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Cisco IOS-XR Overview

LTRARC-2002

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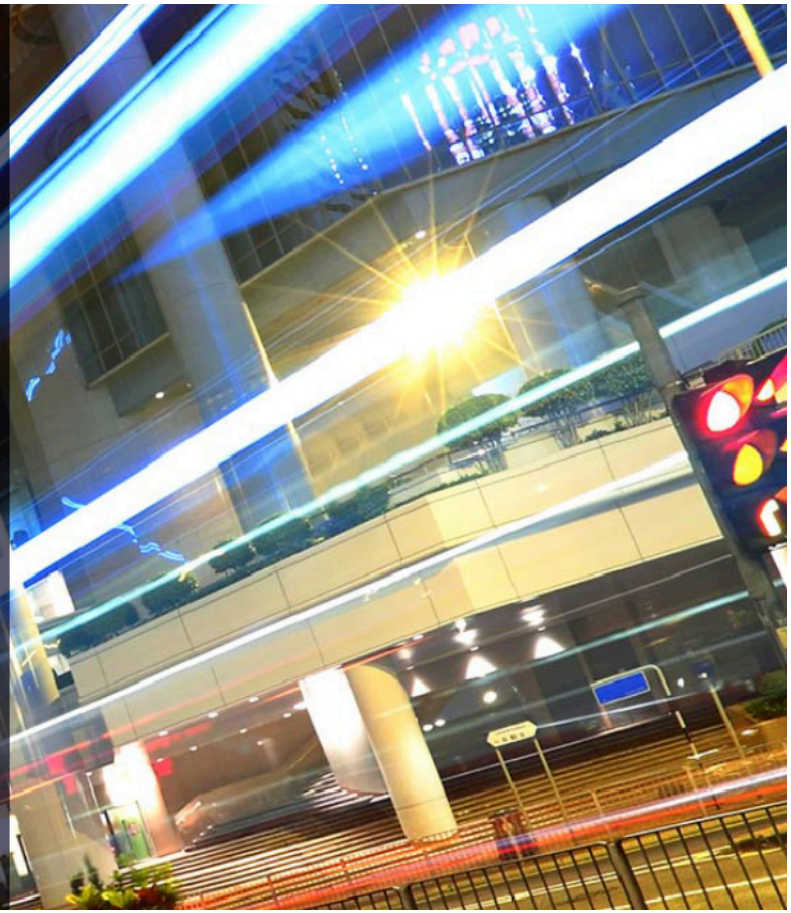
Agenda

- Introduction
- Architecture Overview
- Software Packages, Installation & Upgrades
- Protocol Configuration Overview
- RPL
- Monitoring
- On-Hands Lab



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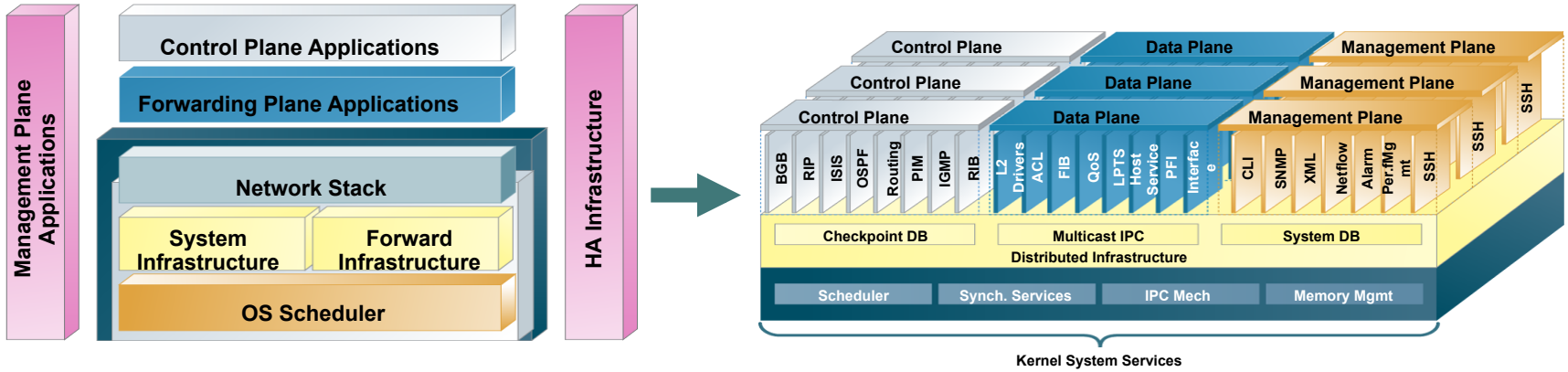
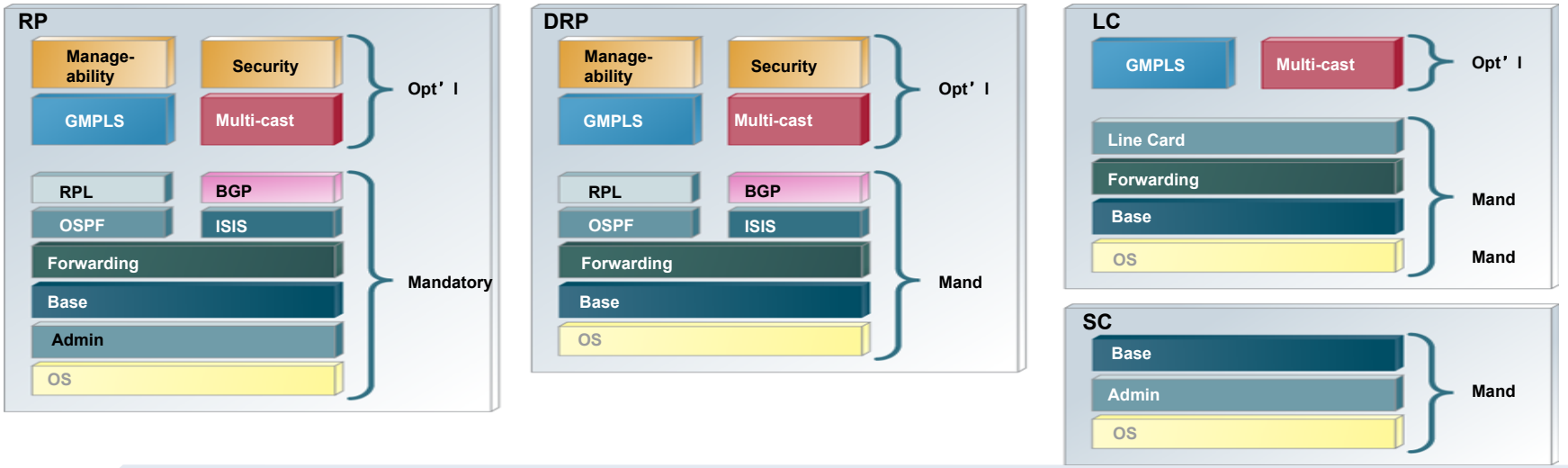
Router OS Evolution



- Monolithic Kernel
- Centralized Infrastructure
- Integrated Network stack
- Centralized applications

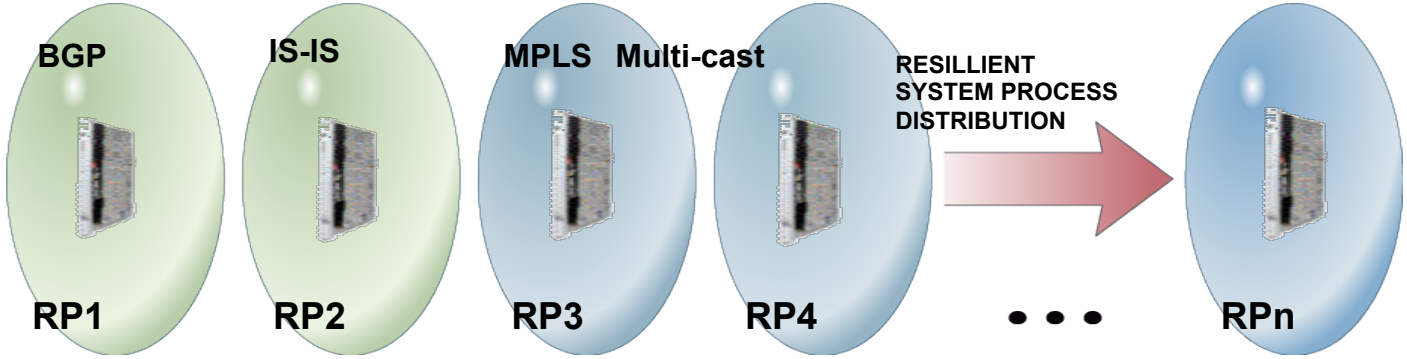
- Micro Kernel
- Distributed Infrastructure
- Independent Network stack
- Distributed applications

IOS XR Modular Packaged Software



- Upgrade specific packages/Composites
  - Across Entire system
    - Useful once a feature is qualified and you want to roll it without lot of cmd
- Point Fix for software faults

Distributed Control Plane



- Routing protocols and signaling protocols can run in one or more (D)RP
- Each (D)RP can have redundancy support with standby (D)RP
- Out of resources handling for proactive planning

System redundancy

- Power redundancy
- Fabric redundancy
- RP redundancy
- NSR
- NSF
- Routing process placement and failure protection.

```
RP/0/RP0/CPU0:CRS1#show redundancy
Wed Apr 15 06:18:20.400 UTC
Redundancy information for node 0/RP0/CPU0:
==========================================
Node 0/RP0/CPU0 is in ACTIVE role
Partner node (0/RP1/CPU0) is in STANDBY role
Standby node in 0/RP1/CPU0 is ready
Standby node in 0/RP1/CPU0 is NSR-ready
```

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Control plane redundancy

```
RP/0/RP1/CPU0:CRS1-MC#show redundancy summary
    Active Node     Standby Node
    -----------     ------------
     0/RP1/CPU0       0/RP0/CPU0 (Node Ready, NSR: Not Configured)
     1/RP0/CPU0       1/RP1/CPU0 (Node Ready, NSR: Not Configured)
     2/RP0/CPU0       2/RP1/CPU0 (Node Ready, NSR: Not Configured)
     3/RP0/CPU0       3/RP1/CPU0 (Node Ready, NSR: Not Configured)
     4/RP0/CPU0       4/RP1/CPU0 (Node Ready, NSR: Not Configured)
     5/RP0/CPU0       5/RP1/CPU0 (Node Ready, NSR: Not Configured)
     6/RP0/CPU0       6/RP1/CPU0 (Node Ready, NSR: Not Configured)
     7/RP1/CPU0       7/RP0/CPU0 (Ready, NSR: Ready)
RP/0/RP1/CPU0:CRS1-MC#
```


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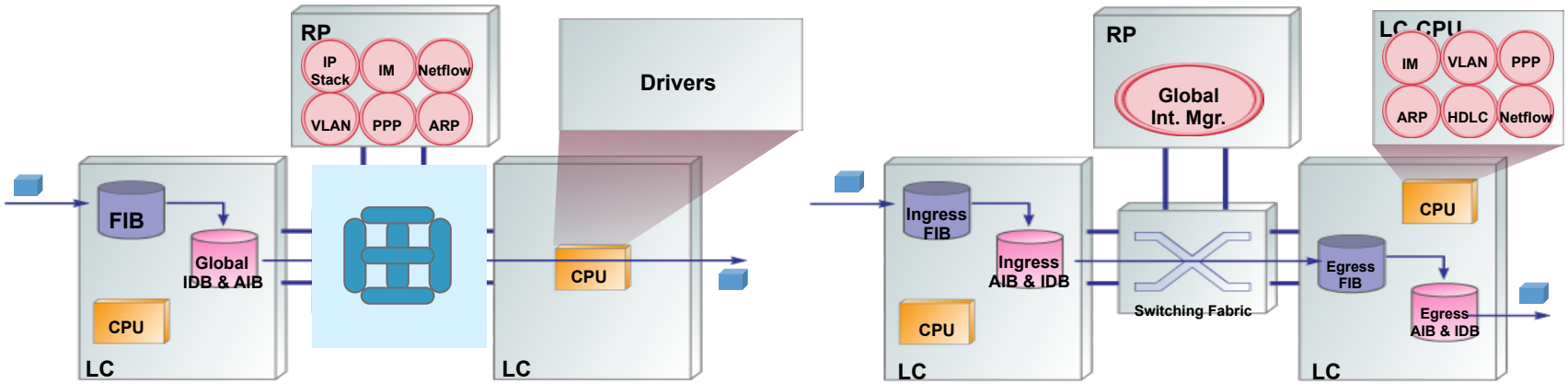
Distributed Forwarding Infrastructure



Single stage forwarding(Centralized)

- Single global Adjacency Information Base (AIB) distributed to all line cards
- Single global Interface Management DB distributed to all line cards
- Only Ingress FIB – forces forwarding features to be run in RP

Two stage forwarding(Distributed)

- Each line card has independent AIB only for local interfaces
- Each line card has independent Interface DB for local interfaces
- Both Ingress and Egress FIB – allows forwarding features to be independently run in LCs

Basic Distributed LC programing

```
RP/0/8/CPU0:GSR1#show route 10.7.107.4
Routing entry for 10.7.107.4/30
  Known via "ospf 2", distance 110, metric 10301, type inter area
  Installed Apr 16 05:08:56.308 for 1d12h
  Routing Descriptor Blocks
    10.5.70.1, from 10.122.0.3, via TenGigE0/0/0/0
      Route metric is 10301
  No advertising protos.

RP/0/8/CPU0:GSR1#show cef 10.7.107.4
10.7.107.4/30, version 18, internal 0x4000001 (ptr 0xaec2d2b8) [1], 0x0 (0xae2252f8), 0x0 (0x0)
 Updated Apr 16 05:08:56.311
 local adjacency 10.5.70.1
 Prefix Len 30, traffic index 0, precedence routine (0)
   via 10.5.70.1, TenGigE0/0/0/0, 8 dependencies, weight 0, class 0 [flags 0x0]
    path-idx 0
    next hop 10.5.70.1
    local adjacency

RP/0/8/CPU0:GSR1#show cef 10.7.107.4  location 0/1/cpu0
10.7.107.4/30, version 18, internal 0x4000001 (ptr 0x543e6c6c) [1], 0x0 (0x543b49f8), 0x0 (0x0)
 Updated Apr 16 05:09:29.038
 local adjacency 10.5.70.1
 Prefix Len 30, traffic index 0, precedence routine (0)
   via 10.5.70.1, TenGigE0/0/0/0, 8 dependencies, weight 0, class 0 [flags 0x0]
    path-idx 0
    next hop 10.5.70.1
    local adjacency
RP/0/8/CPU0:GSR1#
```

Basic Distributed LC programing-ingress

```
RP/0/8/CPU0:GSR1#show cef 10.7.107.4 hardware ingress location 0/1/cpu0
10.7.107.4/30, version 18, internal 0x4000001 (ptr 0x543e6c6c) [1], 0x0 (0x543b49f8), 0x0 (0x0)
 Updated Apr 16 05:09:28.999
 local adjacency 10.5.70.1
 Prefix Len 30, traffic index 0, precedence routine (0)
   via 10.5.70.1, TenGigE0/0/0/0, 8 dependencies, weight 0, class 0 [flags 0x0]
    path-idx 0
    next hop 10.5.70.1
    local adjacency

 Number of Mnodes:   3
 Mnode 0 HW Location: 0x0008301c  HW Value
[ 0x0081e600 00000000 00000000 00000000 ]

  . . . . .  SKIP for brevity

------------------------------------------------
 HW Rx Adjacency  0 Detail:
------------------------------------------------
    Rx Adj HW Address   0x02080040  (ADJ)
    packets 0  bytes 0
    HFA Bits 0x80 gp 48 mtu 9248 (Fabric MTU) TAG length 0
    OI 0x160408 (Tx uidb 11 PPindex 1032)
    OutputQ 0 Output-port 0x0 local-outputq 0x8000

[ 0x80183040 00002420 00160408 00008000 ]
[ 0x00000000 00000000 00000000 00000000 ]
[ 0x00000000 00000000 00000000 00000000 ]
hfa_bits = 080 lb_adj =0

RP/0/8/CPU0:GSR1#
```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Basic Distributed LC programing-egress

```
RP/0/8/CPU0:GSR1#show cef 10.7.107.4 hardware egress location 0/0/cpu0
10.7.107.4/30, version 18, internal 0x4000001 (ptr 0x52d6496c) [1], 0x0 (0x521f42e8), 0x0 (0x0)
 Updated Apr 16 05:08:55.036
 local adjacency 10.5.70.1
 Prefix Len 30, traffic index 0, precedence routine (0)
   via 10.5.70.1, TenGigE0/0/0/0, 8 dependencies, weight 0, class 0 [flags 0x0]
    path-idx 0
    next hop 10.5.70.1
    local adjacency


 Hardware Leaf:      TCAM offset 0x00030c9a
 Hardware Leaf:      Value
[ 0x4000000c 076b0400 00000000 00000000 00000000 ]

 Hardware Leaf:      Mask
[ 0x01ffff00 00000300 00000000 00000000 00000000 ]

 Hardware Leaf:      PLU Leaf Value
[ 0x00000000 00000000 80001e00 12834000 ]

 FCR  18 TLU Address 0x00000000 TI 0 AS 0

VPN Label 1 0
 ************* IGP LoadInfo *****************
 Loadinfo HW Max Index  0
 Loadinfo SW Max Index  0
 PBTS Loadinfo Attached: No
 TxList Attached: No
 LI Path [ 0]  HFA Info: 0x00000000   FCR: 0
 ******************************************
```

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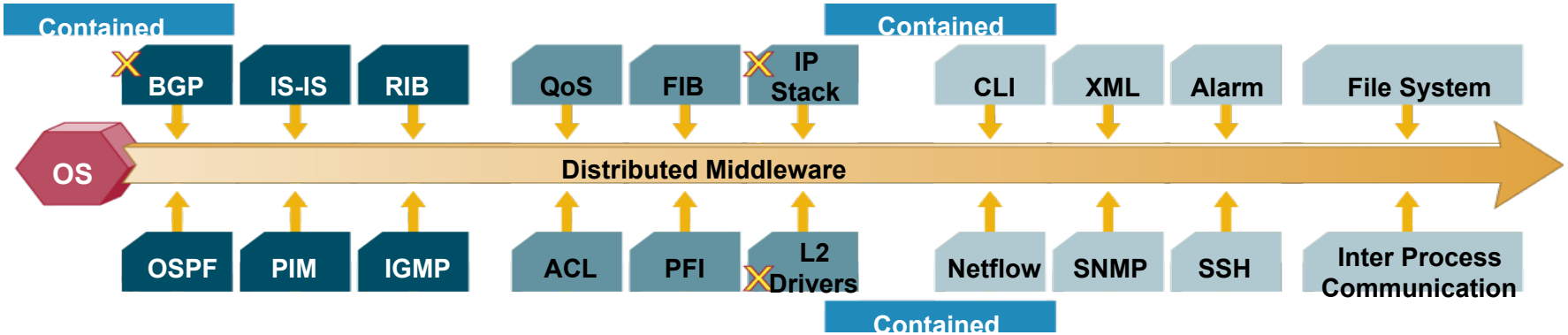
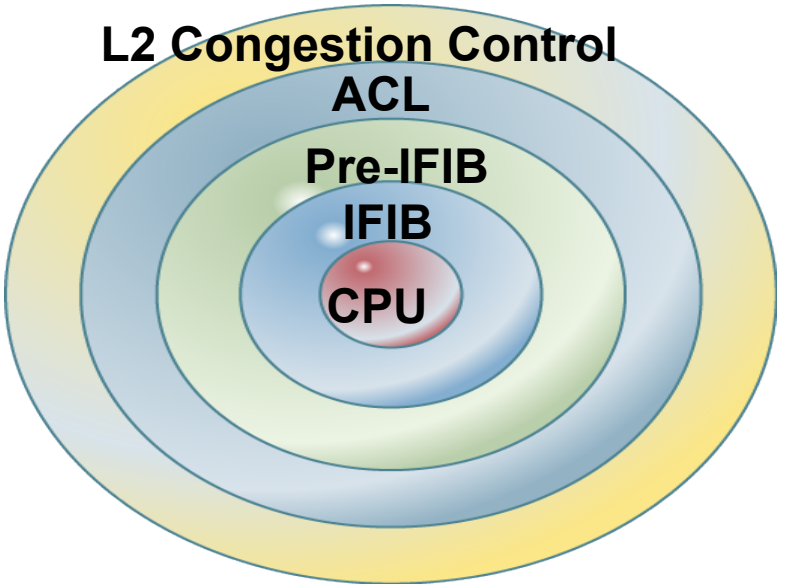
Process Restartability

- Used for small/contained faults (individual or small groups of process failures)
- Processes support restarting with dynamic state recovery
  - –Mirrored State via checkpoint or synchronization with peer
- First line of defense- All Processes are restartable for fault recovery
- Certain processes are ‘mandatory’ – must always be running. Failure of mandatory processes can cause RP failover
- Second line of defense - Card-level Redundancy is used when Process Restart fails-



Protection against DDOS

- Layered Control Plane protection using multiple policers
  - DOS Filter using L2 Congestion Control Mode
  - Line rate ACL filtering
  - Control Plane Session Validation using Pre-filter mechanisms
  - Adjustable performance for trusted control plane session treatment
  - Multiple Queues to CPU



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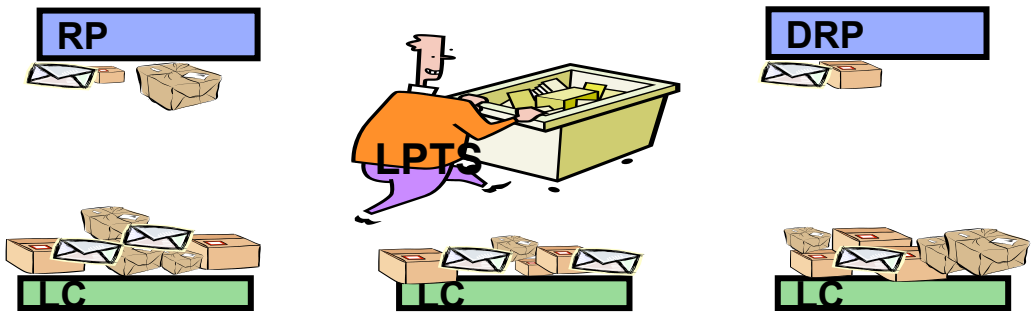
Local Packet Transport Protocol (LPTS)
Interoffice Mail for Data Plane

- Enables delivery of data to distributed processes across the system hardware (RPs, DRPs)
- Used for ‘for_us’ packet prioritization and filtering
  - Sends ‘for us’ packets only to the nodes that want them
  - Uses HW policers to throttle “for us” traffic
  - Applies to data plane traffic, not IPC
- Integral firewall to protects router resources - Packet forwarding executed in HW - no impact on Line Card CPU
- Dynamic adjustment - Flow types reflect both application type (OSPF, BGP, …) and trust (established, configured or unknown peer) - Additional bandwidth allowed once neighbor up

Interoffice Mail for Data Plane



LC/RP CPU guard

LPTS: Dynamic Control Plane Protection

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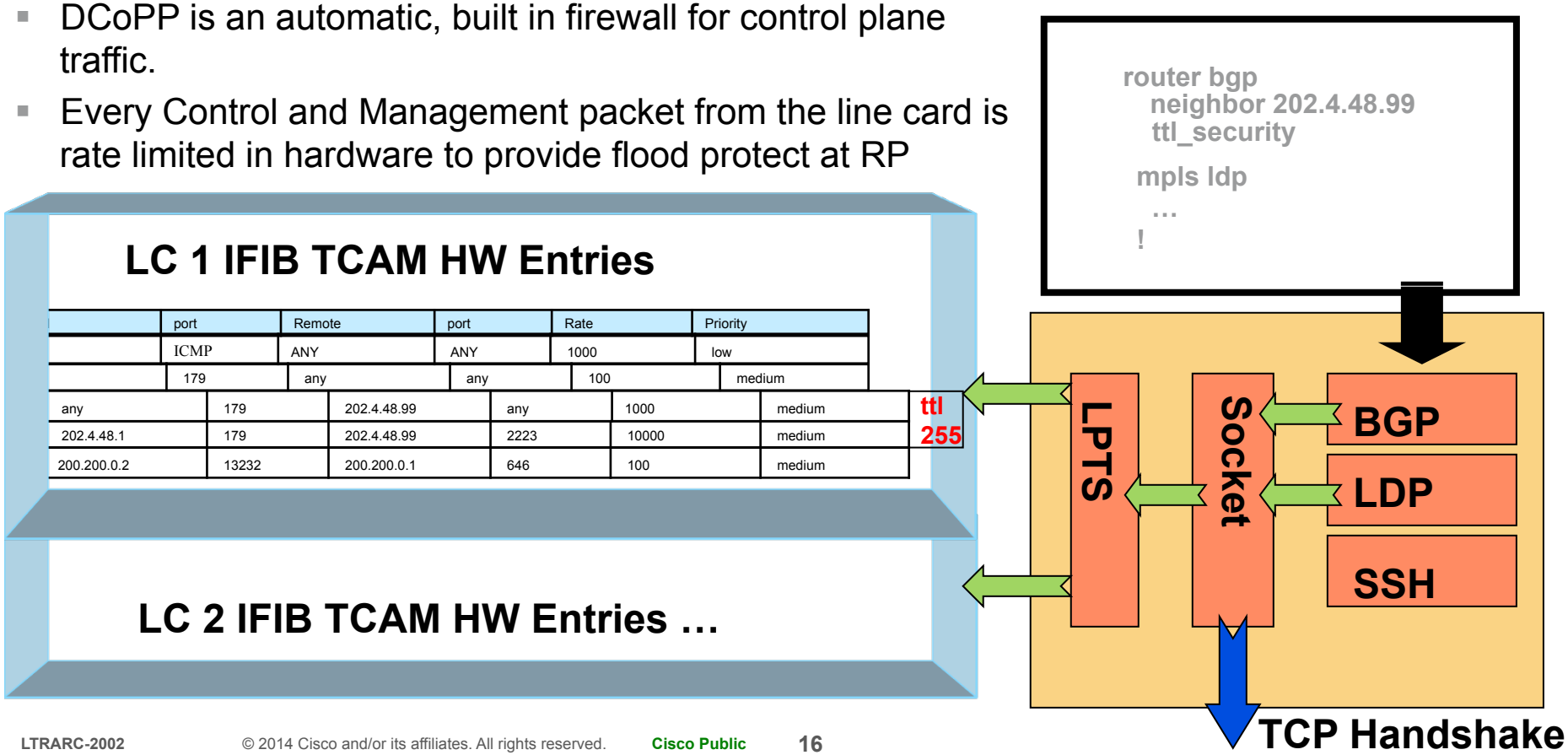
- DCoPP is an automatic, built in firewall for control plane traffic.
- Every Control and Management packet from the line card is rate limited in hardware to provide flood protect at RP



Routers supporting IOS-XR

GSR

ASR9K

NCS6K

CRS

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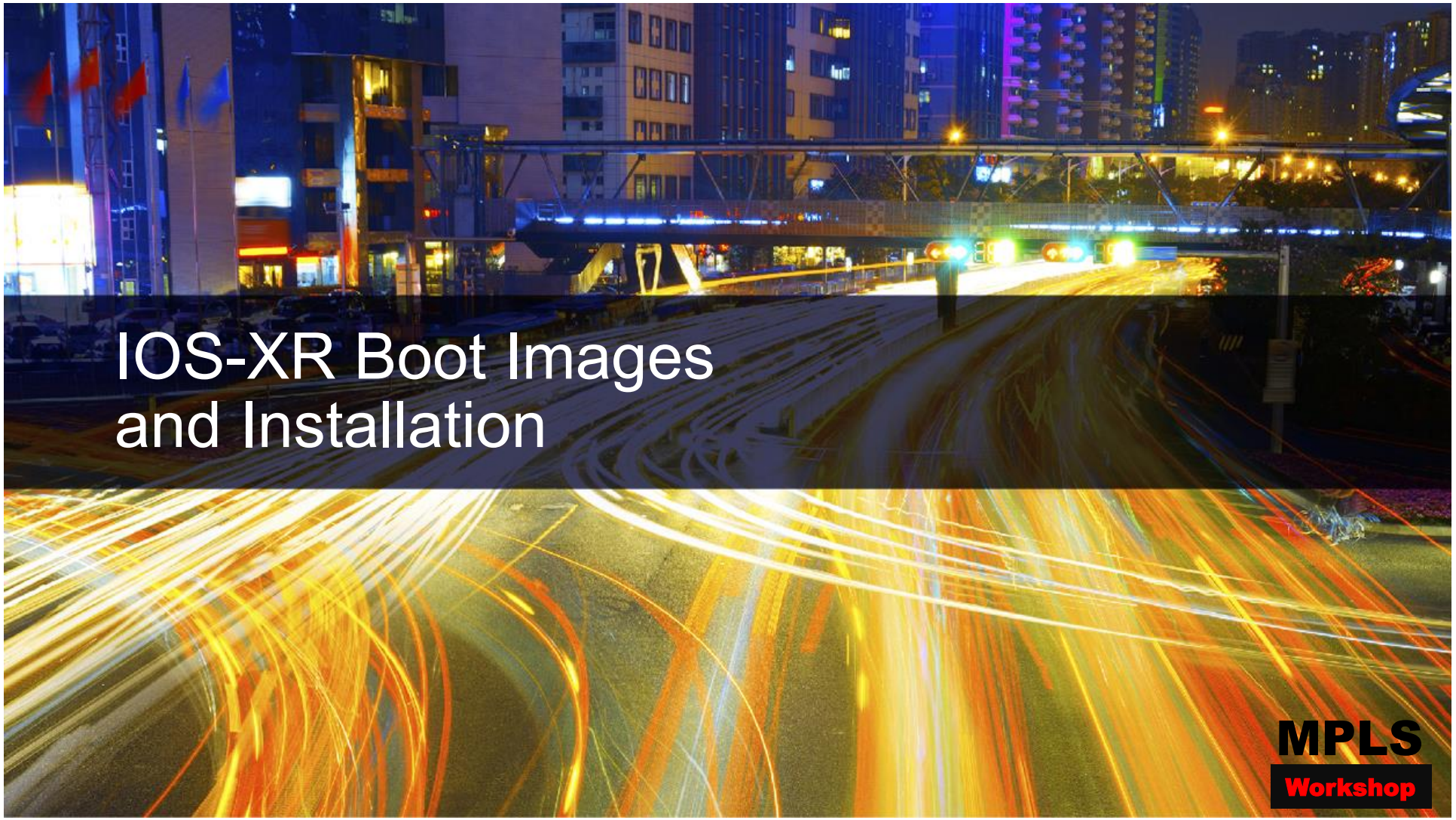
IOS-XR Boot Images
and Installation
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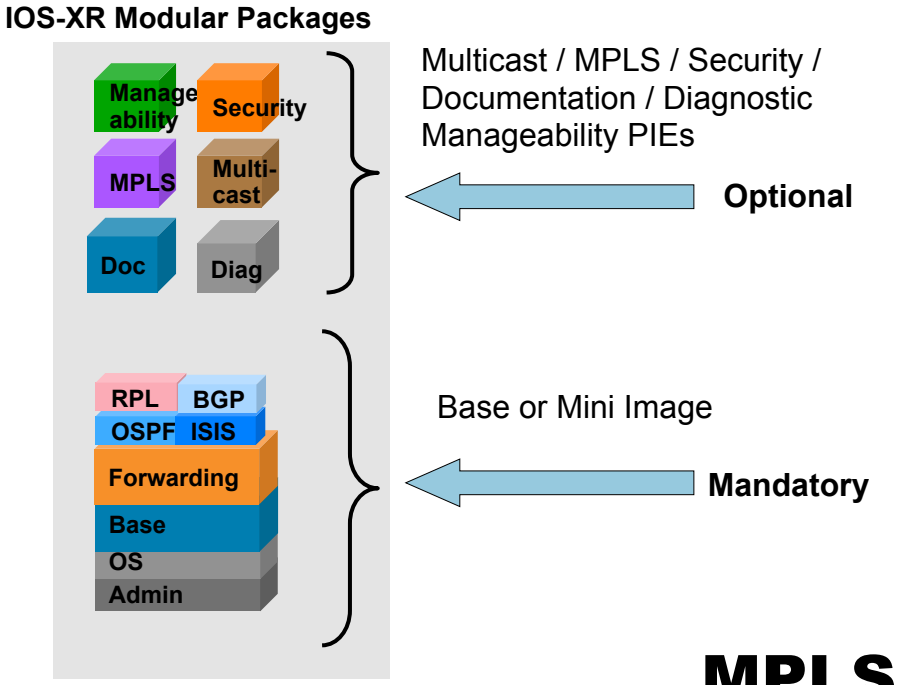
IOS-XR Boot Overview and Software Packages

- IOS-XR Image:
- Base Image:
  - Includes the following components:
    - OS
    - Admin
    - Forwarding (IPv4 / IPv6 Unicast)
    - Features
- PIEs (Package Installation Envelope)
  - Unique PIE for each feature including
    - MPLS
    - Multicast
    - Manageability
    - Security
    - Documentation
    - Diagnostics



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Software Install Terminology
Software Maintenance Upgrade

- Provides timely temporary point fixes for urgent issues for a given package version
- Fix integrated into the subsequent IOS XR maintenance release.
- Implementation changes only. No interface changes (no changes to CLI, APIs, IPC etc.) or new feature content
- Ideally does not impact traffic (Hitless, non traffic impacting)
- SMU is named by release and bugid - Examples - hfr-px-4.2.4.CSCue55783.pie

PIE?

Mini?

Package?

SMU?

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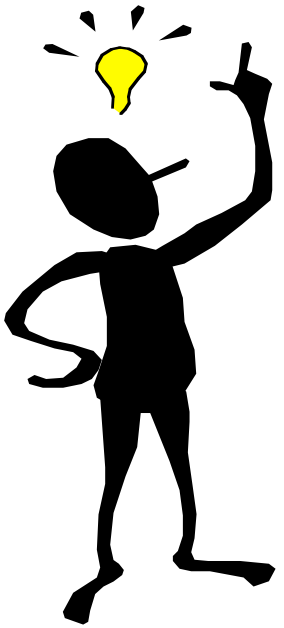
PIE Installation Concepts

- PIE install used once system is operational
- Packages can be added or upgraded
- System performs sanity checks
- 3 phase install
  - Add – Copy package and unpack
  - Activate – Restart processes/nodes with new code
  - Commit – Lock activated packages through reload
- The mini does not have the following functionality:
  - MPLS, Multicast, Security & Manageability through XML/CWI
- PIEs are installed from Admin mode
- Following actions can be performed on PIEs:
  - Add / Remove
  - Activate / De-activate



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`install add` Command

Copy image to disk, verify, and unpack

```
RP/0/0/CPU0:GSR-XR(admin)#install add tftp://172.21.116.8/c12k-mcast.pie-4.2.1.3I

Install: The idle timeout on this line will be suspended for synchronous install operations
Install: Starting install operation. Do not insert or remove cards until the operation
completes.
RP/0/0/CPU0:P4(admin)#
Install: Now operating in asynchronous mode. Do not attempt subsequent install operations
until this operation is complete.
Install 3: [  0%] Install operation 'add /tftp://172.21.116.8/c12k-mcast.pie-4.2.1.3I to
disk0:' assigned request id: 3
Install 3: [  1%] Downloading PIE file from /tftp://172.21.116.8/c12k-mcast.pie-4.2.1.3I
Install 3: [  1%]     Transferred 3298994 Bytes
Install 3: [  1%] Downloaded the package to the router
Install 3: [  1%] Verifying the package
Install 3: [  1%] [OK]
Install 3: [  1%] Verification of the package successful [OK]
Install 3: [ 95%] Going ahead to install the package...
Install 3: [ 95%] Add of '/tftp://172.21.116.8/c12k-mcast.pie-4.2.1.3I' completed.
Install 3: [100%] Add successful.
Install 3: [100%] The following package(s) and/or SMU(s) are now available to be activated:
Install 3: [100%]     disk0:c12k-mcast-4.2.1
Install 3: [100%] Please carefully follow the instructions in the release notes when activating any software
Install 3: [100%] Idle timeout on this line will now be resumed for synchronous install operations
```

`install activate` Command

Begin executing new software

```
RP/0/0/CPU0:GSR-XR(admin)#install activate disk0:c12k-mcast-4.2.1
Install: The idle timeout on this line will be suspended for synchronous installoperations
Install: Starting install operation. Do not insert or remove cards until the operation...
RP/0/0/CPU0:P4(admin)#
Install: Now operating in asynchronous mode. Do not attempt subsequent install operations
until this operation is complete.
Install 3: [ 0%] Install operation 'activate disk0:c12k-mcast-4.2.1' assigned request id: 3
Install 3: [ 1%] Performing Inter-Package Card/Node/Scope Version Dependency Checks
Install 3: [ 1%] [OK]
Install 3: [ 1%] Checking API compatibility in software configurations...
Install 3: [ 1%] [OK]
Install 3: [ 10%] Updating software configurations.
Install 3: [ 10%] RP,DRP:
Install 3: [ 10%] Activating c12k-mcast-4.2.1
Install 3: [ 10%] Checking running configuration version compatibility with newly activated…
Install 3: [ 10%] No incompatibilities found between the activated software and router…configuration.
RP/0/0/CPU0:Nov 12 14:24:01.249 : instdir[181]: %INSTMGR-6-SOFTWARE_CHANGE_END :Software change
transaction 3 is COMPLETE.
Install 3: [100%] Performing software change
Install 3: [100%] Activation operation successful.
Install 3: [100%] NOTE: The changes made to software configurations will not be
Install 3: [100%] persistent across RP reloads. Use the command 'install commit'
Install 3: [100%] to make changes persistent.
Install 3: [100%] Idle timeout on this line will now be resumed for synchronous install operations
```

`install commit` Command

Lock in activated software across reload

```
RP/0/0/CPU0:GSR-XR(admin)#install commit
Install: The idle timeout on this line will be suspended for synchronous
install operations
Install 5: [  1%] Install operation 'commit' assigned request id: 5
Install 5: [100%] Committing uncommitted changes in software configurations.
Install 5: [100%] Commit operation successful.
Install 5: [100%] Idle timeout on this line will now be resumed for
synchronous operations
```


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Deactivating Packages

```
RP/0/0/CPU0:GSR-XR(admin)#install deactivate disk0:c12k-rp-mgbl-4.2.1
Install: The idle timeout on this line will be suspended for synchronous install
operations
Install: Starting install operation. Do not insert or remove cards until the operation completes.
RP/0/0/CPU0:P5(admin)#
Install: Now operating in asynchronous mode. Do not attempt subsequent install operations
until this operation is complete.
Install 8: [ 0%] Install operation 'deactivate disk0:c12k-mgbl-4.2.1' assigned
request id: 8
Install 8: [ 1%] Package 'disk0:c12k-mgbl-4.2.1' is not active and cannot be deactivated.
Install 8: [ 1%] Idle timeout on this line will now be resumed for synchronous
install operations
```

Package features no longer available
Package still installed
Package can be reactivated

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Identifying packages

```
RP/0/RP0/CPU0:CR1-CRS#show install active summary
Tue Apr  1 03:51:10.322 UTC
  Active Packages:
    disk0:hfr-mini-px-4.2.4
    disk0:hfr-doc-px-4.2.4
    disk0:hfr-k9sec-px-4.2.4
    disk0:hfr-mpls-px-4.2.4
    disk0:hfr-px-4.2.4.CSCue55783-1.0.0
    disk0:hfr-mgbl-px-4.2.4
    disk0:hfr-mcast-px-4.2.4
    disk0:hfr-fpd-px-4.2.4
    disk0:hfr-diags-px-4.2.4
```


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Show version

```
RP/0/RP0/CPU0:CRS1# show version brief
Wed Apr 15 06:24:32.946 UTC

Cisco IOS XR Software, Version 4.2.4[Default]
Copyright (c) 2012 by Cisco Systems, Inc.

ROM: System Bootstrap, Version 2.06(20110916:145933) [CRS ROMMON],

CRS1 uptime is 14 weeks, 5 days, 16 hours, 27 minutes
System image file is "disk0:hfr-os-mbi-4.2.4/0x100008/mbihfr-rp-x86e.vm"

cisco CRS-8/S-B (Intel 686 F6M14S4) processor with 12582912K bytes of memory.
Intel 686 F6M14S4 processor at 1729Mhz, Revision 2.174
CRS-8 Line Card Chassis-enhanced for CRS-8/S-B

2 Management Ethernet
18 DWDM controller(s)
4 FortyGigE
22 TenGigE
10 SONET/SDH
10 Packet over SONET/SDH
14 WANPHY controller(s)
1019k bytes of non-volatile configuration memory.
15801M bytes of hard disk.
11223024k bytes of disk0: (Sector size 512 bytes).
11223024k bytes of disk1: (Sector size 512 bytes).
RP/0/RP0/CPU0:CRS1
```


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Config Management
using CLI
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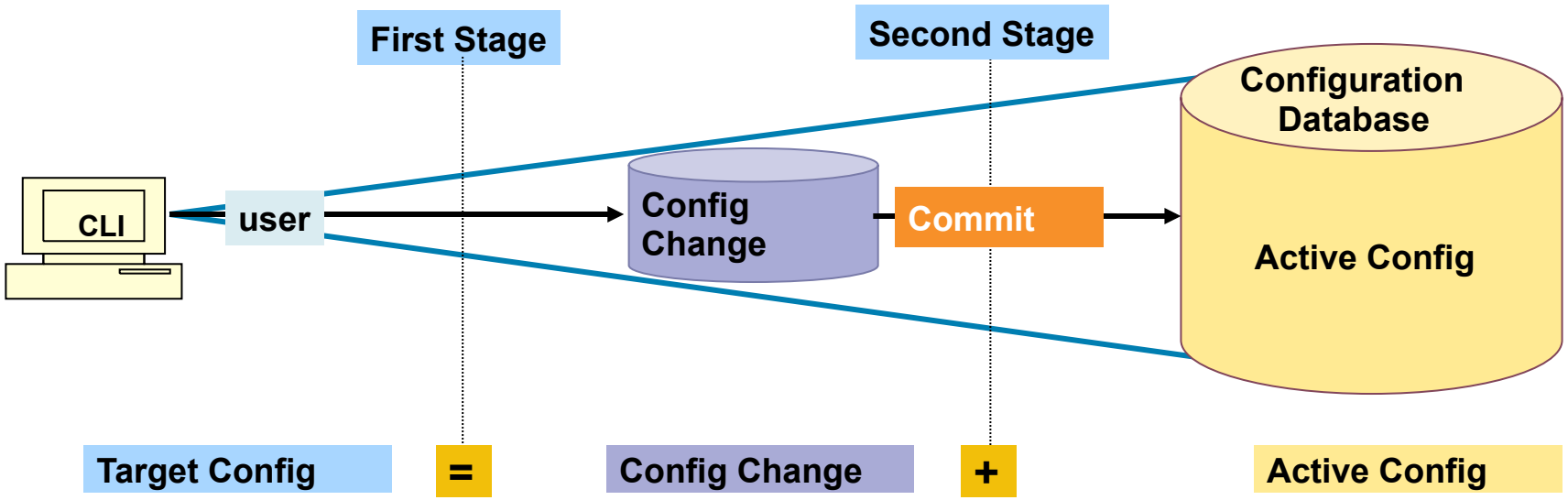
IOS-XR and IOS Config differences

- IOS-XR configuration is held in binary form which is quicker to parse and process - 'show running-configuration' is just an ASCII representation of the binary data extracted from all nodes in the system
- There is no concept of a startup configuration like in IOS
- If one copies the running config to startup, a backup config with the name "startup" is created
- Router config is based on two stage config model.
- "running" or "active" config can not be modified directly.
- Instead, user config first enters a staging area (first stage)
- Must be explicitly promoted to be part of active config (second stage).

IOS-XR	IOS
Configuration changes do NOT take place after <CR>	Configurations take place immediately after <CR>
Configuration changes must be 'committed' before they take effect	No commit
Allows you to verify your configuration before applying it	No verification required
Two stage configuration model	Not available
Configuration rollback	Not available
Provision to pre-configure	Not available
New config plane – Admin mode	Not available
Feature centric	Interface centric

IOS-XR CLI: Two Stage Config model



User establishes config session

Adds/deletes/modifies configuration; these changes:

- Are entered in the staging area
- Are validated for syntax and authorized
- Can be reviewed and modified

Promotes the changes to active configuration; these changes:

- Are verified for semantic correctness
- Are check-pointed on the router

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IOS-XR CLI: New CLI format

- New CLI reflects the HW position in the system
  - Introduces the Hierarchical location scheme
  - Each linecard has three-level identification: Shelf/Slot/cpu #
  - Interfaces have the Shelf/Slot/Bay/Interface scheme
- CRS-1 is designed to scale to 72 linecard chassis with a potential of 1296 (1152+144) linecard and RP slots
  - Location identifiers use R/S/M/I format
    - R = Rack (applicable in multi-chassis systems)
    - S = Slot (physical slot the module is in)
    - M = module (0 for ‘fixed’ PLIMs, n for SPAs)
    - I = Interface
- Protocol referenced by address family type – v4/v6
- Backward compatible command-set with IOS

```
RP/0/0/CPU0:CRS1#show ipv4 interface brief

Interface                      IP-Address      Status          Protocol
MgmtEth0/0/CPU0/0              10.23.1.69      Up              Up
MgmtEth0/0/CPU0/1              unassigned      Shutdown        Down
MgmtEth0/0/CPU0/2              unassigned      Shutdown        Down
GigabitEthernet0/2/0/0         100.12.1.1      Up              Up
```


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IOS-XR CLI: New CLI format and Configuration Modes

- **Config modes include:**
  - Privileged exec mode
  - Global config mode
  - Config sub-mode
  - Admin mode
- **Admin mode is newly introduced compared to IOS**
- **Admin mode allows viewing / configuring shared resources**
  - Fabric
  - Logical Router
  - Package installation

```
RP/0/0/CPU0:CRS1#config t
RP/0/0/CPU0:CRS1(config)#interface MgmtEth 0/0/CPU0/0
RP/0/0/CPU0:CRS1(config-if)#
RP/0/0/CPU0:CRS1#
RP/0/0/CPU0:CRS1#admin
RP/0/0/CPU0:CRS1(admin)#
```


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IOS-XR CLI: Config Commits

```
RP/0/0/CPU0:CRS1#show run int gi0/2/0/0
% No such configuration item(s)

RP/0/0/CPU0:CRS1#conf t
RP/0/0/CPU0:CRS1(config)#interface gig0/2/0/0
RP/0/0/CPU0:CRS1(config-if)#ipv4 address 100.12.1.1/24
RP/0/0/CPU0:CRS1(config-if)#commit
RP/0/0/CPU0:Apr 24 00:49:28.119 : config[65691]: %MGBL-CONFIG-6-DB_COMMIT : Configuration
committed by user 'root'. Use 'show configuration commit changes 1000000036' to view the changes.
RP/0/0/CPU0:iosxr(config-if)#end
RP/0/0/CPU0:Apr 24 00:49:30.701 : config[65691]: %MGBL-SYS-5-CONFIG_I : Configured from
console by root
RP/0/0/CPU0:CRS1#
RP/0/0/CPU0:CRS1#show run int gigabitEthernet 0/2/0/0
interface GigabitEthernet0/2/0/0
 ipv4 address 100.12.1.1 255.255.255.0
```

IOS-XR CLI: Config Commit

- Commit keyword writes config into Active Config
- Supplies a commit ID to help in Config Rollback
  - **1000000036** is the commit ID in previous illustration
- List of commits can be viewed
  - History list is maintained
- Commits can be labeled with user-friendly ‘tags’
  - Eliminates the cumbersome IDs
- Config restrictions can be imposed based on user
  - In previous illustration, the user “root” is indicated

```
RP/0/0/CPU0:CRS1#show configuration commit list
SNo. Label/ID    User      Line              Client      Time Stamp
~~~~ ~~~~~~~~    ~~~~      ~~~~               ~~~~~~      ~~~~~~~~~~
1    1000000037  root      con0_0_CPU          CLI         01:39:03 UTC Mon Apr 24 2013
2    1000000036  JChmbr   vty1:node0_RP0_CPU   CLI         01:18:10 UTC Mon Apr 24 2013
3    1000000035  Mhmali   vty1:node0_RP0_CPU   CLI         01:00:54 UTC Mon Apr 24 2013
```

IOS-XR CLI: Config Rollback

```
RP/0/0/CPU0:CRS1#conf t
RP/0/0/CPU0:CRS1(config)#hostname iox-CL11
RP/0/0/CPU0:CRS1(config)#commit
RP/0/0/CPU0:Apr 24 01:00:55.302 : config[65691]: %MGBL-CONFIG-6-DB_COMMIT : Configuration
committed by user 'root'. Use 'show configuration commit changes 1000000034' to view the changes.
RP/0/0/CPU0:iox-CL11(config)#end
RP/0/0/CPU0:iox-CL11#
RP/0/0/CPU0:iox-CL11#rollback configuration to 1000000033
Loading Rollback Changes.
Loaded Rollback Changes in 1 sec
Committing.
3 items committed in 1 sec (2)items/sec
Updating.RP/0/0/CPU0:Apr 24 01:01:07.143 : config_rollback[65691]: %MGBL-CONFIG-6-DB_COMMIT :
Configuration committed by user 'root'. Use 'show configuration commit changes 1000000035' to
view the changes.

Updated Commit database in 1 sec
Configuration successfully rolled back to '1000000033'.
RP/0/0/CPU0:CRS1#
```

IOS-XR CLI: Config error handling

- **Two levels of config error handling**
- **Parser/Syntax error**
  - Identified by the parser when the <return> key is entered
- **Commit error**
  - Syntactically correct but erroneous from config commit standpoint
  - Error details viewed through "show configuration failed" command
  - Common reasons for this error include:
    - Non-atomic config sequence
    - Lack of predecessor config
    - Unsupported config from platform perspective

```
RP/0/0/CPU0:CRS1#conf t
RP/0/0/CPU0:CRS1 (config)#policy p1
RP/0/0/CPU0:CRS1(config-pmap)#class c0
RP/0/0/CPU0:CRS1(config-pmap-c)#set precedence 0
RP/0/0/CPU0:CRS1(config-pmap-c)#commit
% Failed to commit one or more configuration items during an atomic operation, no changes have been made.
Please use 'show configuration failed' to view the errors
RP/0/0/CPU0:ios(config-pmap-c)#show configuration failed
!! CONFIGURATION FAILED DUE TO SEMANTIC ERRORS
policy-map p1
 class c0
  set precedence routine
!!% Class-map not configured: c0
```


Protocol Configuration and Verification
MPLS
Workshop

IOS-XR Routing Protocols

- IOS
  - Protocol configuration exists at:
    - Global Process Level
    - Routing Process
    - Interface Configuration

    (normally one level deep)
- IOS XR
  - Protocol configuration exists at:
    - Only within the protocol
    - Hiearchical

    (multiple levels deep is common)

MPLS Workshop

Static Routes

IOS

```
ip route 192.1.1.0 255.255.255.0 gi4/0
ip route 223.255.254.0 255.255.255.0 10.13.0.1
ipv6 route 5301::1111/128 fec0::1
```

```
show run | include route
show run | begin ip route
show run | begin ipv6 route
```

IOS XR

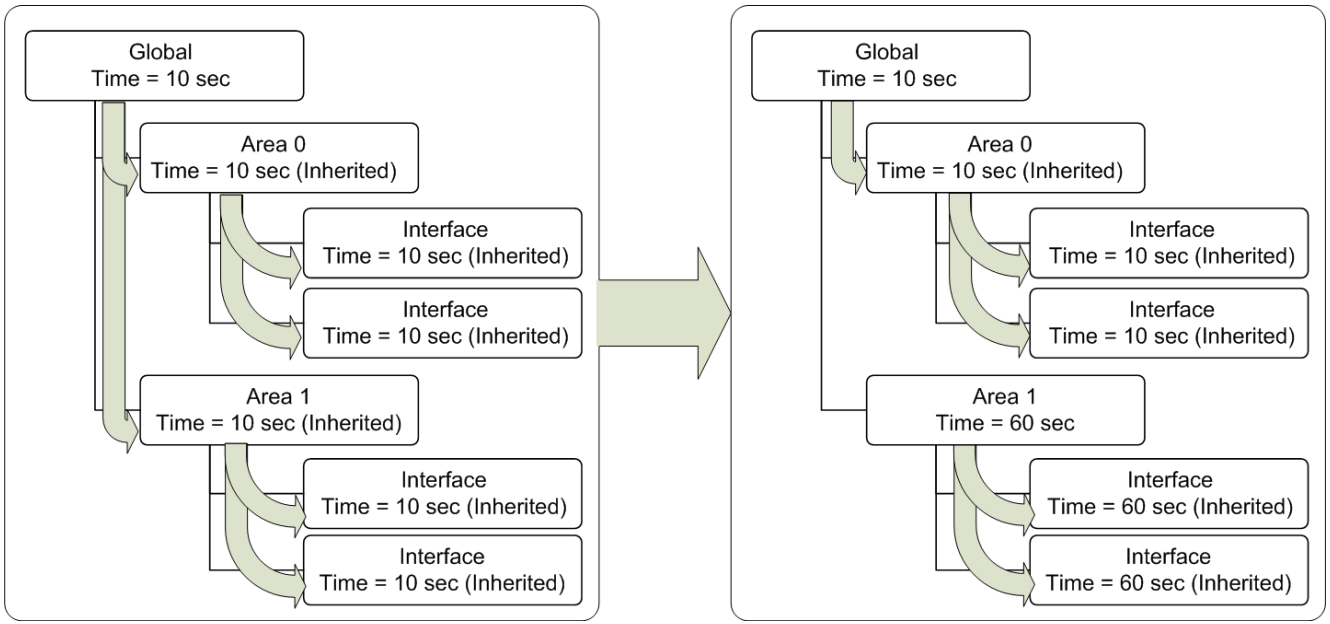
```
router static
 address-family ipv4 unicast
  43.43.44.0/24 Serial0/5/3/3/0:2
  192.1.1.0/24 GigabitEthernet0/4/0/0
  223.255.254.254/32 MgmtEth0/1/CPU0/0
 !
 address-family ipv6 unicast
  5301::1111/128 Serial0/5/3/3/0:0
 !
!
```

```
show run router static
show run router static ipv4 unicast
show run router static ipv6 unicast
```

MPLS Workshop

IOS-XR Routing Protocols Configuration: Hierarchical CLI

- Hierarchical CLI
  - Configuration at lower level pre-empts global configuration



MPLS Workshop

OSPF Configuration

IOS

```
router ospf 1
  area 0 authentication message-digest
  area 2 authentication message-digest
  network 10.100.1.0 0.0.0.7 area 0
  network 10.200.1.0 0.0.0.15 area 2

interface gi0/0
 ip ospf network point-to-point
 ip ospf message-digest-key 1 md5 CISCO
 ip ospf cost 100
!
interface gi0/1
 ip ospf network point-to-point
 ip ospf message-digest-key 1 md5 CISCO
 ip ospf cost 100
!
interface gi0/2
 ip ospf network point-to-point
 ip ospf message-digest-key 1 md5 CISCO
 ip ospf cost 2000
!
interface gi0/3
 ip ospf network point-to-point
 ip ospf message-digest-key 1 md5 CISCO
 ip ospf cost  9999
```

IOS XR

```
router ospf 1
  authentication message-digest
  message-digest-key 1 md5 CISCO
  network point-to-point
area 0
    cost 100
    interface gi0/0/0/0
    !
    interface gi0/0/0/1
    !
  area 2
cost 2000
    interface gi0/0/0/2
    !
    interface gi0/0/0/3
      cost 9999
```

show run router ospf
show run router ospf 1 area 2

MPLS Workshop

ISIS CLI Differences

IOS

```
router isis ios
 net 47.1111.1111.0001.0000.0c00.0006.00
 domain-password mydomainpasswd authenticate snp
validate
 area-password myareapasswd authenticate snp validate
 metric-style wide
 log-adjacency-changes
 nsf ietf
 maximum-paths 6
!
interface POS1/0/0
   ip address 201.1.1.2 255.255.255.0
    ip router isis ios
     isis metric 30
```

IOS-XR

```
router isis iosxr
   net 47.1111.1111.0001.0000.0c00.0007.00
    nsf ietf
    log adjacency changes
    lsp-password mydomainpasswd level 1 send-only snp send-only
    lsp-password myareapasswd level 2 send-only snp send-only
address-family ipv4 unicast
  metric-style wide
   maximum-paths 6
!
interface POS0/2/0/1
  address-family ipv4 unicast
   metric 30
```


MPLS Workshop

BGP

IOS

```
router bgp 65000
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 172.16.2.5 remote-as 65111
 neighbor 192.168.1.2 remote-as 65000
 neighbor 192.168.1.2 update-source Loopback 0
!
 address-family ipv4
 network 192.168.1.1 mask 255.255.255.255
 neighbor 172.16.2.5 activate255.255.255.255
 neighbor 192.168.1.2 activate

 maximum-paths 8
```

IOS XR

```
router bgp 65000
 address-family ipv4 unicast
 network 192.168.1.1/32
 maximum-paths 8
 !
 neighbor 192.168.1.2
  remote-as 65000
  update-source Loopback 0
  address-family ipv4 unicast
 !
 neighbor 172.16.2.5
  remote-as 65111
  address-family ipv4 unicast
   route-policy PASS-ALL in
   route-policy PASS-ALL out
```

Will not accept routes from EBGP peers by default

MPLS Workshop

BGP: Show commands

```
RP/0/1/CPU0:CRS1# show bgp ipv4 unicast summary
BGP router identifier 2.2.2.2, local AS number 300
BGP generic scan interval 60 secs
BGP table state: Active
BGP main routing table version 101
BGP scan interval 60 secs
BGP is operating in STANDALONE mode.

Process       RecvTblVer    bRIB/RIB  LabelVer  ImportVer  SendTblVer
Speaker            101          101       101        101         101

Neighbor        Spk    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  St/PfxRcd
192.1.1.2         0   400    2451    2453      101    0    0 00:24:33        100
```

Show ip bgp summary (IOS)

Show bgp ipv4 unicast summary (IOS XR)

MPLS Workshop


Route Policy Language
MPLS
Workshop

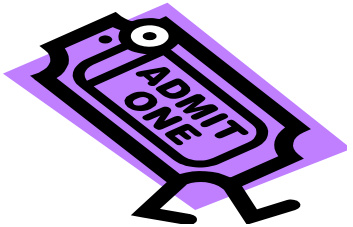
What is RPL

- Route Policy Language
- Used to filter routing information
  - Remove routes
  - Change attributes
- Common tool for XR applications
  - *BGP policy and show commands*
  - *IGPs*
- *Replaces* route maps (and more!)
- Uses “if,then,else” style configuration
- Test a specific policy before its applied
- Scalable – fewer CLI lines, improved clarity

MPLS Workshop

RPL Actions

- Pass – prefix allowed if not later dropped
  - –**`pass`** grants a ticket to defeat default drop
  - –Execution continues after pass
- Set – value changed, prefix allowed if not later dropped
  - –Any **`set`** at any level grants a ticket
  - –Execution continues after **`set`**
  - –Values can be set more than once
- Drop – prefix is discarded
  - –Explicit drop stops policy execution
  - –Implicit drop (if policy runs to end without getting a ticket)
- Done – accepts prefix and halts all processing



When a prefix is allowed a “pass” through a policy statement it is then handed off to the next policy statement in the list. Processing continues until a “drop” or “done” is found or it reaches the end of the entire policy.

MPLS Workshop

RPL Examples

- Basic conditional statement

```
if med eq 150 then
    drop
endif
```

- Branching options

```
if med eq 150 then
     set local-preference 10
elseif med eq 200 then
     set local-preference 60
else
     set local-preference 0
endif
```

Comparison operator

MPLS Workshop

Named and Inline Set (Same behavior)

```
route-policy USE_INLINE
  if as-path in (ios-regex '_42$', ios-regex '_127$') then
    pass
endif
end-policy
```

```
as-path-set NAMED_SET
  ios-regex '_42$',
  ios-regex '_127$'
end-set

route-policy USE_NAMED
  if as-path in NAMED_SET then
    pass
endif
end-policy
```

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RPL Examples

- Bad RPL Logic

```
Route-policy BAD-RPL
        if med eq 150 then
                set local-preference 10
        endif
        set local-preference 0
End-policy
```

Overwrites Setting

- Good RPL Logic

```
Route-policy GOOD-RPL
        if med eq 150 then
                set local-preference 10
                done
        endif
        set local-preference 0
End-policy
```

Stops all processing on matched prefixes

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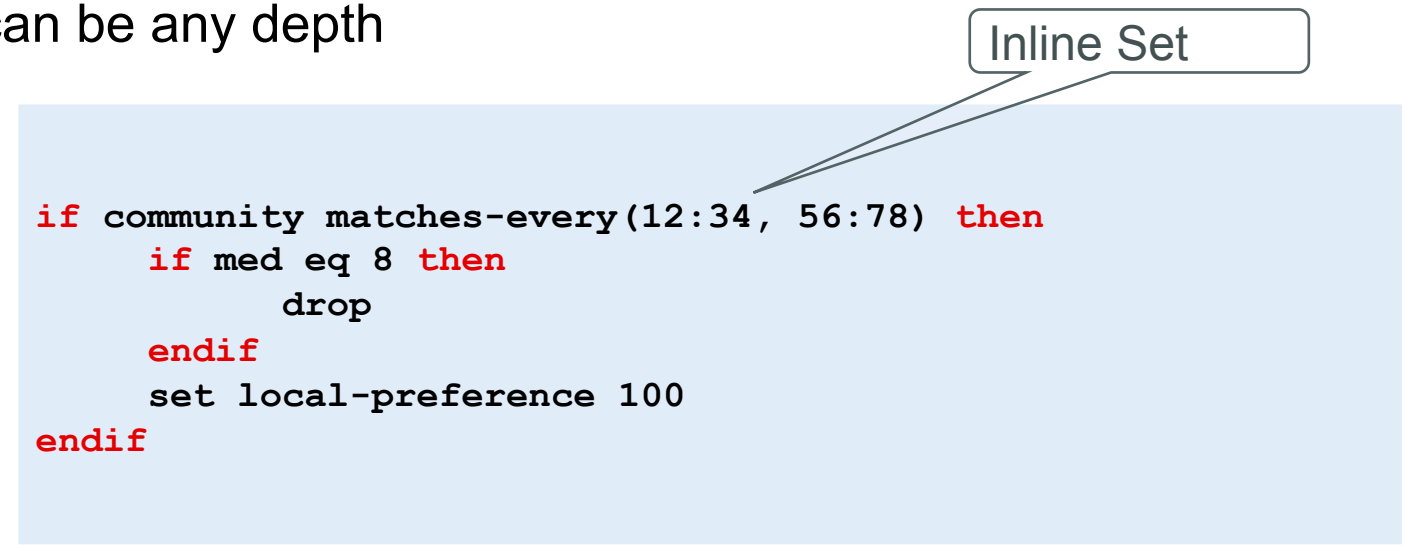
Nested Conditions

- ***If*** statements within other ***if/elseif/else*** statements
- Nesting can be any depth



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Hierarchical Policy Structure

```
route-policy PARENT
    apply CHILD-ONE
    apply CHILD-TWO
    pass
end-policy

route-policy CHILD-ONE
     set weight 100
end-policy

route-policy CHILD-TWO
    apply GRANDCHILD
    set community (2:666) additive
end-policy

route-policy GRANDCHILD
     set med 200
end-policy
```


MPLS Workshop

Parameter Passing

```
route-policy CHILD($MED)
    set med $MED
end-policy

route-policy PARENT
    apply CHILD (10)
end-policy
```

List of policy parameters

Accessing the passed parameter

Calling policy and passing parameter

```
route-policy CHILD($MED,$ORIGIN)
    set med $MED
    set origin $ORIGIN
end-policy

route-policy PARENT
    apply CHILD (10, incomplete)
end-policy
```

Multiple parameters

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Using Parameters in BGP

```
route-policy PARAMETERS($MED,$ORIGIN)
    set med $MED
    set origin $ORIGIN
end-policy

router bgp 300
address-family ipv4 unicast
 !
neighbor 192.1.1.2
  remote-as 400
  address-family ipv4 unicast
    route-policy PARAMETERS (50, incomplete) in
    route-policy PASS-ALL out
```

MPLS Workshop

Boolean (Logical) Operations

- Comparison operators are context sensitive
  - Semantic check not done until RPL policy use is committed
- Supported Operators - Not, And, & Or (in order of precedence)

```
RP/0/1/0:CRS1(config-rpl)#if med eq 42 and next-hop in (1.1.1.1) then
```

  - Compound operators are supported

    Parentheses may be used to override order of operations

    Parentheses also useful to aid clarity

Blue, **then Green**, then Black

```
med eq 10 and not destination in (10.1.3.0/24) or community is (56:78)

med eq 10 and (not destination in (10.1.3.0/24) or community is (56:78 ))
```


MPLS Workshop

RPL Show Commands

Only display prefixes matching policy – filter show command

```
RP/0/0/1:CRS1#show bgp route-policy SAMPLE
BGP router identifier 172.20.1.1, local AS number 1820
BGP main routing table version 729
Dampening enabled
BGP scan interval 60 secs
Status codes: s suppressed, d damped, h history, * valid, > best
i - internal, S stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network Next Hop Metric LocPrf Weight Path
* 10.13.0.0/16 192.168.40.24 0 1878 704 701 200 ?
* 10.16.0.0/16 192.168.40.24 0 1878 704 701 i
```

MPLS Workshop

RPL Show Commands

```
RP/0/0/CPU0:CRS1#show rpl route-policy states

ACTIVE -- Referenced by at least one policy which is attached
INACTIVE -- Only referenced by policies which are not attached
UNUSED -- Not attached (directly or indirectly) and not referenced

The following policies are (ACTIVE)
----------------------------------------
..
The following policies are (INACTIVE)
----------------------------------------
None found with this status.

The following policies are (UNUSED)
----------------------------------------
…
```

MPLS Workshop

RPL Show Commands [attachpoint]

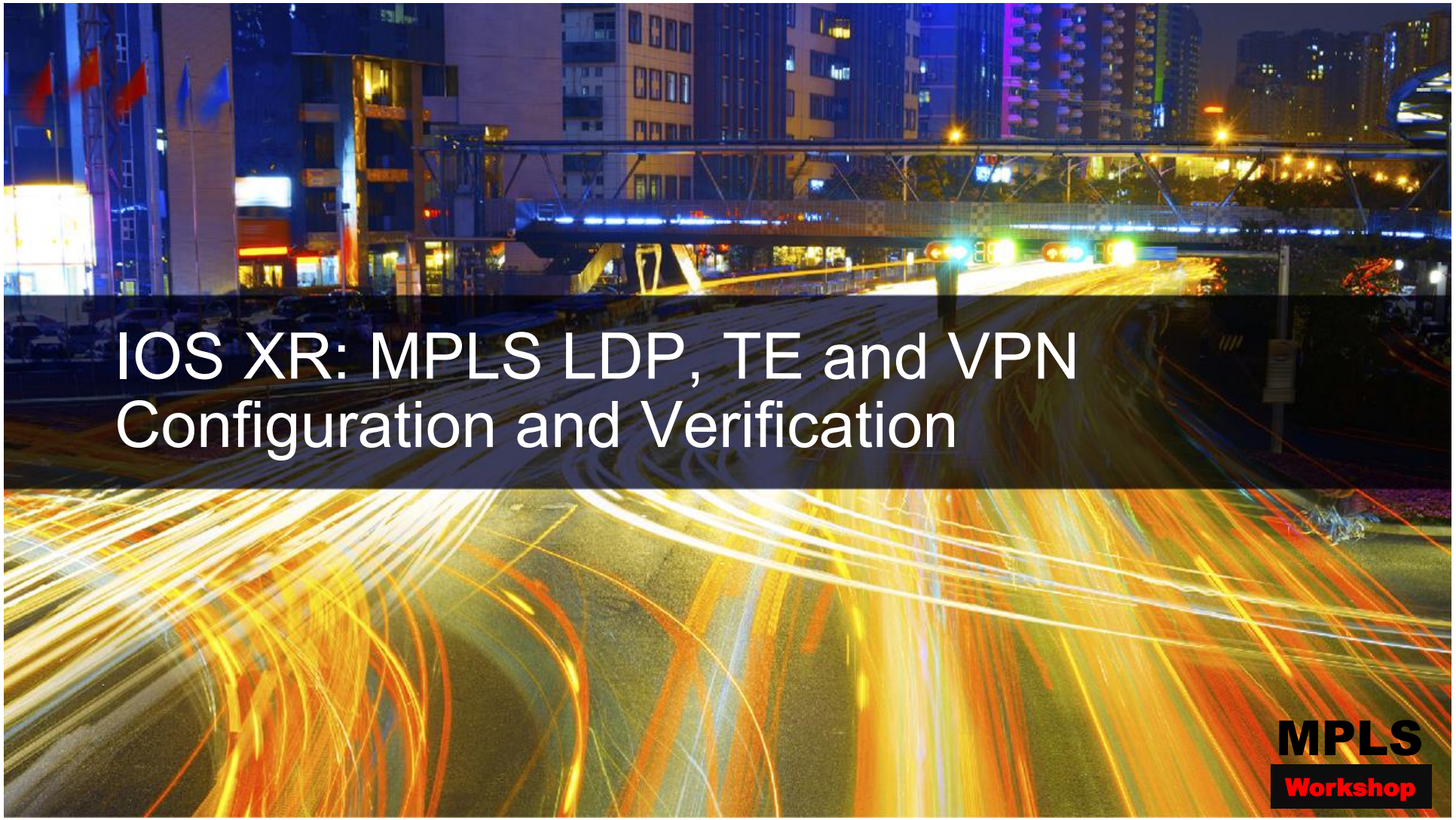
```
RP/0/RP0/CPU0:CRS1#show rpl route-policy PASS
route-policy PASS
  pass
end-policy

RP/0/RP0/CPU0:CRS1#show rpl route-policy PASS attachpoints

BGP Attachpoint: Neighbor

Neighbor/Group   type   afi/safi    in/out    vrf name
-----------------------------------------------------
cavs             nbr    IPv4/uni    in          default
```

MPLS Workshop


IOS XR: MPLS LDP, TE and VPN
Configuration and Verification
MPLS
Workshop

LDP

```
RP/0/0/CPU0:CRS1(config)#mpls ldp
RP/0/0/CPU0:CRS1(config-ldp)#?
  backoff           Configure session backoff parameters
  discovery         Configure discovery parameters
  explicit-null     Configure explicit-null advertisement
  graceful-restart  Configure LDP graceful restart feature
  holdtime          Configure session holdtime
  interface         Enable LDP on an interface and enter interface submode
  label             Configure label advertisement control
  log               Configure log information
  neighbor          Configure neighbor parameters
  router-id         Configure router Id
  signalling        Configure LDP signalling parameters
```

Must be explicitly configured

- LDP is enabled on an interface via the interface submode underneath the LDP submode

```
RP/0/0/CPU0:CRS1(config-ldp)#interface pos0/6/0/2
RP/0/0/CPU0:CRS1(config-ldp-if)#?
  discovery  Configure interface LDP discovery parameter
```

Show mpls forwarding/show mpls Interfaces

```
RP/0/0/CPU0:CRS1#show mpls forwarding
Local  Outgoing    Prefix            Outgoing     Next Hop        Bytes       T
Label  Label       or ID             Interface                    Switched    O
------ ----------- ----------------- ------------ --------------- ----------- -
17     Pop Label   192.168.1.1/32    PO0/6/0/2    192.168.6.1     0
18     Pop Label   192.168.1.3/32    PO0/6/0/0    192.168.7.3     0
19     Unlabelled  192.168.1.4/32    PO0/6/0/1    192.168.8.5     0
20     Unlabelled  192.168.1.5/32    PO0/6/0/1    192.168.8.5     0
21     29          192.168.1.6/32    PO0/6/0/2    192.168.6.1     0
22     30          192.168.1.7/32    PO0/6/0/0    192.168.7.3     0
       Unlabelled  192.168.1.7/32    PO0/6/0/1    192.168.8.5     0

RP/0/0/CPU0:CRS1#show mpls interfaces
Interface                  LDP      Tunnel   Enabled
-------------------------- -------- -------- --------
POS0/6/0/0                 Yes      Yes      Yes
POS0/6/0/1                 No       Yes      Yes
POS0/6/0/2                 Yes      Yes      Yes
```


MPLS Workshop


IOS XR L3VPN
MPLS
Workshop

VRF Configuration

Configuring the VRF in the Global Mode

```
vrf vpn1
    description foo
    router-id 1.1.1.1
    address-family ipv4 unicast
              import route-target 100:1
              export route-target 200:1
              import route-policy vpn1-import
              export route-policy vpn1-export
```

Assigning interface to VRF

```
interface g0/1/0/2
      vrf vpn1
         ipv4 address 1.1.1.2/24
```

Does not remove the IP address like IOS does.

MPLS Workshop

BGP VPNv4 Configuration

Configuring PE to RR VPNV4 iBGP Neighbors

```
router bgp 100
  bgp router-id 100.100.100.100
  address-family vpnv4 unicast
!
  neighbor 192.168.1.1
  remote-as 100
  update-source loopback 0
  address-family vpnv4 unicast
```


MPLS Workshop

PE-CE Configuration

```
router bgp 100
   bgp router-id 100.100.100.100
   address-family vpnv4 unicast
      vrf vpn1
         rd [auto | 100:1]
         label-allocation-mode [per-ce | per-vrf]
         address-family ipv4 unicast
         neighbor 1.1.1.1
            remote-as 65523
            address-family ipv4 unicast
            route-policy vpn1-in in
            route-policy vpn1-out out
```

```
router eigrp 100
      vrf vpn1
           address-family ipv4
              router-id 100.100.100.100
                 redistribute bgp 100 route-policy
            policy1
                  interface g0/1/0/2
                     site-of-origin 100:1
```

```
router ospf 100
      vrf vpn1
           router-id 100.100.100.100
           domain-id type 0005 value 000102030405
           domain-tag 101
           redistribute bgp 100 route-policy policy1
            area 0
              interface g0/1/0/2
```

```
router static
      vrf vpn1
            address-family ipv4 unicast
                  10.1.1.1/32 g0/1/0/2
```

```
router rip
      vrf vpn1
            redistribute bgp 100 route-policy policy1
            interface g0/1/0/2
                  site-of-origin 100:1
```


Traffic Engineering
Configuration and Verification
MPLS
Workshop

Traffic Engineering Configuration

- TE has its own configuration mode
  - Specifies which physical interfaces TE should be enabled on.
  - Various TE timers / Affinity-map / diff serve are all configured in this mode.
- RSVP also has its configuration mode
  - Specifies interface and bandwidth associated with that interface.
- Traffic Engineering needs to be enabled in the IGP
  - This enables TE extensions in that area (OSPF sends type 10 LSA)
- Build the Tunnel-TE interface.
  - Configure the destination ip addr.
  - Path options/ initial signaled b/w / auto route announce are configured here.

MPLS Workshop

TE Submode

```
RP/0/0/CPU0:CRS1(config)#mpls traffic-eng
RP/0/0/CPU0:CRS1(config-mpls-te)#?

   bfd              Configure BFD parameters
  fast-reroute      Fast-reroute config parameters
  interface         Enable MPLS-TE on an interface
  link-management   MPLS Link Manager subcommands
  maximum           Maximum number of configurable tunnels
  path-selection    Path Selection Configuration
  reoptimize        Reoptimize timers frequency
  signalling        Signalling options
  topology          Topology Database Configuration
```

```
RP/0/0/CPU0:CRS1(config-mpls-te)# interface POS0/6/0/0
RP/0/0/CPU0:CRS1#show running-config mpls traffic-eng
mpls traffic-eng
 interface POS0/6/0/0
 !
 interface POS0/6/0/1
 !
 interface POS0/6/0/2
```

RSVP Configuration

- Basic RSVP config:

```
RP/0/0/CPU0:CRS1#show running-config rsvp
rsvp
 interface POS0/6/0/0
  bandwidth 155520
 !
 interface POS0/6/0/1
  bandwidth 155520
 !
 interface POS0/6/0/2
  bandwidth 155520
 !
!
```


MPLS Workshop

Prepare the IGP (OSPF / ISIS)

OSPF

```
router ospf 1
 area 0
  mpls traffic-eng
 !
 mpls traffic-eng router-id Loopback0
!
```

ISIS

```
router isis 1
 address-family ipv4 unicast
  mpls traffic-eng level-1
  mpls traffic-eng router-id Loopback0
 !
!
```

MPLS Workshop

Tunnel Head-End Configuration

1. Create a ‘tunnel-te <num>’ interface
2. Under this, add your head-end interface configuration

```
interface tunnel-te6
 ipv4 unnumbered Loopback0
 autoroute announce
 destination 192.168.1.6
 path-option 5 explicit name foo
 path-option 10 dynamic
!
explicit-path name foo
 index 1 next-address ipv4 unicast 192.168.1.3
 index 2 next-address ipv4 unicast 192.168.1.8
 index 3 next-address ipv4 unicast 192.168.1.6
!
```


MPLS Workshop


IOS-XR Operation and Monitoring Tools
MPLS
Workshop

Process Management

- Process
  - –An executable portion of code run within its own memory space
- Threads
  - –A process may contain one or more threads or a ‘sub-process’ e.g. OSPF process has a thread which handles ‘hellos’
  - –A thread may only run when the parent process is allocated runtime by the system scheduler.
- Job ID (JID) and Process ID (PID)
  - –Each process is allocated a Job ID# or JID when it is first run. Remains associated with the process even if the process is stopped & restarted - The PID changes if the process is stopped and restarted
- Thread ID# (TID)
  - –If a process contains threads, each is assigned a TID# associated with the PID/JID.

- Basic command

  ```
  show process
  ```

- Process restart-ability

  ```
  process restart <process name
  | number> <option>
  ```

- Monitor commands:

  ```
  monitor processes
  monitor threads (or top)
  ```

- Troubleshooting commands:

  ```
  show exception, exception
  dumpcore
  show context, clear context
  process core
  follow process
  ```

MPLS Workshop

Process Restartability

```
RP/0/RP1/CPU0:CRS1#process shutdown snmpd

RP/0/RP1/CPU0:CRS1#show processes snmpd
                  Job Id: 288
                     PID: 143532
         Executable path: /disk0/hfr-base-4.2.1/bin/
snmpd
             Instance #: 1
             Version ID: 00.00.0000
                Respawn: ON
          Respawn count: 1
  Max. spawns per minute: 12
           Last started: Mon May  9 15:32:22 2005
          Process state: Killed (last exit status: 15)
          Package state: Normal
      Registered item(s): cfg/gl/snmp/
                          cfg/gl/udpsnmp/
                          cfg/gl/mibs/
                   core: TEXT SHAREDMEM MAINMEM
               Max. core: 0
            startup_path: /pkg/startup/snmpd.startup
                   Ready: 11.636s
```

```
RP/0/RP1/CPU0:CRS1#process restart snmpd

RP/0/RP1/CPU0:CRS1#show processes snmpd
                  Job Id: 288
                     PID: 8528114
         Executable path: /disk0/hfr-base-4.2.1/bin/
snmpd
             Instance #: 1
             Version ID: 00.00.0000
                Respawn: ON
          Respawn count: 2
  Max. spawns per minute: 12
           Last started: Thu May 12 11:46:38 2005
          Process state: Run (last exit status : 15)
          Package state: Normal
      Started on config: cfg/gl/snmp/admin/community/ww
                   core: TEXT SHAREDMEM MAINMEM
               Max. core: 0
            startup_path: /pkg/startup/snmpd.startup
                   Ready: 6.657s
        Process cpu time: 0.721 user, 0.145 kernel,
0.866 total
```

JID# remains constant, PID# changed on restart

Respawn counter incremented with process restart

Process state reported as 'killed'

MPLS Workshop

‘Monitor process’ command

- Command provide Unix ‘top’ like information
- Displays details on number of running processes, CPU and memory utilization
- Automatically updates every 10 seconds
- Can specify the location of the node that you wish to monitor, for example 0/RP0/CPU0 or 0/2/CPU0
- To change the parameters displayed by monitor processes, enter one of the interactive commands eg. ? to get help, n for the number of entries, t – sorted on cpu time, q to quit

t - Sort on CPU time

```
233 processes; 788 threads; 4663 channels, 5906 fds
CPU states: 94.8% idle, 4.1% user, 1.0% kernel
Memory: 4096M total, 3599M avail, page size 4K

      JID TIDS Chans   FDs Tmrs   MEM   HH:MM:SS   CPU  NAME
        1   26   236   183    1     0   67:18:56  1.06% procnto-600-smp-cisco…
      256    5    39    21    4   292K    0:02:44  0.79% packet
       69   10   454     9    3    2M    0:33:07  0.62% qnet
      331    8   254    21   13    2M    0:15:20  0.52% wdsysmon
       55   11    23    15    6   36M    0:31:18  0.50% eth_server
      241   12    96    83   13    1M    0:04:54  0.37% netio
      171   15    97    44    9    2M    0:03:33  0.12% gsp

      JID TIDS Chans   FDs Tmrs   MEM   HH:MM:SS   CPU  NAME
       55   11    23    15    6   36M    0:00:00  0.00% eth_server
      155    1     7    18    4   12M    0:00:00  0.00% fgid_server
      100    2    11    16    3   11M    0:00:00  0.00% fgid_aggregator
      257    8    16    36    3    8M    0:00:00  0.00% parser_server
    65554    7    16     3    3    7M    0:00:00  0.00% devb-ata
       53    5   237   633    0    4M    0:00:00  0.00% dllmgr
      121   11    48    67   19    3M    0:00:00  0.00% bgp
```

m - Sort on memory usage

MPLS Workshop

‘Show memory compare’ command

- Process how to use the command:
  1. **show memory compare start**
     Takes the initial snapshot of heap usage
  2. **show memory compare end**
     Takes the second snapshot of heap usage
  3. **show memory compare report**
     Displays the heap memory comparison report

```
RP/0/RP1/CPU0:CRS1#show memory compare start
Successfully stored memory snapshot /harddisk:/malloc_dump/memcmp_start.out
RP/0/RP1/CPU0:CRS1#show memory compare end
Successfully stored memory snapshot /harddisk:/malloc_dump/memcmp_end.out
RP/0/RP1/CPU0:CRS1#show memory compare report

JID    name                 mem before    mem after     difference mallocs restart
---    ----                 ----------    ---------     ---------- ------- -------
57     i2c_server           11756         11916         160        1
121    bgp                  2522256       2522208       -48        -1
234    lpts_pa              408536        407632        -904       -14
224    isis                 3089108       3087900       -1208      0
314    tcp                  247196        245740        -1456      -9
241    netio                808136        806464        -1672      -46
```


System Monitoring
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Workshop

Multi pipe support

- Support multiple pipes on the command line so that the output can be processed by enhanced utility set to filter and format the output of any show command.
- Upto 8 pipes are supported. This limit will be superseded by the limit of characters that can be typed on the single line (1024) if the individual commands specified with pipes are long enough.

```
RP/0/RP0/CPU0:CRS1#show platform | in MSC | ex SPA | utility wc -l
       82
RP/0/RP0/CPU0:CRS1#show log start Jan 3 07:00:00 | in LDP | in " UP|DOWN" | ex "10.2[0-5]"
RP/6/RP0/CPU0:Jan  3 17:10:18.428 : mpls_ldp[1038]: %ROUTING-LDP-5-NBR_CHANGE : Neighbor 10.80.1.1:0, DOWN (Interface state down)
RP/6/RP0/CPU0:Jan  3 17:10:58.362 : mpls_ldp[1038]: %ROUTING-LDP-5-NBR_CHANGE : Neighbor 10.80.1.1:0, UP
RP/0/RP0/CPU0:CRS1#

RP/0/RP0/CPU0:CRS1#show proc cpu | ex " 0%  ."
CPU utilization for one minute: 2%; five minutes: 2%; fifteen minutes: 2%

PID    1Min    5Min    15Min Process
131105   1%      1%       1% ce_switch
131106   1%      1%       1% eth_server
RP/0/RP0/CPU0:CRS1#
```

Persistent Syslog

- Router can be configured to have persistent syslogs on the harddisk:
- Logs not written to harddisk in real-time, they are first staged on disk0: then flushed on harddisk after about every 4 hours.
- Useful when syslog server is inaccessible for any reason.

```
logging archive
   device harddisk      ←   Archived on harddisk.
   file-size 500        ←   500 MB (single log file)
   archive-size 500     ←   500 MB (total size of syslogs)
   archive-length 4     ←   4 weeks (logs older than this are removed)
```

```
RP/0/RP0/CPU0:CRS1#dir harddisk:/var/log/2013/11/03
Directory of harddisk:/var/log/2013/11/03
10008690    -rwx  1023890     Sun Nov  3 15:48:26 2013  syslog.03.1
15426650112 bytes total (14786479104 bytes free)
RP/0/RP0/CPU0:CRS1#
```

MPLS Workshop

‘Describe’ command

- **Details of a command and associated process/files**

```
RP/0/RP1/CPU0:CRS#describe show controllers pse summary
The command is defined in metro_driver.parser
Node 0/RP1/CPU0 has file metro_driver.parser for boot package /disk0/hfr-os-mbi-3.2.90/mbihfr-rp.vm from hfr-lc
Package:
    hfr-lc
        hfr-lc V3.2.90[3I]  linecard package for ppc
        Vendor : Cisco Systems
        Desc   : linecard package for ppc
        Build  : Built on Tue May 24 23:46:10 CEST 2005
        Source : By edde-bld1 in /vws/afz/production/3.2.90.3I/hfr/workspace for c2.95.3-p8
Component:
    hfr-metro-driver V0.0.0[main/204]  Driver for Metro ASIC

File: metro_driver.parser

User needs ALL of the following taskids:
        interface (READ)
        drivers (READ)

It will take the following actions:
  Spawn the process:
        metro_cli -t 0x1
```

Package command is located in

Version of component code

Permissions required for execution of command

KSH command that CLI is calling – only visible to ‘cisco-support’ users from 3.2.0

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‘Show tech’ command

```
RP/0/RP0/CPU0:CRS1# show tech-support snmp file harddisk:sh_tech_snmp
++ Show tech start time: 2014-Jan-22.090643.UTC ++
Wed Jan 22 09:06:44 UTC 2014 Waiting for gathering to complete
.....................................................................
Wed Jan 22 09:10:24 UTC 2014 Compressing show tech output
Show tech output available at 0/RP0/CPU0 : harddisk:/sh_tech_snmp.tgz
++ Show tech end time: 2014-Jan-22.091025.UTC ++

RP/0/RP0/CPU0:CRS1# dir harddisk: | in sh_tech_snmp
Wed Jan 22 09:10:46.951 UTC
58948       -rw-  709261      Wed Jan 22 09:10:25 2014  sh_tech_snmp.tgz
RP/0/RP0/CPU0:CRS1#


RP/0/RP1/CPU0:CRS1#show tech-support cef ipv4 location ?
  0/2/CPU0    Fully qualified location specification
  0/3/CPU0    Fully qualified location specification
  0/5/CPU0    Fully qualified location specification
  0/RP0/CPU0  Fully qualified location specification
  0/RP1/CPU0  Fully qualified location specification
  WORD        Fully qualified location specification
```

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Trace functionality

- **'trace' functionality is like a form of 'always-on' debug**

```
RP/0/RP1/CPU0:CRS1#show ospf trace
 OSPF Trace Summary (2, RP/1/RP0/CPU0:CRS1, 0M)

    Trace Name      Size      Count  Description
    ------------ ------- ----------  --------------------------
 1. adj            65536       6291  adjacency
 2. adj_cycle      65536     893383  dbd/flood events/pkts
 3. config          2048        486  config events
 4. errors          8192     868816  errors
 5. events          4096        255  mda/rtrid/bfd/vrf
 6. ha              8192        485  startup/HA/NSF
 7. hello           2048    3982447  hello events/pkts
 8. idb             8192        973  interface
 9. pkt             2048    1927767  I/O packets
10. rib            65536      52190  rib batching
11. spf            65536      93138  spf/topology
12. spf_cycle      65536     352143  spf/topology detail
13. te              4096       3893  mpls-te
14. test            1024      20052  testing info
15. mq             65536          5  message queue info
RP/0/RP0/CPU0:CRS1#show ospf trace hello
Traces for OSPF 2 (Wed Jan 22 08:55:38)
Traces returned/requested/available:  2048/2048/2048
Trace buffer: hello

1    Jan 22 08:49:45.305* ospf_send_hello: area 0.0.0.80 intf MADJ: BE1008 from 0.0.0.0
2    Jan 22 08:49:45.546  ospf_rcv_hello: intf BE1009 area 0.0.0.74 from 10.1.0.9 10.1.9.2
3    Jan 22 08:49:45.546  ospf_check_hello_events: intf MADJ: BE1009 area 0.0.0.74 from 0.0.0.0
4    Jan 22 08:49:45.573* ospf_send_hello: area 0.0.0.74 intf MADJ: BE1008 from 0.0.0.0
5    Jan 22 08:49:45.845* ospf_rcv_hello: intf BE1009 area 0.0.0.80 from 10.1.0.9 10.1.9.2
6    Jan 22 08:49:45.845* ospf_check_hello_events: intf MADJ: BE1009 area 0.0.0.80 from 0.0.0.0
7    Jan 22 08:49:45.917* ospf_send_hello: area 0.0.0.80 intf Te0/5/0/7 from 10.1.80.1
8    Jan 22 08:49:46.232  ospf_rcv_hello: intf BE1008 area 0.0.0.74 from 10.1.0.8 10.1.8.2
```

‘Monitor interface’ command

- **overall reporting (requires MGBL package)**

```
CRS1-CRS              Monitor Time: 00:00:37          SysUptime: 245:59:24

Protocol:General
Interface             In(bps)       Out(bps)      InBytes/Delta  OutBytes/Delta
BE1003                    0/ --%        0/ --%   964.1M/0         893.5M/0
BE1007                12000/  0%     6000/  0%     1.3G/1003     787.2M/963
BE1008                 5000/  0%     8000/  0%     1.5G/1382       1.4G/1471
BE1009                 9000/  0%    11000/  0%   957.4M/372        1.4G/854
BE1010                    0/ --%        0/ --%        0/0             0/0
BE1067                 4000/  0%     5000/  0%   484.4M/324      622.4M/248
Mg1/RP0/CPU0/0         1000/  0%        0/  0%   173.8M/954       79086/0
Mg1/RP1/CPU0/0         1000/  0%        0/  0%   173.9M/954       94122/0
Mg0/RP1/CPU0/0         1000/  0%        0/  0%   173.5M/954      230160/0
Mg0/RP0/CPU0/0         2000/  0%    10000/  0%   186.3M/1614      18.0M/6720
Te1/6/0/0                 0/  0%        0/  0%        0/0             0/0
Te1/6/0/1              7000/  0%     2000/  0%   748.4M/479      276.0M/478
Te1/6/0/2                 0/  0%        0/  0%        0/0             0/0

--- snip

Gi1/15/3/5                0/  0%        0/  0%        0/0             0/0
Gi1/15/3/6                0/  0%        0/  0%        0/0             0/0

Quit='q',     Clear='c',    Freeze='f', Thaw='t',
Next set='n', Prev set='p', Bytes='y',  Packets='k'
(General='g', IPv4 Uni='4u', IPv4 Multi='4m', IPv6 Uni='6u', IPv6 Multi='6m')
```


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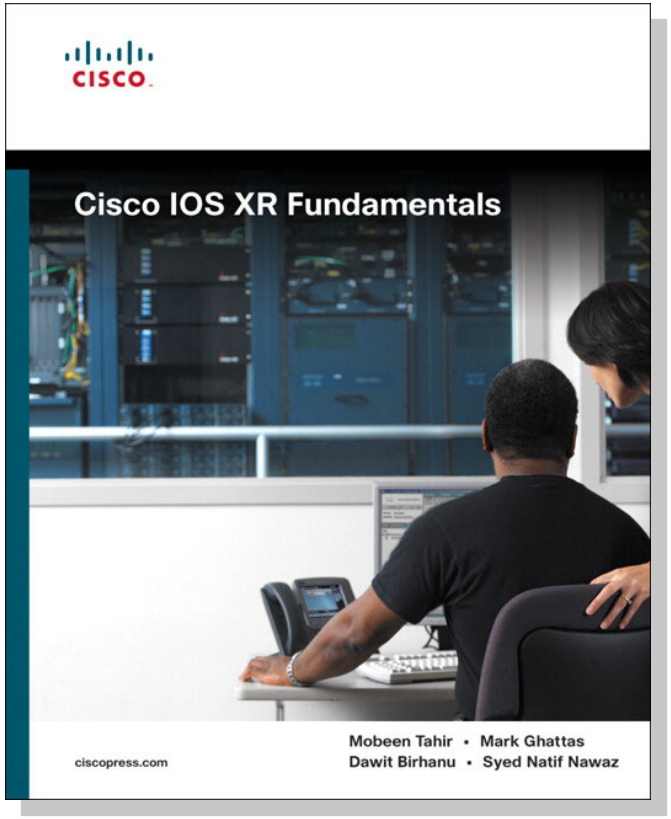
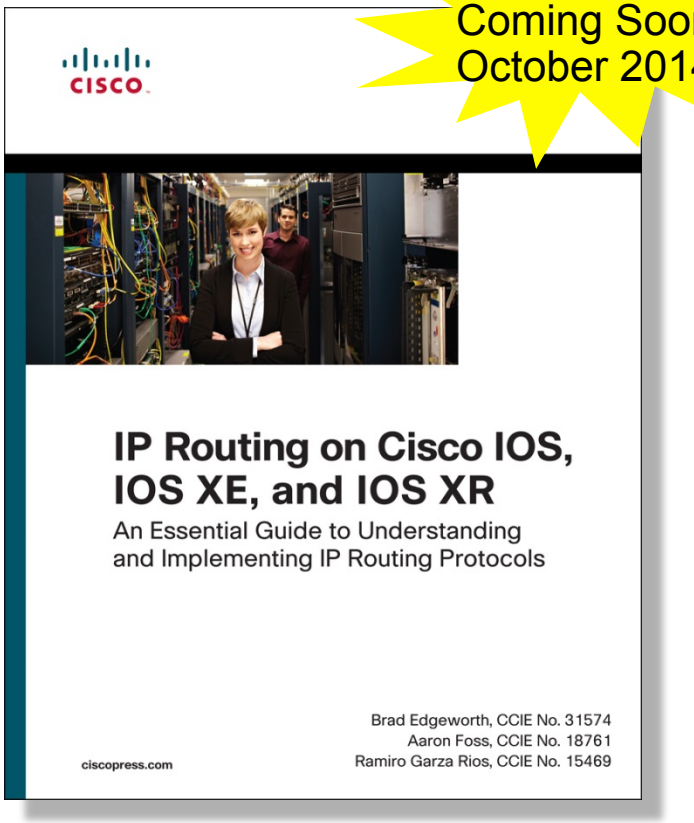
‘Monitor interface’ command

- **per interface reporting (requires MGBL package)**

```
RP/0/RP1/CPU0:CRS1#monitor interface Bundle-ether 1008
CRS1              Monitor Time: 00:00:18          SysUptime: 246:02:20

Bundle-Ether1008 is up, line protocol is up
Encapsulation ARPA

Traffic Stats:(2 second rates)                                 Delta
  Input  Packets:                   6489005                      14
  Input  pps:                             8
  Input  Bytes:                  1507217455                    1274
  Input  Kbps (rate):                     5                  (  0%)
  Output Packets:                   7079943                      15
  Output pps:                             9
  Output Bytes:                  1490126647                    2024
  Output Kbps (rate):                     8                  (  0%)

Errors Stats:
  Input  Total:                           0                       0
  Input  CRC:                             0                       0
  Input  Frame:                           0                       0
  Input  Overrun:                         0                       0
  Output Total:                           0                       0
  Output Underrun:                        0                       0

Quit='q', Freeze='f', Thaw='t', Clear='c', Interface='i',
Next='n', Prev='p'

Brief='b', Detail='d', Protocol(IPv4/IPv6)='r'
```

Additional Reading





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- Is there a training course I can take?
  - Yes! There is a New course: Implementing and Maintaining Cisco Technologies Using IOS XR (IMTXR)
  - https://learningnetwork.cisco.com/community/certifications/service_provider/ios_xr_specialist
- How can I get certified?
  - Pearson VUE
  - The IOS XR Specialist Certification exam number is 644-906.
- How can I get access to IOS XR to prepare?
  - Customer & Partners: Planning in place now for a bookable ASR 9000 Testbed; contact your local Cisco acct team for more info
  - Cisco IOS XRv
- Is there a Cisco Press book?
  - Yes! IOS XR Fundamentals (ISBN-13: 978-1-58714-006-8)

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- Virtualized IOS XR Router that runs on ESX, QEMU, and other platforms
  FREE DEMO VERSION (Requires CCO Account)
- Supported Features
  - https://supportforums.cisco.com/discussion/12101386/xrv-511-workingnon-working-features-and-roadmap
- Download Location
  - https://upload.cisco.com/cgi-bin/swc/fileexg/main.cgi?CONTYPES=Cisco-IOS-XRv
- Installation Guide for ESXi and QEMU
  - https://supportforums.cisco.com/docs/DOC-39939
- Additional Support
  - https://supportforums.cisco.com/community/5996/xr-os-and-platforms

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