IETF draft and numbered in Cisco's namespace from 12.1(3)T through 12.2T**
- **RFC 2981 implemented in 12.2(4)T**
- **Allows you to create custom notifications and log them and/or send them as SNMP traps or informs**
- **Persistence added in 12.2(4)T (same time as RFC)**

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Event MIB

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- Show commands

  show management event

- Debug commands

  debug management event mib

Expression MIB

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- Based on IETF draft and numbered in Cisco's namespace, not RFC 2982—Work is being done to implement RFC
- Allows you to create new SNMP objects based upon formulas
- Available in IOS since 12.0(5)T, added delta and wildcard support in 12.1(3)T
- Persistence added in 12.2(4)T
- No CLI yet—need to use SNMP directly or through tool

Expression MIB

Cisco.com

- Delta and wildcard support allows, for example:

  Calculating utilization for all interfaces with one expression

  This will allow you to recreate the locIfInOctets and locIfOutOctets objects in a standards-based manner—with more flexibility

  Calculating errors as a percentage of traffic

Expression MIB

Cisco.com

- Show commands

  show management expression

- Debug commands

  debug management expression?

  Evaluator Expression MIB evaluator

  Mib Expression MIB SNMP operations

  Parser Expression MIB parsing

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SAA and CISCO-RTTMON-MIB

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- Service Assurance Agent (SAA)
- Session level probe
- Generates availability and threshold traps
- Also collects statistics

Service Assurance Agent Today

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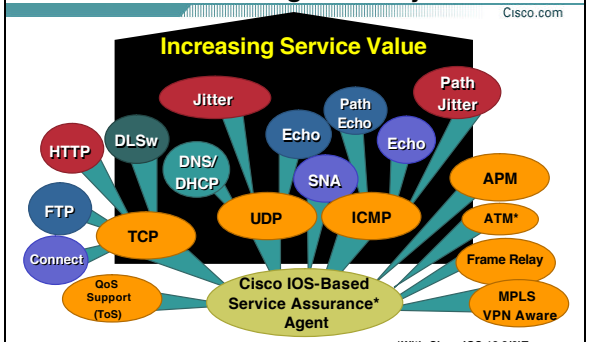

*With Cisco IOS 12.2(9)T

Cisco IOS 12.0(5)T and 12.0(8)S—HTTP Operation

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- Operation Mode for HTTP Transaction time:
  - Get-Mode
    - Minimal parameters required; Only the base html page will be retrieved, not the links contained in the page
  - Raw-Mode
    - User specifies entire http request (optional payload)
    - It allows for security options, proxy servers, web caching
- Each Mode Measures
  - DNS Lookup Time
  - TCP Connect Time
  - HTTP Transaction time
- Uniform Resource Locator:
  - http://<host>:<port>/<url-path>

SAA Traps

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- Defined in the CISCO-RTTMON-MIB
  - rttMonConnectionChangeNotification
  - rttMonTimeoutNotification
  - rttMonThresholdNotification

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Know Thy Router!

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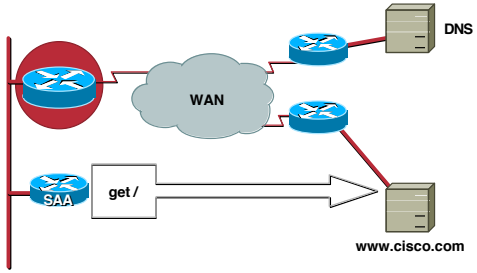

What Happens if a MIB Doesn't Exist?

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- Information may be found using Syslog
- Syslog produces (mostly) structured logs of information
- Syslog receivers/processors include:
  - Unix syslogd
  - Cisco Info Center
  - CW2K RME Syslog Analyzer

Syslog

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- Very basic reporting mechanism
- Very basic "standard"
- Text messages on UDP port 514

Syslog Benefits

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- Easy to implement clients
- All ASCII (easy to manipulate)
- The UNIX standard

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Syslog Problems

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- It's not reliable
- It's not secure
  - Not much worse than SNMP traps
- One way: No query capability
- Priority isn't consistently used

Syslog Format

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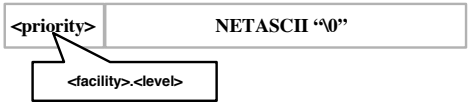

<priority> is not retained in the syslog message file

Timestamp is added by logging host

Logged message looks like:

Apr 18 12:02:34 nms-host /usr 90% full

There Is a Cisco IOS Message Standard for Syslog

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- %FACILITY-SUBFACILITY-SEVERITY-MNEMONIC: Message-text
- Documentation for each release explains the meaning of many of these events
- Facility is not the same as the syslog facility
  - syslog facility is set by configuring:
    - logging facility<facility>
  - syslog facility defaults to local7
- Severity maps to syslog level

What If There Is No Syslog Event?

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- Screen Scraping
  - Telnet/expect scripts sometimes can be the only way to get information

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Fault Management Tuning Cycle

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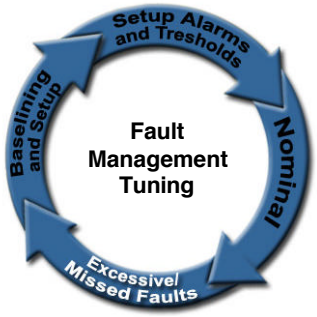

Does Your Fault Console Look Like this?

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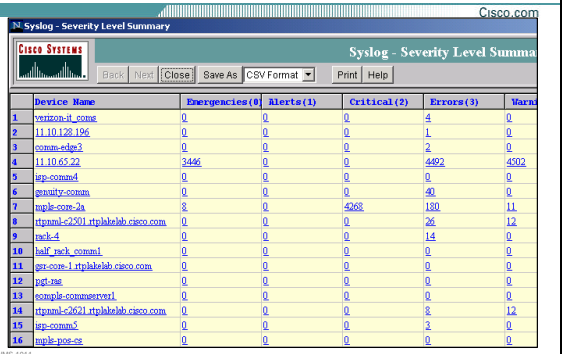

	Device Name	Emergencies(0)	Alerts(1)	Critical(2)	Errors(3)	Warn
1	verizon-it_comm	0	0	0	4	0
2	11.10.128.196	0	0	0	1	0
3	comm-edge3	0	0	0	2	0
4	11.10.65.22	3446	0	0	4492	4502
5	sip-comm4	0	0	0	0	0
6	gwunity-comm	0	0	0	40	0
7	mple-core-2a	8	0	4268	180	11
8	rtpnuml-c2501.rtplabelab.cisco.com	0	0	0	26	12
9	rack-4	0	0	0	14	0
10	leaf_rack_comm1	0	0	0	0	0
11	ger-core-1.rtplabelab.cisco.com	0	0	0	0	0
12	pgt-rac	0	0	0	0	0
13	ecmple-commserver1	0	0	0	0	0
14	rtpnuml-c2621.rtplabelab.cisco.com	0	0	0	8	12
15	sip-comm5	0	0	0	3	0
16	mple-pos-ce	0	0	0	0	0

Monitor Excessive or Missed Faults

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- Adjust thresholds as necessary to catch all faults (no false-negatives) but still have a tolerable false-positive rate
- Iterative process—the network administrator's job is never done

Agenda

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- ✓ Fault Management Tuning Cycle
  - Baseline Network
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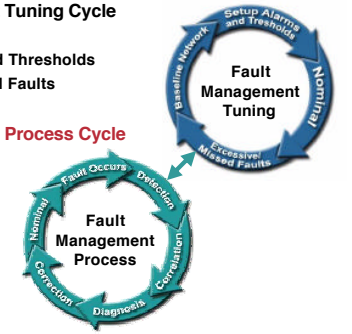
  - Excessive/Missed Faults
  - Nominal
- Fault Management Process Cycle
  - Fault Occurs
  - Detection
  - Correlation
  - Diagnosis
  - Correction
  - Nominal
- Tools



Fault Management Process Cycle

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The Fault

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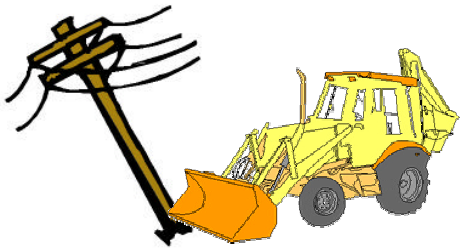

Fault Management Process Cycle

Cisco.com

Knowing there's a Problem

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- Event reporting mechanisms
  - SNMP Traps/Informs
  - SYSLOG
  - Polling
  - Help Desk
- Collect to central repository

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SAA Example

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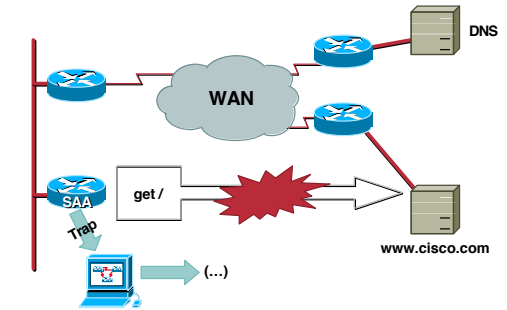

What to Do when You Get a Trap or Inform?

Cisco.com

- Now's the time to poll!
  - Both the device itself and perhaps neighboring devices!
- This is known as event-based polling

When Did an Event Happen?

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- Having the right time is very important
  - Watch multiple time zones
- Use NTP

Fault Management Process Cycle

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Definition

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- Fault correlation: Tying of two or more events to a single fault or group of faults
- Fault correlation! = Diagnosis

Element-Based Correlation

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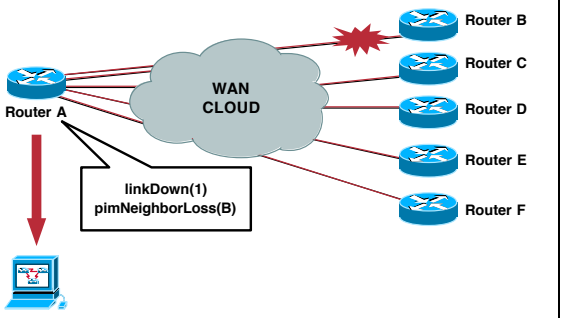

Network-Based Correlation

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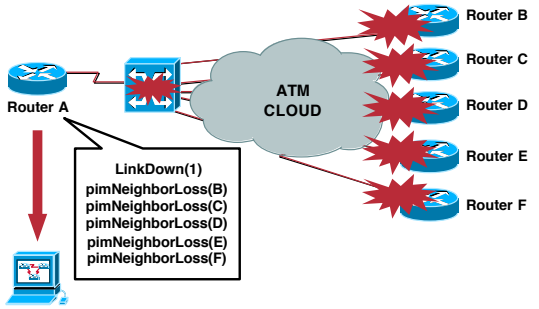

Correlating Faults and Our SAA Example

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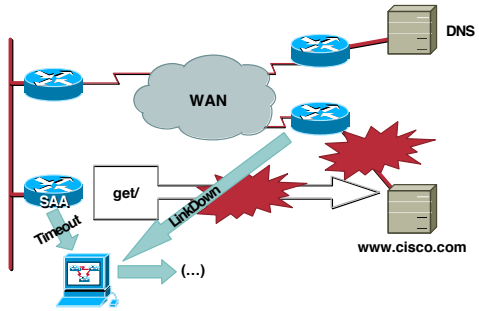

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Bunches of Events

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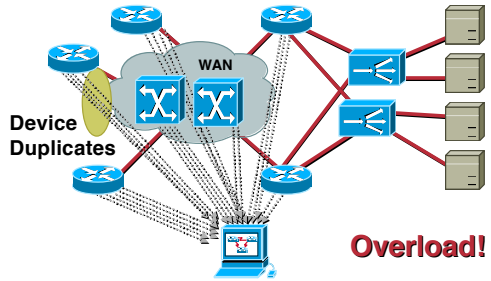

Remove Duplicates and Correlate

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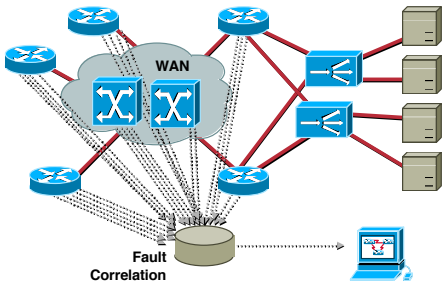

Hierarchical Mechanisms

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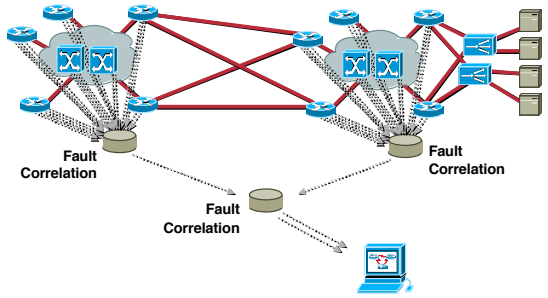

Fault Correlation Tools

Cisco.com

- Rule-based systems that determine that two or more faults are related
- Good ones classify and prioritize as well
  - Ciscoworks Device Fault Manager
    - Device level only
  - SMARTS inCharge
    - Device and network
  - Cisco Information Center

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Fault Management Process Cycle

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Two Ways to Diagnose Problems

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- Smart computers
- Smart humans
- Sometimes both
  - See troubleshooting course

Root Cause Analysis

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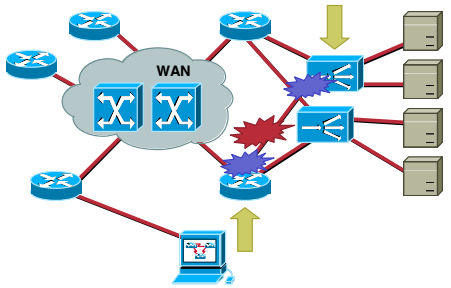

Root Cause Analysis

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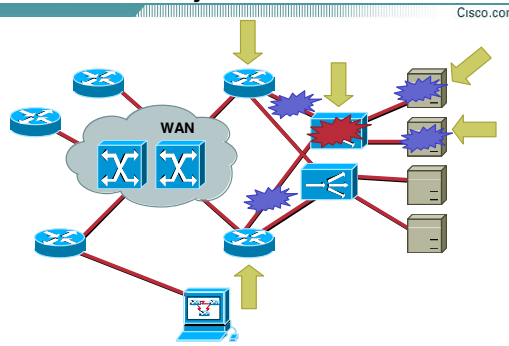

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Root Cause Analysis

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- Network-based mechanisms require some knowledge of topology
- Deals mostly with “hard” failures
- Usually limited to some subset of the network
- May determine a layer 1 failure, but not “Backhoe Syndrome”

Fault Management Process Cycle

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Who Fixes those Problems?

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- Network managers don’t know everything
- Workflow management is the process of delegating to the right person to fix the right problem in a timely fashion

Workflow Management

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- Tools to track the state of network
- Used for escalation, division of labor, provisioning, and planning
- Examples include ‘remedy’ and ‘clarify’

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