Advanced IOS Device Instrumentation

May 2006

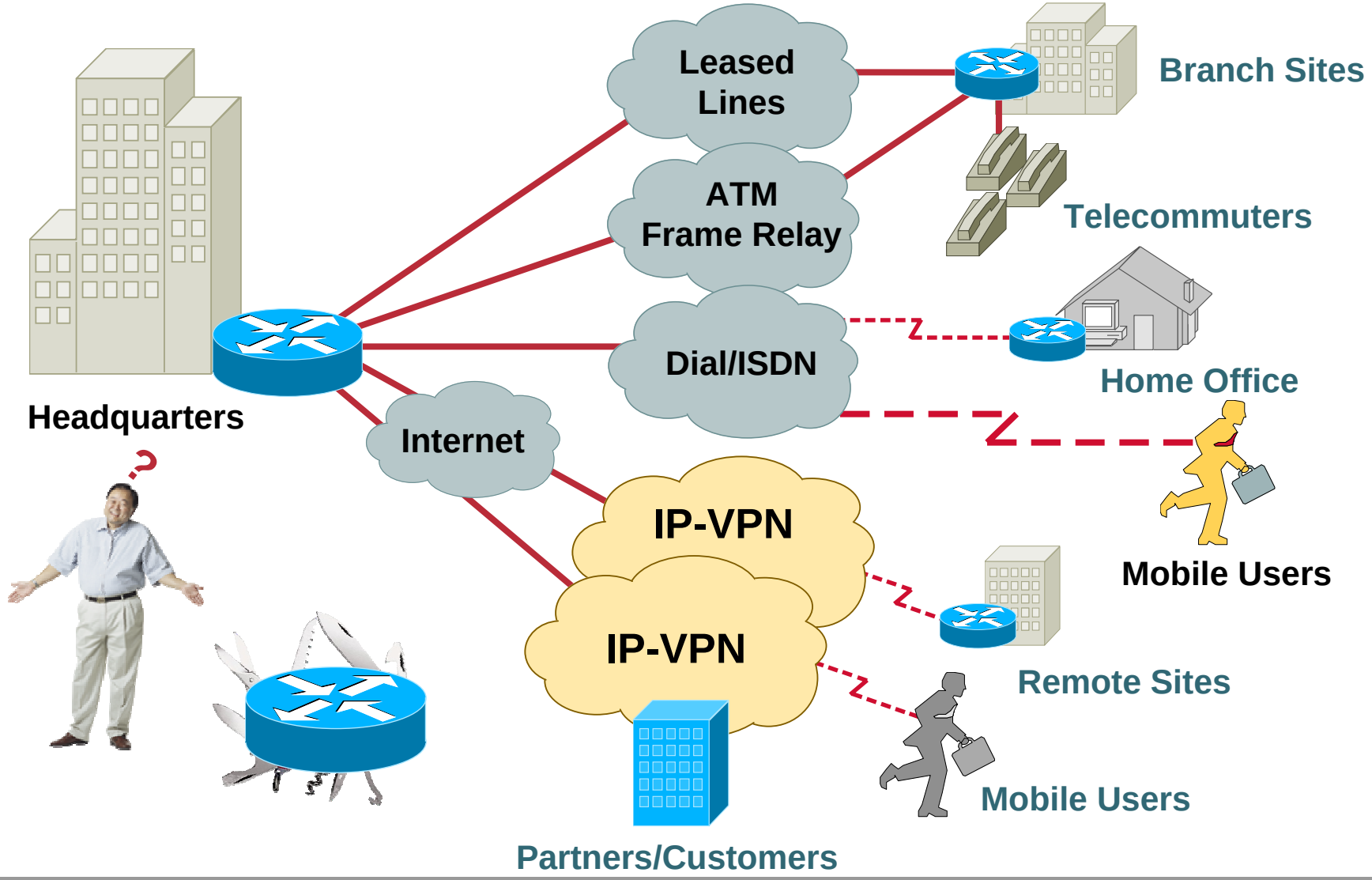
Agenda

- **Introduction**
- **Embedded Management Tools**
  - **Tool Command Language (TCL)**
  - **Embedded Event Manager (EEM)**
  - **Embedded Syslog Manager (ESM)**
  - **Embedded Resource Manager (ERM)**
  - **Command Scheduler (Kron)**
  - **Configuration Replace and Rollback**
  - **Contextual Configuration Diff Utility**
- **Enhanced Device Interface**

Agenda (Cont.)

- **Practical Applications**
- **Summary and Conclusion**

Got Tools?


Leased Lines
ATM Frame Relay
Dial/ISDN
Internet
IP-VPN
IP-VPN
Branch Sites
Telecommuters
Home Office
Mobile Users
Remote Sites
Mobile Users
Headquarters
Partners/Customers

Agenda

- **Introduction**
- **Embedded Management Tools**
  - **Tool Command Language (TCL)**
  - **Embedded Event Manager (EEM)**
  - **Embedded Syslog Manager (ESM)**
  - **Embedded Resource Manager (ERM)**
  - **Command Scheduler (Kron)**
  - **Configuration Replace and Rollback**
  - **Contextual Configuration Diff Utility**

Tool Command Language

Tool Command Language (TCL) Overview

- **TCL is a multithreaded interpreted scripting language**
- **Language resources found at:**

  http://www.tcl.tk/
- **TCL 7.x has been in Cisco IOS Software since 1994**
- **TCL 8.3.4 first released in Cisco IOS Software Release 12.3(2)T and merged into Release 12.2(25)S**

Tool Command Language (TCL) Features

- **Support for scripts compiled with the TCLPro bytecode**
- **Support for TCL namespaces**
- **Allows execution of exec commands and Cisco IOS Software configuration**

Tool Command Language (TCL) Uses Within Cisco IOS Software

- **Build custom show commands**
- **Access SNMP objects**
- **Integrate with the Embedded Syslog Manager and Embedded Event Manager**
- **Build Interactive Voice Response (IVR) scripts**
- **Consolidate complex configuration commands**
- **Autoconfiguration**

Tool Command Language (TCL)
Starting the Interpreter

```
Router#tclsh

Router(tcl)#
```

Tool Command Language (TCL) Configuration

```
Router(config)#scripting tcl ?
  encdir       Specify path for TCL character encoding files
  init         Specify path for TCL initialization script
  low-memory   Configure low water memory mark
```

- **The encdir and init values can be any Cisco IOS URI (ie: disk:, slot:, tftp:, etc.)**
- **Use the `low-memory` command to avoid crashes due to memory allocation (do not go less than 10% of total available memory)**

Tool Command Language (TCL) Configuration (Cont.)

Interactive Shell

TCL Cisco IOS Extended Commands

TCL Built In Command

Cisco IOS Command

```
Router#tclsh
Router(tcl)#puts "Hello Networkers"
Hello Networkers

Router(tcl)#exit
Router#
```

Tool Command Language (TCL) Configuration (Cont.)

Running Cisco IOS Commands

TCL Cisco IOS Extended Commands

TCL Built In Command

Cisco IOS Command

```
Router(tcl)#set output [exec "show interface fa0/0 description"]
Interface                      Status         Protocol Description
Fa0/0                          up             up       FlashNet
Management Connection
Router(tcl)#log_user 0
0
Router(tcl)#set output [exec "show interface fa0/0 description"]

Router(tcl)#puts $output
Interface                      Status         Protocol Description
Fa0/0                          up             up       FlashNet
Management Connection
```

Tool Command Language (TCL) Configuration (Cont.)

TCL and CLI Configuration Commands

TCL Cisco IOS Extended Commands

TCL Built In Command

Cisco IOS Command

```
Router(tcl)#ios_config "interface fa0/0" "description Networkers
Uplink"

Router(tcl)#set output [exec "show interface fa0/0 description"]

Router(tcl)#puts $output
Interface                      Status         Protocol
Description
Fa0/0                          up             up       Networkers
Uplink
```

Tool Command Language (TCL) Configuration (Cont.)

Writing to the Input Buffer

TCL Cisco IOS Extended Commands

TCL Built In Command

Cisco IOS Command

```
Router(tcl)#typeahead "show run\n"

Router(tcl)#show run
Building configuration...
Current configuration : 8245 bytes
!
! Last configuration change at 22:05:49 CET Sat Mar 10 2005
!
version 12.0
no service pad

…
```

Tool Command Language (TCL) Configuration (Cont.)

Capturing Cisco IOS Errors

TCL Cisco IOS Extended Commands

TCL Built In Command

Cisco IOS Command

```
Router(tcl)#set line "snmp server community RO"
Router(tcl)#if {[catch {ios_config $line} result]} {
+>puts "Bad config command: \"$line\""
+>}
Bad config command: "snmp server community RO"
```

Tool Command Language (TCL) Configuration (Cont.)

Loading External Scripts

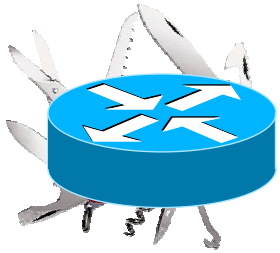
TCL Cisco IOS Extended Commands

TCL Built In Command

Cisco IOS Command

```
Router(tcl)#source slot0:myscript.tcl

Router(tcl)#source tftp://10.10.10.10/myscript.tcl

Router#tclsh tftp://10.10.10.10/myscript.tcl
```

Tip: Keep common scripts in a central TFTP archive



Tool Command Language (TCL) SNMP Support

- Requires an SNMP community to be configured on the router
- Provides easy access to SNMP objects and commands
  - snmp_getbulk—retrieves a large section of the MIB tree
  - snmp_getid—retrieves the system table
  - snmp_getnext—retrieves the next object in the MIB tree
  - snmp_getone—retrieves one object in the MIB tree
  - snmp_setany—sets an object in the MIB tree
- Data is returned in an XML format
- First introduced in Release 12.3(7)T

Tool Command Language (TCL)
SNMP Example

TCL Cisco IOS
Extended Commands
TCL Built In Command
Cisco IOS Command

```
Router(tcl)#snmp_getid public
{<obj oid='system.1.0' val='Cisco IOS Software, 7200 Software
(C7200-JS-M), Version 12.3(14)T, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2005 by Cisco Systems, Inc.
Compiled Fri 25-Mar-05 14:01 by yiyan'/>}
{<obj oid='system.2.0' val='products.108'/>}
{<obj oid='sysUpTime.0' val='71184284'/>}
{<obj oid='system.4.0' val=‘Dan Jerome'/>}
{<obj oid='system.5.0' val=‘dj.cisco.com'/>}
{<obj oid='system.6.0' val=‘Networkers 2005'/>}

Router(tcl)#snmp_setany private system.6.0 -d "Networkers 2006"
{<obj oid='system.6.0' val='Networkers 2006'/>}
```

Tool Command Language (TCL) Limitations

- **The following is a list of differences between the TCL 8.3.4 standards and Cisco IOS Software**

Command	Keyword	Argument	Supported
after	ms	*script*	Yes
file	atime	*atime*	No
file	mtime	*mtime*	No
fileevent			Yes*
history	!n		No
load			No

Tool Command Language (TCL)

- **Script Debugging**

  Use a UNIX or Windows TCL 8.3 interpreter to “sanity check” code

  Make sure log_user is set to 1 to get all possible errors

  Use Control+Shift+6 to interrupt a runaway script

Tool Command Language (TCL) Caveats

- **Use Release 12.3(14)T or later for best results**
- **Use `low-memory` to prevent malloc failures**
- **TCL process runs at medium priority, so be careful with loops**

Tool Command Language (TCL) Security Concerns

- No implied trust with TCL scripts
- Load scripts from network servers with care
- Use privilege levels to control access to the tclsh

```
Router(config)#username admin privilege 7 password cisco
Router(config)#username dan privilege 3 password cisco
Router(config)#privilege tcl all level 7 tclsh
Router(config)#line vty 0 903
Router(config-line)#login local

NMS_server% telnet Router
Trying 10.10.10.10...
Connected to Router.cisco.com.
Escape character is '^]'.
User Access Verification
Username: dan
Password:
Router#tclsh
Translating "tclsh"...domain server (10.10.10.10)
```

Tool Command Language (TCL)

- **Additional References**

  General Language Resources

  http://www.tcl.tk/

  Cisco IOS Scripting with TCL

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5207/products_feature_guide09186a00801a75a7.html

  Cisco Open Source Initiative (COSI) with scripts found in this session

  http://sourceforge.net/project/showfiles.php?group_id=25401&package_id=154317&release_id=332786

Embedded Event Manager

Embedded Event Manager (EEM) Overview

- **Service running in IOS (In-box monitoring)**
- **Offers the ability to monitor events and take informational, corrective or any desired action, when the monitor event occurs or when a threshold is reached via sw agents**
- **Advantages**

  Ability to take proactive actions based on configurable events

  Reduce network bandwidth by doing local event monitoring

Embedded Event Manager (EEM) Overview (Cont.)

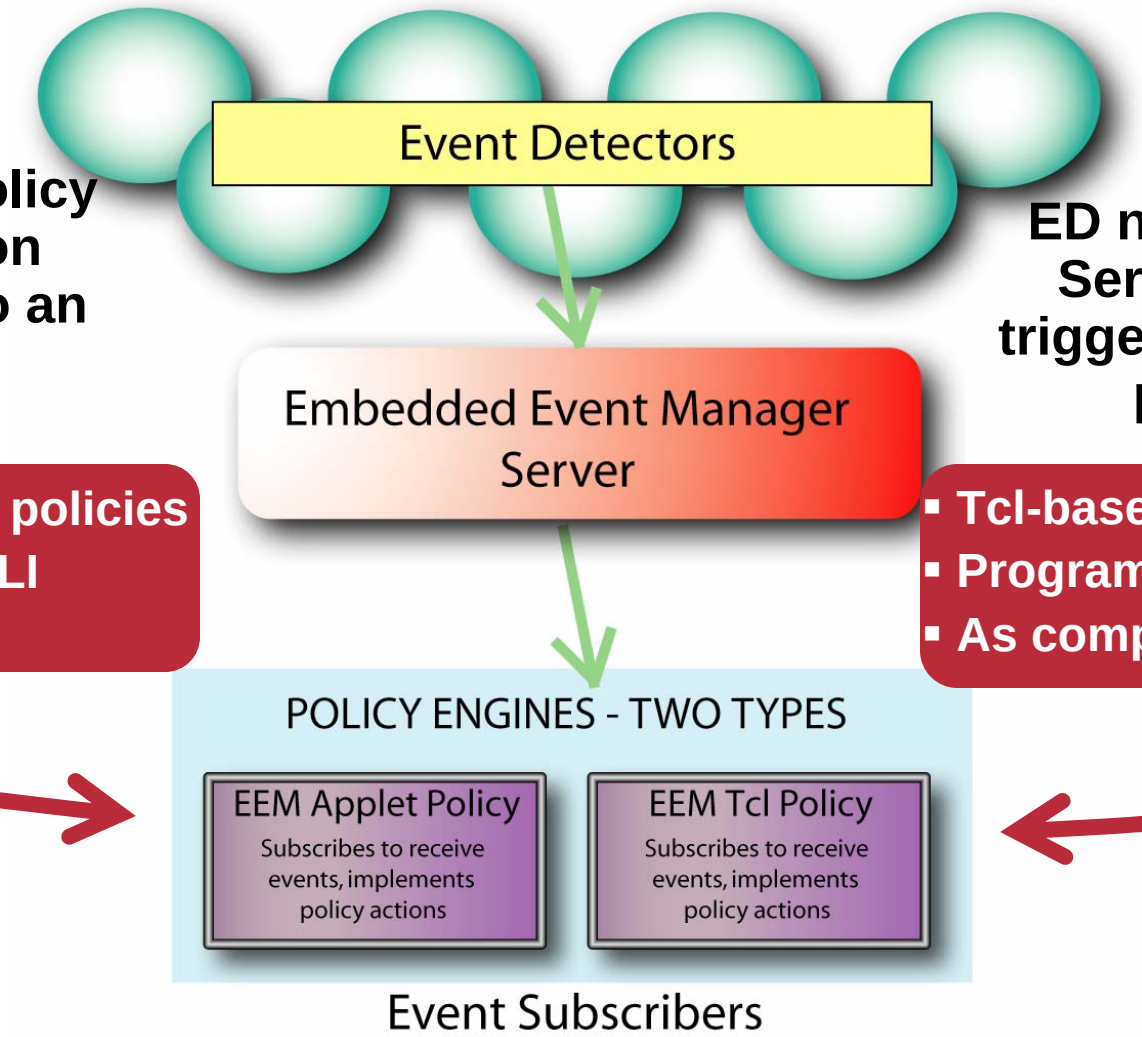
- **Version 1.0 introduced in Releases 12.0(26)S, 12.3(4)T**
- **Version 2.0 introduced in Release 12.2(25)S**
- **Version 2.1 introduced in Release 12.3(14)T**
- **Version 2.1.5 introduced in Release 12.2(18)SXF1**
- **Version 2.2 introduced in Release 12.4(2)T**

EEM Architecture

All of this is internal to Cisco IOS Software

Think of a policy as an action registered to an event

ED notifies EEM Server; which triggers interested policies



- **Applet-based policies**
- **Defined via CLI**
- **Simpler**

- **Tcl-based policies**
- **Programmed in Tcl**
- **As complex as you want**

EEM Policies

- **Entity which defines an event and actions to be taken**
- **Policies should be short scripts that require no less than 20 seconds to interpret and run**
- **Two Engines:**

  CLI Based (Applet Interface)

  Script Based (Tcl) – supported since EEM 2.1
- **Two Policy Types:**

  Synchronous – policy can affect the outcome of the event

  Asynchronous – policy runs asynchronously with the event

EEM Policy Simple Example

- **Write a special syslog message (even with different severity) when we see a particular syslog message**

  When someone leaves config mode, this message is seen:

```
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#exit
Router#
*Oct 15 06:29:44.113: %SYS-5-CONFIG_I: Configured from console
by vty0 (144.254.8.54)
```

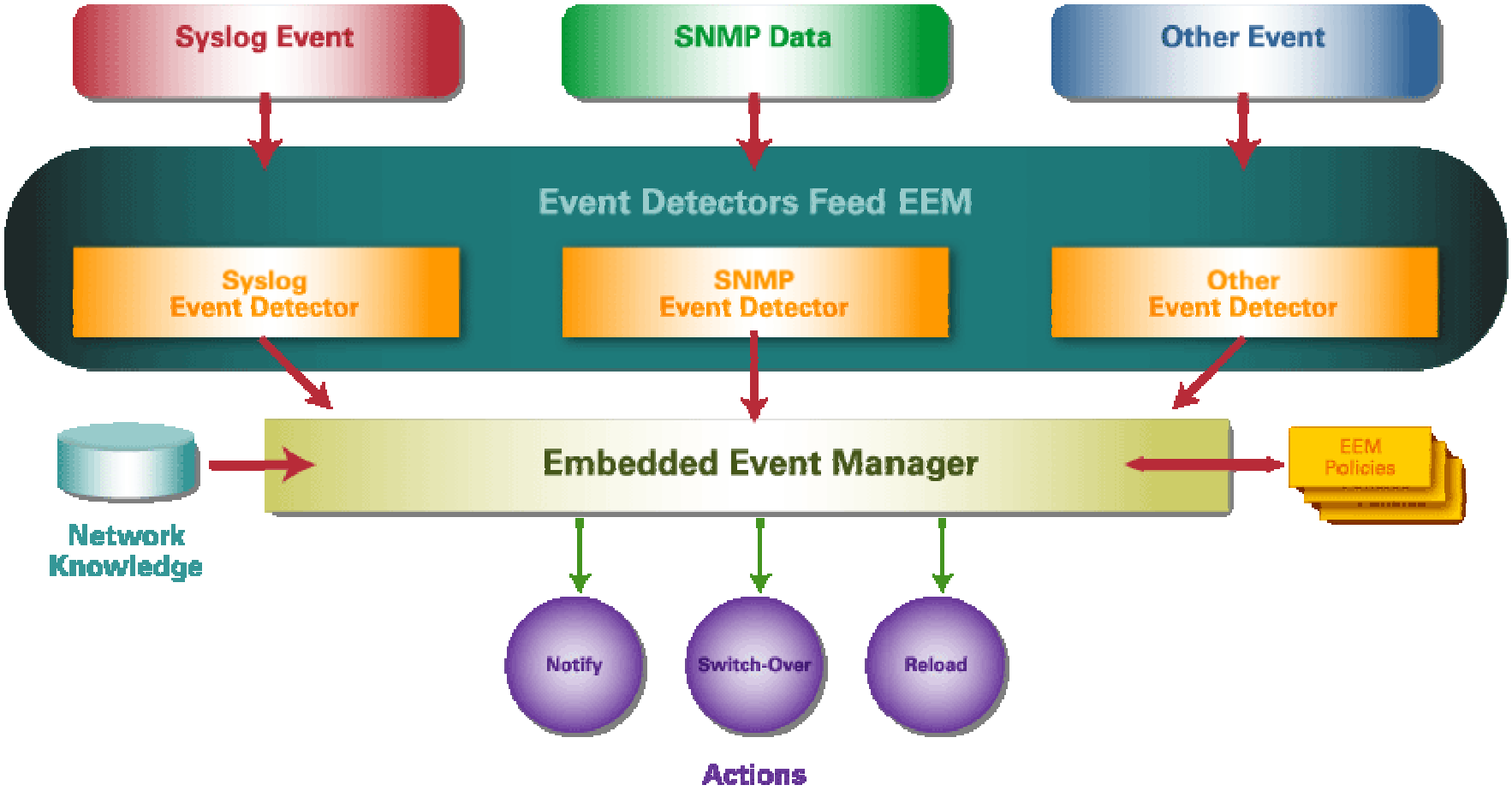
EEM Policy Simple Example (Cont.)

```
Router(config)# event manager applet CFGMSG
Router(config-applet)# event syslog pattern "%SYS-5-CONFIG_I:"
Router(config-applet)# action 1.0 syslog priority warnings msg
“Configuration event occurred“
```

```
Router(config-applet)# exit
Router(config)# exit
Router#
*Oct 15 06:42:34.773: %SYS-5-CONFIG_I: Configured from console by
vty0 (144.254.8.54)
*Oct 15 06:42:34.789: %HA_EM-4-LOG: CFGMSG: Configuration event
occurred
```

```
Router#sh event manager policy registered
No.  Class   Type    Event Type  Trap  Time Registered           Name
1    applet  system  syslog      Off   Sat Oct 15 06:42:31 2005  CFGMSG
 pattern {%SYS-5-CONFIG_I:}
 action 1.0 syslog priority warnings msg "Configuration event occurred"
```

Cisco IOS Embedded Event Manager 1.0 Basic Architecture



Note - EEM 1.0 originally developed to support Cisco IOS High Availability, but applicable to more general situation

Embedded Event Manager 1.0

- **Introduced the following event detectors**

  SNMP—The SNMP event detector allows a standard SNMP MIB object to be monitored and an event to be generated when the object matches specified values or crosses specified thresholds

  Syslog—The syslog event detector allows for screening syslog messages for a regular expression pattern match

Embedded Event Manager 1.0 (Cont.)

- **Introduced the following actions**
  - **Generate custom, prioritized syslog messages**
  - **Generate a CNS event for upstream processing by Cisco CNS devices**
  - **Reload the Cisco IOS Software**
  - **Switch to a secondary processor in a fully redundant hardware configuration**

Embedded Event Manager (EEM) 1.0 Variables

- **Cisco defines read-only environment variables called built-in variables that are pre-set with a specific value when the event is triggered**
- **Can be used in “msg” text.**
- **Environment variable available for all events**

$_event_type	The event type that triggered the event
$_event_pub_time	The time at which the event type was published

- **Environment variable available for SNMP events**

$_snmp_oid	The SNMP object OID that caused the event to be published
$_snmp_oid_val	The SNMP object ID value when the event was published

- **Environment variable available for Syslog events**

$_syslog_msg	The syslog message that caused the event to be published

EEM 1.0 – SNMP ED Example

- **Example:**

  When the primary RP runs low on memory (`ciscoMemoryPoolFree`), an event is triggered at which a certain the threshold is reached

  Then applet named memory-demo runs (2 actions)

  1. **Syslog message to be written to the console (variables)**
  2. **Switch-over to the Secondary RP**

EEM 1.0 – SNMP ED Example (Cont.)

```
event manager applet memory-demo

    event snmp oid 1.3.6.1.4.1.9.9.48.1.1.1.6.1 get-
    type exact entry-op lt entry-val 5120000 poll-interval 10

    action 1.0 syslog priority critical msg "Memory exhausted;
    current available memory is $_snmp_oid_val bytes"

    action 2.0 force-switchover
```

The following syslog messages are created:

```
00:08:31: %HA_EM-2-LOG: memory-demo:
Memory exhausted; current available memory is 4484196 bytes
00:08:31: %HA_EM-6-FMS_SWITCH_HARDWARE:
fh_io_msg: Policy has requested a hardware switchover
```

… a switch-over is forced

Embedded Event Manager (EEM) 2.x Architecture

Embedded Event Manager (EEM) 2.0

- **Introduced the following event detectors**

  Application-Specific—The Application-Specific ED allows any EEM policy to publish an event

  Counter—The Counter ED publishes an event when a named counter crosses a specified threshold

  Interface Counter —The Interface Counter ED publishes an event when a generic Cisco IOS Software interface counter for a specified interface crosses a defined threshold

  Timer—The Timer ED publishes events for the following four different types of timers; absolute-time-of-day, countdown, watchdog, and CRON

  Watchdog—The Cisco IOS Watchdog ED publishes an event when CPU or memory utilization for a Cisco IOS Software process crosses a threshold

Embedded Event Manager 2.0 (Cont.)

- **Added ability to**
  - **Publish an application-specific event**
  - **Modify of a named counter**
  - **Generate an SNMP trap**

Embedded Event Manager (EEM) 2.1

- **Added support for user written TCL-based policies**
- **Introduced the following event detectors:**

  CLI—The CLI ED screens Command-Line Interface (CLI) commands for a regular expression match

  None—The None ED publishes an event when the Cisco IOS Software event manager run CLI command executes an EEM policy

  OIR—The Online Insertion and Removal (OIR) ED publishes an event when a particular HW insertion or removal event occur

Embedded Event Manager 2.1 (Cont.)

- **Introduced the following actions**
  - **Executing a Cisco IOS Command-Line Interface (CLI) command**
  - **Requesting system information when an event occurs**
  - **Sending a short e-mail**
  - **Manually running an EEM policy**
- **Permits multiple concurrent policies to be run using the new event manager scheduler script command**

Embedded Event Manager (EEM) 2.1.5

- **Introduced the following event detectors**

  GOLD —The Generic Online Diagnostic (GOLD) ED publishes an event when a GOLD failure event is detected

  Process —The Process ED publishes an event when a Cisco IOS Software Modularity process starts or stops

  System Manager —The System Manager ED generates events for Cisco IOS Software Modularity process start, normal or abnormal stop, and restart events

    The events generated by the system manager allows policies to change the default behavior of the process restart

Embedded Event Manager 2.1.5 (Cont.)

- **Introduced the following event detectors (Cont.)**

  Watchdog (Cisco IOS Software Modularity)—The Cisco IOS Software Modularity Watchdog System Monitor (WDSYSMON) ED detects infinite loops, deadlocks, and memory leaks in Cisco IOS Software Modularity processes

- **Introduced the ability to display EEM reliability metric data for processes**

Embedded Event Manager (EEM) 2.2

- **Introduced the following ED´s:**

  Enhanced Object Tracking (EOT)—The EOT ED publishes an event when the tracked object changes

  Resource —The Resource ED publishes an event when the Embedded Resource Manager (ERM) Introduced in Release 12.3(14)T, reports an event for the specified policy

  RF —The Redundancy Framework ED publishes an event when one or more RF events occur during synchronization in a dual Route Processor (RP) system; The RF event detector can also detect an event when a dual RP system continuously switches from one RP to another RP (referred to as a ping-pong situation)

Embedded Event Manager 2.2 (Cont.)

- **Introduced the following actions**
  - **Reading the state of a tracked object**
  - **Setting the state of a tracked object**

Cisco IOS Watchdog ED Example (EEM v2.1)

- **Monitor the IP SNMP process every 10 seconds: if CPU exceeds 50%, publish an application-specific event on the well-known user subsystem, and send an SNMP trap**

```
event manager applet IPSNMPWD
    event ioswdsysmon sub1 cpu-proc taskname "SNMP ENGINE" op ge val
    50 period 10
    action 1.0 publish-event sub-system 798 type 1 arg1 "IP SNMP"
    arg2 "50"
    action 2.0 snmp-trap intdata1 50 strdata "IP SNMP Process above
    50% within 10 seconds“

snmp-server enable traps event-manager
```

EEM Policies and TCL

- EEM policies can be written in TCL
- TCL can do everything that applets can do, and more!
- TCL permits global variables—called environment variables—to be defined for use within an EEM policy
  - User-defined
  - Cisco-defined for a specific sample policy
  - Cisco system-defined
- Cisco provides built-in TCL namespaces and libraries to facilitate in creating EEM policies

EEM Policies and TCL (Cont.)

- **Policies should be arranged in the following format**

  Event register keyword *REQUIRED

  Environment “must defines”

  Namespace import

  Entry status

  Body *REQUIRED

  Exit status

EEM Policies and TCL (Cont.)

Enabling Policies

```
Router#mkdir disk0:/policies
Router#copy tftp://10.10.10.10/syslog_policy.tcl
disk0:/policies/syslog_policy.tcl
```

```
event manager directory user policy disk0:/policies
event manager policy syslog_policy.tcl type user
```

- **Three system policies come with Cisco IOS Software**

  sl_intf_down.tcl—run CLI and send email on reception of a configurable syslog message

  tm_cli_cmd.tcl—run CLI and send email at a certain time

  tm_crash_reporter.tcl—triggers 5 sec after bootup and sends crashinfo, if relevant, to the specified URL

- **Can be enabled using the following commands**

```
event manager policy sl_intf_down.tcl
event manager policy tm_cli_cmd.tcl
event manager policy tm_crash_reporter.tcl
```

EEM Environment Variables

- **Variables that are referenced within policies that can be set in the config**
- **Can be used to customize policies**
- **Example:**

```
Router#config t
Router(config)#event manager environment _email_server
email.cisco.com
Router(config)#event manager environment _email_from
soandso@somecompany.com
```

Note: environment variable names that start with the underscore character are reserved for Cisco use only

EEM Namespaces

::cisco::lib Namespace

Library	Procedure	Arguments	Description
SMTP Library	smtp_subst	email_template_file	Substitute global email variables in a template file
	smtp_send_email	email_text	Send email

Required Variables for Email Templates

Environment Variable	Description	Example
_email_server	A Simple Mail Transfer Protocol (SMTP) server	smtp.mydomain.com
_email_from	Address from which mail is sent	admin@mydomain.com
_email_cc (optional)	Address to which email is copied	mgr@mydomain.com
_email_to	The email recipient address	user@mydomain.com

EEM Namespaces (Cont.)

::cisco::eem Namespace Common Procedures

Procedure	Arguments	Description
event_register_*xxx*	Variable	Register a specific type of event (ie: CLI, Syslog, OIR, SNMP, etc.)
event_reqinfo	None	Event-specific info
event_publish	comp_id id type type [arg1 arg] [arg2 arg] [arg3 arg] [arg4 arg]	Publish a susbsystem-specific event (comp_id of 0x031e if reserved for user policies)
action_snmp_trap	[intdata1 data] [intdata2 data] [strdata data]	Send an event manager trap with the specified data
action_syslog	priority prio msg text	Send a syslog message with a specific severity and message body

- **Many more procedures are available**

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5207/products_feature_guide09186a008041231a.html

User Policy Example: Syslog Policy

```
::cisco::eem::event_register_syslog pattern ".*UPDOWN.*Serial0/0.* changed state to down"

# We don't require any global variables to be set.

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

array set arr_einfo [event_reqinfo]

if { $_cerrno != 0 } {
    set result [format "component=%s; subsys err=%s; posix err=%s;\n%s" \
        $_cerr_sub_num $_cerr_sub_err $_cerr_posix_err $_cerr_str]
    error $result
}

global slg_msg
set slg_msg $arr_einfo(msg)
set newmsg [format "Primary uplink has gone down: %s" $slg_msg]

action_syslog priority emerg msg $newmsg
if { $_cerrno != 0 } {
    set result [format "component=%s; subsys err=%s; posix err=%s;\n%s" \
        $_cerr_sub_num $_cerr_sub_err $_cerr_posix_err $_cerr_str]
    error $result
}
```

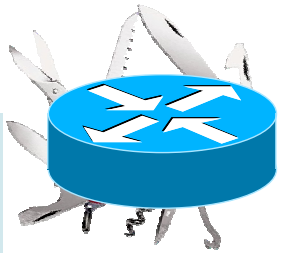
Get event-specific information

Register a syslog event to watch our primary uplink

Send our high priority syslog message

Embedded Event Manager (EEM) Debugging and Show Commands

- **Debug commands**



```
debug event manager tcl cli_lib
debug event manager tcl commands
debug event manager tcl smtp_library
```

Note: EEM delivers debug to syslog at the "debugging level"

- **Show commands**

```
show event manager policy available
show event manager directory user policy
```

- **User policies are run in Safe-Tcl which restricts certain commands**
- **USER POLICIES MUST BEGIN WITH AN event_register_xxx LINE!**

Embedded Event Manager (EEM) Version Comparison

Feature	EEM 1.0	EEM 2.0	EEM 2.1	EEM 2.1.5	EEM 2.2
Syslog, SNMP EDs	X	X	X	X	X
Watchdog, Counter, Interface Counter, Timer, Application-Specific EDs		X	X	X	X
OIR, CLI EDs			X	X	X
Syslog, SNMP Actions	X	X	X	X	X
Counter Modification, System Info, Email Actions		X	X	X	X
User and System TCL Policies			X	X	X
GOLD, System Manager, WDSysMon EDs				X	X
Resource, RF, EOT EDs					X

EEM Built-in Actions

- **An Embedded Event Manager Policy can:**
  - **Execute an IOS CLI command and receive the result**
  - **Send a CNS event**
  - **Increment or decrement an EEM counter**
  - **Force a switchover to the standby in a redundant configuration**
  - **Request system information**
  - **Send an e-mail**

EEM Built-in Actions (Cont.)

- **An Embedded Event Manager Policy can (cont.) :**
  - **Cause another EEM policy to be executed**
  - **Publish an application specific EEM event**
  - **Reload the box**
  - **Send an SNMP trap with custom data**
  - **Log a message to Syslog**

Embedded Event Manager (EEM) Additional References

- **Embedded Event Manager 1.0 guide:**

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5207/products_white_paper09186a00801d2d26.shtml

- **Embedded Event Manager 2.0 guide:**

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1838/products_feature_guide09186a008025951e.html

- **Embedded Event Manager 2.1 guide:**

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5207/products_feature_guide09186a00803cde2b.html

Embedded Event Manager (EEM) Additional References (Cont.)

- **Embedded Event Manager 2.2 guide:**

  http://www.cisco.com/en/US/products/ps6441/products_feature_guide09186a00804aae8c.html

- **Writing Embedded Event Manager policies:**

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5207/products_feature_guide09186a008041231a.html

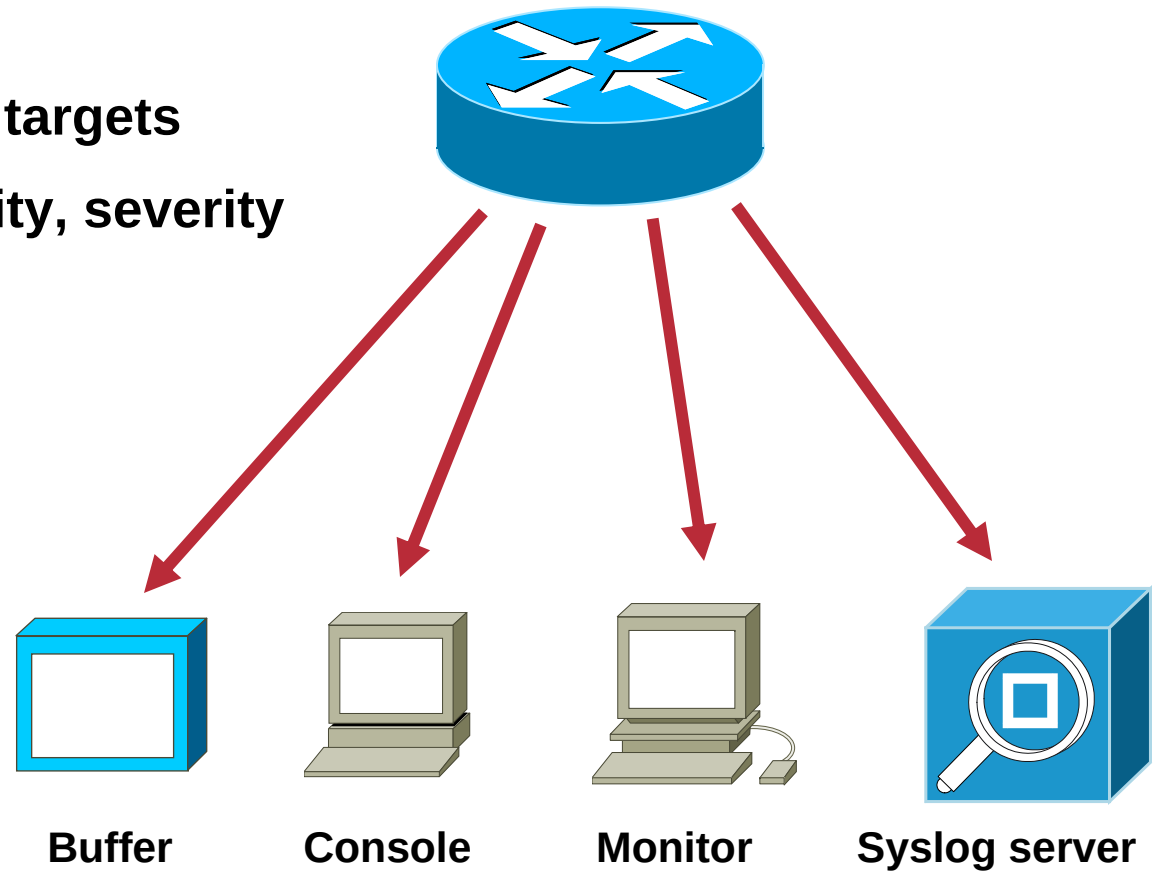
Embedded Syslog Manager

Embedded Syslog Manager (ESM) Introduction

- **Customizable framework for correlating, augmenting, filtering, routing Cisco IOS Software logger output**
- **Does not replace UDP logger (Syslog classic), but operates in parallel**

Classic Syslog Implementation

- **Configure four targets**
- **Configure facility, severity thresholds**

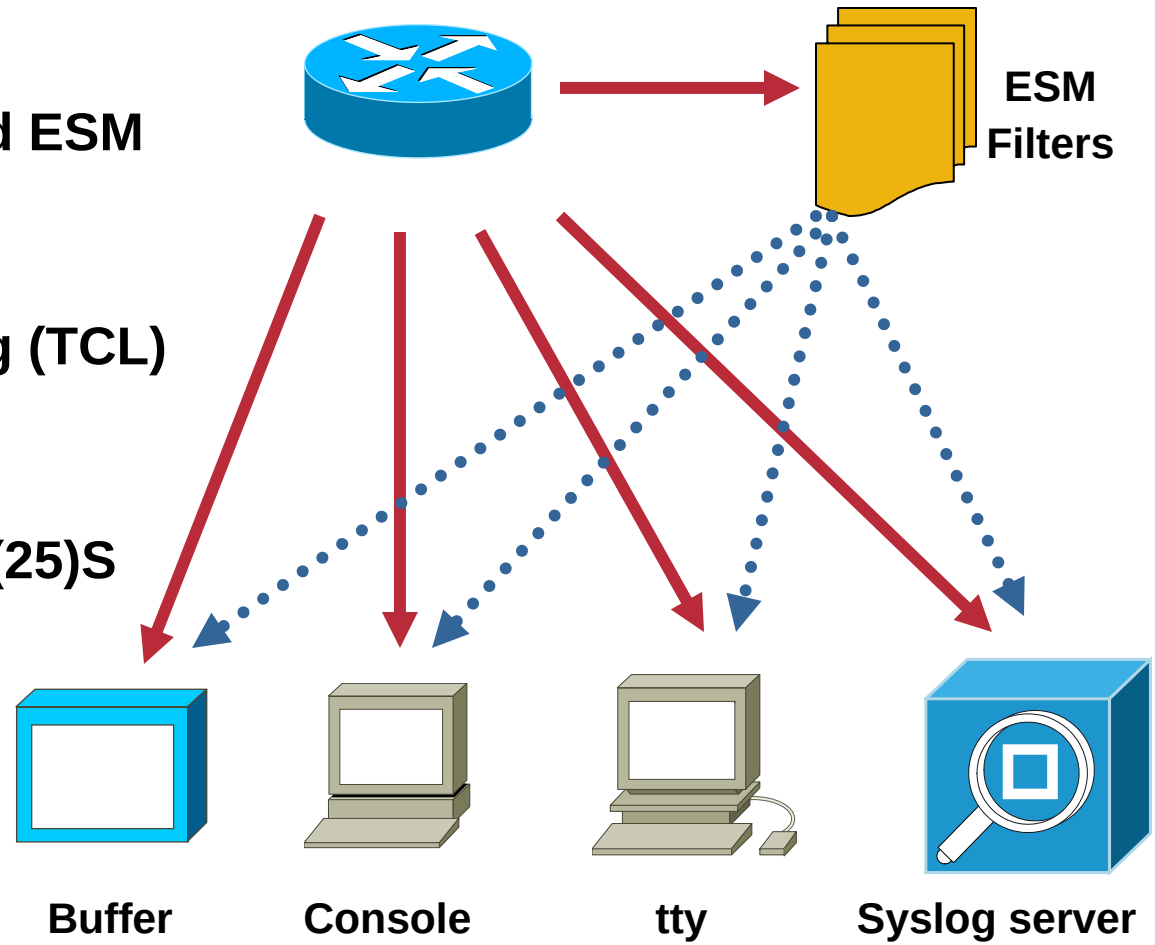


Embedded Syslog Manager (ESM)
Why ESM?

- **On-box intelligence for local event correlation**
- **Severity escalation**
- **Syslog message routing/distribution**
- **Alternate reliable transport/persistence**
- **Custom message formats/tagging**

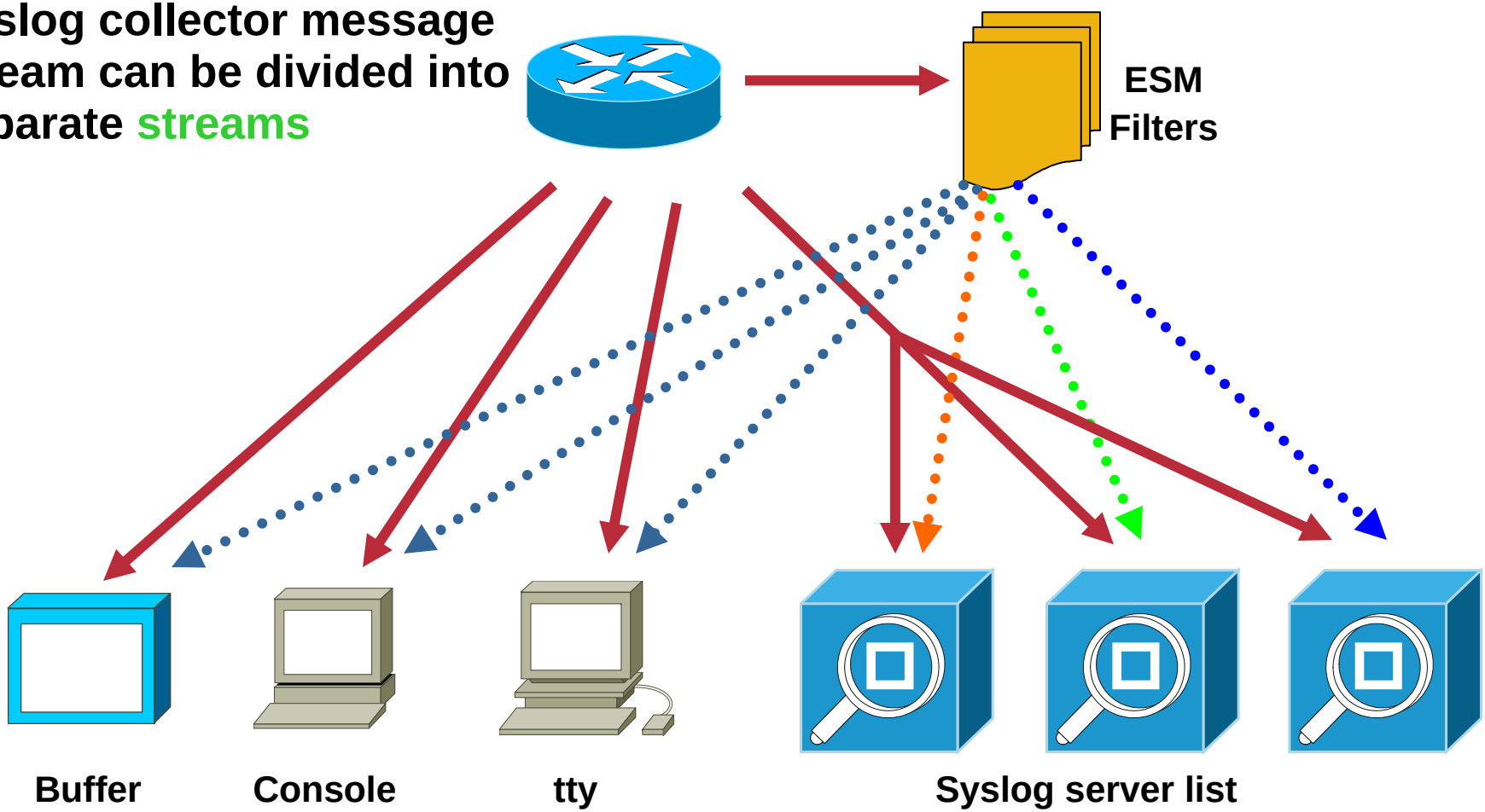
Embedded Syslog Manager (ESM) Design

- **Post-process syslog messages with selected ESM filters (proactive rules-based analysis)**
- **User definable scripting (TCL)**
- **Available in images with TCL 8.3.4, in Releases 12.3(2)T, 12.2(25)S**



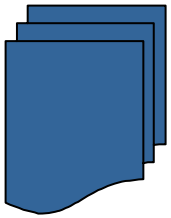
Embedded Syslog Manager (ESM) Design (Cont.)

- **Syslog collector message stream can be divided into separate streams**



ESM Filters

- **TCL Scripts – located locally or remotely**
- **Pre-compiled or plain text**
- **Processed serially**
- **Configured, (re)ordered, and (re)loaded via CLI**
- **Arguments passed via CLI or filters may be edited directly**



ESM Filters

ESM Filters (Cont.)

- Filters are passed all syslog message data elements as TCL global variables, including the original formatted message
- Filters operate on message and return desired message
- Filters can optionally change the “stream” variable to route the message to specific syslog servers
- Filters can optionally change the “severity” variable
- Filters can send messages directly to the output queue or down the filter chain
- ESM Filters can query status via CLI interface

Embedded Syslog Manager (ESM) Configuration

```
Router(config)#logging filter <URL> [position] [args args]
```

- **Where:**

  <URL> is a IOS path to an ESM filter TCL script

  [position] is an optional order number

  (if multiple filters are defined)

  [args] are optional command line arguments to pass to the filter script

```
Router(config)#logging [console|monitor|buffer] filtered
Router(config)#logging host <ip_address> filtered
[stream_id]
```

[stream_id] can be set in the filter script to route certain events to certain destinations

Embedded Syslog Manager (ESM) Example

- **Severity escalation:** **messages that Cisco deemed low priority may be very important to some users**
- **Example: escalate syslog messages that contain the word 'CONFIG_I' to severity level of four (they are by default level five)**

```
Router(config)# logging filter flash:/ABCTCL/escalate.tcl CONFIG_I 4
Router(config)# logging console filtered

Router#
*Nov 18 13:44:26.410: %SYS-4-CONFIG_I: Configured from console by
console
Router#
```

Embedded Syslog Manager (ESM) Example (Cont.)

```
#  Embedded Syslog Manager, Severity Escalation Module
#  ==================================================================
# Usage: Set CLI Args to "mnemonic new_severity"
# Namespace: global
# Check for null message

if { [string length $::orig_msg] == 0} {
   return ""
}

if { [info exists ::cli_args] } {
    set args [split $::cli_args]
    if { [ string compare -nocase [lindex $args 0] $::mnemonic ] == 0 } {
        set ::severity [lindex $args 1]
        set sev_index [ string first [lindex $args 0] $::orig_msg ]
        if {  $sev_index >= 2 } {
           incr sev_index -2
           return [string replace $::orig_msg $sev_index $sev_index \
              [lindex $args 1]]
        }
    }
}
return $::orig_msg
```

First escalate the internal severity

Finally, modify the original message to reflect the new severity

Embedded Syslog Manager (ESM) Other Examples

- **Message routing:** categorize messages using criteria other than facility or severity

  Example: send all spanning tree messages to a separate syslog server

- **SMTP-based email alerts:** capability for notifications using TCP to external servers, such as TCP-based syslog collectors or Simple Mail Transfer Protocol (SMTP) servers

  Example: “configuration changes” sent to administrators via an email message

- **Your example…** the possibilities are endless!

Embedded Syslog Manager (ESM) Show Commands

Q: How do I tell if my image contains ESM?

A: From the CLI, type "show log". The output will contain the status of the filter modules:

```
Router# show log
Syslog logging: enabled (10 messages dropped, 1 messages rate-limited,
                 0 flushes, 0 overruns, xml disabled, filtering
disabled)
    Console logging: level debugging, 12 messages logged, xml
disabled,
                     filtering disabled
    Monitor logging: level debugging, 0 messages logged, xml disabled,
                     filtering disabled
    Buffer logging: level debugging, 12 messages logged, xml disabled,
                    filtering disabled
    Logging Exception size (8192 bytes)
    Count and timestamp logging messages: disabled

No active filter modules.
```

Embedded Syslog Manager (ESM) Show Commands (Cont.)

```
Router#show log
Syslog logging: enabled (10 messages dropped, 1 messages rate-
limited,
                0 flushes, 0 overruns, xml disabled, filtering
enabled)
    Console logging: level debugging, 48 messages logged, xml
disabled,
                     filtering enabled
    Monitor logging: level debugging, 0 messages logged, xml
disabled,
                     filtering disabled
    Buffer logging: level debugging, 67 messages logged, xml
disabled,
                    filtering disabled
    Logging Exception size (8192 bytes)
    Count and timestamp logging messages: disabled

Filter modules:
    flash:/ABCTCL/escalate.tcl args CONFIG_I 4
    flash:escalate.tcl    - INVALID args CONFIG_I 4  - INVALID
```

Embedded Syslog Manager (ESM) Caveats

- No way to debug ESM filter scripts as they run
- ESM filters cannot be applied to SNMP history logs (ie: filters will not be applied to messages logged from logging history or snmp-server enable traps syslog)
- All filters must be written in TCL
- Additional Reference:

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5207/products_feature_guide09186a00801a8516.html

Embedded Resource Manager

Embedded Resource Manager (ERM)

- **Monitors system resource usage to better understand scalability needs by allowing you to configure threshold values for resources such as CPU, buffer, and memory**
- **The ERM framework provides a mechanism to send notifications whenever the specified threshold values are violated by any resource user**
  - **Helps in reducing the CPU, buffer, and memory utilization issues**

Embedded Resource Manager (Cont.)

- **Introduced in Release 12.3(14)T**
- **Embedded Resource Manager guide:**

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5207/products_feature_guide09186a00803790a7.html

ERM Concepts

- **Resource User (RU)**

  Entity or application that consumes one or more resources

  ie: BGP process

- **Resource Owner (RO)**

  Entity that allocates its resources to a RU

  ie: CPU, memory, buffer

ERM Concepts (Cont.)

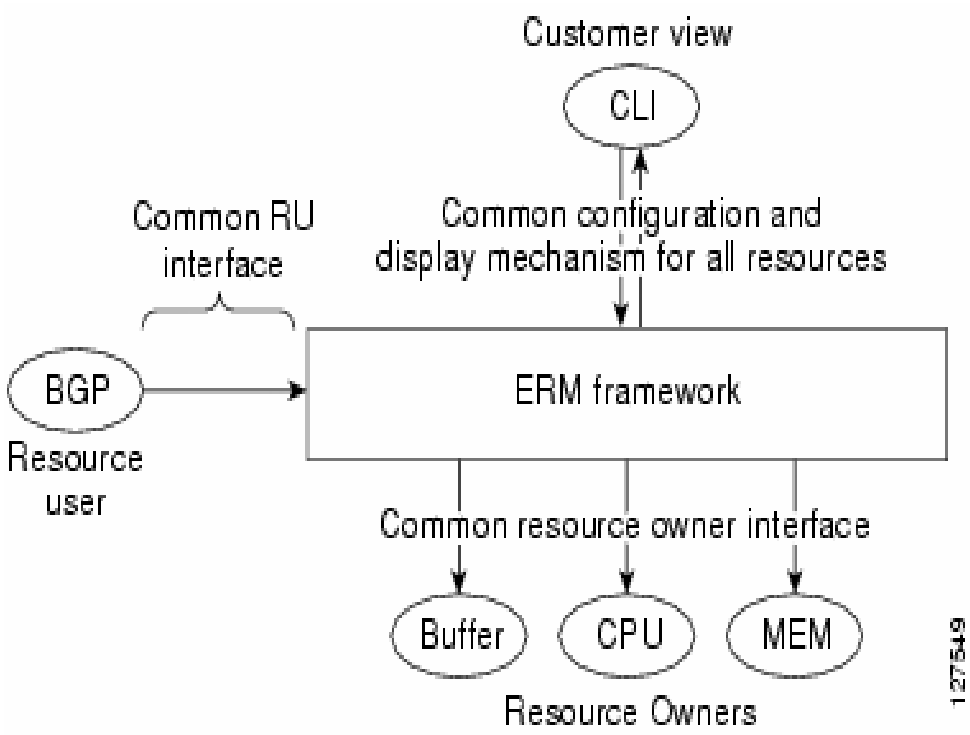
- **Notifications sent and actions taken**

  RU registers with RO for threshold notifications

  RU is expected to change utilization of resource upon notification

  ie: if a process's use of CPU exceeds a threshold, that process is expected to take action to limit use of the CPU

ERM Architecture



Types of Thresholds

- **System Global**

  All RU's are notified when total resource utilization crosses a specified threshold value

- **User Local**

  A specific RU is notified when the resource utilization of that RU crosses a specified threshold value

- **Per User Global**

  A specific RU is notified when total resource utilization crosses a specified threshold value

Configuring Buffer Thresholds

```
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#resource policy
Router(config-erm)#policy policy1 type iosprocess
Router(config-erm-policy)#system
Router(config-policy-node)#buffer public
Router(config-owner-buffer)#critical rising 90 interval 12
falling 20 interval 10 global
Router(config-owner-buffer)#major rising 70 interval 12
falling 15 interval 10 global
Router(config-owner-buffer)#minor rising 60 interval 12
falling 10 interval 10 global
```

user threshold

buffer resource

- If TOTAL buffer usage count rises above 90% at an interval of 12s, a critical Up notification is sent to the iosprocess RU
- IF TOTAL buffer usage falls below 20% at an interval of 10s, a critical Down notification is sent to the iosprocess RU

Useful Debug

```
Router#debug resource policy notification
```

When a threshold is violated:

```
*Mar  3 09:50:44.081: Owner: 'memory' initiated a
notification:
*Mar  3 09:50:44.081: %SYS-4-RESMEMEXCEED: Resource user
usrr1 has exceeded the Major memory threshold
Pool: Processor Used: 42932864 Threshold :42932860
*Mar  3 09:50:46.081: Notification from Owner: 'memory' is
dispatched for User: 'usrr1' (ID: 0x10000B9)
*Mar  3 09:50:46.081: %SYS-4-RESMEMEXCEED: Resource user
usrr1 has exceeded the Major memory threshold
Pool: Processor Used: 42932864 Threshold :42932860
```

Command Scheduler

Command Scheduler (Kron) Overview

- **Allows EXEC commands to run periodically or at a specified time**
- **First introduced in Release 12.3(1)**
- **Runs commands in a fully-automated mode**
- **Interactive commands (ie: reload) are NOT supported**
- **Kron command scheduler guide:**

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5187/products_feature_guide09186a00801b0695.html

Kron Command Scheduler Configuration Example

- **Configure a Kron policy to write the output of show interface to a TFTP server**

```
kron policy-list writeshowint
 cli show interface | redirect tftp://10.1.1.1/router.showint
```

```
kron occurrence showint-occur at 21:40 recurring
 policy-list writeshowint
```

Note: a single occurrence can have multiple Policy-Lists

Kron Command Scheduler Debugging and Show Commands

- **Debug commands**

  `debug kron all` —show all kron debugging

  `debug kron exec-cli` —debug CLI processing

  `debug kron info` —show warnings and progress info

  `debug kron major` —show all major Kron failures

- **Show commands**

  `show kron schedule`

Kron Command Scheduler Debugging and Show Commands (Cont.)

Sample Debug Output

```
Apr 12 01:54:07.479: Major 1, Minor 0
Apr 12 01:54:07.479: Timer Event showint-occur
Apr 12 01:54:07.479: Call parse_cmd 'show interface |
redirect tftp://10.1.1.1/router.showint'
Apr 12 01:54:07.559: Kron CLI return 0
'
**CLI 'show interface | redirect
tftp://10.1.1.1/router.showint':
!'
Apr 12 01:54:07.559: Major 4, Minor 7
Apr 12 01:54:07.559: Respond to end of CLI Process
```

Sample Show Command Output

```
Router#show kron schedule
Kron Occurrence Schedule
showint-occur inactive, will run again in 0 days 23:39:10 at
21:40 on
```

Note: One-Shot Policies will be removed from the config and the show Kron Schedule output after they run

Kron Command Scheduler Caveats

- **Interactive commands are not supported, and will fail at execution time**
- **NTP must be configured or the router clock must be authoritative**
- **Kron and TCL can run together since Release 12.4(4)T**

Configuration Replace and Rollback

Configuration Replace and Rollback Overview

- **Provides ability to replace current running config with a saved complete config**
- **Config rollback provides a way of replacing the current running config with any configuration file**
- **Hooks exist for comparing configs, and viewing context-sensitive diffs**

Configuration Replace and Rollback Overview (Cont.)

- **Questionable configuration changes can be evaluated and automatically backed out**
- **Rollbacks are done efficiently and safely by only reapplying commands that have changed**
- **Reference:**

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5207/products_feature_guide09186a0080356ea5.html

Configuration Replace and Rollback Availability

- **Config replace and rollback was first introduced in Release 12.3(7)T**
- **The features were later integrated into Release 12.2(25)S**
- **Configuration locking support was integrated into Releases 12.3(14)T and 12.2(25)S**

Configuration Archive Configuration

Path to store archived configs (this can be a network URL as well)

Maximum number of configs to archive (between 1 and 14)

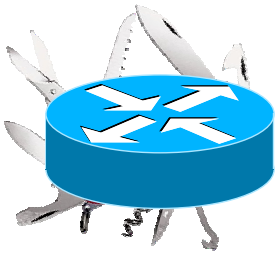
```
archive
  path disk0:/configs

  maximum 14

  time-period 60

  log config

    notify syslog
```

Snapshot config every hour (time-period is in minutes)

Log all config changes

Ad-hoc snapshots can also be taken

```
Router#archive config
```



Configuration Archive

Viewing Archived Configurations

```
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
   8
   9
   10
   11
   12
   13
   14
```

Configuration Rollback

```
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#snmp-server community public ro
Router(config)#snmp-server community private rw
Router(config)#end
Router#config replace disk0:config-archive-1
This will apply all necessary additions and deletions
to replace the current running configuration with the
contents of the specified configuration file, which is
assumed to be a complete configuration, not a partial
configuration. Enter Y if you are sure you want to proceed. ?
[no]: yes
Total number of passes: 0
Rollback Done
```

Configuration Rollback
Configuration Locking

- **Starting in Release 12.3(14)T and 12.2(25)S the running config is locked during a rollback**
- **No other changes can be made to the running configuration during this time**
- **Use the no-lock argument to config replace to override this behavior**

```
Router#show config lock
Parser Configure Lock
---------------------
Owner PID         : 40
User              : mpalmero
TTY               : 2
Type              : EXCLUSIVE
State             : LOCKED
Class             : ROLLBACK
Count             : 1
Pending Requests  : 0
User debug info   : Rollback
```

Configuration Replace and Rollback Show and Debug Commands

- **Viewing configurations in the archive**

  `show archive`

- **Debugging config archive operations**

  `debug archive versioning` — debug all config archive operations

  `debug archive config timestamp` — show times and config sizes at all steps of a rollback

- **Clearing configuration locks**

  `clear configuration lock`

Configuration Replace and Rollback Debug Output

Sample Debugging Output

- **Archive path pointing to misconfigured TFTP server**

```
Router#archive config
TFTP: error code 1 received - 18025

Apr 23 21:26:16.114: backup_running_config
Apr 23 21:26:16.114: Current = 1
Apr 23 21:26:16.114: Writing backup file tftp://10.10.10.10/router-config-1
Apr 23 21:26:18.434:  backup failed
```

- **Archive path pointing to a correctly configured TFTP server**

```
Router#archive config
!!!!
Router#
Apr 23 21:37:54.811: backup_running_config
Apr 23 21:37:54.811: Current = 1
Apr 23 21:37:54.811: Writing backup file tftp://10.10.10.10/router-config-1
Apr 23 21:37:56.059:  backup worked
```

Configuration Replace and Rollback Caveats

- **Free memory must be large enough to hold the current running configuration as well as the replacement configuration**
- **Physical interface statements cannot be removed from a running configuration**
- **Certain Cisco IOS Software configuration commands cannot be fully removed unless the router is reloaded**
- **Archiving configurations via TFTP is a security risk; opt for FTP or RCP instead**

Contextual Configuration Diff Utility

Contextual Configuration Diff Utility

- View line-by-line comparison of two configuration revisions
- Compare order-sensitive data such as ACLs
- Output lists configuration lines that have been added, removed, or modified
- First introduced in Release 12.3(4)T and integrated into Release 12.2(25)S
- Reference:

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5207/products_feature_guide09186a00801d1dc2.html

Contextual Configuration Diffs Example — Startup vs. Running Config

```
Router#show archive config differences nvram:startup-
config system:running-config
Contextual Config Diffs:
+ip http server
+tacacs-server host 172.18.123.33
+tacacs-server directed-request
-no ip http server
-logging 192.168.0.254
```

Lines in running-config
Not in startup-config

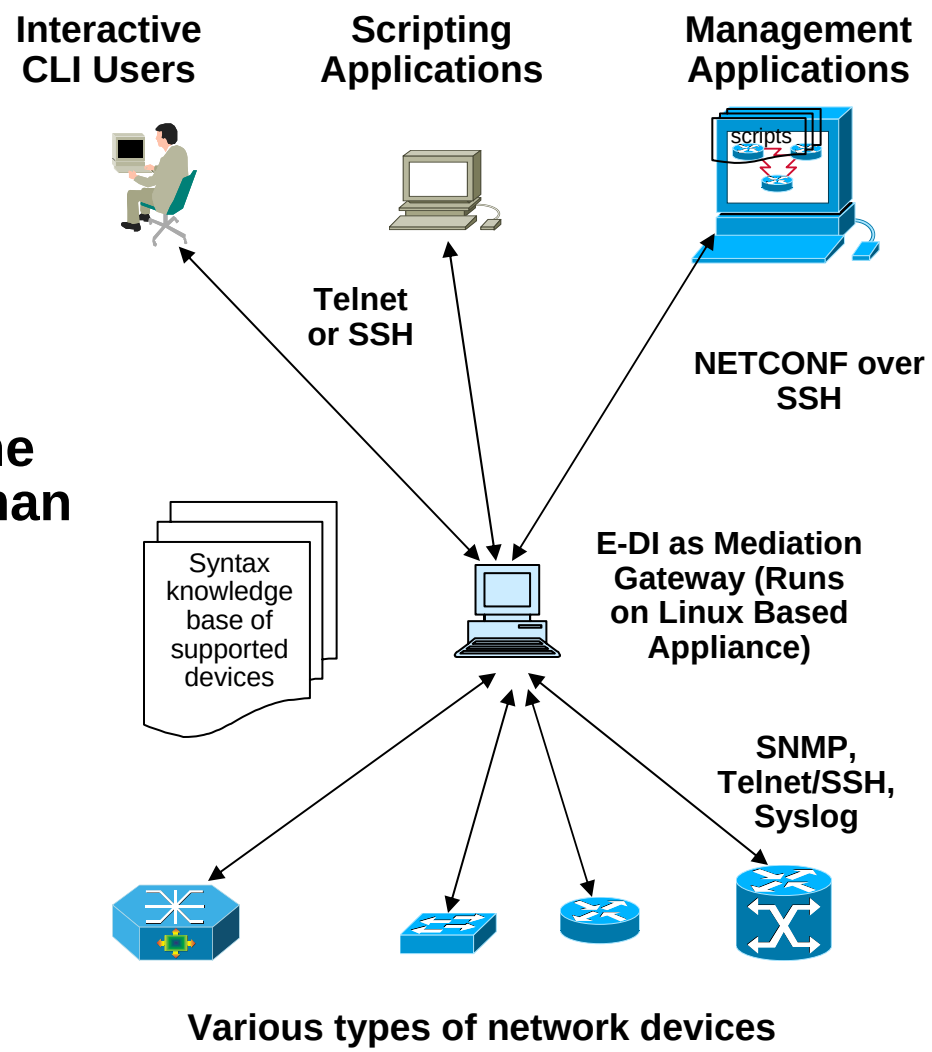
Lines in startup-config
Not in running config

Agenda

- Introduction
- Embedded Management Tools
- Enhanced Device Interface
- Practical Applications
- Summary and Conclusion

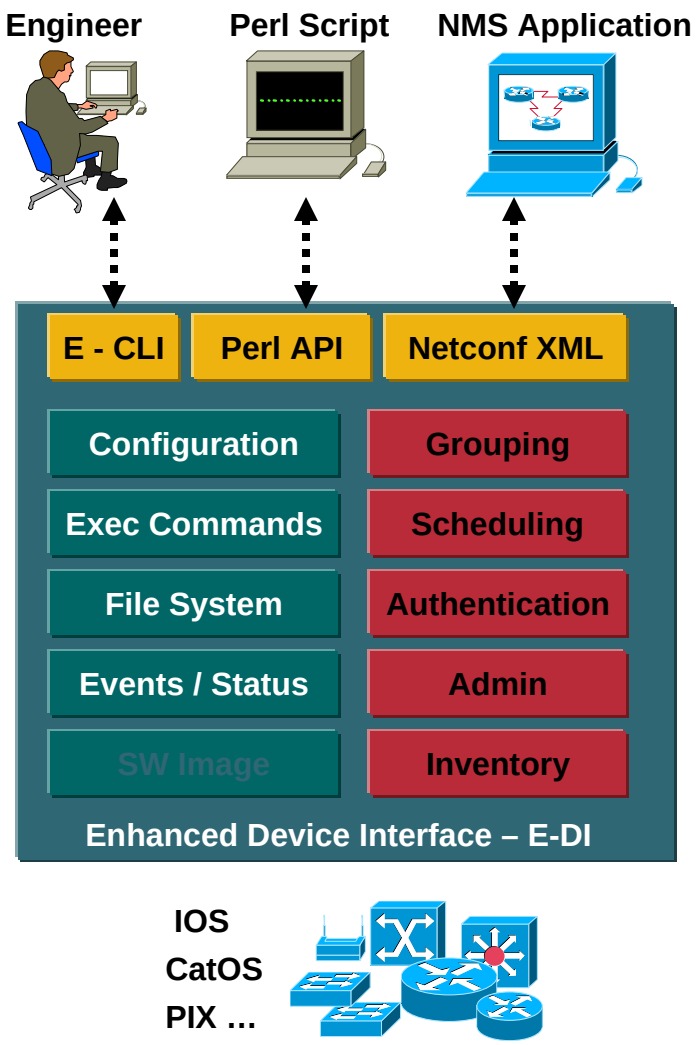
Enhanced Device Interface (E-DI) Overview

- **E-DI is**
  - An extension to the network device's interface
- **E-DI provides**
  - Enhanced Command Line Interface (CLI) to human users
  - XML Programmatic Interface to management applications
  - Scripting interface and platform for scripting applications



Why E-DI ?

- **Improve productivity for**
  - Device configuration
  - Maintenance & troubleshooting
  - CatOS to IOS upgrades (planned)
- **Single point of access to device configuration**
- **Unified interface across platforms & releases**
  - enhanced CLI
  - Perl integration
  - XML API
    (IETF NETCONF draft 5 compliant)
- **Complementary to EMS and NMS**
- **Support existing and new Cisco devices**



Design Approach

- **Build and maintain a device command knowledge base – automatically learned from the device**
- **Maintain a list of managed devices and minimal inventory necessary for operations**
- **Provide a comprehensive configuration data model for supported devices**
- **For More Information:**

  http://www.cisco.com/en/US/products/ps6456/index.html

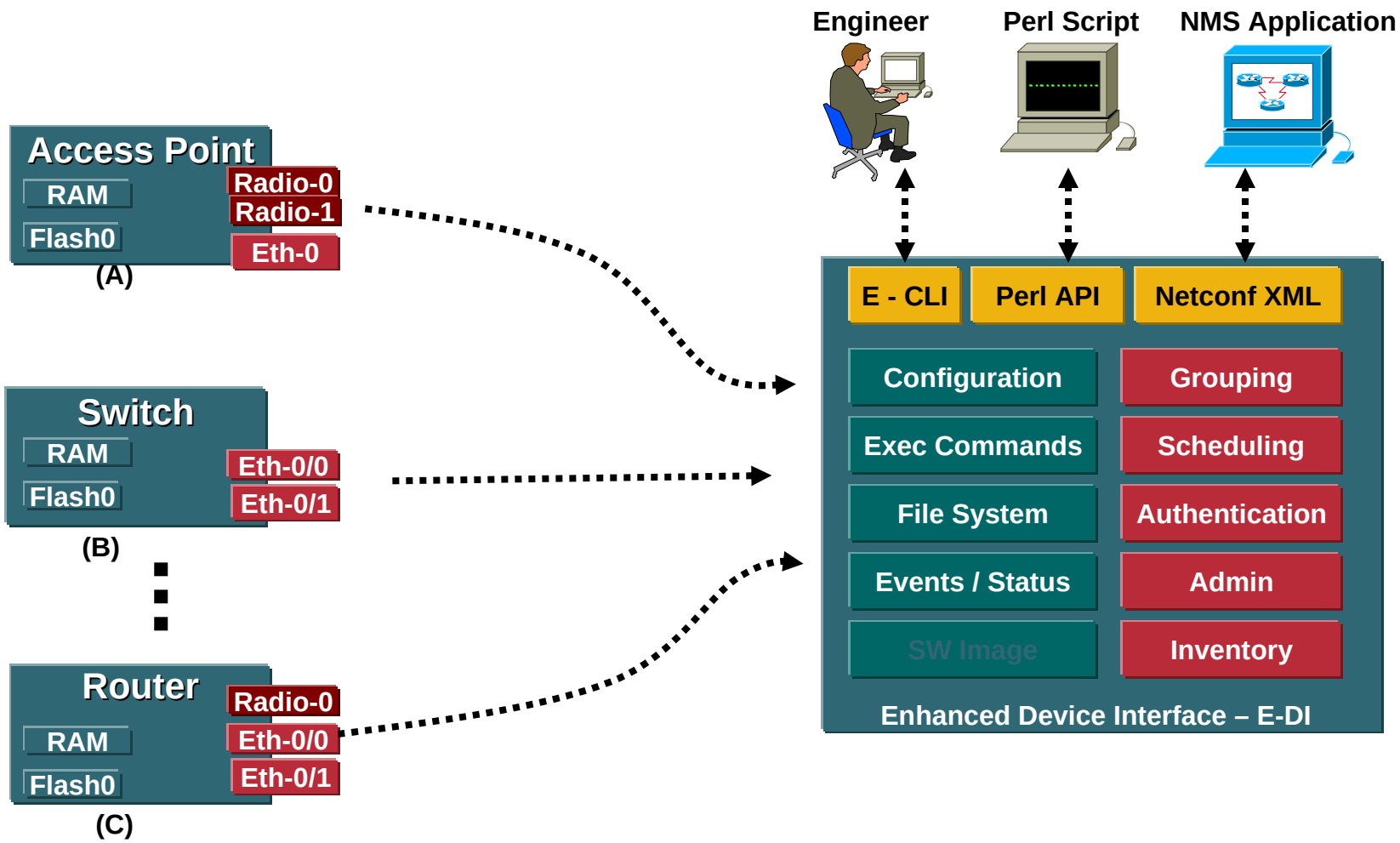
Enhanced Device Interface (E-DI) Device Support Packages

Device Package	Device Package Version	Supported Software Release
Cisco 12000	1.1	Release 12.0(27)S5
Cisco 7600	1.1	Release 12.2(18)SXD4
Catalyst 6500	1.2	Releases 12.1(11b)E1, 12.2(17d)SXB6
Cisco 1700	1.2	Releases 12.2(15)T14, 12.3(8)T6
Cat 6500 Cat OS	1.1	7.6(6)
Cat 3550	1.2	Releases 12.1(14)EA1a, 12.1(22)EA2
Cat 4000	1.1	Release 12.1(19)EW1
Cisco 7200	1.1	Release 12.2(13)T14
Cat 2950	1.1	Release 12.1(13)EA1c
Cisco 2600	1.2	Releases 12.1(17), 12.2(24a)
Cisco 800	1.1	Release 12.3(8)T7
Cisco AP350 IOS	1.1	Release 12.3(2)JA2
Cat 3750	1.0	Release 12.1(19)EA1a
Cisco 3800	1.1	Release 12.3 (11)T
Cisco 1800	1.1	Release 12.3 (11)T
Cisco 3700	1.1	Release 12.3 (6)C

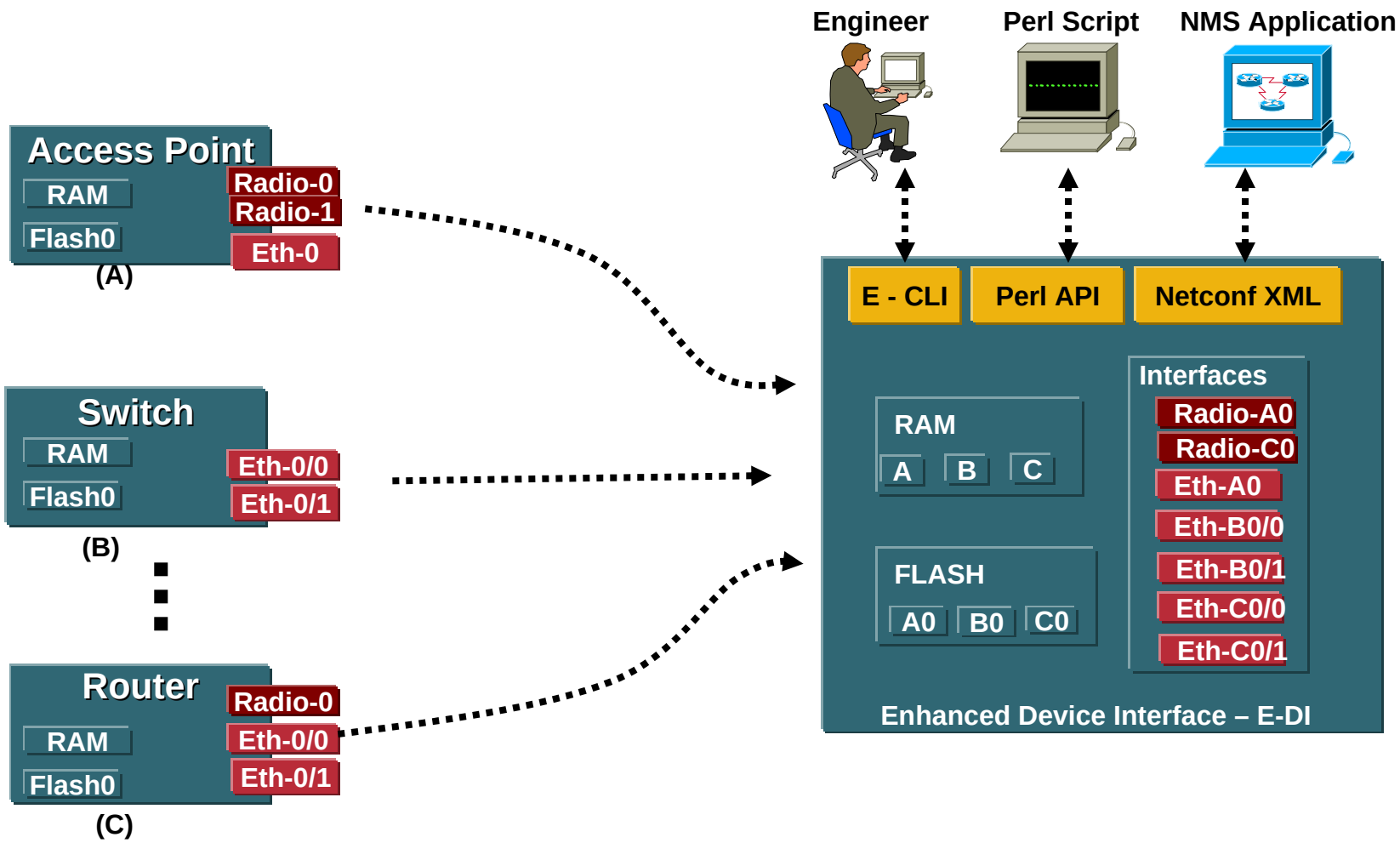
Enhanced Device Interface (E-DI) Device Support Packages (Cont.)

Device Package	Device Package Version	Supported Software Release
Cisco 2800	1.1	Release 12.3(11)T7
IAD 2400	1.1	Release 12.3 (8)T9
Cisco 2600	1.1	Release 12.3(10e)
Catalyst 6500	1.4	CatOS Version: 8.4
PIX Device	1.4	PIX OS Version 7.0(4)
Cat 6500 with CSM module	1.3	Release 12.2.(18)SXE3, IOS Version: Release 12.2.(18)SXF (With FSM Card)

Example: Network Virtualization



Example: Network Virtualization



Main Features

- **OS Parser Emulation**

  CLI syntax checking & command context validation eliminates human errors

- **Device Grouping**

  Definition of administrative domains

  Access control per administrative domain level

  Simplifies configuration and administrative tasks

- **Group least common denominator CLI**

  Perform group operations without risk of generating unsupported command

- **Context – Based CLI**

  Simultaneously apply changes to one or more devices by selecting the context

  Single point for network configuration

Cisco IOS—Like CLI

- **Real-time syntax validation and visual feedback**

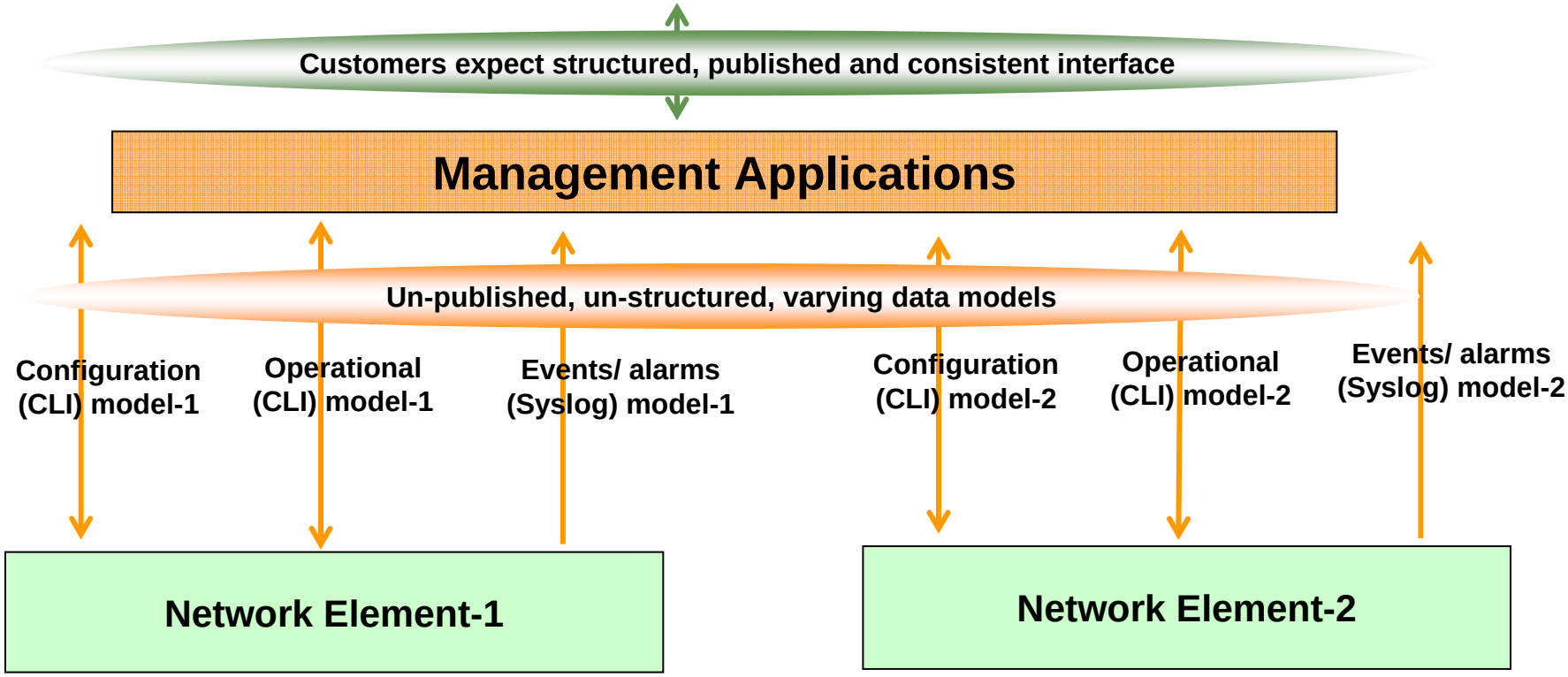
172.25.87.37 - PuTTY

```
admin@edi-hp1[SRV:/]# sh dev
admin@edi-hp1[SRV:/]# sh devices
Number of devices in network-restricted: 3

*  Devices marked with * are not supported by E-DI
   (No matching Device Package could be found).

  Device          Name                 Type                 Status
- --------------- -------------------- -------------------- --------
  172.25.86.104   issc-3550-2          Cat355024            P3-alarm
* 172.25.87.33    edi-qnt-3            CiscoEDI             P2-alarm
                                       in Cisco1760         P2-alarm
```

172.25.87.37 - PuTTY

```
admin@edi-hp1[SVR:/server]# network group CompleteNetwork
You are now in network view.
Your present working directory: /network/groups/CompleteNetwork/


admin@edi-hp1[GRP:~/CompleteNetwork/]# sh cdp ne
admin@edi-hp1[GRP:~/CompleteNetwork/]# sh cdp neighbors

 Local-Dev       Local-If Neighbor           Neighbor Neighbor Type
                          ID/IPAddress       If
 --------------- -------- ----------------- -------- -------------------------
 172.25.87.156   Fa0/0    edi-sw-1           Fa0/19   cisco WS-C2924M-XL
 172.25.87.157   Fa0/1    edi-sw-1           Fa0/20   cisco WS-C2924M-XL
 172.25.86.104   Fa0/1    edi-r45-gwsw1      Fa0/9    cisco WS-C2950C-24
 172.25.87.158   Fa0/1    edi-sw-1           Fa0/17   cisco WS-C2924M-XL
 172.25.87.159   Eth0     lincoln-1          Fa0/18   cisco WS-C3550-24
 172.25.87.160   Fa0/0    edi-sw-2           Fa1/0/6  cisco ME-C3750-24TE
 172.25.87.164   Fa0/0    edi-sw-4           Fa0/14   cisco WS-C2950-24
 172.25.87.172   Fa0      edi-sw-1           Fa0/6    cisco WS-C2924M-XL
 172.25.87.183   Fa0/0    edi-sw-4           Fa0/6    cisco WS-C2950-24
 172.25.87.192   Gi0/1    edi-sw-4           Fa0/5    cisco WS-C2950-24
 172.25.87.167   Fa0/1    edi-sw-2           Fa1/0/1  cisco ME-C3750-24TE
 172.25.87.167   Fa0/12   edi-sw-2           Fa1/0/8  cisco ME-C3750-24TE
 172.25.87.167   Fa0/17   VG224              Fa0/0    Cisco VG224
```

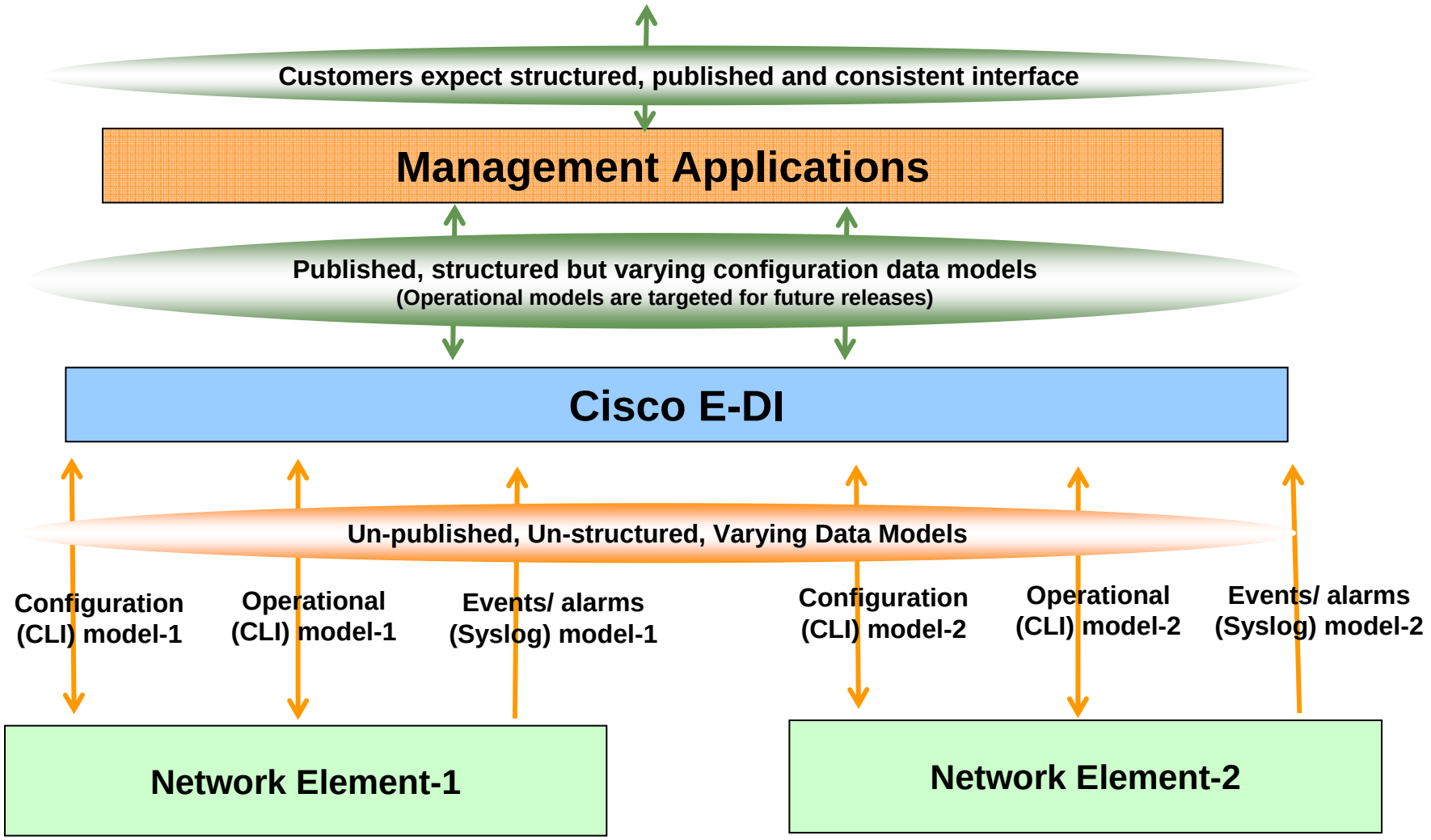
Programmatic Interface Problem Definition



Resulting in

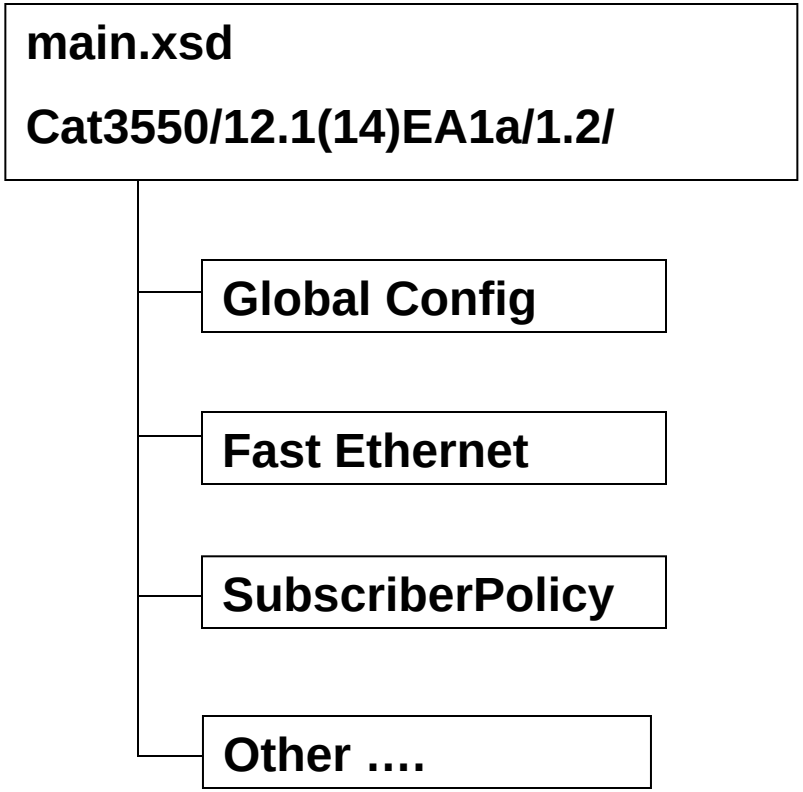
- Longer analysis and design phase
- Longer implementation and validation phases
- Defects may be found towards the tail-end of the project or in the field

Programmatic Interface Use Case
How E-DI Helps?



What Is in E-DI Generated Device Data Model?

- E-DI publishes data models as a collection of XML Schema Definition (XSD) files
- Structured model
- Named and hierarchical elements for predictability in parsing
  - Namespace to identify variations in data models
- Publishes
  - Data type (integers, strings, IP addresses, MAC addresses etc.)
  - Cardinality (min/max occurrences)
  - Constraints (ex: ranges)
  - Key fields (naming)
  - Order (sequence, choice)
  - Identification of negation logic



Agenda

- Introduction
- Embedded Management Tools
- Enhanced Device Interface
- Practical Applications
- Summary and Conclusion

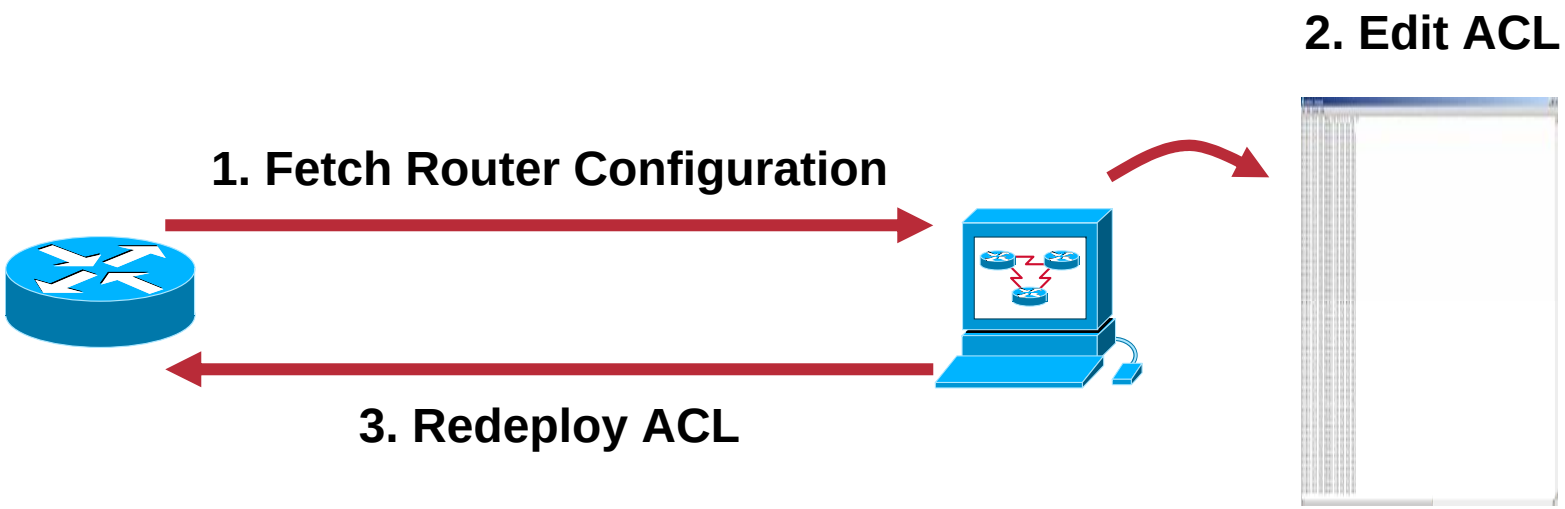
Working with Access-Lists
Exercise 1

- **Problem**

  Editing Access-Lists on routers is time consuming and prone to errors

Working with Access-Lists

Editing Access-Lists the long way



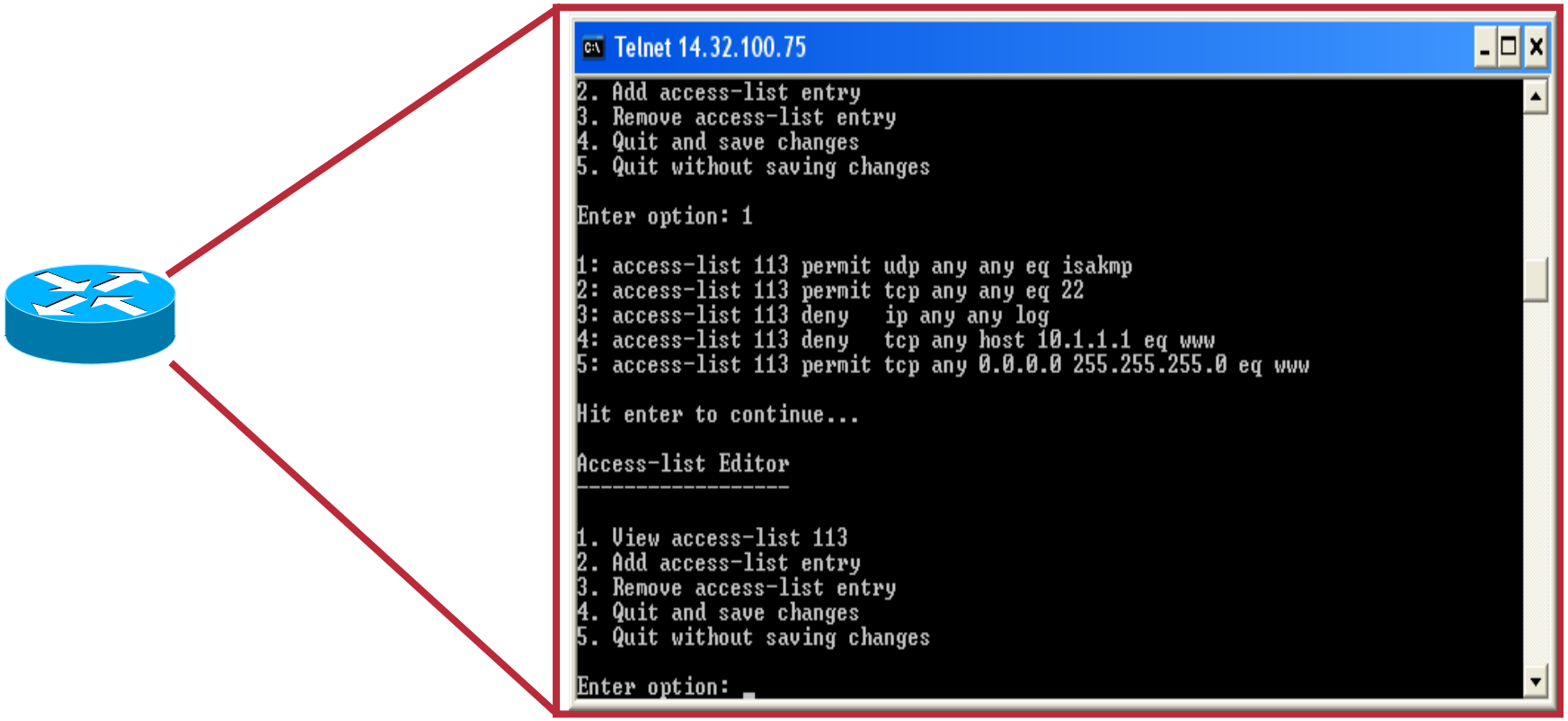
Working with Access-Lists

- **Solution**

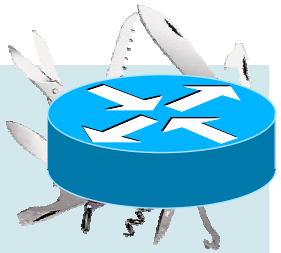
  Write an Access-List Editor in TCL that can run directly on the router

Working with Access-Lists

Using TCL to Edit the Access-List



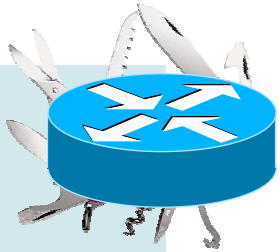
TCL Access-List Editor



```
Router(tcl)#edit_acl 113
Access-list Editor
------------------

1. View access-list 113
2. Add access-list entry
3. Remove access-list entry
4. Quit and save changes
5. Quit without saving changes

Enter option: 1

1: access-list 113 permit udp any any eq isakmp
2: access-list 113 permit tcp any any eq 22
3: access-list 113 deny   ip any any log
4: access-list 113 deny   tcp any host 10.1.1.1 eq www
5: access-list 113 permit tcp any 0.0.0.0 255.255.255.0 eq www
```

TCL Access-List Editor

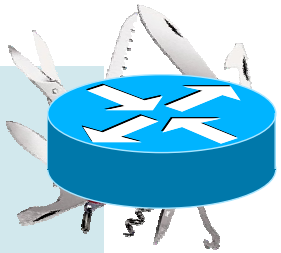
Adding an Access-List entry



```
Access-list Editor
------------------

1. View access-list 113
2. Add access-list entry
3. Remove access-list entry
4. Quit and save changes
5. Quit without saving changes

Enter option: 2

1: access-list 113 permit udp any any eq isakmp
2: access-list 113 permit tcp any any eq 22
3: access-list 113 deny   ip any any log
4: access-list 113 deny   tcp any host 10.1.1.1 eq www
5: access-list 113 permit tcp any 0.0.0.0 255.255.255.0 eq www
Insert before which line number: 3
Enter body of ACL rule to insert (without the access-list 113 portion):
permit tcp any any eq 80
```

TCL Access-List Editor

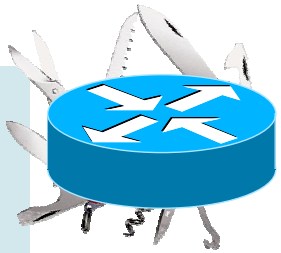
Removing an Access-List Entry



```
Access-list Editor
------------------

1. View access-list 113
2. Add access-list entry
3. Remove access-list entry
4. Quit and save changes
5. Quit without saving changes

Enter option: 3

1: access-list 113 permit udp any any eq isakmp
2: access-list 113 permit tcp any any eq 22
3: access-list 113 permit tcp any any eq 80
4: access-list 113 deny   ip any any log
5: access-list 113 deny   tcp any host 10.1.1.1 eq www
6: access-list 113 permit tcp any 0.0.0.0 255.255.255.0 eq www
Enter ACL entry number to delete: 1
```

TCL Access-List Editor

Saving the Changes



```
Access-list Editor
------------------

1. View access-list 113
2. Add access-list entry
3. Remove access-list entry
4. Quit and save changes
5. Quit without saving changes

Enter option: 4
Access-list 113 was committed successfully.

Router(tcl)#show run | include ^access-list 113
access-list 113 permit tcp any any eq 22
access-list 113 permit tcp any any eq www
access-list 113 deny   ip any any log
access-list 113 deny   tcp any host 10.1.1.1 eq www
access-list 113 permit tcp any 0.0.0.0 255.255.255.0 eq www
```

Deploying Security Fixes
Exercise 2

- **Problem**

  A New PSIRT Advisory has come out, and a workaround needs to be deployed and maintained on all of the routers

Deploying Security Fixes

- **SNMP Message Handling Vulnerability**

  The Cisco IOS "IP SNMP" process incorrectly attempts to process solicited SNMP requests on UDP port 162 as well as a random, high UDP port

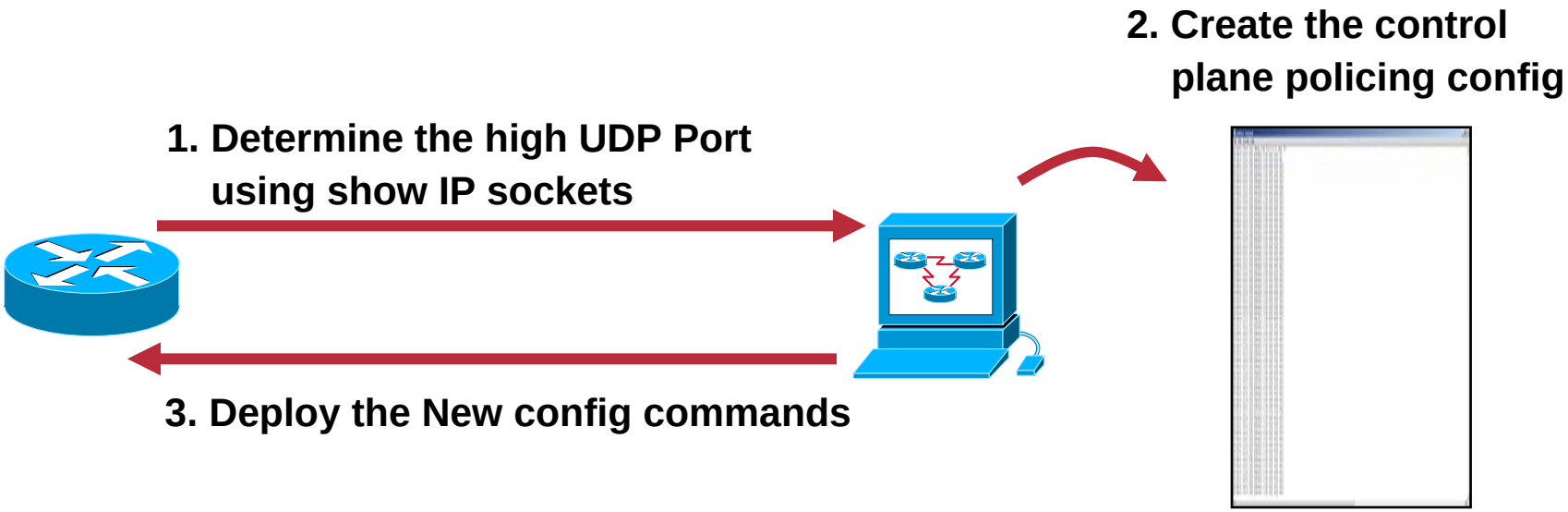
  A successful exploit of this vulnerability will result in a router reload

  To workaround this problem, control-plane policing can be done to block SNMP requests without impacting packet-switching performance

  To do this effectively, the randomly chosen high UDP ports must first be determined on each router

Deploying Security Fixes

Doing Things the Long Way



But, what if the router reloads…?

Deploying Security Fixes

- **Solution**

  Write a TCL Script to dynamically determine the High UDP port

  Automatically add the necessary control-plane policing commands

  Use Cisco IOS Software and do config command to make sure the script is run every time the router reloads

TCL SNMP Security Fix Script

- **Running the script at Boot Time**

  Copy the router's startup configuration to a server, and add the following towards the end of the file

  ```
  do tclsh tftp://10.1.1.1/snmp_fix.tcl
  ```

  Copy the edited file directly into the router's NVRAM

  ```
  copy tftp://10.1.1.1/router.cfg startup
  ```

  The router will load the script from the TFTP server each time it boots

  If the network takes a long time to converge, it might be better to copy the script to each router's flash

Archiving Configurations Example 3

- **Problem**

  Router configurations must be archived periodically to router flash as well as a network server for disaster recovery

  This process is time consuming and sometimes it is forgotten to be done

Archiving Configurations

- **Backup the Config to Flash and to FTP**

  Copy the current running configuration to flash

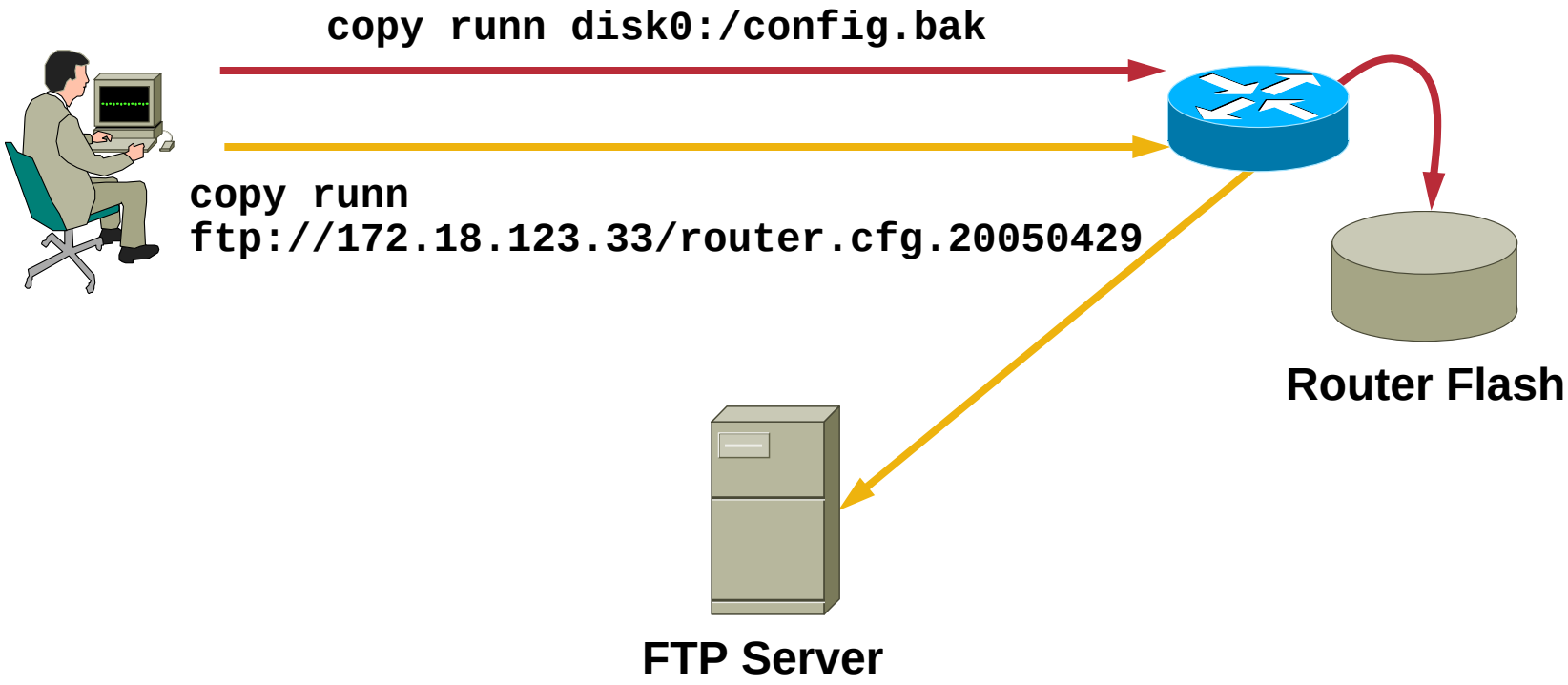
```
copy runn disk0:/config.bak
```

  Archive the configuration on an anonymous FTP server

```
copy runn ftp://172.18.123.33/configs/router.cfg
```

Archiving Configurations

Doing Things the Long Way



Archiving Configurations

- **Solution**

  Use Cisco IOS Software built-in configuration archive feature to backup the running config to flash

  Next schedule a Kron policy to copy the current running configuration to the FTP server

Config Archive Configuration

- **Archive the running configuration to flash every 1440 Minutes (ie: every day)**

```
archive
 path disk0:/config-archive
 maximum 14
 time-period 1440
```

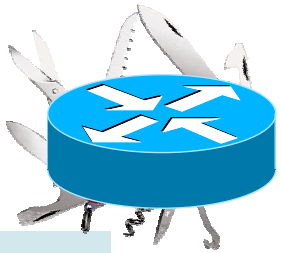
FTP Kron Policy

Run the TCL Script to transfer the latest archive config to the anonymous FTP server every day

```
kron occurrence ftpconfig_occur in 1:0:0 recurring
 policy-list ftpconfig
!
kron policy-list ftpconfig
 cli copy running-config
ftp://172.18.123.33/configs/router.cfg
!
```

Archiving Configurations

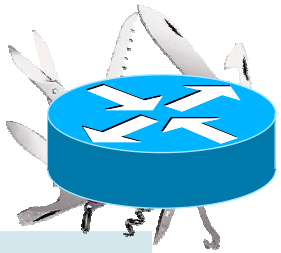
Verifying the Router Configuration



```
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#show kron schedule
Kron Occurrence Schedule
ftpconfig_occur inactive, will run again in 0 days 23:54:17
```

Archiving Configurations

Verifying the FTP Server



```
file-server# cd /nms/ftp/configs
file-server# ls -l router.cfg
-rw-r-----    1 ftp   ftp        6333 Apr 26 17:10
router.cfg
```

Applying Configuration Changes Exercise 4

- **Problem**

  Applying configuration changes to remote routers can cause lockouts

  When console access is not available, someone needs to reload these devices

Applying Configuration Changes

- **Applying a Change to a Remote Router**

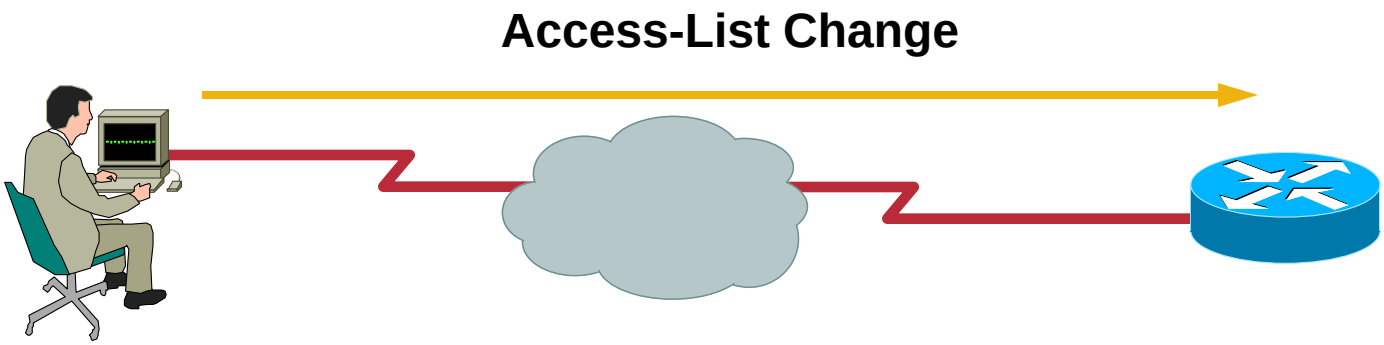
  Applying a configuration change such as an access-list could result in being locked out of the router

  If console access is available, configuration changes can be deployed using the console to avoid network problems

  If no out-of-band access is available, then a reload is necessary to undo the problematic config change

Applying Configuration Changes

Doing Things the Hard Way



Now the Router must be reloaded

Applying Configuration Changes

- **Solution**

  Use Config Rollback to automatically backout the config change after a certain amount of time

Using Config Rollback
Exercise 5

Replace the running configuration with the latest good archive after two minutes unless the change being made is confirmed

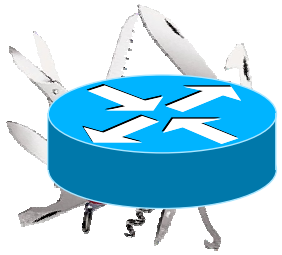
```
Router#show archive
There are currently 4 archive configurations saved.
The next archive file will be named disk0:/config-archive-4
 Archive #  Name
   0
   1       disk0:/config-archive-1
   2       disk0:/config-archive-2
   3       disk0:/config-archive-3 <- Most Recent

Router#config replace disk0:/config-archive-3 time 120
```

Using Config Rollback

Apply the Potentially Problematic Configuration Change

```
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int pos4/0
Router(config-if)#ip access-group 113 in
```

Using Config Rollback



- **If the configuration was successful, apply the changes**

```
Router#config confirm
```

- **If the config changes caused the user to be locked out, the router will automatically revert to the last saved archive configuration after two minutes, and connectivity will be restored**

Agenda

- Introduction
- Embedded Management Tools
- Enhanced Device Interface
- Practical Applications
- Summary and Conclusion

Summary

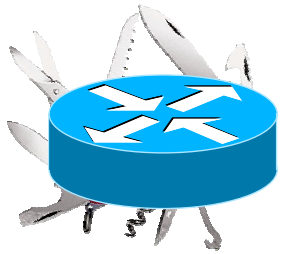
- **TCL can be used to build custom commands, automate device configuration and create other embedded tools**
- **EEM provides a way for the router to monitor itself for potential problems, and act accordingly**
- **ESM can filter and prioritize critical log messages**
- **ERM provides a way to monitor resource usage and set limits**

Summary (Cont.)

- **Command Scheduler** is useful for scheduling automated tasks
- **Configuration Replace and Rollback** provides configuration archival and configuration replacement and rollback
- **Contextual Configuration Diff Utility** enables line-by-line comparison of two configuration versions
- **E-DI** provides an XML programmatic interface to Cisco devices as well as an enhanced CLI

Conclusion

- **Cisco IOS Software has a lot of very powerful embedded tools**
- **Use the scripts and examples to build rich, customized tools that work for YOU**



CISCO SYSTEMS

Appendix

TCL Access-List Editor

The Code

```
proc get_acl { acl } {
        set command "show running-config | include ^access-list $acl"
        return [exec $command]
}
```

Extract the desired Access-List from the running configuration

TCL Access-List Editor
The Code (Cont.)

Display the ACL in 24 line pages

```
proc paginate { l } {
        set i 0
        while { $i < [llength $l] } {
                set new_page 1
                for { } { $i < [llength $l] && ($i == 0 || ($i % 24 != 0)
|| $new_page == 1) } { incr i } {
                        set new_page 0
                        set num [expr {$i+1}]
                        set lentry [lindex $l $i]
                        puts "$num: $lentry"
                }
                if { $i < [llength $l] } {
                        puts -nonewline "Hit enter to continue..."
                        flush stdout
                        gets stdin key
                        incr i
                }
        }

        return $i
}
```

TCL Access-List Editor
The Code (Cont.)

```
proc add_acl { acl acllist } {
        puts "\n"
        set i [paginate $acllist]
        set aclend [expr {$i + 1}]

        puts -nonewline "Insert before which line number ($aclend to append): "
        flush stdout
        gets stdin choice

        if { $choice <= 0 || $choice > $aclend } {
                puts "Invalid line number, $choice.\n"
                return $acllist
        }

        puts -nonewline "Enter body of ACL rule to insert (without the access-list
$acl portion): "
        flush stdout
        gets stdin body

        regsub -nocase {^access-list\s[^\s]+\s} $body "" body

        return [linsert $acllist [expr {$choice - 1}] "access-list $acl $body"]
}
```

Insert a new ACL entry within the existsing ACL

TCL Access-List Editor
The Code (Cont.)

```
proc delete_acl { acl acllist } {
        puts "\n"
        set i [paginate $acllist]

        puts -nonewline "Enter ACL entry number to delete: "
        flush stdout
        gets stdin lineno

        if { $lineno <= 0 || $lineno > $i } {
                puts "Invalid entry number, $lineno.\n"
                return $acllist
        }

        return [lreplace $acllist [expr {$lineno - 1}] [expr {$lineno - 1}]]
}
```

Delete a specific ACL entry

TCL Access-List Editor
The Code (Cont.)

```
proc commit_acl { acl acllist orig_acllist } {
        ios_config "no access-list $acl"

        foreach line $acllist {
                if { [catch { ios_config $line } result] } {
puts "Error committing access-list entry \"$line\" ($result)"
                        puts "Re-adding the original access-list..."
ios_config "no access-list $acl"
                        foreach origline $orig_acllist {
if { [catch { ios_config $origline } result] } {
                                        puts "DANGER! Error committing original
access-list entry \"$origline\" ($result)"
                                        puts "Investigate this immediately!"
                                        return
                                }
                        }
                        return
                }
        }

        puts "Access-list $acl was committed successfully."
}
```

Check for errors to ensure we do not leave the router unprotected

TCL Access-List Editor
The Code (Cont.)

Cisco.com

```
while { $done == 0 } {
                puts "Access-list Editor"
                puts "-----------------\n"
                puts "1. View access-list $aclno"
                puts "2. Add access-list entry"
                puts "3. Remove access-list entry"
                puts "4. Quit and save changes"
                puts "5. Quit without saving changes"
                puts ""
                puts -nonewline "Enter option: ";
                flush stdout

                gets stdin choice

                switch $choice {
                        1 { view_acl $acllist }
                        2 { set acllist [add_acl $aclno $acllist] }
                        3 { set acllist [delete_acl $aclno $acllist] }
                        4 {
                                set done 1
                                set save 1
                        }
                        5 {
                                set done 1
                                set save 0
```

Present the Access-List; edit options to the user in a menu

TCL SNMP Security Fix Script
The Code

Determine the High UDP port dynamically by inspecting the output of show ip sockets

```
proc snmp_fix { } {
    snmp_unfix
    set sockets [exec "show ip sockets"]
    set socket 0
    foreach line [split $sockets "\n"] {
        set line [string trim $line]
        if {[regexp {^17\s+--listen--} $line] || [regexp {^17 0\.0\.0\.0}
$line]} {

            set tsocket [lindex $line 3]
            if {$tsocket > 49152 && $tsocket < 65535} {
                set socket $tsocket
                break
            }
        }
    }
```

TCL SNMP Security Fix Script
The Code (Cont.)

```
 if {$socket > 0} {
        set myacl [find_acl 100 200]
        if {$myacl == 0} {
            set myacl [find_acl 2000 2700]
        }
        if {$myacl == 0} {
            puts "Failed to find a free access-list."
            return
        }
        ios_config "class-map match-all matchsnmp" "match access-group $myacl"
        ios_config "policy-map dropsnmp" "class matchsnmp" "drop"
        ios_config "access-list $myacl permit udp any any eq 162"
        ios_config "access-list $myacl permit udp any any eq $socket"
        ios_config "access-list $myacl deny ip any any"
        ios_config "control-plane" "service-policy input dropsnmp"

        puts "SNMP control plane access now denied to ports 162 and $socket"
        puts "using access-list $myacl.  Use ``snmp_unfix'' to remove this"
        puts "configuration."
    } else {
        puts "Failed to find a listening socket for SNMP."
    }

}
```

Find a free IP ACL, then apply the necessary control plane policing configuration changes

Managing Syslog Events
Exercise 3

- **Problem**

  Cisco Info Center is being used for general syslog and trap management

  However, Resource Manager Essentials needs Config Change Syslog Messages for realtime configuration archival

  Sending all the Syslog Messages to two destinations takes up network bandwidth, and puts unnecessary CPU load on RME

Managing Syslog Events

- **Filter out unwanted syslog messages**

  Configure a filter in RME to drop all syslog messages except the config change messages

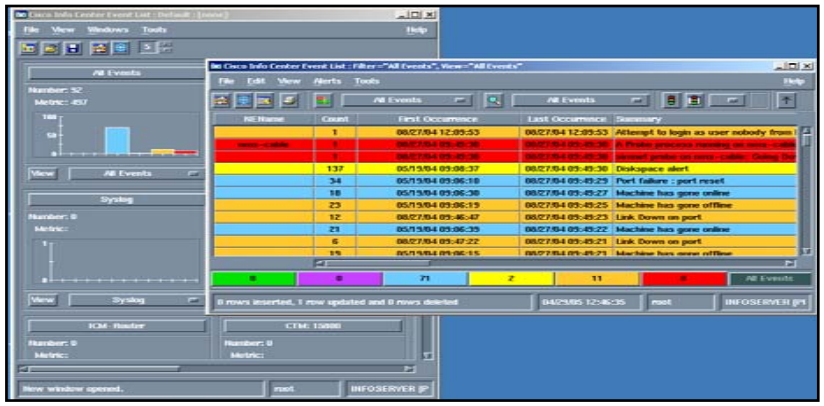
  CONFIG_I

  CONFIG

  This reduces CPU overhead, but does not address the problem of increased network usage

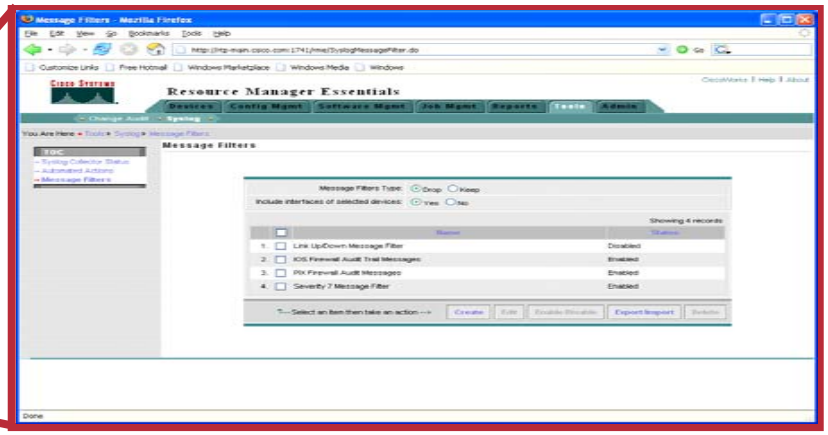
Managing Syslog Events
Doing Things the Long Way

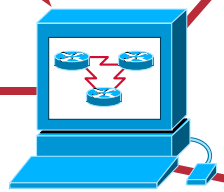
Cisco Info Center



Router Sends OSPF-*-5-ADJCHG
Router Sends SYS-*-5-CONFIG_1
Messages

Define Message Filters in RME





CiscoWorks

Managing Syslog Events

- **Solution**

  Use Embedded Syslog Manager to filter out all but SYS-*-5-CONFIG_I and SYS-*-5-CONFIG Syslog Messages for transmission to the CiscoWorks Server

  This approach does not require any syslog filters in RME, and keeps unwanted messages off of the network

ESM CONFIG Message Filter

Configuring the Router

- **Define the ESM filter**

```
logging filter disk0:/config_chg.tcl
```

- **Add the CiscoWorks server as a logging host, and pass all messages through the config change filter**

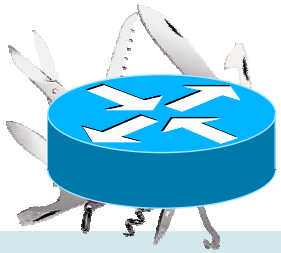
```
logging host 10.10.10.1 filtered
```

- **Add the CIC server as an unfiltered logging host**

```
logging 10.10.10.2
```

ESM CONFIG Message Filter

Verifying the Router Configuration



```
Router#show logging
…
Filter modules:
    disk0:/config_chg.tcl

    Trap logging: level debugging, 103 message lines logged
        Logging to 10.10.10.1 (udp port 514, audit disabled), 24
message lines logged, xml disabled,
               filtering disabled
        Logging to 10.10.10.2 (udp port 514, audit disabled), 3
message lines logged, xml disabled,
               filtering enabled
```

ESM CONFIG Message Filter
The Code

Only pass messages with a mnemonic of CONFIG_I or CONFIG on to the destination

```
# Embedded Syslog Manager, Only send CONFIG and CONFIG_I syslog messages
#
# Namespace: global

if {[string length $::orig_msg] == 0} {
    return ""
}

if {[string compare -nocase "CONFIG_I" $::mnemonic] == 0 ||
        [string compare -nocase "CONFIG" $::mnemonic] == 0} {
            return $::orig_msg
}

return ""
```