IOS XR prakticky

T-SP2
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Program

• IOS-XR Operation and Monitoring Tools
• Config Management using CLI
• Protocol Configuration and Verification
• IOS-XR Boot images and Installation
# Acronyms

<table>
<thead>
<tr>
<th>SDR – Secure Domain Router</th>
<th>IFIB – Internal Forwarding Information Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPL – Route Policy Language</td>
<td>pIFIB – Pre-IFIB</td>
</tr>
<tr>
<td>SMU – Software Maintenance Unit</td>
<td>PIE – Package Installation Envelope</td>
</tr>
<tr>
<td>LPTS – Local Packet Transport Protocol</td>
<td>IPFRR – IP Fast Reroute</td>
</tr>
<tr>
<td>IMDB – In Memory Data Base</td>
<td>LFA – Loop Free Alternate</td>
</tr>
<tr>
<td>DRP – Distributed Route Processor</td>
<td>NSR – Non-Stop Forwarding</td>
</tr>
<tr>
<td>AIB – Adjacency Information Base</td>
<td>BCDL – Bulk Content Downloader</td>
</tr>
<tr>
<td>IDB – Interface Data base</td>
<td>dSDRSC – Designated SDR Shelf Controller</td>
</tr>
<tr>
<td>ISSU – In Service Software Upgrade</td>
<td></td>
</tr>
</tbody>
</table>
**IOS-XR Key Features**

- **Modular** – Runtime SW upgrade/downgrade support
- **Distributed** – scaleable with multi chassis support
- **Platform Independent** – POSIX compliant
- **Management Interface** – Unified Data Model (SNMP/XML)
- **High Availability** – Hot Standby and Process Restart
- **Security** – Control, Data and Management Plane
- **Logical Router** – Router Partitioning
Upgrade specific packages/Composites
- Across Entire system
  - Useful once a feature is qualified and you want to roll it without lot of cmd
- Targeted Install to specific cards
  - Useful while a feature is being qualified
  - Reduces churn in the system to card boundary

Point Fix for software faults
IOS-XR Operation and Monitoring Tools
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
‘show process’ Command

RP/0/RP1/CPU0:equinox# show process snmpd
  Job Id: 288
  PID: 143532
  Executable path: /disk0/hfr-base-3.2.85/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: Run
  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: 11.636s
  Process cpu time: 45.821 user, 5.058 kernel, 50.879 total

<table>
<thead>
<tr>
<th>JID</th>
<th>TID</th>
<th>Stack</th>
<th>pri</th>
<th>state</th>
<th>HR:MM:SS:MSEC</th>
<th>NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>288</td>
<td>1</td>
<td>96K</td>
<td>10</td>
<td>Condvar</td>
<td>0:00:29:0500</td>
<td>snmpd</td>
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<td>288</td>
<td>2</td>
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<td>10</td>
<td>Receive</td>
<td>0:00:00:0049</td>
<td>snmpd</td>
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<tr>
<td>288</td>
<td>3</td>
<td>96K</td>
<td>10</td>
<td>Receive</td>
<td>0:00:01:0427</td>
<td>snmpd</td>
</tr>
<tr>
<td>288</td>
<td>4</td>
<td>96K</td>
<td>10</td>
<td>Receive</td>
<td>0:00:04:0505</td>
<td>snmpd</td>
</tr>
<tr>
<td>288</td>
<td>5</td>
<td>96K</td>
<td>10</td>
<td>Condvar</td>
<td>0:00:00:0000</td>
<td>snmpd</td>
</tr>
<tr>
<td>288</td>
<td>6</td>
<td>96K</td>
<td>10</td>
<td>Receive</td>
<td>0:00:09:0788</td>
<td>snmpd</td>
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<td>288</td>
<td>7</td>
<td>96K</td>
<td>10</td>
<td>Condvar</td>
<td>0:00:00:0042</td>
<td>snmpd</td>
</tr>
<tr>
<td>288</td>
<td>8</td>
<td>96K</td>
<td>10</td>
<td>Receive</td>
<td>0:00:00:0011</td>
<td>snmpd</td>
</tr>
</tbody>
</table>

Example of a process in normal ‘run’ state

SNMP Process contains 8 threads which operate under JID 288
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

Diagram:

- Distributed Middleware
  - BGP
  - IS-IS
  - RIB
  - QoS
  - FIB
  - IP Stack
  - CLI
  - XML
  - Alarm
  - File System
  - OSPF
  - PIM
  - IGMP
  - ACL
  - PFI
  - L2 Drivers
  - Netflow
  - SNMP
  - SSH
  - Inter Process Communication

Contained
Process Restart
Microkernel Architecture Enables Restart of Most Processes

- Microkernel includes minimal functionality
- Non-kernel processes can be restarted
- Critical to HA, ISSU, and MDR functions
- Restarting many processes can be tricky
  Dependent processes may also need to restart

Green areas cannot restart

Monolithic
IOS (7200, 12k (IOS))

Kernel
BSD based routers

Microkernel
IOS XR
Process Restartability

RP/0/RP1/CPU0:equinox# process shutdown snmpd

RP/0/RP1/CPU0:equinox# show processes snmpd
  Job Id: 288
  PID: 143532
  Executable path: /disk0/hfr-base-3.2.85/bin/snmpd
  Instance #: 1
  Version ID: 00.00.0000
  Respawn: ON
  count: 1
  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
start up path:
/pkg/startup/snmpd.startup
  Ready: 11.636s

JID# remains constant, PID# changed on restart

RP/0/RP1/CPU0:equinox# process restart snmpd

RP/0/RP1/CPU0:equinox# show processes snmpd
  Job Id: 288
  PID: 8528114
  Executable path: /disk0/hfr-base-3.2.85/bin/snmpd
  Instance #: 1
  Version ID: 00.00.0000
  Respawn: ON
  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

Respawn counter incremented with process restart

Process state reported as ‘killed’
Process Crash

RP/0/RP1/CPU0:equinox# process crash snmpd

RP/0/RP1/CPU0:equinox# sh processes snmpd
Job Id: 288
PID: 10961090
Executable path: /disk0/hfr-base-3.2.85/bin/snmpd
Instance #: 1
Version ID: 00.00.0000
Respawn: ON
Respawn count: 3
Max. spawns per minute: 12
Last started: Fri May 20 14:32:53 2005
Process state: Run (last exit due to SIGSEGV)
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: 2.001s
Process cpu time: 1.539 user, 0.258 kernel, 1.797 total

Message identifying location of coredump generated by process crash

Identification of JID#/PID# that crash signal is being sent to

Respawn counter incremented on restart

Process will be automatically restarted if Respawn state is set to ‘ON’

Process state reports last termination state as Signalled Segmentation Fault

Log message notes that user ‘Lab’ initiated crash request
“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

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
```

Similar concept for ‘Monitor threads’ command
Protected Process Memory Space

- Each process has a virtual memory space
  Kernel/MMU maps virtual address to physical address (at page level)
  Threads share the memory space

- One process cannot corrupt another’s memory
  Process can only access virtual space
  In IOS – all processes shared same virtual space

- Communication between processes via controlled APIs

- Limited use of shared memory
Memory Management

• Global memory:
  
  show memory summary

• Process memory
  
  show memory
  show process memory
  show dll memory
  show memory heap
  show memory compare

• How to troubleshoot memory leaks – Use commands:
  
  monitor process
  show process memory
  show memory
  follow
  show memory compare
Global Memory

RP/0/RP1/CPU0:equinox# show memory summary

Physical Memory: 4096M total
Application Memory: 3951M (3600M available)
Image: 16M (bootram: 16M)
Reserved: 128M, IOMem: 2028M, flashfsys: 0
Total shared window: 8M

- Physical Memory - amount of physical memory installed on the device
- Application Memory - memory available for the system to use (total memory minus image size, reserved, and flashfsys)
- Image - size of the bootable image
- Reserved - amount of space reserved for packet memory
- IOMem - IO memory—currently used as a backup for packet memory
- Flashfsys - flash file system memory
“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:equinox# `show memory compare start`
Successfully stored memory snapshot /harddisk:/malloc_dump/memcmp_start.out

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

RP/0/RP1/CPU0:equinox# `show memory compare report`

<table>
<thead>
<tr>
<th>JID</th>
<th>name</th>
<th>mem before</th>
<th>mem after</th>
<th>difference</th>
<th>mallocs</th>
<th>restart</th>
</tr>
</thead>
<tbody>
<tr>
<td>57</td>
<td>i2c_server</td>
<td>11756</td>
<td>11916</td>
<td>160</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>283</td>
<td>shelfmgr</td>
<td>273508</td>
<td>273460</td>
<td>-48</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>121</td>
<td>bgp</td>
<td>2522256</td>
<td>2522208</td>
<td>-48</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>qnet</td>
<td>2013844</td>
<td>2013196</td>
<td>-648</td>
<td>-27</td>
<td></td>
</tr>
<tr>
<td>234</td>
<td>lpts_pa</td>
<td>408536</td>
<td>407632</td>
<td>-904</td>
<td>-14</td>
<td></td>
</tr>
<tr>
<td>224</td>
<td>isis</td>
<td>3089108</td>
<td>3087900</td>
<td>-1208</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>314</td>
<td>tcp</td>
<td>247196</td>
<td>245740</td>
<td>-1456</td>
<td>-9</td>
<td></td>
</tr>
<tr>
<td>241</td>
<td>netio</td>
<td>808136</td>
<td>806464</td>
<td>-1672</td>
<td>-46</td>
<td></td>
</tr>
</tbody>
</table>

You are now free to remove snapshot memcmp_start.out and memcmp_end.out under /harddisk:/malloc_dump
System Monitoring
System Monitoring

• Commands

  show tech
  show system verify
  monitor interface
  monitor controller
‘show tech’ Command

• Traditional dump of configuration and show command outputs but can be focussed on functional areas

RP/0/RP1/CPU0:CRS_IOX# show tech-support ?

bcdl Output show commands of interest for bcdl debugging
cef Output show commands of interest for CEF debugging
file Specify a valid file name (e.g. disk0:tmp.log)
gsp Output show commands of interest for gsp debugging
install Show install information for Tech-support
isis Show IS-IS-related diagnostics for Tech-support
mpls Output show commands of interest for MPLS debugging
multicast Show multicast related information
ospfv3 Output show commands for OSPFv3 debugging
password Include password in output
placement Gather lots of information about process placement
platform show tech-support platform output
rib Show IP RIB related information
routing Routing show tech-support output
terminal Send output to terminal

RP/0/RP1/CPU0:CRS_IOX# 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
Trace Functionality

• Many major functions have ‘trace’ functionality to show the last actions it conducted – a form of ‘always-on’ debug

RP/0/RP1/CPU0:CRS1_1# sh cef trace tailf
4 unique entries (128 possible, 0 filtered) May 19 23:37:04.172 ipv4_fib/ipv4_fib_mgr_unique 0/RP1/CPU0 1# IP-CEF platform creates hash set to TRUE.
May 20 07:04:41.574 ipv4_fib/ipv4_fib_mgr_unique 0/RP1/CPU0 5# IP-CEF-Error: Doesn't own external adjacency for 1.1.1.100/32 path 0
May 20 07:04:41.574 ipv4_fib/ipv4_fib_mgr_unique 0/RP1/CPU0 5# IP-CEF-Error: Doesn't own external adjacency for 10.1.2.0/24 path 0
May 20 07:04:41.574 ipv4_fib/ipv4_fib_mgr_unique 0/RP1/CPU0 5# IP-CEF-Error: Doesn't own external adjacency for 10.1.3.0/24 path 0
102 wrapping entries (10240 possible, 0 filtered, 102 total)
May 19 23:37:04.174 ipv4_fib/ipv4_fib_mgr_low 0/RP1/CPU0 t1 IP-CEF-Event: Spawning CEF periodic thread
May 19 23:37:04.199 ipv4_fib/ipv4_fib_mgr_low 0/RP1/CPU0 t3 IP-CEF-Event: Connected to IMP
May 19 23:37:04.207 ipv4_fib/ipv4_fib_mgr_hi 0/RP1/CPU0 t1 IP-CEF-Event: Connected to netio
May 19 23:37:04.218 ipv4_fib/ipv4_fib_mgr_errors 0/RP1/CPU0 t1 IP-FIB:fib_pfi_if_connect pfi_ifh_bind failed : 0x434e8c00, 'pfi-ifh' detected the 'warning' condition 'Failed to contact the IFH server'

RP/0/RP1/CPU0:CRS1_1# sh sysmgr trace tailf
May 19 23:33:17.912 sysmgr/global 0/RP1/CPU0 1# t1 SYSMGR_INIT jid=0 UNKNOWN
May 20 00:27:50.879 sysmgr/global 0/RP1/CPU0 4# t13 [unknown 0x10a/1] 0x00000005
May 20 05:05:02:59.839 sysmgr/global 0/RP1/CPU0 1# t11 FAILOVER jid=0 UNKNOWN
May 20 05:05:15.473 sysmgr/global 0/RP1/CPU0 105# t11 PROC_NOTIFY jid=206 ipv4_smiap
May 20 05:05:15.583 sysmgr/global 0/RP1/CPU0 20# t13 PROC_EXIT jid=312 sysmgr_preload_dll
May 20 07:04:41.509 sysmgr/global 0/RP1/CPU0 61# t14 PROC_AVAIL jid=340 mpls_ldp
May 20 14:32:53.625 sysmgr/global 0/RP1/CPU0 2# t11 PROC_ABORT jid=288 snmpd status=139
May 20 14:32:53.996 sysmgr/global 0/RP1/CPU0 213# t11 PROC_START jid=288 snmpd
May 20 14:32:55.637 sysmgr/global 0/RP1/CPU0 209# t11 PROC_READY jid=288 snmpd
“monitor interface” Command

- per interface reporting (requires MGBL package)

```
RP/0/RP1/CPU0:CRS1_1# monitor interface mgmtEth 0/rp1/CPU0/0

CRS1_1  Monitor Time: 00:00:52  SysUptime: 16:33:16
MgmtEth0/RP1/CPU0/0 is up, line protocol is up
Encapsulation ARPA

Traffic Stats: (5 minute rates)                      Delta
Input  Packets:                313326          17
Input  pps:                     5
Input  Bytes:                 34467898        1033
Input  Kbps:                    3
Output Packets:                37633           4
Output pps:                      0
Output Bytes:                 2034463         244
Output Kbps:                     0

Errors Stats:                      0
Input  Total:                    1
Input  CRC:                      0
Input  Frame:                    0
Input  Overrun:                  0
Output Total:                   0
Output Underrun:                 0

Quit='q', Freeze='f', Thaw='t', Clear='c', Interface='i',
Detail='d', Brief='b', Next='n', Prev='p'
```
“monitor interface” Command

• or all interfaces in the system

RP/0/RP1/CPU0:CRS1_1# monitor interface all

<table>
<thead>
<tr>
<th>Interface</th>
<th>Encap</th>
<th>Input pps</th>
<th>Output pps</th>
<th>Input Kbps</th>
<th>Output Kbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>MgmtEth0/RP0/CPU0/0</td>
<td>ARPA</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>MgmtEth0/RP1/CPU0/0</td>
<td>ARPA</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>POS0/4/0/0/0</td>
<td>HDLC</td>
<td>1230</td>
<td>0</td>
<td>542210</td>
<td>0</td>
</tr>
<tr>
<td>POS0/4/0/3</td>
<td>HDLC</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>POS0/4/0/6</td>
<td>PPP</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>POS0/4/0/7</td>
<td>HDLC</td>
<td>0</td>
<td>1230</td>
<td>0</td>
<td>542210</td>
</tr>
</tbody>
</table>

Quit='q', Freeze='f', Thaw='t', Clear='c', Next set='n', Prev set='p'
“monitor controller sonet” Command

RP/0/RP1/CPU0:CRS1_1# monitor controller sonet 0/2/0/0

equinox Monitor Time: 00:00:47 SysUptime: 172:31:04

Controller for SONET0_2_0_0

<table>
<thead>
<tr>
<th>Controller Stats:</th>
<th>Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path LOP</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Path AIS</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Path RDI</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Path BIP</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Path FEBE</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Path NEWPTR</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Path PSE</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Path NSE</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Line AIS</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Line RDI</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Line BIP</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Line FEBE</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Section LOS</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Section LOF</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
<tr>
<td>Section BIP</td>
<td>0 ( 0 per-sec) 0</td>
</tr>
</tbody>
</table>

Quit='q', Freeze='f', Thaw='t', Clear='c', Select controller='s'
“describe” Command

• Details of a command and associated process/files

RP/0/RP1/CPU0# 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
“describe” Command

Details of a command and associated process/files

RP/0/RP1/CPU0:equinox# describe show mpls label table summary

The command is defined in mpls_lsd.parser

Node 0/RP1/CPU0 has file mpls_lsd.parser for boot package /disk0/hfr-os-mbi-3.2.90/mbihfr-rp.vm from hfr-mpls

Package:
  hfr-mpls
  hfr-mpls V3.2.90[3I]  MPLS Package
  Vendor : Cisco Systems
  Desc   : MPLS Package
  Build  : Built on Tue May 24 23:53:24 CEST 2005
  Source : By edde-bld1 in /vws/afz/production/3.2.90.3I/hfr/workspace for c2.95.3-p8

Component:
  mpls-lds V0.0.0[main/155]  Label Switching Database of MPLS Forwarding Infrastructure

File: mpls_lsd.parser

User needs ALL of the following taskids:
  mpls-te (READ) or mpls-ldp (READ) or mpls-static (READ)

It will take the following actions:
  Spawn the process:
    mpls_lsd_command -t 0x0 -s
Logging Archive

• use disk devices to store syslogs

RP/0/RP1/CPU0:ios(config)#logging archive

archive-length  The maximum no of weeks of log to maintain
archive-size    The total size of the archive
device          Configure the archive device
file-size       The maximum file size for a single log file.
frequency       The collection interval for logs
severity        The minimum severity of log messages to archive

<cr>

RP/0/RP1/CPU0:ios(config)#logging archive device

  disk0   Use disk0 as the archive device
disk1   Use disk1 as the archive device
harddisk Use harddisk as the archive device

• Options must be set for function to work

• recommended defaults:

  • archive-length = 4 weeks
  • archive-size = 300 MB
  • device = harddisk
  • file size = 5 MB
  • frequency = daily
  • severity = informational

RP/0/8/CPU0:PE1#sh run logging archive
logging archive
device harddisk
severity informational
file-size 5
frequency daily
archive-size 300
archive-length 4
Online Manuals: man

• Integrated commands reference with various search options:

RP/0/RP1/CPU0:ios# man keyword mpls

Following Commands Matched for 'mpls'

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>COMMAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>is-is</td>
<td>mpls traffic-eng</td>
</tr>
<tr>
<td>is-is</td>
<td>mpls traffic-eng router-id (is-is)</td>
</tr>
<tr>
<td>is-is</td>
<td>show isis mpls traffic-eng adjacency-log</td>
</tr>
<tr>
<td>is-is</td>
<td>show isis mpls traffic-eng advertisements</td>
</tr>
<tr>
<td>is-is</td>
<td>show isis mpls traffic-eng tunnel</td>
</tr>
<tr>
<td>ospf</td>
<td>mpls traffic-eng area (ospf)</td>
</tr>
<tr>
<td>ospf</td>
<td>mpls traffic-eng router-id (ospf)</td>
</tr>
<tr>
<td>ospf</td>
<td>show ospf mpls traffic-eng</td>
</tr>
<tr>
<td>quality-of-service</td>
<td>match mpls experimental topmost</td>
</tr>
<tr>
<td>quality-of-service</td>
<td>set mpls experimental topmost</td>
</tr>
</tbody>
</table>

RP/0/RP1/CPU0:ios# man command show cef ipv4

COMMAND

    show cef ipv4

DESCRIPTION

To display the IPv4 Cisco Express Forwarding (CEF) table, use the show cef ipv4 command in EXEC mode.

    show cef ipv4 [prefix [mask] | type instance] [detail] [location node-id]
Config Management Using CLI
**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).

<table>
<thead>
<tr>
<th>IOS-XR</th>
<th>IOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration changes do NOT take place after &lt;CR&gt;</td>
<td>Configurations take place immediately after &lt;CR&gt;</td>
</tr>
<tr>
<td>Configuration changes must be ‘committed’ before they take effect</td>
<td>No commit</td>
</tr>
<tr>
<td>Allows you to verify your configuration before applying it</td>
<td>No verification required</td>
</tr>
<tr>
<td>Two stage configuration model</td>
<td>Not available</td>
</tr>
<tr>
<td>Configuration rollback</td>
<td>Not available</td>
</tr>
<tr>
<td>Provision to pre-configure</td>
<td>Not available</td>
</tr>
<tr>
<td>New config plane – Admin mode</td>
<td>Not available</td>
</tr>
<tr>
<td>Feature centric</td>
<td>Interface centric</td>
</tr>
</tbody>
</table>

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**IOS-XR CLI: Two Stage Config Model**

**First Stage**
- 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

**Second Stage**
- Promotes the changes to active configuration; these changes:
  - Are verified for semantic correctness
  - Are check-pointed on the router

**Diagram Notes**
- **Target Config** = **Config Change**
- **Active Config**
  - Configuration Database
  - Active Config
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 72 linecard chassis with a potential of 1296 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:Router-1#show ipv4 interface brief

<table>
<thead>
<tr>
<th>Interface Protocol</th>
<th>IP-Address</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>MgmtEth0/0/CPU0/0</td>
<td>10.23.1.69</td>
<td>Up</td>
</tr>
<tr>
<td>MgmtEth0/0/CPU0/1</td>
<td>unassigned</td>
<td>Shutdown</td>
</tr>
<tr>
<td>MgmtEth0/0/CPU0/2</td>
<td>unassigned</td>
<td>Shutdown</td>
</tr>
<tr>
<td>GigabitEthernet0/2/0/0</td>
<td>100.12.1.1</td>
<td>Up</td>
</tr>
</tbody>
</table>
```

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:ios#config t
RP/0/0/CPU0:ios(config)#interface MgmtEth 0/0/CPU0/0
RP/0/0/CPU0:ios(config-if)#
RP/0/0/CPU0:ios#
RP/0/0/CPU0:ios#admin
RP/0/0/CPU0:ios(admin)#
XR Command Modes

SDR Exec – Normal operations - monitoring routing and CEF

RP/0/RP0/CPU0:router#
show ipv4 interfaces brief    show running-config
show install active    show cef summary location 0/5/CPU0

SDR Config – Configuration for L3 Node

RP/0/RP0/CPU0:router(config)#
router bgp 100    taskgroup admins    policy-map foo
mpls ldp    ipv4 access-list block-junk

Admin – Chassis operations, outside of SDRs

RP/0/RP0/CPU0:router(admin)#
show controllers fabric plane all    config-register 0x0
install add tftp://7.7.7.77/[filename]    show platform

Admin Config

RP/0/RP0/CPU0:router(admin-config)#
sdr backbone location 0/5/*
pairing reflector location 0/3/* 0/4/*
IOS-XR CLI: Config Commits

RP/0/0/CPU0:iosxr1#show run int gi0/2/0/0
% No such configuration item(s)

RP/0/0/CPU0:iosxr1#conf t
RP/0/0/CPU0:iosxr1(config)#interface gig0/2/0/0
RP/0/0/CPU0:iosxr1(config-if)#ipv4 address 100.12.1.1/24
RP/0/0/CPU0:iosxr1(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:iosxr1(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:iosxr1#
RP/0/0/CPU0:iosxr1#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:ios#show configuration commit list

<table>
<thead>
<tr>
<th>SNo.</th>
<th>Label/ID</th>
<th>User</th>
<th>Line</th>
<th>Client</th>
<th>Time Stamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000000037</td>
<td>root</td>
<td>con0_0_CPU</td>
<td>CLI</td>
<td>01:39:03 UTC Mon Apr 24 2006</td>
</tr>
<tr>
<td>2</td>
<td>1000000036</td>
<td>root</td>
<td>con0_0_CPU</td>
<td>CLI</td>
<td>01:18:10 UTC Mon Apr 24 2006</td>
</tr>
<tr>
<td>3</td>
<td>1000000035</td>
<td>root</td>
<td>con0_0_CPU</td>
<td>CLI</td>
<td>01:00:54 UTC Mon Apr 24 2006</td>
</tr>
</tbody>
</table>
IOS-XR CLI: Config Rollback

RP/0/0/CPU0:iosxr1#conf t
RP/0/0/CPU0:iosxr1(config)#hostname iox-CL11
RP/0/0/CPU0:iosxr1(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:iosxr1#
RP/0/0/CPU0:iosxr1#
IOS-XR CLI: Pre-Config Capabilities

- Pre-config feature allows configuring physical interfaces before they are inserted into the router.
- Preconfigured interfaces are not verified or applied until the actual interface with the matching location.
- Allows reduction down time and helps improve operational tasks.
- Prior to the LC being inserted:
  - Select the interface
  - Configure the timing (e.g. for SONET controller)
  - Configure the framing
  - Configure the IP address

```
RP/0/0/CPU0:IOX-4(config)#interface preconfigure POS 0/4/1/0
RP/0/0/CPU0:IOX-4(config-if-pre)#ip address 1.1.1.1 255.255.255.0
RP/0/0/CPU0:IOX-4(config-if-pre)#encapsulation ppp
RP/0/0/CPU0:IOX-4(config)#controller preconfigure sonet 0/4/0/0
RP/0/0/CPU0:IOX-4(config-sonet)#clock source line
```
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:ios#conf t
RP/0/0/CPU0:ios(config)#policy p1
RP/0/0/CPU0:ios(config-pmap)#class c0
RP/0/0/CPU0:ios(config-pmap-c)#set precedence 0
RP/0/0/CPU0:ios(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
```
RPL- Route Policy Language
RPL Motivation and Basic Building Blocks

• **Scaling**
  Using route-maps could lead to 100k – 1M lines of configuration (e.g. 1000s of BGP peers).

• **Modularity**
  Exploit modularity to reuse common portions of configuration.

• **Parameterization**
  For elements which are not exact copies of each other we can add parameterization (think variables) to get further re-use.

• **Improved Clarity**
  No Silently skipped statements.
RPL Syntax: General Structure

- RPL is used in 2 steps:
  
  Define the policy in configuration mode:

  ```
  Route-policy <Policy Name>
  statement A
  statement B
  End-policy
  ```

  ```
  Router bgp 99
  neighbor 2.2.2.2 remote-as 1
  address-family ipv4 unicast
  route-policy <policy Name> in/out
  ```
RPL: Conditional Statements—If and If-Then-Else

An “if” statement uses a conditional expression to decide which actions or dispositions should be taken for the given route.

```plaintext
If as-path in as-path-set-1 then
    drop
endif
```

The “if” statement also permits an “else” clause, which is executed if the expression is false.

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

The statements within an `if` statement may themselves be `if` statements.

```plaintext
if community matches-every(12:34,56:78) then
    if med eq 8 then
        drop
    endif
    set local-preference 100
endif
```
RPL: Boolean Expressions

- Boolean expressions evaluate as either true or false.
- Compound conditions by means of boolean operators: negation (not), conjunction (and), disjunction (or).

```plaintext
if med eq 42 and next-hop in (1.1.1.1) then
if med eq 10 and not destination in (10.1.3.0/24) or community is (56:78)
if med eq 10 and (not destination in (10.1.3.0/24) or community is (56:78))
```

RPL - Hierarchical Policy

```plaintext
route-policy Inner
  set weight 100
end-policy
!
route-policy Outer
  apply Inner
  set community (2:666) additive
end-policy
```
QoS and ACLs
QoS Configuration

- No major difference in CLI configuration between IOS and IOS XR.
- New CLI command in IOS XR is “show qos interface “

```bash
RP/0/RP0/CPU0:IOS-XR# sh run policy-map NW
policy-map NW
  class P1
    police rate 2000 kbps
    priority
  !
  class P2
    police rate 2000 kbps burst 1000 bytes
  !

RP/0/RP0/CPU0:IOS-XR# show run class-map P1
class-map match-any P1
  match precedence priority
  !

RP/0/RP0/CPU0:IOS-XR# show run class-map P2
class-map match-any P2
  match precedence immediate
  !
```
“show qos” Interface

RP/0/RP0/CPU0:IOS-XR# show qos interface poS 0/6/0/0 output

Interface POS0_6_0_0 -- output policy
Total number of classes: 3
-------------------------------------------------------
LEVEL1 class: classid = 0x1
class name = P1
No explicit weight assigned for this class
Sharq Queue ID = 10
This Q belongs to Group = 9
Queue Max. BW. = 2396160 kbps
TailDrop Threshold(bytes)= 2995200
WRED not configured for this class
Policer slot # = 225
Policer avg. kbps = 1953 kbps
Policer peak kbps = 0 kbps
Policer conform burst configured = 0 Kbits
Policer conform burst programmed = 62496 bytes
Policer conform action = Just TX
Policer conform action value = 0
Policer exceed action = DROP PKT
Policer exceed action value = 0
<output omitted>
Base Security Using ACLs

- Creating access lists

```
RP/0/0/0:RP-POD1#conf t
RP/0/0/0:RP-POD1(config)#ip access-list Cisco
RP/0/0/0:RP-POD1(config-ipv4-acl)#
```

- Numbering statements (ACEs)

```
RP/0/0/0:RP-POD1(config-ipv4-acl)#10 permit ip
```
ACL Editing

• Adding a line (ACE)

(config-ipv4-acl)# 30 deny udp any eq netbios-dgm any

• Removing a line (ACE)

(config-ipv4-acl)# no 20

• Re-sequencing ACL

resequence ip access-list <tag>

• Sample re-sequenced ACL

ip access-list Ethernet_In
 10 deny udp any eq netbios-ns any
 20 deny udp any host 255.255.255.255 eq tftp
 30 permit any

• Copying ACL

RP/0/0/0:rp-router#copy ipv4 access-list pod6 pod6copy
Protocol Configuration and Verification
Although you can configure OSPF before you configure an IP address, no OSPF routing will occur until at least one IP address is configured.
RP/0/2/CPU0:PE1#sh ospf

Routing Process "ospf 100" with ID 10.0.0.1

NSR (Non-stop routing) is Enabled

Supports only single TOS(TOS0) routes

Supports opaque LSA

Router is not originating router-LSAs with maximum metric

Initial SPF schedule delay 50 msecs

Minimum hold time between two consecutive SPFs 200 msecs

Maximum wait time between two consecutive SPFs 5000 msecs

Initial LSA throttle delay 50 msecs

Minimum hold time for LSA throttle 200 msecs

Maximum wait time for LSA throttle 5000 msecs

Minimum LSA interval 200 msecs. Minimum LSA arrival 100 msecs

<snip>
# OSPF Traces

**RP/0/2/CPU0:PE1#show ospf trace**

OSPF Trace Summary (100, RP/0/2/CPU0:PE1, 2048M)

<table>
<thead>
<tr>
<th>Trace Name</th>
<th>Size</th>
<th>Count</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. adj</td>
<td>2048</td>
<td>1109</td>
<td>adjacency</td>
</tr>
<tr>
<td>2. adj_cycle</td>
<td>2048</td>
<td>79968</td>
<td>dbd/flood events/pkts</td>
</tr>
<tr>
<td>3. config</td>
<td>512</td>
<td>49</td>
<td>config events</td>
</tr>
<tr>
<td>4. errors</td>
<td>2048</td>
<td>1</td>
<td>errors</td>
</tr>
<tr>
<td>5. events</td>
<td>4096</td>
<td>54</td>
<td>mda/rtrid/bfd/vrf</td>
</tr>
<tr>
<td>6. ha</td>
<td>1024</td>
<td>275</td>
<td>startup/HA/NSF</td>
</tr>
<tr>
<td>7. hello</td>
<td>2048</td>
<td>1300864</td>
<td>hello events/pkts</td>
</tr>
<tr>
<td>8. idb</td>
<td>2048</td>
<td>198</td>
<td>interface</td>
</tr>
<tr>
<td>9. pkt</td>
<td>2048</td>
<td>503752</td>
<td>I/O packets</td>
</tr>
<tr>
<td>10. rib</td>
<td>2048</td>
<td>286</td>
<td>rib batching</td>
</tr>
<tr>
<td>11. spf</td>
<td>1024</td>
<td>1014</td>
<td>spf/topology</td>
</tr>
<tr>
<td>12. spf_cycle</td>
<td>2048</td>
<td>1003</td>
<td>spf/topology detail</td>
</tr>
<tr>
<td>13. te</td>
<td>2048</td>
<td>1838</td>
<td>mpls-te</td>
</tr>
<tr>
<td>14. test</td>
<td>1024</td>
<td>0</td>
<td>testing info</td>
</tr>
<tr>
<td>15. mq</td>
<td>256</td>
<td>13</td>
<td>message queue info</td>
</tr>
</tbody>
</table>

**RP/0/2/CPU0:PE1#show ospf trace hello**

Traces for OSPF 100 (Fri Jun 24 19:52:41)

Traces returned/requested/available: 2048/2048/2048

Trace buffer: hello

1 Jun 24 18:58:43.304 ospf_send_hello: area 0.0.0.0 intf PO0/7/0/1 from 100.14.0.1

2 Jun 24 18:58:45.737 ospf_rcv_hello: intf PO0/7/0/0 area 0.0.0.0 from 10.0.0.2 100.12.0.2

3 Jun 24 18:58:45.737 ospf_check_hello_events: intf PO0/7/0/0 area 0.0.0.0 from 10.0.0.2 100.12.0.1

4 Jun 24 18:58:48.189 ospf_rcv_hello: intf PO0/7/0/1 area 0.0.0.0 from 10.0.0.4 100.14.0.4

5 Jun 24 18:58:48.189 ospf_check_hello_events: intf PO0/7/0/1 area 0.0.0.0 from 100.14.0.1
Comparison of Cisco IOS Static Route and Cisco IOS XR Static Route

<table>
<thead>
<tr>
<th>Static Route IOS</th>
<th>Static Route IOS XR</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOS#sh run</td>
<td>beg ip route 192.1.1.0</td>
</tr>
<tr>
<td>ip route 192.1.1.0 255.255.255.0 g4/0</td>
<td></td>
</tr>
<tr>
<td>ip route 223.255.254.0 255.255.255.0 10.13.0.1</td>
<td></td>
</tr>
<tr>
<td>RP/0/1/CPU0:IOS-XR#sh run router static</td>
<td></td>
</tr>
<tr>
<td>router static</td>
<td></td>
</tr>
<tr>
<td>address-family ipv4 unicast</td>
<td></td>
</tr>
<tr>
<td>43.43.44.0/24 Serial0/5/3/3/0:2</td>
<td></td>
</tr>
<tr>
<td>192.1.1.0/24 Gigabitethernet0/4/0/0</td>
<td></td>
</tr>
<tr>
<td>223.255.254.254/32 MgmtEth0/1/CPU0/0</td>
<td></td>
</tr>
<tr>
<td>!</td>
<td></td>
</tr>
<tr>
<td>address-family ipv6 unicast</td>
<td></td>
</tr>
<tr>
<td>5301::1111/128 Serial0/5/3/3/0:0</td>
<td></td>
</tr>
<tr>
<td>!</td>
<td></td>
</tr>
<tr>
<td>!</td>
<td></td>
</tr>
</tbody>
</table>
Comparison of Cisco IOS BGP and Cisco IOS XR BGP

- New BGP configuration fundamentals consisting of hierarchical CLI.
- Distributed BGP
- Route Policy Language (RPL)

**IOS BGP Configuration**

```plaintext
router bgp 300
  no bgp default ipv4-unicast
  bgp log-neighbor-changes
  neighbor 1.1.1.1 remote-as 400
  neighbor 1.1.1.1 update-source Loopback0
  address-family ipv4
  neighbor 1.1.1.1 activate
  no auto-summary
  no synchronization
```

**IOS XR BGP Configuration**

```
RP/0/1/CPU0:IOS-XR#sh run router bgp
router bgp 300
  bgp router-id 2.2.2.2
  address-family ipv4 unicast
  !
  neighbor 1.1.1.2
    remote-as 400
    address-family ipv4 unicast
    route-policy policy in
    route-policy policy out
  !
  !
```
BGP: Show Commands (1/2)

```
RP/0/1/CPU0:Router-5# sh 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.

<table>
<thead>
<tr>
<th>Process</th>
<th>RecvTblVer</th>
<th>bRIB/RIB</th>
<th>LabelVer</th>
<th>ImportVer</th>
<th>SendTblVer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaker</td>
<td>101</td>
<td>101</td>
<td>101</td>
<td>101</td>
<td>101</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neighbor</th>
<th>Spk</th>
<th>AS</th>
<th>MsgRcvd</th>
<th>MsgSent</th>
<th>TblVer</th>
<th>InQ</th>
<th>OutQ</th>
<th>Up/Down</th>
<th>St/PfxRcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.1.1.2</td>
<td>0</td>
<td>400</td>
<td>2451</td>
<td>2453</td>
<td>101</td>
<td>0</td>
<td>0</td>
<td>00:24:33</td>
<td>100</td>
</tr>
</tbody>
</table>
```

Show ip bgp summary (IOS)

Show bgp ipv4 unicast summary (IOS XR)
show bgp summary

BGP router identifier 10.0.0.1, local AS number 1
BGP main routing table version 45966
BGP scan interval 60 secs
BGP is operating in DISTRIBUTED mode.

<table>
<thead>
<tr>
<th>Process</th>
<th>RecvTblVer</th>
<th>bRIB/RIB</th>
<th>SendTblVer</th>
</tr>
</thead>
<tbody>
<tr>
<td>bRIB</td>
<td>196349</td>
<td>45966</td>
<td>45966</td>
</tr>
<tr>
<td>Speaker 1</td>
<td>113097</td>
<td>112388</td>
<td>13187</td>
</tr>
<tr>
<td>Speaker 2</td>
<td>90942</td>
<td>90379</td>
<td>13187</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neighbor</th>
<th>Spr</th>
<th>AS</th>
<th>MsgRcvd</th>
<th>MsgSent</th>
<th>TblVer</th>
<th>InQ</th>
<th>OutQ</th>
<th>Up/Down</th>
<th>St/PfxRcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0.101.1</td>
<td>1</td>
<td>1</td>
<td>46286</td>
<td>7</td>
<td>13187</td>
<td>982</td>
<td>0</td>
<td>00:04:27</td>
<td>47550</td>
</tr>
<tr>
<td>10.0.101.2</td>
<td>1</td>
<td>1</td>
<td>47119</td>
<td>7</td>
<td>13187</td>
<td>988</td>
<td>0</td>
<td>00:04:27</td>
<td>48384</td>
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<tr>
<td>10.0.101.3</td>
<td>1</td>
<td>1</td>
<td>46973</td>
<td>7</td>
<td>13187</td>
<td>1001</td>
<td>0</td>
<td>00:04:28</td>
<td>48237</td>
</tr>
<tr>
<td>10.0.101.4</td>
<td>1</td>
<td>1</td>
<td>46806</td>
<td>7</td>
<td>13187</td>
<td>1153</td>
<td>0</td>
<td>00:04:28</td>
<td>48071</td>
</tr>
<tr>
<td>10.0.101.5</td>
<td>2</td>
<td>1</td>
<td>34810</td>
<td>7</td>
<td>13187</td>
<td>0</td>
<td>0</td>
<td>00:04:28</td>
<td>35813</td>
</tr>
<tr>
<td>10.0.101.6</td>
<td>2</td>
<td>1</td>
<td>46801</td>
<td>7</td>
<td>13187</td>
<td>900</td>
<td>0</td>
<td>00:04:28</td>
<td>48066</td>
</tr>
</tbody>
</table>

- **When to Use Distributed BGP**
  - Scaling needs exceed abilities of a single RP
  - Process Isolation
Hmmm- No BGP Routes!!
Check Route-Policy

```
RP/0/2/CPU0:PE1# show bgp summary

BGP router identifier 10.0.0.1, local AS number 65518

<snip>

<table>
<thead>
<tr>
<th>Neighbor</th>
<th>Spk</th>
<th>AS</th>
<th>MsgRcvd</th>
<th>MsgSent</th>
<th>TblVer</th>
<th>InQ</th>
<th>OutQ</th>
<th>Up/Down</th>
<th>St/PfxRcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0.0.10</td>
<td>0</td>
<td>65518</td>
<td>1397</td>
<td>1376</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>22:46:55</td>
<td>0</td>
</tr>
<tr>
<td>10.0.0.11</td>
<td>0</td>
<td>65518</td>
<td>1397</td>
<td>1376</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>22:46:54</td>
<td>0</td>
</tr>
<tr>
<td>20.20.1.2</td>
<td>0</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>00:00:11</td>
<td>0!</td>
</tr>
</tbody>
</table>
```

```
RP/0/2/CPU0:PE1#

RP/0/2/CPU0:Jul 5 17:28:13.829 : bgp[123]: %ROUTING-BGP-5-ADJCHANGE : neighbor 20.20.1.2 Up

RP/0/2/CPU0:Jul 5 17:28:13.829 : bgp[123]: %ROUTING-BGP-4-NBR_NOPOLICY : No inbound IPv4 Unicast policy is configured for eBGP neighbor 20.20.1.2. No IPv4 Unicast prefixes will be accepted from the neighbor until inbound policy is configured.

RP/0/2/CPU0:Jul 5 17:28:13.829 : bgp[123]: %ROUTING-BGP-4-NBR_NOPOLICY : No outbound IPv4 Unicast policy is configured for eBGP neighbor 20.20.1.2. No IPv4 Unicast prefixes will be sent to the neighbor until outbound policy is configured.
```
BGP Timers

show bgp neighbor 20.20.1.2

BGP neighbor is 20.20.1.2
Remote AS 10, local AS 65518, external link
Remote router ID 28.28.28.1
BGP state = Established, up for 00:00:20
Last read 00:00:20, hold time is 180, keepalive interval is 60 seconds

Sent 3 messages, 0 notifications, 0 in queue

Minimum time between advertisement runs is **30 seconds**
Minimum time between advertisement runs is **0 seconds**

For Address Family: IPv4 Unicast
BGP neighbor version 1
Update group: 0.2

eBGP neighbor with no inbound or outbound policy; defaults to 'drop'

IOS Default
iBGP Adv: 5,1,0
eBGP Adv: 30 Sec

IOS-XR eBGP Adv.: 30Sec
IOS-XR iBGP Adv.: 0 Sec
Establish IBGP with Route-Reflector Scalable Way

- Peer-Groups in IOS reduce repetitive configuration
- IOS-XR does not use Peer Groups but provides more scalable and granular configuration mechanism via
  - Session Groups
  - Address Family Groups
  - Neighbor Groups
- Allows to stack and inherit very large configuration which makes it easy to read, apply and manage.

- **Session Groups**: Set of commands applicable to BGP session itself.
- **Address-Family Group**: Contents of the neighbor session, Information exchanged in the BGP session
- **Neighbor Group**: Bundling of different Session group and AF-group forms a neighbour group.
Establish BGP using Session, AF and Neighbor Groups

```
RP/0/7/CPU0:D3(config-bgp)#session-group ebgp
RP/0/7/CPU0:D3(config-bgp-sngrp)#remote-as 11
RP/0/7/CPU0:D3(config-bgp-sngrp)#password cisco
RP/0/7/CPU0:D3(config-bgp-sngrp)#description ebgp
RP/0/7/CPU0:D3(config-bgp-sngrp)#exit
RP/0/7/CPU0:D3(config-bgp)#af-group permit-ipv4 address-family ipv4 unicast
RP/0/7/CPU0:D3(config-bgp-afrgrp)#route-policy ebgp in
RP/0/7/CPU0:D3(config-bgp-afrgrp)#route-policy ebgp out
RP/0/7/CPU0:D3(config-bgp-afrgrp)#maximum-prefix 1000
RP/0/7/CPU0:D3(config-bgp-afrgrp)#exit
RP/0/7/CPU0:D3(config-bgp)#neighbor-group ebgp-11
RP/0/7/CPU0:D3(config-bgp-nbrgrp)#use session-group ebgp
RP/0/7/CPU0:D3(config-bgp-nbrgrp)#address-family ipv4 4 unicast
RP/0/7/CPU0:D3(config-bgp-nbrgrp-af)#use af-group permit-ipv4
RP/0/7/CPU0:D3(config-bgp-nbrgrp-af)#exit
RP/0/7/CPU0:D3(config-bgp-nbrgrp)#exit
RP/0/7/CPU0:D3(config-bgp)#neighbor 192.168.1.2
```
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
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

- 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

<table>
<thead>
<tr>
<th>Local</th>
<th>port</th>
<th>Remote</th>
<th>Rate</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any</td>
<td>ICMP</td>
<td>ANY</td>
<td>1000</td>
<td>low</td>
</tr>
<tr>
<td>any</td>
<td>179</td>
<td>any</td>
<td>100</td>
<td>medium</td>
</tr>
<tr>
<td>any</td>
<td>179</td>
<td>202.4.48.99</td>
<td>1000</td>
<td>medium</td>
</tr>
<tr>
<td>202.4.48.1</td>
<td>179</td>
<td>202.4.48.99</td>
<td>10000</td>
<td>medium</td>
</tr>
<tr>
<td>200.200.0.2</td>
<td>13232</td>
<td>200.200.0.1</td>
<td>646</td>
<td>medium</td>
</tr>
</tbody>
</table>

![Diagram showing LPTS, Socket, BGP, LDP, SSH, and TCP Handshake connections.](image)
IOS XR L3VPN
L3VPN Features

• Basic L3VPN
  PE-CE protocols: eBGP, OSPF, EIGRP, RIP, Static
  MPLS Transport for the core: LDP, RSVP-TE

• Inter-AS
  All options: Option A, B, & C

• Label Allocation Schemes
  Per-prefix, Per-CE, Per-VRF
  Per-prefix is the default allocation mode.

• Site Of Origin
• as-override
• remove private-as
• VRF prefix-limit
• allow-as in
• retain route-target
• …
Other Distinguishing Features of IOS XR

- Event based import processing
- Auto-RD—to automatically allocate RD
- Label allocation schemes
- Distributed BGP support
- Automatic trigger of Route-Refresh upon RT config change
- Integration of NHT
- Back to back VRFs
- MP-eBGP for VPNv4 address-family
- ipv4 labeled-unicast address-family
- next-hop-unchanged
- allocate-label
**VRF Configuration**

**Configuring PE/RR VPNV4 IBGP Neighbors**

```conf
router bgp 100
  bgp router-id 100.100.100.100
  address-family vpnv4 unicast
  neighbor 168.1.1.1
    remote-as 100
    address-family vpnv4 unicast
```

**Configuring the VRF in the Global Mode**

```conf
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**

```conf
interface g0/1/0/2
  vrf vpn1
  ipv4 address 1.1.1.2/24
```
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 vpnl-in in
          route-policy vpnl-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 rip
  vrf vpn1
    redistribute bgp 100 route-policy policy1
    interface g0/1/0/2
    site-of-origin 100:1

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

Configuring EBGP ipv4+label/Inter-AS Neighbors

```
router bgp 100
  bgp router-id 100.100.100.100
  address-family vpnv4 unicast
  neighbor 168.1.1.1
    remote-as 100
    address-family vpnv4 unicast
  neighbor 145.1.1.1
    remote-as 101
    address-family ipv4 label-unicast
      send-label route-policy label-policy

router bgp 100
  bgp router-id 100.100.100.100
  address-family ipv4 unicast
    allocate-label route-policy vpn1-label
  neighbor 1.1.1.1
    remote-as 65523
    address-family ipv4 labeled-unicast
      route-policy vpn1-label-in in
    address-family ipv4 unicast
      route-policy vpn1-in in
      route-policy vpn1-out out
```
Sample Configuration

DRP/0/2/CPU1:Rtr#sh run router bgp
router bgp 1
  bgp router-id 10.0.0.1
  address-family ipv4 unicast
  !
  address-family vpnv4 unicast
  !
neighbor-group v4-CE
  address-family ipv4 unicast
  route-policy pass-all in
  route-policy pass-all out
  !
neighbor-group v4-PE
  address-family vpnv4 unicast
  !
neighbor-group v4-EBGP
  address-family ipv4 unicast
  route-policy pass-all in
  route-policy pass-all out
  !
neighbor-group v4-IBGP
  address-family ipv4 unicast

neighbor 11.0.1.2
  remote-as 2
  use neighbor-group v4-EBGP
description ipv4 unicast EBGP
  !
neighbor 11.0.2.2
  remote-as 1
  use neighbor-group v4-IBGP
description ipv4 unicast IBGP
  !
neighbor 11.0.4.2
  remote-as 1
  use neighbor-group v4-PE
description vpnv4 unicast PE
  !
vrf t1
  rd auto
  bgp router-id 10.1.0.1
  address-family ipv4 unicast
  !
neighbor 11.0.3.2
  remote-as 1001
  use neighbor-group v4-CE
  !
L2VPN- E0MPLS PE Configuration

12vpn
  xconnect group Customer_A
  p2p VLAN
    interface GigabitEthernet0/1/0/1.5
    neighbor 20.0.0.5 pw-id 200

  xconnect group Customer_B
  p2p PORT
    interface GigabitEthernet0/1/0/0
    neighbor 20.0.0.5 pw-id 100

  interface GigabitEthernet0/1/0/0 12transport

  interface GigabitEthernet0/1/0/1.5 12transport
    dot1q vlan 5

  interface GigabitEthernet0/1/0/1.6 12transport
    dot1q vlan 10 20

  interface GigabitEthernet0/1/0/1.7 12transport
    dot1q vlan 10 any
IOS-XR Boot Images and Installation
IOS-XR Software Packages

- **IOS-XR Image:**
- **Base Image:**
  - Includes the following components:
    - OS
    - Admin
    - Forwarding (IPv4 / IPv6 Unicast)

- **PIEs (Package Installation Envelope):**
  - Unique PIE for each feature including
    - MPLS, Multicast, Manageability and Security

**IOS-XR Modular Packages**

<table>
<thead>
<tr>
<th>Optional</th>
<th>Multicast / MPLS / Security and Manageability PIEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPLS</td>
<td>Multicast</td>
</tr>
<tr>
<td>MPLS, UCP</td>
<td>PIM, MFIB, IGMP</td>
</tr>
<tr>
<td>Security</td>
<td>IPSec, Encryption, Decryption</td>
</tr>
<tr>
<td>Manageability</td>
<td>ORB, XML, Alarms management</td>
</tr>
</tbody>
</table>

**Core**

- **Base**
  - Interface manager,
  - System database, checkpoint services
  - Configuration management, etc.

- **Forwarding**
  - Platform independent
  - FIB, ARP, QoS, ACL, etc.

- **Line Card**
  - Platform Dependent
  - LC ucode & drivers

- **Admin**
  - Resource Management:
  - Rack, Fabric, LR management

- **OS:**
  - Kernel, file system, memory management, and other slow changing core

**Mandatory**

**Optional**
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 not traffic impacting (Hitless, non traffic impacting)
- SMU is named by release and bugid - Examples - hfr-rout-3.2.2.CSCei63263.pie

PIE?

Package?

Mini?

SMU?
### IOS-XR Boot Overview: CRS-1/ C12K Image Names

<table>
<thead>
<tr>
<th>Type</th>
<th>File Name</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bootable Image</td>
<td>comp-hfr-mini.vm-3.3.0</td>
<td>~ 65MB</td>
</tr>
<tr>
<td>Upgrade PIE Image</td>
<td>comp-hfr-mini.pie-3.2.0</td>
<td>~ 53MB</td>
</tr>
<tr>
<td>Optional PIEs</td>
<td>hfr-mcast.pie-3.2.0</td>
<td>~ 2.4MB</td>
</tr>
<tr>
<td></td>
<td>hfr-mgbl.pie-3.2.0</td>
<td>~ 9.6MB</td>
</tr>
<tr>
<td></td>
<td>hfr-mpls.pie-3.2.0</td>
<td>~ 2.4MB</td>
</tr>
<tr>
<td>Maintenance Updates</td>
<td>hfr-rout-p.pie-3.2.1 (Example)</td>
<td>Variable</td>
</tr>
<tr>
<td>Software Maintenance Update (SMU)</td>
<td>hfr-os-mbi-3.2.0.CSCe07321-1.0.0</td>
<td>Variable</td>
</tr>
<tr>
<td></td>
<td>c12k-mini.vm-3.3.0</td>
<td>~ 90 MB</td>
</tr>
<tr>
<td></td>
<td>mbiprp-rp.vm-3.3.0</td>
<td>~ 10 MB</td>
</tr>
<tr>
<td>Optional PIEs</td>
<td>c12k-mcast.pie-3.2.0</td>
<td>~ 2.4MB</td>
</tr>
<tr>
<td></td>
<td>c12k-mgbl.pie-3.2.0</td>
<td>~ 9.6MB</td>
</tr>
<tr>
<td></td>
<td>c12k-mpls.pie-3.2.0</td>
<td>~ 2.4MB</td>
</tr>
<tr>
<td></td>
<td>c12k-k9sec.pie-3.3.0</td>
<td>~ 1.3MB</td>
</tr>
<tr>
<td>Software Maintenance Update (SMU)</td>
<td>c12k-os-mbi-3.2.0.CSCe07321-1-1.0.0</td>
<td>Variable</td>
</tr>
</tbody>
</table>
PIE: Package Installation Envelope

- PIEs are a delivery mechanism for packages
  - Used to deliver
    - Major release – New functionality (3.8, 3.9, 4.0)
    - Maintenance release – SW fixes (3.8.1, 3.8.2)
    - SMU – Fix for a specific bug

- Includes authentication info

- Installed from IOS XR admin mode

- .vm files are the other delivery mechanism
  - .vm files are bootable images
  - Used as the Initial Install for GSR migration
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
Install add Command
Copy Image to Disk, Verify, and Unpack

RP/0/0/CPU0:P4(admin)#install add tftp://172.21.116.8/c12k-mcast.pie-3.2.85.3I

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-3.2.85.3I to disk0:' assigned request id: 3
Install 3: [  1%] Downloading PIE file from /tftp://172.21.116.8/c12k-mcast.pie-3.2.85.3I
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-3.2.85.3I' 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-3.2.85
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:P4(admin)#install activate disk0:c12k-mcast-3.2.85
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...
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-3.2.85' 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-3.2.85
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:P5(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
Deactivating Packages

RP/0/0/CPU0:P5(admin)#install deactivate disk0:c12k-rp-mgb1-3.2.85
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-mgb1-3.2.85' assigned request id: 8
Install 8: [ 1%] Package 'disk0:c12k-mgb1-3.2.85' 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
General Differences Between Cisco IOS and Cisco IOS XR

Otázky a odpovědi

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  2.den 16:30 – 17:00
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