Borderless Network

MasterClass

Network Automation

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Network Automation

[20110324 - Copenhagen]

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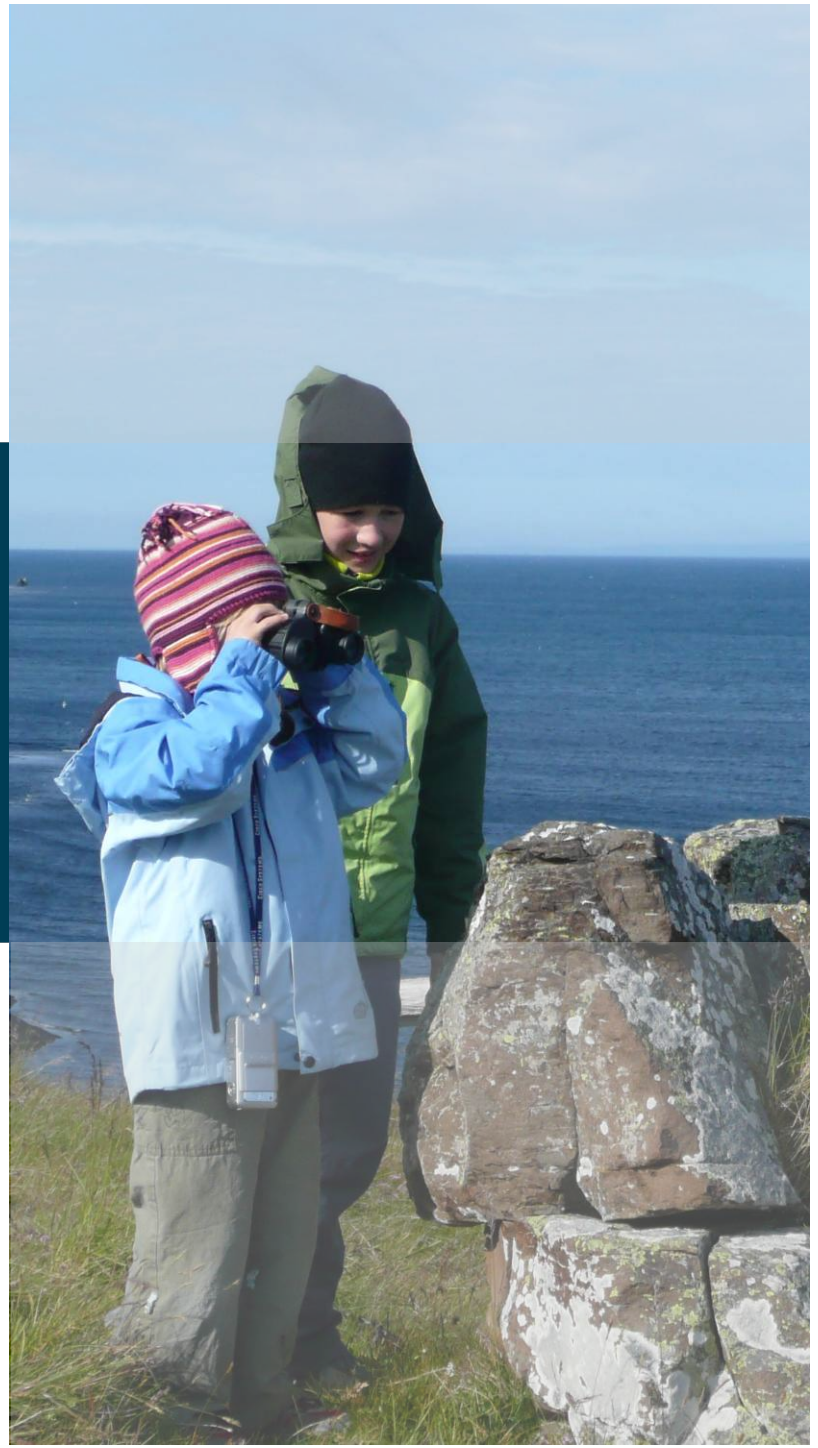


Schedule

Day 1

8:30-09:00 Welcome & Coffee

9:00-12:30 Theory Block I

0. Introduction
1. Service planning
2. Deployment and activation

13:30-17:00 Hands-on Lab

Day 2

8:30-09:00 Welcome & Coffee

9:00-12:30 Theory Block II

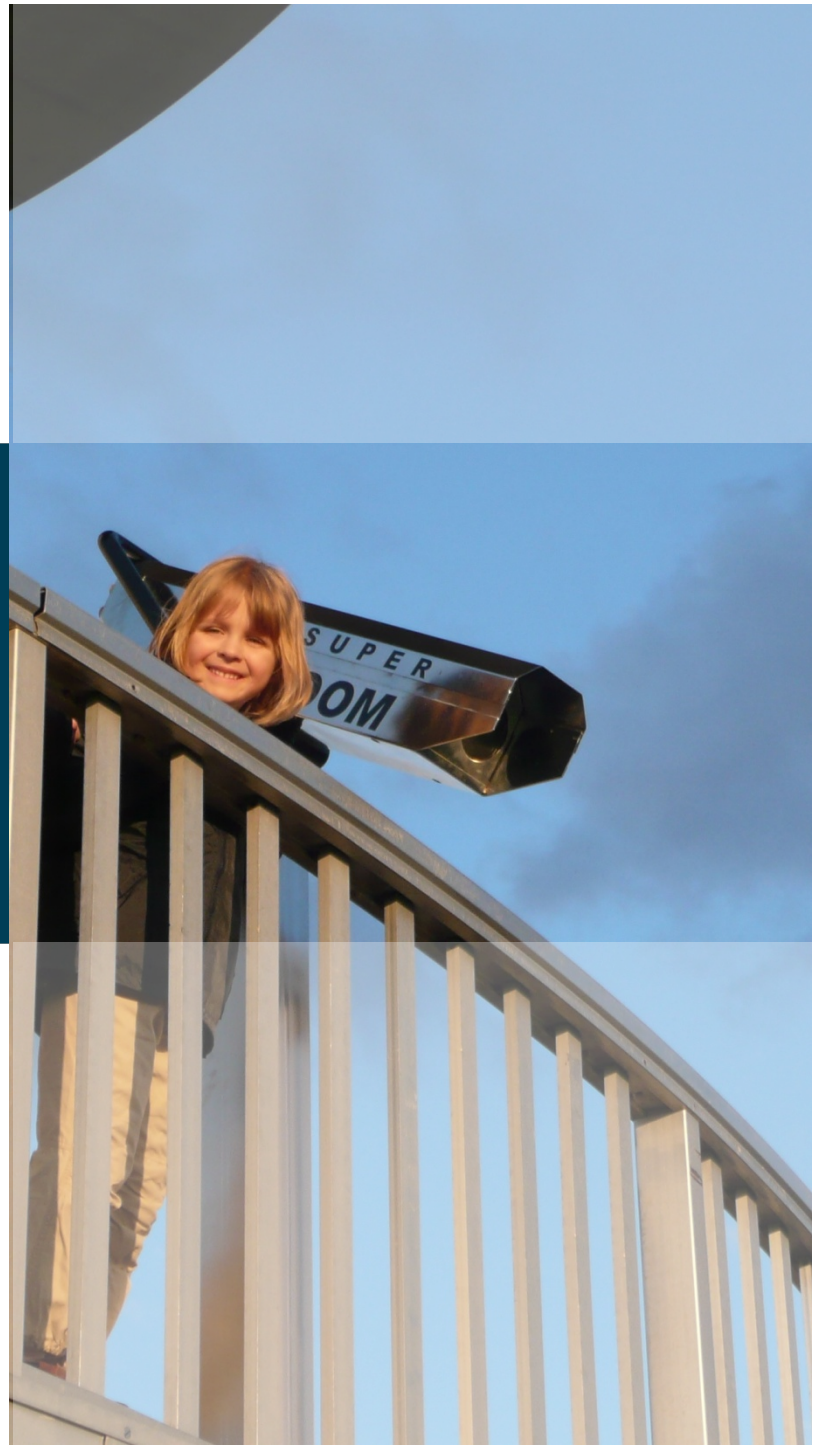
3. Testing and verification
4. Ongoing service assurance
5. Troubleshooting and optimization

13:30-17:00 Hands-on Lab

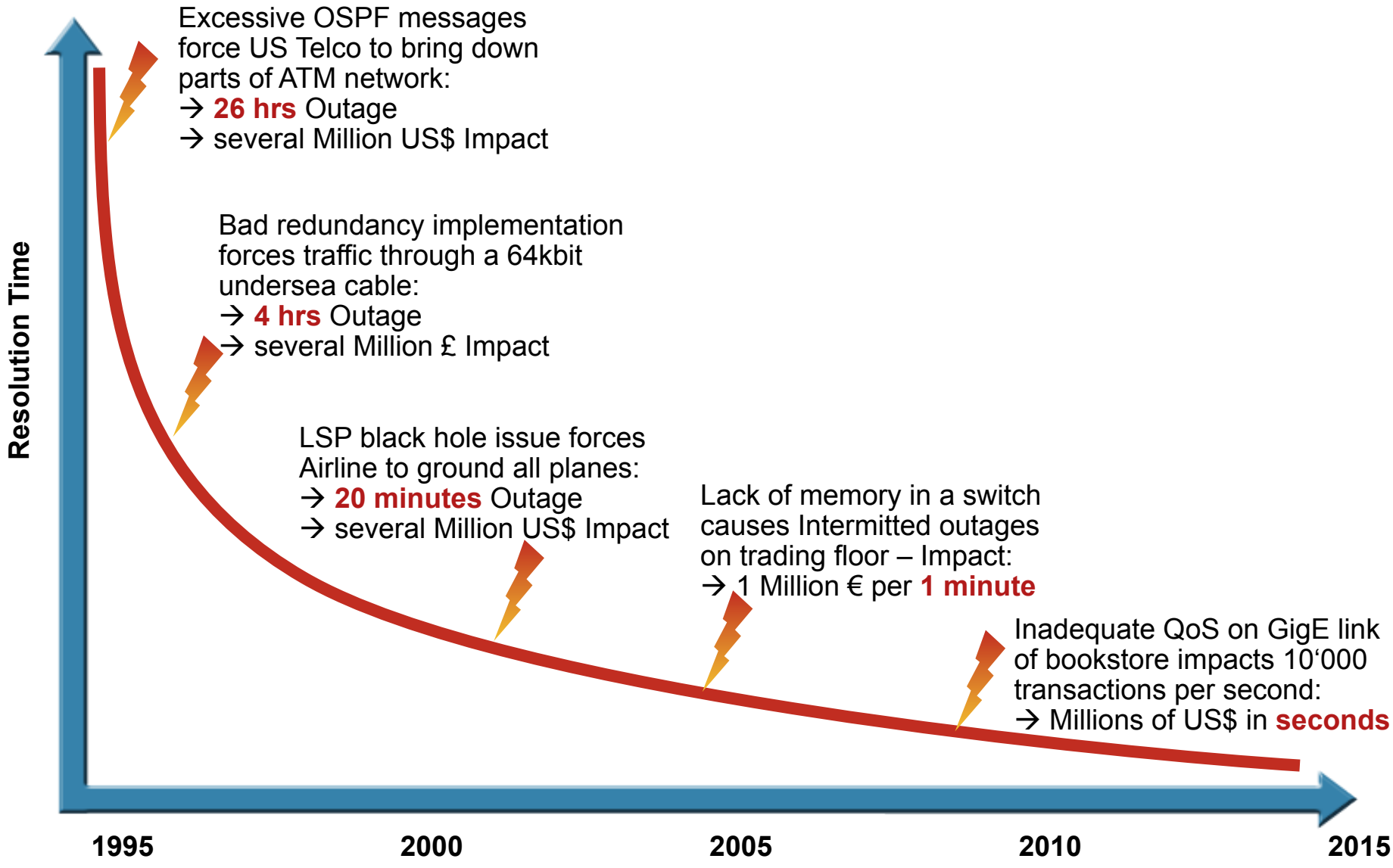
Agenda

- Introduction & Overview
- Service Planning
- Service Deployment & Activation
- Service Testing, Verification & Assurance
- Troubleshooting & Optimization
- Summary

Why Network Automation?

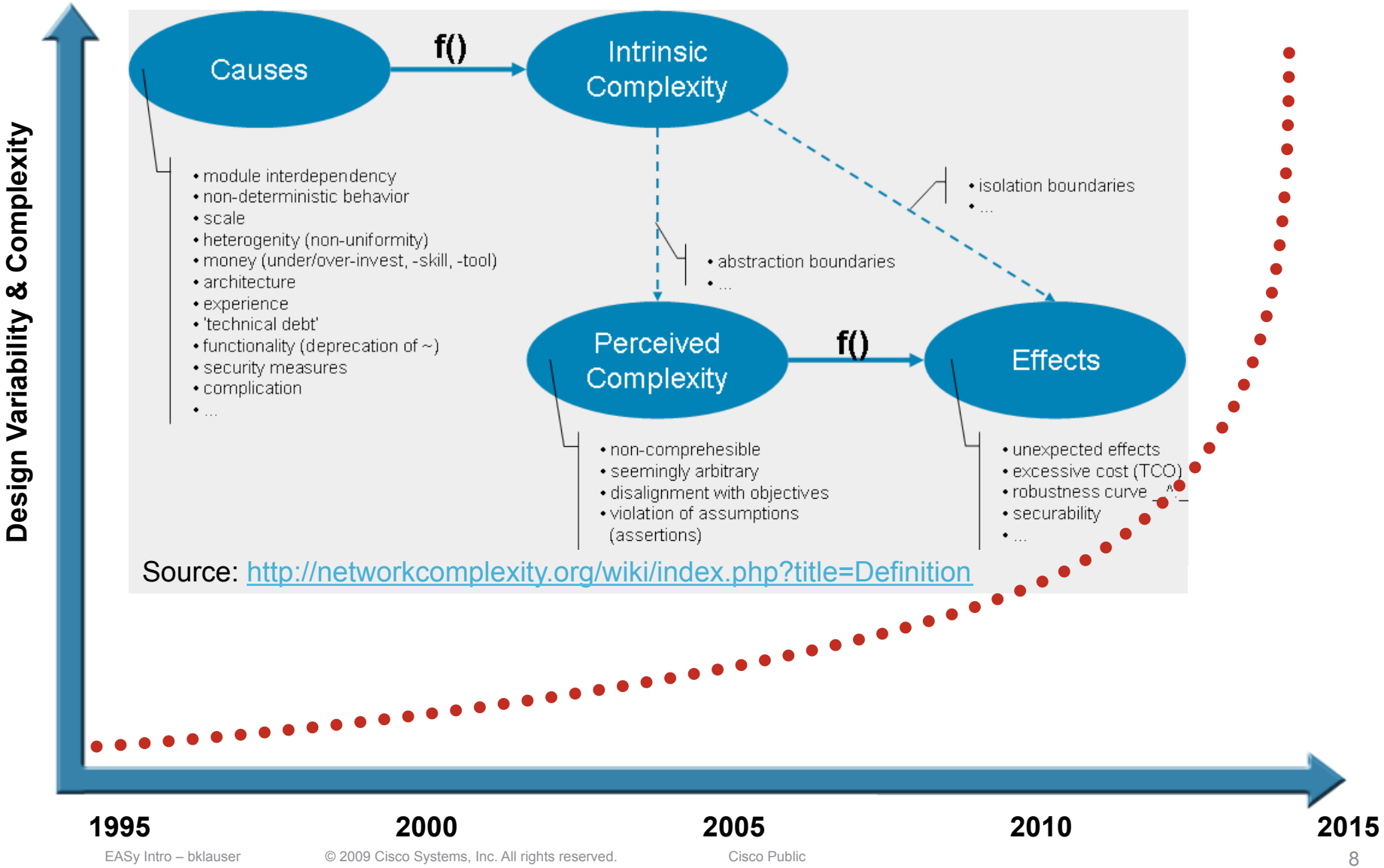


Availability

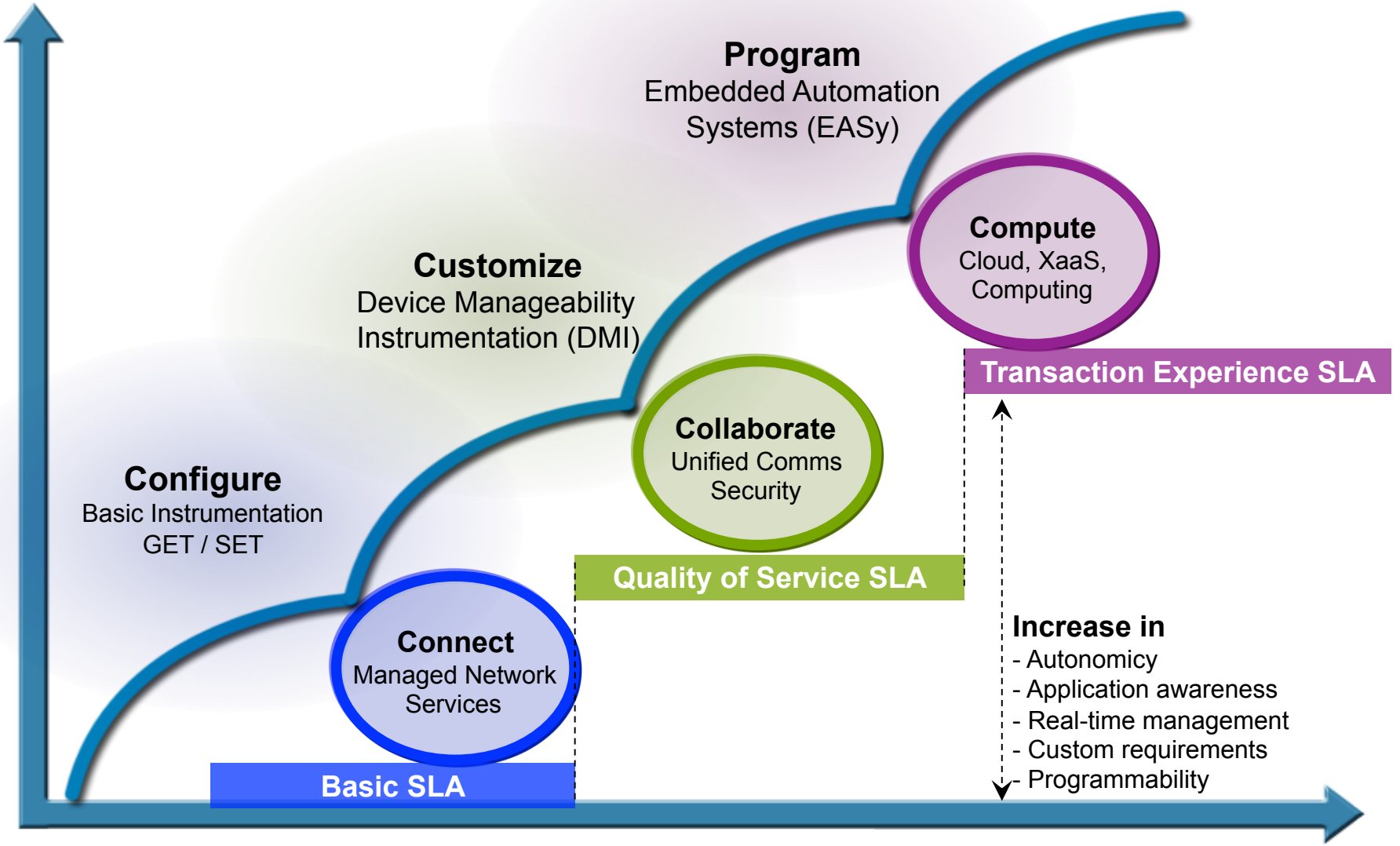


Design Variability and Complexity – 1/2

Design Variability and Complexity – 2/2



Automation and Differentiation



An Analogy

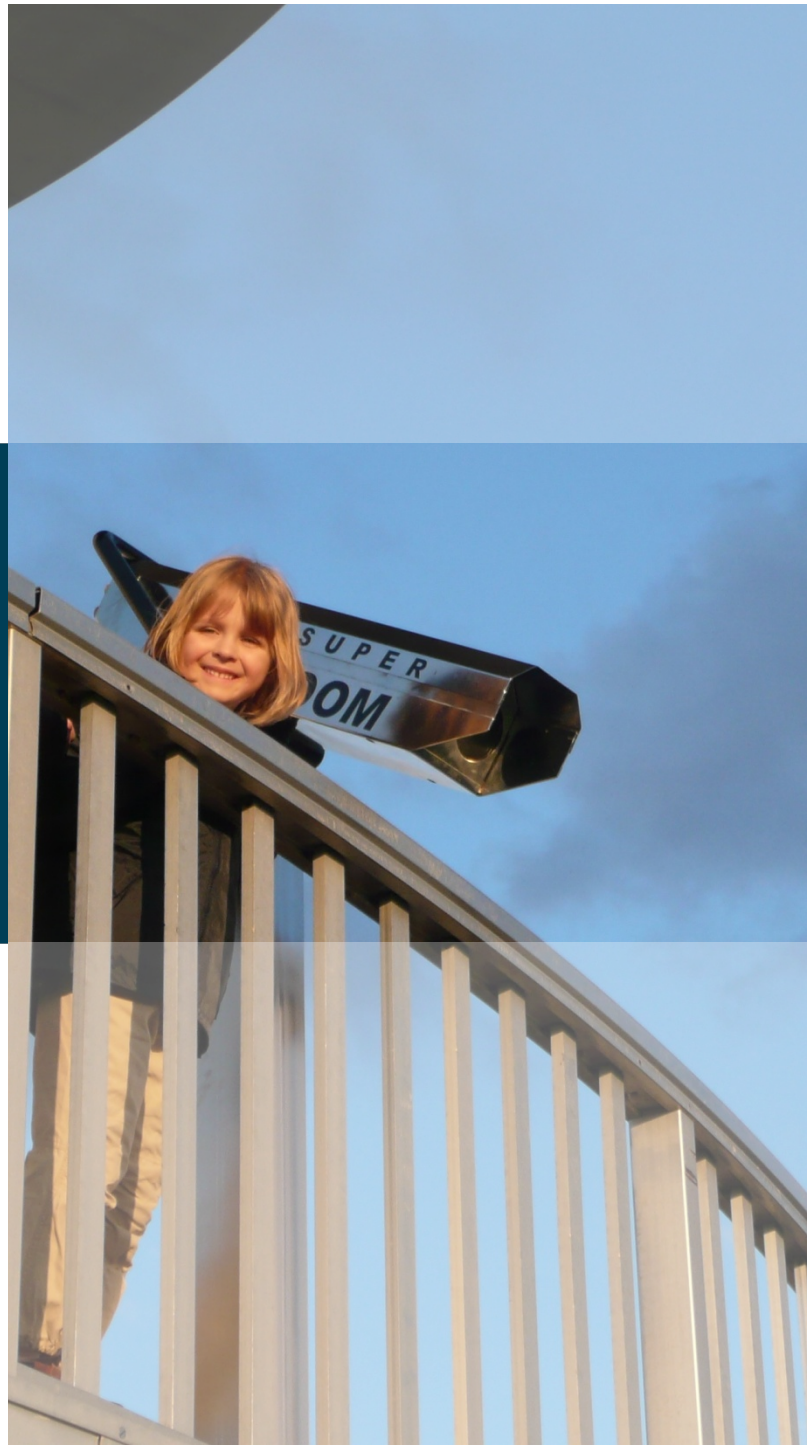
Airplane	Router
Instruments	Embedded Automations
21‘000 sensors	OIDs in MIBs

With increasing scale, complexity, differentiation and availability requirements, operators rely on Embedded Automations

From: Full control by a single central authority

To: Operating a system of self-managing components

What is Network Automation?



Network Automation

Taxonomy of Network Automations

By Infrastructure Span

- Device level
- Domain wide
- Service end-to-end

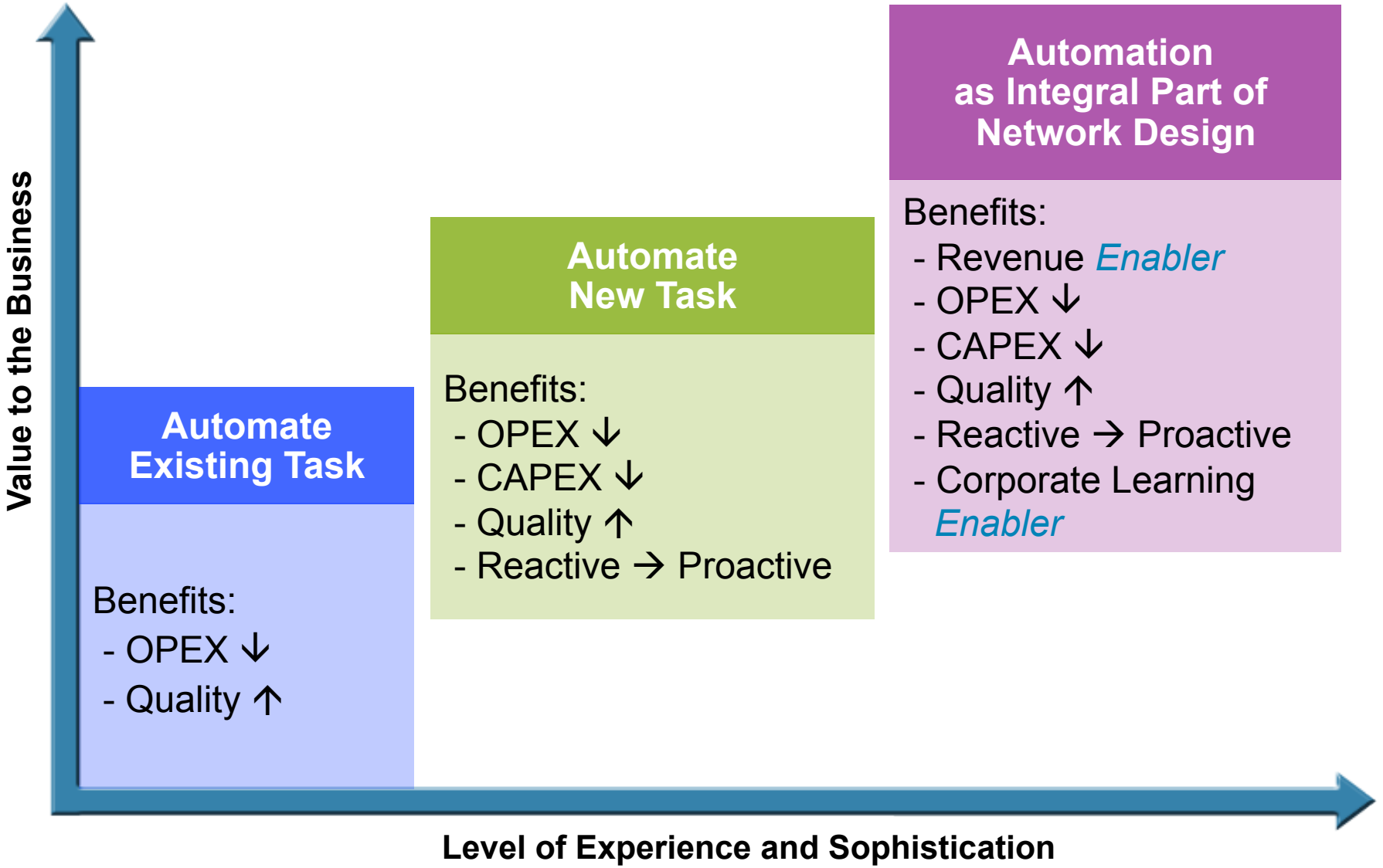
By Automation Function

- Task Execution
- Workflow Orchestration
- Decision Triggers

By Adoption Type and Benefit …

Network Automation

Network Automation Adoptions



Example: Sharing Information 1/2

Problem: Sometimes we need to quickly get some parameters from a website and share information from the router (or a neighboring device) across organizational and technical borders …

Solution I: Initiate a Project to make use of SNMP, Syslog, Event Management Software, Reporting, Provisioning and CRM Systems ...

Solution II: Use Cisco IOS DMI to gather the information and EEM/Tcl to post it via http to a shared location

1. Import the http package into your EEM TCL Policy

```
namespace import ::http::*
```

2. Gather and format whatever information you need

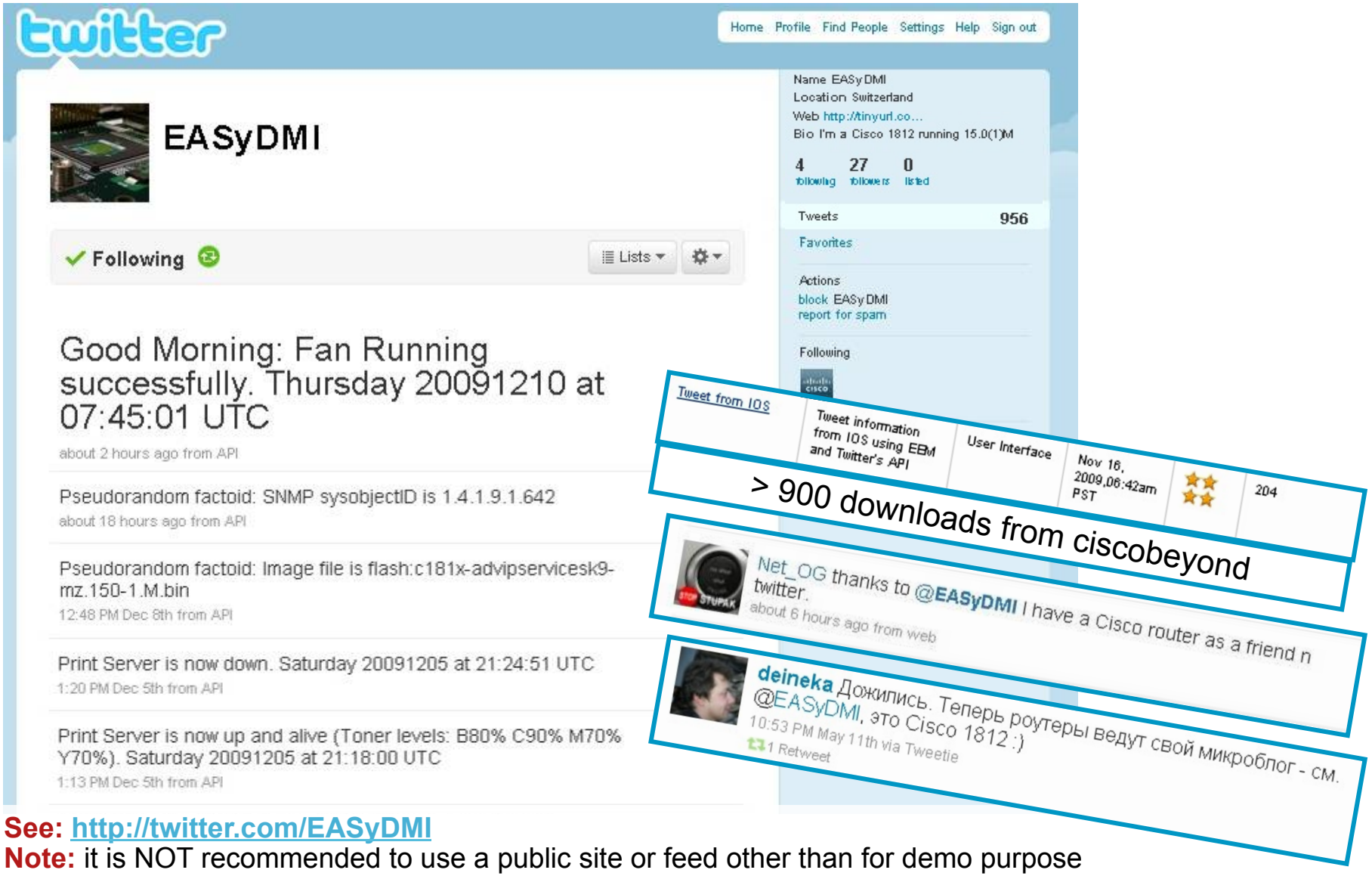
3. Build your query for the HTTP POST operation

```
set my_query [::http::formatQuery "status" $my_info]
```

4. Use the HTTP reply to get and HTTP POST to share your information

```
set my_reply [::http::geturl $my_server_url -query $my_query]
```

Example: Sharing Information 2/2



See: http://twitter.com/EASyDMI

Note: it is NOT recommended to use a public site or feed other than for demo purpose

Network Automation

Example: Integrating CleanAir and Security

Problem: A new rogue WLAN device in sensitive areas should be detected by Cisco CleanAir and automatically focus/pan/zoom a security camera.

Solution: Use Network Automation based on Cisco IOS Embedded Event Manager to receive an SNMP Notification from WLC and trigger the Video Operations Manager via HTTP

1. Rogue WLAN Device added
2. Rogue Device detected by CleanAir AP
3. WLC sends SNMP Notification
4. EEM triggers upon SNMP Notification
5. EEM notifies VSOM via HTTP
6. Security Camera Focus/Pan/Zoom

Example 1: NBAR Effectiveness Monitoring

Problem: Application protocols as well as user behavior are changing, hence the traffic mix changes too. We need to permanently assess how effective the NBAR deployment is – especially when using CBQoS with match protocol.

Solution: Automate the comparison between ‘unknown’ versus ‘total’ traffic

```
Router# show ip nbar protocol-discovery top-n 5 Serial0/0

  Protocol     Input                       Output
               Packet Count                Packet Count
               Byte Count                  Byte Count
               5 minute bit rate (bps)     5 minute bit rate (bps)
  ---------- ------------------------ ------------------------
    :               :                          :
  unknown                205                                  204
                         14976                                10404
                         0                                    0
  Total                  41304                                40944
                         2649809                              2619839
                         3000                                 3000
```

Upon low % of traffic recognized by NBAR, it’s time to check for new PDLMs …

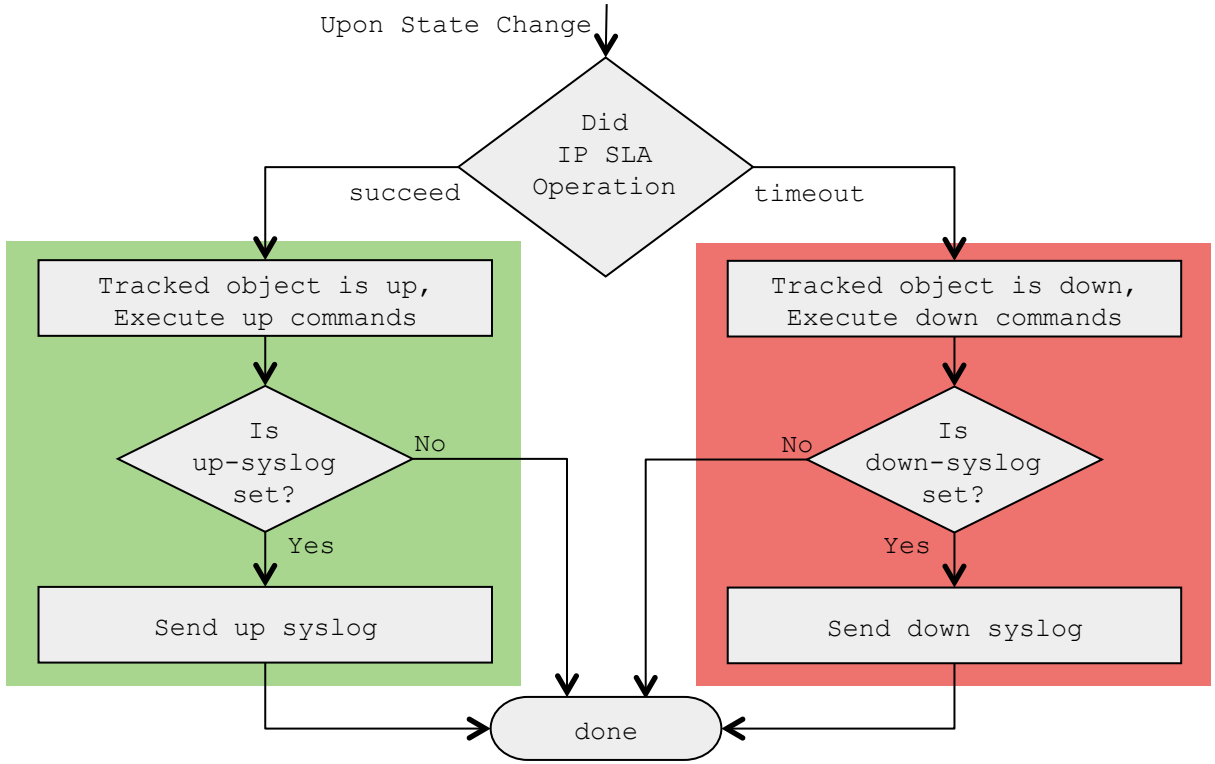
$$NBARrecognized(\%) = \frac{[(total - unknown) \times 100]}{[total]}$$

See: Available as an EASy Package:
http://www.cisco.com/go/easy
See: Scripts available from CiscoBeyond:
http://forums.cisco.com/eforum/servlet/EEM?page=eem&fn=script&scriptId=2101

Example 2: Connectivity Verification

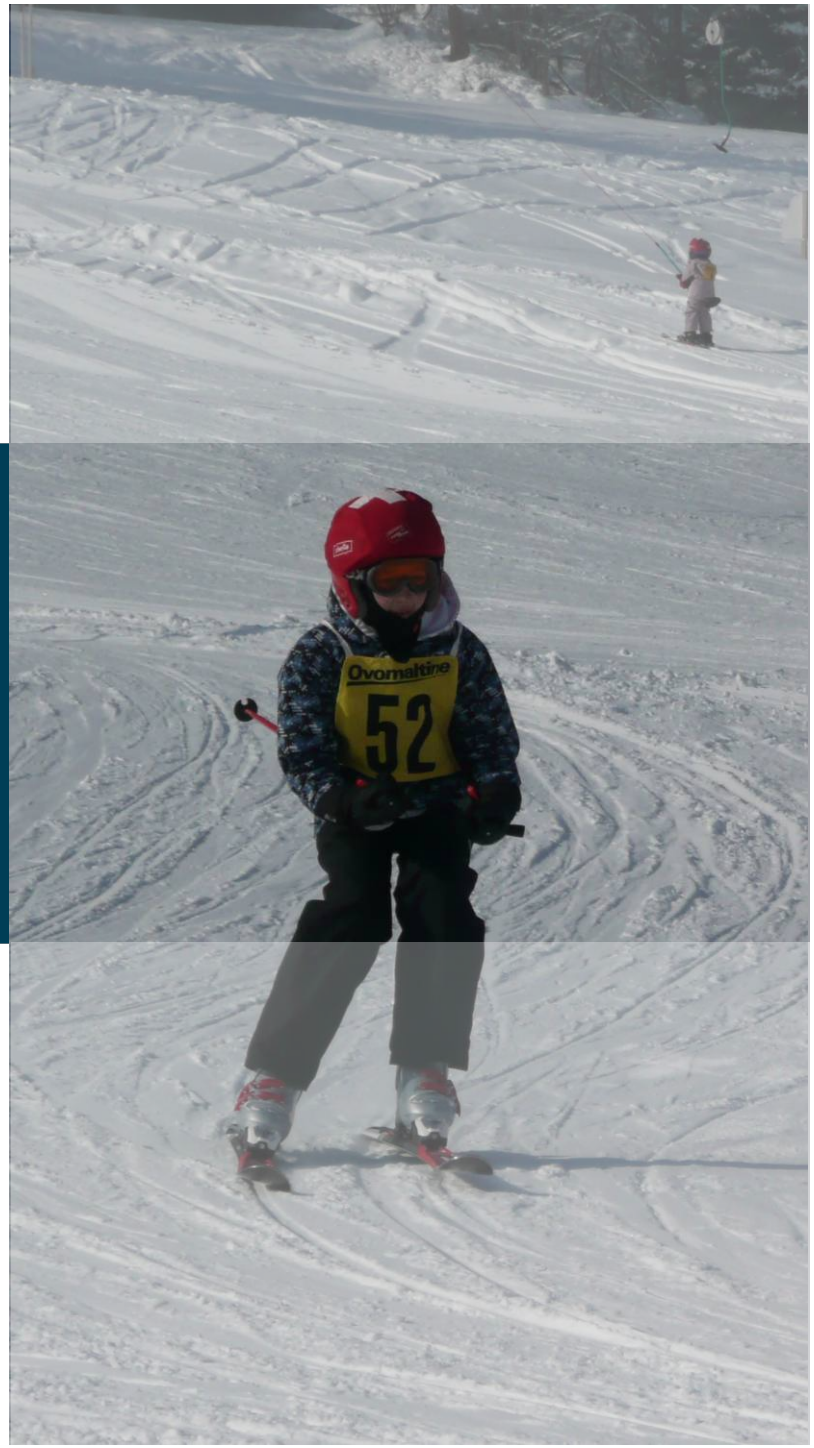
Problem: We need a failover from primary to secondary link – but with flexibility and custom notification beyond what a simple routing protocol based solution provides

Solution: Automate based on IP SLA, EOT and Embedded Event Manager



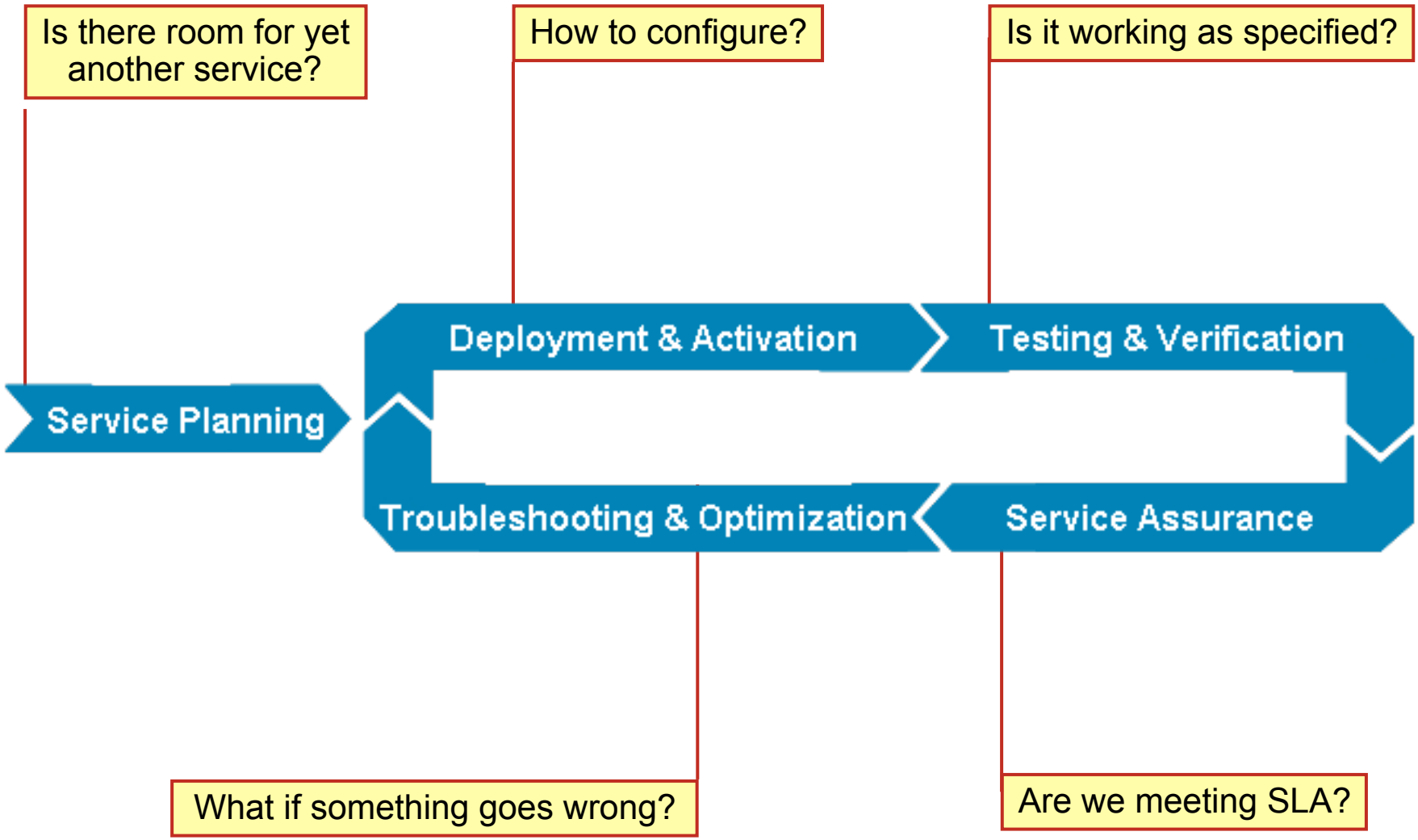
See: Available as an EASy Package:
http://www.cisco.com/go/easy

What are the key IOS Technologies for EASy?

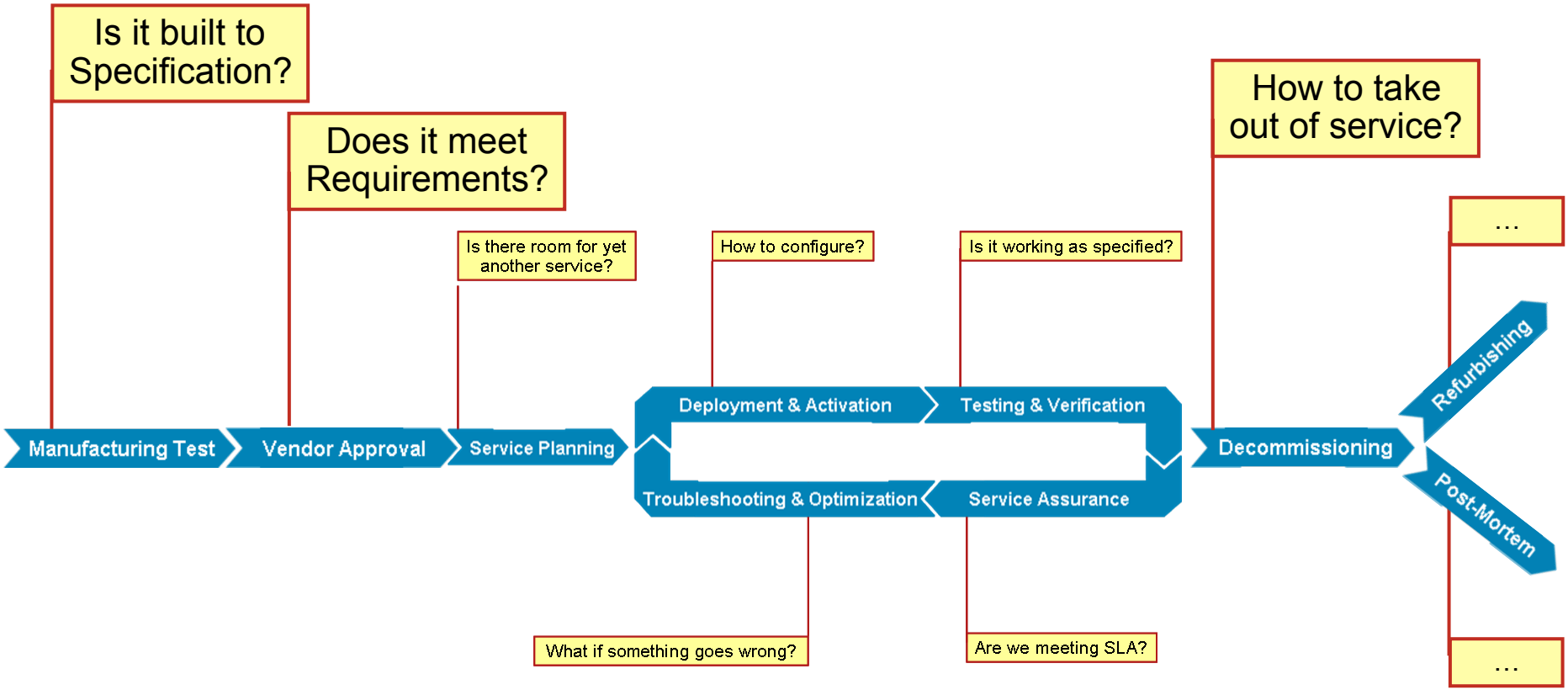


That is exactly what we will discuss during the next 537 slides …

Operating Models – 2/2



Operating Models – 2/2



Network Automation goes beyond ‚just' the Operational Life Cycle

Introduction & Overview

Feature Availability

- Main focus on what is available in IOS 15.1T on ISR platforms
- Most Features have been around for some time already
- More Details in Appendix II
- Feature Navigator: www.cisco.com/go/fn

Cisco 7304 Router	Cisco 7301 and 7200 Routers	Cisco Catalyst 6500 Series	C	12.4(4)T	12.4(2)T	12.3(14)T	12.3(4)T	12.3(2)T	12.2(12)T
12.2SB	12.2SB/SR	12.2SX/ SR		X	X	X	X	X	X
12.2(1st)SB5	12.2(1st)SRC	12.2(1st)SXH		X	X	X	X	X	X
12.2(1st)SB5	12.2(1st)SRC	12.2(1st)SXH		X	X	X	X	X	
12.2(25)S	12.2(31)SB	12.2(1st)SXH		X	X	X	X		
12.2(1st)SB5	12.2(1st)SRC	12.2(1st)SXI	12.2(11th)SG	12.2(44)SE	12.3(14)T				
12.2(1st)SB5	12.2(1st)SRC	12.2(1st)SXI	12.2(12th)SG	12.2(6th)SE	12.4(2)T				
12.2(1st)SB5	12.2(1st)SRC	12.2(1st)SXI	12.2(12th)SG	12.2(6th)SE	12.4(4)T				
12.2(1st)SB5	12.2(1st)SRC	12.2(1st)SXI	12.2(31)SGA	NA	NA				
12.2(31)SB	12.2(31)SB	12.2(1st)SXH	12.2(12th)SG	12.2(6th)SE					
12.2(31)SB	12.2(31)SB	HD	12.2(13th)SG	12.2(7th)SE	12.5(2nd)T				

Device Manageability Instrumentation

Cisco IOS® Device Manageability Instrumentation (DMI)

Fault

- **IP OAM**—Ping, Trace, BFD, ISG per session
- **802.3ah**—Link monitoring and remote fault indication
- **802.1 ag**—Continuity check, L2 ping, trace, AIS
- **MPLS OAM**—LSP ping, LSP trace, VCCV
- **EEM**—Embedded Event Manager
- **EVENT-MIB**—OID-based triggers, events, or SNMP Set, IETF DISMON
- **EXPRESSION-MIB**—OID expression-based triggers, IETF DISMON
- …

Configuration

- **Config CLI**—diff, logging, lock, replace, rollback
- **E-LMI**—parameter and status signaling
- **E-DI**—Enhanced Device Interface, CLI, Perl, IETF Netconf
- **EMM —** Embedded Menu Manager
- **NETCONF—**IETF NETCONF XML PI
- **CNS** and **WSMA**
- **TR-069**
- **KRON**—command scheduler
- **AutoInstall**—bootstrapping
- **IOS.sh** —IOS Shell
- **SmartInstall**
- **Auto SmartPorts**
- …

Performance

- **Auto IP SLA**—delay, jitter, loss probability
- **CBQoS MIB**—class-based QoS
- **NBAR**
- **RMON**
- **EPC** – Embedded Packet Capture
- **ERM**—Embedded Resource Manager
- **GOLD**—Generic Online Diagnosis
- **Smart Call Home**—preventive maintenance
- **VidMon**—Video Monitoring
- …

Accounting

- **Flexible NetFlow**—IETF IPFIX
- **BGP policy accounting** – includes AS information
- **Periodic MIB bulk data collection and transfer**
- …

Security

- **Auto Secure**—one-touch device hardening
- **LDP Auth**—message authentication
- **Routing Auth**—MD5 authentication, BGP, OSPF
- …

Device Manageability Instrumentation Has Evolved

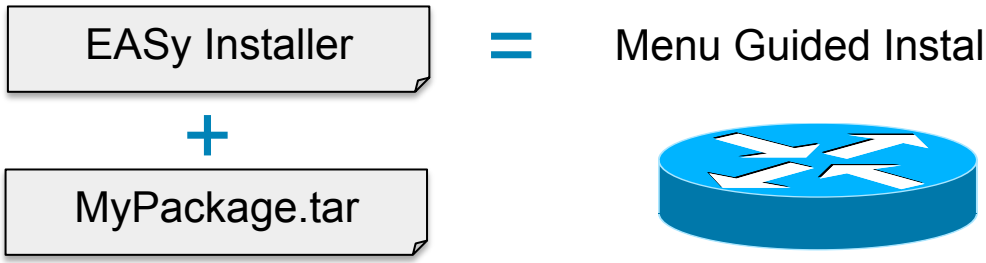
Packaging Embedded Automations

Problem: Automations may consist of multiple elements – how to deploy them in a professional and efficient manner ?

Solution I: Write detailed requirements and step-by-step instructions

Solution II: Create an installable EASy package

- Package Description
- Pre-Requisite Verification
- Pre-Installation Config
- Pre-Installation Exec
- Environment Variables
- Configuration
- Files
- Post-Requisite Verification
- Post-Installation Config
- Post-Installation Exec
- Uninstall




```
Router# easy-installer tftp://10.1.1.1/mypackage.tar flash:/easy
-----------------------------------------------------------------
Configure and Install EASy Package 'mypackage-1.03'
-----------------------------------------------------------------
1. Display Package Description
2. Configure Package Parameters
3. Deploy Package Policies
4. Exit

Enter option: 2
```

See: http://www.cisco.com/go/easy
See: http://www.cisco.com/en/US/prod/collateral/iosswrel/ps6537/ps6555/ps10777/application_note_c27-574650.html

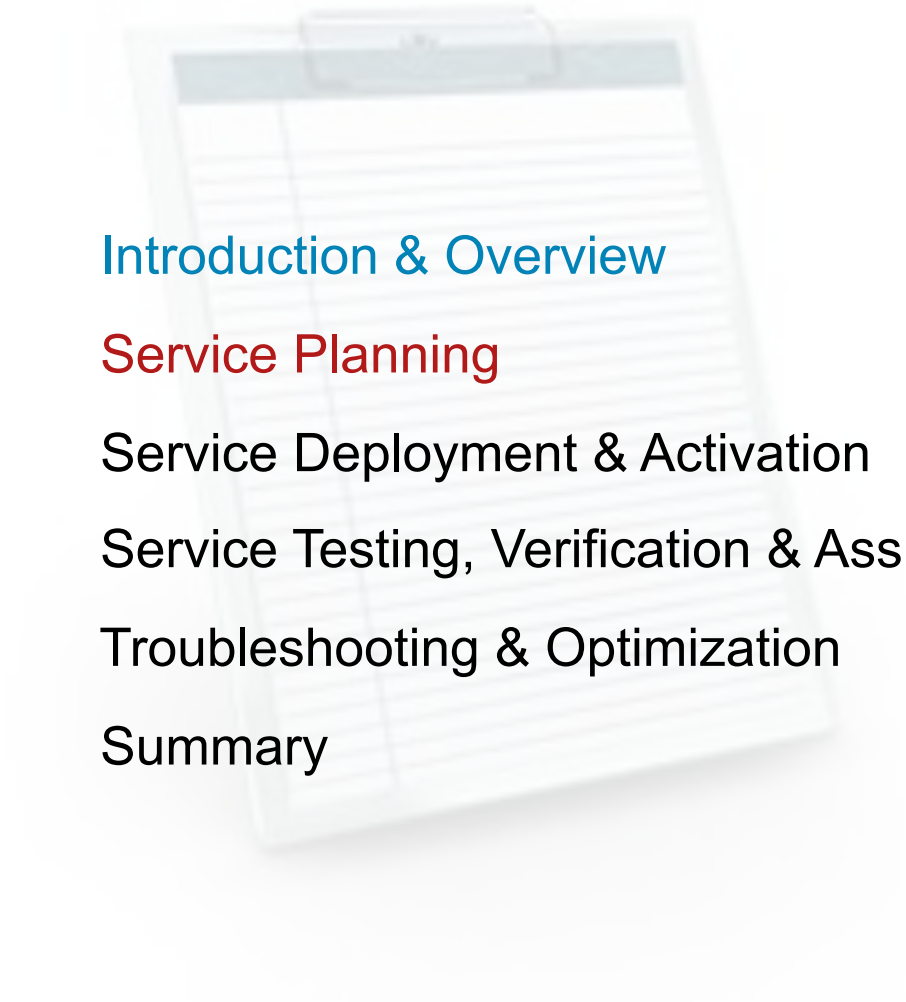
Embedded Automation Systems

For Your Reference

Embedded Automation Systems (EASy)

1. Browse and Download EASy Packages
   www.cisco.com/go/easy
2. Make Sure to also download EASy Installer
3. Browse Other Embedded Automations
   www.cisco.com/go/ciscobeyond
4. Learn About The Technology Under The Hood
   www.cisco.com/go/instrumentation
   www.cisco.com/go/eem
   www.cisco.com/go/pec
5. Discuss, Ask Questions, Suggest Answers
   supportforums.cisco.com
6. Upload your own Examples to CiscoBeyond
   www.cisco.com/go/ciscobeyond
7. Engage via ask-easy@cisco.com

Agenda



Introduction & Overview

➲ Service Planning

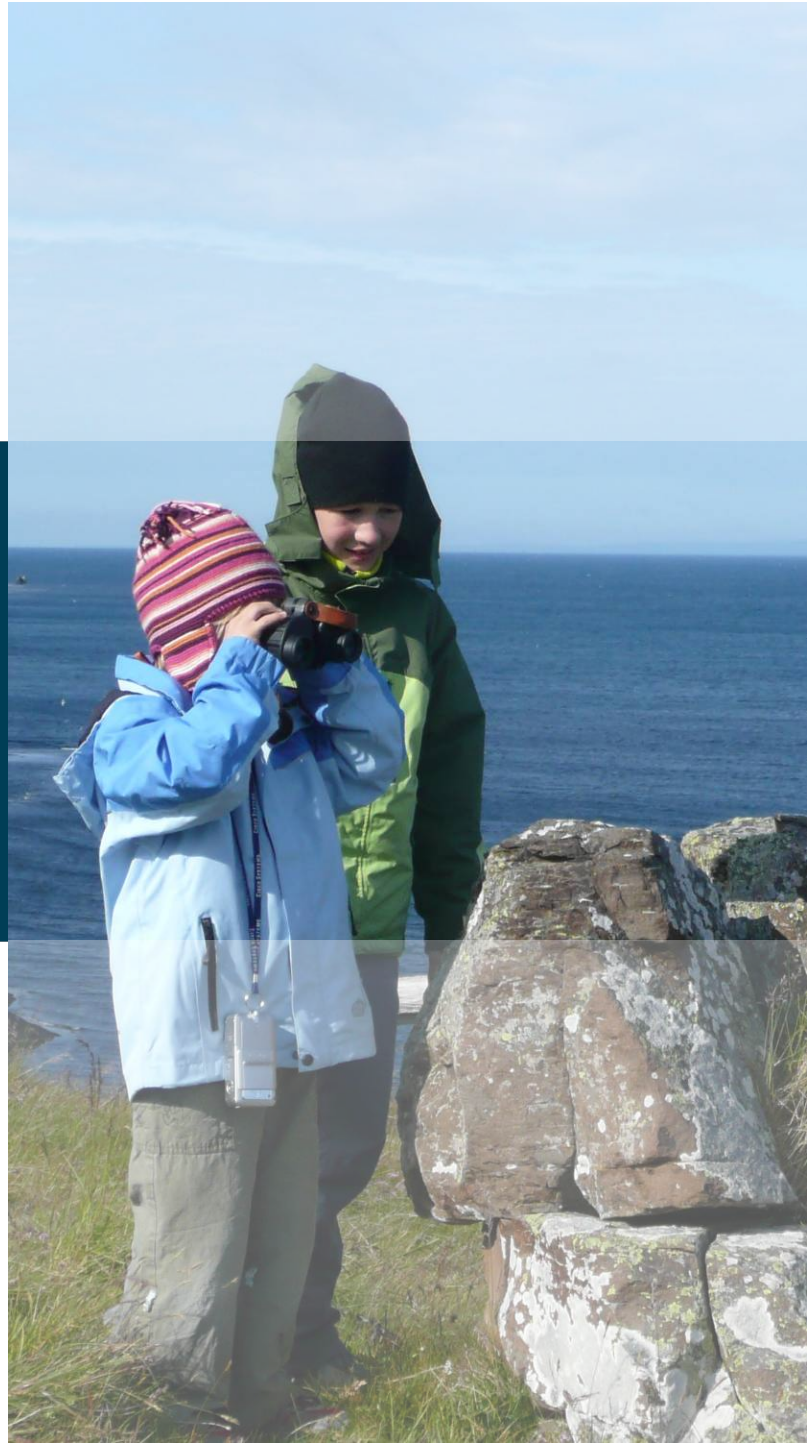
Service Deployment & Activation

Service Testing, Verification & Assurance

Troubleshooting & Optimization

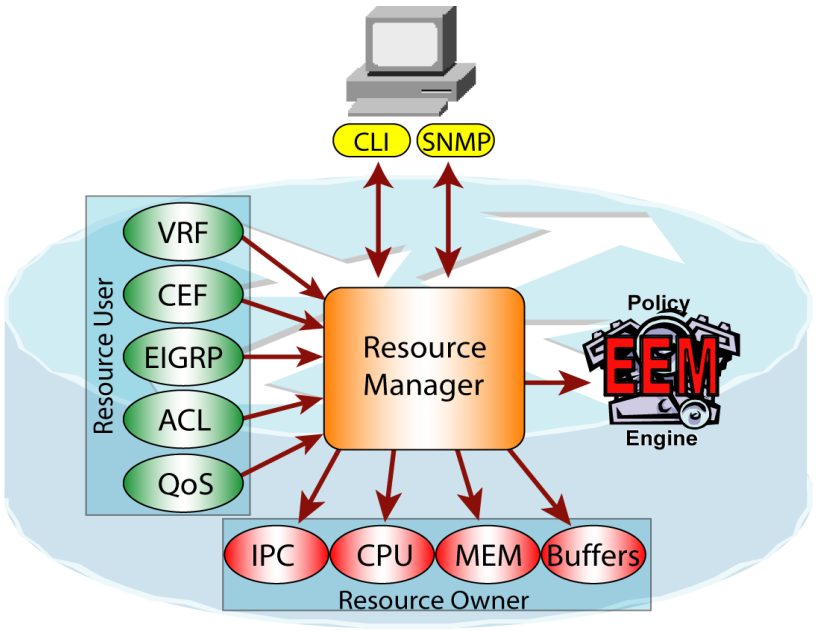
Summary

How is my current Use of Resources ?



Service Planning
Embedded Resource Manager (ERM)

- The ERM framework tracks resource depletion and resource dependencies across processes and within a system
- Monitor thresholds for CPU, buffer, and/or memory
- For system or line card
- ERM can define "group", i.e. group of different CPU processes
- CISCO-ERM-MIB
- Interface into EEM



Available from: IOS 12.2(33)SRB, 12.4(15)T
Platforms: UC520, 800, x8xx ISR,x900x ISR, 65xx, 72xx, 73xx, 75xx, 76xx, 10xxx

Service Planning

Example – Monitoring Resources

Problem: During the planning cycle, we would like to understand if total CPU usage reaches critical levels

Solution: Define an ERM policy to notify upon resource depletion

```
resource policy
 policy my-erm-policy-1 type iosprocess
  system
    cpu total
     critical rising 90 interval 15 falling 20 interval 10 global
     major rising 70 interval 15 falling 15 interval 10 global
     minor rising 60 interval 15 falling 10 interval 10 global
!
```

➔ If **Total** CPU usage count rises above 90% at an interval of 15s, a Critical Up notification is sent

```
Feb 17 13:32:18.283: %SYS-4-CPURESRISING: System is seeing global
cpu util 62% at total level more than the configured minor limit 60%
```

Service Planning

Example – Monitoring Multiple Processes

Problem: In order to detect resource consumption caused by brute force login attempts, we want to keep an eye on CPU utilization by the login processes

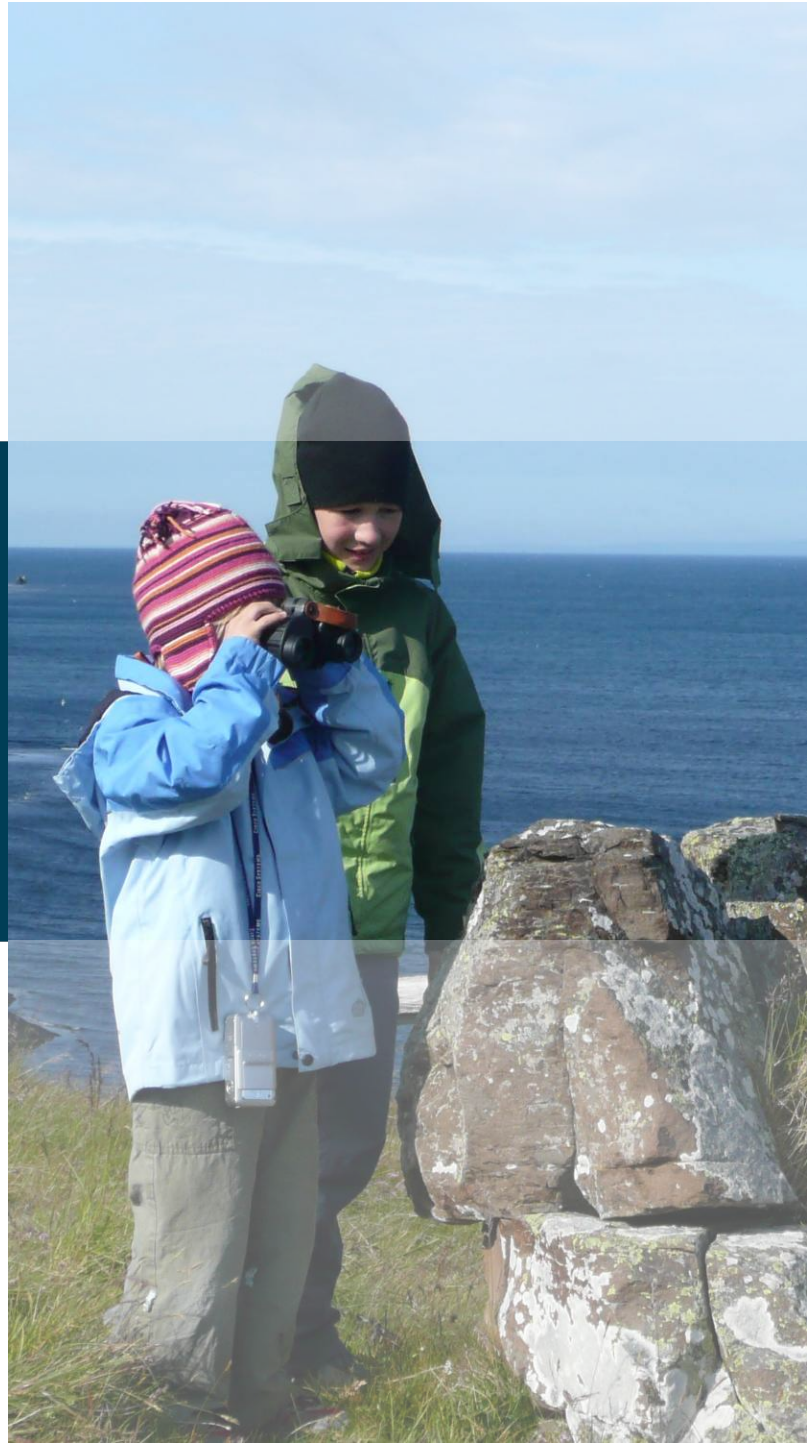
Solution: Define an ERM policy to notify upon critical / suspicious levels

```
resource policy
  policy my-login-policy type iosprocess
    system
      cpu process
        critical rising 30 interval 10 falling 20 interval 10
        major rising 20 interval 10 falling 10 interval 10
        minor rising 10 interval 10 falling 5 interval 10
  user group my-login-group type iosprocess
    instance "SSH Process"
    instance "SSH Event handler"
    :
    policy my-login-policy
```

➔ Syslog if **Group** CPU Usage Count Rises Above 10% at an Interval of 10s

```
*Aug 25 12:56:26.089: %SYS-4-CPURESRISING: Resource group my-login-group is
seeing local cpu util 16% at process level more than the configured minor limit
10%

*Aug 25 12:56:41.089: %SYS-6-CPURESFALLING: Resource group my-login-group is no
longer seeing local high cpu at process level for the configured minor limit
10%, current value 0%
```

Exporting MIB Statistics?



Service Planning

Quickly export SNMP Statistics?

Problem: Sometimes we need data from one or multiple MIBs, but

- we may not want to (re-)configure an NMS
- don't want to constantly poll
- need to gather data during temporary loss of connectivity

Solution: Use Bulk File MIB to define the data we need and periodically transfer it to a convenient location

- group data from multiple MIBs
- single, common polling interval
- buffer data
- transfer using RCP, FTP, TFTP
- format ASCII or Binary

Feature Name: Periodic MIB Data Collection and Transfer Mechanism

Available from: IOS 12.0(24)S, 12.2(25)S, 12.3(2)T, IOS XE 2.1, IOS XR 3.2
Platforms: ASR1k, x8xx ISR, x900x ISR, 72xx, 73xx, 76xx, 10xxx, ME3400, C4k, C6k, …
See: http://tools.cisco.com/Support/SNMP/do/BrowseOID.do?local=en&translate=Translate&objectInput=1.3.6.1.2.1.2

Service Planning

Configuration – Example

1. Define Lists of relevant OIDs (Names for IF-MIB, ASN.1 for all others)

```
Router(config)# snmp mib bulkstat object-list my-if-data
Router(config-bulk-objects)# add ifIndex
Router(config-bulk-objects)# add ifDescr
Router(config-bulk-objects)# add ifAdminStatus
Router(config-bulk-objects)# add ifOperStatus
Router(config-bulk-objects)# exit
```

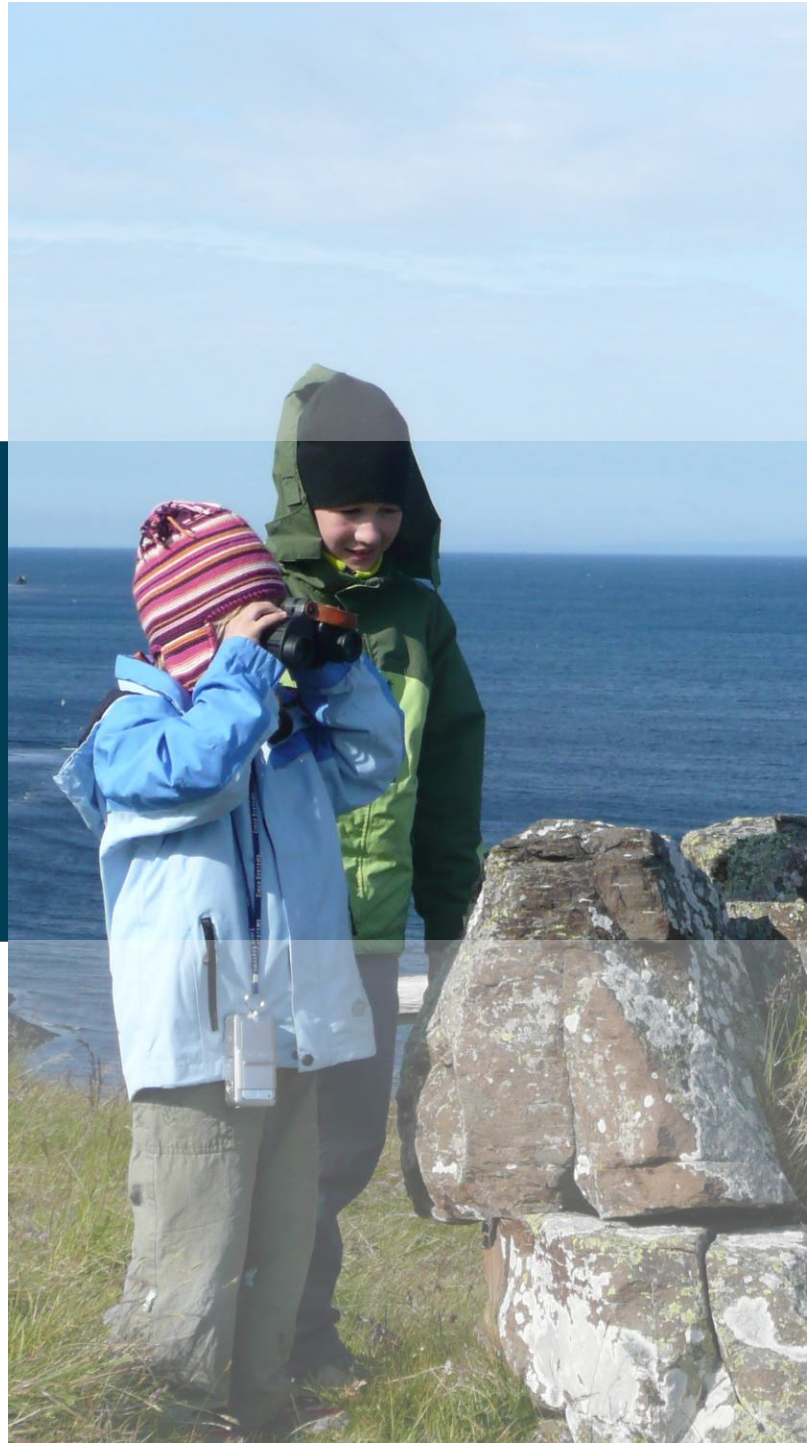
2. Specify Polling Schema

```
Router(config)# snmp mib bulkstat schema my-if-schema
Router(config-bulk-sc)# object-list my-if-data
Router(config-bulk-sc)# poll-interval 1
Router(config-bulk-sc)# instance exact interface FastEthernet0
Router(config-bulk-sc)# exit
```

3. Configure the Transfer Mechanism – and enable it !

```
Router(config)# snmp mib bulkstat transfer my-fa0-transfer
Router(config-bulk-tr)# schema my-if-schema
Router(config-bulk-tr)# transfer-interval 5
Router(config-bulk-tr)# url primary tftp://10.10.10.10/folder/
Router(config-bulk-tr)# retain 30
Router(config-bulk-tr)# buffer-size 4096
Router(config-bulk-tr)# enable
```

What if it’s neither in ERM nor a MIB?



Service Planning

Expression MIB

- Allows you to create new SNMP objects based upon existing MIB variables and formulas
- Interesting when combined with the EVENT-MIB
- EXPRESSION MIB proposed by Cisco to IETF DISMON Working Group, accepted standard track RFC-2982
  - Based on IETF draft, again in the DISMON Working Group, and numbered in Cisco's namespace
- 3 Phases:
  - MIB Introduction, SNMP Only - 12.0(5)T
    - However "show command" exists
    - However "debug command" exists
  - Introduction of Scriptable Interface
  - Introduction of CLI Support - 12.4(20)T

See: http://www.cisco.com/en/US/docs/ios/netmgmt/configuration/guide/nm_cfg_snmp_sup.html
Available from: IOS 12.0(5)T (EXPRESSION-MIB), 12.3(7)T (SNMPset in TCL script), 12.4(20)T (CLI)

Service Planning

Event-MIB

- The EVENT MIB provides a superset of the capabilities of the RMON alarm and event
- EVENT MIB can monitor
  - any MIB object (existence)
  - any integer/counter (boolean, threshold)
- EVENT-MIB sends an SNMP notification in response to a trigger (like RMON) but add the concept of setting a MIB object (integers)
- EVENT-MIB can specify which variables to add to the notification
- RFC 2981-compliant introduced in 12.2(4)T
- Configuration support via CLI added in 12.4(20)T

See: http://www.cisco.com/en/US/docs/ios/netmgmt/configuration/guide/nm_cfg_snmp_sup_ps6441_TSD_Products_Configuration_Guide_Chapter.html#wp1125529
Available from: IOS 12.2(4)T (EVENT-MIB), 12.3(7)T (SNMPset in TCL script), 12.4(20)T (CLI)
Platforms: x8xx ISR,x900x ISR, 72xx, 73xx, 76xx

Service Planning

EXPRESSION-& EVENT-MIB

- Simply capacity planning example: if my link utilization is above 50% for an hour, it's time to upgrade the link
- Steps:

Expression-MIB

1. Create an Expression

Utilization = (Δ ifInOctets + Δ ifOutOctets) * 8 * 100 / hour / ifSpeed

Event-MIB

2. Create an Event

If utilization > 50% → generate an Event

Service Planning

EXPRESSION-& EVENT-MIB

- Simply capacity planning example: Calculate link utilization on all the interfaces in the router

```
Router# show running | beg expression
snmp mib expression owner administrator name exp3
  expression ($1*800)/$2
  enable
  object 1
    id ifInOctets
    wildcard
  object 2
```

```
NMS% snmpwalk -c public -v 2c <router> expValueCounter32Val
SNMPv2-SMI:: expValueCounter32Val.7.109.97.114.105.115.111.108.4.101.120.112.51.0.0.1 = Counter32: 214800
SNMPv2-SMI:: expValueCounter32Val.7.109.97.114.105.115.111.108.4.101.120.112.51.0.0.2 = Counter32: 0
SNMPv2-SMI:: expValueCounter32Val.7.109.97.114.105.115.111.108.4.101.120.112.51.0.0.4 = Counter32: 0
SNMPv2-SMI:: expValueCounter32Val.7.109.97.114.105.115.111.108.4.101.120.112.51.0.0.5 = Counter32: 0
```

Service Planning

Adding a Custom MIB Variable

- **Problem:** Collect data via SNMP, even if there is no MIB support currently available.

- **Solution:** Expression-MIB provides the capability to process data into more relevant information via SNMP
  - Expression-MIB can be configured using SNMP directly since 12.0(5)T.
  - Initially Cisco Implementation was based on OID 1.3.6.1.4.1.9.10.22 but current Cisco implementation is based on RFC2982-MIB, OID 1.3.6.1.2.1.90.
  - In 12.4(20)T Expression-MIB feature is enhanced to add CLIs to configure expressions.

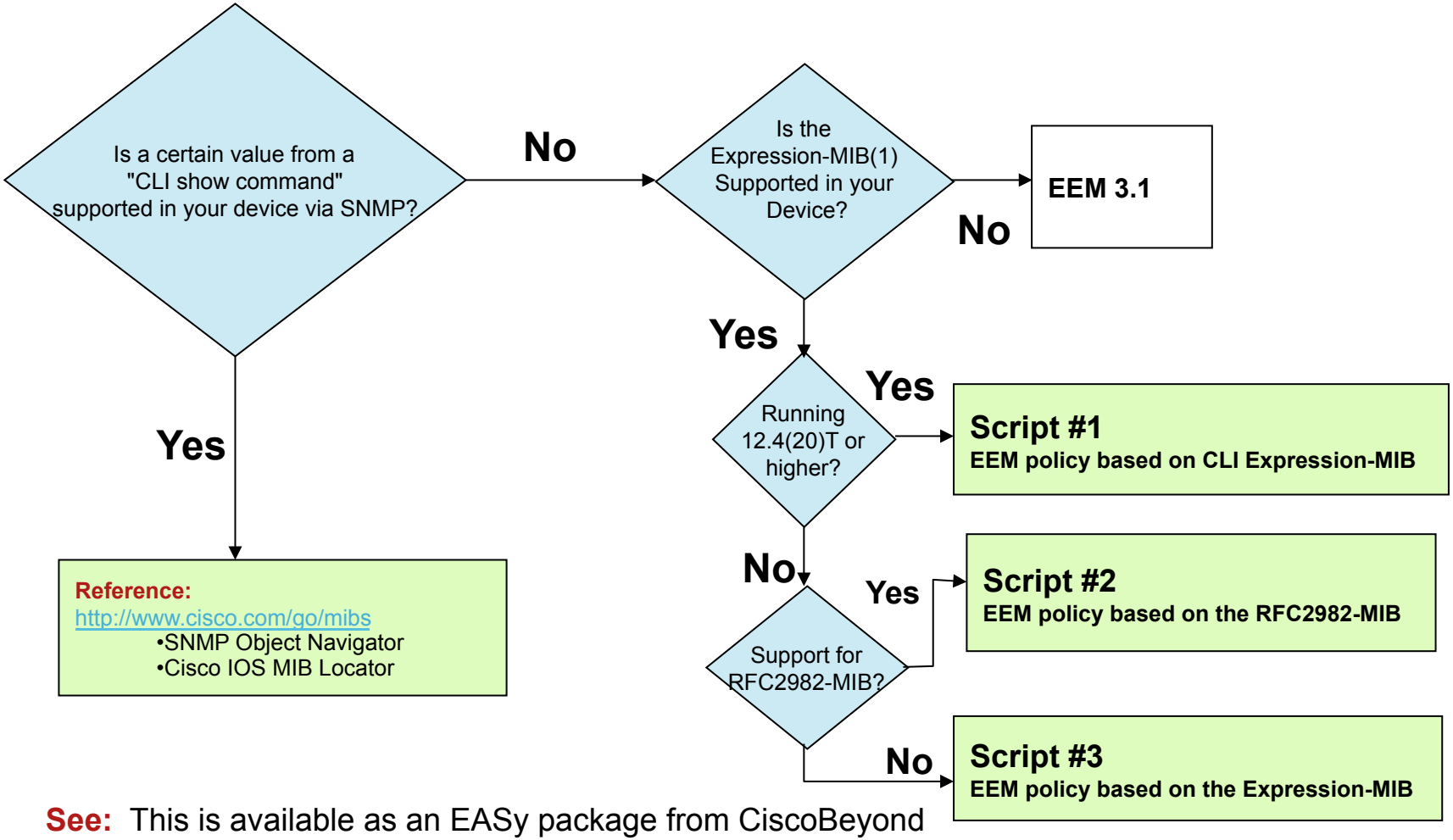
- Expression-MIB can gather data from Command Line Interface (CLI show commands), even if there is no MIB support

- EEM 3.1 provides similar capability without the need to involve Expression-MIB or Event-MIB

See: http://www.cisco.com/en/US/docs/ios/netmgmt/configuration/guide/nm_cfg_snmp_sup.html

Service Planning

Adding a Custom MIB Variable



See: This is available as an EASy package from CiscoBeyond
http://forums.cisco.com/eforum/servlet/EEM?page=eem&fn=script&scriptId=1961

For the ASR 1000 version
http://forums.cisco.com/eforum/servlet/EEM?page=eem&fn=script&scriptId=2283

Service Planning

Custom MIB – EASy Package

Embedded Automation Systems (EASy)

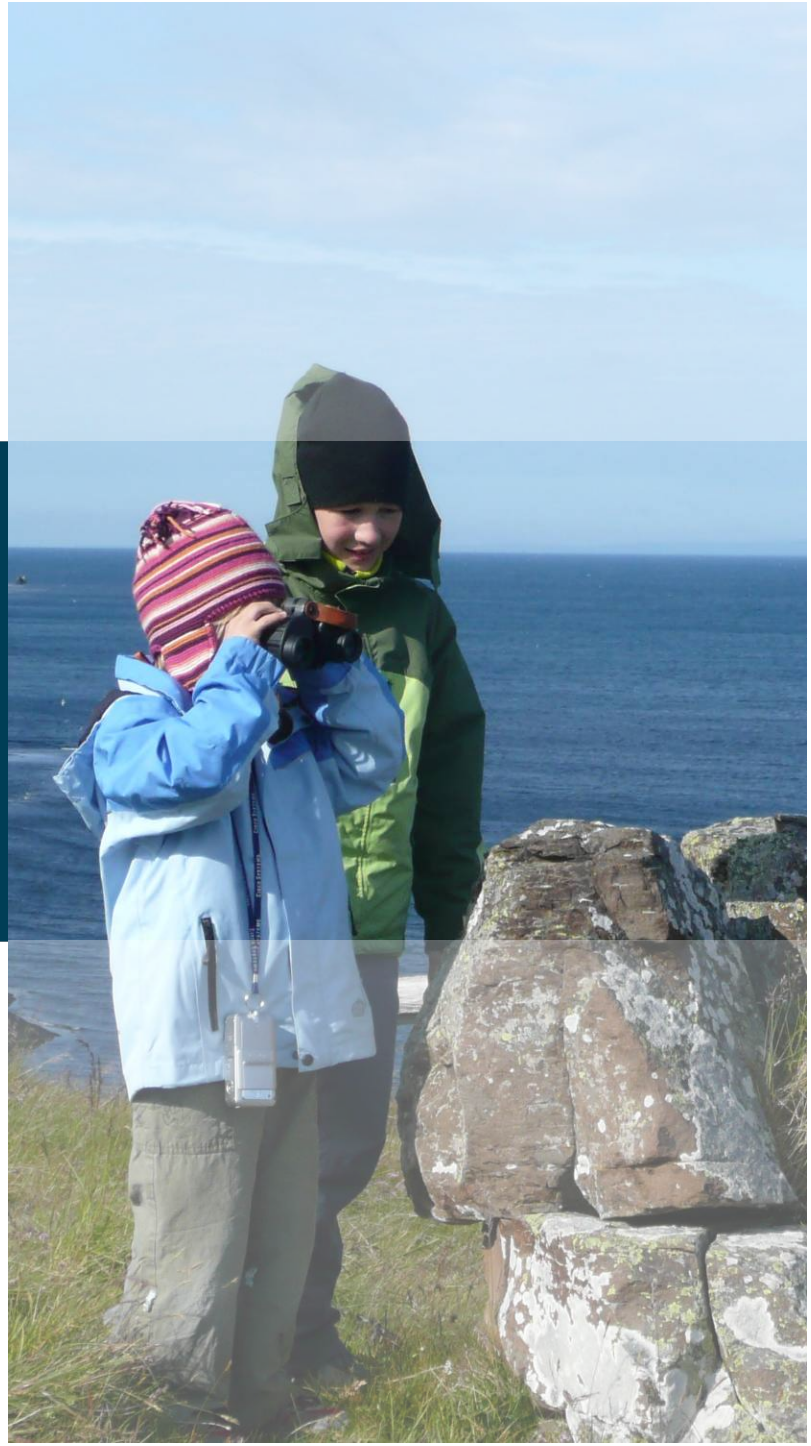
Custom MIB EASy Package:

- **Periodically evaluate a show command**
- **Update a custom MIB Variable**
- **Trigger Syslog and/or custom actions**

To use the Package:

1. Browse and Download EASy Package
   www.cisco.com/go/easy
2. Make Sure to also download EASy Installer
3. Watch VOD and/or read documentation
   www.cisco.com/go/easy
4. Customize and tailor to your needs
5. Install and Use

What about Traffic Flows?



What is NetFlow ?

- Developed and patented at Cisco® Systems in 1996
- NetFlow is the defacto standard for acquiring IP operational data
- Provides network and security monitoring, network planning, traffic analysis, and IP accounting
- NetFlow v9 (RFC3954) serves as the basis for IETF IPFIX Standard (RFC5101 & RFC5102)

Network World article – NetFlow Adoption on the Rise:

http://www.networkworld.com/newsletters/nsm/2005/0314nsm1.html

Service Planning

Flexible NetFlow (FNF)

- Traditional NetFlow with the v5, v7, or v8 NetFlow export

- NetFlow Version 9 (RFC3954)

  Advantages: extensibility

  Integrate new technologies/data types quicker (MPLS, IPv6, BGP next hop, etc.)

  Integrate new aggregations quicker

  Basis for IETF IPFIX Standard (RFC5101 & RFC5102)

Exporting Process

- Flexible NetFlow

  Advantages: cache and export content flexibility

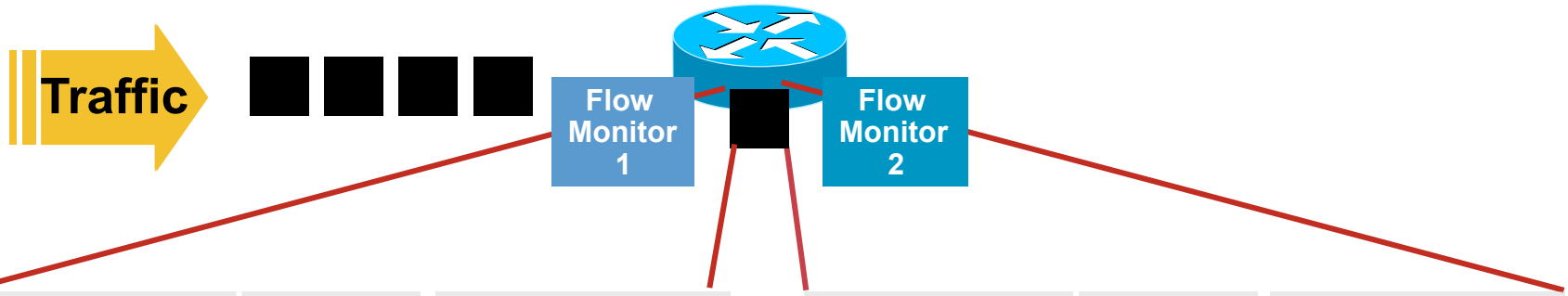
  User selection of flow keys

  User definition of the records

Metering Process

Flexible NetFlow

Multiple Monitors with Unique Key Fields



Key Fields	Packet 1
Source IP	3.3.3.3
Destination IP	2.2.2.2
Source Port	23
Destination Port	22078
Layer 3 Protocol	TCP - 6
TOS Byte	0
Input Interface	Ethernet 0

Non-Key Fields
Packets
Bytes
Timestamps
Next Hop Address

Key Fields	Packet 1
Source IP	3.3.3.3
Dest IP	2.2.2.2
Input Interface	Ethernet 0
SYN Flag	0

Non-Key Fields
Packets
Timestamps

Traffic Analysis Cache

Source IP	Dest. IP	Source Port	Dest. Port	Protocol	TOS	Input I/F	…	Pkts
3.3.3.3	2.2.2.2	23	22078	6	0	E0	…	1100

Security Analysis Cache

Source IP	Dest. IP	Input I/F	Flag	…	Pkts
3.3.3.3	2.2.2.2	E0	0	…	11000

Flexible NetFlow

Configuration – Example

1. Configure the Exporter

```
Router(config)# flow exporter my-exporter
Router(config-flow-exporter)# destination 1.1.1.1
```

2. Configure the Flow Record

```
Router(config)# flow record my-record
Router(config-flow-record)# match ipv4 destination address
Router(config-flow-record)# match ipv4 source address
Router(config-flow-record)# collect counter bytes
```

3. Configure the Flow Monitor

```
Router(config)# flow monitor my-monitor
Router(config-flow-monitor)# exporter my-exporter
Router(config-flow-monitor)# record my-record
```

4. Apply to an Interface

```
Router(config)# interface s3/0
Router(config-if)# ip flow monitor my-monitor input
```

Flexible Flow Record: Key Fields

Flow
Sampler ID
Direction
Interface
Input
Output
Layer 2
Source VLAN
Dest VLAN
Dot1q VLAN
Dot1q priority
Source MAC address
Destination MAC address

NEW

IPv4	
IP (Source or Destination)	Payload Size
Prefix (Source or Destination)	Packet Section (Header)
Mask (Source or Destination)	Packet Section (Payload)
Minimum-Mask (Source or Destination)	TTL
Protocol	Options bitmap
Fragmentation Flags	Version
Fragmentation Offset	Precedence
Identification	DSCP
Header Length	TOS
Total Length	

IPv6	
IP (Source or Destination)	Payload Size
Prefix (Source or Destination)	Packet Section (Header)
Mask (Source or Destination)	Packet Section (Payload)
Minimum-Mask (Source or Destination)	DSCP
Protocol	Extension Headers
Traffic Class	Hop-Limit
Flow Label	Length
Option Header	Next-header
Header Length	Version
Payload Length	

Flexible Flow Record: Key Fields

NEW

Routing
src or dest AS
Peer AS
Traffic Index
Forwarding Status
IGP Next Hop
BGP Next Hop
Input VRF Name

NEW

Transport	
Destination Port	TCP Flag: ACK
Source Port	TCP Flag: CWR
ICMP Code	TCP Flag: ECE
ICMP Type	TCP Flag: FIN
IGMP Type*	TCP Flag: PSH
TCP ACK Number	TCP Flag: RST
TCP Header Length	TCP Flag: SYN
TCP Sequence Number	TCP Flag: URG
TCP Window-Size	UDP Message Length
TCP Source Port	UDP Source Port
TCP Destination Port	UDP Destination Port
TCP Urgent Pointer	

Application
Application ID*

Multicast
Replication Factor*
RPF Check Drop*
Is-Multicast

***: IPv4 Flow only**

Flexible Flow Record: Non-Key Fields

Counters
Bytes
Bytes Long
Bytes Square Sum
Bytes Square Sum Long
Packets
Packets Long

Timestamp
sysUpTime First Packet
sysUpTime First Packet

IPv4
Total Length Minimum (*)
Total Length Maximum (*)
TTL Minimum
TTL Maximum

IPv4 and IPv6
Total Length Minimum (**)
Total Length Maximum (**)

- Plus any of the potential “key” fields: will be the value from the first packet in the flow

(*) IPV4_TOTAL_LEN_MIN, IPV4_TOTAL_LEN_MAX
(**)IP_LENGTH_TOTAL_MIN, IP_LENGTH_TOTAL_MAX

Service Planning
Three Types of FNF NetFlow Caches

- Normal cache (traditional NetFlow)
  - More flexible active and inactive timers: one second minimum
- Immediate cache
  - Flow accounts for a single packet
  - Desirable for real-time traffic monitoring, DDoS detection, logging
  - Desirable when only very small flows are expected (ex: sampling)
  - Caution: may result in a large amount of export data
- Permanent cache
  - To track a set of flows without expiring the flows from the cache
  - Entire cache is periodically exported (update timer)
  - After the cache is full (size configurable), new flows will not be monitored
  - Uses update counters rather than delta counters

Service Planning
Core Traffic Matrix with Flexible NetFlow

Problem: Network wide capacity planning requires the traffic matrix

Solution: Use Flexible NetFlow with a permanent cache

```
flow record traffic-matrix-record
   match interface input
   match ipv4 dscp
   match routing next-hop address ipv4 bgp
   collect counter bytes long
   collect timestamp sys-uptime first
   collect timestamp sys-uptime last

flow monitor traffic-matrix-monitor
   record traffic-matrix-record
   cache entries 1000
   cache type permanent
   exporter capacity-planning-collector

interface pos3/0
   ip flow monitor traffic-matrix-monitor
```

We must define the maximum number of entries for the permanent cache

Service Planning

Configuration Using EEM + Cron + CLI

Problem: No synchronized NetFlow export across routers

Solution: Use Flexible NetFlow with a permanent cache

```
Router(config)# event manager applet periodicexport
Router(config-applet)# event timer cron name
          "everyhour" cron-entry "0 * * * *"
Router(config-applet)# action 1.0 cli command
  "clear flow monitor traffic-matrix-record force-export"
```

- Export the content of the permanent cache every one hour
- If time is synchronized across routers (NTP), we have a synchronized export (snapshot)

Service Planning
Flexible NetFlow TopTalkers

show flow monitor *monitor-name* **cache filter** ***options***
… aggregation *options* **sort** *options*

- Flow filtering, aggregation and sorting can be combined to select what information and how it will be displayed

- Top ten protocols observed:

```
Router# show flow monitor <monitor> cache
        aggregate ipv4 protocol sort highest counter bytes top 10
```

Available from: IOS 12.4(22)T
Platforms: x8xx ISR,x900x ISR, 72xx, ..

Service Planning
Flexible NetFlow Top Talkers - Examples

- Top ten IP addresses that are sending the most packets

```
Router# show flow monitor <monitor> cache
        aggregate ipv4 source address
        sort highest counter bytes top 10
```

- Top five destination addresses to which we're routing most traffic from the 10.10.10.0/24 prefix

```
Router# show flow monitor <monitor> cache
        filter ipv4 destination address 10.10.10.0/24
        aggregate ipv4 destination address
        sort highest counter bytes top 5
```

- 5 VLAN's that we're sending the least bytes to:

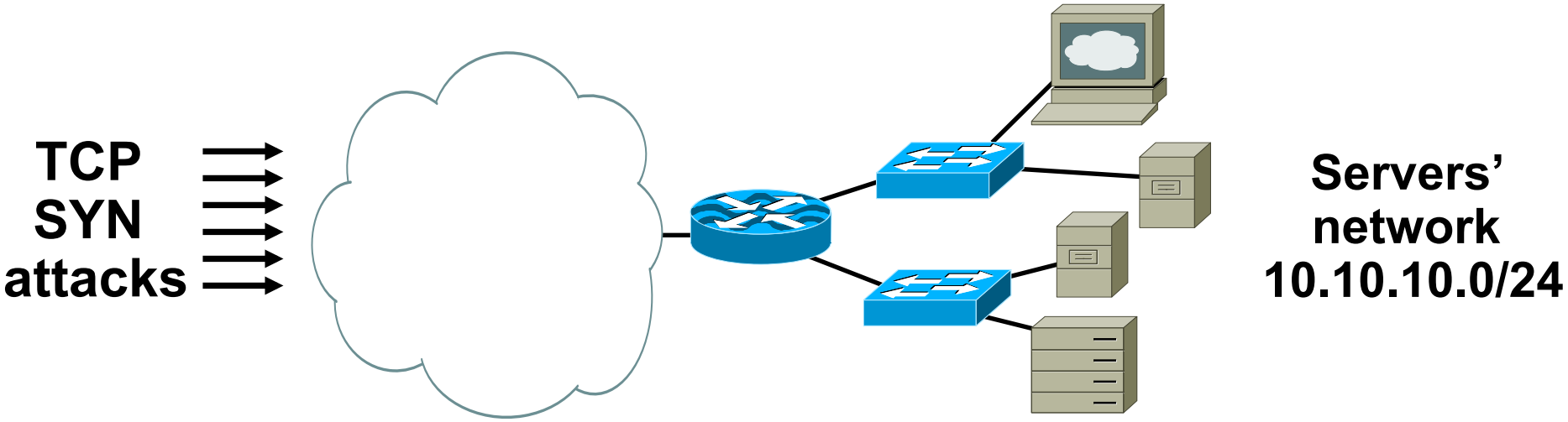
```
Router# show flow monitor <monitor> cache
        aggregate datalink dot1q vlan output
        sort lowest counter bytes top 5
```

- Top 20 sources of 1-packet flows:

```
Router# show flow monitor <monitor> cache
        filter counter packet 1
        aggregate ipv4 source address
        sort highest flow packet top 20
```

Service Planning

Flexible NetFlow Top Talkers – Example




```
Router# show flow monitor <monitor> cache
        filter ipv4 destination address 10.10.10.0/24
               counter packet regex[1-2]
        aggregate ipv4 source address
                  ipv4 destination address
        sort highest flow top 100
```

- The top 100 pairs of IP addresses with one or two packet(s) that are destined for my servers' network

Flexible NetFlow

Example: Cat4500 Supervisor Engine 7-E

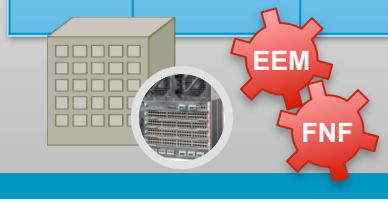
New

- Auto Smart Ports
- Embedded Event Manager (EEM) 3.2
- Flexible Netflow and NetFlow v9 support for IPv4, IPv6, L2
- Generic Online Diagnostics (GOLD)
- In-Service Software Upgrade (ISSU)
- Smart Call Home

Anomaly Detection using EEM and FNF

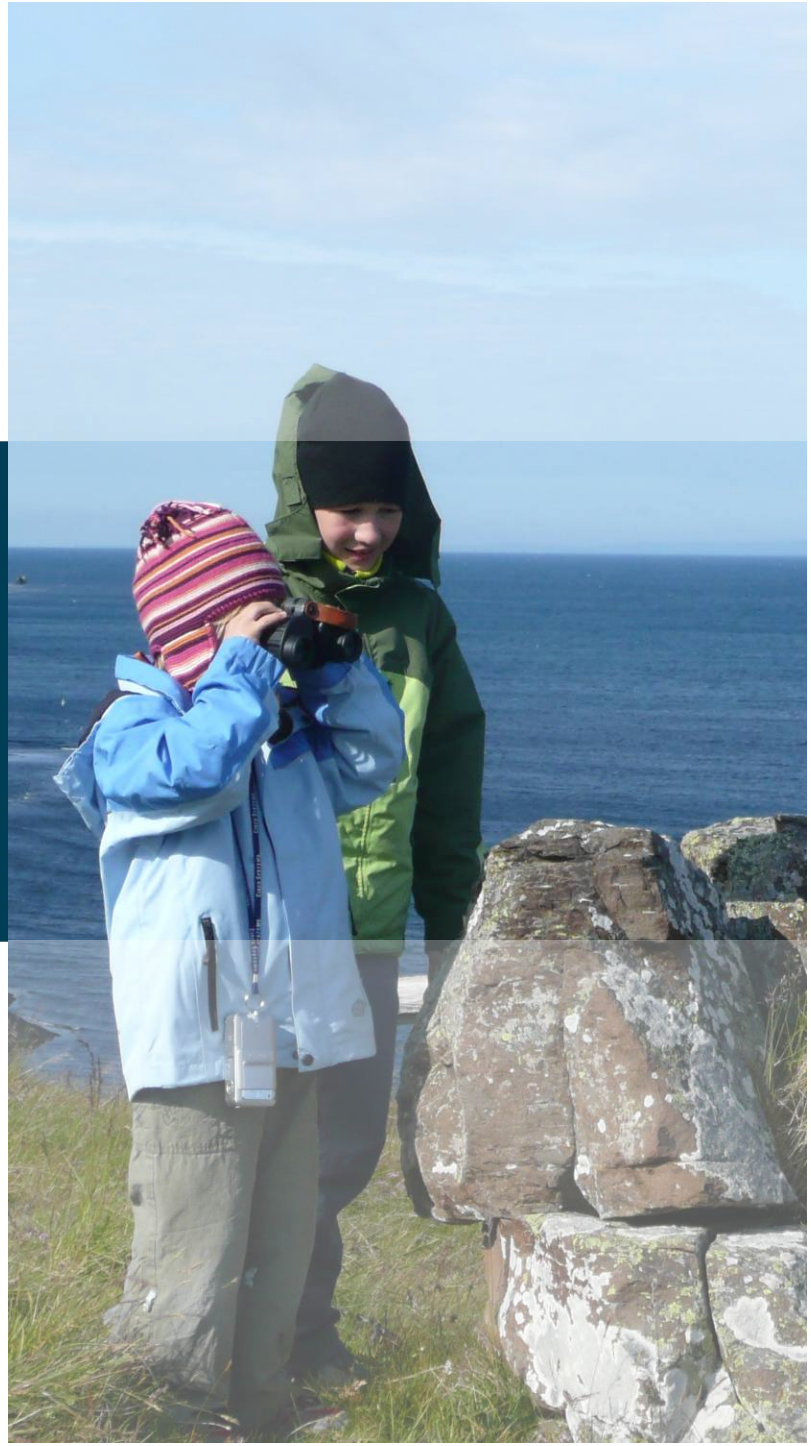
srcIf	SrcIPadd	DstIf	DstIPadd	MAC	TCP Flags	bytes
Fa1/0	173.1.1.2	Fa0/0	10.0.277.1	…	…	3465
Fa1/0	173.1.1.2	Fa0/0	10.0.277		….	300
Fa1/0	173.1.1.2	Fa0/0	10.0.277.1	….	….	1000

Anomaly detected!



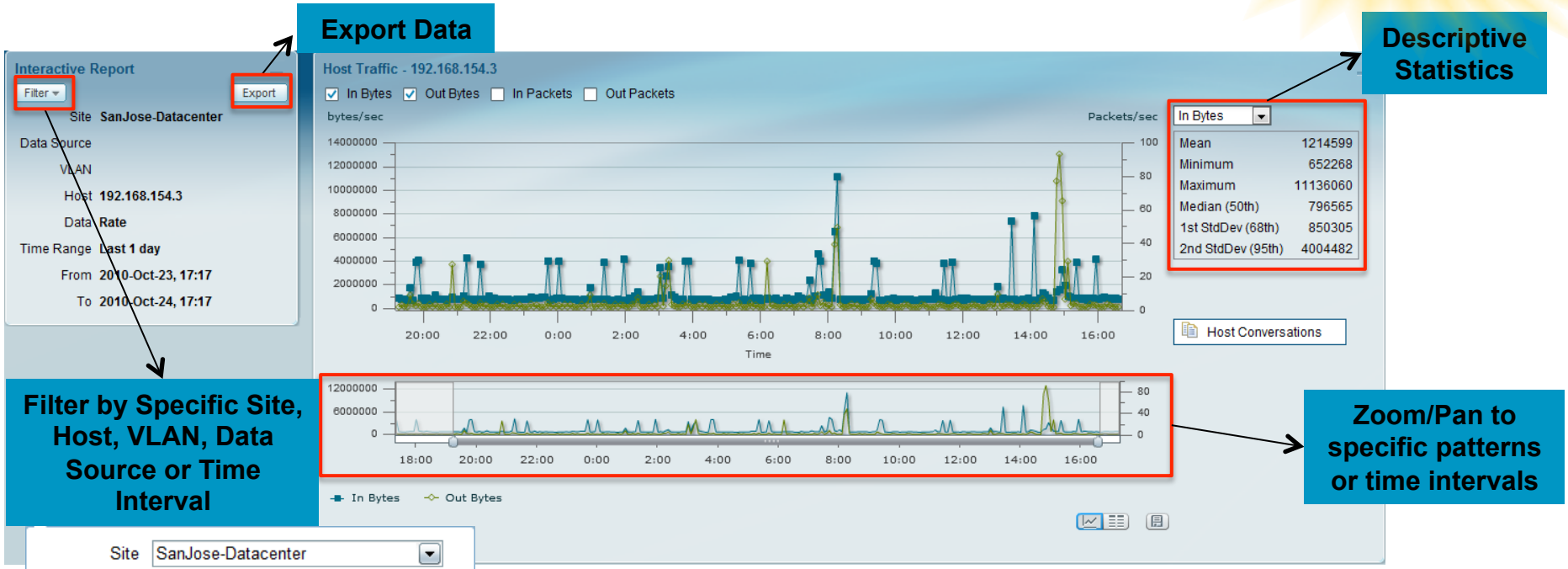
- Policy Action: (Port Shutdown, ACL, QoS, …)
- Custom Syslog

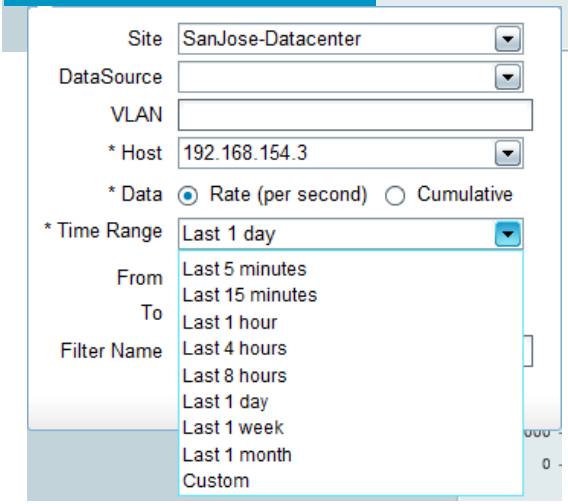
What about Trending and Graphical Views?



NAM 5.0 Interactive Reports
Analyze Performance/Usage Trends and Patterns

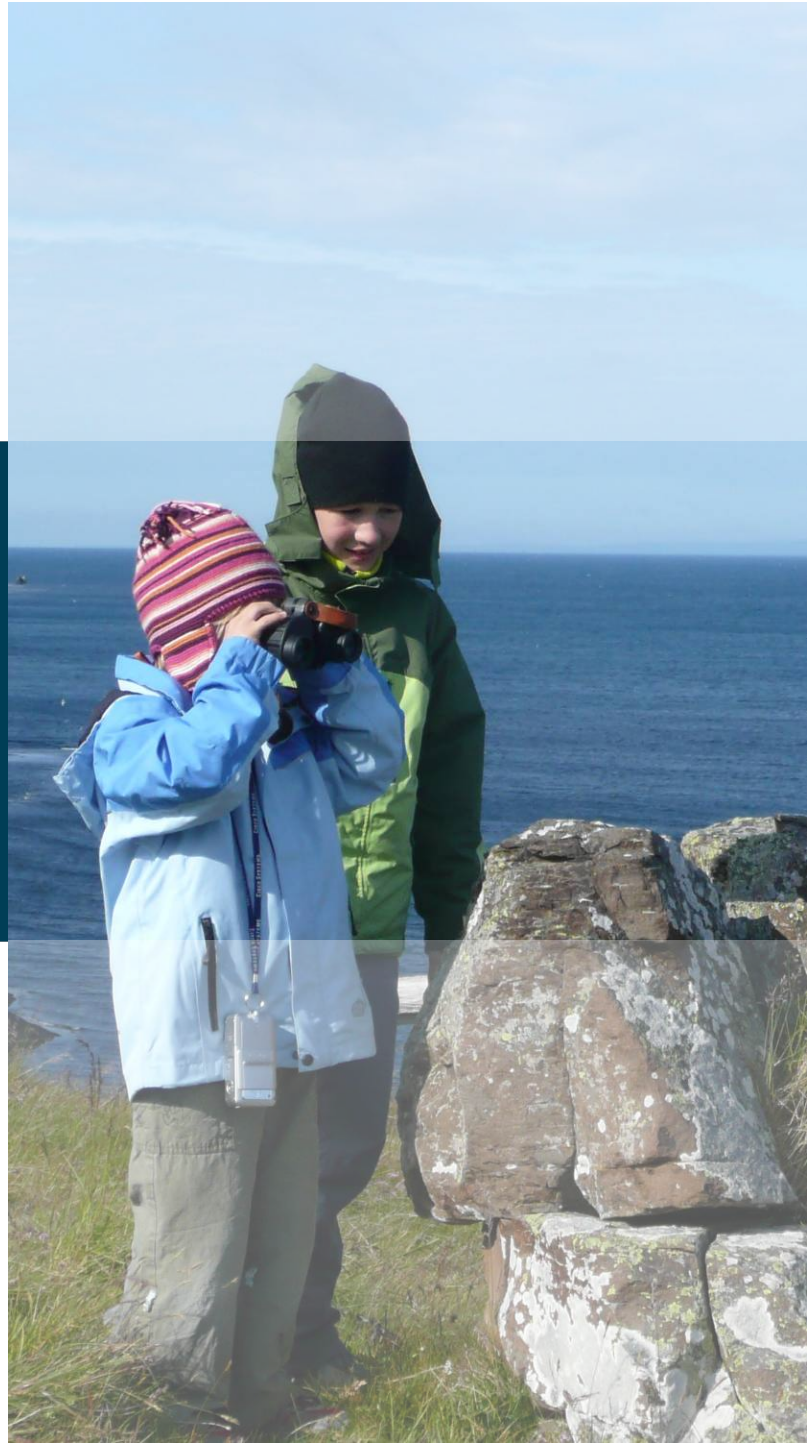
New Jan 2011





- Analyze data over last month or more
- Define custom time interval for analysis
- Export data in raw format for consumption by external management application
- Drill-down to analyze related trends to support planning decisions

But my Teleworkers don’t have a Cisco Router yet!



Cisco Visual Networking Index

New

Problem: Sometimes we need trending and forecasting info beyond our current reach and/or where there is no IOS-based network yet

Solution: Visual Networking Index

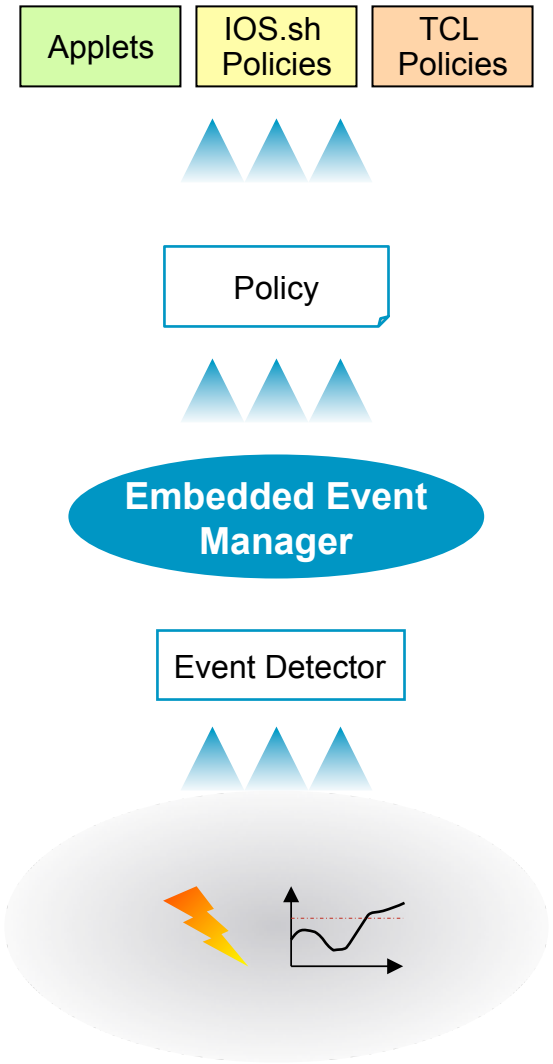
- Global initiative to analyze and forecast IP network growth
- Mobile and PC-based data collection
- Graphical data summaries publicly available
- Individual network usage reports available to service provider participants

See: www.ciscovnipulse.com

How To Analyze Transient Conditions?

Service Planning

Embedded Event Manager (EEM)



3. An EEM Policy is activated that initiates a pre-defined set of actions

2. An EEM Event Detector receives notification

1. Something happens on the  causing an Event to trigger

Service Planning

Embedded Event Manager (EEM) Versions

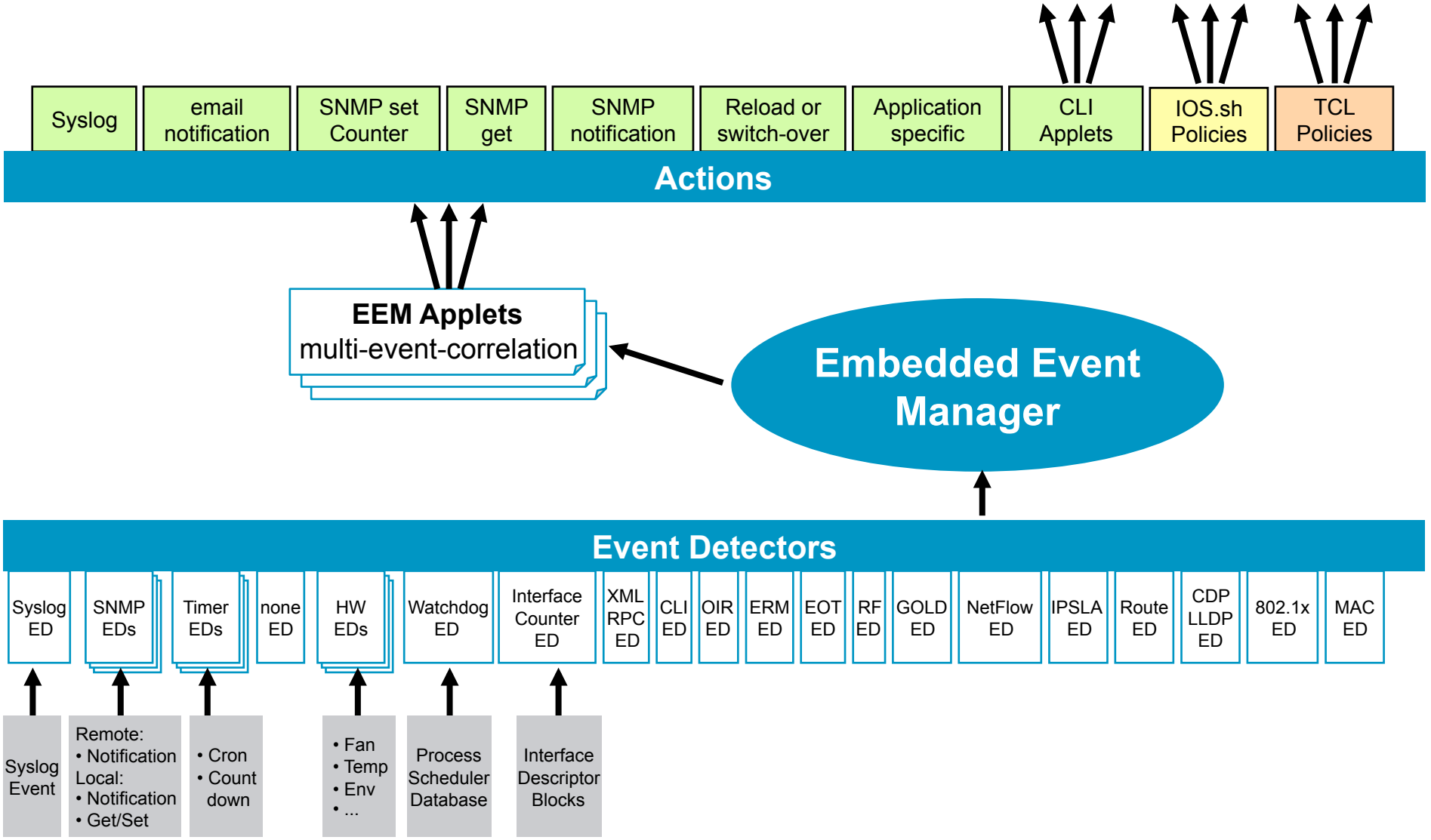
- Embedded monitoring of different components of the system via a set of software agents (event detectors)
- Event detectors (ED) notify EEM when an event of interest occurs; based on this, a policy will trigger an action to be taken
- Advantages: Local programmable actions, triggered by specific events – growing set of detectors and actions:
  - EEM 1.0 introduced in 12.0(26)S, 12.3(4)T
  - EEM 2.0 introduced in 12.2(25)S
  - EEM 2.1 introduced in 12.3(14)T
  - EEM 2.2 introduced in 12.4(2)T
  - EEM 2.3 introduced in 12.4(11)T
  - EEM 2.4 introduced in 12.4(20)T
  - EEM 3.0 introduced in 12.4(22)T
  - EEM 3.1 introduced in 15.0(1)M
  - EEM 3.2 introduced in 12.2(52)SE
  - stay tuned ...

Adds multi-event correlation

Adds programmatic Applets

Service Planning

EEM Architecture



Service Planning

EEM Applets and Policies

CLI Applets	IOS.sh Policies	TCL Policies
▪ Part of the Cisco IOS Configuration	▪ Separate ASCII File `my-policy.sh`	▪ Separate ASCII File `my-policy.tcl`
▪ Based on CLI Commands	▪ Based on Cisco IOS CLI and Shell Commands	▪ Based on Cisco IOS CLI and Safe TCL Commands
▪ Simple Actions	▪ Effective shell-like simple scripting	▪ Flexible and powerful scripting capabilities
▪ Programmatic Applet Extensions	▪ Registered via the Cisco IOS Config	▪ Registered via the Cisco IOS Config

Service Planning

Example: Trigger a Config Change – 1/3

- **Problem**: a PKI related config change on a remote device should only happen once NTP has successfully synched the time

```
Router(config)# ntp logging
Router(config)# ntp update-calendar
Router(config)# ntp server 172.16.154.40 prefer
```

- **Solution I**: use EEM Syslog Event Detector and a CLI Applet to trigger the change

CLI Applet

```
event manager applet config_upon_ntp
event syslog pattern ".*%NTP-5-PEERSYNC.*"
action 10 syslog msg "Starting ..."
:
 ... Your Config Changes Here ...
:
action 30 syslog msg "... done"
```

```
Dec 10 13:03:57.746: %NTP-5-PEERSYNC: NTP synced to peer
172.16.254.40
Dec 10 13:03:57.750: %HA_EM-6-LOG: config_upon_ntp: Starting ...
Dec 10 13:03:57.750: %HA_EM-6-LOG: config_upon_ntp: ... done
```

Service Planning

Example: Trigger a Config Change – 2/3

- **Solution II**: use EEM Syslog Event Detector and an IOS.sh Policy to trigger the change

IOS.sh Policy

```
##::cisco::eem::event_register_syslog pattern .*%NTP-5-PEERSYNC.*
send log "Starting ..."
enable
conf t
hostname $new_hostname
:
 ... Your Config Changes Here ...
:
end
send log "... done"
# End of IOS.sh Policy demo script
```

```
router#
*Dec 22 18:27:09.659: %HA_EM-6-LOG: sl_cfg_ntp.sh: Starting ...
*Dec 22 18:27:09.801: %SYS-5-CONFIG_I: Configured from console by on vty0 (EEM:sl_cfg_ntp.sh)
*Dec 22 18:27:09.927: %HA_EM-6-LOG: sl_cfg_ntp.sh: Set hostname from router to it-worked
*Dec 22 18:27:09.927: %HA_EM-6-LOG: sl_cfg_ntp.sh: ... done
it-worked#
```

- **Solution III**: use EEM Syslog Event Detector and a TCL Policy to trigger the change …

TCL Policy

```
::cisco::eem::event_register_syslog occurs 1 pattern .*%NTP-5-PEERSYNC.* queue_priority low nice 1 maxrun 90

namespace import ::cisco::eem::*
namespace import ::cisco::lib::*

action_syslog msg "Starting ..."

set oldname [info hostname]
set newname "it-worked"

if [catch {cli_open} result] {
  error $result $errorInfo
} else {
  array set cli $result
}

if [catch {cli_exec $cli(fd) “enable\n conf term\n hostname $newname\n end"} result] {
    action_syslog msg "Failed to set hostname: $result : $errorInfo"
   error $result $errorInfo
} else {
   action_syslog msg "Set hostname from $oldname to $newname"
}

cli_close $cli(fd) $cli(tty_id)
action_syslog msg "... done"
```

Policy runtime
Default = 20 seconds
Increase this value if you see a “Process Forced Exit” message from the router.

```
router#
*Dec 10 10:43:29.061: %HA_EM-6-LOG: config_upon_ntp.tcl: Starting ...
*Dec 10 10:43:29.197: %SYS-5-CONFIG_I: Configured from console by  on vty0 (EEM:config_upon_ntp.tcl)
*Dec 10 10:43:29.329: %HA_EM-6-LOG: config_upon_ntp.tcl: Set hostname from router to it-worked
*Dec 10 10:43:29.329: %HA_EM-6-LOG: config_upon_ntp.tcl: ... done
it-worked#
```

EEM
Getting Started with TCL Policies

1. Define directory

```
Router(config)#event manager directory user policy flash:
```

2. Copy Tcl script to flash

```
Router#copy tftp flash:
Address or name of remote host []? 10.1.88.9
Source filename []? foobar.tcl
Destination filename [tcl]? foobar.tcl
Accessing tftp://10.1.88.9/foobar.tcl...!
1232 bytes copied in 0.620 secs (1987 bytes/sec)
```

3. Configure any required environment variables

```
event manager environment _email_server 172.27.121.177
event manager environment _email_from  noc@cisco.com
event manager environment _email_to it@cisco.com
```

4. Configure any IOS features EEM may depend on (optional)

Examples include IP SLA, ERM and Embedded Object Tracking

5. Register Tcl policy

```
Router(config)#event manager policy foobar.tcl type user
```

Event Detector	Description (ED Triggers, based on ...)	EEM Version in IOS													IOS XR					IOS XE		NX-OS	
		1.0	2.0	2.1	2.2	2.3	2.4	3.0	3.1	3.2					3.6	4.0				2.1	2.2	4.0	4.1
Syslog	RegExp match of local syslog message	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓				✓	✓		
SNMP Notif	SNMP MIB Variable Threshold	✓	✓	✓	✓	✓	✓	✓	✓	✓										✓	✓	✓	✓
Watchdog	IOS process or subsystem activity events		✓	✓	✓	✓	✓	✓	✓	✓					✓	✓				✓	✓		
Interface Counter	(Interface) Counter Threshold		✓	✓	✓	✓	✓	✓	✓	✓										✓	✓	✓	✓
Timer	Designated Time or Interval		✓	✓	✓	✓	✓	✓	✓	✓					✓	✓				✓	✓		
Counter	Change of a designated counter value		✓	✓	✓	✓	✓	✓	✓	✓					✓	✓				✓	✓		
Application specific	An IOS subsystem or policy script		✓	✓	✓	✓	✓	✓	✓	✓					✓	✓				✓	✓		
CLI	RegExp match of input via command line interface			✓	✓	✓	✓	✓	✓	✓										✓	✓	✓	✓
OIR	Hardware online insertion and removal OIR			✓	✓	✓	✓	✓	✓	✓					✓	✓				✓	✓	✓	✓
none	No trigger, used in conjunction with exec command			✓	✓	✓	✓	✓	✓	✓					✓	✓				✓	✓		
ERM	Embedded Resource Manager (ERM) events				✓	✓	✓	✓	✓	✓													
EOT	Enhanced Object Tracking variable (EOT) events				✓	✓	✓	✓	✓	✓										✓	✓	✓	✓
RF	IOS Redundancy Facility (switchover)				✓	✓	✓	✓	✓	✓										✓	✓		
GOLD	Generic Online Diagnostics (GOLD) events					✓	✓	✓	✓	✓												✓	✓
SNMP Proxy	Incoming remote SNMP Notification						✓	✓	✓	✓													
XML RPC	Incoming XML message						✓	✓	✓	✓													
Routing	State change of Routing Protocols							✓	✓	✓													
Netflow	Traffic Flow information from Netflow							✓	✓	✓													
IPSLA	IPSLA events (supersedes EOT for EEM / IPSLA)							✓	✓	✓													
CLI enhanced	Integrates CLI Ed with the XML PI							✓	✓	✓													
SNMP Object	Intercept SNMP GET/SET requests								✓	✓													
Neighbor Disco	CDP, LLPD, Link up/down events									✓													
Identity	802.1x and MAB authentication events									✓													
MAC	MAC Address Table entry changes									✓													
Hardware	Register for environmentla monitoring hardware														✓	✓							
Statistics	Threshold crossing of a statistical counter														✓	✓							
Sysmgr	Process start and stop events														✓	✓							
Fan (absent / bad)	Presence and State of a Fan																					✓	✓
Module failure	Occurence of a Module Failure Event																					✓	✓
Storm Control	Occurence of a Storm Control Event																					✓	✓
Temperature	Temperature Sensor Thresholds																					✓	✓

Viewing EEM Available System TCL Policies

- Use the show event manager policy available system command to get a list of available System Policies for a given IOS release

```
Router# show event manager policy available system

No. Type        Time Created   Name
1   System      Thu Feb 7 01:28:15 2036 ap_perf_test_base_cpu.tcl
2   System      Thu Feb 7 01:28:15 2036 cl_show_eem_tech.tcl
3   System      Thu Feb 7 01:28:15 2036 no_perf_test_init.tcl
4   System      Thu Feb 7 01:28:15 2036 sl_intf_down.tcl
5   System      Thu Feb 7 01:28:15 2036 tm_cli_cmd.tcl
6   System      Thu Feb 7 01:28:15 2036 tm_crash_reporter.tcl
7   System      Thu Feb 7 01:28:15 2036 tm_fsys_usage.tcl
```

- System Policies live under `tmpsys:/lib/tcl/eem_scripts` and can be viewed with the `more` command

EEM 2.0: Timer Event Detector
EEM 2.1: CLI Action

Export a Permanent Flexible NetFlow Cache on regular basis

```
Minute (0 59)
Hour (0 23)
Day of the month (1 31)
Month of the year (1 12)
Day of the week (0 6 with 0=Sunday)
```

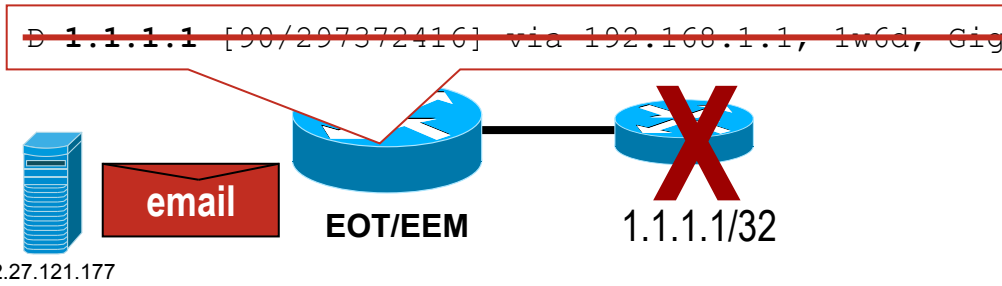
```
Router(config)# event manager applet periodicexport
Router(config-applet)# event timer cron name
          "everyhour" cron-entry "0 * * * *"
Router(config-applet)# action 1.0 cli command
          "clear flow monitor traffic-matrix-record force-export"
```

```
Router# debug flow exporter event
Router#
Nov  6 17:00:00.763: FLOW EXP: Exporting packet
            (ID: 256, Exporter: capacity-planning-collector)
```

EEM 2.0: EOT Event Detector

Problem: A Notification is required upon failure of a specific route

Solution: Track the Route using Enhanced Object Tracking (EOT) and Embedded Event Manager (EEM)




```
track 400 ip route 1.1.1.1/32 reachability
   delay down 10 up 10
!
event manager environment my_server 172.27.121.177
event manager environment my_from router-abc@customer.com
event manager environment my_to attach@cisco.com
event manager environment my_route 1.1.1.1/32
!
event manager applet email_track_iproute
event track 400 state down
action 1.0 syslog msg "Prefix to [$my_route] has been withdrawn!"
action 1.1 mail server "$my_server" to "$my_to" from "$my_from"
 subject "EEM: Prefix to Remote Site [$my_route] is DOWN" body ""
action 1.2 syslog msg "EEM: Path Failure alert email sent!"
```

Note: New Routing Event Detector in EEM 3.0

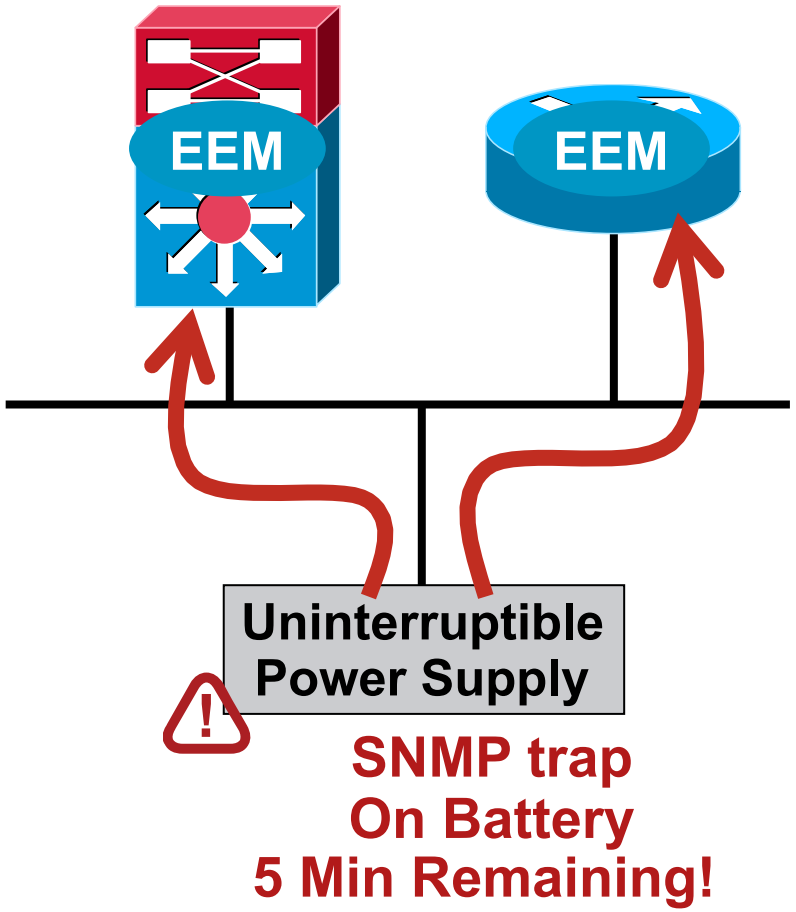
EEM 2.4: Proxy Event Detector

- Router or switch can RECEIVE an SNMP trap
- EEM event upon trap receipt
- Execute (trigger) EEM script to take local action
- Script sees varbind info
- Example:

  UPS on battery backup ===> Shut non-critical POE ports to conserve power

  Only 5 minutes remaining ===> Shutdown service modules gracefully

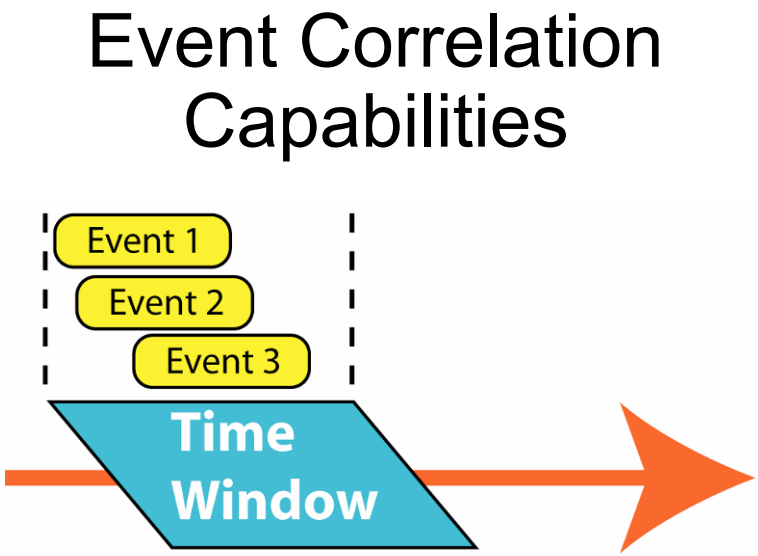
- Example: managed Services



EEM 2.4: Multiple Event Correlation

- Previous to EEM v2.4, there was a one-to-one correspondence between a single event and the triggered policy
- In other words, a policy could only be triggered by a single event and any event correlation had to be coded by the user
- ***Multiple Event Support ushers in an event correlation specification such that multiple events may be considered together to trigger a policy***
- For example:

  If (Event 1 OR Event 2) AND Event 3, then
  Trigger Policy A



EEM 2.4: Multiple Event Correlation

Problem: A Syslog message is required upon state change of either Ethernet1/0 or Ethernet1/1

Solution: Use Embedded Event Manager (EEM) Multiple Event Correlation with a correlate statement within the trigger block to define the logic between individual events and optional occurs clauses to define the number of times a specific event must be raised before being used in the correlation (inner level), or the number of times the total correlation must be true before invoking the action (outer level):

```
event manager applet example
  event tag e1 syslog pattern ".*UPDOWN.*Ethernet1/0.*"
  event tag e2 syslog pattern ".*UPDOWN.*Ethernet1/1.*"
  trigger occurs 1
    correlate event e1 or event e2
    attribute e1 occurs 1
    attribute e2 occurs 1
  action 1.0 syslog msg "Critical interface status change"
  set 2.0 _exit_status 0
```

Service Planning

EEM 3.0: Programmatic Applet Example

```
event manager applet route-watch
 event routing network 10.1.1.0/24 type add protocol ospf
 action 001 cli command "enable"
 action 002 set done 0
 action 003 while $done eq 0
 action 004  wait 5
 action 005  cli command "ping ip 10.1.1.1"
 action 005  regexp "!!!!!" "$_cli_result"
 action 006  if $_regexp_result eq 1
 action 007   cli command "config t"
 action 008   cli command "int Tunnel0"
 action 009   cli command "shut"
 action 010   cli command "end"
 action 011   set done 1
 action 012  end
 action 013 end
```

- The applet will trigger when the route 10.1.1.0/24 is learned via OSPF
- The applet will try and ping host 10.1.1.1, and when it is successful, it will take down the backup tunnel interface

Question: how many ping attempts will be made ?

Service Planning

EEM 3.1: SNMP Notification + Description

```
Router(config}# event manager applet test_trap
router(config-applet)# description test snmp notification unmanaged service
router(config-applet)# event snmp-notification oid 1.3.6.1.6.3.1.1.4.1.0
        oid-val "1.3.6.1.6.3.1.1.5.3" op eq src-ip-address 10.51.89.176
        direction incoming
router(config-applet)# action 1.0 …
router(config-applet)# action 2.0 …
```

snmpTrapOID

"snmp-notification" can intercept incoming or outgoing notifications, but outgoing only for locally generated notifications

Note: SNMPv2c notification contains the snmpTrapOID OID, which contains an unique value per notification type

Service Planning

Example: Synchronizing EEM Scripts 1/2

Problem: Synchronize EEM Policy .tcl files from a central Repository

Solution I: Use event manager update commands

1. Configure the default Repositiory:

```
router(config)# event manager directory user repository tftp://172.16.64.1
```

2. Single exec command to download, un-register and re-register:

```
router# event manager update user policy name my
%EEM: Update will use the repository path: tftp://172.16.64.1
%EEM: Attempting to copy tftp://172.16.64.1/my.tcl to flash:/eemtcl/my.tcl
Loading my.tcl from 172.16.64.1 (via FastEthernet0): !
[OK - 647 bytes]
%EEM: Copied 647 bytes from tftp://172.16.64.1/my.tcl to flash:/eemtcl/my.tcl
%EEM: Policy my.tcl has been successfully copied and re-registered
```

```
*Dec 10 20:12:43.198: %HA_EM-6-FMPD_UPDATE_POLICY_COPY: Policy update has copied 647 bytes from tftp
*Dec 10 20:12:43.230: %HA_EM-6-FMPD_UPDATE_POLICY_REGISTER: Policy update has successfully re-regist
```

2bis. Can also synch entire groups, based on regular expression match:

```
router# event manager update user policy group m.*
```

3. Verify using show command:

```
router# show event manager policy registered
No.  Class     Type    Event Type          Trap  Time Registered            Name
1    script    user    syslog              Off   Wed Dec 10 20:12:43 2008   my.tcl
     occurs 1 pattern {.*%NTP-5-PEERSYNC.*}
     nice 1 queue-priority low maxrun 90.000 scheduler rp_primary
```

Available from: IOS 12.4(20)T

Service Planning

Example: Synchronizing EEM Scripts 2/2

Solution II: Use new event manager update command

1. Single exec command to specify repository, download, un-register and re-register:

```
router# event manager update user policy name my.tcl repository tftp://10.1.1.1/
%EEM: Update will use the repository path: tftp://10.1.1.1
%EEM: Attempting to copy tftp://10.1.1.1/my.tcl to flash:/eemtcl/my.tcl
Loading my.tcl from 10.1.1.1 (via FastEthernet0): !
[OK - 647 bytes]
%EEM: Copied 647 bytes from tftp://10.1.1.1/my.tcl to flash:/eemtcl/my.tcl
%EEM: Policy my.tcl has been successfully copied and re-registered
```

```
*Dec 16 22:09:11.303: %HA_EM-6-FMPD_UPDATE_POLICY_COPY: Policy update has copied 647 bytes from tftp://1
*Dec 12 22:09:11.329: %HA_EM-6-FMPD_UPDATE_POLICY_REGISTER: Policy update has successfully re-registered
```

1bis. Can also synch entire groups, based on regular expression match:

```
router# event manager update user policy group m.*
```

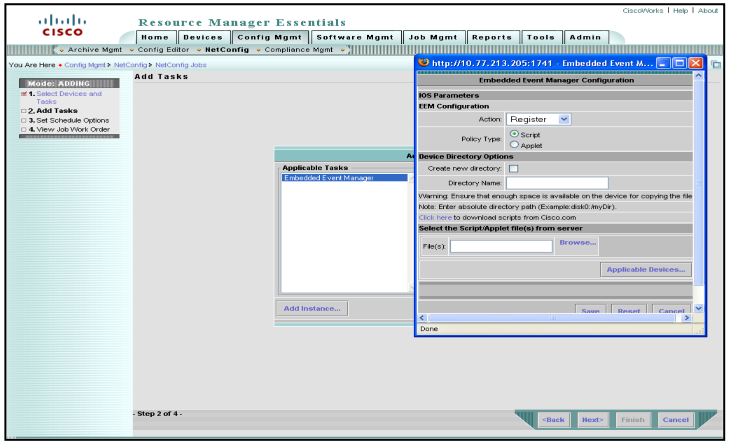
2. Verify using show command:

```
router# show event manager policy registered
No.  Class     Type    Event Type          Trap  Time Registered           Name
1    script    user    syslog              Off   Wed Dec 10 20:12:43 2008  my.tcl
     occurs 1 pattern {.*%NTP-5-PEERSYNC.*}
     nice 1 queue-priority low maxrun 90.000 scheduler rp_primary
```

Available from: IOS 15.0(1)M

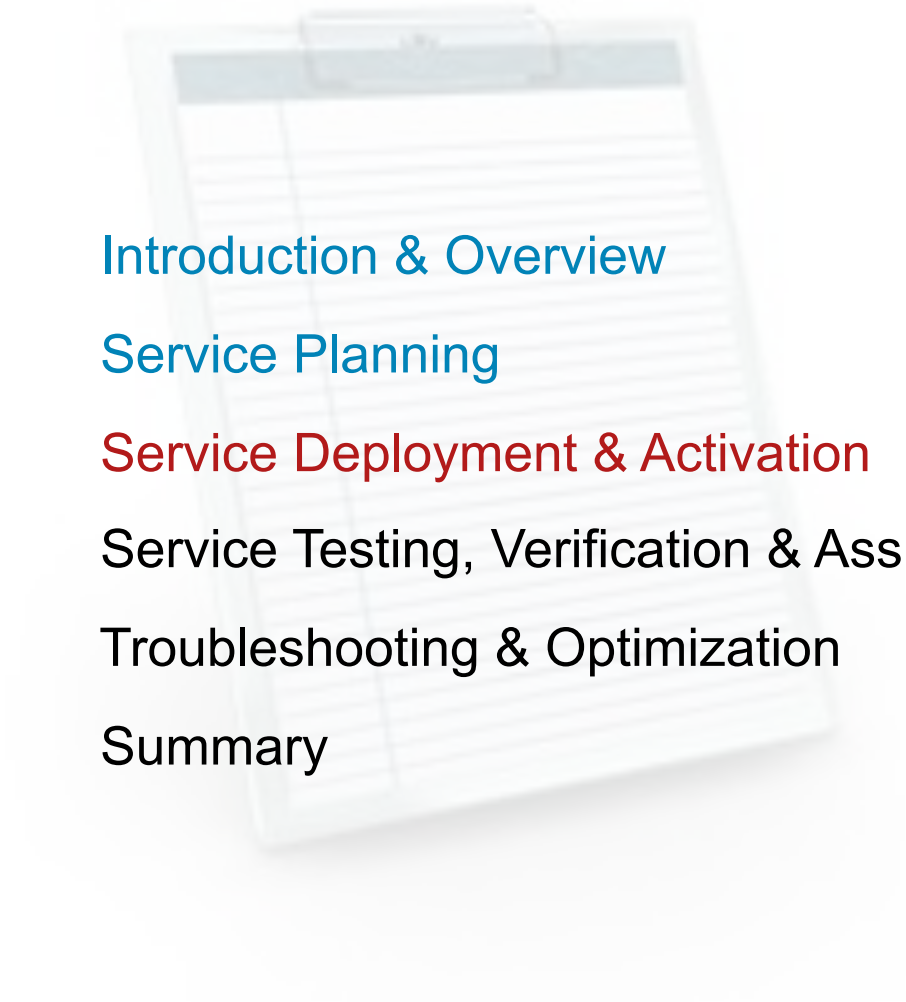
Service Planning
Using EEM step-by-step

1. Which problem do you want to solve?
2. Which event detector and action do you need?
   – Upgrade to the right IOS image
   – **show event manager detector <detector-type> detailed**
3. Check whether a suitable script/applet is available already
   – http://www.cisco.com/go/ciscobeyond
   – http://www.cisco.com/go/eem
   – http://www.cisco.com/go/easy
4. Work from an existing example



5. Deploy and Monitor
   – CiscoWorks LMS (from 3.1) via RME http://www.cisco.com/go/lms
   – Davra Networks EEMLive http://www.davranetworks.com/
6. If customization/new development/testing is required
   – “Network Programming Advisors“ http://www.progrizon.com/
   – Cisco Advanced Services
7. Don’t forget to ask to (and share with) the EEM forum

Agenda



Introduction & Overview

Service Planning

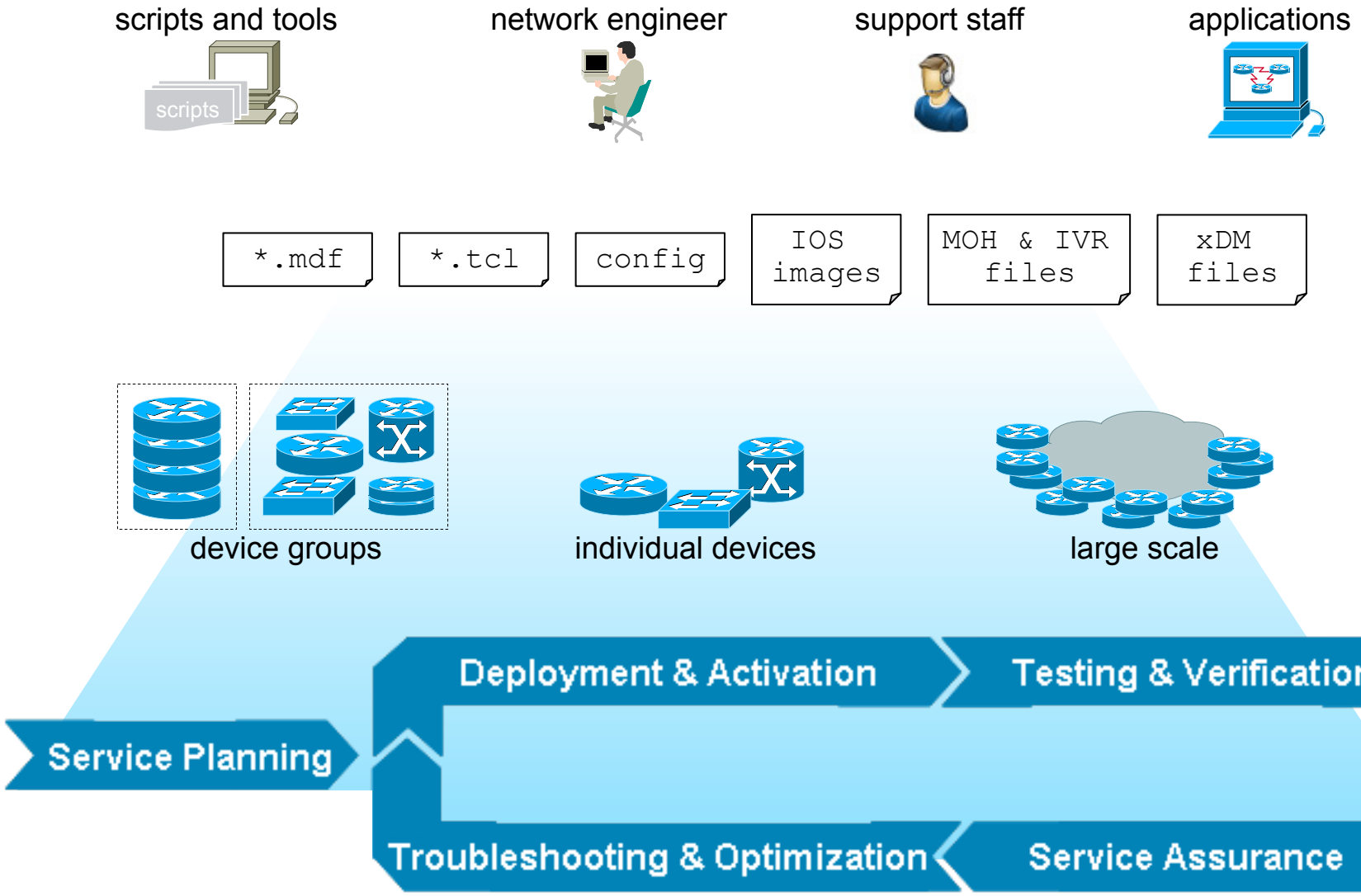
➲ Service Deployment & Activation

Service Testing, Verification & Assurance

Troubleshooting & Optimization

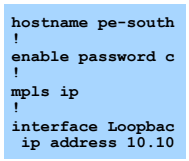
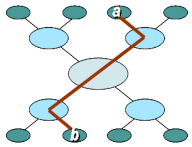
Summary

Introduction & Overview
‘Configuration‘ in a Service Life Cycle



Introduction & Overview

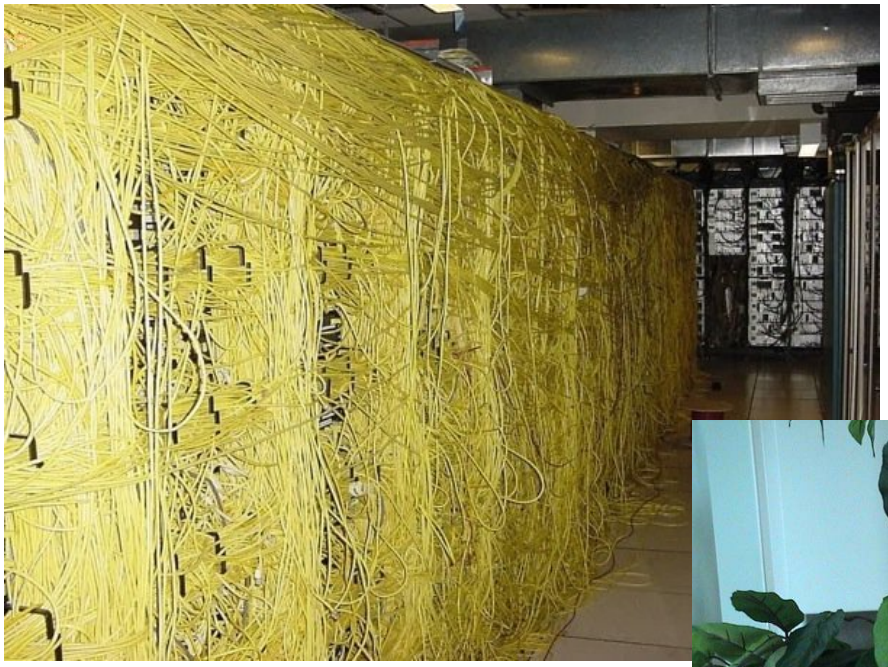
Definition of Activities

	Deployment	Move physical network equipment into it‘s operating location
	Commissioning	Make new network equipment ready for use and reachable by operations, NMS
	Configuration	Configure a network element depending on it’s role and function in the network
	Provisioning	Configure portions of a network for the purpose of a specific user and/or service
	Activation	Enable users to start using a service

Focus

Introduction & Overview

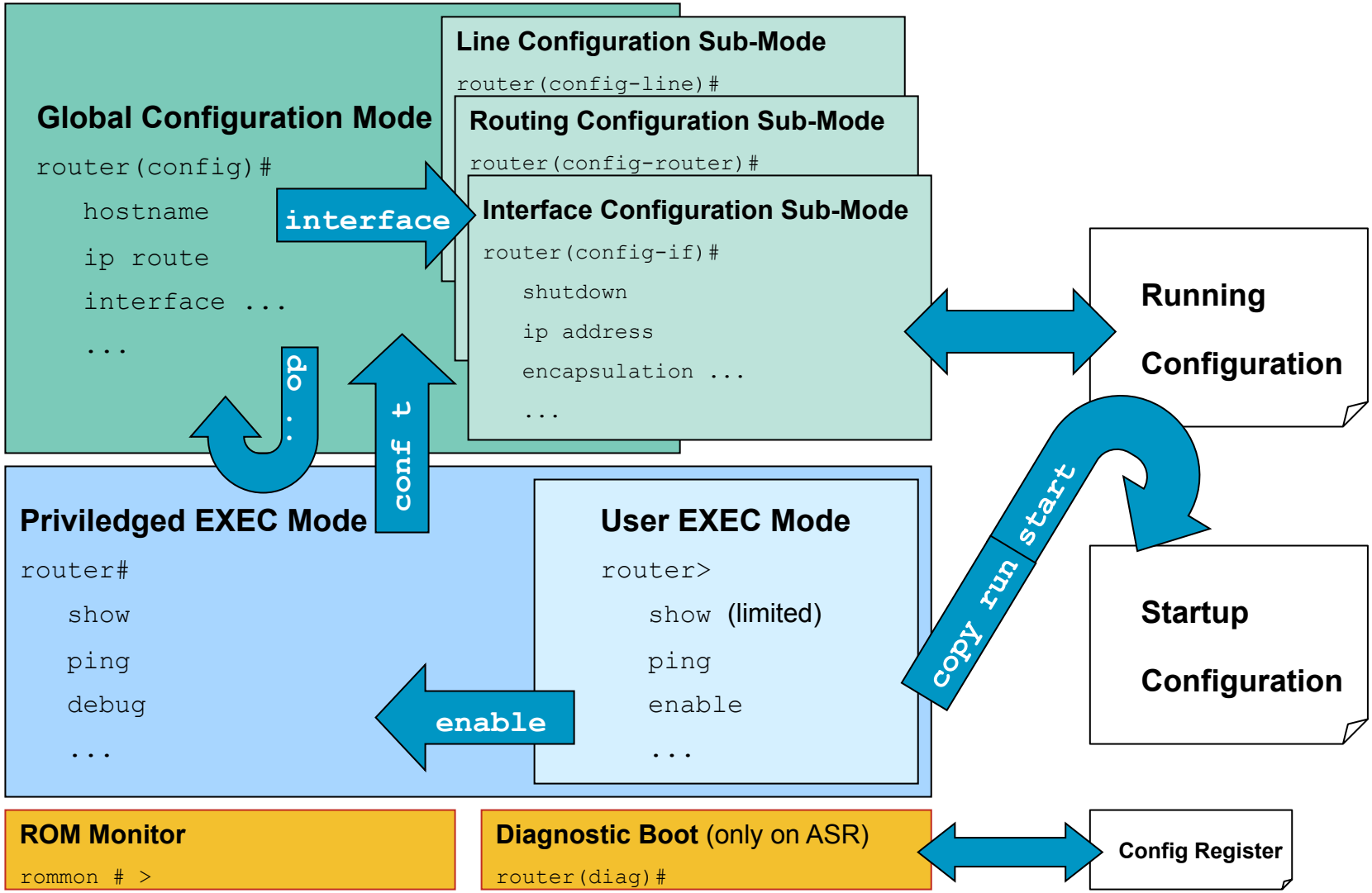
The Human Factor ...



```
!
interface Serial1/0.121 point-to-point
 description " NOC Bastelstunde "
```

Command Line Interface (CLI) – The Basics

Command Line Interface (CLI) – Modes



See: www.cisco.com/en/US/docs/ios/preface/usingios.html

Command Line Interface (CLI) – Basics 1/2

A Series of usability features are available in IOS:

- Exec Commands from within Config Mode (from 12.0(21)S, 12.2(8)T)

Issue Exec commands without leaving Config Mode

```
router# conf t
router(config)# do copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
router(config)#
```

- Command Aliases (from 10.3, 12.2(33)SRA)

Pre-defines Aliases are available on the CLI

Custom Aliases can be defined per (Sub-)Mode

```
router# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
router(config)# alias exec shib show ip interface brief
router(config)# alias exec shru show running-config
router(config)# alias exec shrb show running-config | begin
router(config)# alias configure h hostname
Router(config)# alias interface nsh no shutdown
```

```
router# show aliases
Exec mode aliases:
  h              help
  lo             logout
  p              ping
  r              resume
  s              show
  u              undebug
  un             undebug
  w              where
```

Note: ROM Monitor also provides an alias command

Command Line Interface (CLI) – Basics 2/2

- Interface Ranges and Macros (from 12.1(5)T, 12.1(1)E, IOS XE 2.1)

  Define Interface Ranges / Groups

  Apply Config to Interface Ranges / Groups

```
router(config)# interface range FastEthernet 1 - 3
router(config-if-range)# no shut
```

Define and Use immediately

Consequtive Range

```
router(config)# define interface-range mylist FastEthernet 2 , FastEthernet 4 -
router(config)# interface range macro mylist
router(config-if-range)# no shut
```

Define Once
Use multiple times

Arbitrary Group

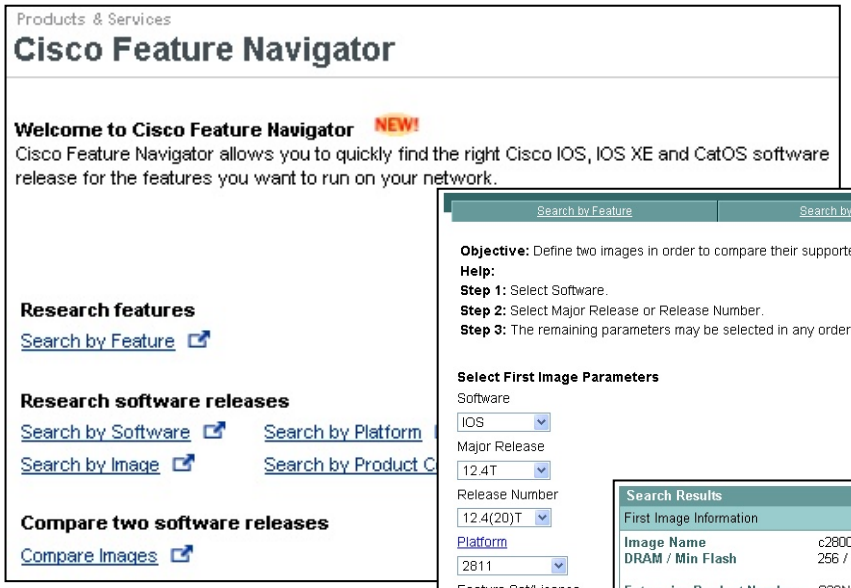
```
router(config)# interface range FastEthernet 5/1.1 - FastEthernet 5/1.4
router(config-if-range)# encapsulation dot1Q 220
router(config-if-range)# no shut
```

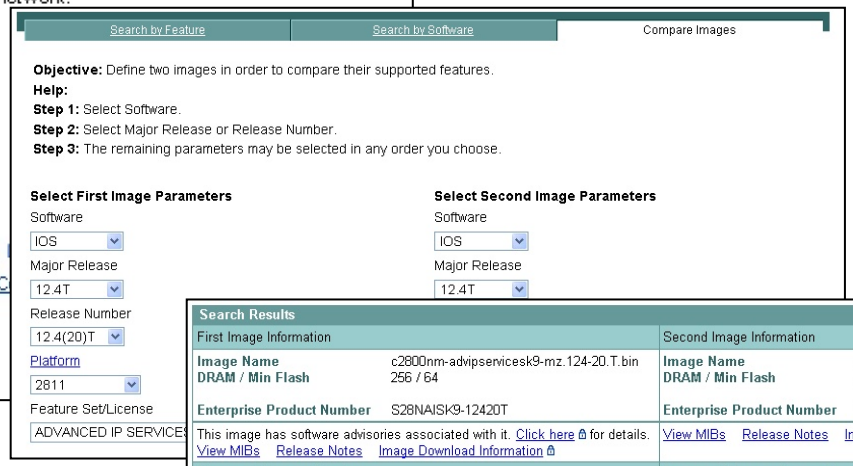
This will apply:
VLAN ID 220 → FastEthernet 5/1.1
VLAN ID 221 → FastEthernet 5/1.2
VLAN ID 222 → FastEthernet 5/1.3
VLAN ID 223 → FastEthernet 5/1.4

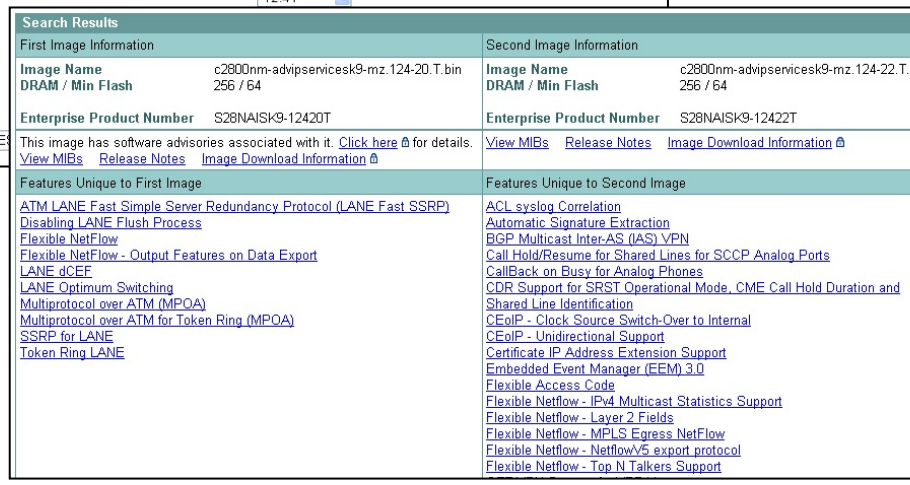
Works on Subinterfaces and VLAN Ranges too from 12.2(8)T

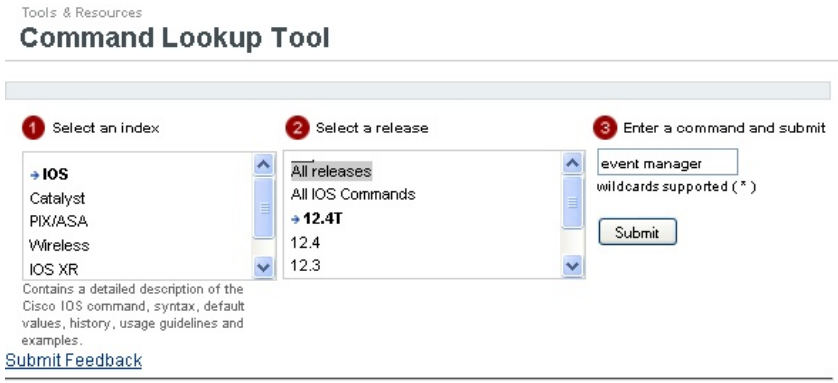
Where to start with CLI ?

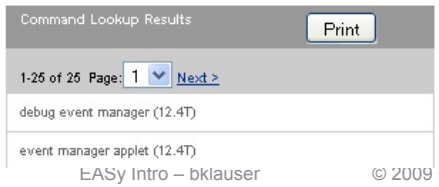
Feature Navigator:
http://www.cisco.com/go/fn











Command Lookup Tool: http://tools.cisco.com/Support/CLILookup/

Command Line Interface (CLI) – More Advanced

Command Line Interface (CLI) – More Advanced

Son: Dad, why are there always 2 Pilots ?
Dad: one has to prevent the other from doing stupid things
Son: which one is doing the stupid things ?

Deployment & Activation

IOS CLI Configuration ‚Safety' Features

- Contextual configuration diff utility (from 12.3(4)T, 12.2(25)S)
  - Easily show differences between running and startup configuration
  - Compare any two configuration files
- Config change logging and notification (from 12.3(4)T, 12.2(25)S)
  - Tracks config commands entered per user, per session
  - Notification sent indicating config change has taken place—changes can be retrieved via SNMP
- Configuration replace and rollback (from 12.3(7)T, 12.2(25)S)
  - Replace running config with any saved configuration (only the diffs are applied) to return to previous state
  - Automatically save configs locally or off box
  - Config Rollback Confirmed Change (from 12.4(23)T, 12.2(33)S)
- Configuration locking (from 12.3(14)T, 12.2(25)S)
  - Ensures exclusive configuration change access

Deployment & Activation

Example: Using Config Rollback

- **Problem**: critical config change to a remote router may result in loss of connectivity, requiring a reload
- **Solution**: replace the running configuration with the latest good archive after two minutes – unless the change made is confirmed

```
router# show archive
There are currently 4 archive configurations saved.
The next archive file will be named disk0:/config-archive-4
 Archive #  Name
   0
   1        disk0:/config-archive-1
   2        disk0:/config-archive-2
   3        disk0:/config-archive-3 <- Most Recent

router# config replace disk0:/config-archive-3 time 120
   :
   ... your Config Change work here ...
   :
router# no config replace disk0:/config-archive-3
```

Available from: IOS 12.3(7)T, 12.2(25)S

Deployment & Activation

Example: Using Config Revert

- **Problem**: critical config change to a remote router may result in loss of connectivity, requiring a reload
- **Solution**: revert the running configuration after two minutes – unless the change made is confirmed

```
router# config terminal revert time 2
Rollback Confirmed Change: Backing up current running config to flash:bk-2

Enter configuration commands, one per line.  End with CNTL/Z.
  :
  ... your Config Change work here ...
  :
router# hostname oops
oops(config)# end
oops# Rollback Confirmed Change: Rollback will begin in one minute. Enter
"configure confirm" if you wish to keep what you've configured
```

```
oops# Rollback Confirmed Change:
rolling to:flash:bk-2
Total number of passes: 1
Rollback Done
router#
```

or

```
oops# config confirm
oops#
```

Available from: IOS 12.4(23)T, 12.2(33)S

What if I need a simple script?

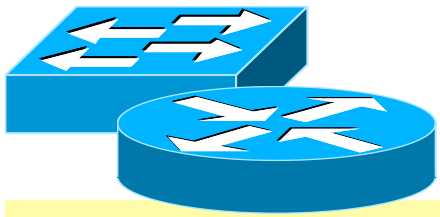
IOS Shell Scripting

IOS Shell

- **Problem:** Sometimes we need more than what Interface ranges, Macros, Auto SmartPorts and other CLI features already offer.

  But we may not want all the power and complexity of Tcl Scripting or Embedded Event Manager

- **Solution**: Use IOS Shell (IOS.sh)



```
IOS.sh # _
```

IOS Shell offers

▪ Environment Variables	`MY_VAR=value, %n`
▪ Pipe and Redirection	`|`
▪ Condition Testing	`if […]; then else fi`
▪ Loops	
▪ Built-in Functions	`show shell functions` `shell exec <function>`
▪ Custom Function Definitions	`function <name>(…){…}`

Phase I Available from: IOS 12.2(52)SE

IOS Shell - Example

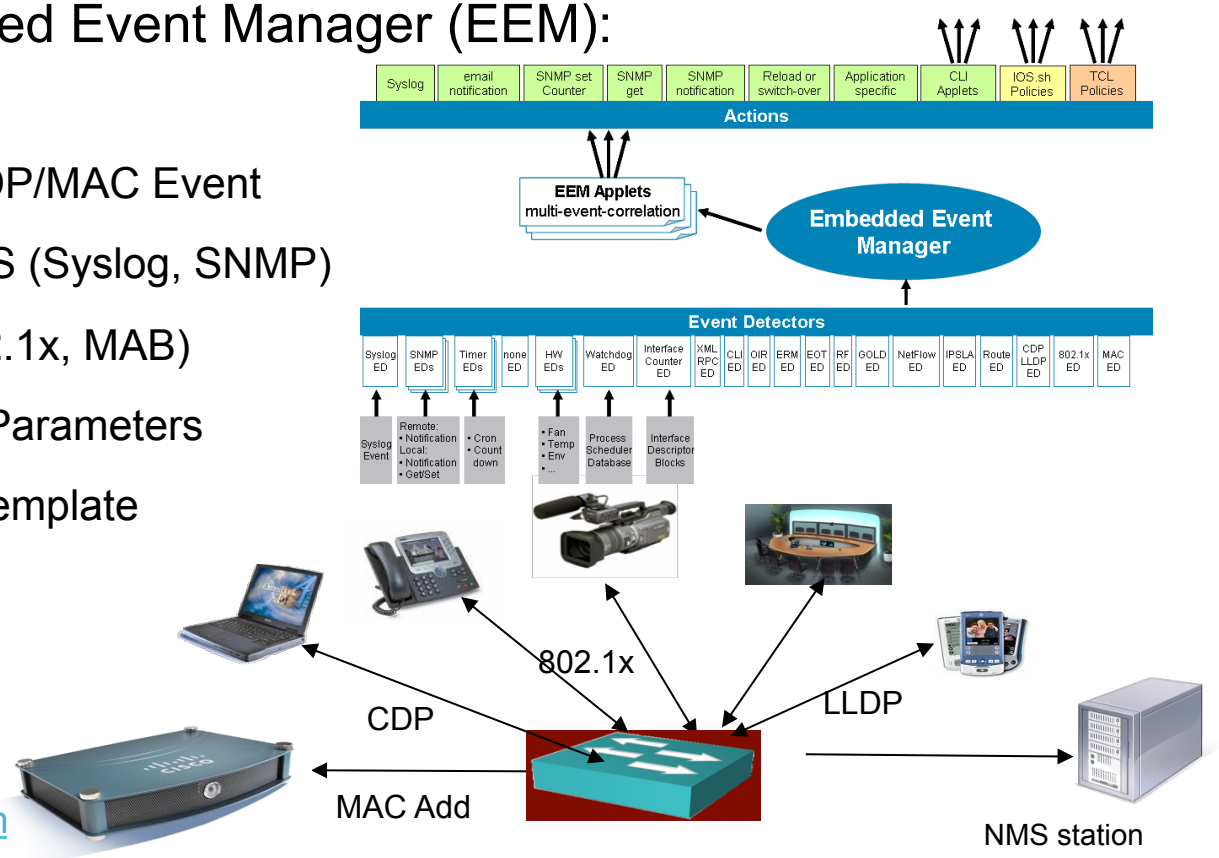
- The pre-built shell functions for Auto SmartPorts are a good starting point:

```
switch# show shell functions CISCO_AP_AUTO_SMARTPORT

function CISCO_AP_AUTO_SMARTPORT () {
    if [[ $LINKUP -eq YES ]]; then
        conf t
            interface  $INTERFACE
                macro description $TRIGGER
                switchport trunk encapsulation dot1q
                switchport trunk native vlan $NATIVE_VLAN
                switchport trunk allowed vlan ALL
                switchport mode trunk
                switchport nonegotiate
                auto qos voip trust
                mls qos trust cos
            exit
        end
    fi
    if [[ $LINKUP -eq NO ]]; then

:
```

What if SmartPorts are almost good enough?

Example: Automated Port Provisioning

- **Problem**: When a new device connects, we want to trigger a sequence of events and configurations in a customizable way and based on the type of device
- **Solution**: use Embedded Event Manager (EEM):
  - Trigger based on CDP/LLDP/MAC Event
  - Send custom Event to NMS (Syslog, SNMP)
  - Trigger Authentication (802.1x, MAB)
  - Fetch/Build Configuration Parameters
  - Apply Port Configuration Template



See: http://www.cisco.com/go/eem

Beyond Auto SmartPorts

Take Full Control With EEM

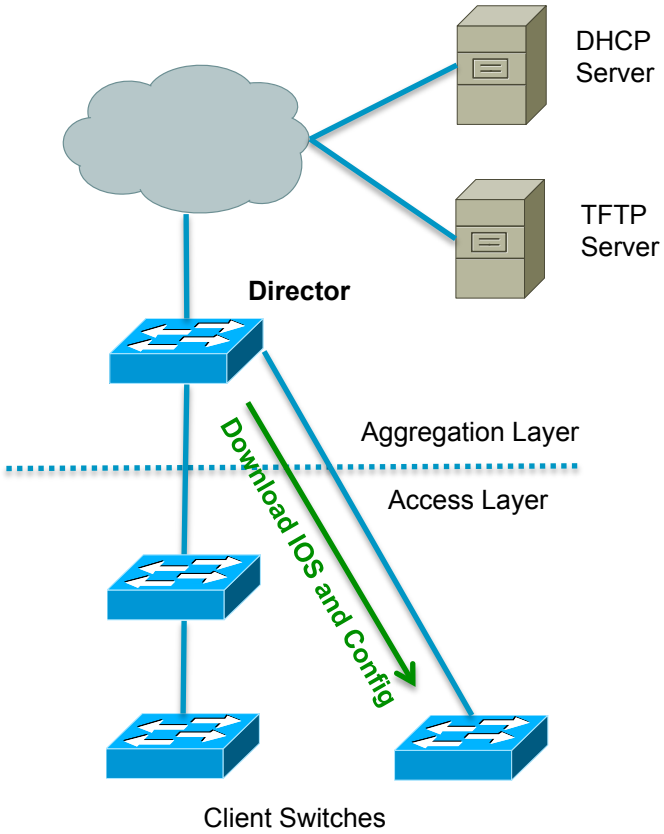
- Auto SmartPorts are powered by EEM
- When a printer is added to the network, use an EEM applet to create a new ASP event

```
event manager applet dectect-printer
 event neighbor-discovery interface regexp FastEthernet.* cdp add
 action 001 regexp ".*LasterJet.*" "$_nd_cdp_platform"
 action 002 if $_regexp_result eq 1
 action 003  cli command "enable"
 action 004  cli command "config t"
 action 005  cli command "interface $_nd_local_intf_name"
 action 006  cli command "switchport access vlan $printer_vlan"
 action 007  cli command "switchport mode access"
 action 008  cli command "switchport port-security"
 action 009  cli command "switchport port-security violation restrict"
 action 010  cli command "switchport port-security aging time 2"
 action 011  cli command "switchport port-security aging type inactivity"
 action 012  cli command "spanning-tree portfast"
 action 013  cli command "spanning-tree bpduguard enable"
 action 014  cli command "end"
 action 015  syslog msg "New printer added: $_nd_cdp_entry_name , type:
$_nd_cdp_platform"
 action 016 end
```

How about a smarter deployment procedure?

Smart Install

- Smart Install is a plug-and-play configuration and image-management feature that provides zero-touch deployment for new switches.
- In a Smart Install network, the switch selected as the director provides a single management point for images and configuration of client switches.
- When a client switch is first installed into the network, the director automatically detects the new switch, and identifies the correct Cisco IOS image and the configuration file for downloading. It can allocate an IP address and host name to a client.
- The director can also perform on-demand configuration and software image updates of a switch or a group of switches in the network.



Smart Install

Supported Devices and Images

Device Type	Minimum Software
Catalyst 3750, 3750v2, 3750E	12.2(52)SE
Catalyst 3560, 3560v2, 3560E, 3560 12 port, 3560 8 port	12.2(52)SE
Catalyst 2960, 2960 8 port	12.2(52)SE
Catalyst 2975	12.2(52)SE
Catalyst 2918	12.2(52)SE

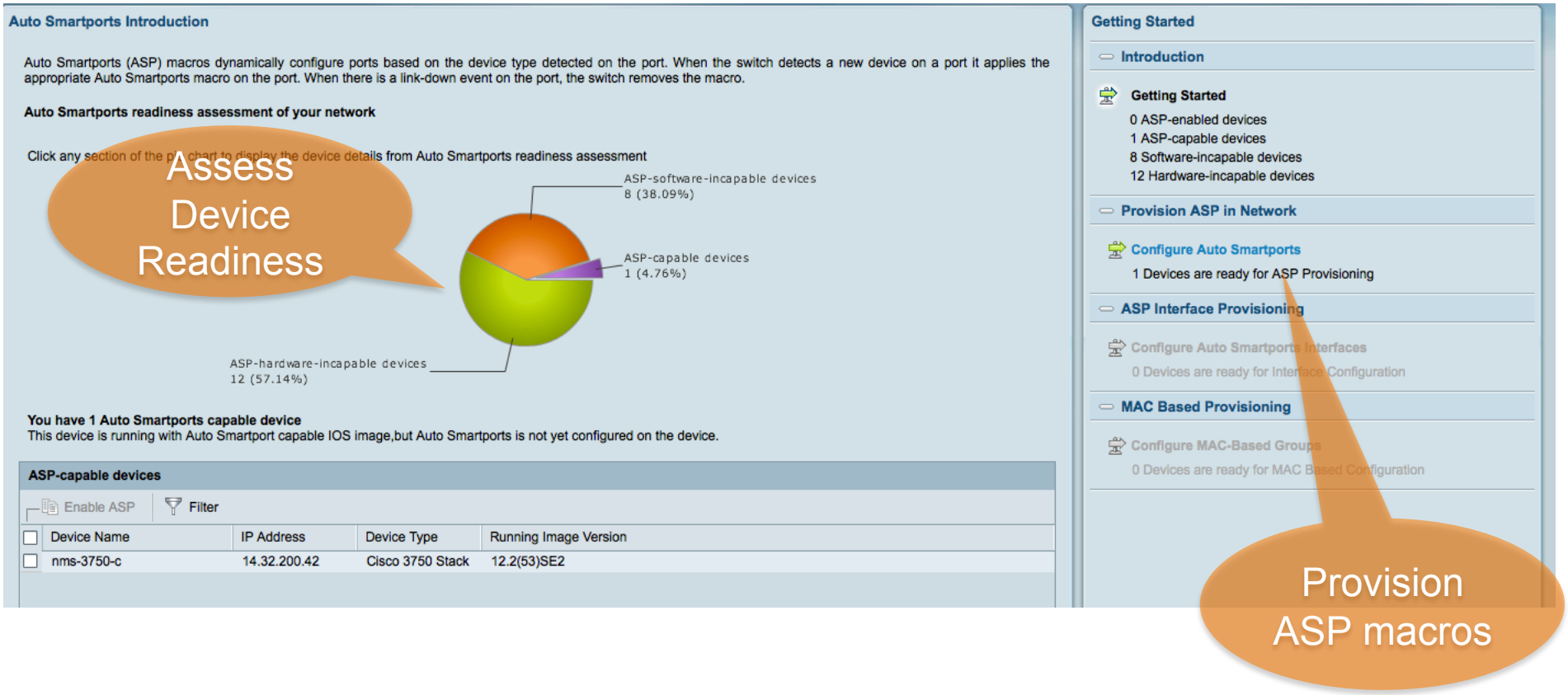
- The director in a Smart Install network must be running Cisco IOS release 12.2(52)SE or later.

- The director can be a Catalyst 3750E, 3750, 3560E, or 3560 switch. Catalyst 2960 and 2975 switches cannot be Smart Install directors currently.

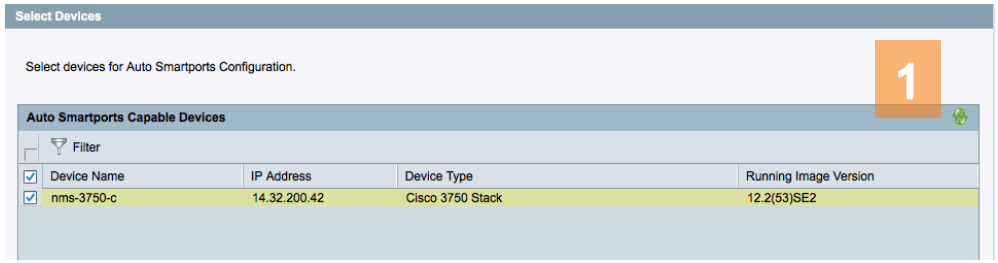
- A client switch can be an intermediate switch connected to another client switch. A client can be a standalone switch or a switch stack

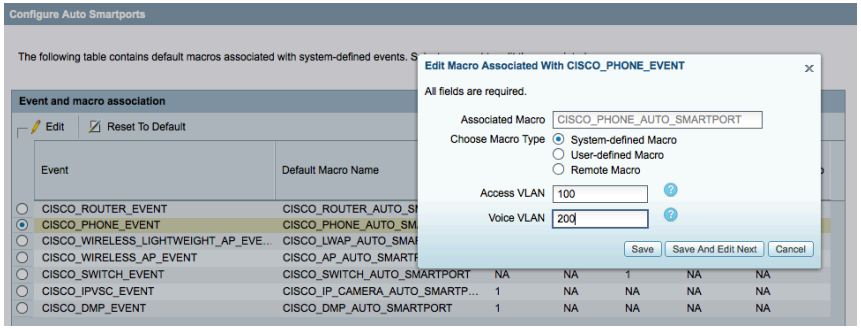
Driving the bigger Workflow?

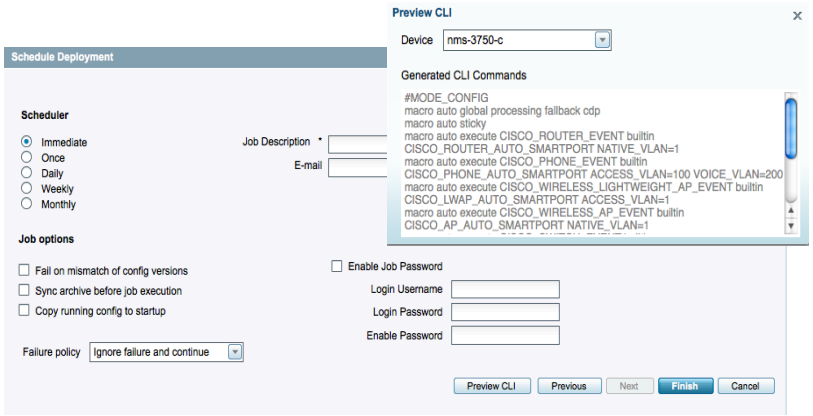
LMS 4.0 Auto Smart Ports Work Center



LMS 4.0 Auto Smart Ports Provisioning

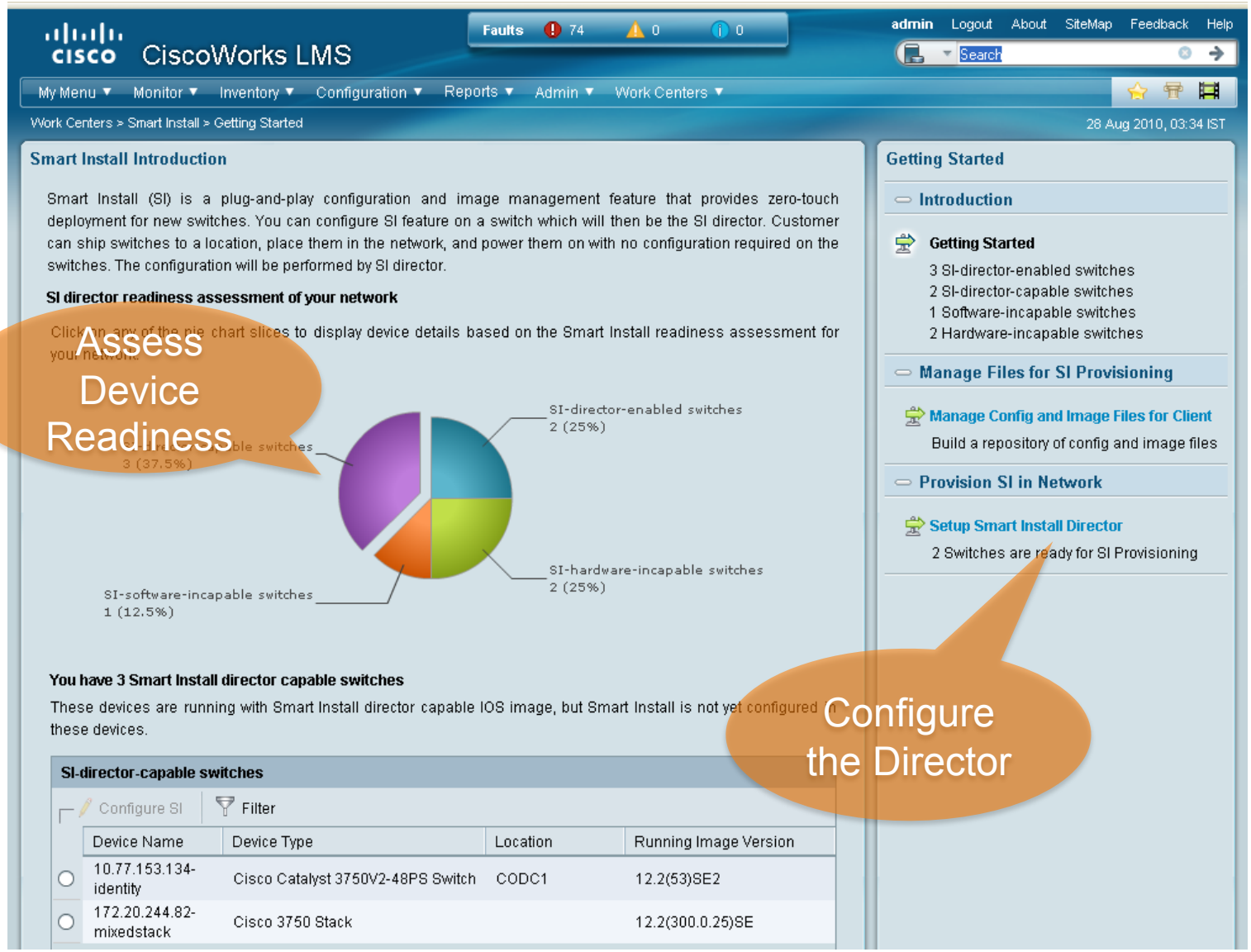




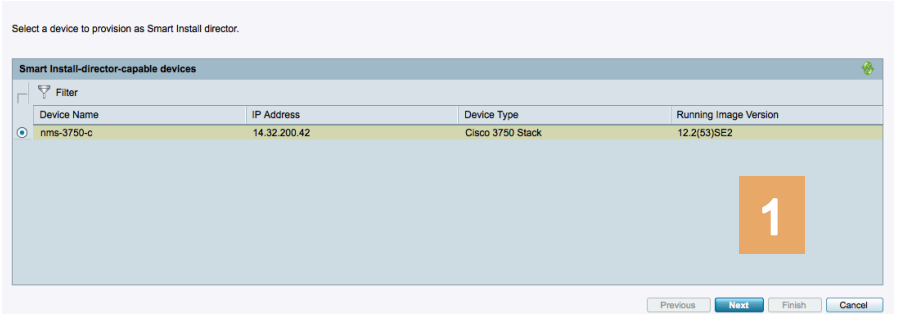


1. Select device
2. Associate macros to events and configure macros
3. Deploy

LMS 4.0 Smart Install Work Center

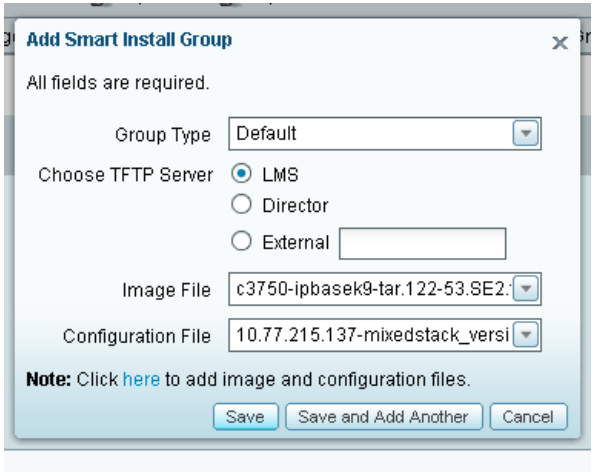


LMS 4.0 Smart Install Configuration

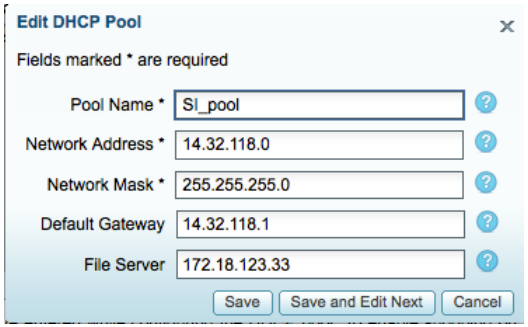


1. Select Director device
2. Specify software and config
3. Configure DHCP pool
4. Deploy

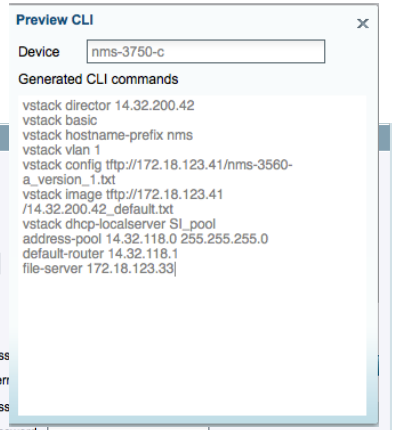
2

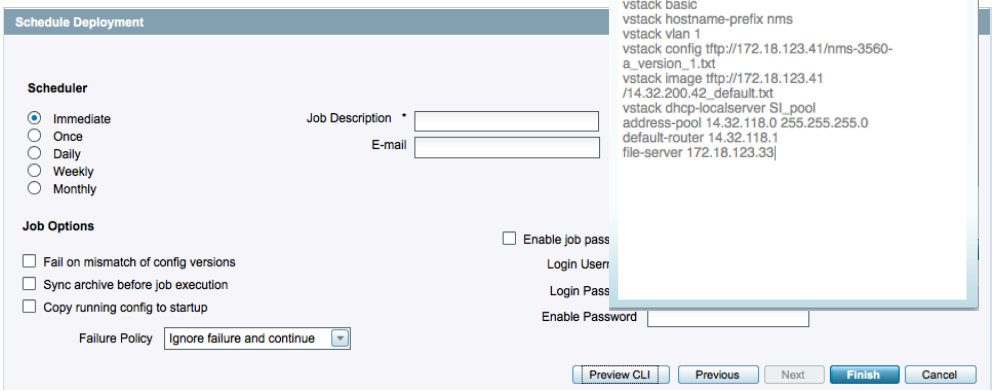


3



4





How to be triggered by a Config Change ?

Embedded Event Manager (EEM)

Using EEM to trigger upon config change

Two Options:

- Syslog Event Detector upon any potential config change
- CLI Event Detector upon specific CLI command
  - – Asynchronous:
    - Trigger Policy and then execute CLI command
    - Trigger Policy and skip CLI command
  - – Synchronous:
    - Trigger Policy and execute/skip based on exit status

_exit_status == 0	→	skip CLI command (default)
_exit_status == 1	→	execute CLI command

```
event [tag event-tag] cli pattern regular-expression
   {[default] [enter] [questionmark] [tab]}
   [sync {yes | no skip {yes | no}]
   [mode variable]
   [occurs num-occurrences] [period period-value]
   [maxrun maxruntime-number]
```

Available from: EEM 2.1, integrated with XML PI from EEM 3.0

Example: Using EEM CLI Event Detector

- **Problem**: VLAN 380 should not be accidentally removed from a trunk
- **Solution**: use EEM CLI Event Detector:

Other Examples:
- no mpls ip
- no router isis
- debug all

Option a: Don't prevent anything, just issue a syslog notification:

```
event manager applet cli-async
 event cli pattern "switchport trunk allowed vlan remove.*380.*" sync no skip no
 action 1.0 syslog msg "Removing VLAN 380"
```

Option b: Prevent the entire command and issue a syslog notification:

```
event manager applet cli-async-skip
 event cli pattern "switchport trunk allowed vlan remove.*380.*" sync no skip
yes
 action 1.0 syslog msg "Will NOT remove VLAN 380"
```

Option c: Ask for confirmation, then allow or prevent the entire command:

```
event manager applet cli-sync
 event cli pattern "switchport trunk allowed vlan remove.*380.*" sync yes
 action 1.0 puts "Confirm removing VLAN 380 [yes|no]:"
 action 2.0 gets response
 action 3.0 if $response eq yes goto 5.0
 action 4.0 puts "NOK - VLAN 380 will NOT be removed"
 action 4.1 exit 0
 action 5.0 puts "OK - VLAN 380 will be removed"
 action 5.1 exit 1
```

Caveats: command may be (much) bigger than what you match! Ranges!

Editing Files on the CLI

Editing Files

- **Problem**: Often ASCII files are being used when using Device Manageability Instrumentation in IOS:
  - Tcl scripts and EEM Tcl Policies
  - EMM Menu Definition Files
  - Config Templates and other text files

  During Development and Test it would be useful to be able to edit these files directly from IOS.

  But: IOS does not include an ASCII Editor ...

- **Solution**: Use a Tcl implementation of an Editor in IOS

  The GNU <ed> editor is a very simple, line-based editor available as Tcl implementation

  see: http://en.wikipedia.org/wiki/Ed_(Unix)
  see: http://www.gnu.org/software/ed/ed.html

Editing Files – Using `ed.tcl`

1. Copy ed.tcl and a simple test file to the flash:

```
router# show flash
:
8         27091 Nov 19 2008 10:51:26 ed.tcl
9            68 Nov 19 2008 11:00:12 testfile.txt
```

2. Define an Alias for simplicity:

```
router(config)# alias exec ed tclsh flash:/ed.tcl
```

3. Edit the file using ed:

```
router# ed flash:/testfile.txt
65
1,$p
line one of the test file
line two of the test file
another line
,p
line one of the test file
line two of the test file
another line
,n
1       line one of the test file
2       line two of the test file
3       another line
```

1,$p – print lines 1 to last

,p – print all lines

,n – numbered print all lines

```
a
and here are
yet another two lines
.
,n
1       line one of the test file
2       line two of the test file
3       another line
4       and here are
5       yet another two lines
w
99
q
router#
```

a – add lines

. – end adding

w – write file

q – quit

Available from www.cisco.com/go/ciscobeyond (http://tinyurl.com/ed-on-ios)

(See http://forums.cisco.com/eforum/servlet/EEM?page=eem&fn=script&scriptId=1461)

Archiving and keeping Files up to date

Deployment & Activation

Example: Archiving Configuration – 1/6

Problem: Device configurations must be archived periodically, collecting them from the outside should not be the only answer.

Solution 0: Manually create meaningful copies of the running config:

```
nexus-7000# copy run bootflash:/$(TIMESTAMP)-$(SWITCHNAME).conf

nexus-7000# dir bootflash:
29796 Apr 27 17:38:16 2009 2009-04-27-17.38.16-nexus-7000.conf

nexus-7000# show cli variable
VSH Variable List
-----------------
  SWITCHNAME="nexus-7000"
  TIMESTAMP="2009-04-27-17.47.48"
```

Note: from IOS 12.3T onwards, refer to $h and $t variables within archive config path option

Deployment & Activation

Example: Archiving Configuration – 2/6

Solution 1: Archive the running configuration once every day locally:

```
archive
 path disk0:/config-archive
 maximum 7
 time-period 1440
```

View the content of the archive:

```
Router#show archive
There are currently 3 archive configurations saved.
The next archive file will be named disk0:config-archive-3
 Archive #  Name
   0
   1        disk0:config-archive-1
   2        disk0:config-archive-2 <- Most Recent
   3
   4
   5
   6
   7
```

Deployment & Activation

Example: Archiving Configuration – 3/6

Solution 2: Archive the running configuration to tftp upon write:

```
archive
 path tftp://10.1.1.1
 write-memory
```

Note: Config can also be archived on-demand:

```
 Router#archive config
```

Solution 3: Use Kron to schedule periodic archiving (plus other activity)

```
archive
 path tftp://10.1.1.1
!
kron policy-list backupconfig
 cli archive config
!
kron occurrence backup-occur at 23:23 recurring
 policy-list backupconfig
```

multiple policy-lists possible

Deployment & Activation

Example: Archiving Configuration – 4/6

Solution 4: Use Embedded Event Manager (EEM) with a Syslog Event Detector and a TCL Applet to only archive configs if there was a change

Define EEM Environment Variable

```
Router(config)# event manager environment filename <myfile.txt>
Router(config)# event manager directory user policy "flash:/TCL"
Router(config)# event manager policy archive.tcl type user

Router(config)# archive
Router(config-archive)# path flash:disk0
Router(config-archive)# maximum 14
```

Register EEM TCL Script

Configure Archive Location and Size

This script is available from www.cisco.com/go/ciscobeyond
(See http://forums.cisco.com/eforum/servlet/EEM?page=eem&fn=script&scriptId=1103)

Deployment & Activation

Example: Archiving Configuration – 5/6

```
::cisco::eem::event register syslog pattern ".*%SYS-5-CONFIG.*" maxrun 90
##################################################
# EEM TCL Script to archive the config upon change
#
# Developed by Marisol Palmero
#
# The following EEM environment variable is used:
# - filename: name of the file specified in the path command within
#
# Lets check if all the variable exists, otherwise quit
##################################################
if {![info exists filename]} {
  set result "Policy cannot be run: variable filename not set"
error $result $errorInfo
}

namespace import ::cisco::eem::*
namespace import ::cisco::lib::*

if [catch {cli_open} result] {
  puts stderr $result
  exit 1
} else {
  array set cli1 $result
}
```

Sylog Event

Policy runtime
Default = 20 seconds
Increase this value if you see a "Process Forced Exit" message from the router.

Deployment & Activation

Example: Archiving Configuration – 6/6

```
if [catch {cli_exec $cli1(fd) "en"} result] {
  puts stderr $result
  exit 1
}

set showarchive [cli_exec $cli1(fd) "show archive"]
set lines [split $showarchive "\n"]

foreach line $lines {
  set result [regexp {<- Most Recent} $line ]
  if {$result != 0} {
    set result1 [regexp {^\s+\d+\s+(.+)-(\d+)\s+<-} $line -> path extension]
    set output [cli_exec $cli1(fd) "show archive config differences
        system:/running-config flash:$filename-$extension"]
    if { [regexp "!No changes were found" $output] } {
      break
    } else {
      cli_exec $cli1(fd) "archive config"
      break
    }
 } }
if {$result == 0} {
 cli_exec $cli1(fd) "archive config"
}
```

Archive if there was a change of if there was no archived version yet

Example: Synchronizing EEM Scripts 1/2

Problem: Synchronize EEM Policy .tcl files from a central Repository

Solution I: Use event manager update commands

1. Configure the default Repositiory:

```
router(config)# event manager directory user repository tftp://172.16.64.1
```

2. Single exec command to download, un-register and re-register:

```
router# event manager update user policy name my
%EEM: Update will use the repository path: tftp://172.16.64.1
%EEM: Attempting to copy tftp://172.16.64.1/my.tcl to flash:/eemtcl/my.tcl
Loading my.tcl from 172.16.64.1 (via FastEthernet0): !
[OK - 647 bytes]
%EEM: Copied 647 bytes from tftp://172.16.64.1/my.tcl to flash:/eemtcl/my.tcl
%EEM: Policy my.tcl has been successfully copied and re-registered
```

```
*Dec 10 20:12:43.198: %HA_EM-6-FMPD_UPDATE_POLICY_COPY: Policy update has copied 647 bytes from tftp
*Dec 10 20:12:43.230: %HA_EM-6-FMPD_UPDATE_POLICY_REGISTER: Policy update has successfully re-regist
```

2bis. Can also synch entire groups, based on regular expression match:

```
router# event manager update user policy group m.*
```

3. Verify using show command:

```
router# show event manager policy registered
No.  Class     Type    Event Type          Trap  Time Registered            Name
1    script    user    syslog              Off   Wed Dec 10 20:12:43 2008   my.tcl
     occurs 1 pattern {.*%NTP-5-PEERSYNC.*}
     nice 1 queue-priority low maxrun 90.000 scheduler rp_primary
```

Available from: IOS 12.4(20)T

Example: Synchronizing EEM Scripts 2/2

Solution II: Use new event manager update command

1. Single exec command to specify repository, download, un-register and re-register:

```
router# event manager update user policy name my.tcl repository tftp://10.1.1.1/
%EEM: Update will use the repository path: tftp://10.1.1.1
%EEM: Attempting to copy tftp://10.1.1.1/my.tcl to flash:/eemtcl/my.tcl
Loading my.tcl from 10.1.1.1 (via FastEthernet0): !
[OK - 647 bytes]
%EEM: Copied 647 bytes from tftp://10.1.1.1/my.tcl to flash:/eemtcl/my.tcl
%EEM: Policy my.tcl has been successfully copied and re-registered
```

```
*Dec 16 22:09:11.303: %HA_EM-6-FMPD_UPDATE_POLICY_COPY: Policy update has copied 647 bytes from tftp://1
*Dec 12 22:09:11.329: %HA_EM-6-FMPD_UPDATE_POLICY_REGISTER: Policy update has successfully re-registered
```

1bis. Can also synch entire groups, based on regular expression match:

```
router# event manager update user policy group m.*
```

2. Verify using show command:

```
router# show event manager policy registered
No.  Class     Type    Event Type          Trap  Time Registered           Name
1    script    user    syslog              Off   Wed Dec 10 20:12:43 2008  my.tcl
     occurs 1 pattern {.*%NTP-5-PEERSYNC.*}
     nice 1 queue-priority low maxrun 90.000 scheduler rp_primary
```

Available from: IOS 15.0(1)M

Example: Install Embedded Automations

Problem: Embedded Automations based on Tcl Scripting or Embedded Event Manager may include multiple scripts, policies, configurations, variables and pre-requisites. How can we install (and un-install) all of these in a consistent manner?

Solution: Create a package and use the EASy Installer

```
Router# easy-installer tftp://10.1.1.1/my-package.tar flash:/easy

------------------------------------------------------------------------
Configure and Install EASy Package 'my-package'

------------------------------------------------------------------------
1. Display Package Description
2. Configure Package Parameters
3. Deploy Package Policies
4. Verify Installed Package
5. Exit

Enter option:
```

See: http://www.cisco.com/go/easy

How to pre-commission new Cisco Devices ?

AutoInstall (DHCP Opt 150)

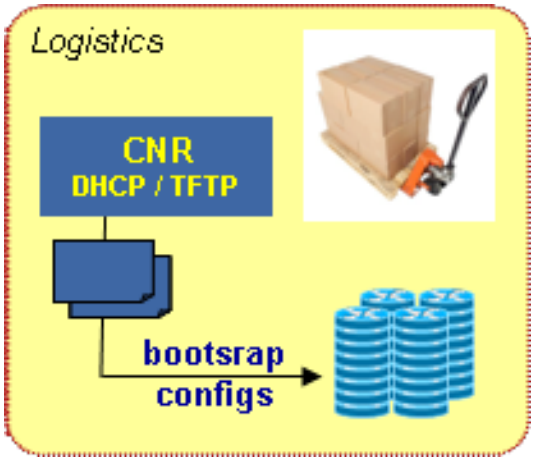
How to deal with new routers ...

?

How to deal with new routers – Auto Install

IOS AutoInstall Feature consists of:

- Ethernet Interface up
- DHCP Client + Option 150



Combined with external

- DHCP and TFTP Server

this enables a new router to

- automatically retrieve a default configuration
- without manual interaction via console cable or telnet

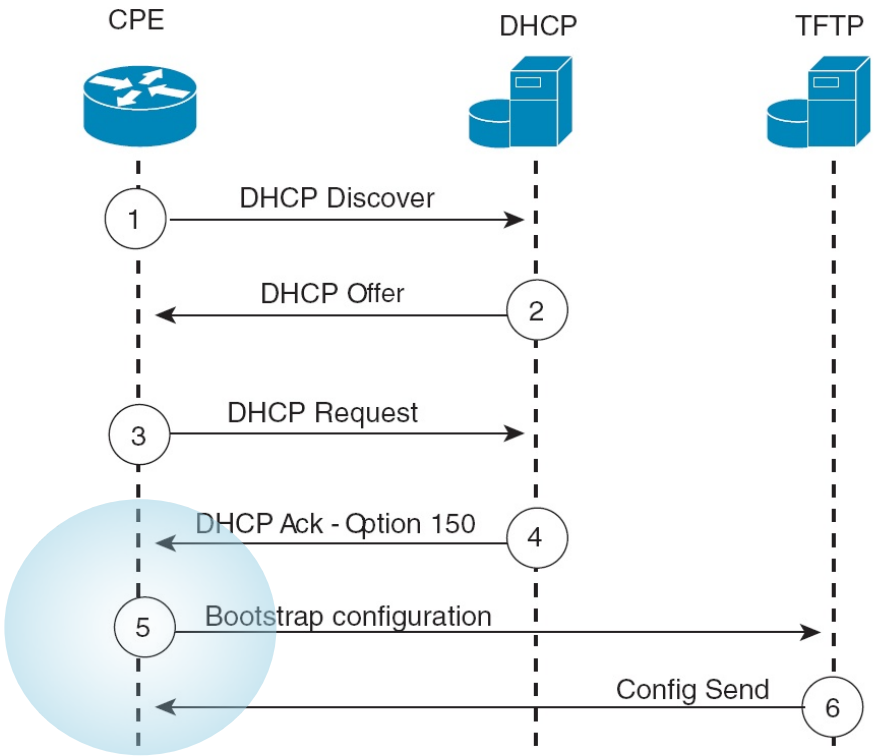
See: http://www.cisco.com/en/US/docs/ios/12_1t/12_1t5/feature/guide/dt_dhcpa.html
Available from: IOS 12.1(5)T, IOS-XE 2.1.0
Platforms: ASR 1000, x8xx ISR, x9xx ISR, 37xx, ME3400, ME4900, Cat4k, Cat6k, 76xx, 10k, UC520
See also: Smart Install

Deployment & Activation

Example: Automated Pre-Commissioning

Problem: How to automatically pre-commission a new Cisco ISR without manual intervention on the Console

Solution: Use the AutoInstall Feature combined with an external DHCP and TFTP server



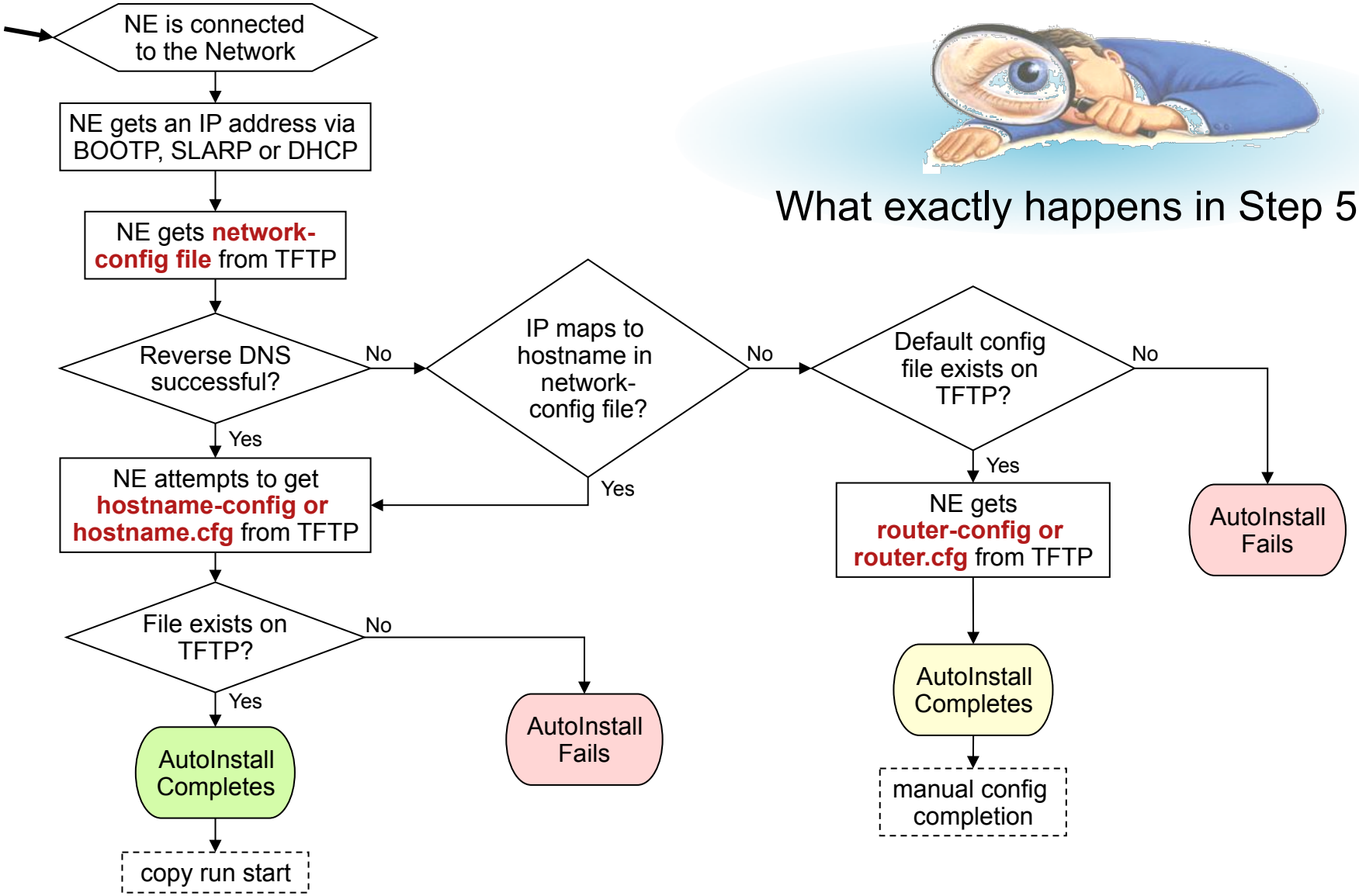
0. Power up the CPE and connect to Ethernet
1. CPE sends DHCP Discover
2. DHCP Server replies with Offer
3. CPE sends DHCP Request
4. DHCP Server replies with option 150
5. CPE requests **`hostname-confg`** file from TFTP
6. TFTP erver sends **`hostname-config`** file to CPE

➔ CPE is now pre-commissioned

Deployment & Activation

Example: Automated Pre-Commissioning

What exactly happens in Step 5



How to automate entire deployment / maintenance scenarios ?

Zero Touch Deployment

Scaling Robust Remote Deployment ...

Telnet

```
Router>
Router> enable
Router# conf t revert time 2
Router(config)#
```

?

Deployment & Activation

Sometimes we need to automate ...

Typical Challenges:

- Large Scale
  - more than just a few 12 image updates
  - more than a few 100 config or file updates
- Robustness
  - unreliable / un-managed access
  - interruptions, outages
- Security
  - authentication, privacy,
  - trust and skills of on-site staff
  - unknown hostnames / ip addresses
- Time
  - de-coupling of deployment and activation
  - many devices within small time window
- Cost
  - manual, skilled labour cost vs. automated solution

→ Automate initial and partial configuration, image upgrades or distribution of files (any file, any place)

Deployment & Activation

Zero-Touch Deployment Methods

Method	Cisco IOS Deployment Agents	External Mediation Server	Notes
DOCSIS	DOCSIS	Cisco Broadband Access Center (BAC)	For Cable Modem Access Only Widely Standardized
TR-069	TR-069	Cisco Broadband Access Center (BAC)	For DSL Access Standard Is Work in Progress with Currently Loose Definition, Check Interop Test from Plugfest
EEM	Embedded Event Manager	FTP, TFTP, SCP,…	Flexibility for Scenarios Not Covered by Any Other Method Sometimes Used in Concert with Other Methods
Kron	Kron and TCL	FTP, TFTP, SCP,…	When EEM Is Not Available
DHCP (AutoInstall)	DHCP	Cisco Network Registrar, TFTP	Agnostic of Access Technology Partially Standardized, Multiple Options Used
CNS	CNS Config Agent CNS Image Agent CNS Inventory Agent CNS Event Agent	Cisco Configuration Engine	Most Secure and Robust Agnostic of Access Technology Agnostic of IP Addressing

Zero-Touch Deployment = Embedded Agents + External Mediation

Deployment & Activation

Example: Zero-Touch Deployment – 1/3

Problem: A large number of Teleworker Routers have to be deployed. Access Technology and Service Provider vary; IP Addressing is not known in advance

Solution: Pre-Configure Routers with a generic boostrap config
This config ensures initial IP connectivity, identifies the device and communicates back to Configuration Engine for appropriate config

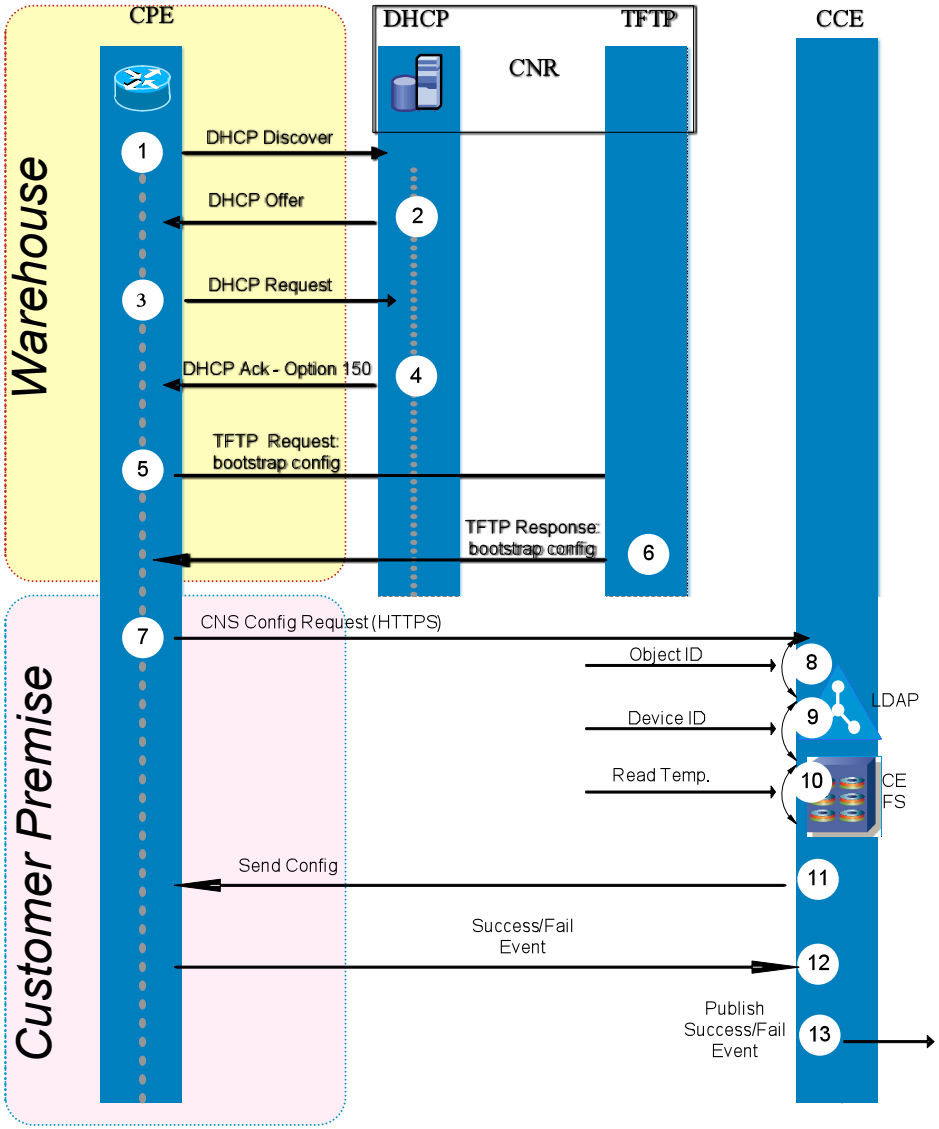
```
Router # cns id hardware-serial
Router # cns config initial MyConfigEngine 80 event no-persist
Router # cns id hardware-serial event
Router # cns event MyConfigEngine 11011
```

Note: Many other options for ID exist and are often used instead of hardware-serial:

```
AMB07300FZX(config)#cns id ?
  Async                Async interface
  BVI                  Bridge-Group Virtual Interface
  CTunnel              CTunnel interface
  Dialer               Dialer interface
  Ethernet             IEEE 802.3
  FastEthernet         FastEthernet IEEE 802.3
  Group-Async          Async Group interface
  Loopback             Loopback interface
  MFR                  Multilink Frame Relay bundle interface
  Multilink            Multilink-group interface
  Tunnel               Tunnel interface
  Vif                  PGM Multicast Host interface
  Virtual-PPP          Virtual PPP interface
  Virtual-Template     Virtual Template interface
  Virtual-TokenRing    Virtual TokenRing
  hardware-serial      Use hardware serial number as unique ID
  hostname             Use hostname as unique ID
  string               Use an arbitrary string as the unique ID
```

Deployment & Activation

Example: Zero-Touch Deployment – 2/3



1. CPE sends DHCP Discover
2. DHCP Server replies with Offer
3. CPE sends DHCP Request
4. DHCP Server replies with option 150
5. CPE requests **`bootstrap-confg`** file via TFTP
6. TFTP server sends CPE **`bootstrap-config`** file

⇒ CPE is shipped to Customer Site

⇒ Customer Order linked to CPE ID

7. CPE sends HTTP request to CNS-CE
8. CNS-CE verifies object ID
9. CNS-CE verifies Device ID
10. CNS-CE reads template from File System
11. CNS-CE sends Config (= template + parameters from LDAP)
12. Successful event
13. Publish success event

Solution Tested

Custom Interactive Menus on the CLI

Menu Command and Embedded Menu Manager (EMM)

Interactive Menus on the CLI

Problem: How to make some CLI commands available in a guided way (for example to 1st Line Support, Local IT, Field Force, etc)

Solution I: Configure a Menu using the old <menu> commands

Solution II: Define a custom Menu in Embedded Menu Manager (EMM)

IOS `menu` Command

- ☺ easy to learn, simple to use
- ☹ limited functionality and flexibility
- ☹ menu only, cli only
- ☹ selections only
- ☹ part of the IOS config
- ☺ widely available

Embedded Menu Manager (EMM)

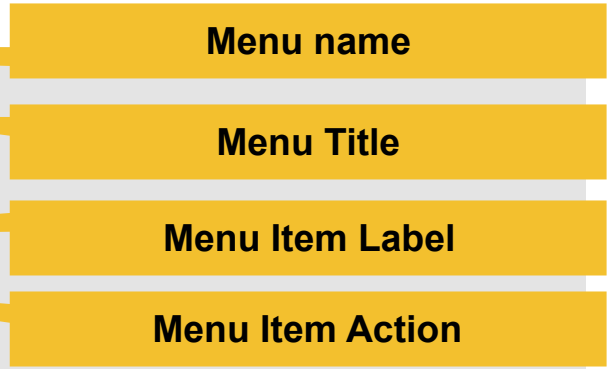
- ☺ easy to learn, simple to use
- ☺ very flexible
- ☺ menus and wizards, cli and tcl
- ☺ selections, inputs, actions, help texts
- ☺ separate MDF file(s)
- ☹ recent development – 12.4(20)T

Menu Config Command – 1/2

Simple Menu Defined in the Config

- Custom ASCII Menus
- Part of IOS Config
- Simple CLI Actions

```
menu OldMenu title ^C
A simple example of the OLD menu command^C
menu OldMenu prompt ^C
Please select a menu item:^C
menu OldMenu text 1 Run a ping test
menu OldMenu command 1 ping 10.1.1.1
menu OldMenu options 1 pause
menu OldMenu text 9 Exit
menu OldMenu command 9 exit
menu OldMenu status-line
```



- Caveats:
  - Remember to provide an <exit> option
  - Simple menus and actions only
  - No user input other than menu items
  - Part of the running- and startup-config

Available from: IOS 10.0, 12.2(33)S

Menu Config Command – 2/2

```
router# menu OldMenu
Server "router"    Line 0    Terminal-type (unknown)

A simple example of the OLD menu command

    1           Run a ping test

    9           Exit


Please select a menu item: 1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
--More—
Server "router"    Line 0    Terminal-type (unknown)

A simple example of the OLD menu command

    1           Run a ping test

    9           Exit


Please select a menu item:
```

Embedded Menu Manager (EMM)

Programmable Menu Framework

- Custom ASCII Menus
- XML based Menu Definition Files (MDF)
- Range / Type Checking
- TCL Scripting Actions
- Nested and Sequential Menus (Wizards)

```
==============================================================================
                    Branch Router Operations Menu on branch-99
                                                Enter ? for help or ?# for item help
------------------------------------------------------------------------------
    1. Install Diagnostic Scripts
    2. Change Hostname
    3. Run CPU Diagnostic Script
    4. Run Memory Diagnostic Script
    5. Run WAN Diagnostic Script
    6. Instant World Peace
    7. Exit
Enter selection [6]:
```

Available from: IOS 12.4(20)T

EMM Menu Definition File Example – 1/2

```
<?xml version="1.0"?>
<Menu MenuName="NMS" schemaVersion="1.1">
  <MenuTitle>
    <EmbTCLValue>
      <TCLCommand>
              return " Branch Router Operations Menu on [hostname]"
          </TCLCommand>
    </EmbTCLValue>
  </MenuTitle>
  <HelpString>
      <Constant String="View and modify some common Network Management
configuration parameters"/>
  </HelpString>
  <GlobalTCL>
    <TCLCommand>
          proc get_config { regex } {
              set config [exec "show run | inc $regex"]
              return $config
          }
      </TCLCommand>
  </GlobalTCL>
:
:
```

Menu name and required schema version

Title can be constant or generated with Tcl

The menu and each item can have its own help text

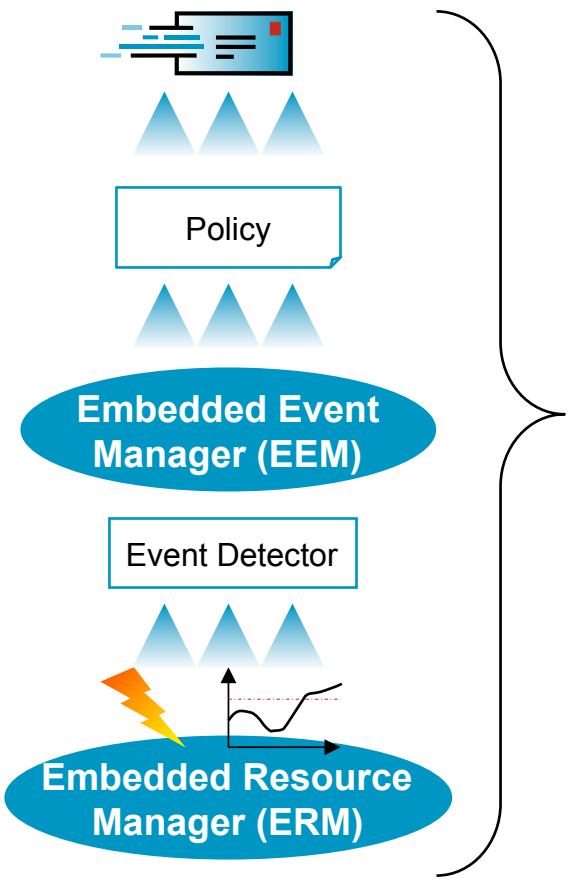
Optional global Tcl section to store procs used throughout menu

EMM Menu Definition File Example – 2/2

From simple menu choices to complete customized wizards

```
⋮
<Item ContinuePrompt="true" ItemJustification="LEFT">
        <ItemTitle>
             <Constant String="Change Hostname" />
        </ItemTitle>
        <HelpString>
             <Constant String="This selection lets you type a new hostname" />
        </HelpString>
        <Wizard>
            <QueryPrompt>
                <Constant String="What hostname do you suggest?" />
            </QueryPrompt>
            <FreeForm />
        </Wizard>
        <IOSConfigCommand>
           "hostname $r(1)"
        </IOSConfigCommand>
⋮
```

Example: Combining ERM, EEM and EMM



Embedded Menu Manager (EMM)

```
============================================================
                        ERM Diagnostics
                        Enter ? for help or ?# for item help
------------------------------------------------------------
1. Install Diagnostic Scripts
2. Set Global Variables (email parameters)
3. Deploy CPU Diagnostic Script
4. Deploy Memory Diagnostic Script
5. Deploy Buffer Diagnostic Script
6. Display Diagnostic Policy Configuration
7. Remove Diagnostic Policies
8. Exit

Enter selection [8]:
```

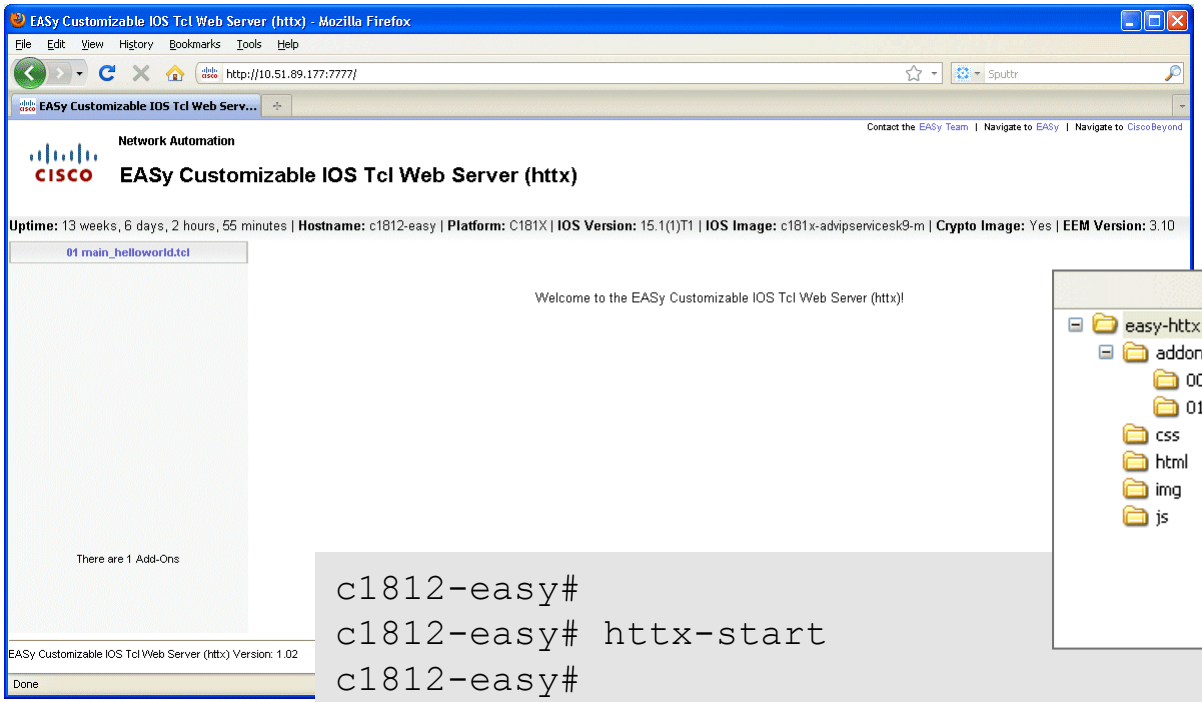
This MDF file and Tcl scripts are available from www.cisco.com/go/ciscobeyond
(See http://forums.cisco.com/eforum/servlet/EEM?page=eem&fn=script&scriptId=1363)

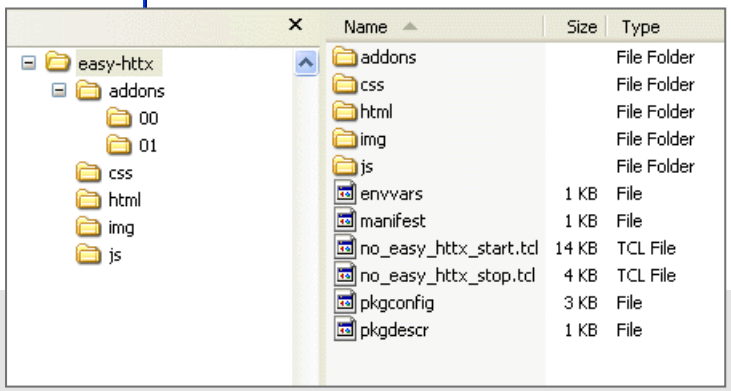
Custom Interactions via HTTP

Extensible HTTP Server in IOS

Problem: Sometimes we may event want to (or need to) provide a web-based custom interaction with IOS

Solution: Customize the EASy HTTx Package – which provides an extensible HTTP Server running on IOS






```
c1812-easy#
c1812-easy# httx-start
c1812-easy#
*Jan  6 11:02:44.649: %HA_EM-6-LOG: no_easy_httx_start.tcl: Accepting connection from 10.55.146.51:3235
*Jan  6 11:02:44.669: %HA_EM-6-LOG: no_easy_httx_start.tcl: "GET flash:/easy/easy-httx_public/html/index
*Jan  6 11:02:44.825: %HA_EM-6-LOG: no_easy_httx_start.tcl: Accepting connection from 10.55.146.51:3236
```

EASy HTTx Package – Extensible HTTP

Embedded Automation Systems (EASy)

HTTx EASy Package Provides:

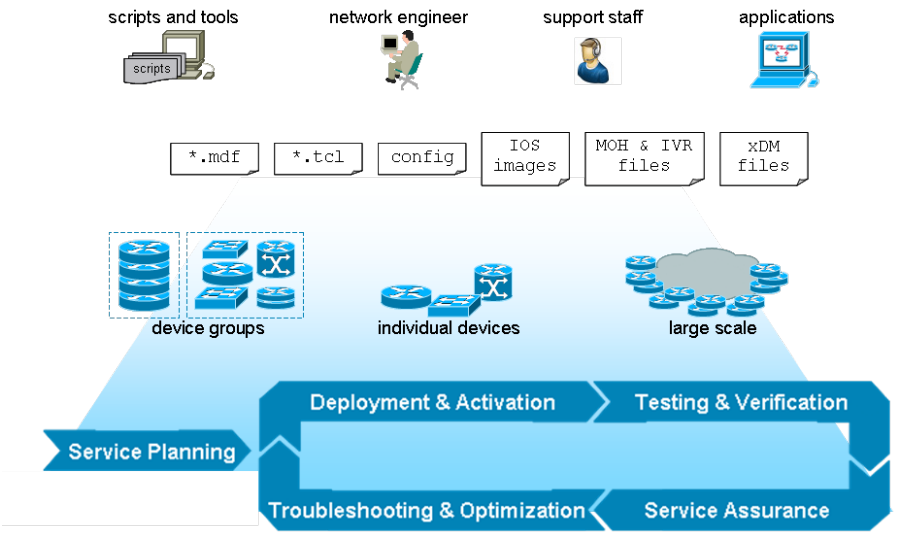
- **Interactive Installation**
- **Light-weight HTTP Server in Tcl**
- **Ability to trigger Tcl scripts on IOS**
- **Extensible Framework**

To use the Package:

1. Browse and Download HTTx EASy Package
   www.cisco.com/go/easy
2. Make Sure to also download EASy Installer
3. Watch VOD and/or read documentation
   www.cisco.com/go/easy
4. Customize and tailor to your needs
5. Install and Use

Wrap-Up & Close

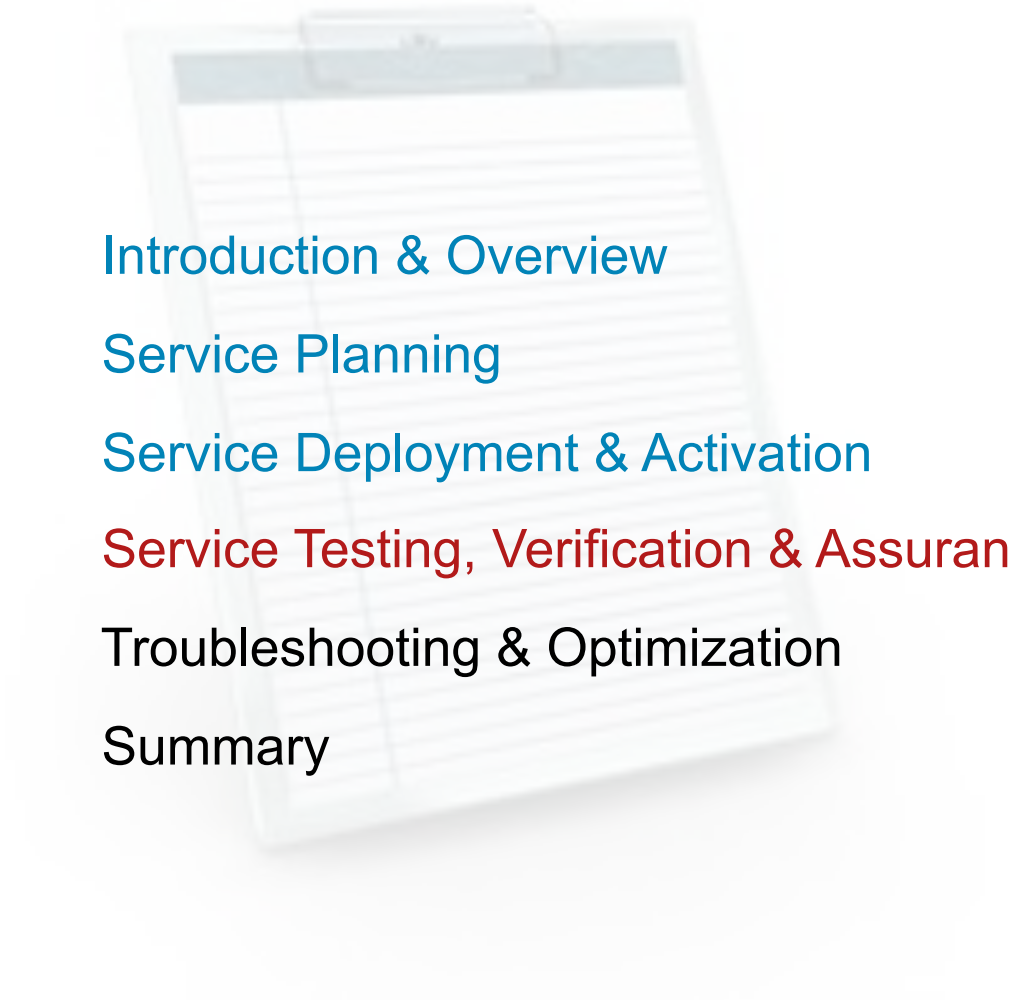
In Summary



- All ‘Configuration’ tasks are NOT equal
- There are a Range of Users / Applications with different configuration Skills and Needs
- It‘s not only about telnet and running-config
- Cisco IOS offers a plethora of configuration features to address the specific needs

→ Always choose the best fit

Agenda



Introduction & Overview

Service Planning

Service Deployment & Activation

➲ Service Testing, Verification & Assurance

Troubleshooting & Optimization

Summary

Testing, Verification & Assurance

Two Types of Questions

- **Is it working ?** **Testing and Verification**
  - Verify planning and design assumptions were valid
  - Ensure Deployment & Activation Phase was successful
  - Proactively eliminate well-known potential problems
  - Periodically verify design assumptions

- **Are we meeting SLA ?** **Service Assurance**
  - Ensure business objectives and service level agreements are met on an ongoing basis
  - Proactively mitigate well-known potential incidents

Testing, Verification & Assurance

Two Types of Connectivity

- **Connectivity, Yes/No** — **Testing and Verification**

  If the user can reach the IP endpoint the service is available

  Can be calculated using basic availability equation

$$Availability = 1 - \frac{[\text{Probes with No Response}]}{[\text{Total Probes Sent}]}$$

- **Bounded Criteria Connectivity** — **Service Assurance**

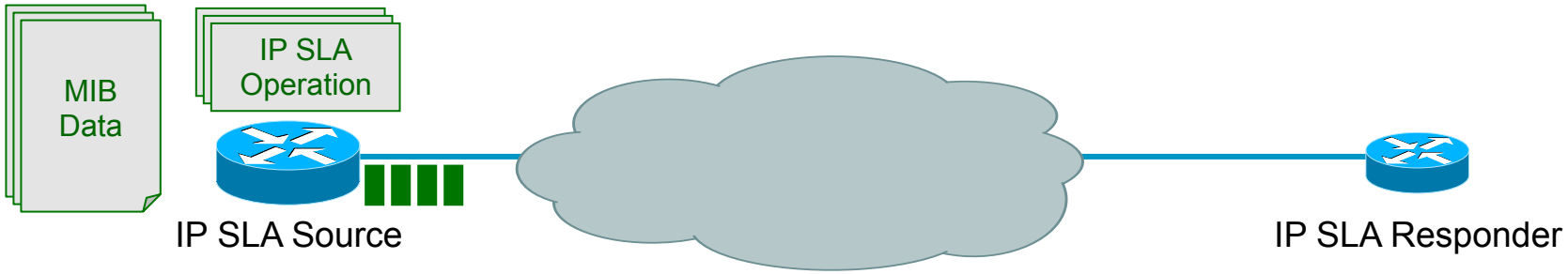
  The user can reach the IP endpoint within some bounded criteria agreed upon between the service provider and customer

  Connectivity is a prerequisite for bounded crieria connectivity

IP Service Level Agreements (IP SLA)

- Active probing by injecting synthetic test traffic
- Experience and Adoption across markets and technology domains
- Vast range of Cisco and 3rd Party NMS tool support

Metrics	Latency		Jitter		Packet Loss				Connectivity		
Domains	IP		Ethernet		MPLS		VoIP		Services		Medianet
Operations	ICMP Echo	ICMP Jitter	UDP PathEcho	TCP Connect	802.1ag Jitter	LSP Trace	PWE3 VCCV	H.323 GD	SIP GD	HTTP	DNS
	ICMP PathEcho	UDP Echo	UDP Jitter	802.1ag Echo	LSP Ping	LSP Tree	H.323 CS	SIP CS		DHCP	FTP



See: www.cisco.com/go/ipsla

Testing, Verification & Assurance

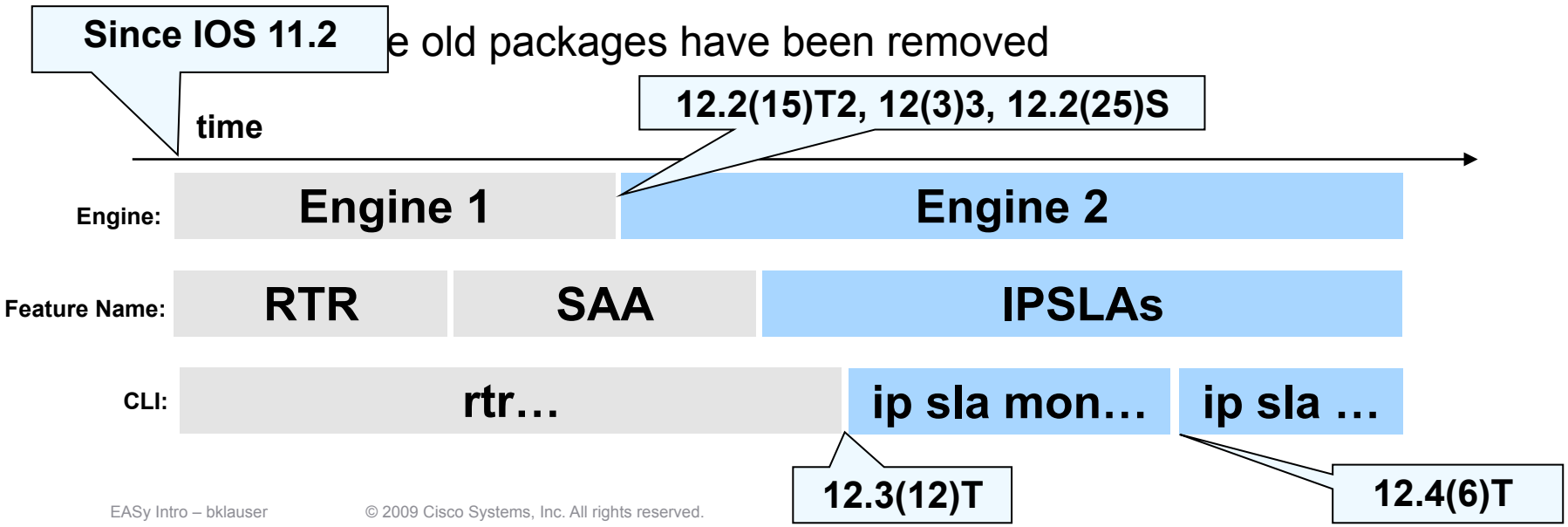
IPSLA – Introduction 2/2

- Cisco IOS feature available on most platforms
- Measure Delay, Jitter, Loss Probability

Accessible via CLI and SNMP (CISCO-RTTMON-MIB)

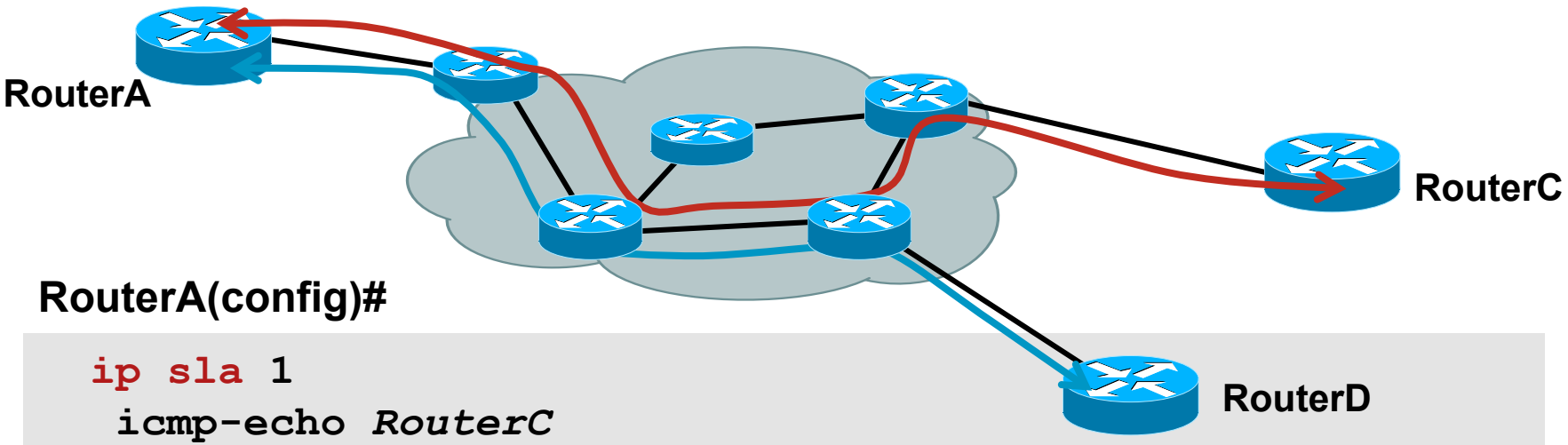
- IPSLAs responder and ICMP echo probe were available within IP Base in 12.4(6)T and above
- IPSLAs functionality is available in IPVoice and above packages
- In 12.3T a customer can still obtain the old package types and use IPSLAs

Since IOS 11.2 e old packages have been removed



Testing, Verification & Assurance

IPSLA – ICMP and UDP Jitter Examples



RouterA(config)#

```
ip sla 1
 icmp-echo RouterC
 timeout 500
 frequency 10
ip sla schedule 1 start-time now
```

```
ip sla 10
 udp-jitter RouterD 16384 num-packets 1000 interval 20
 request-data-size 172
 tos 20
 frequency 60
ip sla schedule 10 start-time now
```

Testing, Verification & Assurance

IPSLA – ICMP Echo Operation

```
Router#show ip sla sta mon 1
Round trip time (RTT)   Index 1
         Latest RTT: 1 ms
Latest operation start time: *05:26:00.226 UTC Fri Jan 4 2008
Latest operation return code: OK
Number of successes: 1
 Number of failures: 0
Operation time to live: 188 sec

Router#sh ip sla sta 1 detail
Round trip time (RTT)   Index 1
         Latest RTT: 1 ms
Latest operation start time: *05:26:30.224 UTC Fri Jan 4 2008
Latest operation return code: OK
Over thresholds occurred: FALSE
Number of successes: 2
Number of failures: 0
Operation time to live: 155 sec
Operational state of entry: Active
Last time this entry was reset: Never
```

Testing, Verification & Assurance

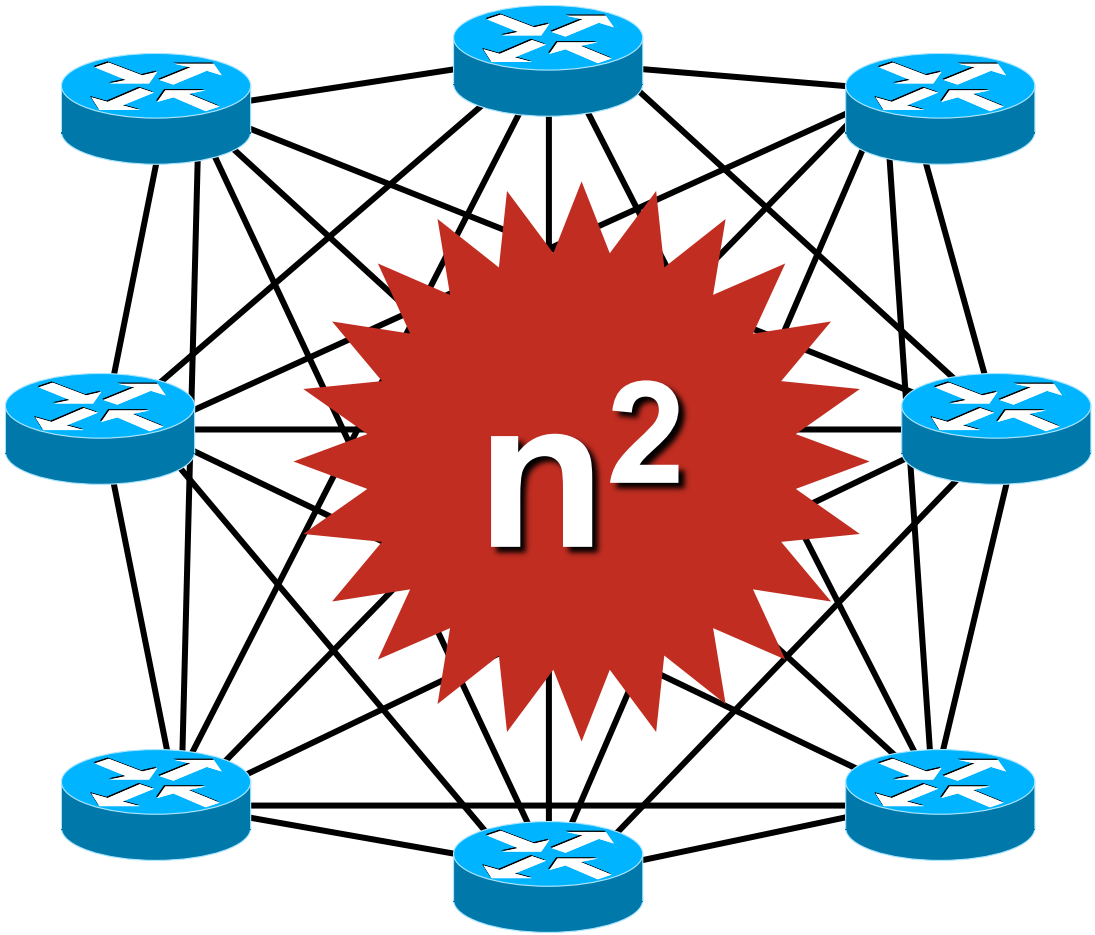
IPSLA – UDP Jitter Operation

```
Router#sh ip sla statistics 10
Round trip time (RTT)   Index 10
         Latest RTT: 1 ms
Latest operation start time: *05:43:28.720 UTC Fri Jan 4  2008
Latest operation return code: OK RTT Values
         Number Of RTT: 10
         RTT Min/Avg/Max: 1/1/1 ms
Latency one-way time milliseconds
         Number of one-way Samples: 0
         Source to Destination one way Min/Avg/Max: 0/0/0 ms
         Desination to source one way Min/Avg/Max: 0/0/0 ms
Jitter time milliseconds
         Number of Jitter Samples: 9
         Source to Destination Jitter Min/Avg/Max: 20/20/23 ms
         Destination to Source Jitter Min/Avg/Max: 22/21/24 ms
Packet Loss Values
         Loss Source to Destination: 0           Loss Destination to
Source: 0
         Out Of Sequence: 0      Tail Drop: 0    Packet Late
Arrival: 0
Number of successes: 1
Number of failures: 0
Operation time to live: 3567 sec
```

Design Decisions and Factors

- Topology
  - partial mesh based on traffic matrix
  - full mesh
  - hub and spoke
- Scheduling
  - minimize the number of concurrent operations
  - minimize resource competition
- Use the same operation across various classes of service to generate comparable metrics.

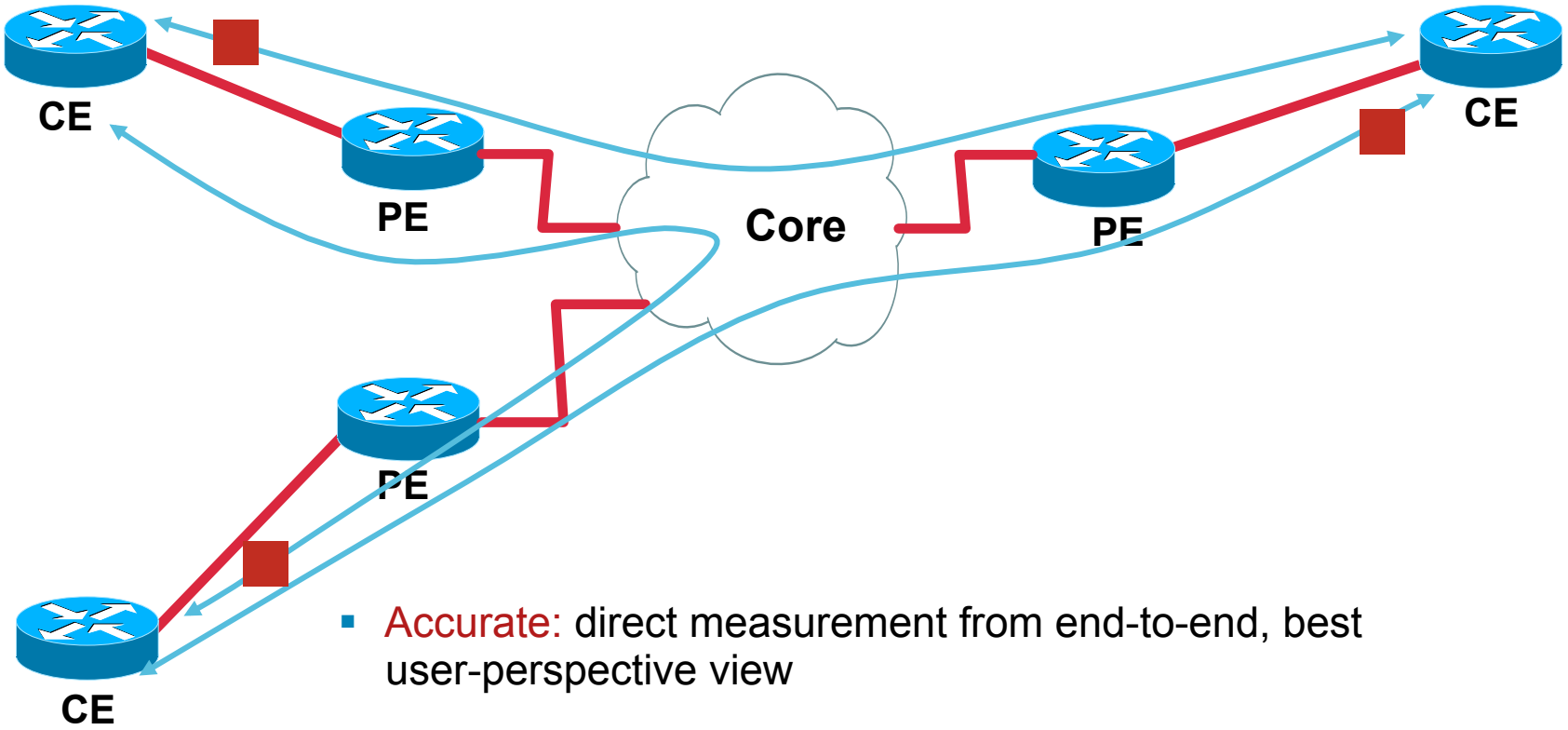
Full Mesh



Nodes	Operation
2	1
3	3
4	6
5	10
6	15
7	21
8	28
…	…
100	4950

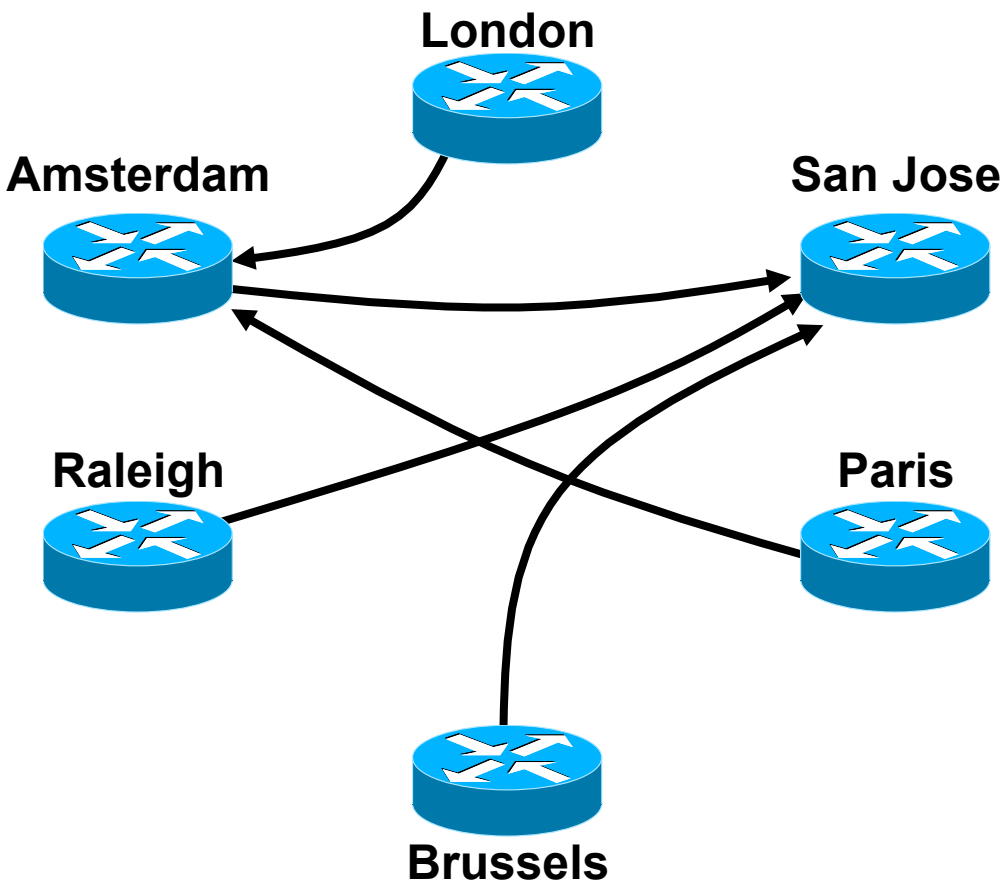
- Number of operations is proportional to the square of the number of nodes
- Does not scale

Full Mesh CE-to-CE [Example]



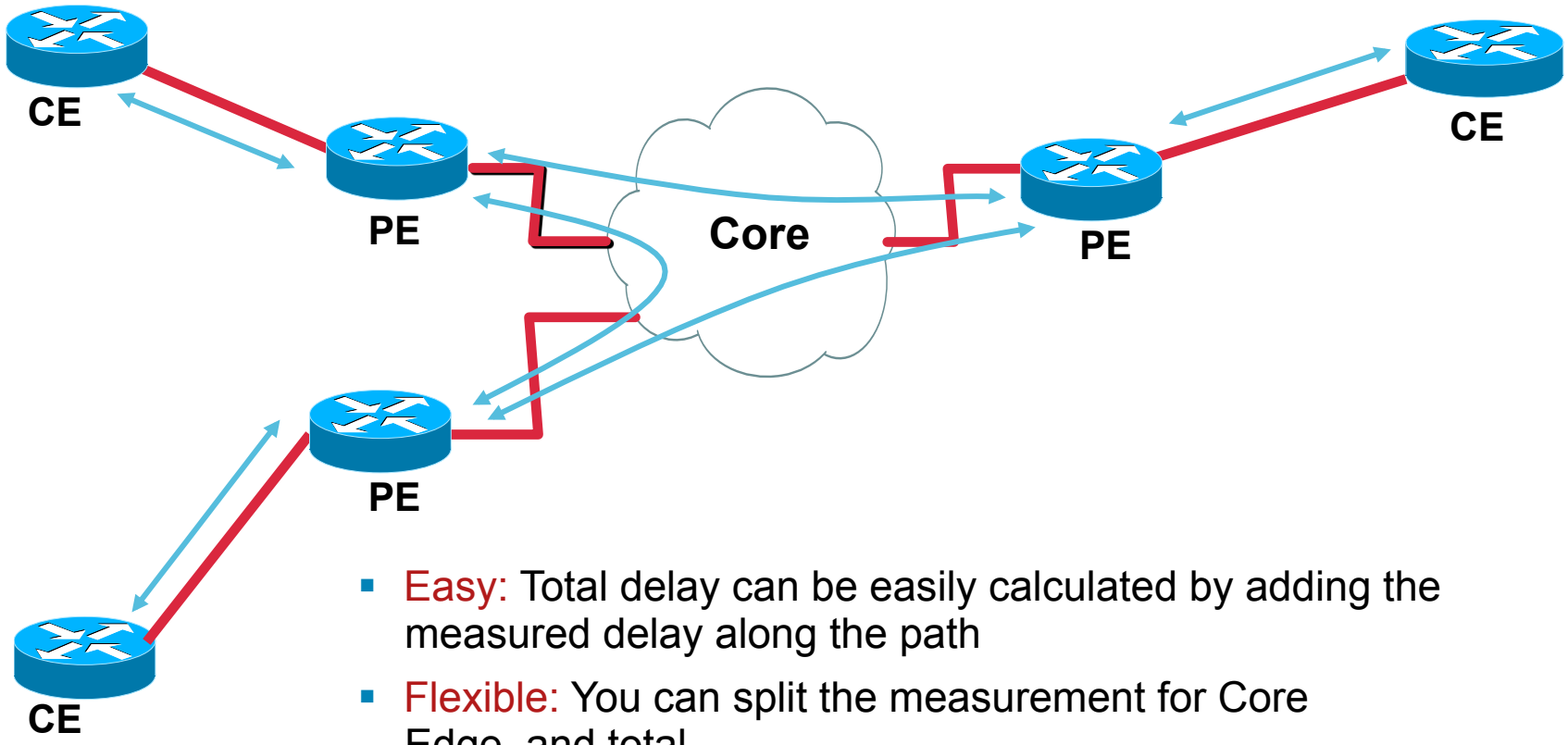
- Accurate: direct measurement from end-to-end, best user-perspective view
- Expensive: for n nodes, requires n(n-1)/2 operations
- In certain cases, it might be difficult to poll the results with SNMP on the CE

Partial Mesh



- Full mesh is not always desirable
- Select only critical path, like branch offices to headquarters
- Dramatically reduces the number of probes

Composite SLA for Delay [Example]



- Easy: Total delay can be easily calculated by adding the measured delay along the path
- Flexible: You can split the measurement for Core Edge, and total
- Measurements are less accurate, as each measurement carry its own error tolerance (typically ± 1 ms per measurement)

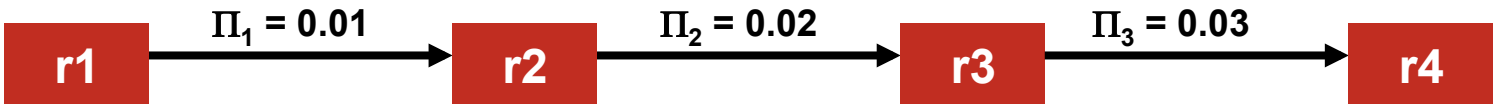
Composite SLA for Packet Drop [1/2]

- A trivial solution might is to consider the sum of drop probabilities; this is conservative
- A more accurate approach is to invert the probability of a successful packet delivery
- If Π_x is the loss probability across section x, then the total loss probability is:

$$\prod_{1\ldots x} = 1 - [(1 - \prod_1).(1 - \prod_2) \cdots (1 - \prod_n)]$$

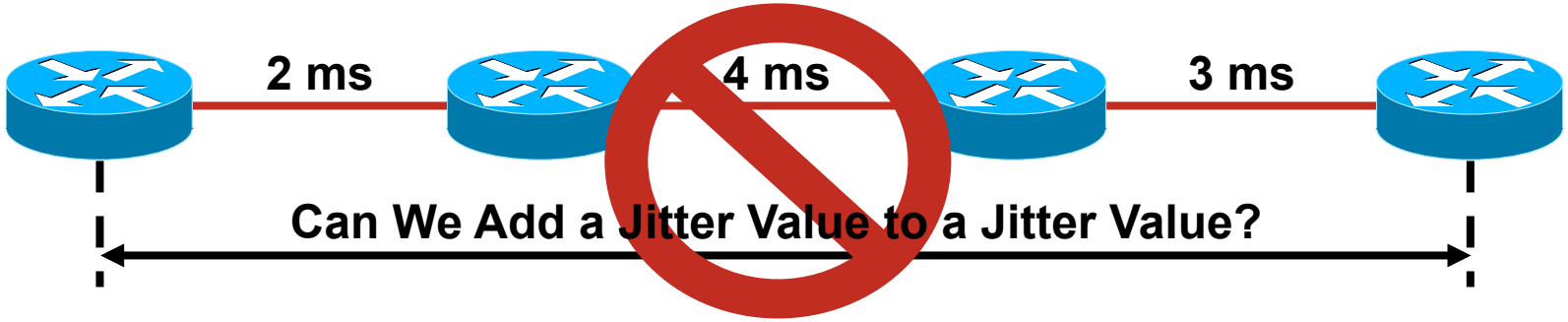
Composite SLA for Packet Drop [2/2]

Example: We Have Three Sections with Various Drop Probabilities:



- First solution:
  0.01+0.02+0.03=0.06 (6%)
- Second solution:
  1-[(1-0.01).(1-0.02).(1-0.03)]=0.058906 (5.8%)

Composite SLA for Jitter



- Short answer: NO!
- This is not a valid approach to calculate total jitter based on measured jitter
  (jitter is not additive)
- Too many factors: positive jitter, negative jitter, percentile-95 of jitter, average jitter,…
- You'd better measure it, not calculate it

Testing, Verification & Assurance

IPSLA – Recurring Scheduling

- You can schedule a single IPSLAs operation to start automatically at a specified time and for a specified duration every day:

  The life value for a recurring IPSLAs operation should be less than one day.

  The ageout value for a recurring operation must be "never" (which is specified with the value 0, this is the value by default), or the sum of the life and ageout values must be more than one day.

- Example:

```
Router(config)# ip sla  schedule 5 start-time 12:00:10
  life 3600 recurring
```

***12.3(8)T**

Testing, Verification & Assurance

IPSLA – Multiple Operations Scheduling

- Operations of the same type and same frequency should be used with IPSLA multiple operations scheduling:
  - Notion of group, it lets you start many operations at once
  - Reduced load on the network
  - If you do not specify a frequency, the default frequency will be the same as that of the schedule period)
- Example, start operations 1 to 3 within the next 20 seconds

```
Router (config)# ip sla 1
Router (config)# icmp-echo RouterC
Router (config)# ip sla 2
Router (config)# icmp-echo RouterD
Router (config)# ip sla 3
Router (config)# icmp-echo RouterE

Router (config)#ip sla group schedule 1 1-3 sch 20 start now

Router #show ip sla group schedule
```

Testing, Verification & Assurance

IPSLA – Random Scheduling

Problem: Strictly periodically starting IPSLA operations might be subject to ‘synchronization effects’ with other processes (ie. routing updates), leading to inaccurate data.

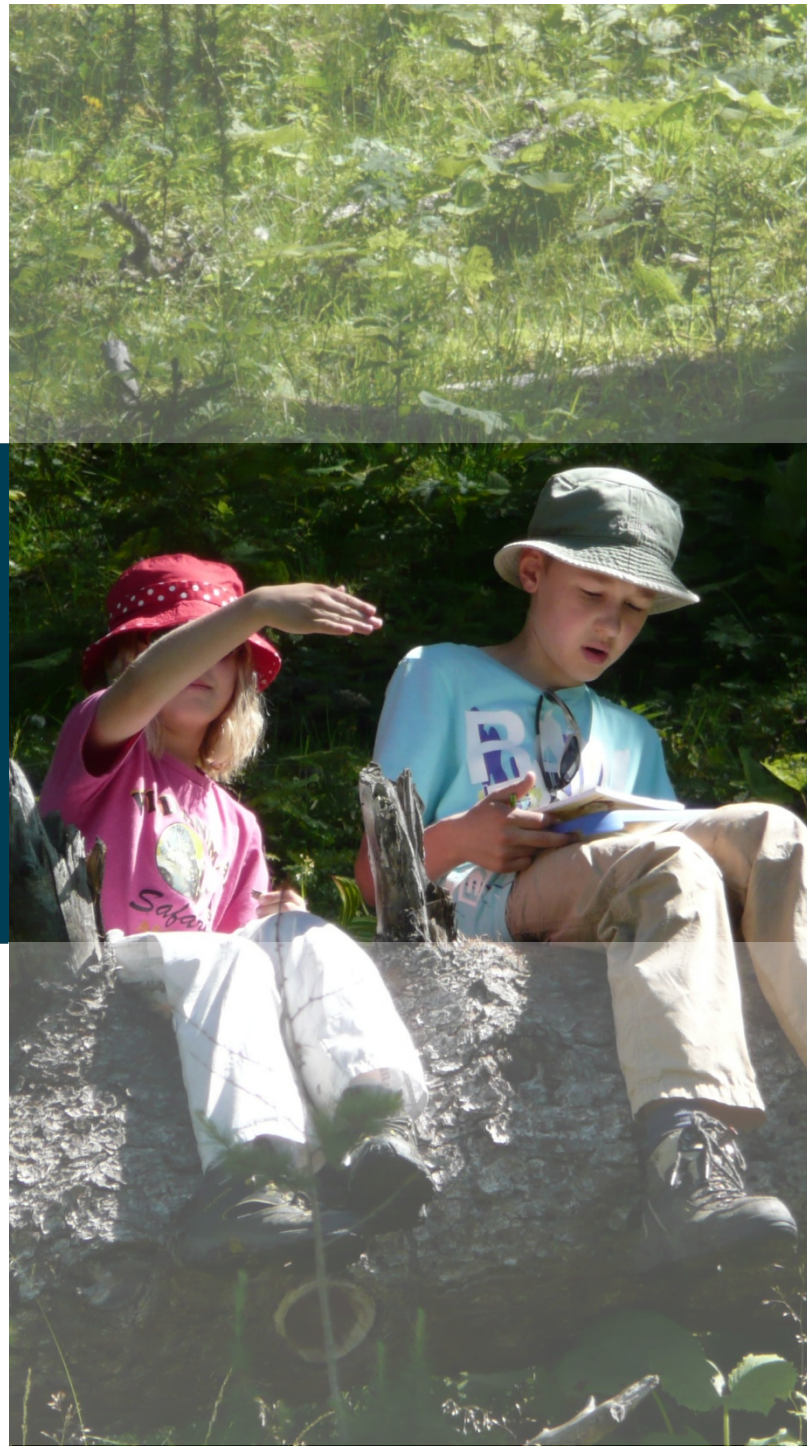
Solution: Use IPSLA Random Scheduling to randomize start time

This example starts operation 1 to 3 within the next 44 seconds, and each operation will have a random frequency varying between 10 and 15 seconds:

```
Router(config)#ip sla group schedule 1 1-3 schedule-period 44 frequency range
  10-15 start-time now life forever


Router#sh ip sla op | i start
Latest operation start time: *12:56:12.243 PST Fri Jan 4 2008
Latest operation start time: *12:56:06.323 PST Fri Jan 4 2008
Latest operation start time: *12:56:07.743 PST Fri Jan 4 2008
router#sh ip sla op | i start
Latest operation start time: *13:00:19.423 PST Fri Jan 4 2008
Latest operation start time: *13:00:15.895 PST Fri Jan 4 2008
Latest operation start time: *13:00:21.015 PST Fri Jan 4 2008
```

***12.4(2)T**

What about SLA in dynamic networks?



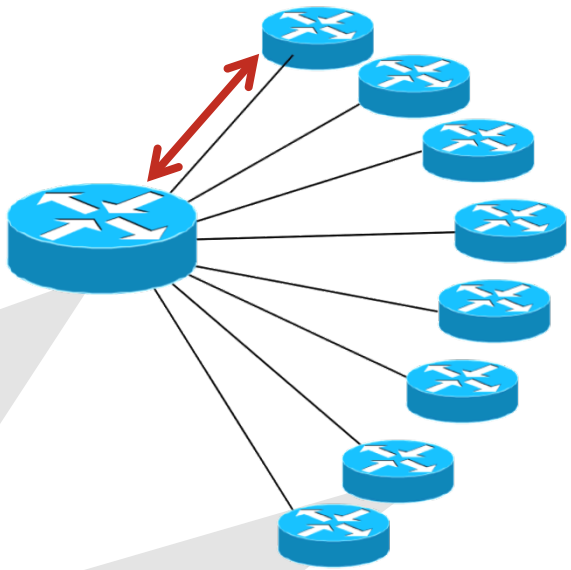
Auto IP SLA – Don‘t touch your Hub

New 15.1T

Some IP SLA Topologies …

- … are naturally Hub and Spoke
- … have a large number of Spokes with similar IP SLA requirements
- … consist of dynamically joining / disappearing Spokes

```
ip sla auto template type ip udp-jitter my-ipsla-template
  parameters
    request-data-size 64
    num-packets 1000
ip sla auto schedule my-ipsla-schedule
  frequency 45
  start-time now
ip sla auto endpoint-list type ip my-ipsla-endpoints
  discover
    ageout 36000
ip sla auto group type ip my-ipsla-group
  schedule my-ipsla-schedule
  template udp-jitter my-ipsla-template
  destination my-ipsla-endpoints
```



```
ip sla responder auto-register 10.10.10.2 endpoint-list my-ipsla-endpoints
```

Service Testing, Verification and Assurance

Example: Network Automation with IPSLA – 1/4

Problem

- Need to monitor IP SLA
- Trigger actions upon violation of SLA

Solutions

- IP SLAs Thresholds
- Using EEM and the EOT Event Detector
- Using EEM 3.x and the IP SLA Event Detector

Service Testing, Verification and Assurance

Example: Network Automation with IPSLA – 2/4

Solution 1: Using IP SLA reaction triggers:

```
RouterA(config)#

ip sla 10

 icmp-echo 3.3.3.3

 frequency 10

ip sla reaction-configuration 10 react timeout threshold-type consecutive 3
  action-type trapAndTrigger

ip sla schedule 10 life forever start-time now

ip sla reaction-trigger 10 20


logging on

ip sla logging trap

snmp-server host nms_server version 2c public

snmp-server enable traps syslog
```

Sending SNMP trap with IP SLAs embedded threshold

Service Testing, Verification and Assurance

Example: Network Automation with IPSLA – 3/4

IP SLA

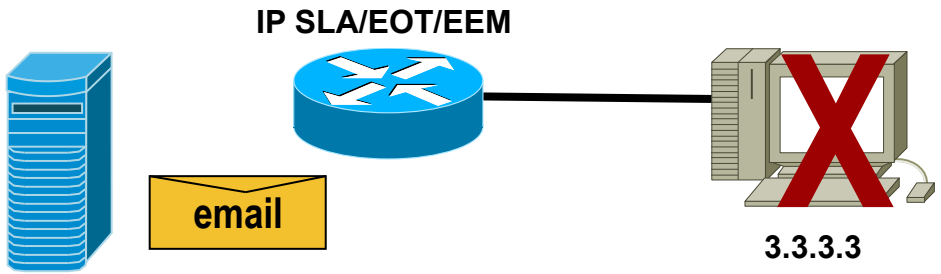
```
ip sla 10
 icmp-echo 3.3.3.3
 timeout 500
 frequency 3
ip sla schedule 10 life forever start-time now
```

Embedded Object Tracking (EOT)

```
track 10 rtr 10 reachability
delay down 10 up 20
```

Environment Variables

($_* variables to be defined)



EEM Applet

```
event manager applet email_server_unreachable
 event track 10 state down
 action 1.0 syslog msg "Ping has failed, server unreachable!"
 action 1.1 cli command "enable"
 action 1.2 cli command "del /force flash:server_unreachable"
 action 1.3 cli command "show clock | append server_unreachable"
 action 1.4 cli command "show ip route | append server_unreachable"
 action 1.5 cli command "more flash:server_unreachable"
 action 1.6 mail server "$_email_server" to "$_email_to" from "$_email_from" subject "Server Unreachable: ICMP-Echos
    Failed" body "$_cli_result"
 action 1.7 syslog msg "Server unreachable alert has been sent to email server!"
```

Example: Network Automation with IPSLA – 4/4

Solution 3: Using Embedded Event Manager 3.0 IP SLA Event Detector:

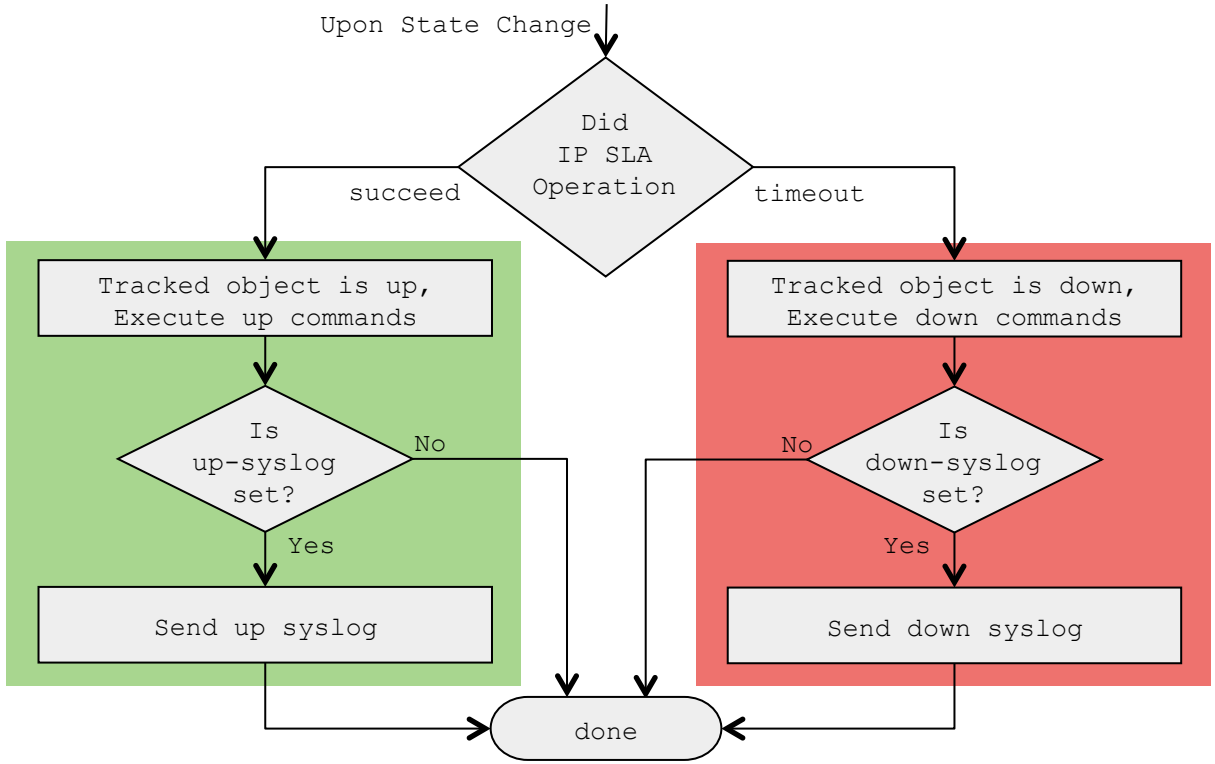
```
Router(config)# ip sla 10
Router(config-ip-sla)# icmp-echo 3.3.3.3

Router(config)# ip sla enable reaction-alerts

Router(config)#ip sla reaction-config 1 react Timeout
   action-type none threshold-type consecutive 3

Router(config)# ip sla schedule 10 start now

Router(config}# event manager applet test
router(config-applet)# event ipsla operation-id 10 reaction-type Timeout
router(config-applet)# action 1.0 syslog priorities emergencies
   msg "IP SLA operation $_ipsla_oper_id to server XYZ has timed out"
```

Trigger an Embedded Event Manager Applet when the IP SLA operation threshold is crossed

EASy Package: Custom High-Availability

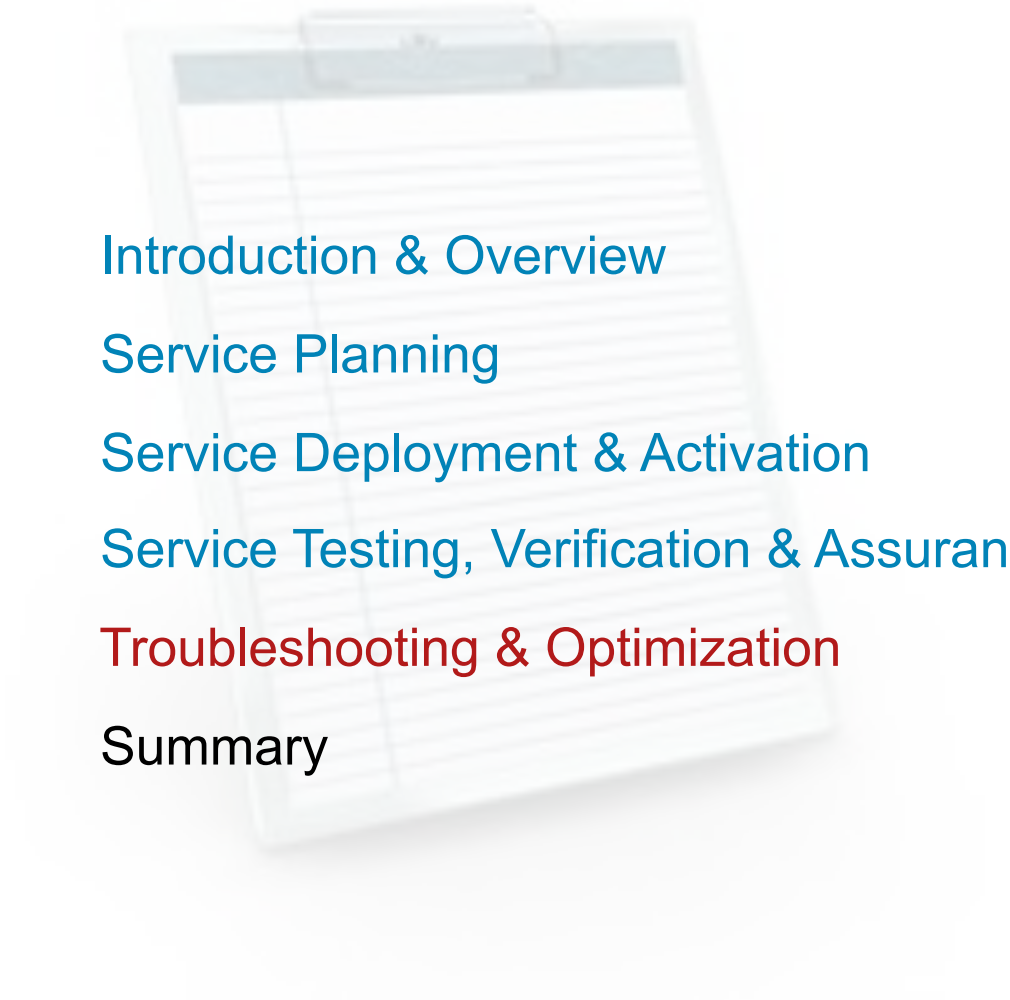
Problem: We need a failover from primary to secondary link – but with flexibility and custom notification beyond what a simple routing protocol based solution provides

Solution: Automate based on IP SLA, EOT and Embedded Event Manager



See: Available as an EASy Package:
http://www.cisco.com/go/easy

Agenda



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➲ Troubleshooting & Optimization

Summary

Be Prepared – Some Good Practices

Be Prepared – Some Good Practices

Troubleshooting & Optimization

Good Practice: Reserve Memory for Cons.

Problem: Network or Device Problems may consume a lot of Memory and/or Memory may become extensively fragmented – potentially there won't be enough Memory left for the Console …

Solution: Reserve Memory for the console ahead of time, on every device

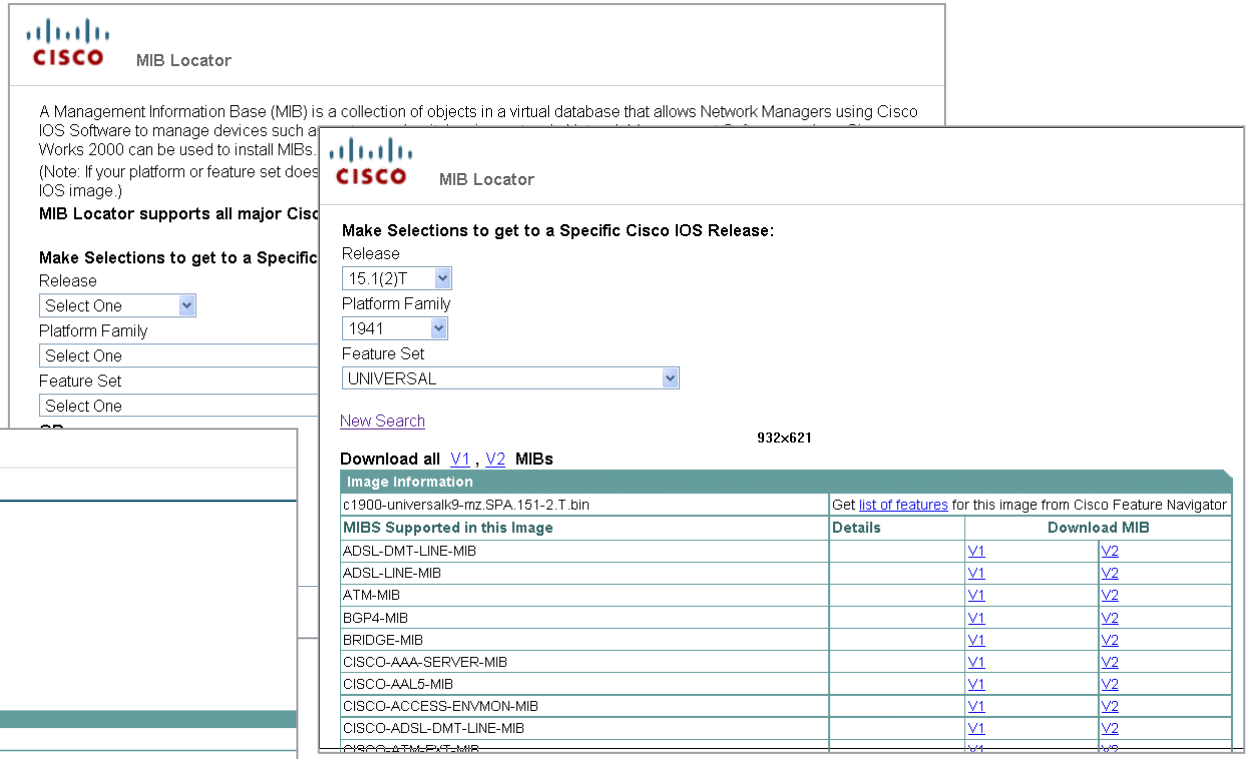
```
Router(config)# memory reserved console <number-of-kilobytes>
```

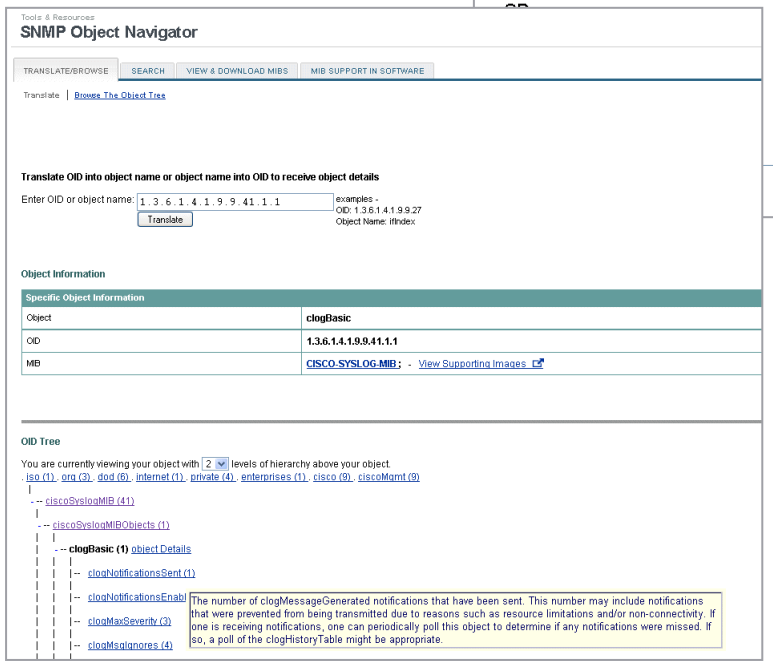
Rule of Thumb: for the number of kilobytes use a value greater than 3 times the NVRAM size

- IOS Default is 256 kilobytes
- available since 12.0(22)S, 12.2(28)SB (7300), 12.4(15)T

Where to start with MIBs ?

MIB Locator:
http://www.cisco.com/go/mibs





SNMP Object Navigator:
http://www.cisco.com/go/mibs

Troubleshooting & Optimization

Good Practice: Check SNMP OID Statistics

Which OIDs are my NMS Apps (CiscoView) polling ?

```
Router#show snmp statistics oid

time-stamp     #of times requested  OID
16:16:50 CET Jan 12 2005      97 sysUpTime
16:16:50 CET Jan 12 2005      9  cardTableEntry.7
16:16:50 CET Jan 12 2005      9  cardTableEntry.1
16:16:50 CET Jan 12 2005      4  cardTableEntry.9
16:16:50 CET Jan 12 2005      16 ifAdminStatus
16:16:50 CET Jan 12 2005      16 ifOperStatus
16:16:50 CET Jan 12 2005      6  ciscoEnvMonSupplyStatusEntry.3
16:16:50 CET Jan 12 2005      17 ciscoFlashDeviceEntry.2
16:16:50 CET Jan 12 2005      8  ciscoFlashDeviceEntry.10
16:16:50 CET Jan 12 2005      2  ltsLineEntry.1
16:16:50 CET Jan 12 2005      2  chassis.15
16:16:27 CET Jan 12 2005      11 ciscoFlashDeviceEntry.7
16:16:27 CET Jan 12 2005      2  cardIfIndexEntry.5
16:16:24 CET Jan 12 2005      1  ciscoFlashDevice.1
```

Available from: IOS 12.0(22)S, 12.4(20)T

Good Practice: IfIndex Persistence – 1/3

- Feature which can make ifIndex persist across reboots (In Switches is on by default)
- ifIndex persistence means that the mapping between the ifDescr (or ifName) and ifIndex object values from the IF-MIB is retained across reboots.
- Useful:
  - SNMP: monitoring the interfaces counters
  - NetFlow: reporting of the interface ifIndex
  - RMON: events/alarms based on specific interfaces
- 25 bytes of NVRAM used by this feature per interface.

Applying ifIndex persistence to all interfaces

```
Router(conf)# snmp-server ifindex persist
Router(config-if)# snmp-server ifindex persist
```

Applying ifIndex persistence to an specific interface

Good Practice: IfIndex Persistence – 2/3

Now there is a show command:

```
Router# show snmp mib ifmib ifindex
 Ethernet0/0: Ifindex = 1
 Loopback0: Ifindex = 39
 Null0: Ifindex = 6
:

Router# snmp mib ifmib ifindex loopback 0
 Loopback0: Ifindex = 39
```

Introduced in 12.0(7)S, 12.2(2)T

http://www.cisco.com/en/US/customer/products/sw/iosswrel/ps1839/products_feature_guide09186a0080087b0d.html

Good Practice: IfIndex Persistence – 3/3

```
Router(config)# snmp-server ifindex persist
Router(config)# snmp mib persist event
Router(config)# snmp mib persist expression
Router(config)# snmp mib persist circuit
Router(config)# snmp mib persist cbqos
```

EVENT-MIB

EXPRESSION-MIB

CIRCUIT-MIB

CISCO-CLASS-BASED-QOS-MIB

- You must perform a *copy running starting* command to persist the newly assigned ifIndex values.

copy running start!

```
Router # dir nvram:ifIndex-table

  Directory of nvram:/ifIndex-table

      2   -rw-   283  <no date>  ifIndex-table

  126968 bytes total (114116 bytes free)
```

Reliable Delivery and Filtering of Syslog

Reliable Delivery and Filtering of Syslog

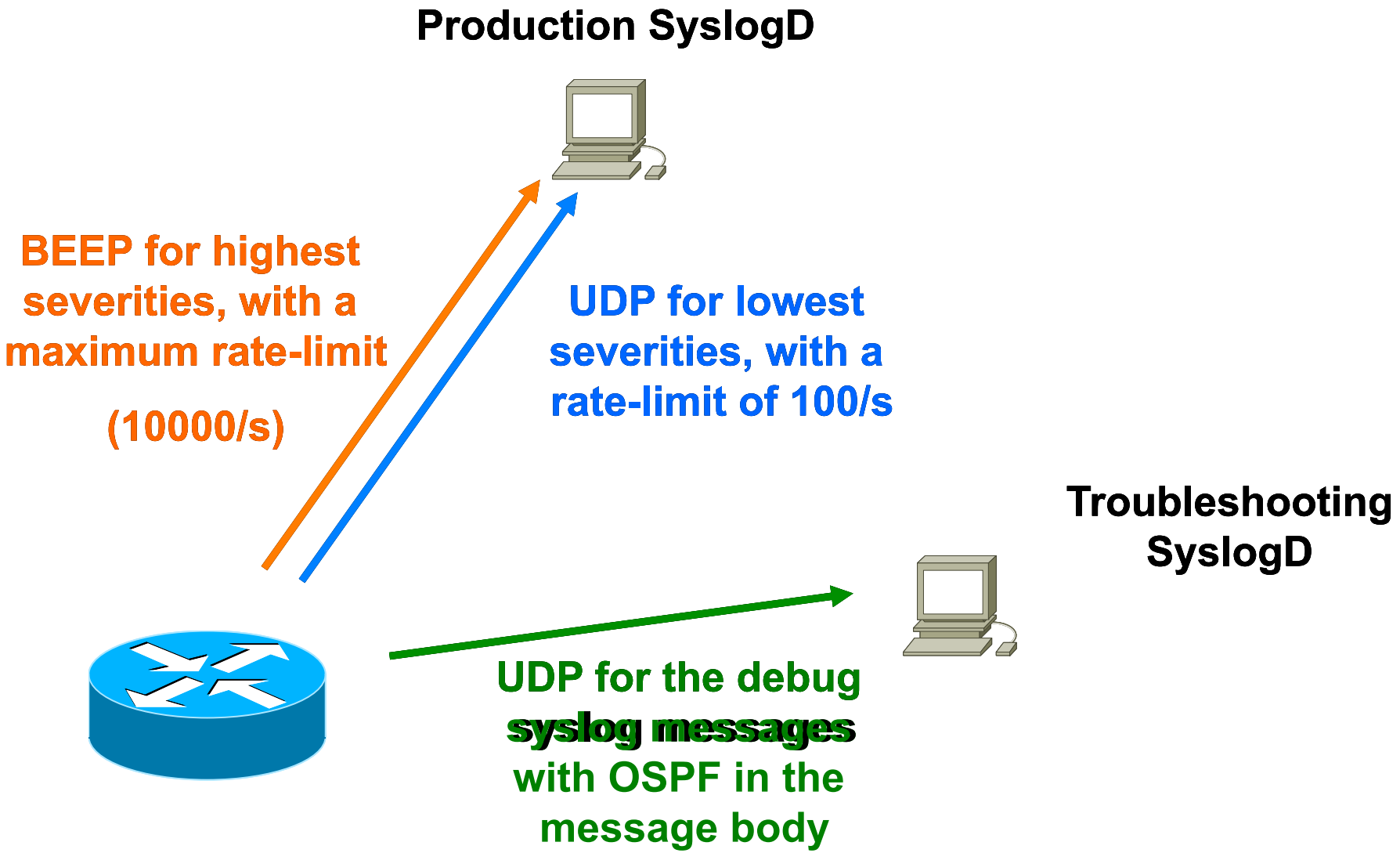
- Provides for reliable and secure delivery for syslog messages using Blocks Extensible Exchange Protocol (BEEP)

  RFC 3195, “Reliable Delivery for syslog”

- Provides a filtering mechanism per syslog session, called a message discriminator
- Provides a rate-limiter per syslog session
- Integrated in 12.4(11)T, even if the BEEP framework was supported for quite some time, 12.4(2)T
- Which syslog servers support BEEP?

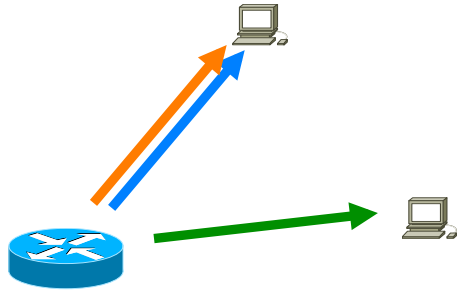
  http://www.syslog.cc/ietf/rfcs/3195.html

Example: Filtering of Syslog – 1/2



Troubleshooting & Optimization

Example: Filtering of Syslog – 2/2



```
Router(config)# logging discriminator filter1
  severity includes 0,1,2,3 rate-limit 10000
Router(config)# logging discriminator filter2
  severity includes 4,5,6,7 rate-limit 100
Router(config)# logging discriminator filter3 msg-
  body includes debug includes facility OSPF

Router(config)# logging trap debugging

Router(config)# logging host <production> transport
  beep discriminator filter1
Router(config)# logging host <production> transport
  udp port 1471 discriminator filter2
Router(config)# logging host <troubleshooting>
  discriminator filter3
```

What about Syslog messages indicating an ACL hit ?

Troubleshooting & Optimization

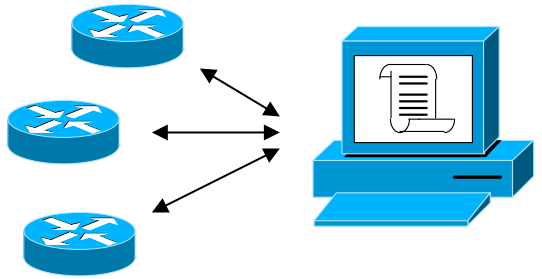
ACL Syslog Correlation

Problem: ACL hits can produce a Syslog message – but often in the NOC or SOC we want to know which specific line of an ACL (ie.: ACE – Access Control Entry) was kicking-in ...

Solution: Make use of IOS ACL Tags and Syslog Correlation

1. Define Tags for your ACEs:

```
ip access-list extended access-control
   permit ip any host 10.10.10.100 log red-server
   permit ip any host 10.10.10.200 log blue-
server
   permit ip any any
```



2. Tags will be appended to Syslog Messages:

```
*Apr 13 16:31:18.958: %SEC-6-IPACCESSLOGDP: list access-control
permitted icmp 192.168.1.100 -> 10.10.10.100 (0/0), 11 packets  [ red-
server ]
*Apr 13 16:32:18.953: %SEC-6-IPACCESSLOGDP: list access-control
permitted icmp 192.168.1.100 -> 10.10.10.200 (0/0), 3 packets  [ blue-
server ]
```

See: http://www.cisco.com/en/US/partner/docs/ios/security/configuration/guide/sec_acl_syslog.html
Available from: IOS 12.4(22)T
Platforms: 18xx, 28xx, 38xx, 72xx, 73xx, 76xx

Example: ACL Syslog Correlation and EEM

Problem: Let's assume we not only need a syslog message, but also want to take specific actions ...

Solution: Combine ACL Syslog Correlation with EEM

1. Define Tags for your ACEs:

```
access-list 100
   deny tcp host 10.0.2.2 host 10.0.2.181 eq 9000 log ThisIsBlocked
   permit ip any any
```

2. Define an EEM Applet to match the Tag and take action:

```
event manager applet catch-an-ace-tag
   event syslog pattern "ThisIsBlocked"
   action 1.0 syslog priority emergencies msg "Start... "
    :
   Your Actions Here
    :
   action 9.0 syslog priority emergencies msg "... done"
```

3. A matching packet will generate a syslog message, which will in turn trigger EEM :

```
*Apr 13 16:58:06.386: %SEC-6-IPACCESSLOGDP: list 100 denied tcp 10.0.2.2
(56273)  10.0.2.181(9000), 1 packet [ThisIsBlocked]
*Apr 13 16:58:06.394 UTC: %HA_EM-0-LOG: catch-an-ace-tag: Start ...
*Apr 13 16:58:07.025 UTC: %HA_EM-0-LOG: catch-an-ace-tag: ... done
```

Good to know: any traffic with low TTL?

Troubleshooting & Optimization

Good Practice: Know about low-TTL

TTL is:

- An IP Header field used to limit packet life time (upon routing loops)
- Each routing hop along a packet's path decrements this value
- Upon TTL==0 the packet is dropped

Low TTL Values are also (mis-)used:

- to establish bidirectional TCP sessions across NAT (aka TCP hole-punching)
- by some applications (multicast, load-balancing, …)
- by security attacks (denial of service, break-in, ...)

Hence Low TTL can indicate:

- Routing issues
- Funny application behaviour
- Security incidents (what is my normal low-TTL traffic ?)

➔ How to report on low-TTL in my network ?

Troubleshooting & Optimization

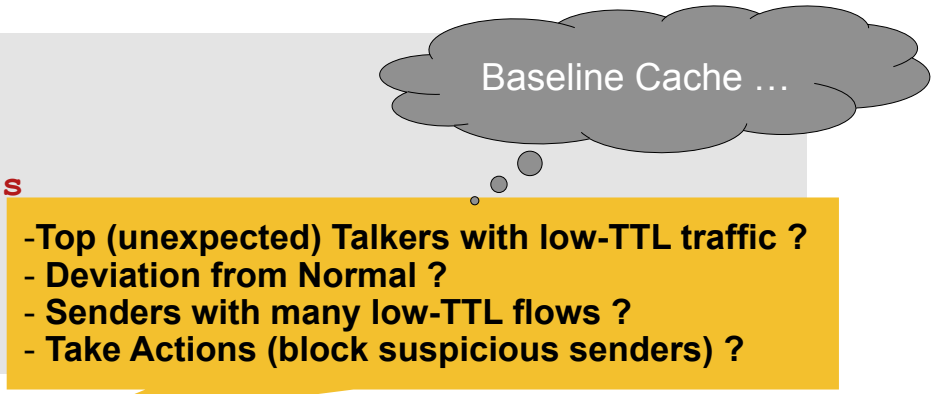
Example: Monitor low-TTL Traffic ...

Problem: We want to know about low-TTL traffic

Solution: Use Flexible Netflow and Embedded Event Manager 3.0 to detect traffic flows with TTL < 5

1. Configure flexible Netflow to match on TTL, Source- and Destination Address

```
flow record <my-record>
         match ipv4 ttl
         match ipv4 source address
         match ipv4 destination address
:
flow monitor <my-monitor>
         record <my-record>
:
```



2. Configure the Netflow Event Detector in EEM to notify upon a new flow record

```
event manager applet my-ttl-applet
         event nf monitor-name "my-ttl-monitor" event-type create event1
               entry-value "5" field ipv4 ttl entry-op lt
         action 1.0 syslog msg "Low-TTL flow from $_nf_source_address"
```

3. Syslog message and/or use `show flow monitor <my-monitor> cache` command

```
*Dec  2 17:39:31.221: %HA_EM-6-LOG: my-ttl-applet: Low-TTL flow from 192.168.2.248
```

What if I need a Packet Capture – I?

Troubleshooting & Optimization

Embedded Packet Capture (EPC)

Problem: Sometimes a Packet Capture would be useful for Troubleshooting, Security or Application Analysis, Baselining, etc.
BUT: deploying Packet Sniffers is slow, expensive and requires local skills and equipment ...

Solution: Make use of IOS Embedded Packet Capture to capture PCAP format data and/or analyze on the device

1. Defining a capture buffer on the device

```
Router# monitor capture buffer …
```

2. Defining a capture point

```
Router# monitor capture point …
```

3. Associate capture point to buffer

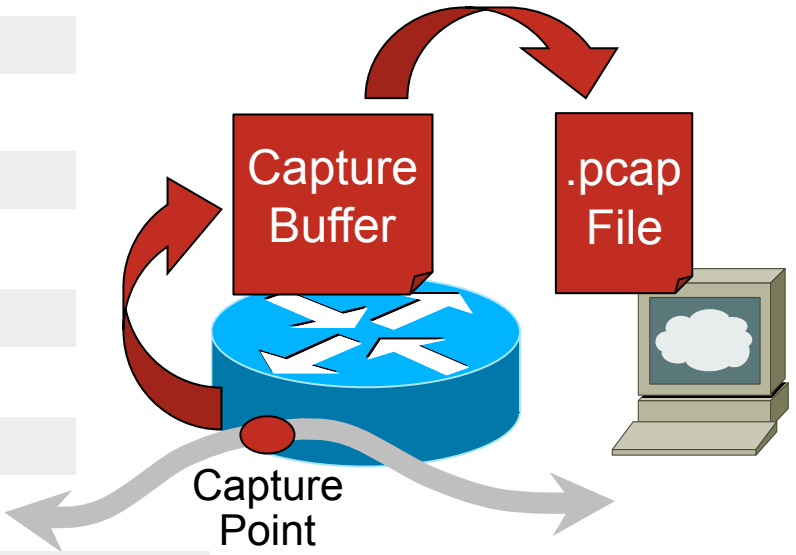
```
Router# monitor capture point associate …
```

4. Start / Stop capture points

```
Router# monitor capture point start …
```

5. Show and/or Export the content of the buffer

```
Router# monitor capture buffer <tracename> export
```



See: http://www.cisco.com/go/epc
Available from: IOS 12.4(20)T
Platforms: 8xx, 18xx, 28xx, 38xx ISRs, 72xx

Troubleshooting & Optimization

Example: process-switched traffic – 1/2

We want to capture process-switched traffic:

1-3. Define a capture buffer, capture point and associate the two

```
Router# monitor capture buffer my-buffer size 100 max-size 1000 circular
Router# monitor capture point ip process-switched my-capture in
Router# monitor capture point associate my-capture my-buffer
```

4. Start capturing traffic

```
Router# monitor capture point start all
*Nov 25 10:00:58.990: %BUFCAP-6-ENABLE: Capture Point my-capture enabled.
```

5. Show / Analyze on the router …

```
Router# show monitor capture buffer all parameters
  Capture buffer my-buffer (circular buffer)
  Buffer Size : 102400 bytes, Max Element Size : 1000 bytes, Packets : 28
  Allow-nth-pak : 0, Duration : 0 (seconds), Max packets : 0, pps : 0
  Associated Capture Points:
  Name : my-capture, Status : Active
  Configuration:
  monitor capture buffer my-buffer size 100 max-size 1000 circular
  monitor capture point associate my-capture my-buffer
```

We have some traffic

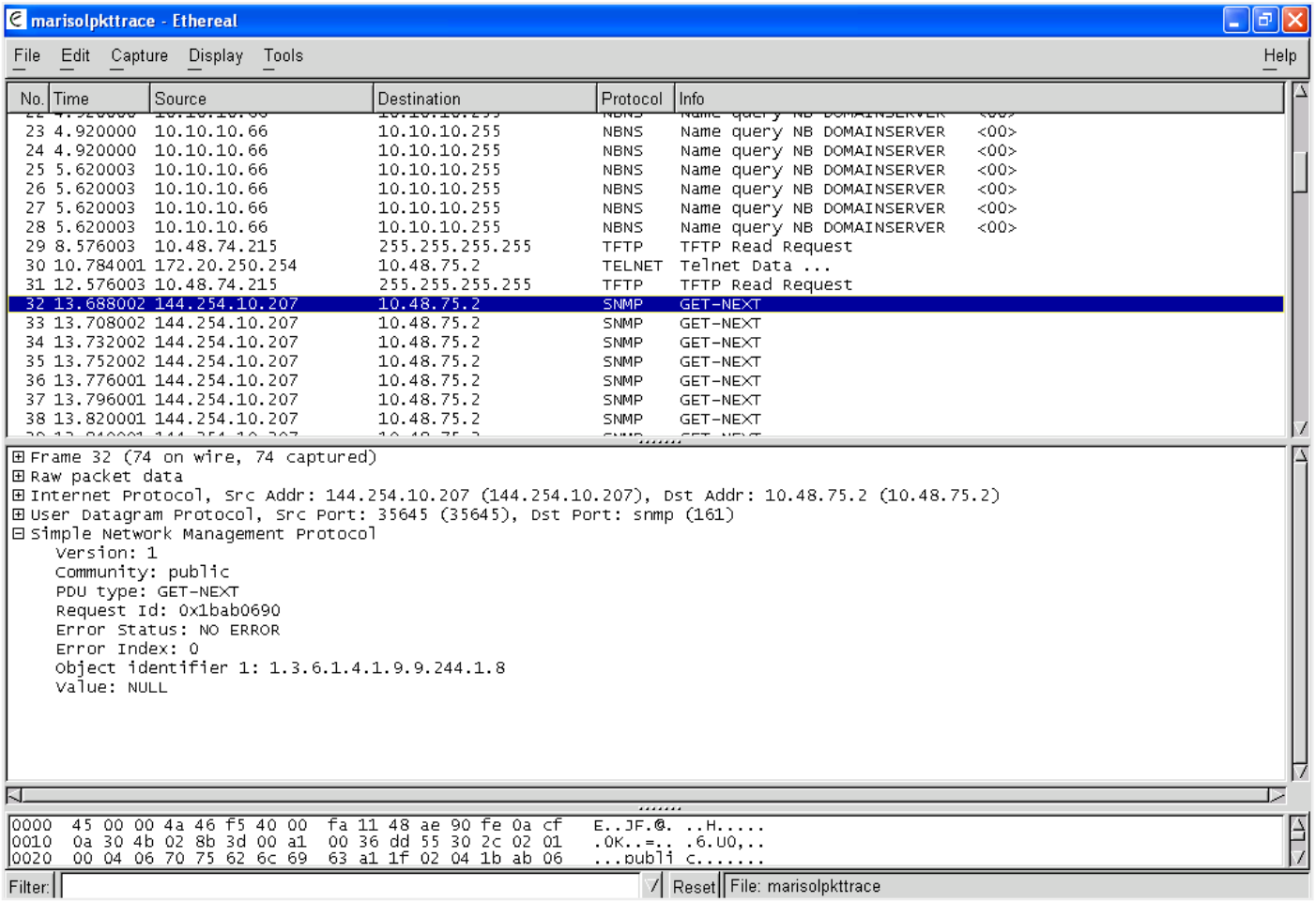
```
Router# show monitor capture buffer my-buffer dump
  10:14:05.914 UTC Nov 25 2008 : IPv4 Process    : Fa0/0 None
  66A3C5B0:          FFFFFFFF FFFF0001 64FF4C01      ........d.L.
  66A3C5C0: 080045C0 00300000 00000111 0B5AACA1  ..E@.0.......Z,!
  66A3C5D0: 0103FFFF FFFF02C7 02C7001C 85F60001  .......G.G...v..
  66A3C5E0: 0010AC12 01020000 5D4C0F03 0004AC12  ..,.....]L....,.
```

Troubleshooting & Optimization

Example: process-switched traffic – 2/2

5. … or export as PCAP file and analyze externally

```
Router# monitor capture buffer my-buffer export tftp://10.10.10.10/mypcap
```



Troubleshooting & Optimization

EPC – Additional Considerations

- Capture stop criteria:
  - manual stop
  - after a specified time interval
  - after given number of packets
- Capture point:
  - IPv4 or IPv6
  - CEF (drop, punt) or process switching
  - interface specific or all interface
  - Direction: in, out, both, from-us (process-switched specific)
  - multicast: only ingress packets are captured, not the replicated egress packets
  - MPLS: does not capture MPLS encapsulated frames today
- Buffer can be defined as linear or circular
- Buffer filter based on an access-list

```
Router# monitor capture buffer my-buffer filter access-list 10
```

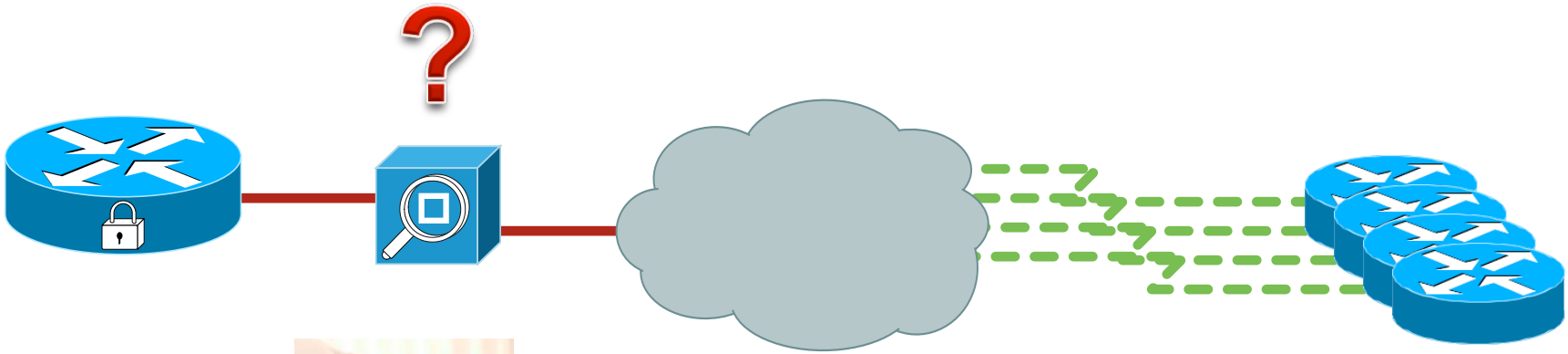
- Buffer export options: FTP, HTTP, HTTPS, RCP, SCP, or TFTP

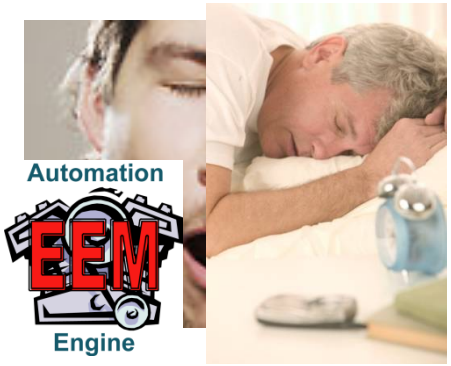
Note: exec mode commands only, nothing in the configuration

What if I need a Packet Capture – II?

Diagnosing Transient Problems

Problem: you are seeing VPN tunnel drops on your VPN head-end router at 3:00 am every day. The tunnels continue to flap until the physical interface is reset. You want to analyze the traffic on the wire at that time.





3:00 AM

EPC – EASy Package

Embedded Automation Systems (EASy)

EPC EASy Package Supports:

- **Interactive Installation**
- **Timed or manual capture start**
- **Linear or circular buffer**
- **Buffer Export**

To use the Package:

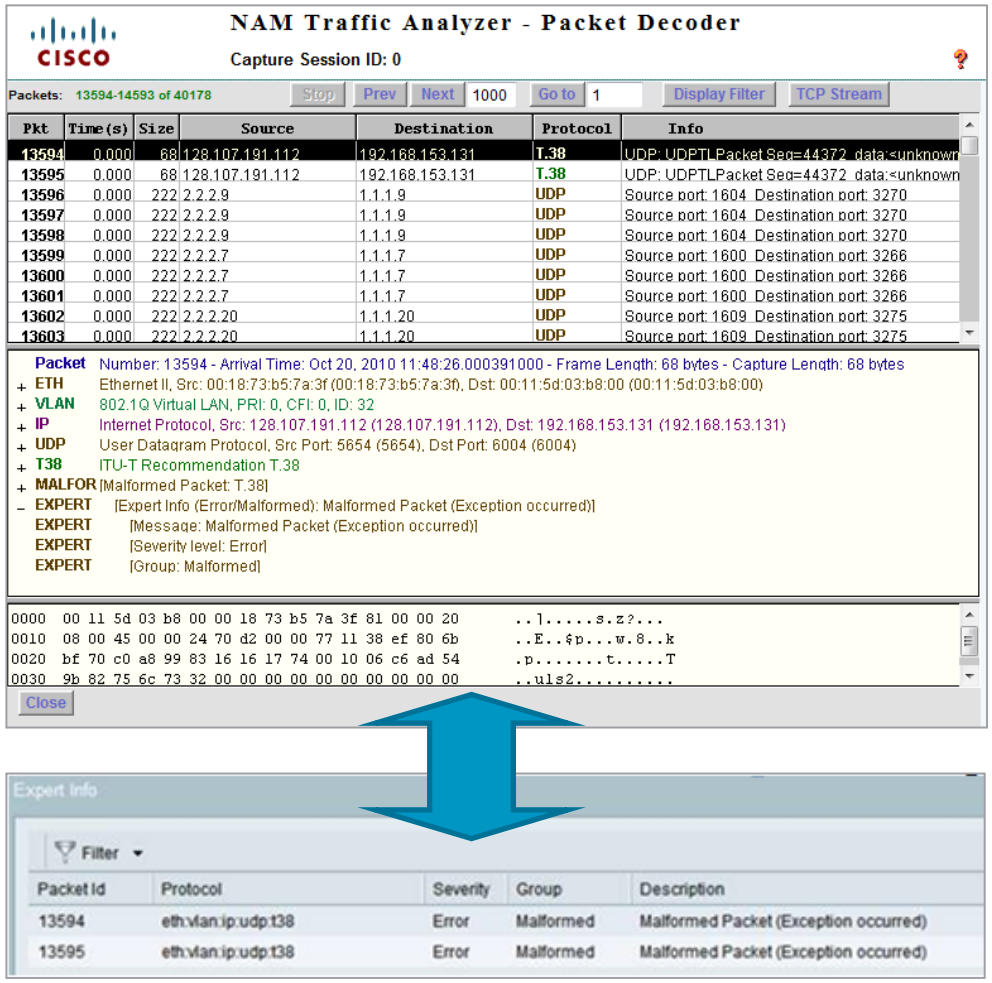
1. Browse and Download EPC EASy Package
   www.cisco.com/go/easy
2. Make Sure to also download EASy Installer
3. Watch VOD and/or read documentation
   www.cisco.com/go/easy
4. Customize and tailor to your needs
5. Install and Use

What if I need a Packet Capture – III?

NAM 5.0: Smart Capture Analysis

Highlights observed anomalies in packet traces

New
Jan 2011



NAM enables:

- Packet trace analysis highlighting observed protocol/ packet level anomalies
- One-click targeted packet captures
- Combined application visibility, traffic analysis and smart packet capture analysis

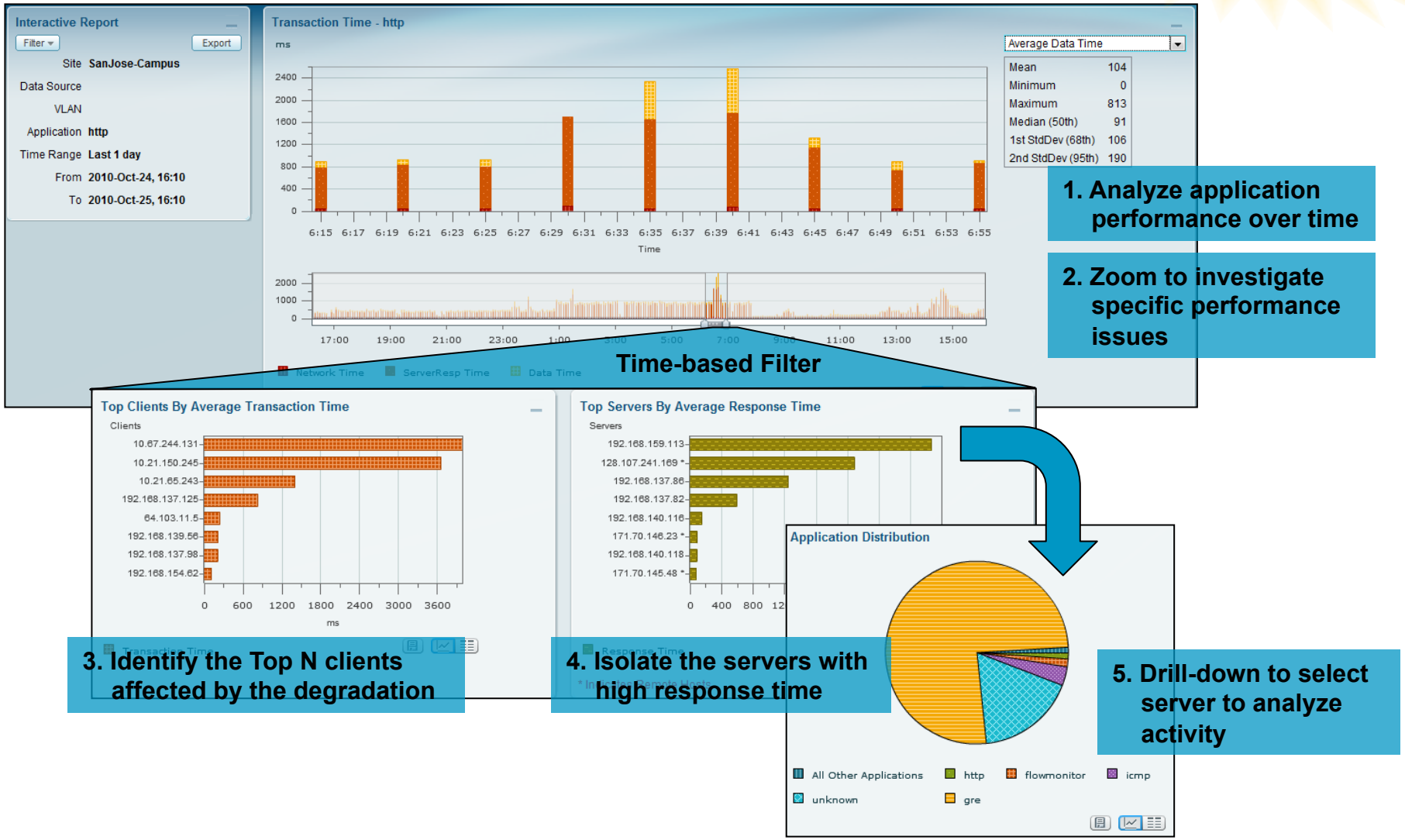
NAM benefits:

- Improves operational efficiency with on-demand captures
- Smart analysis pinpoints root-cause much faster than manually analyzing or scanning the packet traces

NAM 5.0: Troubleshooting Workflow

Isolate Source of Application Performance Degradation

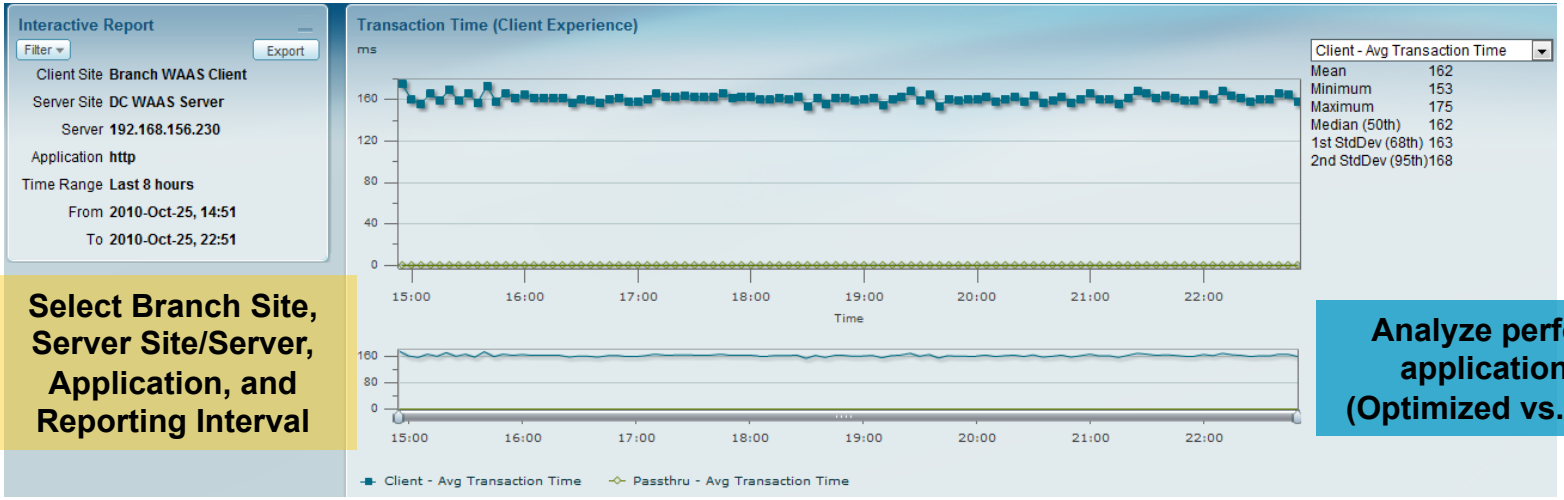
New
Jan 2011



NAM 5.0: WAN Optimization Analysis

Monitor Client Experience and Optimization Improvements

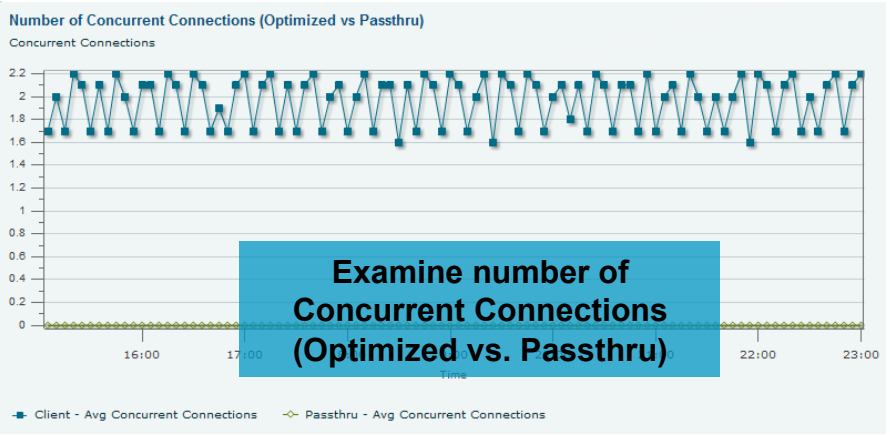
New
Jan 2011



Select Branch Site, Server Site/Server, Application, and Reporting Interval

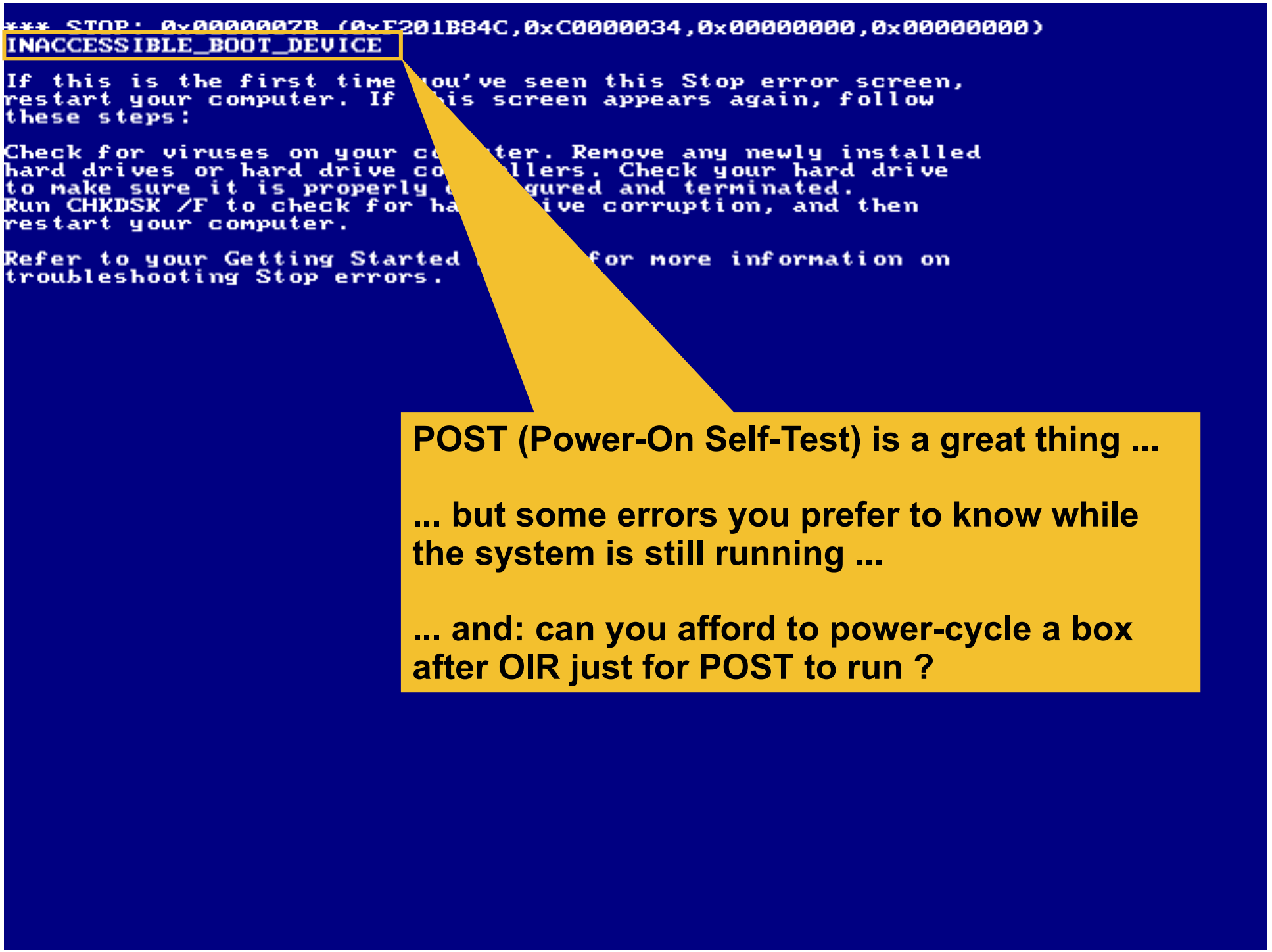
Analyze performance application traffic (Optimized vs. Passthru)

Examine Traffic Volume (Client, WAN) and achieved Compression Ratio



Examine number of Concurrent Connections (Optimized vs. Passthru)

Preventive Maintenance – anyone ?


*** STOP: 0x0000007B (0xF201B84C,0xC0000034,0x00000000,0x00000000)
INACCESSIBLE_BOOT_DEVICE
If this is the first time you've seen this Stop error screen,
restart your computer. If this screen appears again, follow
these steps:
Check for viruses on your computer. Remove any newly installed
hard drives or hard drive controllers. Check your hard drive
to make sure it is properly configured and terminated.
Run CHKDSK /F to check for hard drive corruption, and then
restart your computer.
Refer to your Getting Started for more information on
troubleshooting Stop errors.
POST (Power-On Self-Test) is a great thing ...
... but some errors you prefer to know while the system is still running ...
... and: can you afford to power-cycle a box after OIR just for POST to run ?

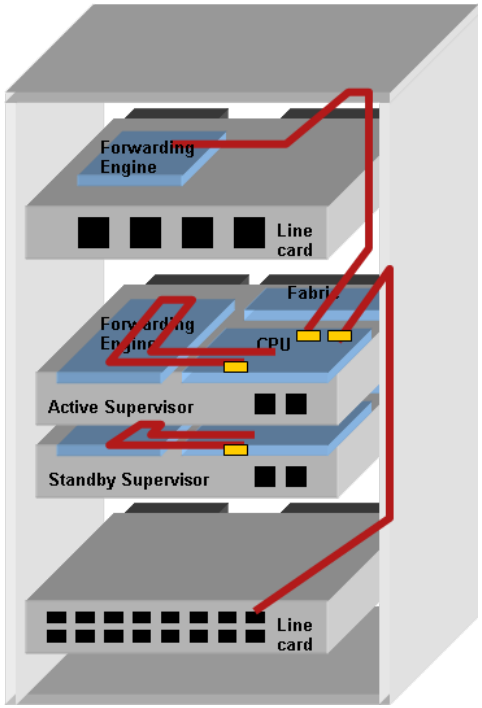
Troubleshooting & Optimization

Generic OnLine Diagnostics (GOLD)

CLI and scheduling for Functional Runtime Diagnostics

- Bootup Diagnostics (upon bootup and OIR)
- Periodic Health Monitoring (during operation)
- OnDemand (from CLI)
- Scheduled Testing (from CLI)
- Test Types include:
  - Packet switching tests
    - Are supervisor control plane & forwarding plane functioning properly?
    - Is the standby supervisor ready to take over?
    - Are linecards forwarding packets properly?
    - Are all ports working?
    - Is the backplane connection working?
  - Memory Tests
  - Error Correlation Tests
- Complementary to POST

Good Practice: schedule all non-disruptive tests periodically



Available from: CatOS 8.5(1), IOS 12.2(14)SX
Platforms: CBS 3xxx, Cat 3560, 3750, 6500, ME6524, 72xx, 10k, CRS

Troubleshooting & Optimization

Example: The effect of wear and tear – 1/2

Problem: Repeated insertion and removal of Modules can lead to wear and tear damage on connectors. This in turn can cause failures … how do you find out during operation, without power-cycling the box ?

Solution: Use GOLD to verify functionality of a mis-behaving module

1) Let's see which GOLD tests are available and scheduled for our Module:

```
Router# show diagnostic content module 3
Module 3:

  Diagnostics test suite attributes:
    M/C/* - Minimal level test / Complete level test / Not applicable
      B/* - Bypass bootup test / Not applicable
      P/* - Per port test / Not applicable
    D/N/* - Disruptive test / Non-disruptive test/ Not applicable
      S/* - Only applicable to standby unit / Not applicable
      X/* - Not a health monitoring test / Not applicable
      F/* - Fixed monitoring interval test / Not applicable
      E/* - Always enabled monitoring test / Not applicable
      A/I - Monitoring is active / Monitoring is inactive

  ID    Test Name                                 Attributes    (day hh:mm:ss.ms)
  ==== ===================================== ============ =================
    1) TestScratchRegister -------------> *B*N****A    000 00:00:30.00
    2) TestSPRPInbandPing --------------> *B*N****A    000 00:00:15.00
  :
   18) TestL3VlanMet ------------------> M**N****I    not configured
  :
```

See: http://www.cisco.com/en/US/docs/switches/lan/catalyst6500/ios/12.2SX/configuration/guide/diagtest.html

Example: The effect of wear and tear – 2/2

2) Now let's run TestL3VlanMet on-demand for Module 3:

```
Router# diagnostic start module 3 test 18
:
00:09:59: %DIAG-SP-3-MINOR: Module 3: Online Diagnostics detected a
Minor Error. Please use 'show diagnostic result <target>' to see
test results.
```

3) Then check the test results:

show diagnostics result module 3 detail

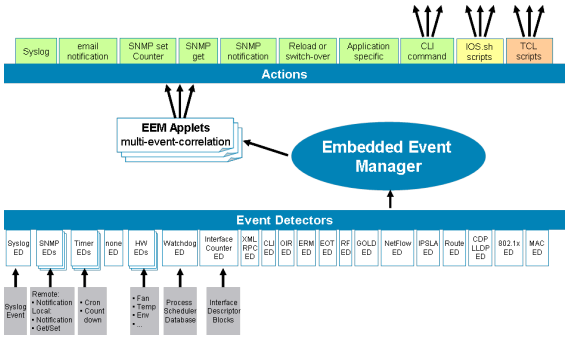
```
Router# show diagnostic result module 3
Module 3: CEF720 48 port 1000mb SFP  SerialNo : xxxxxxxx

  Overall Diagnostic Result for Module 3 : MINOR ERROR
  Diagnostic level at card bootup: minimal

  Test results: (. = Pass, F = Fail, U = Untested)
    1) TestTransceiverIntegrity:
   Port  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
   ------------------------------------------------------------------------
         U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U

   Port 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
   ------------------------------------------------------------------------
         U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U  U

:
:
   18) TestL3VlanMet ------------------> F
```

Troubleshooting & Optimization

GOLD and Embedded Event Manager

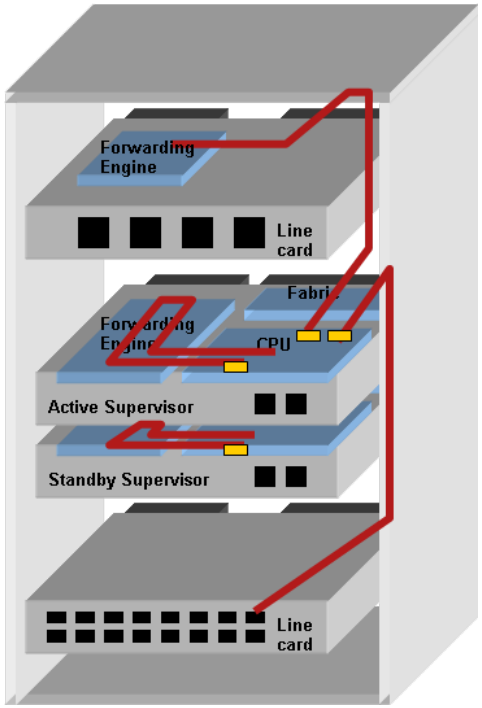
Combine GOLD and

Embedded Event Manager



- GOLD Event Detector: to trigger EEM actions based on GOLD test results
  (custom alerts, failover, diagnostics, ...)

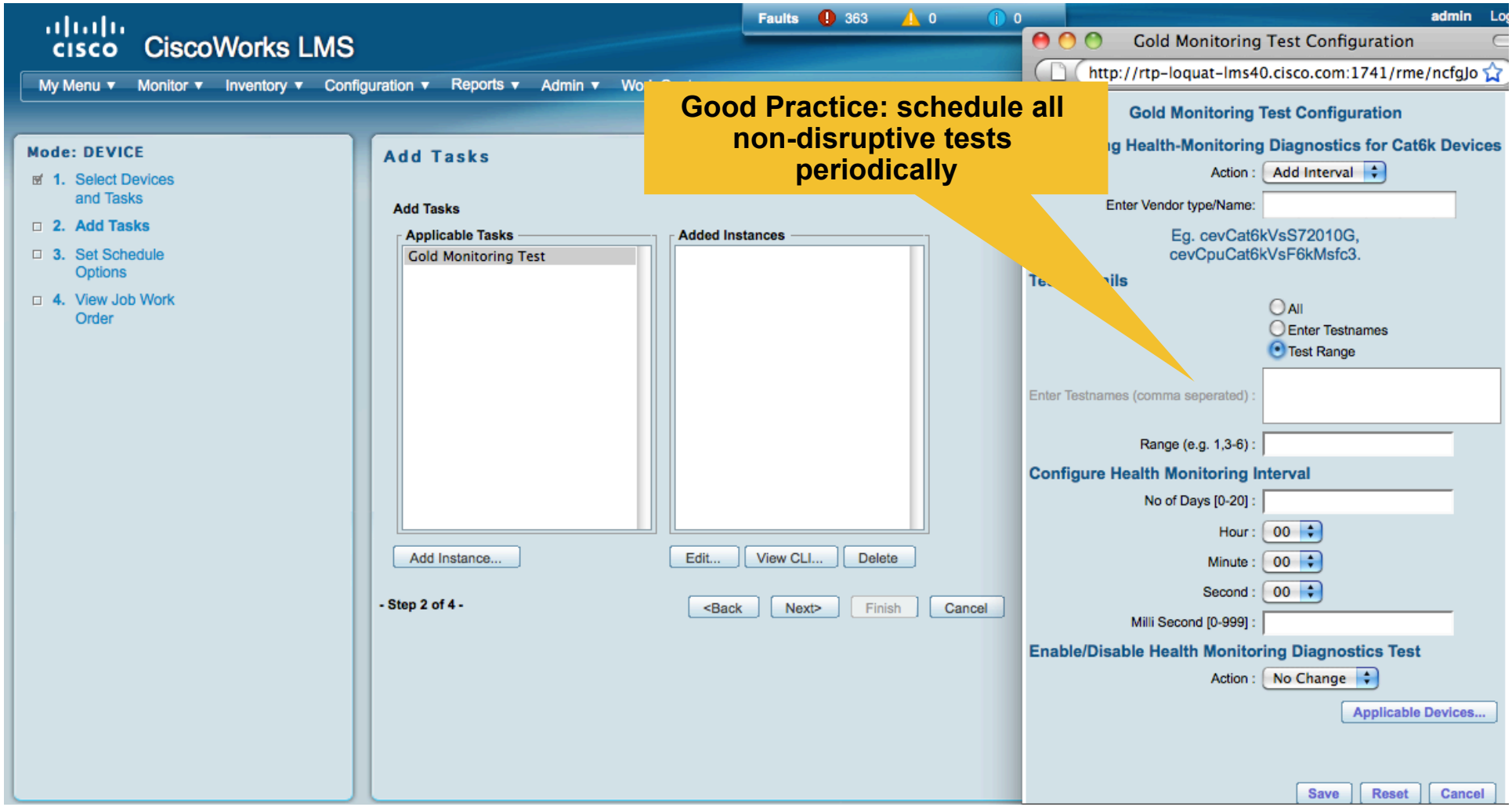
- OIR or CLI Event Detector: to trigger an on-demand GOLD test as post-validation of deployment or maintenance work



Troubleshooting & Optimization

GOLD and CiscoWorks LMS

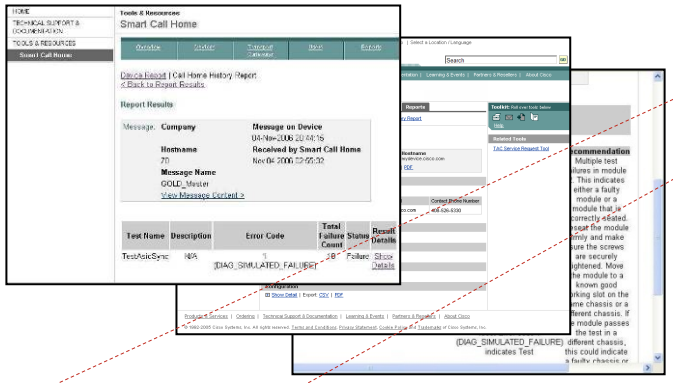
CiscoWorks LMS supports GOLD configuration and monitoring



Troubleshooting & Optimization

Smart Call Home – CCO Application

- Personalized Reports
  - Messages, diagnostics and recommendations
  - Inventory and configuration for all Call Home devices
  - Security alerts, Field notices, and End-of-Life notices
  - Configuration Sanity Analysis
  - PDF and XLS Export



Products & Services

Smart Call Home

Overview | Registration Management | Reports

Device Report | Call Home History Report | Global Summary Report | Registration Summary Report

< Back to Report Results

Message Details

Message:	Company	Generated on device at
	CISCO SYSTEMS, INC.	04-Jan-2007 06:07:43 AM (Local Time Zone)
	Hostname	**Processed by Smart Call Home at**
	Prod_-Cat6503-01	01-Mar-2009 10:36:29 AM(PST)
	Message Name	
	Diagnostic	
	View Message Header >	
	View Device Output >	

Overall Results within Analysis Period

Service Request	Technology	Sub-Technology	Problem Code
610856247 for USI1149012H	Other	Smart Call Home Demo Only - Do Not Use	HARDWARE_FAILURE

Problem Details WS-C6509-E with Host Name Prod_-Cat6503-01 and Supervisor WS-SUP720-3BXL reported GOLD Diagnostics test failure:

TestL3VlanMet on module WS-X6548-RJ-45 in slot 2 in USI1149012H
TestIngressSpan on module WS-X6548-RJ-45 in slot 2 in USI1149012H
TestEgressSpan on module WS-X6548-RJ-45 in slot 2 in USI1149012H
TestFirmwareDiagStatus on module WS-X6548-RJ-45 in slot 2 in USI1149012H
TestLoopback on module WS-X6548-RJ-45 in slot 2 in USI1149012H

Recommendation

There were multiple test failures in module 2 that very possibly have a single root cause.
Take the following steps to resolve the failure:
- Multiple test failures in module 2. This indicates either a faulty module or a module that is incorrectly seated.
- Reseat module 2 firmly and make sure the screws are securely tightened.
- Move the module to a known good working slot on the same chassis or a different chassis. If the module passes the test in a different chassis could indicate a faulty chassis or a module that is inserting an indirect fault.
- Rerun the test using the 'diagnostic start' command to ensure that the test continues to fail.
- If the problem continues to occur, replace module 2

The recommendation for each individual test failure is listed in the individual result below in case further troubleshooting is required.

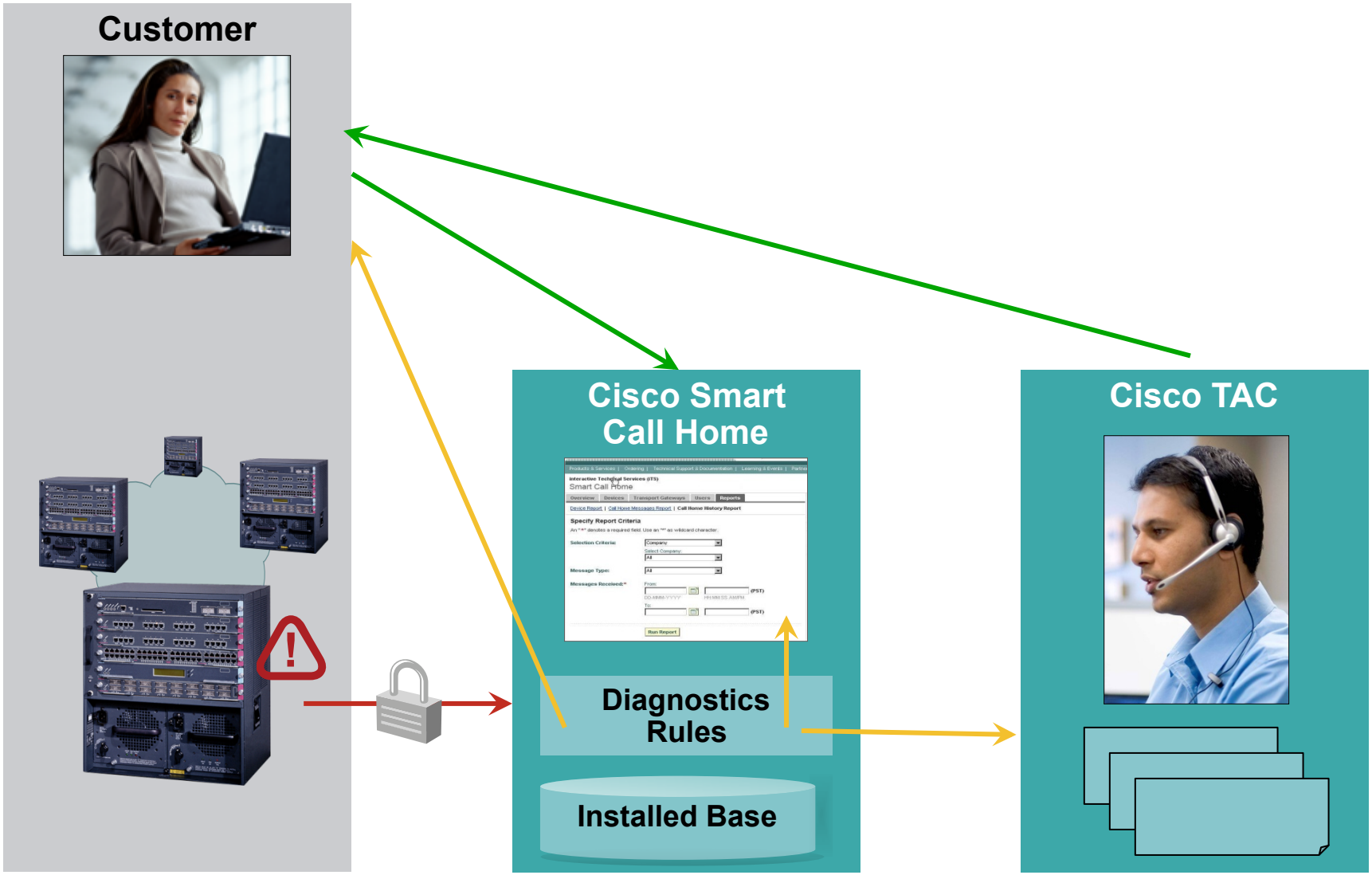
Individual Results within Analysis Period

Device	Test Name	Recommendation	Count	Status
USI1149012H	TestLoopback Show Details	Show Recommendation	1	Failure
USI1149012H	TestL3VlanMet		1	Failure
			1	Failure
			1	Failure

Recommendation

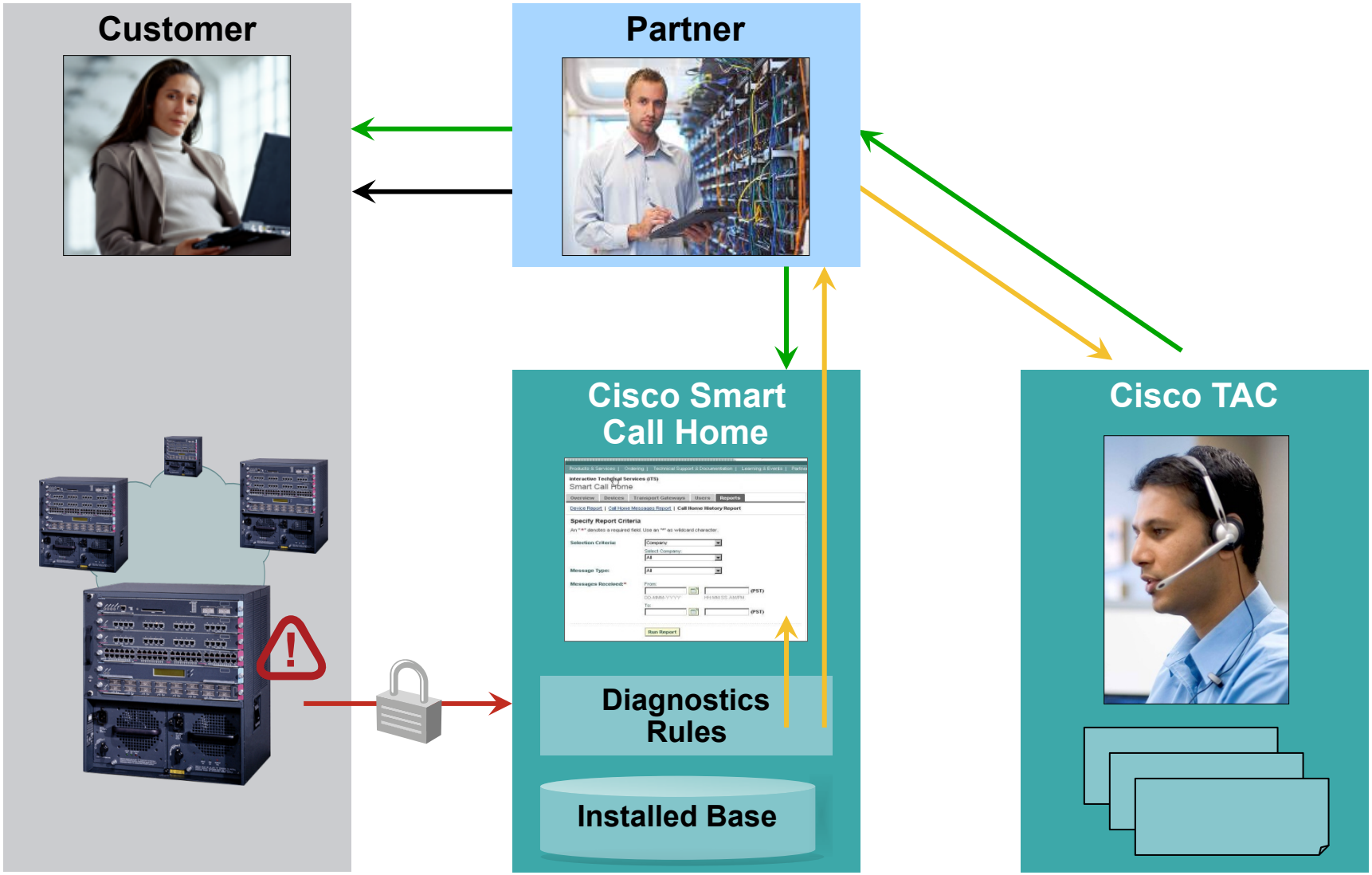
There were multiple test failures in module 2 that very possibly have a single root cause.
Take the following steps to resolve the failure:

Smart Call Home

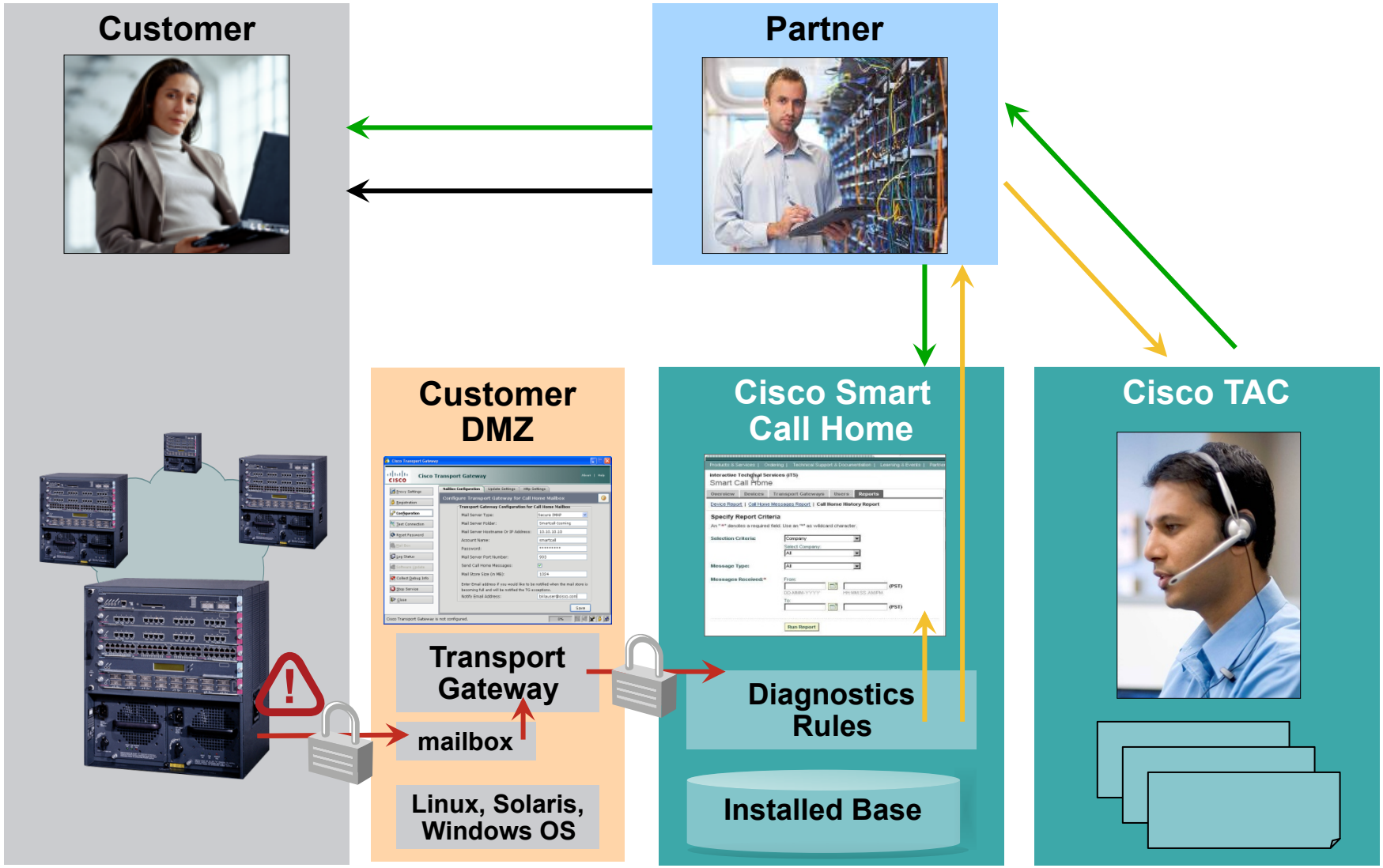


Troubleshooting & Optimization

Smart Call Home with a Partner

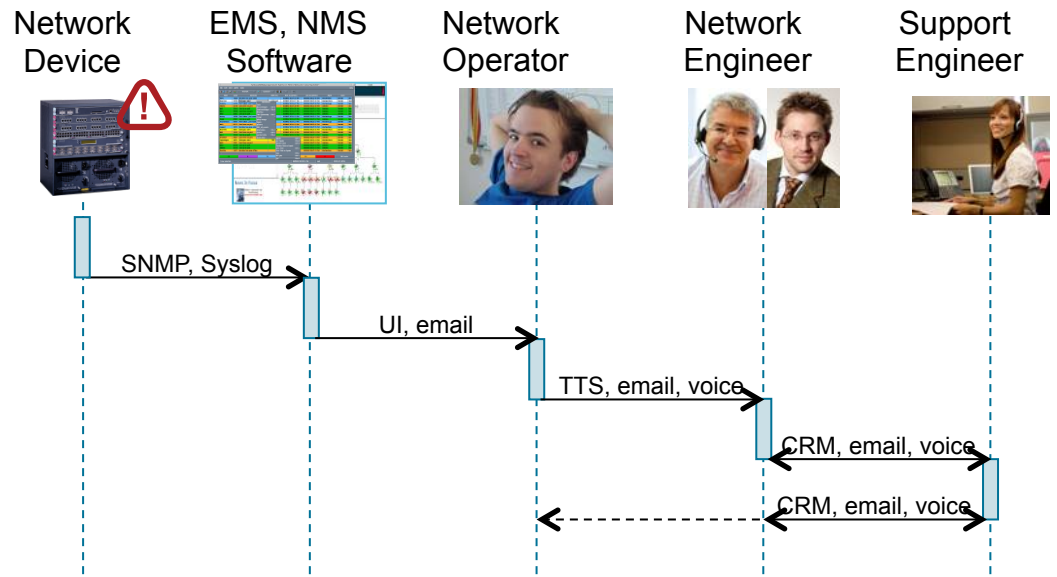


Smart Call Home – Transport Gateway



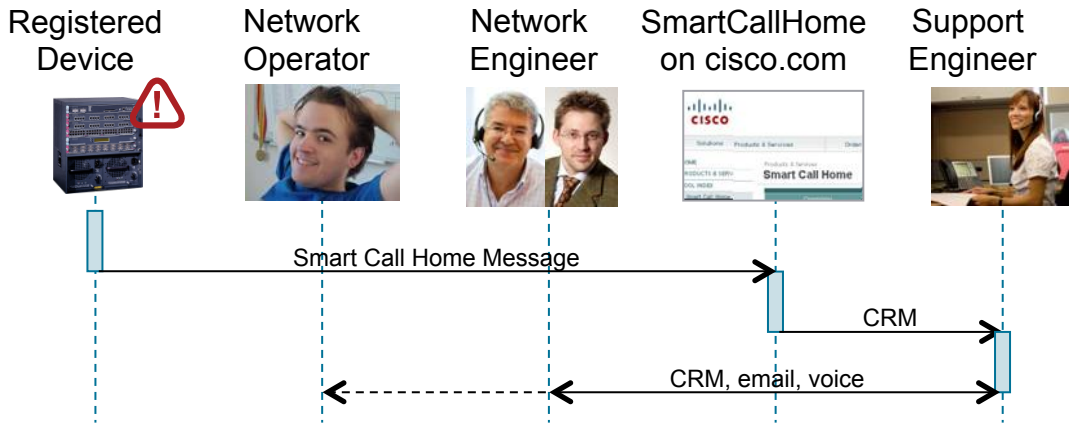
Troubleshooting & Optimization

Smart Call Home



From

- Late Surprises
- Multiple Manual Escalation Steps
- Iterative Problem Isolation
- Phone, Email based Data Exchange

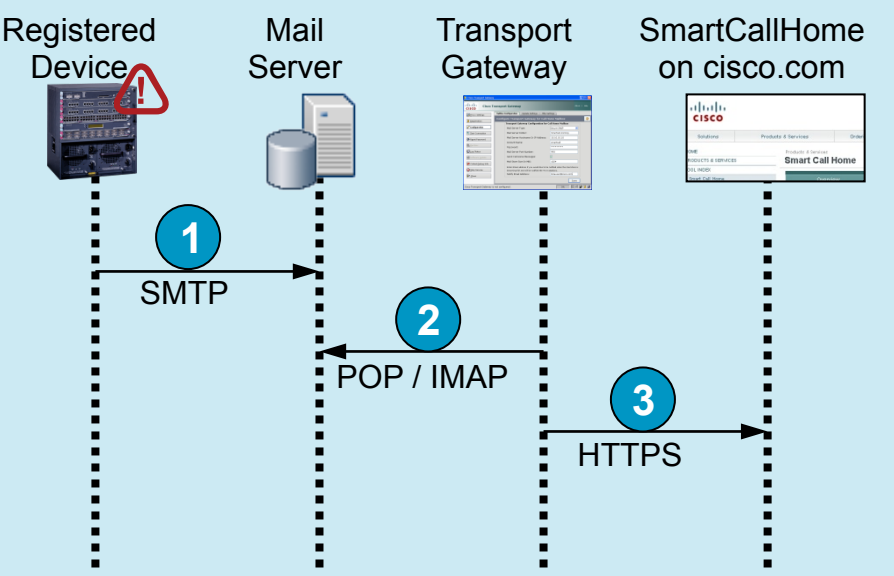


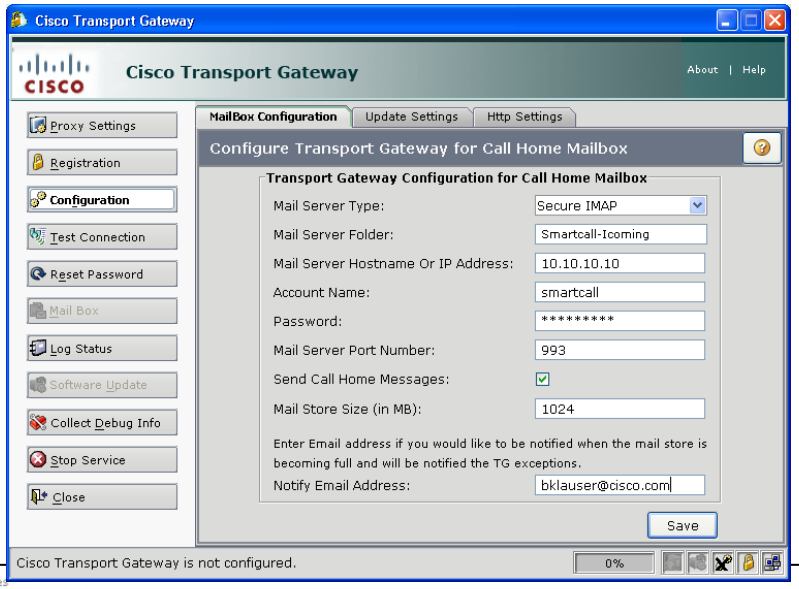
To

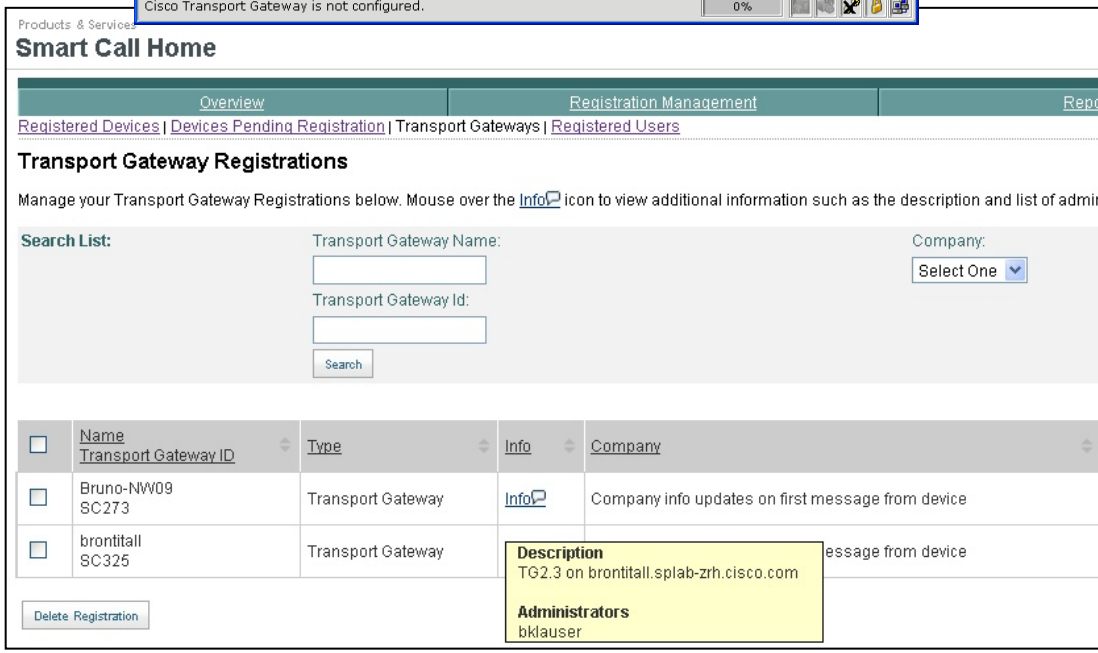
- Early Warnings
- Automated Flow
- Pinpoint Detailed Events
- Reporting and Exports

Troubleshooting & Optimization

Smart Call Home – Transport Gateway







- Platform Support
  - Redhat Linux
  - Solaris
  - Microsoft Windows
- Free Download and Install Guide

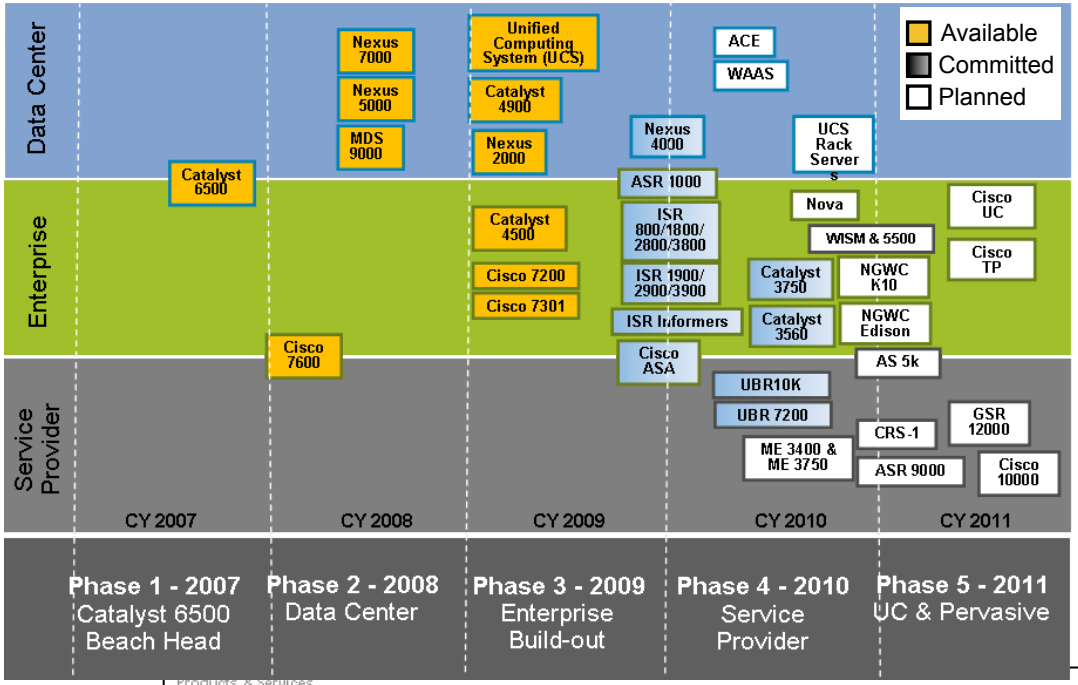
  www.cisco.com/go/smartcall

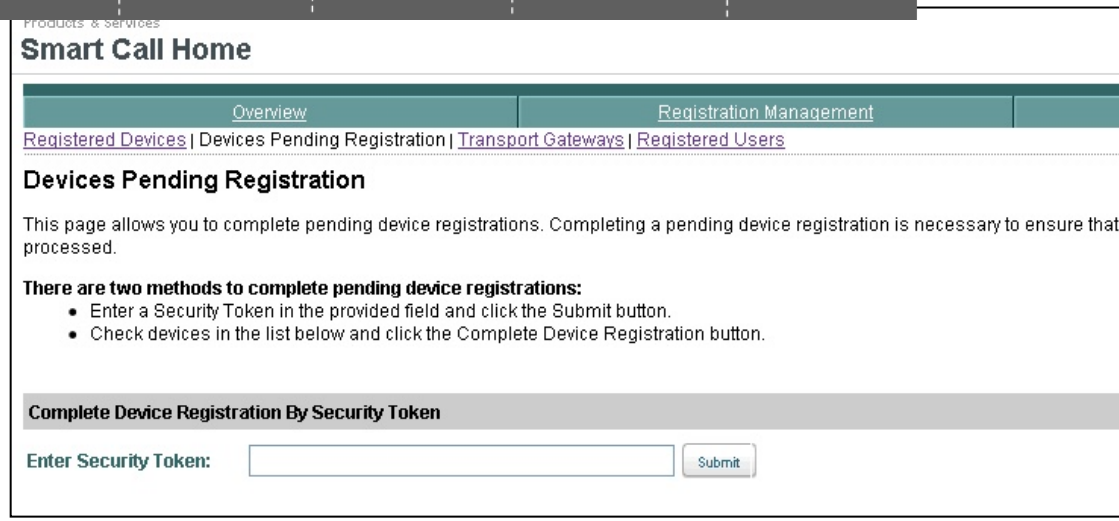
Troubleshooting & Optimization

Smart Call Home – How to get started ...

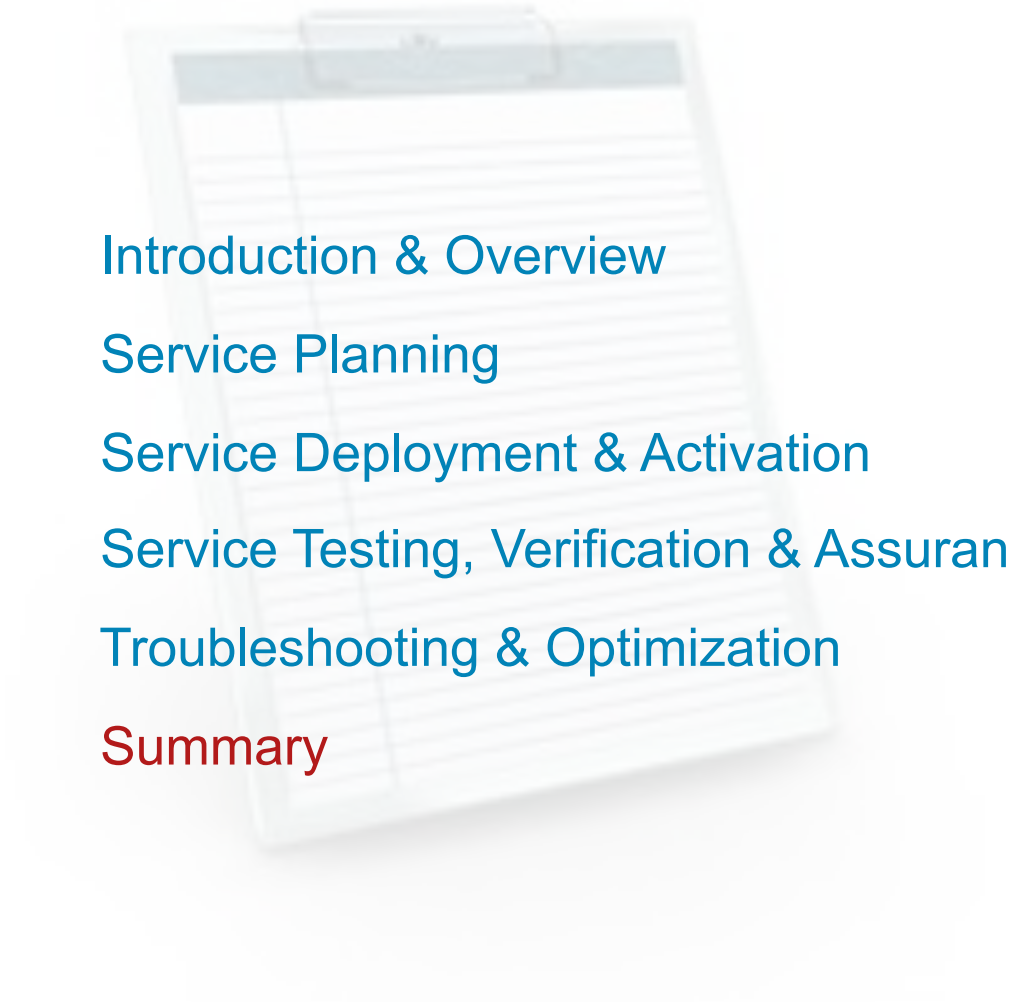
- Verify Device Coverage
  - Across segments
  - Platform support
- Enroll TG first if needed
- Step-by-Step Quick Start Enrollment Guides:

  www.cisco.com/go/smartcall
- Complete Enrollment by providing Security Token received via email





Agenda



Introduction & Overview

Service Planning

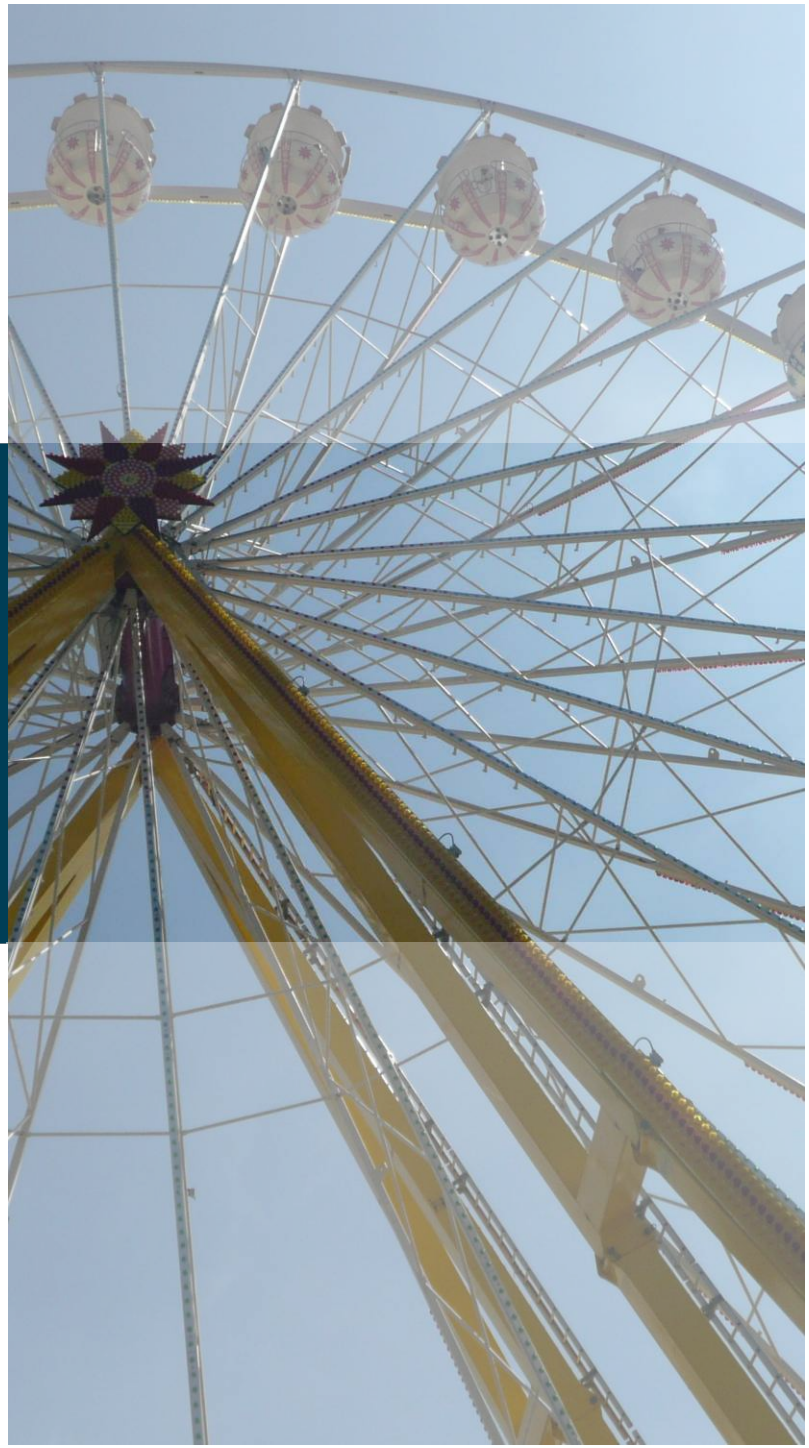
Service Deployment & Activation

Service Testing, Verification & Assurance

Troubleshooting & Optimization

➲ Summary

References



Q & A
References – Instrumentation

Device Manageability Instrumentation (DMI) www.cisco.com/go/instrumentation

- Embedded Event Manager (EEM): www.cisco.com/go/eem
- Cisco Beyond – EEM Community: www.cisco.com/go/ciscobeyond
- Embedded Menu Manager (EMM): http://tinyurl.com/emm-in-124t
- Embedded Packet Capture (EPC): www.cisco.com/go/epc
- Flexible NetFlow: www.cisco.com/go/netflow and www.cisco.com/go/fnf
- GOLD: http://www.cisco.com/en/US/products/ps7081/products_ios_protocol_group_home.html
- IPSLA (formerly SAA, formerly RTR): www.cisco.com/go/ipsla
- Network Analysis Module: http://www.cisco.com/go/nam
- Network Based Application Recognition (NBAR): www.cisco.com/go/nbar
- Security Device Manager (SDM): http://www.cisco.com/go/sdm
- Smart Call Home: www.cisco.com/go/smartcall
- Web Services Management Agents (WSMA): http://tinyurl.com/wsma-in-150M
- Cisco Configuration Engine (CCE): www.cisco.com/go/ciscoce

- **Feature Navigator: www.cisco.com/go/fn**
- **MIB Locator: www.cisco.com/go/mibs**

References

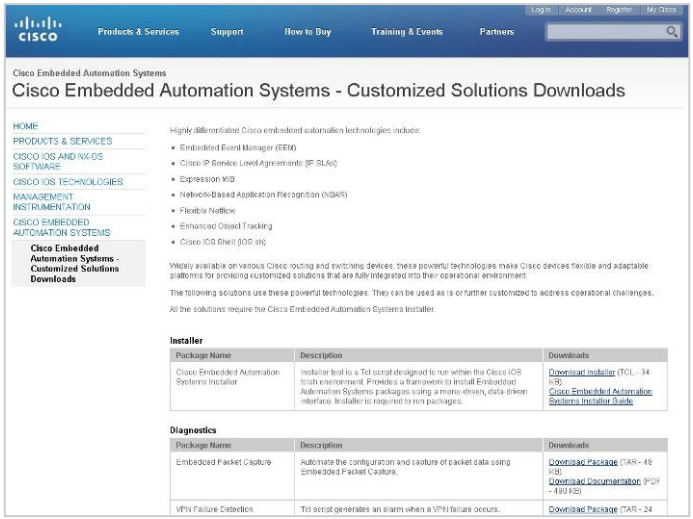
Embedded Automation Systems (EASy)

Embedded Automation Systems (EASy)

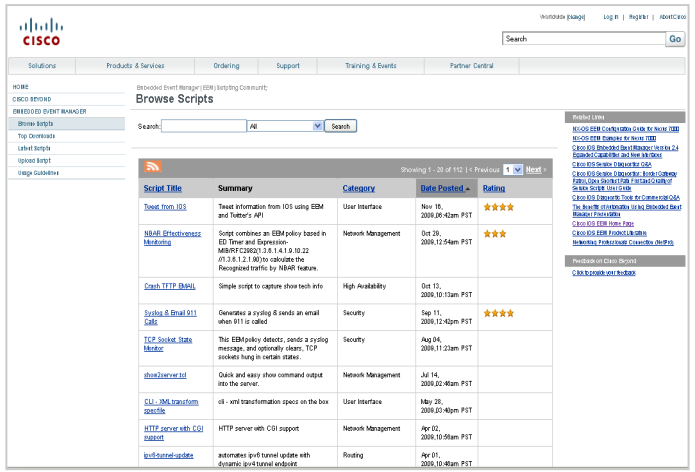
1. Browse and Download EASy Packages
   www.cisco.com/go/easy
2. Make Sure to also download EASy Installer
3. Browse Other Embedded Automations
   www.cisco.com/go/ciscobeyond
4. Learn About The Technology Under The Hood
   www.cisco.com/go/instrumentation
   www.cisco.com/go/eem
   www.cisco.com/go/pec
5. Discuss, Ask Questions, Suggest Answers
   supportforums.cisco.com
6. Upload your own Examples to CiscoBeyond
   www.cisco.com/go/ciscobeyond
7. Engage via ask-easy@cisco.com

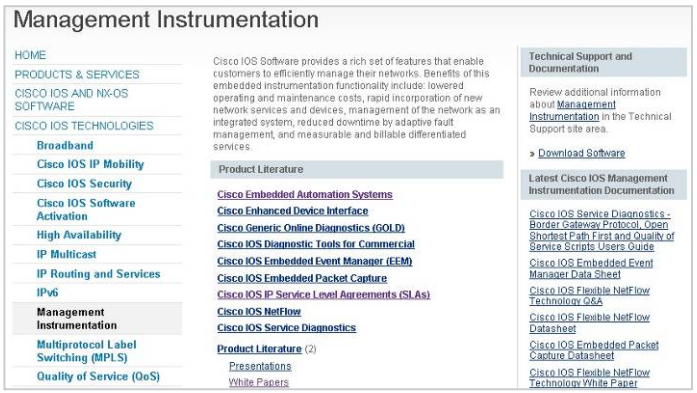
References
Embedded Automation Systems (EASy)

www.cisco.com/go/easy

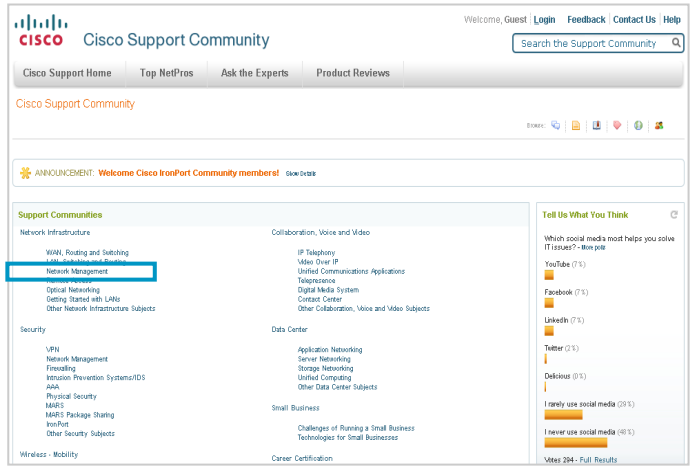


www.cisco.com/go/ciscobeyond





www.cisco.com/go/instrumentation



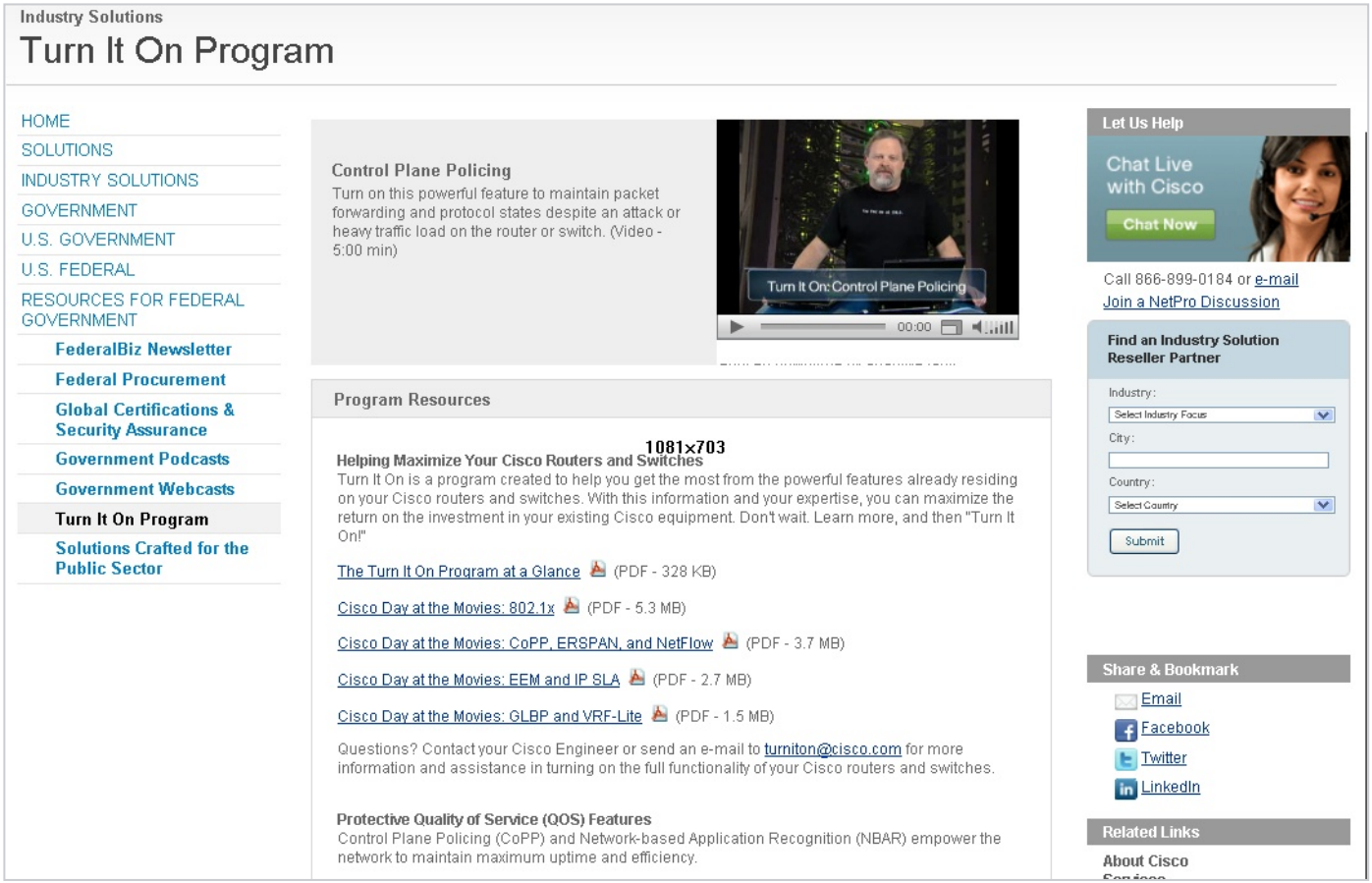
supportforums.cisco.com

References
Network Automation @ Turn It On

www.cisco.com/go/turniton

Turn It On Program

includes several small Network Automation Examples around Cisco IOS unique features



References

TechWise TV Episode 73 (August 2010)

Recorded at CiscoLive 2010

Targeted at Geeks and TDMs

Small, real, practical, engaging examples

Cult Status of Robb and Jimmy Ray ☺

Featuring Cisco Solutions Experts Robb Boyd and Jimmy Ray Purser and Borderless Networks Host Jennifer Geisler

Special Guests:

- **Joe Clarke**
- **Tracy Jiang**
- **Matt Lambert**
- **Bruno Klauser**
- **David Lin**

See: http://www.cisco.com/en/US/solutions/ns340/ns339/ns638/ns914/html_TWTV/twtv_episode_73.html

Localized Events / Broadcasts are possible …

References

Network Automation @ CiscoLive 2011

Session Catalogue

The content catalogue is a preliminary guide to the sessions taking place at Cisco Live 2011, London and are therefore subject to change. Please refer to schedule builder for the full session listing and schedule.

Switch to Basic Search

Search for items containing: Automation
Leave search field blank to see all records
in the: Title
Type: Show All
Level: Show All
Session Group: Show All
Search

Show Descriptions | Print View

All | Type | Technical Level | Session Group: | Day

Session ID	Title	Type
BRKCDN-2005	Building Innovative Solutions with Embedded Automation Technologies	Cisco Developers Program - 2 hour
BRKCRS-2929	Industrial Automation Switching	Technical Breakout - 90 mins
BRKIPM-2090	Implementing Network Automations	Technical Breakout - 90 mins
BRKNMS-2464	13 Smart Automations to Configure Your Cisco IOS Network	Technical Breakout - 2 hours
BRKNMS-2465	13 Smart Automations to Monitor Your Cisco IOS Network	Technical Breakout - 2 hours
BRKNMS-2466	13 Smart Automations to Troubleshoot Your Cisco IOS Network	Technical Breakout - 2 hours
LABNMS-1262	Implementing Network Automation Module 0 - Basics	Lab: Self-Paced
LABNMS-1263	Implementing Network Automation Module 1 - Planning	Lab: Self-Paced
LABNMS-1264	Implementing Network Automation Module 2 - Deployment	Lab: Self-Paced
LABNMS-1265	Implementing Network Automation Module 3 - Monitoring	Lab: Self-Paced
LABNMS-1266	Implementing Network Automation Module 4 - Troubleshooting	Lab: Self-Paced
LABNMS-1422	Network Automation Solutions using Cisco IOS EEM	Lab: Self-Paced
LABNMS-2001	Advanced Network Automation and Solutions using Cisco IOS EEM	Lab: Instructor Led - 2 hours
TECNMS-2234	Designing and Implementing Network Automation	Technical Seminar - 8 hours

1. Navigate to http://bit.ly/cSMV3N
2. Search for ‚Automation‘
3. Enjoy !

Q & A

References – Conferences and Events

- Cisco Networkers and CiscoLive
  - Life Events in Europe, Emerging Markets and US
  - Virtual Events and Recordings

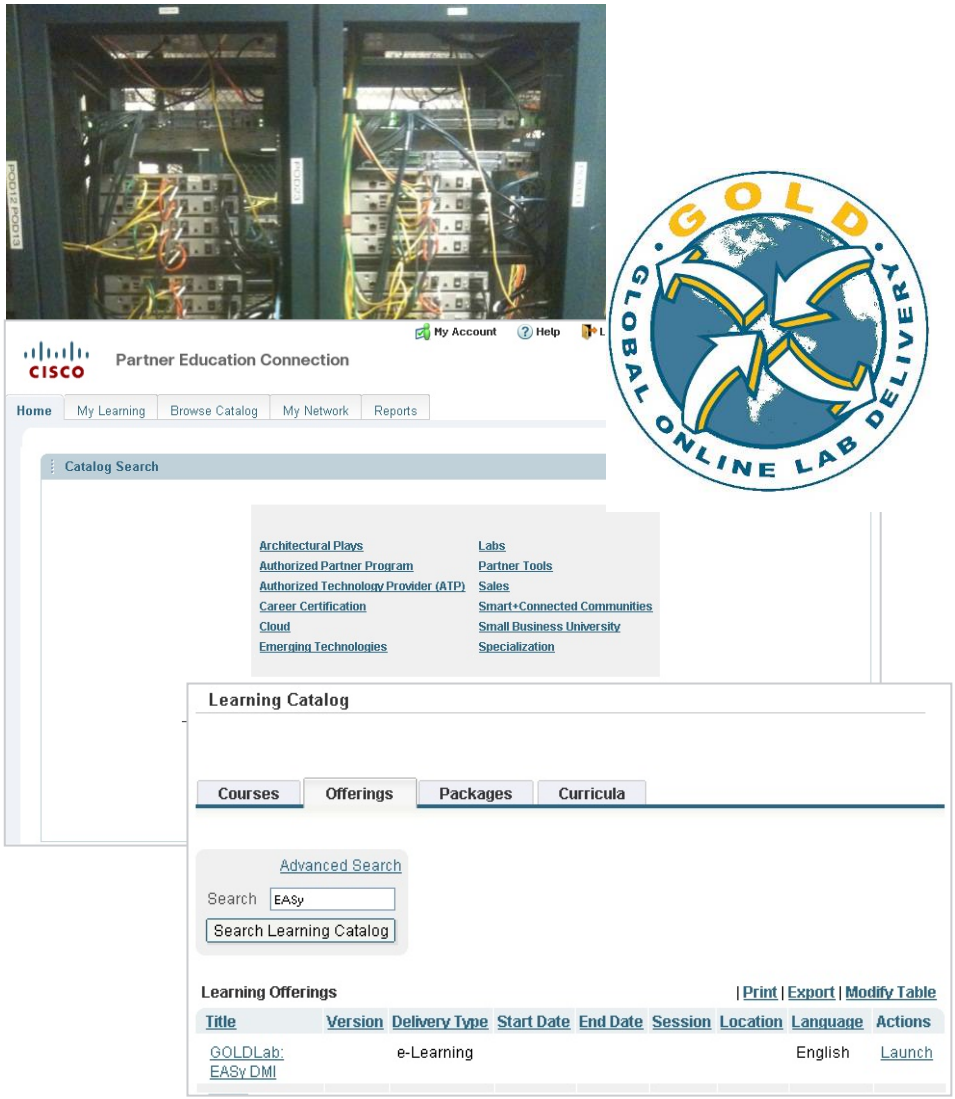
- Network Automation
  November 8-10th 2011, Paris

- NEMA
  October 28th 2011, Paris
  http://nema.networkembedded.org/

- SASO and IEEE SelfMan
  - Contributions since 2006
- EMANICS
- CNSM, AIMS, IM and NOMS

References

Network Automation Hands-On Lab – PEC



1. Navigate to PEC http://www.cisco.com/go/pec
2. Click on >Launch
3. Search for ‚%EASy%‘ in the Title
4. Enjoy !

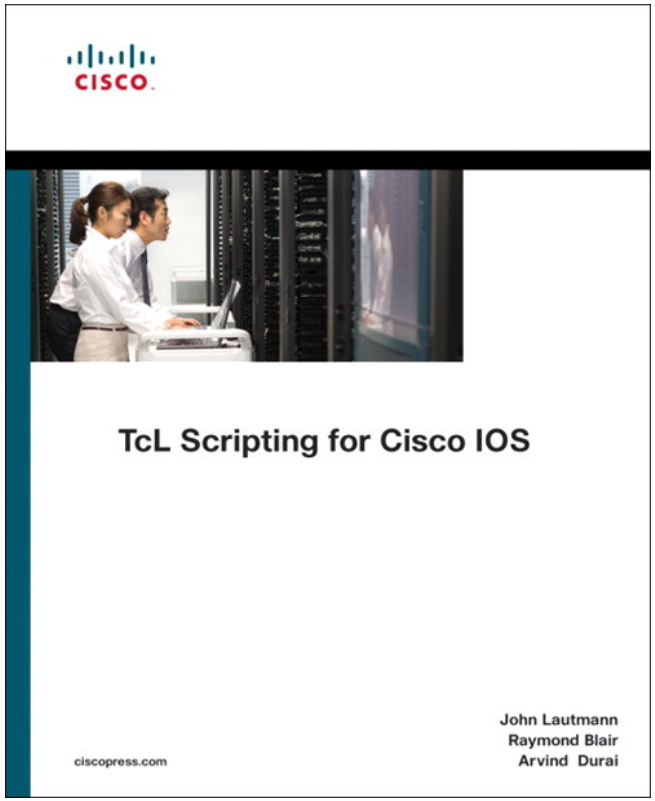
Until Oct 2010

V1: EASy DMI Lab

From Feb 2011

V2: Network Automation made EASy

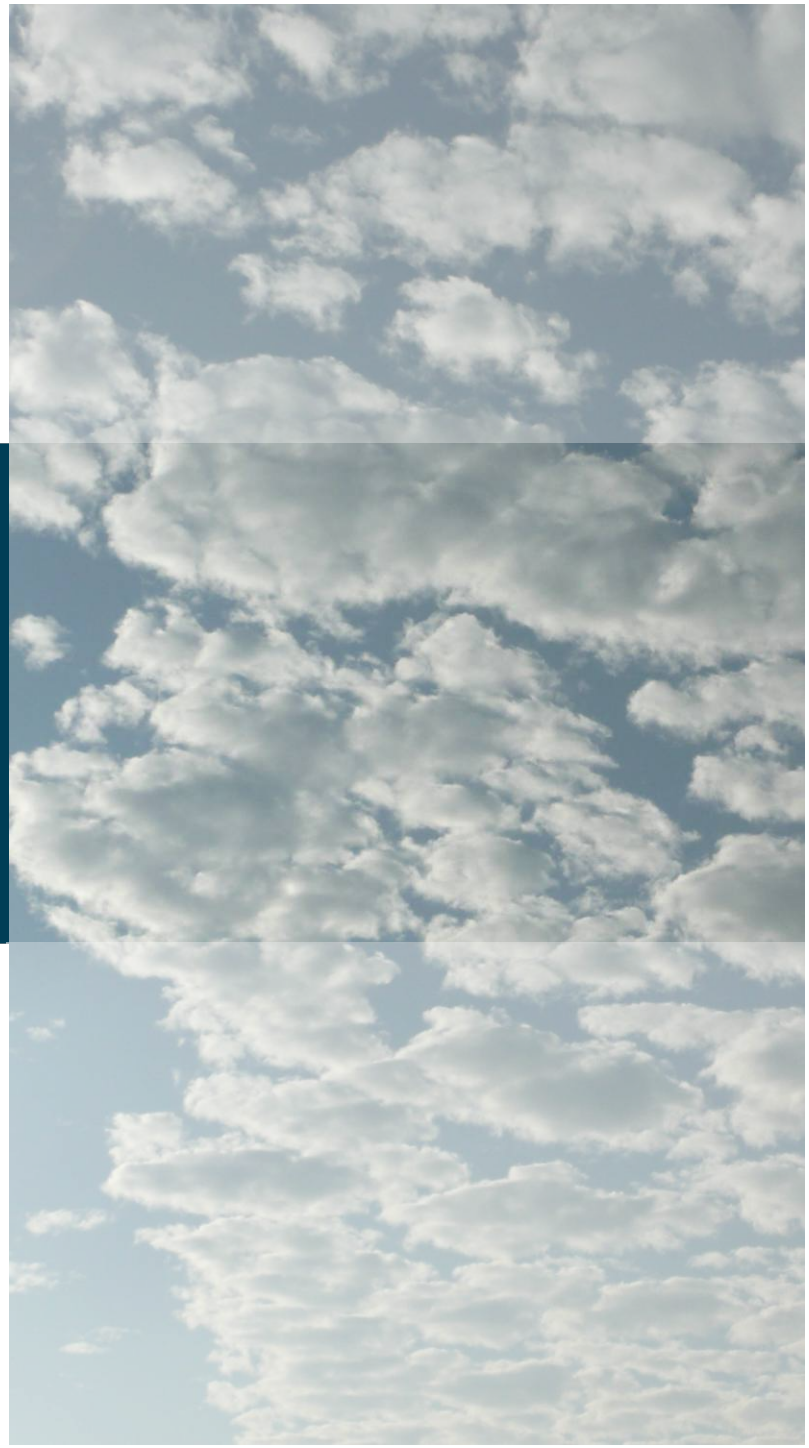
Q & A
Recommended Reading



Published: Jun 9, 2010

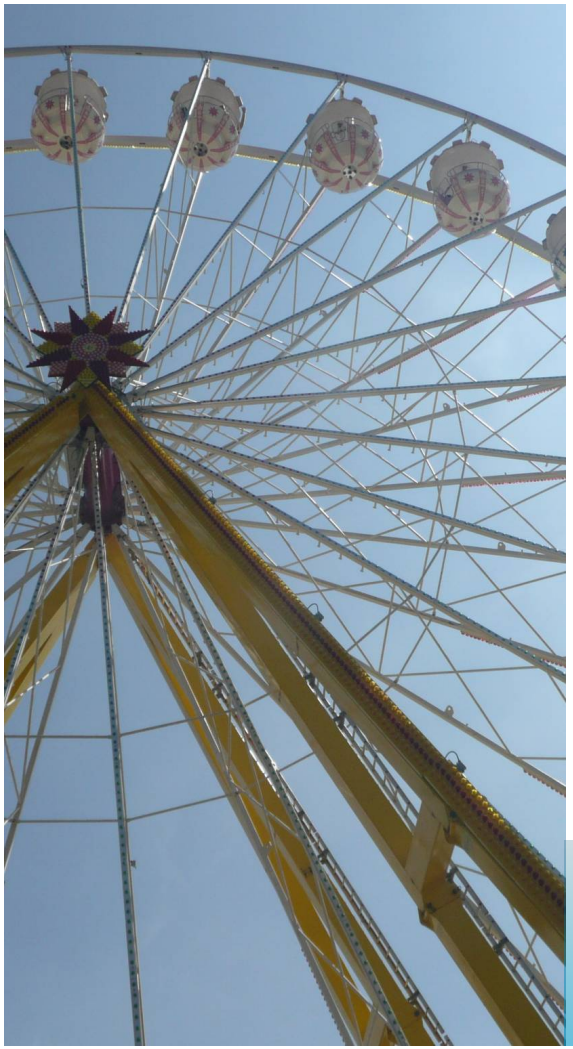
www.ciscopress.com/title/1587059452

Questions?



Wrap-Up & Close

In Summary



Network Automation …

Based on Embedded Automation Systems (EASy)
Device Manageability Instrumentation (DMI)

… is a Paradigm Change
… offers opportunities far beyond 'just' OPEX savings
… extends beyond the traditional operational life cycle
… is EASy to adopt now

How will You use Network Automation?

Thank You

Please Complete Your Evaluations

bklauser@cisco.com