智慧生活
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亞太電信

IOS XR

2016/7/1

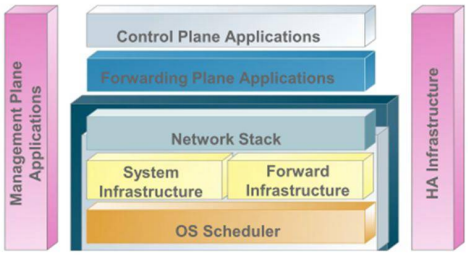
IOS XR Routers

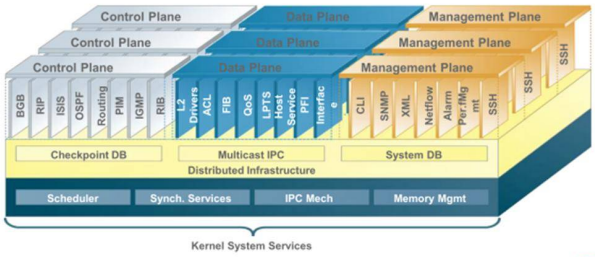
Carrier Routing System (CRS)

Network Convergence System (NCS)

Aggregation Services Router (ASR) 9000

Evolution of Router OS





IOS	IOS XR
Monolithic Kernel	Micro Kernel
Run to Completion Scheduler	Preemptive Multitasking
Centralized Infrastructure	Distributed Infrastructure
Centralized applications	Distributed applications
Everything has hardware access	Limited access to hardware

Established 2004

8

IOS XR's Software Packaging

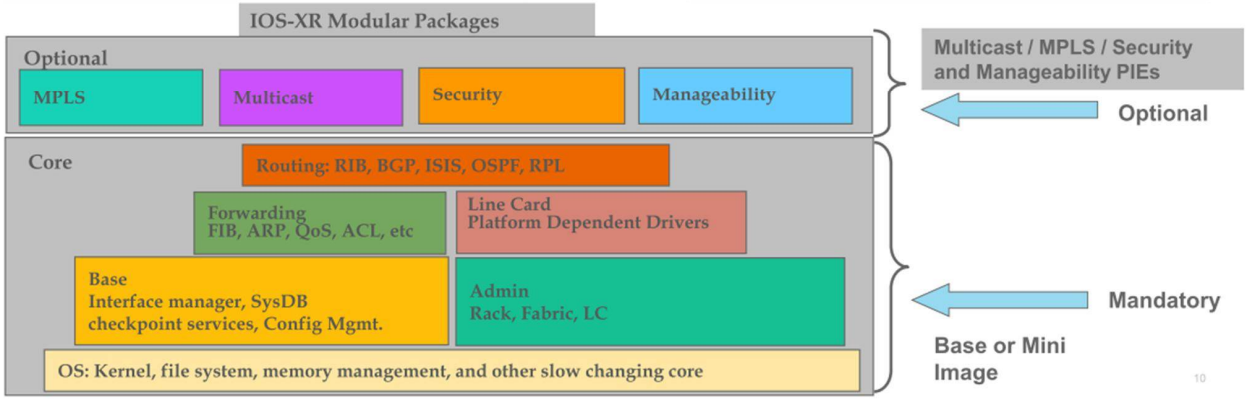
- Does not use a single file
- Package Installation Envelopes (PIEs) are a delivery mechanism for packages.
- The 'mini' is the core composite package that contains mandatory software to boot IOS XR

PIE?

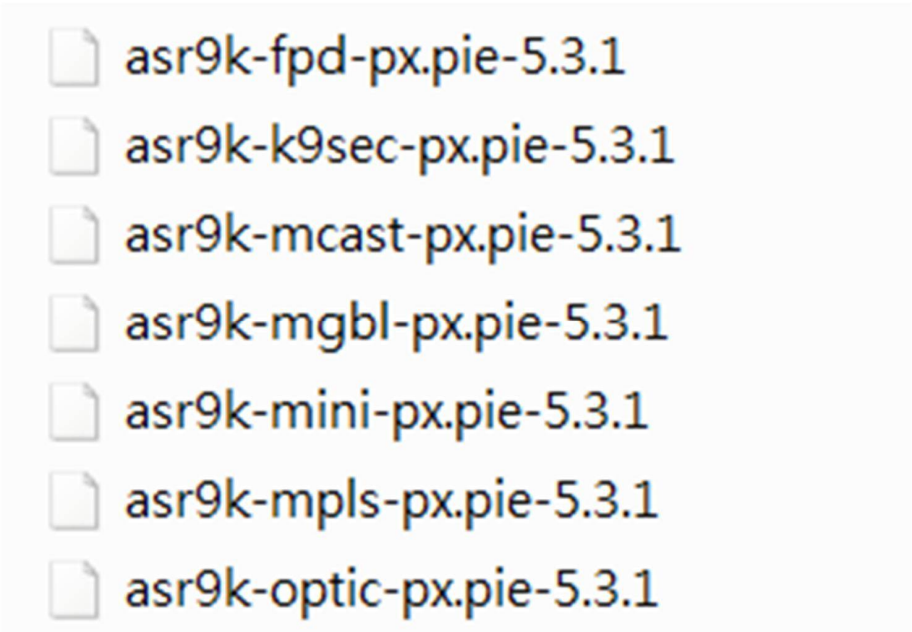
IOS-XR Software Packages

- 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, Documenation, Diagnostics



Example



IOS XR Versioning

- **Major release – New functionality (4.2, 4.3, 5.1, 5.2, etc.)**
- **Maintenance release – SW fixes (5.2.0, 5.2.1, 5.2.2)**
- **There are not any special S, T, J, or XT trains; special functionality is added through packages.**

IOS XR EMR – Extended Maintenance Release

- Bug fix only release
- Concentrated testing on features with high CFD & SRs
- Focused bug backlog reduction
- Significantly lower or no bug collaterals
- Higher quality image from each branch
- SMUs fully integrated from x.0/x.1 releases
- Field feedback incorporated
- Extended support

Software Feature Release	4.3	5.1	5.2	5.3
SMR (24 months)	4.3.0	5.1.0	5.2.0	5.3.0
	4.3.1	5.1.1	5.2.2	5.3.1
	4.3.2	5.1.2	5.2.4	5.3.2
EMR (36 months)	**4.3.4**	**5.1.3**		**5.3.3**

PIE Installation Concepts

- PIEs can be added, upgraded, or removed.
- Three phases of PIE installation
  - **Add** : Copies the package file to the local storage and unpacks the files
  - **Activate** :Installs the new code by restarting processes/nodes with new code
  - **Commit** : Locks the activated code to sustain reloads

Removing a PIE

Three phases of removing a PIE

1. **DeActivate** – Removes the code from runtime
2. **Commit** – Locks the code change to sustain reloads
3. **Delete** – Removes unused packages from the local storage

Software Maintenance Upgrade (SMUs)

- Patches for urgent issues for a specific code release and platform
- Fix integrated into the subsequent IOS XR maintenance release.
- Corrects defects only.
- SMU is named by release and bugid - Examples - hfr-px-5.2.1.CSCue55783.pie

XR Install

TURBOBOOT

Demo:

TURBOBOOT=on,disk0,format
IP_ADDRESS=10.1.1.1
IP_SUBNET_MASK=255.255.255.0
DEFAULT_GATEWAY=10.1.1.2
TFTP_BLKSIZE=1024
rommon 35 > boot tftp://10.1.1.2/hfr-mini-px.vm-4.1.2
USB: boot usb://xxxx.vm-4.1.2

Install Mode

1. RP/0/RSP0/CPU0:ASR-1(admin)#install add source tftp://124.74.212.29 asr9k-mini-p.pie-4.2.1 asr9k-k9sec-p.pie-4.2.1 asr9k-mcast-p.pie-4.2.1 asr9k-mgbl-p.pie-4.2.1 asr9k-doc-p.pie-4.2.1 asr9k-mpls-p.pie-4.2.1 sync (this can be done before Upgrade)
2. RP/0/RSP0/CPU0:ASR-1(admin)#install activate disk0:*4.2.1* sync
3. After system reload, Install SMU and Upgrade FPD

Protected Memory Space For Processes

Each process has a virtual memory space

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

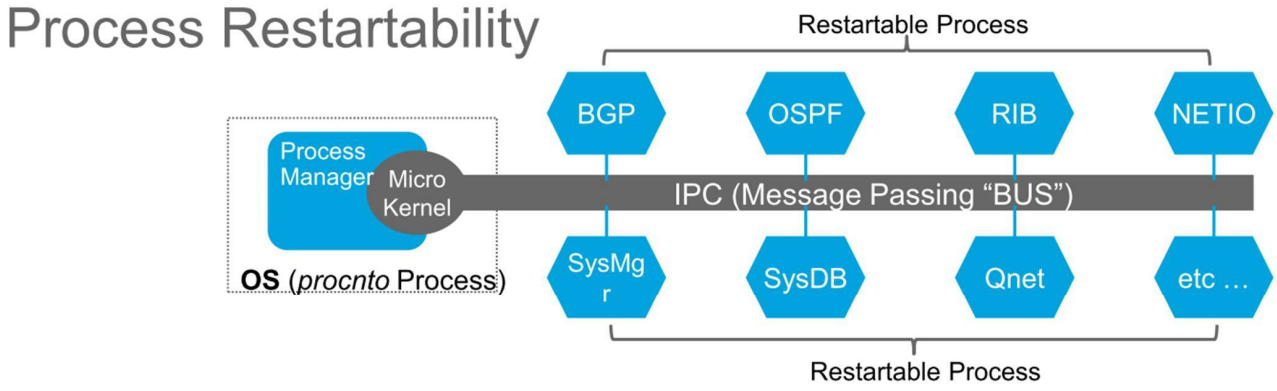
One process cannot corrupt another's process's memory

- Process can only access virtual space

IOS processes share same memory space

through aliasing. Possible for one process to corrupt another process's memory

Process Restartability

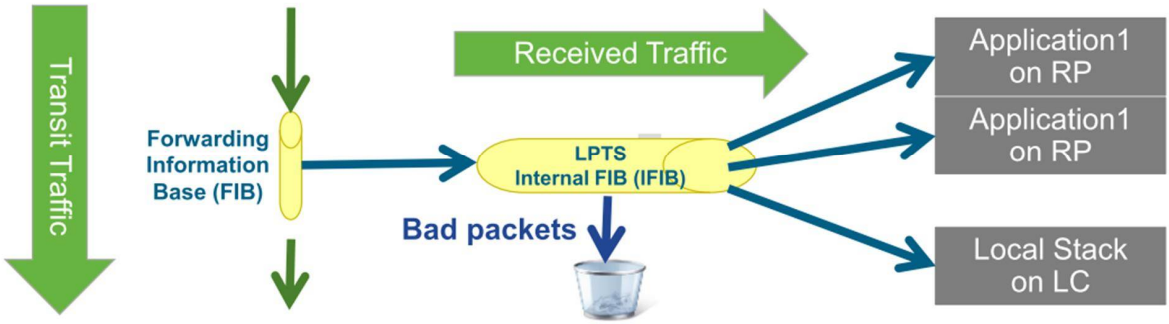


- Used for containing small faults or process failures
- All processes outside the microkernel process manager are individually restartable.
- If any of the processes, including SysMgr, SysDB, BGP, or Qnet, is restarted it does not cause the entire system to reload.
- Certain processes are '**mandatory**' – must always be running. Failure of mandatory processes can cause RP failover

Local Packet Transport Services (LPTS)

- Equivalent to CoPP but MUCH better
- Responsible for delivery of data destined for a router.
- Does not apply to transit or IPC traffic
- Enables delivery of data to distributed processes across the system hardware (RPs, LCs)

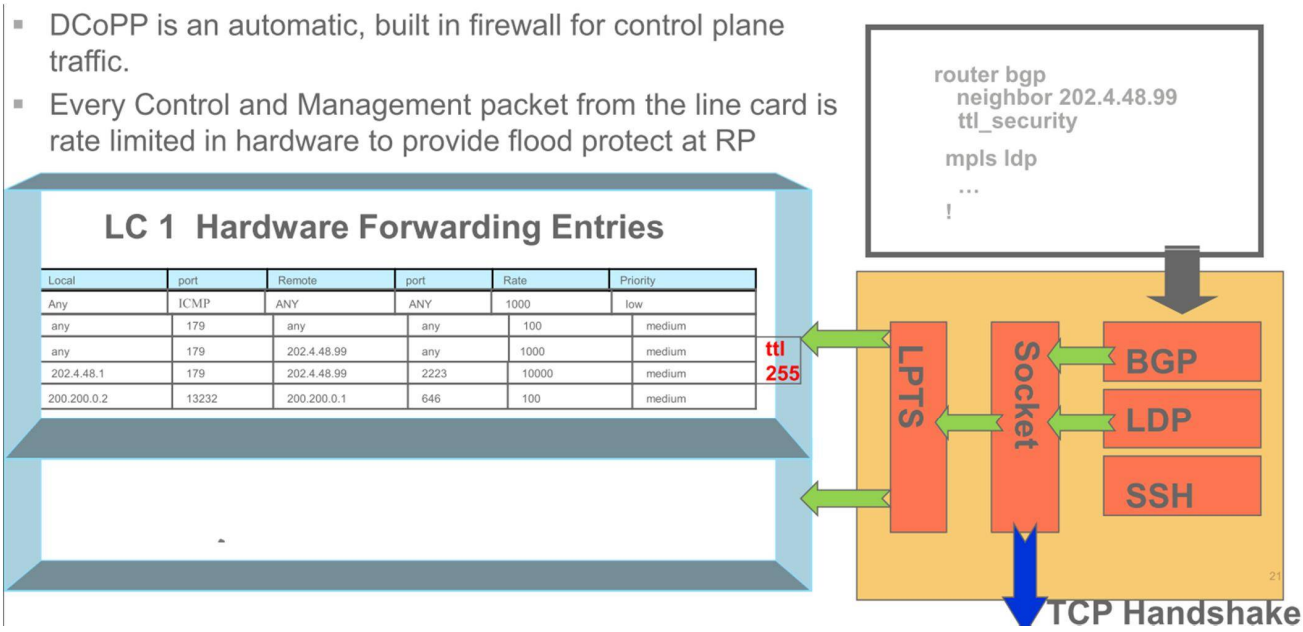
Local Packet Transport Services (LPTS)



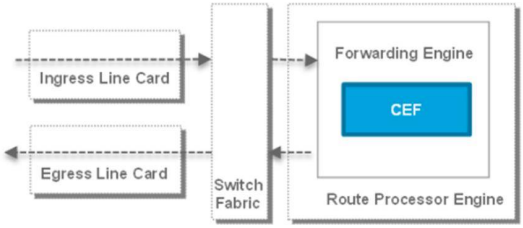
- LPTS is transparent and automatic
- LPTS acts as an dynamic internal firewall to protects router resources
  - Rules are dynamically built based upon control plane flows

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



Router Forwarding Architectures: Centralized



- Forwarding Engine (FE) resides on the route processor (RP)
- Packets received on a line card are forwarded to the forwarding engine (on route processor) for destination lookup.
- Packets are then forwarded to the appropriate LC for egress
- Packets on are sent to FE even if they the ingress and egress ports are on the same LC.
- Not efficient or scalable

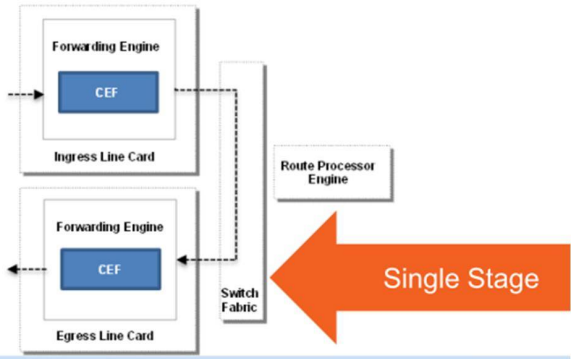
Router Forwarding Architectures: Single-Stage Distributed

LC1 Forwarding Engine Table

Destination Network	Out Int	Next-Hop IP	Next-Hop MAC	Outbound MAC
10.10.10.0/24	Gi 2/0	10.1.1.1	00:10:00:C1:5C:01	00:10:00:00:11:01
10.20.20.0/24	Gi 1/0	10.2.2.2	00:10:00:C1:5C:02	00:10:00:00:11:02

LC2 Forwarding Engine Table

Destination Network	Out Int	Next-Hop IP	Next-Hop MAC	Outbound MAC
10.10.10.0/24	Gi 2/0	10.1.1.1	00:10:00:C1:5C:01	00:10:00:00:11:01
10.20.20.0/24	Gi 1/0	10.2.2.2	00:10:00:C1:5C:02	00:10:00:00:11:02



- Route processor programs forwarding engine based upon routing protocols
- Forwarding Engine (FE) resides on the line cards. Contains all the routes, next-hops, and outbound IP addresses
- Ingress line card performs destination lookup.
- Packets are sent out on the fabric only if the egress port is on a different LC. Packets are locally forwarded if the ingress and egress ports are on the same LC.

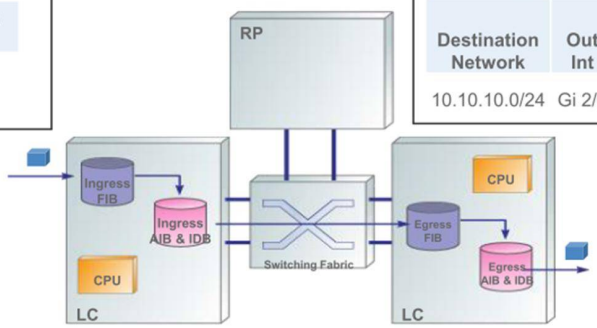
Router Forwarding Architectures: Two-Stage Distributed

LC1 Ingress FE Table

Destination Network	Out LC
10.10.10.0/24	2
10.20.20.0/24	1

LC2 Egress FE Table

Destination Network	Out Int	Next-Hop IP Address	Next-Hop MAC	Outbound MAC
10.10.10.0/24	Gi 2/0	10.1.1.1	00:10:00:C1:5C:01	00:10:00:00:11:01



Required for IOS XR

Two stage forwarding(Distributed)

- Each line card has two forwarding engines: Ingress and Egress
- Ingress forwarding engine contains destination networks and destination LC
- Egress forwarding engine maintains AIB & IDB for networks attached to it. Egress FE Identifies next-hop, re-writes MAC address, etc

IDB, or interface descriptor block, is Cisco terminology for a special control structure internal to the IOS that contains all the information on any given interface.

CLI Modes

There is no user mode prompt

```
IOS>
```

Executive mode

(Protocol Configuration)

```
RP/0/0/CPU0:IOS-XR#config t
RP/0/0/CPU0:IOS-XR(config)#
```

Admin Mode

(Platform Power and Software Version)
(Package Installation/Upgrade/Removal)

```
RP/0/0/CPU0:IOS-XR#admin
RP/0/0/CPU0:IOS-XR(admin)#
```

CLI Parsing Utilities

```
RP/0/RP0/CPU0:CRS-D#show run | ?
  begin    Begin with the line that matches
  exclude  Exclude lines that match
  file     Save the configuration
  include  Include lines that match
  utility  A set of common unix utilities
```

CLI Parsing Utilities

```
RP/0/RP0/CPU0:CRS-D#show run | utility ?
  cut      Cut out selected fields of each line of a file
  egrep    Extended regular expression grep
  fgrep    Fixed string expression grep
  head     Show set of lines/characters from the top of a file
  less     Fixed string pattern matching
  more     Paging Utility More
  script   Launch a script for post processing
  sort     Sort, merge, or sequence-check text files
  tail     Copy the last part of files
  uniq     Report or filter out repeated lines in a file
  wc       Counting lines/words/characters of a file
  xargs    Construct argument list(s) and invoke a program
```

RegEx Queries

```
RP/0/RP0/CPU0:CRS1#show processes  cpu | exclude  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#show processes cpu | exclude " 0%|ce_"
CPU utilization for one minute: 2%; five minutes: 2%; fifteen minutes: 2%

PID    1Min    5Min    15Min Process
131106   1%      1%       1% eth_server
```

Multi pipe support

- Support multiple pipes on the command line so that the output can be processed by
- multiple parsers with the output of any show command.
- Up to 8 pipes are supported.
- Support for Include, Exclude and Regex all at the same time

```
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: mpls_ldp[1038]: %ROUTING-LDP-5-NBR_CHANGE : Neighbor 10.1.1.1:0, DOWN
       (Interface state down)
RP/6/RP0/CPU0:Jan 3 17:10:58: mpls_ldp[1038]: %ROUTING-LDP-5-NBR_CHANGE : Neighbor 10.1.1.1:0, UP
```

IOS-XR Interface Format

New CLI reflects the HW position in the system

- Introduces the Hierarchical location scheme
- Interfaces have the Rack/Shelf/(Slot/Bay)/Interface scheme

Protocol referenced by address family type – v4/v6

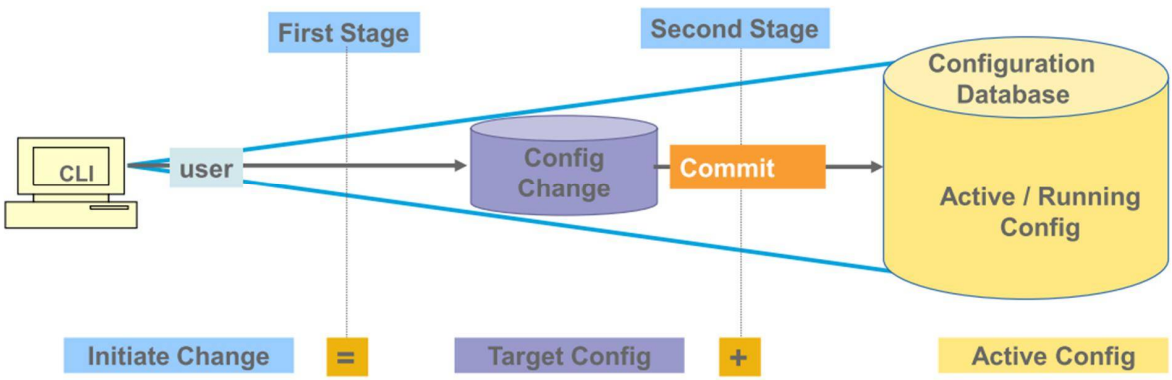
```
RP/0/0/CPU0:CRS1#show ipv4 interface brief

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

Differences in IOS XR's Configuration Management

- IOS-XR's configuration is held in a System DB (SysDB)

  There is not a startup-config
- Router configuration is based on two stage configuration model.
- The "running" or "active" configuration can not be modified directly.
- User makes changes to a Target Configuration for the staging of all the changes.
- Supports pre-configuration of hardware
- The Target Configuration must be explicitly Commited to the active configuration (second stage) which applies the changes to the running-config.

IOS-XR CLI: Two Stage Configuration Model



Target Configuration

```
RP/0/0/CPU0:ios#conf terminal
RP/0/0/CPU0:ios(config)#hostname XR1
RP/0/0/CPU0:ios(config)#cdp
RP/0/0/CPU0:ios(config)#int gigabitEthernet 0/0/0/0
RP/0/0/CPU0:ios(config-if)#cdp
RP/0/0/CPU0:ios(config-if)#int gigabitEthernet 0/0/0/1
RP/0/0/CPU0:ios(config-if)#cdp

RP/0/0/CPU0:ios(config-if)#show configuration
Building configuration...
hostname XR1
cdp
interface GigabitEthernet0/0/0/0
 cdp
!
interface GigabitEthernet0/0/0/1
 cdp
!
End
```

Nothing has been processed to the running-configuration

This is the target configuration

Commit'ng the Change

- The target configuration is checked for validity. It is applied all at once to the running-configuration.
- If an invalid configuration is found, the commit will fail
- All successful commits are given a Commit-ID and is stored in the SysDB

```
RP/0/0/CPU0:ios(config-if)#commit
RP/0/0/CPU0:Sep 21 00:26:25.360 : config[66391]: %MGBL-CONFIG-6-DB_COMMIT : Configuration
committed by user 'JCHAMBR'.  Use 'show configuration commit changes 1000000638' to view
the changes.
RP/0/0/CPU0:XR1(config-if)#
```

IOS-XR CLI: Config error handling

Commit error

- None of the configuration is applied to the running-configuration
- Syntactically correct but 'invalid' from configuration commit standpoint
- Error details viewed through "show configuration failed" command

```
RP/0/0/CPU0:CRS1#configuration term
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)#
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)#
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
```

Viewing of List of Commit-IDs in SysDB

```
RP/0/0/CPU0:XR1#show configuration commit list
No. Label/ID    User      Line                 Client   Time Stamp
~~~ ~~~~~~~~    ~~~~      ~~~~                 ~~~~~~   ~~~~~~~~~~
1    1000000038 JCHAMBR   vty3:node0_0_CPU0    CLI      Fri May 13 11:06:35 2015
2    1000000037 KJOHNS    vty3:node0_0_CPU0    CLI      Fri May 13 11:05:33 2015
3    1000000036 BEDGEW    vty3:node0_0_CPU0    CLI      Fri May 13 11:00:41 2015
4    1000000035 MOALI     vty3:node0_0_CPU0    CLI      Fri May 13 10:59:39 2015
5    1000000034 JCHAMBR   vty3:node0_0_CPU0    CLI      Tue Apr 27 15:08:04 2015
6    1000000033 KJOHNS    vty1:node0_0_CPU0    CLI      Tue Mar 16 15:32:27 2015
7    1000000032 MOALI     vty3:node0_0_CPU0    CLI      Mon Mar 15 16:22:54 2015
8    1000000031 BEDGEW    vty3:node0_0_CPU0    CLI      Mon Mar 15 16:21:14 2015
```

Viewing List of Configuration Changes in SysDB

```
RP/0/0/CPU0:XR1#show configuration commit changes 1000000025
Building configuration...
!
no route-policy RPL-L3-IPv4-IN-BETA
end
```

```
RP/0/0/CPU0:XR1#show configuration commit changes last 3
Building configuration...
no cdp
!
no interface Loopback0
!
no router ospf 1
end
```

Configuration Rollback

- Allows the configuration to be rolled back a # of changes or restores the configuration to a specific point of time.
- Configuration rollback is considered a change.
- It is possible to view the list of changes being made before issuing a rollback

```
RP/0/0/CPU0:XR1-COMMITREPLACE#rollback configuration last 3
Loading Rollback Changes.
Loaded Rollback Changes in 1 sec
Committing..
10 items committed in 2 sec (4)items/sec
Updating.
Updated Commit database in 1 sec
Configuration successfully rolled back 3 commits.
RP/0/0/CPU0:XR1#
RP/0/0/CPU0:XR1#show configuration commit list
SNo. Label/ID    User      Line             Client      Time Stamp
~~~~ ~~~~~~~~    ~~~~      ~~~~             ~~~~~~      ~~~~~~~~~~
1    1000000021  JCHAMBR   con0_0_CPU0      Rollback    Fri May 20 16:37:10 2015
2    1000000020  JCHAMBR   con0_0_CPU0      CLI         Fri May 20 16:08:57 2015
```

Show configuration commit list

```
RP/0/0/CPU0:ios(config)#int loopback 0
RP/0/0/CPU0:ios(config-if)#ipv4 address 1.1.1.1 255.255.255.255
RP/0/0/CPU0:ios(config-if)#commit
Tue Dec  8 09:44:22.934 UTC
```

commit changes 1000000001

```
RP/0/0/CPU0:ios(config)#snmp-server community public ro
RP/0/0/CPU0:ios(config)#commit
Tue Dec  8 09:45:07.881 UTC
RP/0/0/CPU0:ios(config)#exit
```

commit changes 1000000002

```
RP/0/0/CPU0:ios(config)#hostname XRv01
RP/0/0/CPU0:ios(config)#commit
Tue Dec  8 09:45:58.478 UTC
RP/0/0/CPU0:XRv01(config)#end
```

commit changes 1000000003

```
RP/0/0/CPU0:XRv01#show configuration commit list
Tue Dec  8 09:55:46.807 UTC
SNo. Label/ID             User      Line                Client      Time Stamp
~~~~ ~~~~~~~~             ~~~~      ~~~~                ~~~~~~      ~~~~~~~~~~
1    1000000003           michael   con0_0_CPU0         CLI         Tue Dec  8 09:45:58 2015
2    1000000002           michael   con0_0_CPU0         CLI         Tue Dec  8 09:45:07 2015
3    1000000001           michael   con0_0_CPU0         CLI         Tue Dec  8 09:44:22 2015
```

Show configuration commit changes

```
RP/0/0/CPU0:XRv01#show configuration commit changes 1000000003
Tue Dec  8 09:56:37.364 UTC
Building configuration...
!! IOS XR Configuration 5.3.2
hostname XRv01
end

RP/0/0/CPU0:XRv01#show configuration commit changes 1000000002
Tue Dec  8 09:56:38.614 UTC
Building configuration...
!! IOS XR Configuration 5.3.2
snmp-server community public RO
end

RP/0/0/CPU0:XRv01#show configuration commit changes 1000000001
Tue Dec  8 09:56:40.114 UTC
Building configuration...
!! IOS XR Configuration 5.3.2
interface Loopback0
 ipv4 address 1.1.1.1 255.255.255.255
!
end
```

Show configuration roolback changes to

```
RP/0/0/CPU0:XRv01#show configuration rollback changes to 1000000003
Tue Dec  8 09:57:31.470 UTC
Building configuration...
!! IOS XR Configuration 5.3.2
no hostname XRv01
end

RP/0/0/CPU0:XRv01#show configuration rollback changes to 1000000002
Tue Dec  8 09:57:33.930 UTC
Building configuration...
!! IOS XR Configuration 5.3.2
no hostname XRv01
no snmp-server community public RO
end

RP/0/0/CPU0:XRv01#show configuration rollback changes to 1000000001
Tue Dec  8 09:57:35.610 UTC
Building configuration...
!! IOS XR Configuration 5.3.2
no hostname XRv01
no snmp-server community public RO
no interface Loopback0
end
```

Show configuration rollback changes last

```
RP/0/0/CPU0:XRv01#show configuration rollback changes last 3
Tue Dec  8 10:01:40.443 UTC
Building configuration...
!! IOS XR Configuration 5.3.2
no hostname XRv01
no snmp-server community public RO
no interface Loopback0
end

RP/0/0/CPU0:XRv01#show configuration rollback changes last 2
Tue Dec  8 10:01:41.853 UTC
Building configuration...
!! IOS XR Configuration 5.3.2
no hostname XRv01
no snmp-server community public RO
end

RP/0/0/CPU0:XRv01#show configuration rollback changes last 1
Tue Dec  8 10:01:43.213 UTC
Building configuration...
!! IOS XR Configuration 5.3.2
no hostname XRv01
end
```

Rollback

```
RP/0/0/CPU0:XRv01#rollback configuration last 3
Tue Dec  8 10:05:13.359 UTC

Loading Rollback Changes.
Loaded Rollback Changes in 1 sec
Committing.
5 items committed in 1 sec (4)items/sec
Updating.
Updated Commit database in 1 sec
Configuration successfully rolled back 3 commits.
RP/0/0/CPU0:ios#show configuration commit list
Tue Dec  8 10:07:29.959 UTC
SNo. Label/ID              User      Line                Client      Time Stamp
~~~~ ~~~~~~~~              ~~~~      ~~~~                ~~~~~~      ~~~~~~~~~~
1    1000000004            michael   con0_0_CPU0         Rollback    Tue Dec  8 10:05:14 2015
2    1000000003            michael   con0_0_CPU0         CLI         Tue Dec  8 09:45:58 2015
3    1000000002            michael   con0_0_CPU0         CLI         Tue Dec  8 09:45:07 2015
4    1000000001            michael   con0_0_CPU0         CLI         Tue Dec  8 09:44:22 2015
RP/0/0/CPU0:ios#
```

Check rollback - No loopback interface

```
RP/0/0/CPU0:ios#sho ip int brief
Tue Dec  8 10:10:17.118 UTC

Interface                      IP-Address      Status                Protocol
MgmtEth0/0/CPU0/0              unassigned      Shutdown              Down
GigabitEthernet0/0/0/0         unassigned      Shutdown              Down
GigabitEthernet0/0/0/1         unassigned      Shutdown              Down
GigabitEthernet0/0/0/2         unassigned      Shutdown              Down
GigabitEthernet0/0/0/3         unassigned      Shutdown              Down
GigabitEthernet0/0/0/4         unassigned      Shutdown              Down
GigabitEthernet0/0/0/5         unassigned      Shutdown              Down
GigabitEthernet0/0/0/6         unassigned      Shutdown              Down
```

Commit Confirmed

- 1st Commit is a Trial.
- Initiates an automatic rollback if the trial commit is not committed a 2 nd time.
- Ensures that a change does as it is supposed to.
- Helps prevent lockouts!!!

```
RP/0/0/CPU0:XR1(config)#hostname XR1-COMMIT-CONFIRM
RP/0/0/CPU0:XR1(config)#commit confirmed 30
RP/0/0/CPU0:Sep 16 13:46:53.374 : config[66625]: %MGBL-CONFIG-6-DB_COMMIT : Configuration
  committed by user 'BEDGEW'. Use 'show configuration commit changes 1000000042' to view
  the changes.
RP/0/0/CPU0:XR1-COMMIT-CONFIRM(config)#
RP/0/0/CPU0:Sep 16 13:47:24.075 : cfgmgr_trial_confirm[66653]: %MGBL-CONFIG-6-DB_COMMIT :
  Configuration committed by user 'BEDGEW'. Use 'show configuration commit changes
  1000000043' to view the changes.
RP/0/0/CPU0:XR1(config)#

RP/0/0/CPU0:XR1#show configuration commit list
Mon May 16 13:59:44.908 EDT
SNo. Label/ID    User      Line                Client      Time Stamp
~~~~ ~~~~~~~~    ~~~~      ~~~~                ~~~~~~      ~~~~~~~~~~
1    1000000043  BEDGEW    vty3:node0_0_CPU0   Rollback    Mon May 16 13:47:23 2015
2    1000000042  BEDGEW    vty3:node0_0_CPU0   CLI         Mon May 16 13:46:53 2015
```

Commit Confirmed

2nd Commit does not register as a change

```
RP/0/0/CPU0:XR1(config)#hostname XR1-COMMIT-CONFIRM
RP/0/0/CPU0:XR1(config)#commit confirmed 30
RP/0/0/CPU0:Sep 16 13:51:47.414 : config[66850]: %MGBL-CONFIG-6-DB_COMMIT : Configuration
  committed by user 'BEDGEW'. Use 'show configuration commit changes 1000000044' to view
  the changes.
RP/0/0/CPU0:XR1-COMMIT-CONFIRM(config)#
RP/0/0/CPU0:XR1-COMMIT-CONFIRM(config)#commit
% Confirming commit for trial session.
RP/0/0/CPU0:XR1-COMMIT-CONFIRM(config)#exit
RP/0/0/CPU0:XR1-COMMIT-CONFIRM#
RP/0/0/CPU0:XR1-COMMIT-CONFIRM#show configuration commit list
SNo. Label/ID    User      Line                Client      Time Stamp
~~~~ ~~~~~~~~    ~~~~      ~~~~                ~~~~~~      ~~~~~~~~~~
1    1000000044  BEDGEW    vty3:node0_0_CPU0   CLI         Mon May 16 13:51:47 2015
2    1000000043  BEDGEW    vty3:node0_0_CPU0   Rollback    Mon May 16 13:47:23 2015
3    1000000042  BEDGEW    vty3:node0_0_CPU0   CLI         Mon May 16 13:46:53 2015
```

Trace functionality

- Trace functionality is a form of ‘always-on’ debug without performance hit
- Circular logging
- Built-In to almost every component of IOS XR

Trace functionality

```
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
```

Trace functionality (continued)

```
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

```
RP/0/0/CPU0:ios#monitor Interface
Tue Dec  8 09:34:18.326 UTC

IOS-XR                Monitor Time: 00:00:30          SysUptime: 272:43:01

Protocol:General
Interface              In(bps)       Out(bps)      InBytes/Delta  OutBytes/Delta
Gi0/0/0/0                  0/  0%         0/  0%         0/0             0/0
Gi0/0/0/1                  0/  0%         0/  0%         0/0             0/0
Gi0/0/0/2                  0/  0%         0/  0%         0/0             0/0
Gi0/0/0/3                  0/  0%         0/  0%         0/0             0/0
Gi0/0/0/4                  0/  0%         0/  0%         0/0             0/0
Gi0/0/0/5                  0/  0%         0/  0%         0/0             0/0
Gi0/0/0/6                  0/  0%         0/  0%         0/0             0/0
Mg0/0/CPU0/0               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')
```

Process Management

Process

- An executable portion of code run within its own memory space
- 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
- Processes can be viewed or restarted by name or JID on a system level or for a specific LC

Threads

- A process may contain one or more threads or a 'sub-process'. e.g. OSPF process has a thread which handles 'hellos'.
- Each thread is assigned a PID#. The PID changes if the process is stopped and restarted

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
                 Respawn: ON
           Respawn count: 1
            Last started: Mon May  9 15:32:22 2015
           Process state: Killed (last exit status: 15)
                   Ready: 11.636s
```

Process state reported as 'killed'

```
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
                 Respawn: ON
           Respawn count: 2
            Last started: Thu May 12 11:46:38 2015
           Process state: Run (last exit status : 15)
                   Ready: 6.657s
```

JID# remains constant, PID# changed on restart

Respawn counter incremented with process restart

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

Monitor processes

```
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
```

t - Sort on CPU time

m - Sort on memory usage

‘Show tech’ command

```
RP/0/RP0/CPU0:CRS1# show tech-support snmp file harddisk:sh_tech_snmp
++ Show tech start time: 2015-Jan-22.090643.UTC ++
Wed Jan 22 09:06:44 UTC 2015 Waiting for gathering to complete
.....................................................................
Wed Jan 22 09:10:24 UTC 2015 Compressing show tech output
Show tech output available at 0/RP0/CPU0 : harddisk:/demo_sh_tech.tgz
++ Show tech end time: 2015-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 2015  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
```

IOS-XR Protocol Configuration

IOS XR

- **Protocol configuration exists:**
  - **Only within the protocol**
  - **Hierarchical**
  - **Avoids having to scroll back and forth in the configuration**

Configuring Static Routes

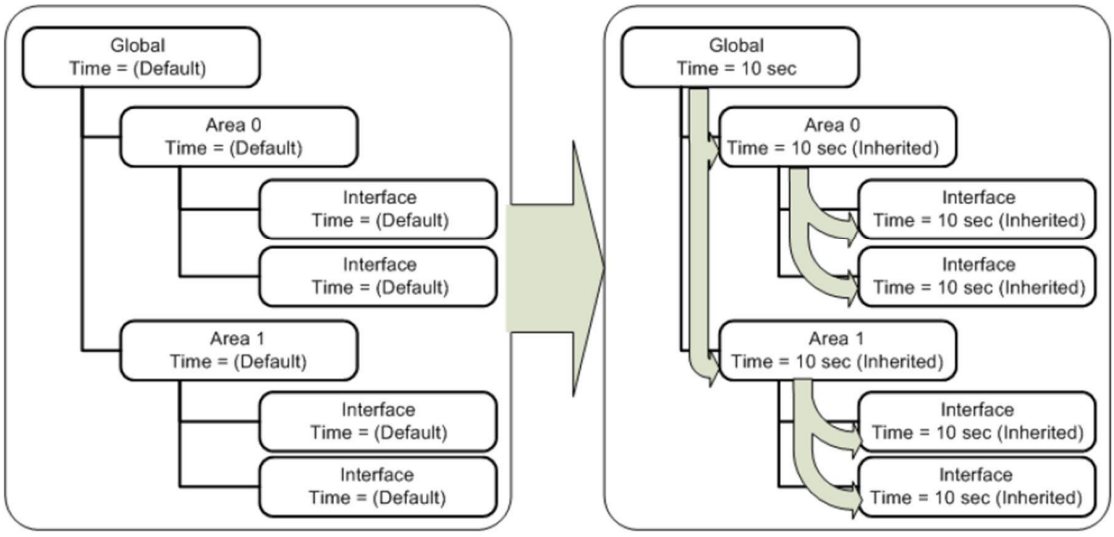
```
router static
 address-family ipv4 unicast
  192.168.1.0/24 Serial0/0/0/0
  192.168.2.0/24 1.2.3.4
!
 address-family ipv6 unicast
  fec0:1234::3/64 fec0::88
```

Configuring OSPF

```
router ospf 1
 area 0
  interface GigabitEthernet0/0/0/0
  !
  interface GigabitEthernet0/0/0/1
  !
 !
 area 2
  interface GigabitEthernet0/0/0/2
  !
  interface GigabitEthernet0/0/0/3
  !
 !
!
```

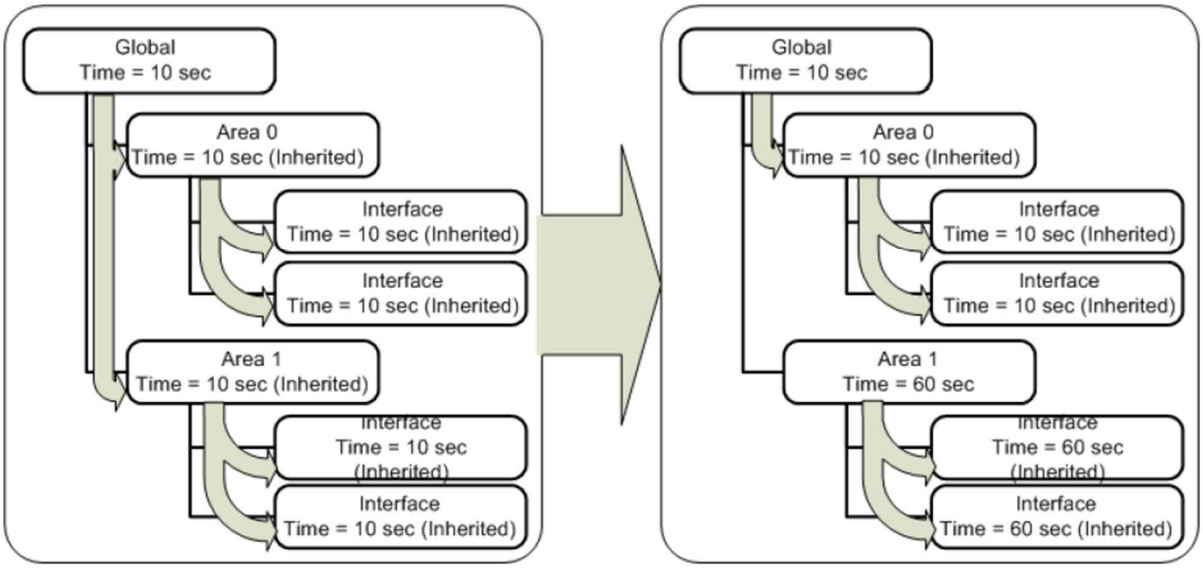
OSPF Hierarchical Configuration

Settings at higher levels are inherited at lower levels



Protocol Pre-emption

Configuration at lower level pre-empts global configuration



Configuring OSPF Features

```
router ospf 1
 authentication message-digest
 message-digest-key 1 md5 CISCO
 network point-to-point
 area 0
  cost 100
  interface GigabitEthernet0/0/0/0
  !
  interface GigabitEthernet0/0/0/1
  !
 !
 area 2
  cost 2000
  interface GigabitEthernet0/0/0/2
  !
  interface GigabitEthernet0/0/0/3
   cost 9999
```

OSPF Side-By-Side Comparison to IOS with Inheritance

IOS XR

```
router ospf 1
 authentication message-digest
 message-digest-key 1 md5 CISCO
 network point-to-point
 area 0
  cost 100
  interface GigabitEthernet0/0/0/0
  !
  interface GigabitEthernet0/0/0/1
  !
 !
 area 2
  cost 2000
  interface GigabitEthernet0/0/0/2
  !
  interface GigabitEthernet0/0/0/3
   cost 9999
```

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 999
```

OSPF Verification Commands

```
RP/0/0/CPU0:XR1#show ospf interface brief

Interfaces for OSPF 1

Interface          PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0                1     0               192.168.1.1/32     1     LOOP  0/0
Gi0/0/0/0          1     0               10.1.1.1/24        1     DR    0/0
Gi0/0/0/2          1     0               10.123.4.1/24      1     DROTH 2/3
```

```
RRP/0/0/CPU0:XR1#show ospf neighbor
Neighbors for OSPF 1

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.2.2     1     2WAY/DROTHER    00:00:32    10.123.4.2      GigabitEthernet0/0/0/2
    Neighbor is up for 00:46:45
192.168.3.3     1     FULL/BDR        00:00:35    10.123.4.3      GigabitEthernet0/0/0/2
    Neighbor is up for 00:49:55

Total neighbor count: 2
```

Bridging the Gap

alias "show ip ospf" show ospf

Configuring IS-IS

```
router isis ISIS
 net 49.1234.0000.0000.0001.00
 log adjacency changes
 interface GigabitEthernet0/0/0/0
  address-family ipv4 unicast
  !
 !
 interface GigabitEthernet0/0/0/1
  address-family ipv4 unicast
  !
 !
!
```

Configuring IS-IS Features

```
router isis ISIS
 net 49.1234.0000.0000.0001.00
 log adjacency changes
 address-family ipv4 unicast
  metric-style wide
 !
 interface GigabitEthernet0/0/0/0
  circuit-type level-1
  address-family ipv4 unicast
   !
 !
 interface GigabitEthernet0/0/0/1
  address-family ipv4 unicast
   !
 !
!
```

IS-IS Neighbor Verification

```
RP/0/0/CPU0:XR1#show isis neighbors

IS-IS ISIS neighbors:
System Id      Interface     SNPA            State Holdtime Type IETF-NSF
R2             Gi0/0/0/2     aabb.cc00.6500  Up    25       L1L2 Capable
R3             Gi0/0/0/2     aabb.cc00.6600  Up    7        L1L2 Capable

Total neighbor count: 2
```

Configuring BGP

```
router bgp 100
 bgp router-id 192.168.1.1
 address-family ipv4 unicast
  network 192.168.0.0/16
 !
 neighbor 10.0.0.1
  remote-as 100
  update-source Loopback0
  address-family ipv4 unicast
```

BGP Route Policies

```
router bgp 100
 address-family ipv4 unicast
!
 neighbor 10.0.0.1
  remote-as 200
  address-family ipv4 unicast
```

```
RP/0/0/CPU0: 16:28:06.171 : bgp[1047]: %ROUTING-BGP-6-NBR_NOPOLICY : No inbound
IPv4 Unicast policy is configured for eBGP neighbor 10.0.0.1. No IPv4 Unicast
prefixes will be accepted from the neighbor until inbound policy is configured.

RP/0/0/CPU0:16:28:06.171 : bgp[1047]: %ROUTING-BGP-6-NBR_NOPOLICY : No outbound
IPv4 Unicast policy is configured for eBGP neighbor 10.0.0.1. No IPv4 Unicast
prefixes will be sent to the neighbor until outbound policy is configured.
```

BGP Route Policies

```
router bgp 100
 address-family ipv4 unicast
!
 neighbor 10.0.0.1
  remote-as 200
  update-source Loopback0
  address-family ipv4 unicast
   route-policy PASS in
   route-policy PASS out
```

Routing policies are optional for IBGP sessions

BGP Verification

```
RP/0/0/CPU0:XR1#show bgp ipv4 unicast summary
! Output omitted for brevity
BGP router identifier 192.168.1.1, local AS number 100
BGP main routing table version 4

Process       RcvTblVer   bRIB/RIB   LabelVer  ImportVer  SendTblVer  StandbyVer
Speaker               4          4          4          4           4           4

Neighbor        Spk    AS MsgRcvd MsgSent   TblVer  InQ OutQ  Up/Down  St/PfxRcd
10.12.1.2         0   100       8       7        4    0    0 00:05:23          0
```

```
RP/0/0/CPU0:XR1#show bgp ipv4 unicast
! Output omitted for brevity
BGP main routing table version 6

Status codes: s suppressed, d damped, h history, * valid, > best
              i - internal, r RIB-failure, S stale
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network            Next Hop            Metric LocPrf Weight Path
*> 10.12.1.0/24       0.0.0.0                  0         32768 i
* i                   10.12.1.2                0    100      0 i
*> 192.168.1.1/32     0.0.0.0                  0         32768 i
*>i192.168.2.2/32     10.12.1.2                0    100      0 i
Processed 2 prefixes, 2 paths
```

Show run ……

```
RP/0/0/CPU0:XR1#show run router ospf 1
! Output omitted for brevity
router ospf 1
 area 0
  interface TenGigE9/0/0/0
  !
 !
 area 1
  interface TenGigE9/0/0/1
    cost 10
  interface TenGigE9/0/0/2
  !
 !
!
RP/0/0/CPU0:XR1#show run router ospf 1 area 1 interface TenGigE9/0/0/1
! Output omitted for brevity
router ospf 1
 area 1
  interface TenGigE9/0/0/1
    cost 10
  !
 !
!
```

Supports Autocomplete

Works with all protocols and almost any process!!

Route Policy Language

What is RPL (Route Policy Language)

- Used to filter routing information
  - Remove routes
  - Change attributes
- Replaces route maps
  - More Scalable
  - Provides Clarity through (“if, then, else” style configuration)

Actions in a RPL

- There is an implicit drop at the end of RPL processing.
- A route must be given a 'ticket' to ensure that it has been inspected by the RPL
  - Pass
  - Set
  - Drop
  - Done

Basic RPL Action

- 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 stops processing

Basic RPL Examples

- Basic Pass Policy

Example Configuration

```
route-policy PASS-ALL
  pass
end-policy
```

- Basic Drop Policy

Example Configuration

```
route-policy DROP-ALL
  drop
end-policy
```

Somewhat redundant due to implicit drop

Basic RPL Examples

RPL Examples

- Basic conditional statement

Logic	Example Configuration

if **Match-Condition-One** then
  Action-One
end-if
	`if med eq 150 then`
	`  pass`
	`endif`

Conditional Match

Action

- Branching options

Logic	Example Configuration

if **Match-Condition-One** then
  Action-One
else
  Action-Two
end-if
	`if destination in (10.0.0.0/8 ge 8) then`
	`  pass`
	`else`
	`  drop`
	`endif`

Comparison operator

Notice we are matching networks directly in the RPL.

Supports Prefix Matching or WildCard

Multiple Branching options

Logic

if **Match-Condition-One** then
  Action-One
elseif **Match-Condtion-Two** then
  Action-Two
else
  Action-Three
end-if

```
if destination in (10.0.0.0/8 ge 8) then
  set tag 1
elseif destination in (172.16.0.0/12 ge12) then
  set tag 2
else
  drop
endif
```

Nested Conditions

Logic	Example Configuration

if **MATCHING-CONDITION-ONE** then
  if **MATCHING-CONDITION-TWO** then
  ACTION-ONE
  end-if
end-if
	if as-path passes-through '100' **then**
	  if destination in PREFIX-SET-RFC1918 **then**
	  pass
	  endif
	endif

Simplifying BGP AS-Path Conditions

AS Path Selection Criteria	Route-Map AS-Path ACL Logic *(ip as-path access-list 1)*	RPL Logic
Local Routes	`permit ^$`	`if as-path is-local`
Only Routes From Neighbor AS 200	`permit ^200_`	`if as-path neighbor-is '200'`
Only Routes Originating From AS 200	permit _200$	`if as-path originates-from '200'`
Passes Through AS200	permit _200_	`if as-path passes-through '200'`
Routes From 3 ASes or less away	permit ^[0-9]+ [0-9]+ [0-9]+?	`if as-path length le 3`

RPL Examples

Bad RPL Logic

```
route-policy METRIC-MODIFICATION
  if destination in (192.168.0.0/16 ge 16) then
    set med 100
  endif
  set med 200
end-policy
```

Overwrites Setting

Good RPL Logic Option #1

```
route-policy METRIC-MODIFICATION
  if destination in (10.0.0.0/8 ge 8) then
    set med 100
  else
    set med 200
  endif
end-policy
```

Option #2

```
route-policy METRIC-MODIFICATION
  if destination in (10.0.0.0/8 ge 8) then
    set med 100
    done
  endif
  set med 200
end-policy
```

Stops all processing on matched prefixes

RPL Policy Sets

- IOS XR uses policy sets to store the information:

  Prefix Set, Community Set, Extended Community Set, AS_Path Set
- There is not a deny in a Policy Set

As-path-set

```
as-path-set as_51
ios-regex '_2129$',
ios-regex '_2147$',
ios-regex '_2856$',
ios-regex '_3486$',
ios-regex '_6432$',
ios-regex '_6468$',
ios-regex '_7310$',
ios-regex '_7768$',
ios-regex '_7862$',
ios-regex '_8296$'
end-set
```

The same set can be written as follows:

```
as-path-set as_51
ios-regex '_(2129|2147|2856|3486|6432|6468|7310|7768|7862|8296)$'
end-set
```

Community-Set

```
community-set cset1
    12:34,
    12:78,
    internet
end-set
```

Support for common community keywords

- Internet Internet (BGP well-known community)
  Advertise this route to the Internet community.
  All BGP-speaking networking devices belong to this community.
- no-advertise Do not advertise to any peer (BGP well-known community)
- no-export Do not export to next AS (BGP well-known community)

Prefix-Set

```
prefix-set galaga
171.68.118.0/24,
192.168.0.0/16 ge 16 le 30
end-set
```

Prefix-Set

10.0.1.1

match only one possible value, 10.0.1.1/32, mask omitted means 32.

10.0.2.0/24

match only one possible value, 10.0.2.0/24

10.0.3.0/24 ge 28

match a range of prefix values, from 10.0.3.0/28 to 10.0.3.255/32

10.0.4.0/24 le 28

match a range of values, from 10.0.4.0 to 10.0.4.240

(eg we can't "reach" the last 4 bits)

Test

10.0.3.0/24 ge 28

*>i10.0.3.0/28	8.1.1.1	100	1234	0 2 3 {4} i
*>i10.0.3.16/28	8.1.1.1	100	1234	0 2 {3,4} i
*>i10.0.3.32/28	8.1.1.1	100	1234	0 2 3 {4,5} i
*>i10.0.3.48/28	8.1.1.1	100	1234	0 2 i
*>i10.0.3.0/26	8.1.1.1	100	300	0 2 3 {4} i
*>i10.0.3.64/26	8.1.1.1	100	300	0 2 {3,4} i
*>i10.0.3.2/31	8.1.1.1	100	1234	0 2 {3,4} i
*>i10.0.3.4/31	8.1.1.1	100	1234	0 2 3 {4,5} i
*>i10.0.3.6/31	8.1.1.1	100	1234	0 2 i
*>i10.0.3.0/24	8.1.1.1	100	300	0 2 3 {4} i

10.0.4.0/24 le 28

*>i10.0.4.0/24	8.1.1.1	100	1234	0 2 3 {4} i
*>i10.0.4.0/26	8.1.1.1	100	1234	0 2 3 {4} i
*>i10.0.4.64/26	8.1.1.1	100	1234	0 2 {3,4} i
*>i10.0.4.128/26	8.1.1.1	100	1234	0 2 3 {4,5} i
*>i10.0.4.48/28	8.1.1.1	100	1234	0 2 i
*>i10.0.4.64/28	8.1.1.1	100	1234	0 2 3 {4,5} i
*>i10.0.4.24/30	8.1.1.1	100	300	0 2 3 i
*>i10.0.4.28/30	8.1.1.1	100	300	0 2 {3} i

10.0.5.0/24 ge 26 le 30

*>i10.0.5.4/30	8.1.1.1	100	1234	0 2 {3,4} i
*>i10.0.5.8/30	8.1.1.1	100	1234	0 2 3 {4,5} i
*>i10.0.5.12/30	8.1.1.1	100	1234	0 2 i
*>i10.0.5.4/31	8.1.1.1	100	300	0 2 3 {4,5} i
*>i10.0.5.6/31	8.1.1.1	100	300	0 2 i
*>i10.0.5.5/32	8.1.1.1	100	300	0 2 3 {4,5,6} i
*>i10.0.5.6/32	8.1.1.1	100	300	0 2 3 i
*>i10.0.5.0/25	8.1.1.1	100	300	0 2 3 {4} i
*>i10.0.5.128/25	8.1.1.1	100	300	0 2 {3,4} i
*>i10.0.5.64/26	8.1.1.1	100	1234	0 2 {3,4} i
*>i10.0.5.128/26	8.1.1.1	100	1234	0 2 3 {4,5} i

extcommunity-set

```
extcommunity-set rt extcomm-rt
10002:666
10.0.0.2:666
end-set
```

Named and Inline Set

Inline Example Configuration

```
if destination in (10.0.0.0/8 ge 8, 172.16.0.0/12 ge 12, 192.168.0.0/16 ge 16) then
   pass
  else
   drop
  endif
```

Set Example Configuration

```
route-policy RFC1918-PREFIX-SET
  if destination in PREFIX-SET-RFC1918 then
    pass
  endif
end-policy
!
prefix-set PREFIX-SET-RFC1918
  10.0.0.0/8 ge 8,
  172.16.0.0/12 ge 12,
  192.168.0.0/16 ge 16
end-set
```

Named and Inline Set

Viewing Set Based RPLS

Keyword required to see sets in the RPL

Inline Example Configuration

```
RP/0/0/CPU0:XR1#show rpl route-policy RFC1918-PREFIX-SET inline

route-policy RFC1918-PREFIX-SET
  if destination in (10.0.0.0/8 ge 8, 172.16.0.0/12 ge 12, 192.168.0.0/16 ge 16) then
    pass
  endif
end-policy
```

Avoids having to scroll back and forth in the configuration

Inline:

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

Named-Set:

```
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
else
    drop
 endif
end-policy
```

Nesting of RPLs

Example Configuration

```
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
      set community (2:1234) additive
end-policy
```

Can go multiple levels deep

Boolean Operators

Negation

```
if not destination in PREFIX-SET-RFC1918 then
   pass
endif
```

Conjunction

```
if destination in PREFIX-SET-RFC1918 and as-path passes-through '100'  then
   pass
endif
```

Disjunction

```
if destination in PREFIX-SET-RFC1918 or as-path passes-through '100'  then
   pass
endif
```

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
```

sample

```
RP/0/RSP0/CPU0:ASR9006-B#show bgp
<SNIP>
Status codes: s suppressed, d damped, h history, * valid, > best
              i - internal, r RIB-failure, S stale, N Nexthop-discard
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network            Next Hop            Metric LocPrf Weight Path
*> 82.210.208.124/30  82.210.208.125           0             0 8151 i
*> 82.210.211.4/30    82.210.208.125           0             0 8151 i

Processed 2 prefixes, 2 paths
```

```
RP/0/RSP0/CPU0:ASR9006-B#show bgp route-policy ACL
<SNIP>
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network            Next Hop            Metric LocPrf Weight Path
*> 82.210.208.124/30  82.210.208.125           0             0 8151 i

Processed 1 prefixes, 1 paths
```

RPL Show Commands [attachpoint]

RPL Attachment Points

```
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
```

RPL Show Commands

RPL Attachment States

```
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)
----------------------------------------
...
```

Editing route policies

RP/0/RSP0/CPU0:A9K-BNG(config)#route-policy test
RP/0/RSP0/CPU0:A9K-BNG(config-rpl)#if med eq 100 then
RP/0/RSP0/CPU0:A9K-BNG(config-rpl-if)#set local-preference 100
RP/0/RSP0/CPU0:A9K-BNG(config-rpl-if)#endif
RP/0/RSP0/CPU0:A9K-BNG(config-rpl)#end-policy
RP/0/RSP0/CPU0:A9K-BNG(config)#commit
RP/0/RSP0/CPU0:A9K-BNG(config)#

RP/0/RSP0/CPU0:A9K-BNG(config)#route-policy test
Fri Jan 20 14:58:39.900 EDT
% WARNING: Policy object route-policy test' exists! Reconfiguring it via CLI will replace current definition. Use 'abort to cancel.
RP/0/RSP0/CPU0:A9K-BNG(config-rpl)#

edit

```
RP/0/RSP0/CPU0:A9K-BNG#edit route-policy test ?
  emacs  to use Emacs editor
  nano   to use nano editor
  vim    to use Vim editor
  <cr>
```

If prefer VI and then you can edit your RPL in a VI like manner

Management Virtual Address

```
interface MgmtEth0/RSP0/CPU0/0
  vrf mgmt
 ipv4 address 192.168.236.1 255.255.255.128

interface MgmtEth0/RSP1/CPU0/0
vrf mgmt
 ipv4 address 192.168.236.2 255.255.255.128


ipv4 virtual address vrf mgmt 192.168.236.3/25
ipv4 virtual address use-as-src-addr
```

RSP Reload Reason

- **RP/0/RSP0/CPU0:F241-38-19-ASR9001-02#sh reboot history reverse location 0/0/cPU0**

```
Sun Dec  1 23:54:50.951 EST
No  Time                    Cause Code  Reason
--------------------------------------------------------------------------------
02  Sun Sep 29 08:34:25 2013  0x0400004f  Cause: MBI-HELLO reloading node on rec
                                          eiving reload notification
                                          Process: mbi-hello
01  Wed Nov 20 17:10:36 2013  0x04000043  Cause: Reloading managed node
                                          Process: insthelper
```


L2vpn Overview

- All configuration goes under the L2vpn container
- EFP replaces sub-interface
- Two Options to apply Configuration under L2vpn
  - Under l2vpn container (xconnect configuration generally)
  - Create bridge-group (more then 2 connections)
- Every show command starts with the keyword "*show l2vpn*"

```
RP/0/RSP0/CPU0:F241-38-19-ASR9001-02#sh run l2vpn
  Sat Nov 30 23:59:20.740 EST
  l2vpn
   xconnect group 9k-9001
    p2p 9k-9001-svc1
     interface TenGigE0/0/0/1.100
     neighbor ipv4 172.16.1.1 pw-id 1
     !
```

L2vpn Troubleshooting

- RP/0/RSP0/CPU0:F241-38-19-ASR9001-02#show l2vpn xconnect state up

```
Sun Dec  1 00:04:01.342 EST
Legend: ST = State, UP = Up, DN = Down, AD = Admin Down, UR = Unresolved,
        SB = Standby, SR = Standby Ready, (PP) = Partially Programmed

XConnect                    Segment 1                   Segment 2
Group      Name       ST    Description          ST     Description          ST
------------------------   ---------------------------   ---------------------------
9k-9001    9k-9001-svc1
                      UP    Te0/0/0/1.100        UP     172.16.1.1     1     UP
------------------------------------------------------------------------------------
```


L2vpn Troubleshooting

- RP/0/RSP0/CPU0:F241-38-19-ASR9001-02#sh l2vpn xconnect neighbor 172.16.1.1

```
Sun Dec  1 00:06:46.561 EST
Legend: ST = State, UP = Up, DN = Down, AD = Admin Down, UR = Unresolved,
        SB = Standby, SR = Standby Ready, (PP) = Partially Programmed

XConnect                          Segment 1                   Segment 2
Group      Name             ST    Description          ST     Description          ST
------------------------   ---------------------------   ---------------------------
9k-9001    9k-9001-svc1
                            UP    Te0/0/0/1.100        UP     172.16.1.1     1     UP
------------------------------------------------------------------------------------
```

L2vpn Troubleshooting – AC States

States	Note
UP	All segments are configured and their state is up
DN	Segment is configured. Interface has been configured for l2transport but local interface is down
UR	At least one of the segments is not configured
CO	Service is available, interface has been configured for l2transport but interface is not up and not ready to distribute labels
LU	AC is up but remote AC/PW is not ready
RU	Remote AC/PW are up but local AC/PW are not ready
Ad	Atleast one of the segments is not configured

BGP Best Path Algorithm

- Explains why the bestpath is the best
- IOS-XR has
  - sho bgp x.x.x.x/x bestpath-compare

```
ASR9010-01#sho bgp 211.73.77.64/28 bestpath-compare
.......
Path #1: Received by speaker 1
  Not advertised to any peer
  Local, (received & used)
    211.73.76.2 (metric 101) from 211.73.76.3 (211.73.76.2)
      Origin IGP, metric 0, localpref 100, valid, internal, best, group-best
      Received Path ID 0, Local Path ID 1, version 57
      Originator: 211.73.76.2, Cluster list: 211.73.76.3
      best of local AS, Overall best
  Path #2: Received by speaker 1
  Not advertised to any peer
  Local, (received & used)
    211.73.76.2 (metric 101) from 211.73.76.13 (211.73.76.2)
      Origin IGP, metric 0, localpref 100, valid, internal
      Received Path ID 0, Local Path ID 0, version 0
      Originator: 211.73.76.2, Cluster list: 211.73.76.13
      Higher neighbor address than best path (path #1)
```

Optical Power

- show controllers gigabitEthernet 0/5/0/1 phy

#show controllers tenGigE0/6/1/7 phy
Wed Jun 22 18:20:07.723 cst
PHY data for interface: TenGigE0/6/1/7

SFP EEPROM port: 7
Xcvr Type: SFP
Xcvr Code: SFP-10G-LR
Encoding: 64B66B
Bit Rate: 10300 Mbps
…….
Temperature: 44.414
Voltage: 3.358 Volt
Tx Bias: 31.878 mAmps
Tx Power: 0.55560 mW (-2.55238 dBm)
Rx Power: 0.45720 mW (-3.39894 dBm)
Oper. Status/Control:

Environment

- admin show environment all
- admin show environment table
- admin show environmen fans
- admin show environmen power-supply