Troubleshooting Cisco Catalyst 9000 Series Switches

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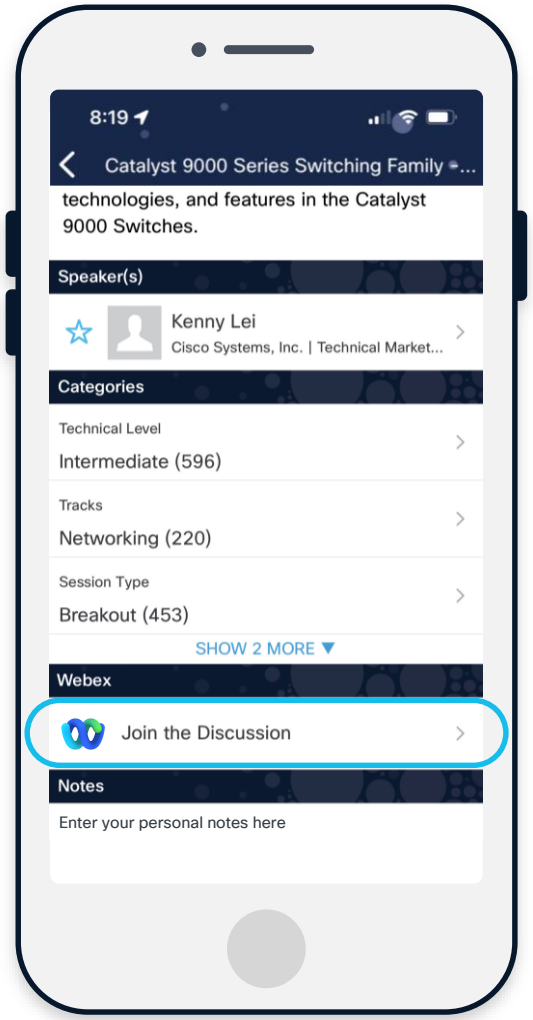


Agenda

01 Introduction

02 Memory and CPU

03 Packet Drops

04 Forwarding Verification

Introduction

Catalyst 9k family

Cisco Catalyst 9200 Series

Cisco Catalyst 9300 Series

Cisco Catalyst 9400 Series

Cisco Catalyst 9500 Series

Cisco Catalyst 9600 Series

	9200/9200L	9300/9300X	9400	9500/9500X	9600/9600X
Format	Stackable	Stackale	Chassis	Standalone	Chassis

All Catalyst 9000 series switches are based upon UADP and Silicon One ASICs and run IOS-XE.

Different feature sets and performance but same architecture

Catalyst IOS-XE Software release schedule

	17.12	17.14	17.15	17.16	17.17
Next planned release	17.12.6	None	17.15.4	None	None
End of Software Maintenance	March 2026	May 2025	-	Jan 2026	-
End of Vulnerability Security Support	Sept 2027	May 2025	-	Jan 2026	-
Extended Maintenance Release	Yes	No	Yes	No	No

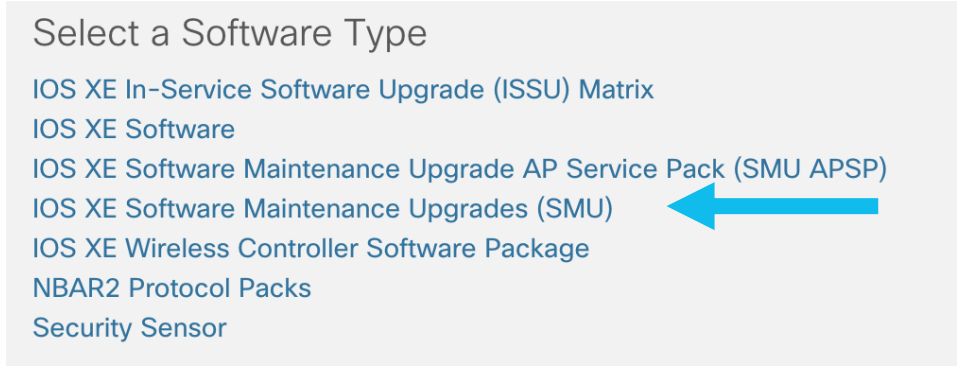
Recommended releases:
https://www.cisco.com/c/en/us/support/docs/switches/catalyst-9300-series-switches/214814-recommended-releases-for-catalyst-9200-9.html

Software Maintenance Upgrade(SMU)

- SMU's provide patches on top of IOS-XE
- - Hitless , No reload needed to apply on top of IOS-XE
  - Reboot, Reload is performed to apply SMU
- Apply with the command:

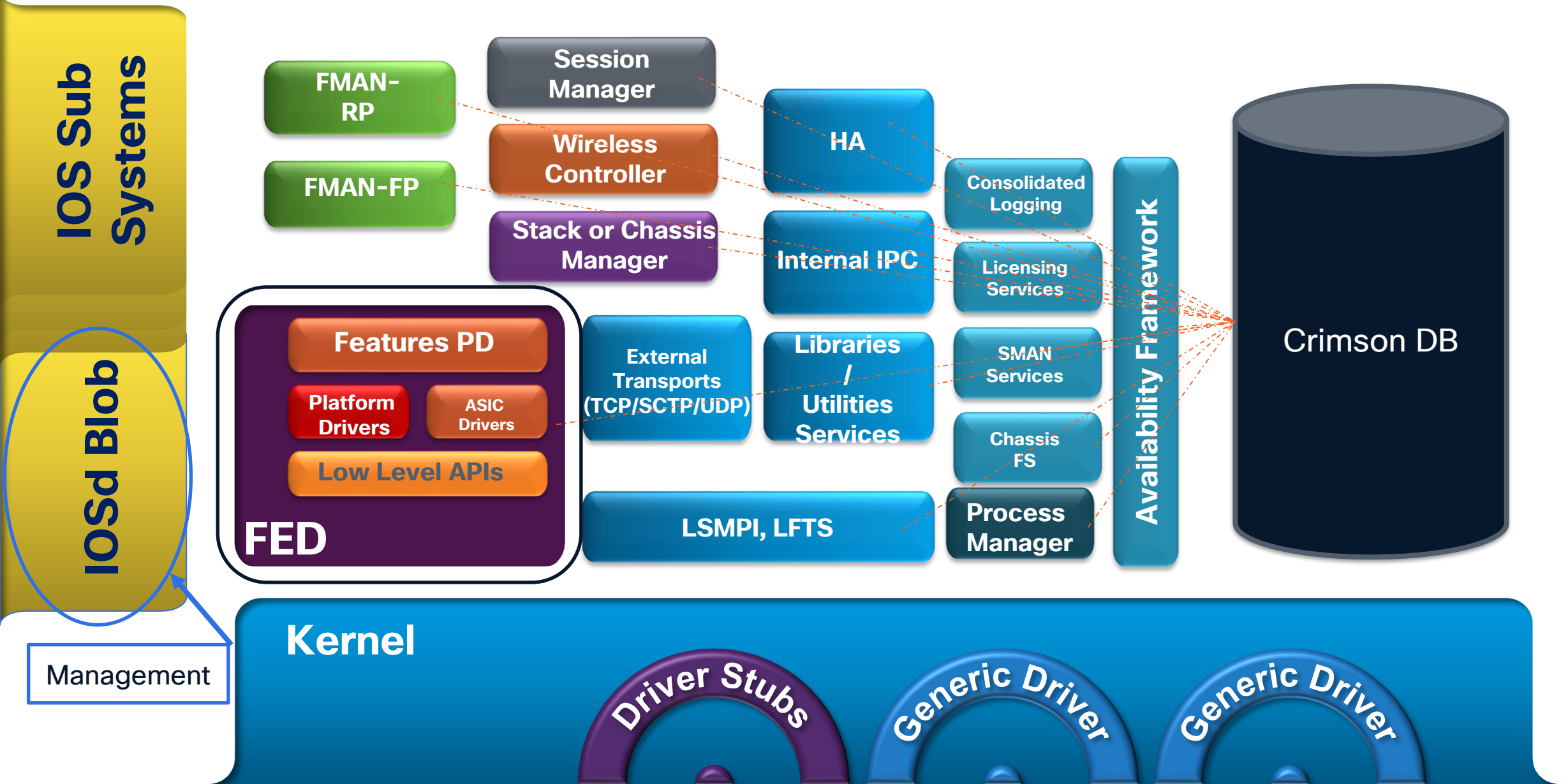
  install add file <smu> activate commit
- Confirm with command :

  show install summary
- Remove with :
  install deactivate file <file>
- Do not remove .bin from smu from flash



File Information	Release Date	Size
Hitless/Recommended SMU, LISP Address-Resolution entry randomly disappears on 17.9.5 cat9k_iosxe.17.09.05.CSCwm47533.SPA.smu.bin Advisories	16-Oct-2024	0.03 MB
Hitless/Recommended SMU, Catalyst 9K Switches: Unexpected reload in FED due to SIGFPE Arithmetic exception cat9k_iosxe.17.09.05.CSCwj55093.SPA.smu.bin Advisories	26-Sep-2024	0.03 MB
Hitless/Recommended SMU, Hitless - September 2024 SMU PSIRT Bundle cat9k_iosxe.17.09.05.CSCwm01146.SPA.smu.bin Advisories	25-Sep-2024	0.16 MB

IOS-XE graphical overview



Show and Debug Commands

- Many of the features run primarily on IOSd
- Those features provide the regular debugs and show commands

```
Switch#show ip route
Switch#show cdp neig
Switch#debug ip packet 101
```

- Note: Debugs/show commands shows IOSd's view of the system
  ex, debug ip packet shows ip packets IOSd has visibility on.
- Processes out of IOSd do communicate with IOSd,
  ex, show access-session gets access-session information from Session Manager Progress

IOS-XE Specific Show Commands

- Many processes outside IOSd are non-platform specific
  Ex: Forwarding manager (fman) , WebUI (nginx), Wireless (wncd)
- Debug/show commands similar on all IOS-XE Devices

```
Switch#show platform software ip switch active R0 cef
ASR_1k#show platform software ip rp active cef
CSRv#show platform resources
```

- Specify location for command execution:
  - Active, Standby or switch number
  - RP/R0, Route Processor,
  - FP/F0 , Forwarding Processor

Catalyst 9k Platform Specific Show Commands

- FED (Forwarding Engine Driver) is the Catalyst 9000 platform specific layer
- Catalyst 9k platform specific commands :
  show/set/debug platform hardware|software fed

```
9300#show platform software fed switch active ifm mappings
9300#show platform software fed switch 5 ifm mappings
9400#show platform software fed active ifm mappings
```

- A FED instance runs on every switch in a stack and every supervisor module
- FMAN FP processes run on every switch in the stack. FMAN RP process only on Active and Standby Supervisor/Switches

Debugging outside IOSd process

- To facilitate debugging/logging trace logs are available for all processes using always on tracing
- Tracing levels set with granularity (default notice). Always on tracing
- Common processes:
  - smd, session manager
  - fed, forwarding engine driver
  - wncd, wireless process
  - fman, forwarding manager process
- Processes do not run on just active switch/supervisor

```
Switch#set platform software trace smd switch active R0 dot1x-all verbose
Switch#show platform software trace level smd switch active R0 | inc dot1x
dot1x                                    Notice
dot1x-all                                Verbose
dot1x-redun                              Notice
Switch#set platform software trace all notice ← set all back to default
```

Displaying trace logs

- Tracelog files are stored in crashinfo:/logs in binary format.
- Analyzing traces: show logging process <process> [internal]
- Bundle creation of binary traces:
  “request platform software trace archive”

```
Edge_1#sh logging process smd | inc RADIUS
2022/06/06 23:24:03.268912 {smd_R0-0}{1}: [radius] [24732]: (info): RADIUS: Send Accounting-Request to
10.48.91.222:1813 id 1813/184, len 850
2022/06/06 23:24:03.268937 {smd_R0-0}{1}: [radius] [24732]: (info): RADIUS:  authenticator e5 d1 b7 4d 8b e9 d5
06 - 14 b9 8d b6 8c 29 93 94
2022/06/06 23:24:03.268945 {smd_R0-0}{1}: [radius] [24732]: (info): RADIUS:  Vendor, Cisco       [26]   211
2022/06/06 23:24:03.268954 {smd_R0-0}{1}: [radius] [24732]: (info): RADIUS:   Cisco
AVpair       [1]    205  "cts-pac-opaque=”
2022/06/06 23:24:03.268960 {smd_R0-0}{1}: [radius] [24732]: (info): RADIUS:  Vendor, Cisco       [26]    36
2022/06/06 23:24:03.268966 {smd_R0-0}{1}: [radius] [24732]: (info): RADIUS:   Cisco
AVpair       [1]     30  "dc-profile-name=Cisco-Device"
```

Radius Debugs for dot1x/mab are in Session Manager trace

Memory and CPU

Looking at the Kernel CPU information

- Kernel CPU utilization can be seen per switch/supervisor module

```
9300_54#show proc cpu platform sorted location switch active R0
CPU utilization for five seconds: 12%, one minute:  9%, five minutes:  5%
Core 0: CPU utilization for five seconds: 14%, one minute: 10%, five minutes:  5%
Core 7: CPU utilization for five seconds: 14%, one minute: 10%, five minutes:  6%
   Pid    PPid    5Sec    1Min    5Min  Status        Size  Name
-------------------------------------------------------------------------------
 14854   13498     51%     38%     22%  S           951436  linux_iosd-imag
 15322   15160     42%     30%     15%  S           313236  fed main event
  2960       2      8%      5%      2%  R                0  lsmpi-xmit
  2961       2      5%      4%      2%  S                0  lsmpi-rx
```

- linux_iosd-image process as seen on kernel is IOSd process
- Lsmpi processes are part of Linux Shared Memory Punt Interface
- Every switch might run different processes.
- Changing the location will display cpu to check standby or members

IOSd CPU utilization

```
9300_54#show proc cpu sort
CPU utilization for five seconds: 25%/1%; one minute: 22%; five minutes: 11%
 PID Runtime(ms)     Invoked      uSecs   5Sec   1Min   5Min TTY Process
  40     9474304    54714487        173 22.95% 16.12%  8.15%   0 ARP Input
  24       95502    12431773          7  0.07%  0.00%  0.00%   0 IPC Mcast Pendin
  41      152951    13280277         11  0.07%  0.00%  0.00%   0 ARP Background
  53      102409    12729984          8  0.07%  0.00%  0.00%   0 Dynamic ARP Insp
  83     4759850    48620416         97  0.07%  0.03%  0.02%   0 IOSD ipc task
 121     5602021    50896336        110  0.07%  0.04%  0.05%   0 Crimson config p
 136     5112131   792052381          6  0.07%  0.03%  0.02%   0 L2 LISP Punt Pro
```

- Inside IOSd process many functions and processes run
  Examples: BGP, RIP, CEF, ARP, UDLD, CDP, SSH, SNMP, Telnet
- CPU not involved in data plane forwarding
- Control Plane Policing enabled by default on cat9k to protect CPU
- CoPP parameters can be modified, use caution when doing

CPU utilization in IOSd

- CPU history gives an overview of CPU history for last minute, hour and day

```
9300_54#show processor cpu history
  100
   90
   50   **     **     **     **     **     **     ***    ***
   40   *#*    *#*    *#*    *#*    *#*    *#*    *#*    *#*
   30   ##*    ##*    ##*    ##*    ##*    ##*    ##*    ##*
   20   ##*    ##*    ##*    ##*    ##*    ##*    ##*    ##*
   10   ###    ###    ###    ###    ###    ###    ###    ###
     0....5....1....1....2....2....3....3....4....4....5....5....6
              0    5    0    5    0    5    0    5    0    5    0
              CPU% per minute (last 60 minutes)
             * = maximum CPU%   # = average
```

- Pattern of Interval and length of CPU spikes can point to trigger.
- Average high CPU more cause for concern then short spikes

Catching CPU spikes in IOSd

- CPU spikes often occur when not actively watching the switch.
- IOS allows CPU monitoring :
  process cpu threshold type total rising <%> interval <s> falling <%> interval <s>
- When threshold are exceeded syslog is generated
- Syslog can be used by Embedded Event Manager to automate collection of data during time of failure

```
%SYS-1-CPURISINGTHRESHOLD: Threshold: Total CPU Utilization(Total/Intr): 48%/15%, Top 3
processes(Pid/Util):  40/32%, 94/0%, 105/0%

9300_54#show proc cpu | inc 40 | 94 | 105 | PID
 PID Runtime(ms)     Invoked      uSecs   5Sec   1Min   5Min TTY Process
  40    19640520    69264320        283 22.48% 20.61% 10.14%   0 ARP Input
  94      652410     6428606        101  0.07%  0.00%  0.00%   0 PuntInject Keepa
 105     3477489     6127722        567  0.00%  0.02%  0.02%   0 Crimson flush tr
```

Top 3 processes,
ARP input is highest

Determining Cause of Inband traffic

```
9300_54#sh platform software fed switch active punt rates interfaces
Packets per second averaged over 10 seconds, 1 min and 5 mins
=============================================================================
                                |           |  Recv  |  Recv  |  Recv  |  Drop  |  Drop  |  Drop
 Interface Name                 |  IF_ID    |  10s   |  1min  |  5min  |  10s   |  1min  |  5min
=============================================================================
 GigabitEthernet1/0/11          0x00000013    5999     1707     2074        0        0        0
 Vlan192                        0x00000036    5999     1707     2074        0        0        0
9300_54#sh platform software fed switch active punt cpuq rates
Packets per second averaged over 10 seconds, 1 min and 5 mins
=============================================================================
 Q   |          Queue              |  Rx    |  Rx    |  Rx    |  Drop   |  Drop    |  Drop
 no  |          Name               |  10s   |  1min  |  5min  |  10s    |  1min    |  5min
=============================================================================
 0   CPU_Q_DOT1X_AUTH                  0        0        0         0         0         0
 1   CPU_Q_L2_CONTROL                  0        0        0         0         0         0
 5   CPU_Q_FORUS_ADDR_RESOLUTION    6000     1874     2414         0         0         0
```

Active interfaces sending to cpu

Per Queue Statistics

Queue information

Drops typically seen on Port Asic not in FED punt path

Using Embedded Packet Capture

- EPC provides packet capture on interface or control plane level
- Data capture in hardware, traffic copied to EPC process for capturing
- Packet capture rate limited to protect CPU , good for visibility, not for performance captures

```
9300_54#monitor capture CL interface GigabitEthernet 1/0/11 in
9300_54#monitor capture CL match any
9300_54#monitor capture CL start
9300_54#monitor capture CL stop
9300_54#monitor capture CL export location flash:cl.pcap
9300_54#sh monitor capture file flash:cl.pcap display-filter arp
Starting the packet display ........ Press Ctrl + Shift + 6 to exit
  352   57.9 00:00:ca:fe:ca:fe ff:ff:ff:ff:ff:ff ARP 60 Who has 192.168.5.1? Tell 192.168.2.8
  353   57.9 00:00:ca:fe:ca:fe ff:ff:ff:ff:ff:ff ARP 60 Who has 192.168.5.2? Tell 192.168.2.8
  354   57.9 00:00:ca:fe:ca:fe ff:ff:ff:ff:ff:ff ARP 60 Who has 192.168.5.3? Tell 192.168.2.8
  355   57.9 00:00:ca:fe:ca:fe ff:ff:ff:ff:ff:ff ARP 60 Who has 192.168.5.4? Tell 192.168.2.8
  356   57.9 00:00:ca:fe:ca:fe ff:ff:ff:ff:ff:ff ARP 60 Who has 192.168.5.5? Tell 192.168.2.8
```

Where and what to capture

Export capture to file

Displays capture from flash or buffer

Determine packets hitting a specific CPU queue

- FED allows limited packet captures done in punt and inject path
- Allows filter to be setup to collect specific data.
- Use filter “fed.queue==<queue>” for collecting specific cpu queue
- Detail and brief packet display.
  Detail contains internal forwarding meta data

```
9300_54#debug plat soft fed switch active punt packet-capture set-filter "fed.queue == 5"
9300_54#debug platform software fed switch active punt packet-capture [start|stop]
9300_54#show platform software fed switch active punt packet-capture brief
Punt packet capturing: disabled. Buffer wrapping: disabled
Total captured so far: 4096 packets. Capture capacity : 4096 packets
Capture filter : "fed.queue == 5"
------ Punt Packet Number: 3, Timestamp: 2023/05/31 13:14:45.888 ------
 interface : physical: GigabitEthernet1/0/11[if-id: 0x00000013], pal: Vlan192 [if-id: 0x00000036]
 metadata  : cause: 7 [ARP request or response], sub-cause: 1, q-no: 5, linktype: MCP_LINK_TYPE_IP
 ether hdr : dest mac: ffff.ffff.ffff, src mac: 0000.cafe.cafe
 ether hdr : ethertype: 0x0806 (ARP)
```

Metadata indicates why it was punted

Control Plane Policing HW stats

- Control plane policing drops frames on port asic's to protect CPU
- Do not modify defaults without clear understanding of the impact

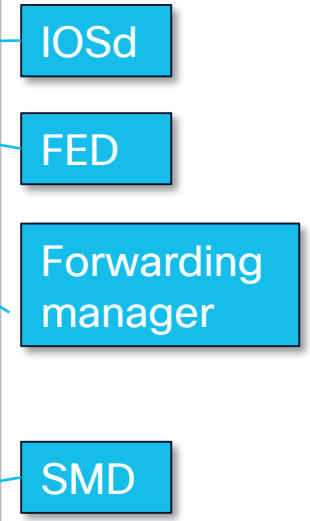
```
9300_1#show plat hardware fed switch active qos queue stats internal cpu policer
                        CPU Queue Statistics
                                                (default) (set)      Queue          Queue
QId PlcIdx  Queue Name                  Enabled   Rate      Rate       Drop(Bytes)   Drop(Frames)
--------------------------------------------------------------------------------------------
4    2      Routing Control             Yes      5400      5400       0             0
5    14     Forus Address resolution    Yes      4000      65000      2212622868    345698644
                     CPU Queue Policer Statistics
Policer    Policer Accept   Policer Accept  Policer Drop  Policer Drop
  Index         Bytes           Frames         Bytes           Frames
-------------------------------------------------------------------
12         0                0               0             0
13         9562218          122704          453808601     7079824
                       CPP Classes to queue map
PlcIdx CPP Class                                 :  Queues
-------------------------------------------------------------------------------
0      system-cpp-police-data                    :  ICMP GEN/ BROADCAST/ ICMP Redirect/
14     system-cpp-police-forus                   :  Forus Address resolution/ Forus traffic/
```

Control Plane policing drops

Rate changed from Default rate

Platform Memory

```
9600_SVL#sh processes memory platform sorted location switch 1 R0
System memory: 15993924K total, 6935004K used, 9058920K free,
Lowest: 9025140K
   Pid    Text      Data    Stack   Dynamic       RSS                Name
-------------------------------------------------------------------------
  5373  256860   1488024      136       488   1488024   linux_iosd-imag
 31175     203    885528      136    132984    885528     fed main event
 26748    7236    295848      136      3808    295848           fman_rp
 15847    8158    263112      136      4692    263112     fman_fp_image
 27259     450    235088      136      4720    235088              dbm
 28641    2583    228456      164    101856    228456            confd
 30179      87    208392      136      7832    208392             pubd
 25903     336    193308      136       388    193308          ndbmand
  4272     790    177200      136     33732    177200            smand
 18087     178    176024      136     13104    176024          sessmgrd
```



- Kernel memory utilization is available per switch
- linux_iosd-image process is IOSd
- Resident Set Size(RSS), memory occupied by each Process

IOSd Memory

```
9600_SVL#sh processes memory sorted holding
Processor Pool Total: 2959189564 Used:  687714160 Free: 2271475404
reserve P Pool Total:     102404 Used:         88 Free:     102316
 lsmpi_io Pool Total:    6295128 Used:    6294296 Free:        832


 PID TTY  Allocated      Freed    Holding    Getbufs    Retbufs Process
   0   0  488208064   77059624  381785696          0          0 *Init*
 238   0  137113496    1017784  136266568          0          0 IP ARP Adjacency
  82   0   50195904    2966104   27577736          0          0 IOSD ipc task
 565   0  720962728  696333696   24623088          0          0 DHCPD Receive
   4   0   42371936   17822928   22358600          0          0 RF Slave Main Th
```

- IOSd runs as a process , but does still provides some kernel features like memory management for all processes running inside IOSd
- Processor Pool: Pool for Processes on IOSd
- lsmpi_io : Linux Shared Memory Punt Interface memory, IO buffers

IOSd Memory Allocator

```
9600_SVL#sh processes memory 565
Tracekey : 1#01327ced3d92c0f78c7959f154fa0114
Process ID: 565
Process Name: DHCPD Receive
Total Memory Held: 24623088 bytes

Processor memory Holding = 24623088 bytes
size =  10549344, count =  321, pc = :5644D0D8C000+934D623
size =  10450752, count =  318, pc = :5644D0D8C000+548EF85
size =   1478880, count =   45, pc = :5644D0D8C000+861423D
size =   1032040, count =  120, pc = :5644D0D8C000+8615EB3
size =    985920, count =   30, pc = :5644D0D8C000+8608243
```

- Allocator PC indicator of what allocated memory
- Not all increased in memory are leaks, memory might get released again or functions might just need more memory
- Monitor over time and multiple boxes to determine possible pattern

Packet Drops

Checking interface status

Err-disabled => check
show interface status errdisable
or show log for cause

Vlan column shows routed(L3) ,
trunk or base vlan

Half Duplex 1Gb/s, possible
duplex mismatch?

```
9500_1#show interfaces status | ex notc
Port          Name               Status       Vlan       Duplex  Speed Type
Twe1/0/7                         connected    routed     a-full a-1000 10/100/1000BaseTX SFP
Twe1/0/12                        err-disabled 1            full     10G SFP-10GBase-CU1M
Twe1/0/15                         connected    routed       full     10G SFP-10GBase-CU3M
Twe1/0/20                        connected    4094         full     10G SFP-10GBase-CU1M
Twe1/0/21                         connected    routed     a-half a-1000 10/100/1000BaseTX SFP
Twe1/0/22                        disabled     1            auto   auto 10/100/1000BaseTX SFP
Hu1/0/26                         connected    trunk        full     40G QSFP 40G CU3M
Hu1/0/27                         connected    4094         full    100G QSFP 100G CU2M
```

Show interface status command gives a quick overview of interface status

Ethernet Statistics

```
Switch#show controllers ethernet-controller gi 5/0/48
Transmit                  GigabitEthernet5/0/48 Receive
   1562496684 Total bytes                2968958225 Total bytes
      5032561 Unicast frames                6004241 Unicast frames
    700808558 Unicast bytes              1807110661 Unicast bytes
      1269484 Multicast frames              2789759 Multicast frames
    861688062 Multicast bytes            1161847500 Multicast bytes
            1 Broadcast frames                    1 Broadcast frames
            0 Cos 0 Pause frames                  0 Cos 0 Pause frames
      1236978 Minimum size frames            871517 Minimum size frames
      1892419 65 to 127 byte frames         2181611 65 to 127 byte frames
      1941967 128 to 255 byte frames        2712229 128 to 255 byte frames
       685594 256 to 511 byte frames        1260418 256 to 511 byte frames
        20261 512 to 1023 byte frames        900135 512 to 1023 byte frames
       524827 1024 to 1518 byte frames       868091 1024 to 1518 byte frames
            0 8192 to 16383 byte frames             0 8192 to 16383 byte frames
            0 16384 to 32767 byte frame             0 16384 to 32767 byte frame
            0 > 32768 byte frames                 0 > 32768 byte frames
            0 Late collision frames               0 SymbolErr frames
            0 Excess Defer frames                 0 Collision fragments
            0 Good (1 coll) frames                0 ValidUnderSize frames
            0 Good (>1 coll) frames               0 InvalidOverSize frames
            0 Deferred frames                     0 ValidOverSize frames
LAST UPDATE 361 msecs AGO
```

Ethernet controller statistics give more detailed port statistics

Frame size distribution

Error statistics

Verifying link utilization

Input/output rates show average over 5 minutes (default). Traffic might be bursty in nature

load-interval has a range of 30-600 seconds

```
Switch#show interfaces | inc line|rate
Vlan1 is up, line protocol is up , Autostate Enabled
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
GigabitEthernet0/0 is administratively down, line protocol is down
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
GigabitEthernet1/0/11 is up, line protocol is up (connected)
  30 seconds input rate 575000 bits/sec, 958 packets/sec
  30 seconds output rate 126975000 bits/sec, 10473 packets/sec
GigabitEthernet1/0/12 is down, line protocol is down (notconnect)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bit
GigabitEthernet1/0/13 is dow
  5 minute input rate 0 bits
  5 minute output rate 0 bit
```

```
Switch#show controllers utilization
Port          Receive Utilization  Transmit Utilization
Gi1/0/1                        0                     0
Gi1/0/11                       0                    92
.
Gi1/0/24                       0                     0
Te1/1/1                        0                     0
Te1/1/4                        9                     0
Total Ports : 33

Total Ports Receive Bandwidth Percentage Utilization  : 0
Total Ports Transmit Bandwidth Percentage Utilization : 0
Average Switch  Percentage Utilization : 0
```

Bandwidth in % Current load

cisco

Verifying QoS

Ingress class,marking on protocol

Per class statistics

Egress, set dscp , priority queue and police

```
Switch#show policy-map interface te 1/0/11  | sec VOICE
    Class-map: DNA-MARKING_IN#VOICE (match-all)
      182156 packets
      Match: protocol attribute traffic-class voip-telephony
      Match: protocol attribute business-relevance business-relevant
      QoS Set
        dscp ef
    Class-map: DNA-EZQOS_2P6Q3T_9K#VOICE-PQ1 (match-any)
      337900 packets
      Match:  dscp ef (46)
      Priority: Strict,
      Priority Level: 1
      police:
          rate 10 %
          rate 1000000000 bps, burst 31250000 bytes
        conformed 437456190 bytes; actions:
          transmit
        exceeded 0 bytes; actions:
          drop
```

```
Switch#sh plat hard fed switch active qos dscp-cos  counters interface te 1/0/11
                    Frames          Bytes
Ingress DSCP0       13098           0
Ingress DSCP46      534087          0
Ingress COS0        679340          0
Ingress COS7        0               0
Egress DSCP0        1446            0
Egress DSCP46       337900          0
Egress COS0         6411995         0
Egress COS7         18400           0
```

Ingress counters

Egress counters

QoS Hardware configuration

```
9300_45#sh plat hard fed switch active qos queue config interface gi 1/0/11
Asic:0 Core:1 DATA Port:11 GPN:1 LinkSpeed:0x1
------------------------------------------------------------
   DTS  Hardmax  Softmax   PortSMin  GlblSMin  PortStEnd
  ----- --------  --------  --------  --------  ---------
 0   1  5   200  12  3200   5   500   0     0   6  9600
 1   1  4     0  13  4800   5   750   2   300   6  9600
 Priority   Shaped/shared   weight  shaping_step  sharpedWeight
 --------   -------------   ------  ------------   -------------
 0       0     Shared           50           0           0
 1       0     Shared           75           0           0
 Port       Port            Port    Port
 Priority   Shaped/shared   weight  shaping_step
 --------   -------------   ------  ------------
        2     Shaped           254         255
   Weight0 Max_Th0 Min_Th0 Weigth1 Max_Th1 Min_Th1  Weight2 Max_Th2 Min_Th2
   ------- ------- ------- ------- ------- -------  ------- ------- ------
 0       0    2709       0       0    3028       0       0    3400       0
 1       0    3825       0       0    4275       0       0    4800       0
```

Hardmax : Reserved
Softmax : Global pool

Queue mode:
shaped or shared
Queue limit for shaping
Step/weight * speed

Drop thresholds for queue/threshold
In Buffers (256 byte)

- qos softmax-queue-multiplier <percentage> allow all queue sizes to be increased. Use with caution

QoS hardware statistics

```
9300_45#sh platform hardware fed switch active qos queue stats interface gigabitEthernet 1/0/11
-------------------------------------------------------------------------------------------
AQM Global counters
GlobalHardLimit:  7976   |   GlobalHardBufCount: 0
GlobalSoftLimit: 11872   |   GlobalSoftBufCount: 0
-------------------------------------------------------------------------------------------
High Watermark Soft Buffers:     429 <--- clear on read
-------------------------------------------------------------------------------------------
Asic:0 Core:1 DATA Port:10 Hardware Enqueue Counters
-------------------------------------------------------------------------------------------
 Q Buffers          Enqueue-TH0          Enqueue-TH1          Enqueue-TH2             Qpolicer
   (Count)              (Bytes)              (Bytes)              (Bytes)              (Bytes)
-- ------- -------------------- -------------------- -------------------- --------------------
 0     200                    0               385820             46085690                    0
 1       0                    0                    0                    0                    0
Asic:0 Core:1 DATA Port:0 Hardware Drop Counters
-------------------------------------------------------------------------------------------------------------------------
 Q             Drop-TH0             Drop-TH1             Drop-TH2            SBufDrop             QebDrop         QpolicerDrop
                (Bytes)              (Bytes)              (Bytes)              (Bytes)              (Bytes)              (Bytes)
-- -------------------- -------------------- -------------------- -------------------- -------------------- --------------------
 0                    0                    0               412312                    0                    0                    0
 1                    0                    0                    0                    0                    0                    0
```

Highest number of buffers in use by interface since last issuing command

Current buffer count per queue

- At Asic level there are 8 Queues/3 Thresholds
- Enqueue/Drop Counters available per queue/per threshold
- Buffers (count) show currently assigned buffers to Queue (256 bytes)
- To enable high water mark counter monitoring.
  set platform hardware fed switch active qos port-monitor interface <if>

Doppler ASIC packet forwarding drop counters

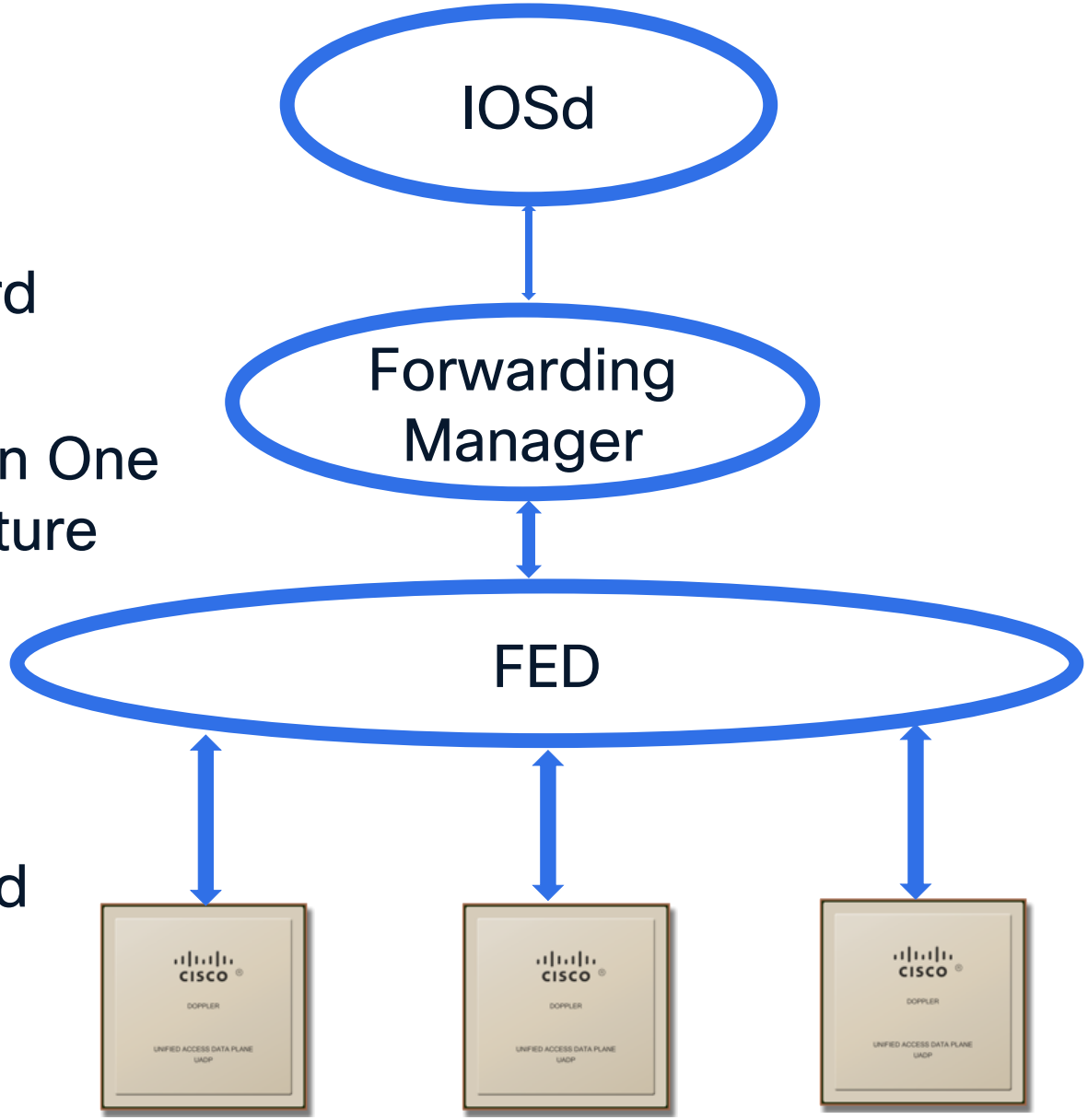
```
9300_45#sh platform hardware fed switch active fwd-asic drops exceptions
****EXCEPTION STATS ASIC INSTANCE 0 (asic/core 0/0)****
=============================================================================
 Asic/core |                    NAME                     |   prev   |  current  |  delta
=============================================================================
0   0   NO_EXCEPTION                                     35364016   35364108    92
0   0   IPV4_CHECKSUM_ERROR                              0          0           0
0   0   ROUTED_AND_IP_OPTIONS_EXCEPTION                  2          2           0
0   0   CTS_FILTERED_EXCEPTION                           0          0           0
0   0   AUTH_DRIVEN_DROP                                 0          0           0
0   0   PKT_DROP_COUNT                                   0          3732        3732
0   0   ALLOW_DOT1Q_EXCEPTION_COUNT                      0          0           0
0   0   ALLOW_PRIORITY_TAGGED_EXCEPTION_COUNT            0          0           0
0   0   IGR_EXCEPTION_L5_ERROR                           0          363         363
0   0   IP_UNICAST_TTL_REACHED_ZERO                      0          0           0
0   0   MISC_FATAL_ERROR                                 0          0           0
```

- Every packet passing through Port Asic gets parsed by the port-asic's on both receive and transmit side
- Exception drops are counted per Asic, not per port.

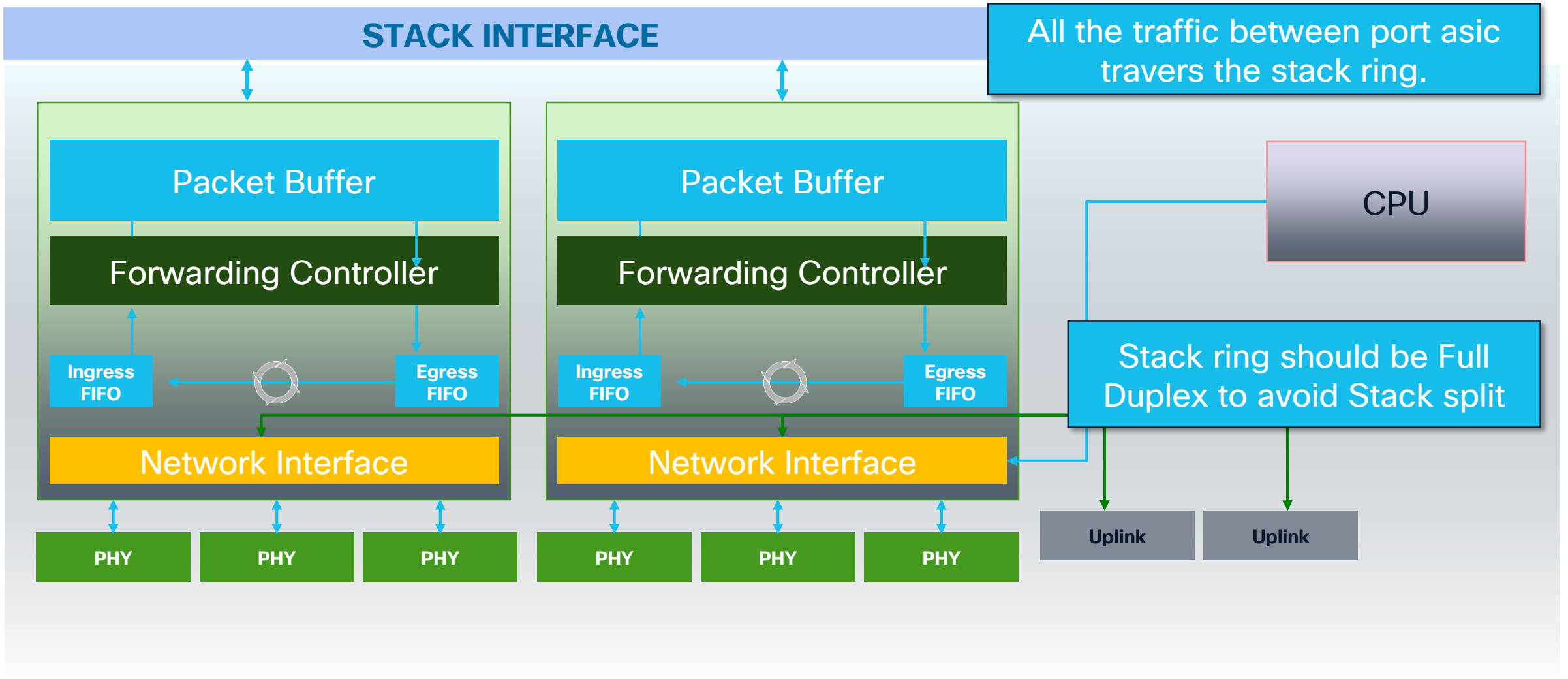
Forwarding Verification

Troubleshooting Forwarding

- Many layers are involved in forwarding
- Troubleshoot from top (IOSd) down toward the hardware layer
- 9500X and 9600 (Supervisor 2) use Silicon One
  All other models based on UADP architecture
- Packet processing happens on port asics.
- CPU path only supports limited packet forwarding.
- Understand HW architecture to understand Flow of the packet through the system



Catalyst 9200/9300 Stackable Switches

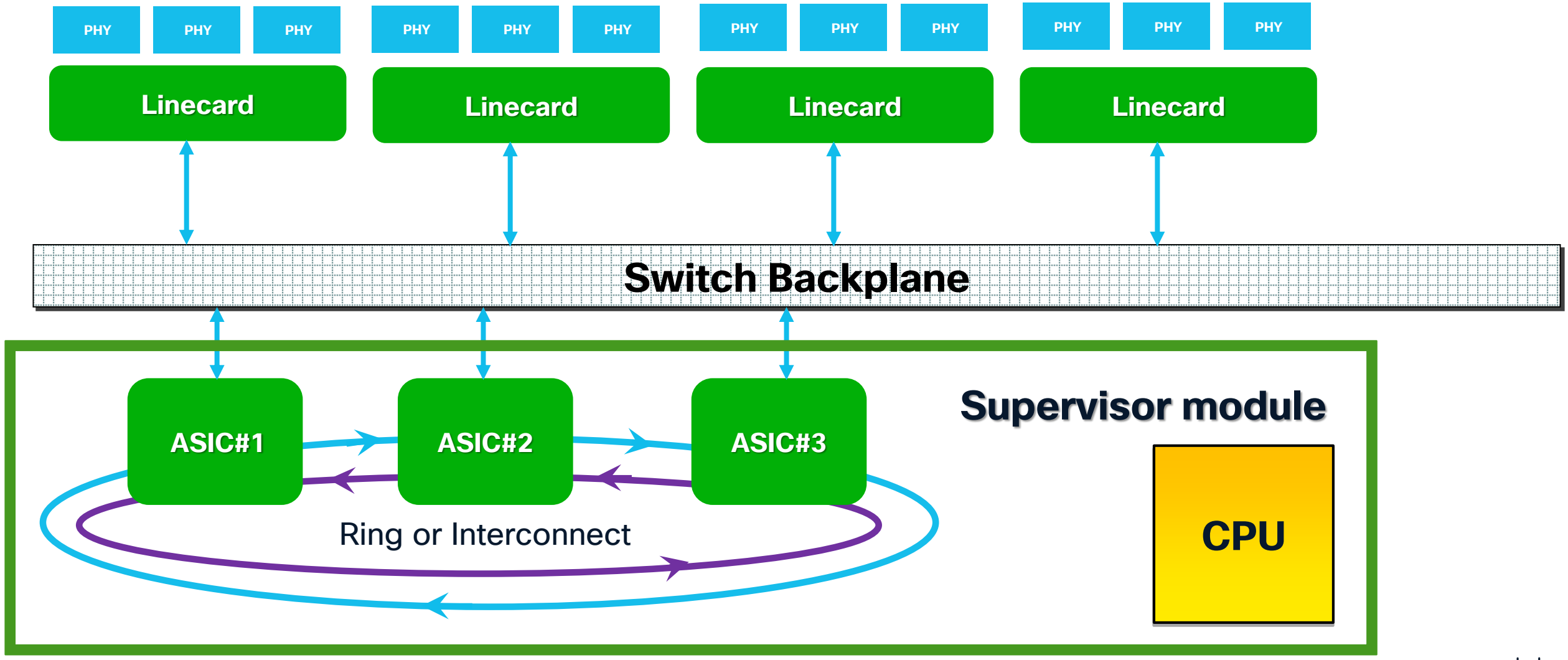


Switch Stacks

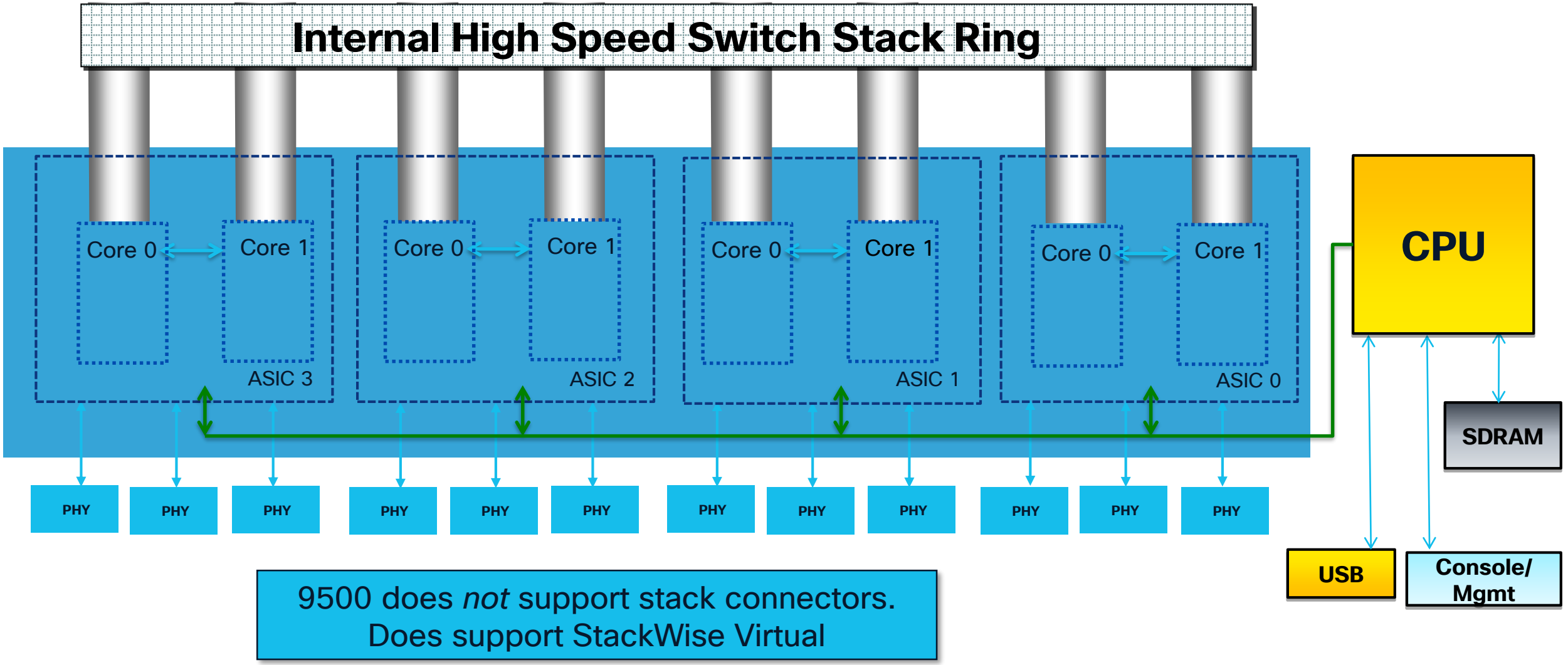
```
9300_10#sh switch stack-ports summary
Sw#/Port#   Port Status   Neighbor/Port   Cable Length    Link OK   Link Active   Sync OK   #LinkOK   In Loopback
-----------------------------------------------------------------------------------------------------------
1/1         OK            4/2             100cm           Yes       Yes           Yes       1         No
1/2         OK            2/1             50cm            Yes       Yes           Yes       1         No
2/1         OK            1/2             50cm            Yes       Yes           Yes       2         No
2/2         OK            3/1             50cm            Yes       Yes           Yes       1         No
3/1         OK            2/2             50cm            Yes       Yes           Yes       1         No
3/2         OK            4/1             50cm            Yes       Yes           Yes       2         No
4/1         OK            3/2             50cm            Yes       Yes           Yes       1         No
4/2         OK            1/1             100cm           Yes       Yes           Yes       2         No
```

- Ensure all stack ports are connected and Link Ok to ensure stack is running with redundancy and full bandwith
- High Number of #linkOK or inability to read cable length might indicate bad cable/stack ports
- Show tech-support stack to gather detailed information

Catalyst 9400/9600 Chassis based



Catalyst 9500 Fixed Switches



9500 does *not* support stack connectors.
Does support StackWise Virtual

Interface Internal Mappings

Interface to ASIC mapping important to understand data flows

```
9300_1#show platform software fed switch active ifm mappings
Interface                IF_ID     Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
GigabitEthernet1/0/1     0x8         1    0    1    0       0      26   6    1    1    NIF  Y
GigabitEthernet1/0/2     0x4c        1    0    1    1       0      6    7    2    2    NIF  Y
GigabitEthernet1/0/3     0x4d        1    0    1    2       0      28   8    3    3    NIF  Y
```

Internally used interface addressing:

- LPN : Local Port Number
- GPN : Global Port Number
- IF_ID : Interface Identification, used for many fed CLI
- Type : Type of interface, NIF = Network Interface
- Inst : Instance : ASIC + Core
- Port : Asic Ports
- Active : Is Interface Active

Troubleshoot between ports on same ASIC when possible

IFM Mappings logical interface

```
9600_SVL#show platform software fed switch active ifm interfaces vlan
Interface                              IF_ID                State
-------------------------------------------------------------------
Vlan1                                  0x0005ffff           READY
Vlan123                                0x00420012           READY
Vlan900                                0x00420010           READY
9600_SVL#show platform software fed switch active ifm interfaces svi
Interface                              IF_ID                State
-------------------------------------------------------------------
Vlan123                                0x0000013b           READY
9600_SVL#show platform software fed switch active ifm interfaces tunnel
Interface                              IF_ID                State
-------------------------------------------------------------------
Tunnel1                                0x00000143           READY
```

- An unique IF_ID is assigned to every logical and physical.
- Every type of interface has its unique IF_ID.
  Ex:Layer 2 Vlan has a different IF_ID as the Layer 3 SVI

IF_ID more detail

```
9600_SVL#show platform software fed switch active ifm if-id 0x138
Interface IF_ID          : 0x0000000000000138
Interface Name           : FortyGigabitEthernet2/1/0/1
Interface Block Pointer  : 0x7f33b89fd918
Interface Block State    : READY
Interface State          : Enabled
Interface Status         : ADD, UPD
Interface Type           : ETHER
Port Type           : ROUTE PORT
Port Location       : LOCAL
Slot                : 15
Unit                : 0
Slot Unit           : 1
SNMP IF Index       : 148
GPN                 : 577
Port Handle         : 0xb7000104
IPv4 MTU            : 9100
IPv6 MTU            : 0
IPv4 VRF ID         : 0x0
IPv6 VRF ID         : 0x0
Protocol flags      : 0x0007 [ ipv4 ipv6 pim_ipv4 ]
```

Specifying the IF-ID gives verbose information

Information available varies depending on Interface Type

One VRF ID per VRF, VRF ID 0 is Global Routing Table

Layer 2 Forwarding. Verifying HW STP state

- Show spanning tree gives IOSd view of Spanning Tree
- Hardware forwarding states can be checked *per switch* on FED layer
- Outputs will show what interface are in forwarding state and if traffic is tagged or untagged
- Flood list indicates what Ports will receive flooded traffic on this switch

```
9300_54#sh platform hardware fed switch active vlan 192 egress
VLAN STP State in hardware
vlan id is:: 192
Interfaces in forwarding state: : Gi1/0/11(Untagged), Te1/1/1(Untagged), Te1/1/4(Tagged)
9300_54#sh platform hardware fed switch active vlan 192 ingress
VLAN STP State in hardware
vlan id is:: 192
Interfaces in forwarding state: : Gi1/0/11(Untagged), Te1/1/1(Untagged), Te1/1/4(Tagged)
flood list: : Gi1/0/11, Te1/1/1, Te1/1/4
```

Layer 2 Forwarding, IOSd mac address tables

```
9300_54#show mac address vlan 192
          Mac Address Table
Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
 192    0000.cafe.cafe    DYNAMIC     Gi1/0/11
 192    0013.c3c1.0d89    DYNAMIC     Gi1/0/11
 192    0050.5693.5e70    DYNAMIC     Te1/1/4
 192    a0f8.4910.2dd3    STATIC      Vl192
 192    d0ec.35c9.d353    DYNAMIC     Te2/1/1
Total Mac Addresses for this criterion: 5
```

- Show mac address-table command shows overview of All mac addreses That includes Mac Addresses owned by the switch
- IOSd shows global view in the system.
  FED on each stack member maintains its own Mac Address Table

FED MATM Mac Address Table

```
9300_1#sh platform software fed switch 1 matm macTable vlan 100
VLAN   MAC                 Type   Seq#   EC_Bi  Flags  machandle   siHandle    diHandle  *a_time *e_time  ports
-------------------------------------------------------------------------------------------------------------------
192    0000.cafe.cafe       0x1   71718      0      0  0x7f2348    0x7f2198    0x7f2478  300      112   GigabitEthernet1/0/11
192    d0ec.35c9.d353     0x101   71719      0      0  0x7f2328    0x7f2148    0x7f2588  300       14   TenGigabitEthernet2/1/1
192    0013.c3c1.0d89       0x1   71720      0      0  0x7f23d8    0x7f2378    0x7f4278  300       11   GigabitEthernet1/0/11
192    a0f8.4910.2dd3    0x8002       0      0     64  0x7f2308    0x7f21c8    0x5234      0        0   Vlan192
192    0050.5693.5e70       0x1   12772      0      0  0x7f23d8    0x7f2358    0x7f23e8  300       13   TenGigabitEthernet1/1/4

*a_time=aging_time(secs)  *e_time=total_elapsed_time(secs)
Type:
MAT_DYNAMIC_ADDR          0x1  MAT_STATIC_ADDR           0x2  MAT_CPU_ADDR              0x4  MAT_DISCARD_ADDR          0x8
MAT_ALL_VLANS            0x10  MAT_NO_FORWARD           0x20  MAT_IPMULT_ADDR          0x40  MAT_RESYNC               0x80
MAT_DO_NOT_AGE          0x100  MAT_SECURE_ADDR         0x200  MAT_NO_PORT             0x400  MAT_DROP_ADDR           0x800
MAT_DUP_ADDR           0x1000  MAT_NULL_DESTINATION    0x2000  MAT_DOT1X_ADDR         0x4000  MAT_ROUTER_ADDR        0x8000
MAT_WIRELESS_ADDR     0x10000  MAT_SECURE_CFG_ADDR    0x20000  MAT_OPQ_DATA_PRESENT  0x40000  MAT_WIRED_TUNNEL_ADDR 0x80000
MAT_DLR_ADDR         0x100000  MAT_MRP_ADDR          0x200000  MAT_MSRP_ADDR        0x400000  MAT_LISP_LOCAL_ADDR   0x800000
MAT_LISP_REMOTE_ADDR 0x1000000 MAT_VPLS_ADDR        0x2000000
```

- Type Field indicates the type of mac address using bitmap.
- Sequence number of an entry changing would indicate relearning
- Owning FED responsible for aging entries. MAT_DO_NOT_AGE bit set in type for non owning FED instances

Layer 3 Forwarding. Routing protocols

```
9300_20#sh ip route 10.48.13.0
Routing entry for 10.48.13.0/24
  Known via "isis", distance 115, metric 30, type level-2
  Redistributing via isis
  Last update from 172.18.255.9 on TenGigabitEthernet1/0/47, 00:40:35 ago
  Routing Descriptor Blocks:
  * 172.18.255.9, from 172.31.254.18, 00:40:35 ago, via TenGigabitEthernet1/0/47
      Route metric is 30, traffic share count is 1

9300_20#show ip arp 172.18.255.9
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  172.18.255.9            41   0072.78f8.aed6  ARPA   TenGigabitEthernet1/0/47
```

- Verify routing table and next hop information with known correct path
- Confirm the route shown is covered by the correct subnet and learned by the expected routing protocol.

Cisco Express Forwarding

- CEF shows the Forwarding Information Base showing how traffic will be forwarded through the system.
- Sources show where the route is learned from. RIB(Routing Information Base)
- Use Detail or Internal keywords to get even more detail

```
9300_20#show ip cef 10.48.13.0 internal
10.48.13.0/24, epoch 4, RIB[I], refcnt 6, per-destination sharing
  sources: RIB
  feature space:
    IPRM: 0x00028000
    Broker: linked, distributed at 4th priority
  ifnums:
    TenGigabitEthernet1/0/47(144): 172.18.255.9
  path list 70C9760F41F0, 327 locks, per-destination, flags 0x4D [shble, hvsh, rif, hwcn]
    path 70C978450268, share 1/1, type attached nexthop, for IPv4
      nexthop 172.18.255.9 TenGigabitEthernet1/0/47, IP adj out of TenGigabitEthernet1/0/47, addr
172.18.255.9 70C9761536E8
  output chain:
    IP adj out of TenGigabitEthernet1/0/47, addr 172.18.255.9 70C9761536E8
```

Cisco Express Forwarding

```
9300_20#show adjacency 172.18.255.9 detail
Protocol Interface                 Address
IP       TenGigabitEthernet1/0/47  172.18.255.9(174)
                                   0 packets, 0 bytes
                                   sourced in sev-epoch 9
                                   Encap length 14
                                   007278F8AED6007278F813550800
                                   L2 destination address byte offset 0
                                   L2 destination address byte length 6
                                   Link-type after encap: ip
                                   ARP
9300_20#sh ip arp TenGigabitEthernet 1/0/47
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  172.18.255.10           -   0072.78f8.1355  ARPA   TenGigabitEthernet1/0/47
Internet  172.18.255.9          221   0072.78f8.aed6  ARPA   TenGigabitEthernet1/0/47
```

- CEF adjacency displays next hop information.
- Layer 2 rewrite information displayed to verify Destination and Source Mac Address of rewritten packet

Forwarding Manager (FP/RP)

- Forwarding Manager should show the prefix on both Standby/Active RP and on all FP (stack members or supervisor modules)
- aom id shown with FP can be used to display prefix in object manager

```
9300_20#sh platform software ip switch active F0 cef prefix 10.48.13.0/24 detail
Forwarding Table
10.48.13.0/24 -> OBJ_ADJACENCY (0x4a), urpf: 81
Prefix Flags: unknown
aom id: 11562925, HW handle: (nil) (created)

9300_20#sh platform software object-manager switch active f0 object 11562925
Object identifier: 11562925
  Description: PREFIX 10.48.13.0/24 (Table id 0)
  Obj type id: 71
  Obj type: route-pfx
  Status: Done, Epoch: 0, Client data: 0x452c6ae8
```

Forwarding Manager (FP/RP)

- Forwarding Manager should show the prefix on both Standby/Active RP and on all FP (stack members or supervisor modules)
- aom id shown with FP can be used to display prefix in object manager

```
9300_20#show platform software adjacency switch active f0 index 0x4a
Adjacency id: 0x4a (74)
  Interface: TenGigabitEthernet1/0/47, IF index: 144, Link Type: MCP_LINK_IP
  Encap: 0:72:78:f8:ae:d6:0:72:78:f8:13:55:8:0
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 9100
  Flags: no-l3-inject
  Nexthop addr: 172.18.255.9
  IP FRR MCP_ADJ_IPFRR_NONE 0
  aom id: 8386846, HW handle: (nil) (created)
```

Forwarding Manager (FP/RP)

- By using downlinks, parents and children keyword the hierarchy in object manager can be explored for related objects

```
9300_20#show platform software object-manager switch active f0 object 8386846
Object identifier: 8386846
  Description: adj 0x4a, Flags None
  Obj type id: 40
  Obj type: adj
  Status: Done, Epoch: 0, Client data: 0x4546afd8
9300_20#sh plat soft object-manager switch active f0 object 8386846 downlinks
Object identifier: 987
  Description: PREFIX 0.0.0.0/0 (Table id 0)
  Status: Done
Object identifier: 11562925
  Description: PREFIX 10.48.13.0/24 (Table id 0)
  Status: Done
..
```

Error Objects

- Error object that do not get cleared could suggest forwarding issues
- Lookup objects to verify relationship to potential issues

```
9600X_50#show platform software object-manager f0 statistics
Forwarding Manager Asynchronous Object Manager Statistics
Object update: Pending-issue: 2, Pending-acknowledgement: 0
Batch begin:   Pending-issue: 0, Pending-acknowledgement: 0
Batch end:     Pending-issue: 0, Pending-acknowledgement: 0
Command:       Pending-acknowledgement: 0
Total-objects: 1897
Stale-objects: 0
Resolve-objects: 0
Childless-delete-objects: 0
Backplane-objects: 0
Error-objects: 9
Number of bundles: 0
Paused-types: 0
```

Error Objects

- Use keyword error-object, pending-* to see object id's
- Check objects in error to confirm their detail and possible impact

```
9600X_50#sh platform software object-manager f0 error-object
Object identifier: 650830
  Description: LB 0x10000417
  Status: Modify/delete-failed
9600X_50#sh platform software object-manager f0 object 650830
Object identifier: 650830
  Description: LB 0x10000417
  Obj type id: 60
  Obj type: loadbalance
  Status: Modify/delete-failed, Epoch: 0, Client data: 0xad0635e8
```

FED Routing tables

```
9300_20#show plat software fed switch active ip  route 10.48.13.0/24 detail
vrf   dest             htm            flags   SGT   DGID Last-modified             SecsSinceHit
---   ----             ---            -----   ---   ---- ------------------------- ------------
0     10.48.13.0/24    0x78bcb94983a8 0x0     0     0    2025/02/04 20:36:50.190            3
  FIB: prefix_hdl:0x2600007a, mpls_ecr_prefix_hdl:0, sgtOverWrite: 0
  ========== OCE chain =====
  ADJ:objid:74 {link_type:IP ifnum:0x90, adj:0x62000050, si: 0x78bcb9199178  IPv4:    172.18.255.9 }
[Output omitted]
Station Index (SI) [0xc3]
RI = 0x1f
DI = 0x53a8
Replication Bitmap: LD
Destination index   = 0x53a8
pmap                = 0x00000000 0x400000000000
pmap_intf : [TenGigabitEthernet1/0/47]
..
```

- FED layer output dependant on platform used (S1 vs Doppler)
- Replication Bitmap (per Asic/Core) shows if traffic is Local, Remote or to other Core on forwarding asic.
- Bits in pmap are set for interfaces that will receive traffic

FED Adjacency table

- FED Adjacency tables show detail regarding how to possibly packet will be rewritten
- Rewrite happens on Egress

```
9300_20#sh platform software fed switch 1 ip adj 172.18.255.9 detail
IPV4 Adj entries
dest            if_name         dst_mac           si_hdl   ri_hdl   adj_id Last-modified
172.18.255.9    TenGiga1/0/47   0072.78f8.aed6    0x78178  0x78158  0x4a   2024/12/31 16:31:09
Asic        SI-Index                DI-Index
----        --------                -------
0           195                     0x53a8
Destination index    = 0x53a8
pmap                 = 0x00000000 0x400000000000
pmap_intf : [TenGigabitEthernet1/0/47]
Rewrite info:
 ASIC#:0 RI:31 Rewrite_type:AL_RRM_REWRITE_L3_UNICAST_IPV4_SHARED(1)
Mapped_rii:L3_UNICAST_IPV4(9)
        MAC Addr: MAC Addr: 00:72:78:f8:ae:d6, L3IF LE Index 38
```

FED Tables, Silicon One

```
9600X_50#show plat software fed active ip  route 10.48.13.0/24
IPV4ROUTE_ID:id:0x5dd182def298 nobj:(IPNEXTHOP_ID,0x1000001d) 10.48.13.0/24 tblid:0 DA:0
   NPD: device:0 lspa_rec:0 api_type:route(3)
   SDK: is_host:0 l3_dest:0x7b8bedf76590 l3_dest:la_l3_fec_impl_base(oid=2851) vrf(gid/oid):0/0x267
  ADJ:objid:0x1000001d (IPv4: 172.31.250.218)  nh_type:NHADJ_NORMAL iif_id:0x4bc ether_type:0x8
#child:105
      srcmac:a453.0e46.22c5 dstmac:4ce1.75eb.0e82
     NPD: fec_oid:2851 was_nor_nh:1 cr_def:0 stale:0 l3port_valid:1
     NPD: device:0 nh_gid/oid:10/0xb1a old_gid/oid:0/0x0 parent_oid:2711
     SDK: cla_nhtype:0
9600X_50#show plat software fed active ip adj 172.31.250.218
Number of IPv4 Adjacency entries: 13
Adjacency ID        Adjacency IPAddress     Dest MacAddr        Nexthop Type    Interface
0x1000001d          172.31.250.218          4ce1.75eb.0e82      NORMAL          HundredGigE1/0/16
```

- Silicon One outputs differ from Doppler based platform on FED layer but can provide similar outputs
- Note : Not all FED commands work on both Doppler and S1.

TCAM route utilization

```
9300_20#sh platform software fed switch active ip route summary
Total number of v4 fib entries = 11348
Total number succeeded in hardware = 8186

 Mask-Len 0 :-  Total-count 1  hw-installed count 1
 Mask-Len 4 :-  Total-count 1  hw-installed count 1
 Mask-Len 8 :-  Total-count 2  hw-installed count 2
 Mask-Len 24 :-  Total-count 10002  hw-installed count 8171
 Mask-Len 30 :-  Total-count 1331  hw-installed count 0
 Mask-Len 32 :-  Total-count 11  hw-installed count 11
```

- Hardware installed count should match Total-Count
- Routes not installed into Hardware are mostly due to resource issues
- TCAM's use regions to program hardware.

Verifying TCAM Utilization

```
9300_20#show platform hardware fed switch active fwd-asic resource tcam utilization
Codes: EM - Exact_Match, I - Input, O - Output, IO - Input & Output, NA - Not Applicable
CAM Utilization for ASIC  [0]
 Table                  Subtype      Dir      Max      Used    %Used       V4       V6     MPLS    Other
 ---------------------------------------------------------------------------------------------------
 Mac Address Table      EM           I      32768        97    0.30%        0        0        0       97
 Mac Address Table      TCAM         I       1024        21    2.05%        0        0        0       21
 L3 Multicast           EM           I       8192         0    0.00%        0        0        0        0
 L3 Multicast           TCAM         I        512         9    1.76%        3        6        0        0
 L2 Multicast           EM           I       8192         0    0.00%        0        0        0        0
 L2 Multicast           TCAM         I        512        11    2.15%        3        8        0        0
 IP Route Table         EM           I      24576        12    0.05%       11        0        1        0
 IP Route Table         TCAM         I       8192      8190   99.98%     8177       10        2        1
 QOS ACL                TCAM         IO      5120       181    3.54%       52       86        0       43
 Security ACL           TCAM         IO      5120       129    2.52%       26       58        0       45
 Netflow ACL            TCAM         I        256        42   16.41%       20       20        0        2
```

- TCAM Full situation can lead to performance issues
- Choose suitable SDM template to optimize TCAM allocation
- TCAM utilization can vary per ASIC
- Check syslog for error messages

Verifing Hardware Forwarding

- Catalyst 9000 based switches allow for packets to be send through the system to verify hardware forwarding.
- Show Platform Hardware switch <id> fed forward command allows building packet from CLI of through pcap to verify hardware forwarding
- Using “exact-route” provides a faster response with less detailed outputs
- Use packet parameters as it arives on the interface to see where and if it will be forwarded through the system
- When using full show platform forward see results with Show Platform Hardware switch <id> fed forward last summary|detail

Verifing Hardware Forwarding

```
•9300_20#show platform hardware fed switch 1 forward exact-route interface te 1/0/1 0072.78f8.aed1 0072.78f8.1354 ipv4
10.48.91.151 10.48.13.151 tcp 10001 23  0

•Ingress Packet Details:

ether hdr : dest mac: 0072.78f8.1354, src mac: 0072.78f8.aed1
ether hdr : ethertype: 0x0800 (IPv4)
ipv4  hdr : dest ip: 10.48.13.151, src ip: 10.48.91.151
ipv4  hdr : packet len: 40, ttl: 64, protocol: 6 (TCP)
tcp   hdr : dest port: 23, src port: 10001

Ingress Packet Hexdump (first 128 bytes):

•007278F813550072  78F8AED608004500  0028000100004006  FD410A305B970A30
..

•Egress Interface: TenGigabitEthernet1/0/47

•Egress Packet Details:
ether hdr : dest mac: 0072.78f8.aed6, src mac: 0072.78f8.1355
ether hdr : ethertype: 0x0800 (IPv4)
ipv4  hdr : dest ip: 10.48.13.151, src ip: 10.48.91.151
ipv4  hdr : packet len: 40, ttl: 63, protocol: 6 (TCP)
tcp   hdr : dest port: 23, src port: 10001

Egress Packet Hexdump (first 128 bytes):
007278F8AED60072  78F8135508004500  0028000100003F06  FE410A305B970A30
…
```

Ingress packet

Egress packet

Before needing to troubleshoot

Get familiar with the CLI's
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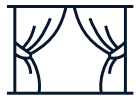

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