# Possibilities

#CiscoLive

# Catalyst 9k Troubleshooting

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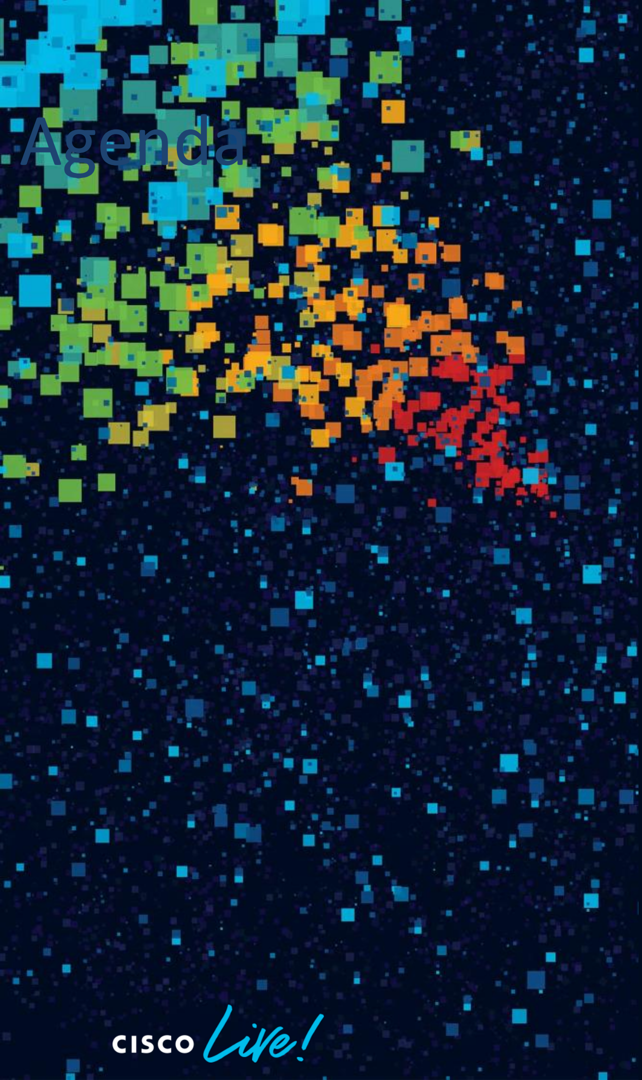


Agenda

# Agenda

- Catalyst 9k Platform & Software Architecture
- Troubleshooting tools
- Platform Issues
- Packet Drops
- Forwarding Issues

# Platform & Software Architecture

# Catalyst 9k family

Cisco Catalyst
9200 Series

Cisco Catalyst
9300 Series

Cisco Catalyst
9400 Series

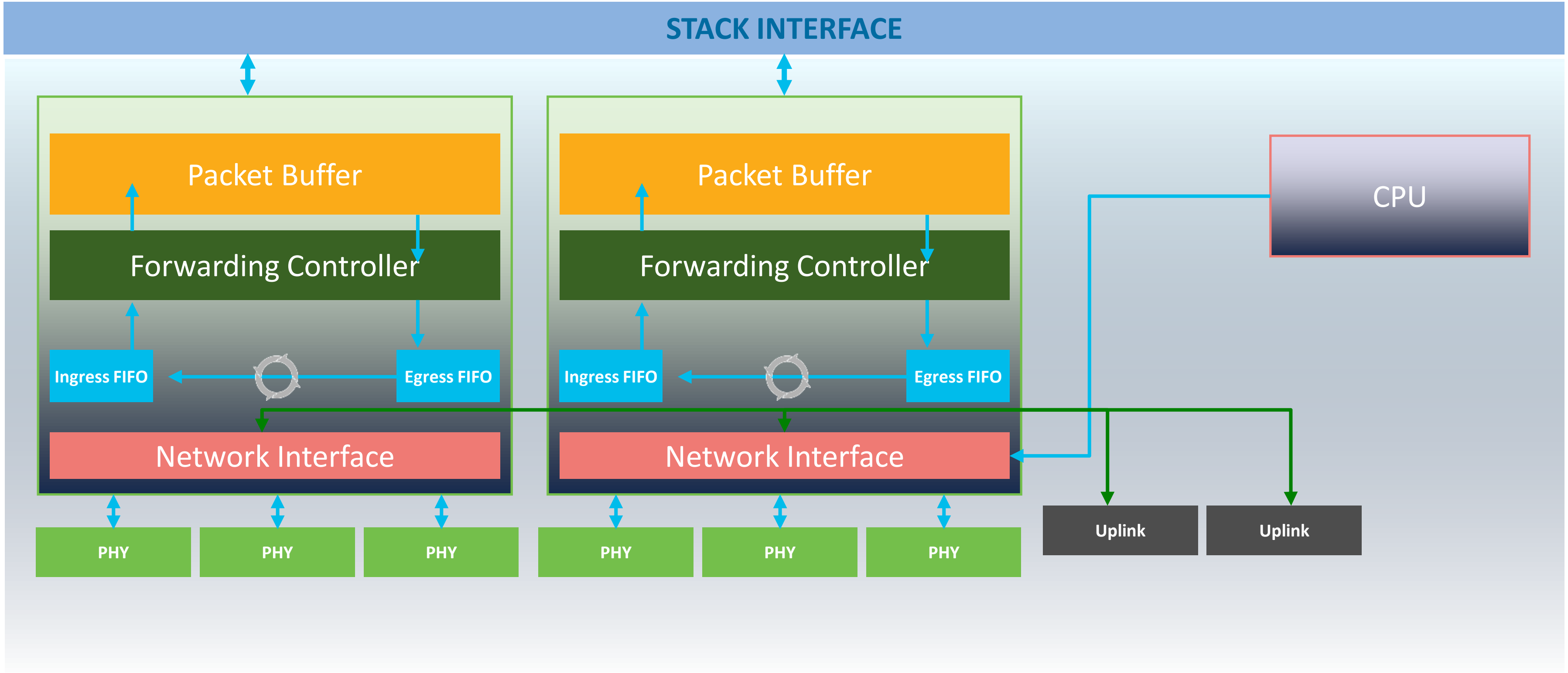
Cisco Catalyst
9500 Series

Cisco Catalyst
9600 Series

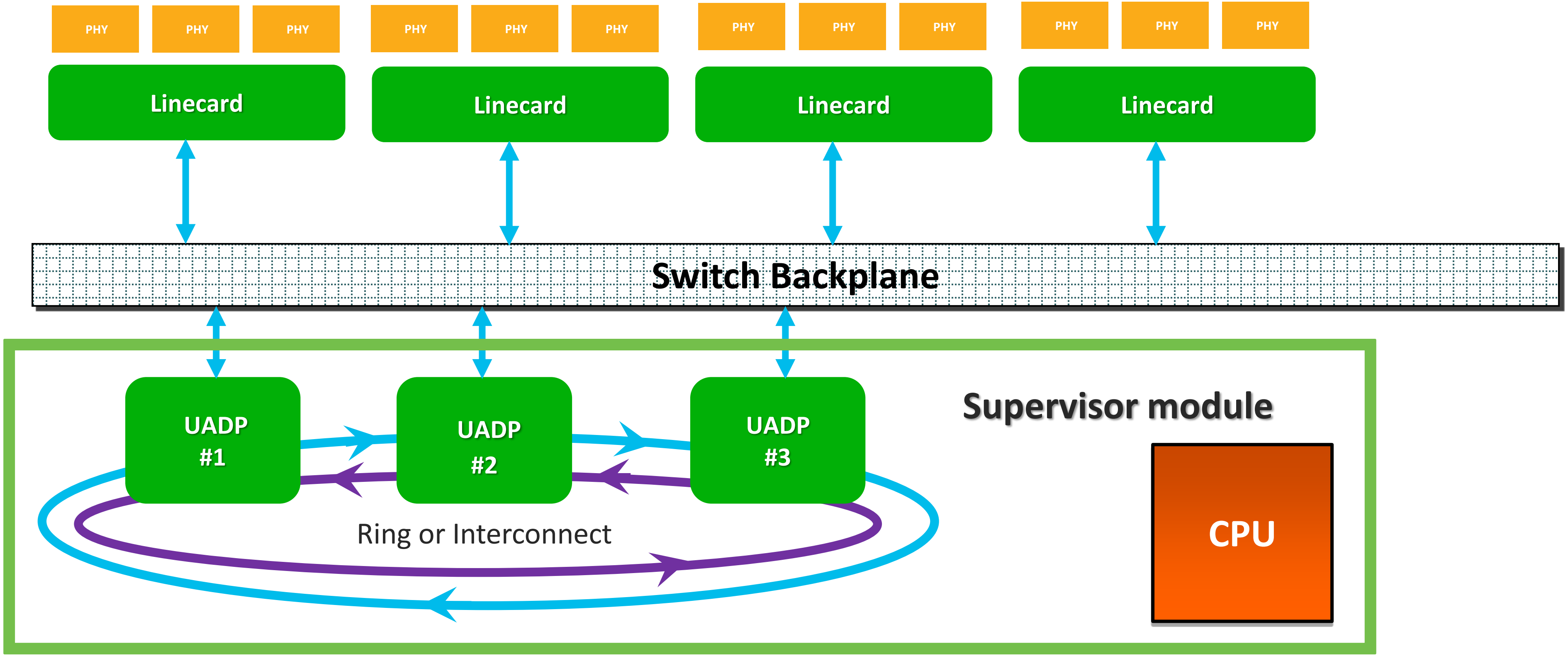
| | 9200 | 9300 | 9400 | 9500 | 9600 |
|---|---|---|---|---|---|
| UADP | 2.0 mini | 2.0 | 2.0 XL | 2.0 XL & 3.0 | 3.0 |
| Format | Stackable | Stackale | Chassis | Standalone | Chassis |

- UADP Asics are the foundation of all Catalyst 9K switches
- 3850/3650 switches originally launches with UADP 1.x
- Port Asics (UADP) responsible for data plan forwarding
- CPU’s handle control plane traffic and forwarding tables

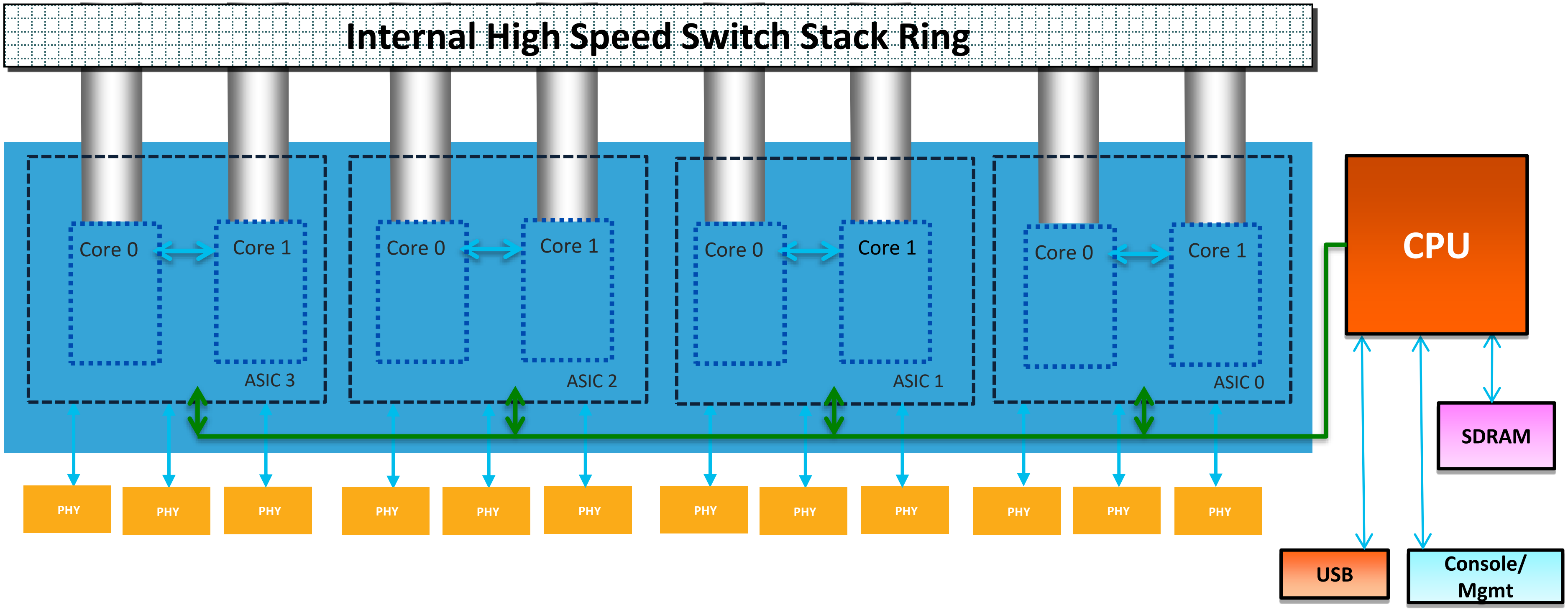
# Catalyst 9200/9300 Stackable Switches



# Catalyst 9400/9600 Chassis based



# Catalyst 9500 Fixed Switches



# 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 , multipurpose ports

# IFM Mappings 9400/9500/9600

```
9500_1#sh platform software fed switch active ifm mappings | inc 1/./[1] |Int
Interface                IF_ID     Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
TenGigabitEthernet1/0/1  0x2c         1    0    1    0       0   11    0    1    1  NIF   Y
TenGigabitEthernet1/1/1  0x18         0    0    0   16       0    0   19   17   17  NIF   N
FortyGigabitEthernet1/1/1 0x3c        0    0    0   24       0    4    4   25   25  NIF   Y

9600_1#sh platform software fed active ifm mappings | inc /0/[12][5] |Int
Interface                IF_ID     Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
FortyGigabitEternet1/0/15 0x17        3    1    1   24       0   30
HundredGigE1/0/25        0x21         0    0    0    0       0    0
TwentyFiveGigE2/0/15     0x47         1    0    1   21       0   21
TwentyFiveGigE2/0/25     0x51         3    1    1    7       0    7

C9407R#sh platform software fed active ifm mappings | inc /0/1 |Int
Interface                IF_ID     Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
GigabitEthernet2/0/1     0x7          1    0    1    0       0    7    7    1  201  NIF   Y
TenGigabitEthernet3/0/1  0x7f         4    2    0   19       0   19    3    1  301  NIF   Y
TenGigabitEthernet4/0/1  0x7e         5    2    1    3       0   11    3    1  401  NIF   Y
GigabitEthernet5/0/1     0x4b         3    1    1    0       0    4    4    1  501  NIF   Y
```

Different mappings on different platforms

# More detail  IF_ID mappings

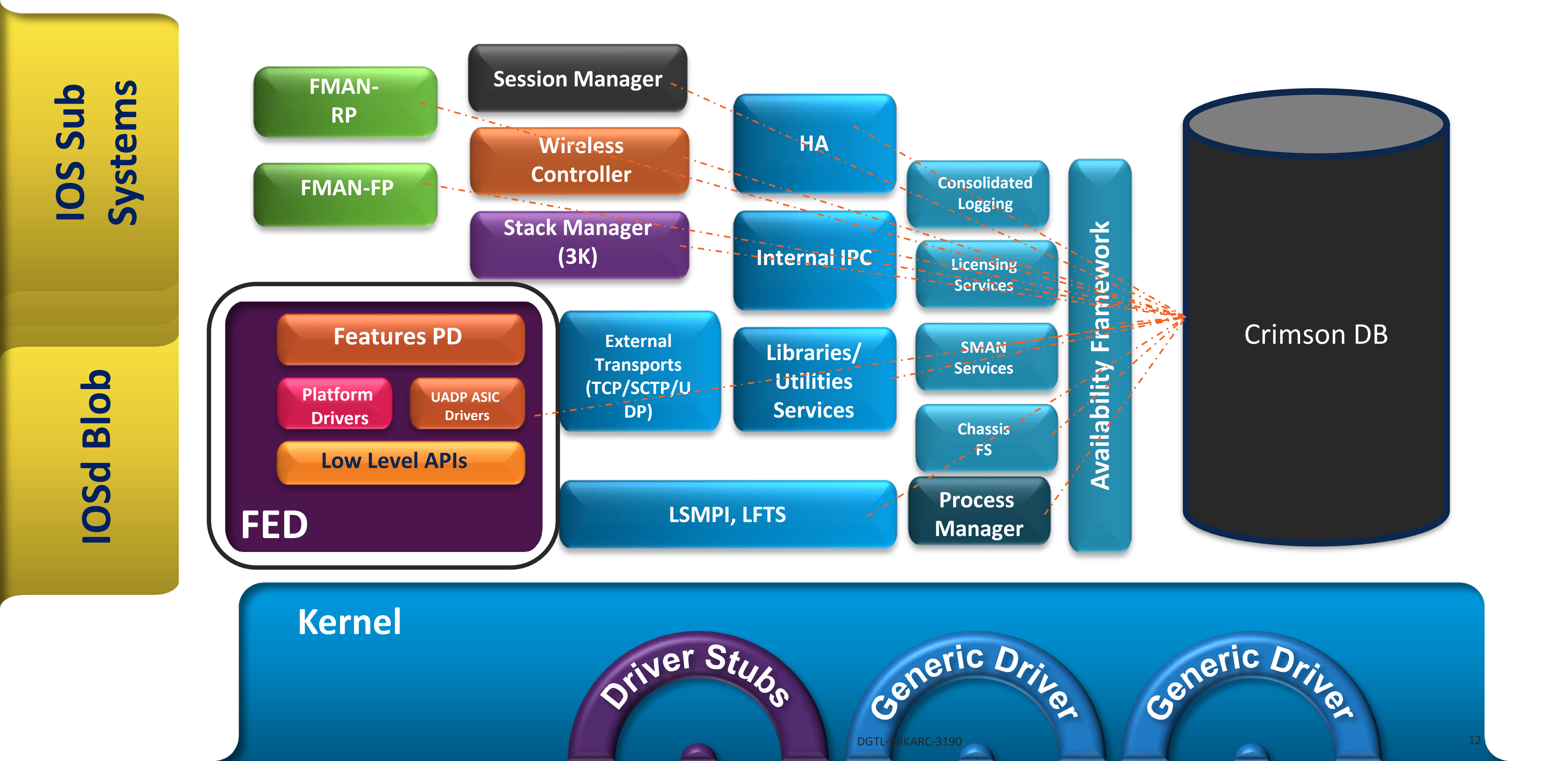
```
9300_1#sh platform software fed switch active ifm interfaces ?
  access-tunnel      Access Tunnel Interface information
  detail             Information for all type interfaces
  efp                EFP Interface Information
  ethernet           Interface ethernet information
  internal           Internal Interface information
  l2-lisp            Layer 2 LISP Interface information
  lisp               LISP Interface information
  loopback           Interface loopback information
  nve                NVE Interface Information
  svi                Interface SVI information
  sw-subif           SW Sub-interface information
  tunnel             Layer 3 Tunnel Interface Information
  vfi-segment        L2VPN VFI Segment Interface Information
  virtualportgroup   Interface vpg information
  vlan               Interface VLAN information
  wired-client       Interface wired client information
```

```
9300_1#sh plat soft fed sw act ifm int svi
Interface     IF_ID     State
------------------------------------
Vlan1       0x0000004b      READY
Vlan100     0x0000005a      READY
```

All physical and logical Interfaces have an IF_ID

More detail about interfaces can be gathered with
**show platform software fed switch <switch> ifm if-id <id>**

# IOS-XE 16 & IOS-XE 17 graphical overview



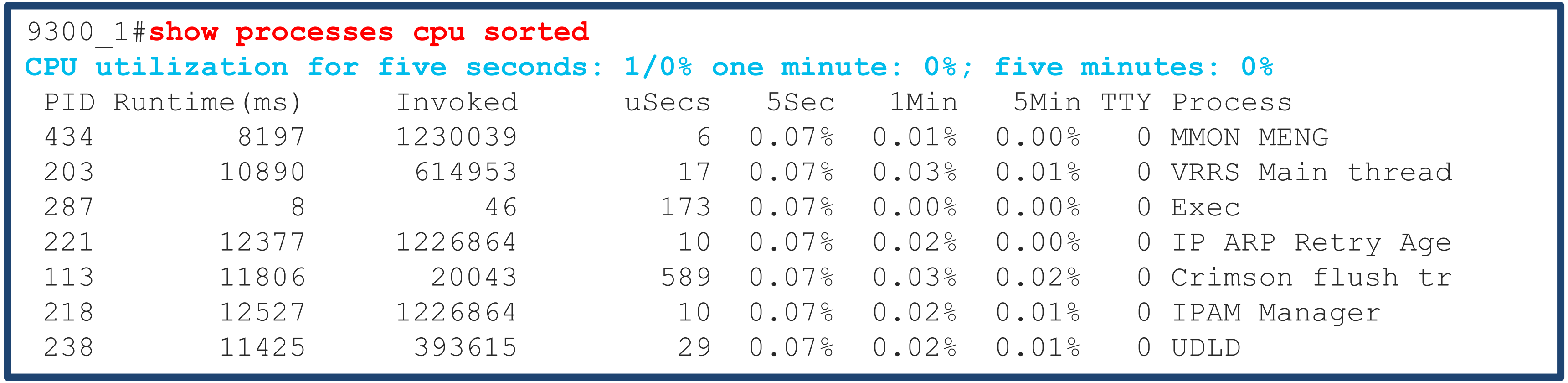
# Kernel CPU information

```
9300_1#sh proc cpu platform sorted location switch active R0
CPU utilization for five seconds:  1%, one minute:  1%, five minutes:  1%
Core 0: CPU utilization for five seconds:  3%, one minute:  2%, five minutes:  2%
Core 7: CPU utilization for five seconds:  1%, one minute:  1%, five minutes:  0%
                  5Sec    1Min    5Min  Status         Size  Name
--------------------------------------------------------------------------------
 14416   13034      6%      6%      6%  S            223452  fed main event
 10014    9623      1%      1%      1%  S             52212  sif_mgr
  9738    9215      1%      1%      1%  S            818660  linux_iosd-imag
```

- Underlaying kernel shows Multi Core Architecture
- IOSd runs as process on kernel-> linux_iosd-image
- Not all processes run on all switches

```
Switch_1#sh processes cpu platform sorted location switch 1 R0 | in fman
 27777   26990      0%      0%      0%  S         314179584  fman_rp
 19145   17642      0%      0%      0%  S         296591360  fman_fp_image
Switch_1#sh processes cpu platform sorted location switch 3 R0 | in fman
 20643   19400      0%      0%      0%  S         296599552  fman_fp_image
```

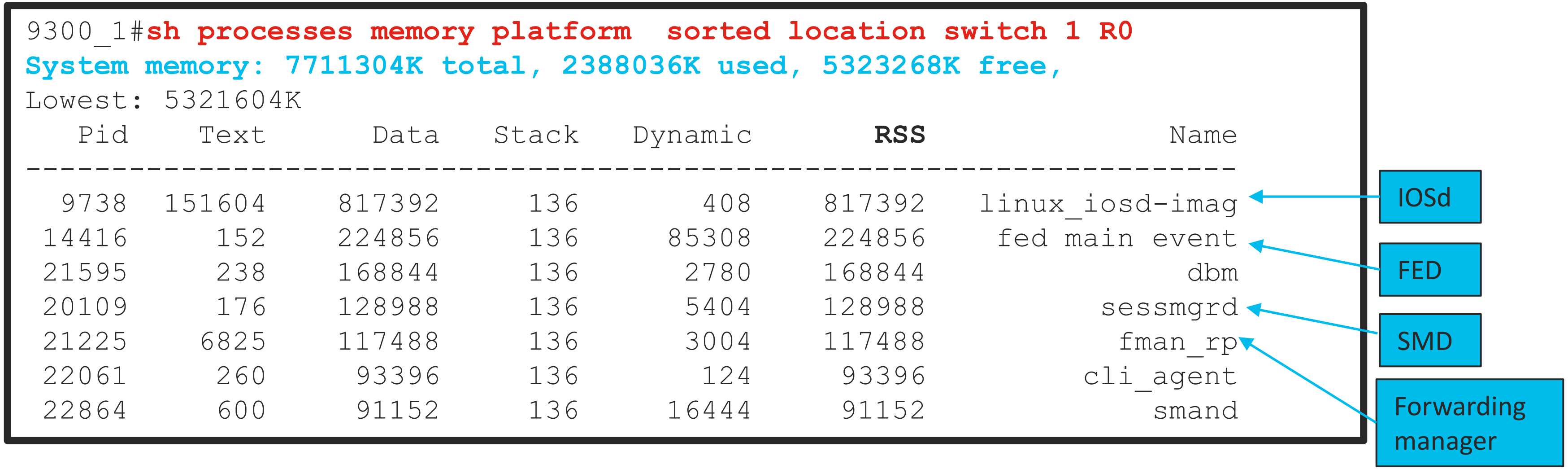
# IOSd CPU utilization



```
9300_1#show processes cpu sorted
CPU utilization for five seconds: 1/0% one minute: 0%; five minutes: 0%
 PID Runtime(ms)     Invoked      uSecs   5Sec   1Min   5Min TTY Process
 434        8197     1230039          6  0.07%  0.01%  0.00%   0 MMON MENG
 203       10890      614953         17  0.07%  0.03%  0.01%   0 VRRS Main thread
 287           8          46        173  0.07%  0.00%  0.00%   0 Exec
 221       12377     1226864         10  0.07%  0.02%  0.00%   0 IP ARP Retry Age
 113       11806       20043        589  0.07%  0.03%  0.02%   0 Crimson flush tr
 218       12527     1226864         10  0.07%  0.02%  0.01%   0 IPAM Manager
 238       11425      393615         29  0.07%  0.02%  0.01%   0 UDLD
```

- Many process like still running as processes inside IOSd process (BGP, RIP, CEF, ARP, UDLD, CDP , etc)
- CPU utilization 1%/0% showing Utilization for Processes and Utilization for Interrupt
- IOSd does not provide multicore architecture

# Platform Memory



```
9300_1#sh processes memory platform  sorted location switch 1 R0
System memory: 7711304K total, 2388036K used, 5323268K free,
Lowest: 5321604K
   Pid    Text      Data   Stack   Dynamic       RSS              Name
------------------------------------------------------------------------
  9738  151604    817392     136       408    817392  linux_iosd-imag
 14416     152    224856     136     85308    224856   fed main event
 21595     238    168844     136      2780    168844              dbm
 20109     176    128988     136      5404    128988         sessmgrd
 21225    6825    117488     136      3004    117488          fman_rp
 22061     260     93396     136       124     93396        cli_agent
 22864     600     91152     136     16444     91152            smand
```

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

# IOSd Memory

```
9300_1#sh processes memory sorted
Processor Pool Total: 1445417856 Used:  290878080 Free: 1154539776
 lsmpi_io Pool Total:    6295128 Used:    6294296 Free:        832

 PID TTY  Allocated      Freed    Holding    Getbufs    Retbufs Process
   0   0  288949984   53306504  214634744          0          0 *Init*
   4   0   22511680     100104   22277344          0          0 RF Slave Main Th
  81   0   24107152    2420648   13717584          0          0 IOSD ipc task
 472   0    4133424     105760    4069608     849828          0 EEM ED Syslog
   0   0   62739512   58194512    2978824   23259559     382788 *Dead*
 609   0    6717728    3968088    2803904          0          0 ISIS Upd
 490   0    1719800      90880    1659432          0          0 EEM Server
```

- 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

# Catalyst IOS-XE Software release schedule

| | Everest 16.6 | Fuji 16.9 | Gibraltar 16.12 | Amsterdam 17.1 | Amsterdam 17.2 |
|---|---|---|---|---|---|
| **Next planned release** | 16.6.9 | 16.9.6 | 16.12.4 | 17.1.2 | 17.2.2 |
| **9200** | No | No | Yes | Yes | Yes |
| **9300/9400/9500** | Yes | Yes | Yes | Yes | Yes |
| **9600** | No | No | Yes | Yes | Yes |
| **Maintenance Throttle** | Yes | Yes | Yes | No | No |

Maintenance throttles receive more rebuilds and thus would be recommended over feature releases

Not all SKU support all IOS-XE versions, above table indicative

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

# Troubleshooting Tools

# Platform Specific Show commands

- Platform Independent Show commands are similar like on any IOS platform.
  Ex. Show cdp, show bgp, show udld

- IOS-XE specific troubleshooting commands are under show platform

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

- *Show platform [hardware|software] fed* contain Platform Dependent troubleshooting for the Catalyst 3k and 9k (FED layer)

```
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
```

- Outputs might vary depending on if it executed on active/standy and or/on Forwarding Processor or Route Processor

# Debugging IOSd processes

- Features running inside IOSd can be debugged in traditional methods/debugs

```
9300_1#debug arp
ARP packet debugging is on
9300_1#debug ip icmp
ICMP packet debugging is on
```

- Some processes on IOSd support additional event-tracing inside IOSd

```
9300_1#sh monitor event-trace arp all
*Jan 20 03:52:48.977: RCV PKT: S: 10.100.10.100 T: 10.100.10.1 IF: Vlan100 OP: rep
*Jan 20 03:52:52.740: RCV PKT: S: 172.17.11.2 T: 172.17.11.1 IF: Vlan1 OP: req
9300_1#sh monitor event-trace  bgp all
Tracing currently disabled, from exec command
```

Global Config:
 monitor event-trace ..

# Debugging, non-IOSd Processes

- IOSd cannot do real time debugging on processes outside IOSd
- To facilitate debugging/logging trace logs are available per process
- Tracing levels set with granularity (default notice). Tracing always on
- Common processes: smd , fed, forwarding-manager

```
Switch#set platform software trace smd switch active R0 dot1x-all debug
Switch#show platform software trace level smd switch active R0 | inc dot1x
dot1x                      Notice
dot1x-all                   Debug
dot1x-redun                  Notice
```

- Processes *can* run on any switch in the stack, not just on active

# Always on Tracing usage

- Tracelog files are stored in crashinfo:/logs in binary format.
- Traces can be displayed using show platform software trace command
- Archive of traces can be created using the command  
  **“request platform software trace archive”**
- Archives contain binary files, not readable with text viewer

Example fed logs from switch 1.

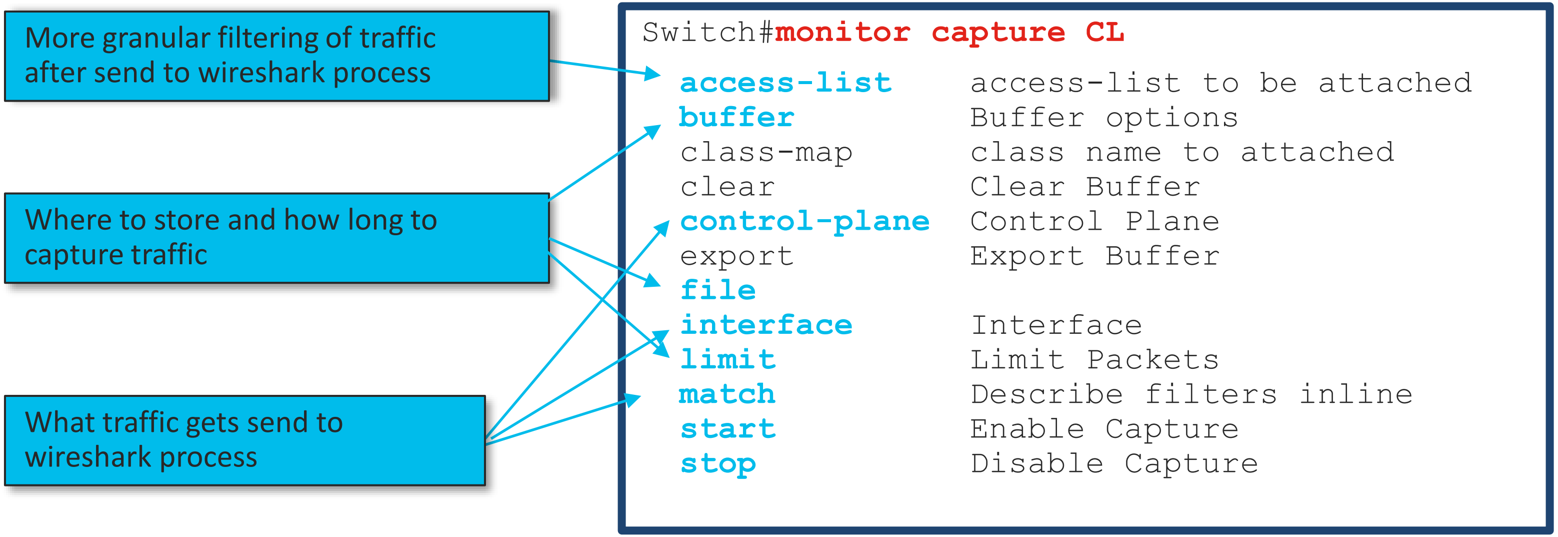
‘| inc dot1x’ filters out dot1x logs

```
Switch#show platform software trace message smd switch active | include dot1x
2020/01/29 21:49:20.540 {smd_R0-0}{1}: [dot1x] [19244]: UUID: 0, ra: 0, TID: 0 (debug): [0000.0000.0000:Gi1/0/1]
Received pkt saddr = 70e4.22e5.c4f7 , daddr = 0180.c200.0003, pae-ether-type = 0x888E
2020/01/29 21:49:20.540 {smd_R0-0}{1}: [dot1x] [19244]: UUID: 0, ra: 0, TID: 0 (debug): [0000.0000.0000:Gi1/0/1]
Queuing an EAPOL pkt on Authenticator Q
2020/01/29 21:49:20.540 {smd_R0-0}{1}: [dot1x] [19244]: UUID: 0, ra: 0, TID: 0 (debug): [0000.0000.0000:unknown]
Pkt body: 02 a3 00 16 04 10 12 ee 6c c4 9e 43 29 ef dd f4 0e 9c ae 75 34 0a
2020/01/29 21:49:20.540 {smd_R0-0}{1}: [dot1x] [19244]: UUID: 0, ra: 0, TID: 0 (info): [70e4.22e5.c4f7:Gi1/0/1]
EAP Packet - RESPONSE, ID : 0xa3
2020/01/29 21:49:20.540 {smd_R0-0}{1}: [dot1x] [19244]: UUID: 0, ra: 0, TID: 0 (info): [70e4.22e5.c4f7:Gi1/0/1]
Received EAPOL packet - Version : 1,EAPOL Type : EAP, Payload Length : 22, EAP-Type = MD5-Challenge
2020/01/29 21:49:20.540 {smd_R0-0}{1}: [dot1x] [19244]: UUID: 0, ra: 0, TID: 0 (debug): [0000.0000.0000:unknown]
Received EAPOL pkt (size=92u) on l2 socket
```

# Embedded Packet Capture (EPC)

- EPC provides insight into both Data Plane and Control Plane traffic
- Captures can be done on Interfaces or Control Plane
- Data can be buffered and exported or stored directly in flash
- Data capture implemented on Port Asics, traffic copied to EPC process.
- EPC process provides deeper packet capture and display filtering
- Analysis can be done off-box or on box using included packet dissectors

# Running Embedded Packet Capture



More granular filtering of traffic after send to wireshark process

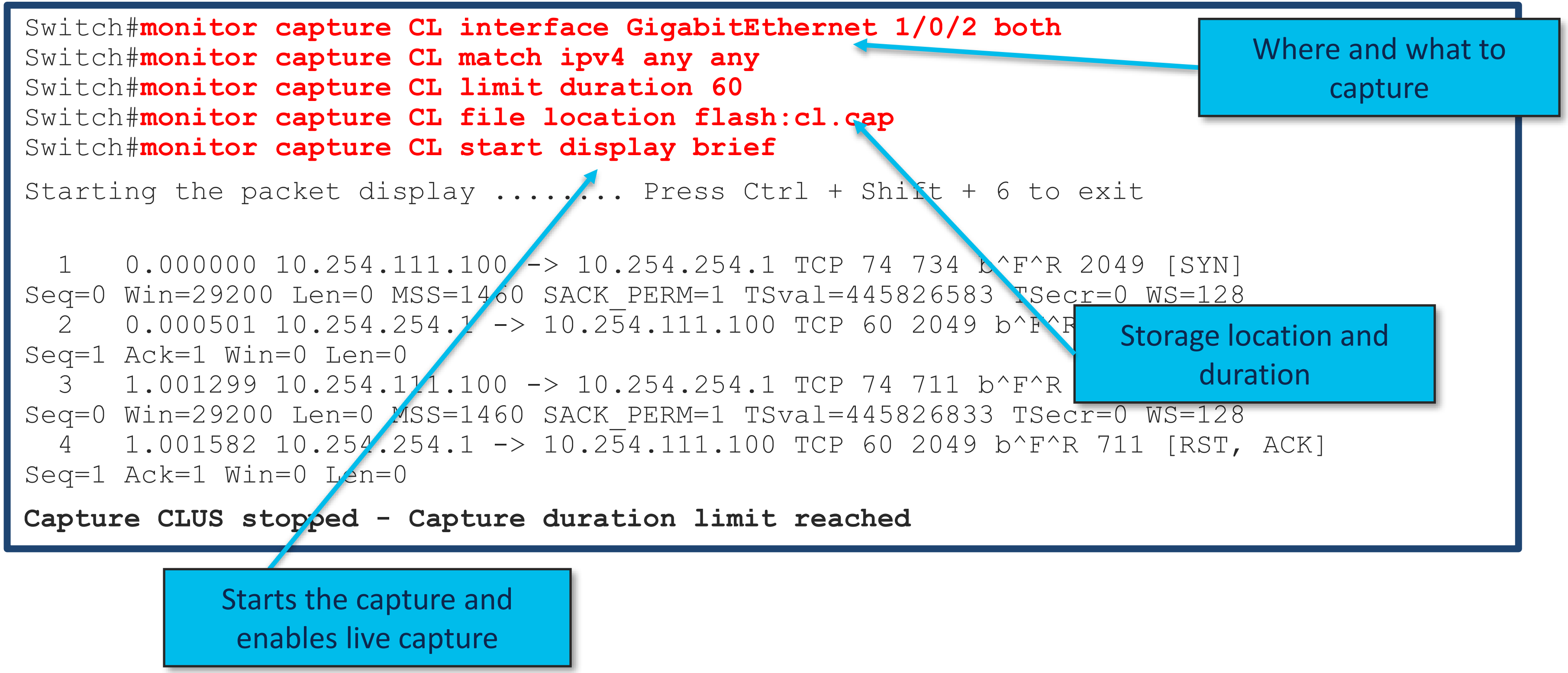
Where to store and how long to capture traffic

What traffic gets send to wireshark process

```
Switch#monitor capture CL
  access-list    access-list to be attached
  buffer         Buffer options
  class-map      class name to attached
  clear          Clear Buffer
  control-plane  Control Plane
  export         Export Buffer
  file
  interface      Interface
  limit          Limit Packets
  match          Describe filters inline
  start          Enable Capture
  stop           Disable Capture
```

Up to 8 capture points can be defined. *One* can be active

# Running Embedded Packet Capture



```
Switch#monitor capture CL interface GigabitEthernet 1/0/2 both
Switch#monitor capture CL match ipv4 any any
Switch#monitor capture CL limit duration 60
Switch#monitor capture CL file location flash:cl.cap
Switch#monitor capture CL start display brief

Starting the packet display ........ Press Ctrl + Shift + 6 to exit


  1   0.000000 10.254.111.100 -> 10.254.254.1 TCP 74 734 b^F^R 2049 [SYN]
Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=445826583 TSecr=0 WS=128
  2   0.000501 10.254.254.1 -> 10.254.111.100 TCP 60 2049 b^F^R
Seq=1 Ack=1 Win=0 Len=0
  3   1.001299 10.254.111.100 -> 10.254.254.1 TCP 74 711 b^F^R
Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=445826833 TSecr=0 WS=128
  4   1.001582 10.254.254.1 -> 10.254.111.100 TCP 60 2049 b^F^R 711 [RST, ACK]
Seq=1 Ack=1 Win=0 Len=0

Capture CLUS stopped - Capture duration limit reached
```

Where and what to capture

Storage location and duration

Starts the capture and enables live capture

# Displaying packet captures

On Box Analysis of saved captures

```
Switch#show monitor capture file flash:cl.cap brief
Starting the packet display ........ Press Ctrl + Shift + 6 to exit
  1   0.000000 10.200.10.100 -> 10.200.10.200 TCP 66 59498 b^F^R 80 [ACK] Seq=1 Ack=1
Switch#show moni capture file flash:cl.cap packet-number 1 detailed | be Transmission
Transmission Control Protocol, Src Port: 59498 (59498), Dst Port: 80 (80), Seq: 1, Ack:
1,  Source Port: 59498
    Destination Port: 80
    Sequence number: 1    (relative sequence number)
    Acknowledgment number: 1    (relative ack number)
    Header Length: 32 bytes
    Flags: 0x010 (ACK)
        000. .... .... = Reserved: Not set
        ...0 .... .... = Nonce: Not set
        .... 0... .... = Congestion Window Reduced (CWR): Not set
        .... .0.. .... = ECN-Echo: Not set
        .... ..0. .... = Urgent: Not set
        .... ...1 .... = Acknowledgment: Set
        .... .... 0... = Push: Not set
        .... .... .0.. = Reset: Not set
        .... .... ..0. = Syn: Not set
        .... .... ...0 = Fin: Not set
        [TCP Flags: *******A****]
    Window size value: 24464
```

Details packet decodes

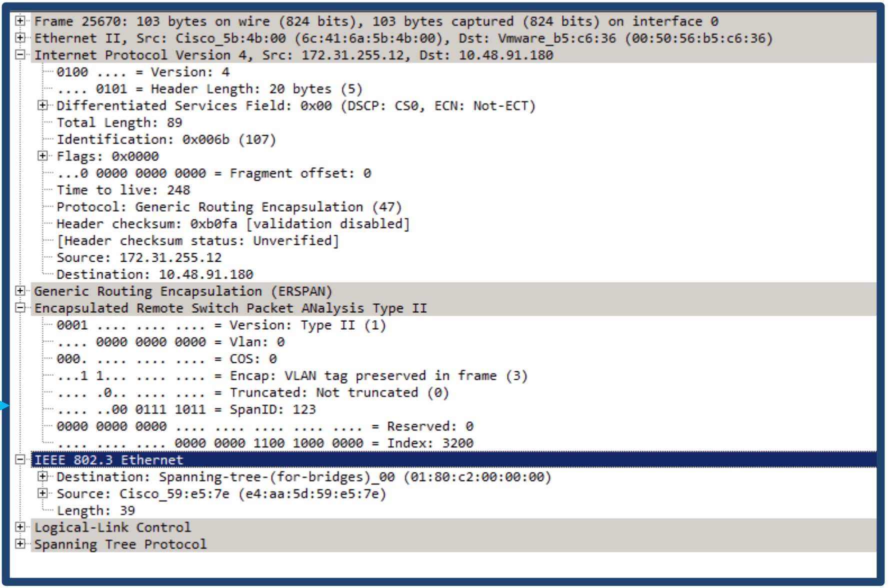
Off Box Analysis using Wireshark also possible

# SPAN

- Local SPAN, local traffic copied to interface on switch (Local)
- Remote SPAN , traffic copied to/from special rspan VLAN (Layer 2 domain)
- Encapsulated RSPAN, traffic encap/decap'd using GRE (Layer 3 domain)

```
monitor session 1 type erspan-source
 source interface Gi2/0/3
 destination
  erspan-id 123
  ip address 10.48.91.180
  origin ip address 172.31.255.12
```

Using ERSPAN to send traffic from Gi2/0/3 to PC



```
⊞ Frame 25670: 103 bytes on wire (824 bits), 103 bytes captured (824 bits) on interface 0
⊞ Ethernet II, Src: Cisco_5b:4b:00 (6c:41:6a:5b:4b:00), Dst: Vmware_b5:c6:36 (00:50:56:b5:c6:36)
⊟ Internet Protocol Version 4, Src: 172.31.255.12, Dst: 10.48.91.180
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  ⊞ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 89
    Identification: 0x006b (107)
  ⊞ Flags: 0x0000
    ...0 0000 0000 0000 = Fragment offset: 0
    Time to live: 248
    Protocol: Generic Routing Encapsulation (47)
    Header checksum: 0xb0fa [validation disabled]
    [Header checksum status: Unverified]
    Source: 172.31.255.12
    Destination: 10.48.91.180
⊞ Generic Routing Encapsulation (ERSPAN)
⊟ Encapsulated Remote Switch Packet ANalysis Type II
    0001 .... .... .... = Version: Type II (1)
    .... 0000 0000 0000 = Vlan: 0
    000. .... .... .... = COS: 0
    ...1 1... .... .... = Encap: VLAN tag preserved in frame (3)
    .... .0.. .... .... = Truncated: Not truncated (0)
    .... ..00 0111 1011 = SpanID: 123
    0000 0000 0000 .... .... .... .... .... = Reserved: 0
    .... .... .... 0000 0000 1100 1000 0000 = Index: 3200
⊟ IEEE 802.3 Ethernet
  ⊞ Destination: Spanning-tree-(for-bridges)_00 (01:80:c2:00:00:00)
  ⊞ Source: Cisco_59:e5:7e (e4:aa:5d:59:e5:7e)
    Length: 39
⊞ Logical-Link Control
⊞ Spanning Tree Protocol
```

# Embedded Event Manager, reacting to events

```
event manager applet RouteChange authorization bypass

event routing network 10.48.91.0/24 type all vrf Bru

  action 0.1 cli command "enable"
  action 1.0 cli command "show ip bgp vpnv4 all | append flash:rclog.txt"
  action 1.1 cli command "show ip route vrf Bru | append flash:rclog.txt"
  action 2 syslog msg "Route change detected, flash:rclog.txt appended"
```

Definition

Trigger

Actions

- EEM framework allows actions to be taken based on a number of triggers
- Assists with information gathering and possibly  corrective actions
- Automated capture allows information to be gather close to an event

# Show Tech Enhancements

- Show tech contains lot of generic information, not feature specific
- For more focused information gathering show tech <keyword>
- Scripted command generation based on provided parameters
- Examples:

    show tech-support cts
    show tech-support port
    show tech-support acl
    show tech-support fabric

Show tech can be large, redirect to flash

```
9300_1#sh tech identity mac 0001.0001.0001 interface Gi 1/0/1 | redirect flash:shtech.log
9300_1#dir flash:shtech.log
Directory of flash:/shtech.log
671754  -rw-          1504931  Jun 10 2019 00:07:47 +00:00  shtech.log
11353194496 bytes total (9337597952 bytes free)
```

# Show tech enhancement example

- Show tech enhancements go further then just show commands
- Results of outputs are used to generate and execute follow up commands

```
9300_1#sh tech-support cef ipv4 10.48.91.128/25 | re flash:shtechcef.log
9300_1#more flash:shtechcef.log | inc ---- show
------------------ show clock ------------------
------------------ show version ------------------
------------------ show running-config ------------------
------------------ show cef state ------------------
------------------ show cef state capabilities ------------------
------------------ show cef table internal ------------------
------------------ show ip cef vrf Default 10.48.91.128/25 internal ------------------
------------------ show ip route 10.48.91.128 255.255.255.128 ------------------
------------------ show interface TenGigabitEthernet1/1/6 ------------------
------------------ show cef interface TenGigabitEthernet1/1/6 internal ------------------
------------------ show adj link IP TenGigabit1/1/6 172.31.250.30 connectionid 0 internal
------------------ show arp 172.31.250.30 TenGigabitEthernet1/1/6 detail ---
------------------ show monitor event-trace cef ipv4 vrf Default 10.48.91.128 all ----
```

# Programmability & Troubleshooting

- IOSXE Programmability helps gathering information and detecting failures
- Ability to execute CLI on IOSd, parse and possibly react to events
- Python (Guest shell)

  Python on guestshell allows interaction with IOSd, config, cli etc

```
9300_1#guestshell enable
9300_1#guestshell run python3
Python 3.6.3 (default, Nov  1 2018, 15:47:26)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-36)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import cli
>>> print (cli.execute("show run | inc app-|iox" ))
iox
app-hosting appid guestshell
 app-vnic management guest-interface 0
```

# Programmability & Troubleshooting

- TCL included in IOS-XE.
- Does not require guestshell to be enabled
- TCL scripts can be sourced from filesystem or inputted

```
9300_1#tclsh
9300_1(tcl)#puts [ exec "show ver" ]
Cisco IOS XE Software, Version 17.01.01
Cisco IOS Software [Amsterdam], Catalyst L3 Switch Software (CAT9K_IOSXE), Version 17.1.1, RELEASE
SOFTWARE (fc3)
Technical Support: http://www.cisco.com/techsupport
```

```
9300_1#tclsh tftp://10.48.91.151/cl.tcl
Loading cl.tcl from 10.48.91.151 (via TenGigabitEthernet1/1/6): !
[OK - 418 bytes]
Number of Up CLNS neigbours 4 Number of up BFD sessions 4
 Number of sessions match
```

# Platform Issues

# Platform Health overview

Overview of Memory & CPU usages

```
9300_1#show platform resources
**State Acronym: H - Healthy, W - Warning, C - Critical
Resource                 Usage                 Max              Warning          Critical         State
----------------------------------------------------------------------------------------------------------
 Control Processor       1.39%                 100%             5%               10%              H
  DRAM                   2336MB(31%)           7530MB           90%              95%              H
```

Yellow threshold and Fan Fail action configurable.

```
9300_1#show environment all
Switch 1 FAN 1 is OK
Switch 1 FAN 2 is OK
Switch 1 FAN 3 is OK
FAN PS-1 is OK
FAN PS-2 is NOT PRESENT
Switch 1: SYSTEM TEMPERATURE is OK
Inlet Temperature Value: 37 Degree Celsius
Temperature State: GREEN
Yellow Threshold : 46 Degree Celsius          Red Threshold    : 56 Degree Celsius
Hotspot Temperature Value: 56 Degree Celsius
Temperature State: GREEN
Yellow Threshold : 105 Degree Celsius.        Red Threshold    : 125 Degree Celsius
SW  PID                 Serial#     Status            Sys Pwr  PoE Pwr  Watts
--  ------------------  ----------  ---------------   -------  -------  -----
1A  PWR-C1-715WAC       DCA2120G1D4  OK               Good     Good     715
1B  Not Present
```

# CPU Inband Traffic

- Dataplane forwarding occurring on UADP without CPU interaction
- CPU Destined traffic sent to corresponding CPU queue by UADP
- CPU queues:

  - Routing Protocol, ex EIGRP, OSPF, PIM, etc
  - Layer 2 Control , ex Spanning Tree, UDLD , etc
  - Software Forwarding, Traffic hitting exception, TCAM overload
  - Host Traffic (For us), ex SNMP, SSH, NETCONF, ICMP
  - ICMP, traffic needing ICMP generation
  - ..
- Control Plane policing default *enabled* to protect CPU resources

# Inband Packet Statistics

```
9300_1#sh controllers cpu-interface
queue                     retrieved   dropped     invalid     hol-block
--------------------------------------------------------------------------
Routing Protocol          42856       0           0           0
L2 Protocol               52577       0           0           0
sw forwarding             1           0           0           0
broadcast                 11360       0           0           0
icmp gen                  0           0           0           0
icmp redirect             0           0           0           0
logging                   0           0           0           0
rpf-fail                  0           0           0           0
DOT1X authentication      0           0           0           0
Forus Traffic             120         0           0           0
Forus Resolution          46750       0           0           0
Inter FED                 0           0           0           0
L2 LVX control            0           0           0           0
EWLC control              0           0           0           0
EWLC data                 0           0           0           0
L2 LVX data               0           0           0           0
Openflow                  0           0           0           0
Topology control          85166       0           0           0
Proto snooping            0           0           0           0
DHCP snooping             0           0           0           0
```

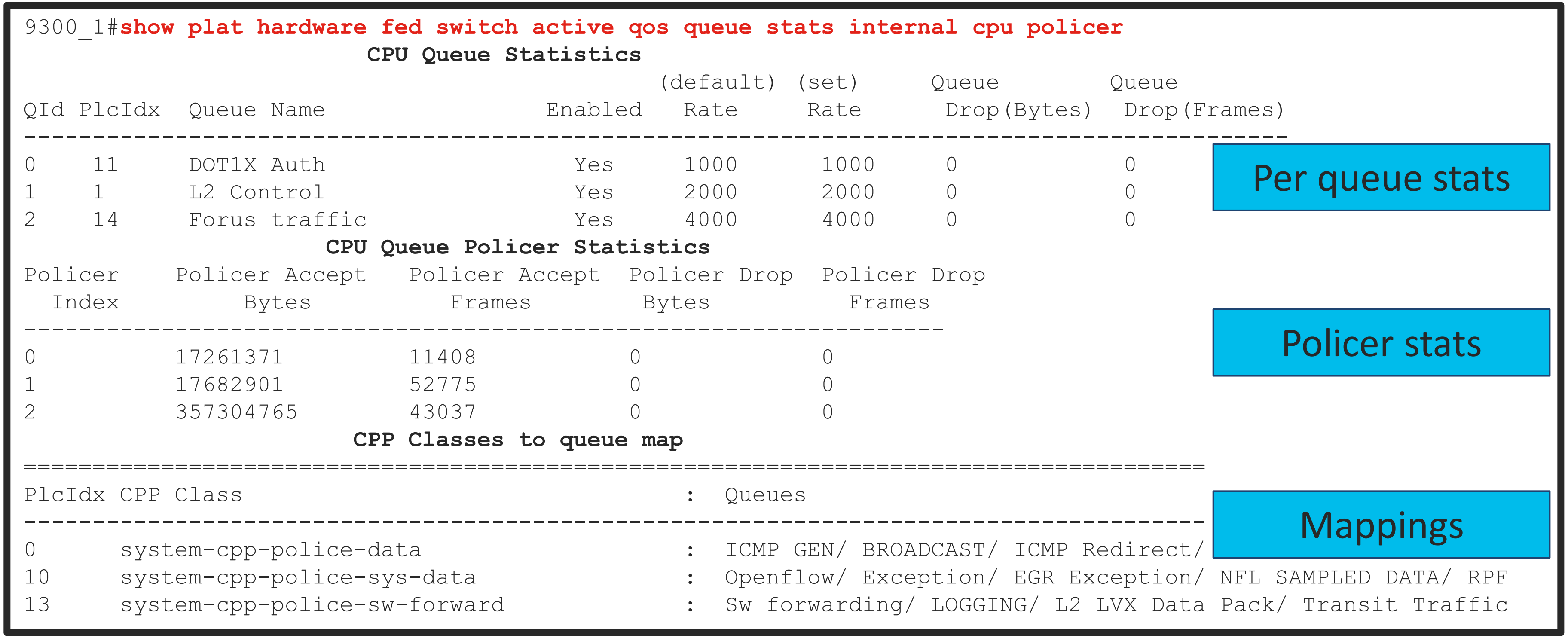
- Counts packets received at CPU
- Different Queues to handle different classes of traffic for CPU

# Control Plane Policing Statistics

```
9300_1#show policy-map control-plane
 Control Plane
  Service-policy input: system-cpp-policy
    Class-map: system-cpp-police-ios-routing (match-any)
      0 packets, 0 bytes
      5 minute offered rate 0000 bps, drop rate 0000 bps
      Match: none
      police:
          rate 13000 pps, burst 3173 packets
        conformed 379638519 bytes; actions:
          transmit
        exceeded 0 bytes; actions:
          drop
    Class-map: system-cpp-police-ios-feature (match-any)
      0 packets, 0 bytes
      5 minute offered rate 0000 bps, drop rate 0000 bps
      Match: none
      police:
          rate 6000 pps, burst 1464 packets
        conformed 20422413 bytes; actions:
          transmit
        exceeded 0 bytes; actions:
          drop
```

- Multiple Queues might map to one class map
- COPP policy map configurable (not recommended)
- Drops in critical queues can lead to instability

# Control Plane Policing HW stats



```
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)
---------------------------------------------------------------------------------------------
0    11     DOT1X Auth                        Yes     1000      1000      0            0
1    1      L2 Control                        Yes     2000      2000      0            0
2    14     Forus traffic                     Yes     4000      4000      0            0
                      CPU Queue Policer Statistics
Policer     Policer Accept   Policer Accept  Policer Drop  Policer Drop
  Index         Bytes           Frames         Bytes          Frames
-------------------------------------------------------------------
0           17261371         11408           0             0
1           17682901         52775           0             0
2           357304765        43037           0             0
                        CPP Classes to queue map
=======================================================================================
PlcIdx CPP Class                                :  Queues
---------------------------------------------------------------------------------------
0      system-cpp-police-data                   :  ICMP GEN/ BROADCAST/ ICMP Redirect/
10     system-cpp-police-sys-data               :  Openflow/ Exception/ EGR Exception/ NFL SAMPLED DATA/ RPF
13     system-cpp-police-sw-forward             :  Sw forwarding/ LOGGING/ L2 LVX Data Pack/ Transit Traffic
```

Per queue stats

Policer stats

Mappings

# Determining where CPU traffic originates from

```
9500_1#show plat software fed switch active punt rates interfaces
Punt Rate on Interfaces Statistics
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
===========================================================================================
 TenGigabitEthernet1/0/1       0x0000002e       1       1       1       0       0       0
 FortyGigabitEthernet1/1/1     0x00000032       1       1      18       0       0       0

9500_1#show platform software fed switch active punt cpuq rates
Punt Rate CPU Q Statistics
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
======================================================================================
 2  CPU_Q_FORUS_TRAFFIC             0        0       17       0        0        0
 4  CPU_Q_ROUTING_CONTROL           3        3        3       0        0        0
```

Active Interfaces sending to CPU

Per Queue Statistics

# Ternary Content-Addressable Memory

- UADP asics use TCAM memory for storing a majority of the forwarding related tables
- Normal Memory  has 0 or 1. TCAM has 0, 1 and “don’t care”
- Provides ability to do fast lookups needed for forwarding
- TCAM stores tables with Values , Mask and Result (VMR)
- TCAM memory shared by various features. Allocation of TCAM space done using Switching Database Manager (SDM)
- Different SDM templates available depending on platform
- SDM changes require reload
- Exceeding TCAM space impacts ability to do Hardware forwarding. Depending on feature SW forwarding, drops or flooding

```
9500#show sdm prefer ?
  core            Core Template
  distribution    Distribution Template
  nat             NAT Template
  sda             SDA Template
```

# Monitoring TCAM Utilization

```
9300_1#show platform hardware fed switch active fwd-asic resource tcam utilization
CAM Utilization for ASIC  [0]
 Table                                              Max Values        Used Values
 --------------------------------------------------------------------------------
 Unicast MAC addresses                              32768/1024         81/21
 L3 Multicast entries                               8192/512           0/7
 L2 Multicast entries                               8192/512           0/9
 Directly or indirectly connected routes            24576/8192         24/37
 QoS Access Control Entries                         5120                40
 Security Access Control Entries                    5120               125
 Ingress Netflow ACEs                                256                 8
 Policy Based Routing ACEs                          1024                20
 Egress Netflow ACEs                                 768                 8
  ..
```

- Not all Port Asics get programmed equally.
- Exceeding TCAM resources could lead to performance issues, traffic might be software forwarded, flooded or dropped

# Dumping TCAM entries

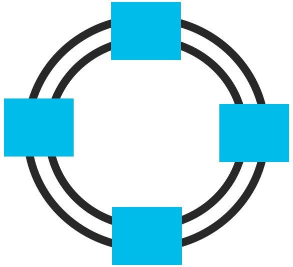
- TCAM information can be displayed per switch and per ASIC
- For forwarding check on both ingress Asic and egress Asic
- TCAM dumps show raw information, content might not be easily readable

```
9300_1#sh plat hard fed sw act fwd-asic resource tcam table ?
  acl                L3 IPv4 ACL Table
  client_le          Client LE Table
  l2                 L2 Lookup Table
  l2_multicast       L2 IPv4 Multicast Forwarding Table
  l3_multicast       L3 IPv4 Multicast Forwarding Table
  qos                L3 IPv4 QoS Table
  sghash             SGT/DGT Lookup Table
  spd_lookup         SPD Lookup Table
  tunnel             Tunnel Termination Table
  unicast            L3 Unicast Table
```

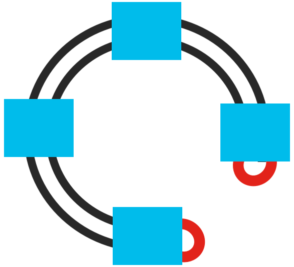
```
9300_1#sh platform hardware fed switch active fwd-asic resource tcam table l2
Printing entries for region L2_EXACT_MATCH (0) type 1 asic 0
=========================================================
HashTable 0 Left bucket 593 Index 0 (A:0,C:0) Valid
KEY - vlan:53 mac:0xa0f849104867 l3_if:1 gpn:19 epoch:0 static:0 flood_en:0 vlan_lead_wless_flood_en: 0
client_home_asic: 0 learning_peerid 0, learning_peerid_valid 0
MASK - vlan:0 mac:0x0 l3_if:1 gpn:0 epoch:0 static:0 flood_en:0 vlan_lead_wless_flood_en: 0 client_home_asic: 0
learning_peerid 0, learning_peerid_valid 0
SRC_AD - need_to_learn:0 lrn_v:0 catchall:0 static_mac:0 chain_ptr_v:0 chain_ptr: 0 static_entry_v:0 auth_state:0
auth_mode:0 auth_behavior_tag:0 traf_m:0 is_src_ce:0
DST_AD - si:0x2d bridge:0 replicate:0 blk_fwd_o:0 v4_rmac:1 v6_rmac:1 catchall:0 ign_src_lrn:0 port_mask_o:0
afd_cli_f:0 afd_lbl:0 prio:3 dest_mod_idx:0 destined_to_us:1 pv_trunk:0 smr:0
```

# Catalyst 9200, 9300 Stacking

- Stack connections are crucial to system stability
- 9200/9300 stackable switches deploy ring topology to form a stack
- One failure in stack recoverable. Dual Failure fatal
- Ensure proper fitting and tightening of stack connectors.



Dual Rings



Single Ring

# Stack Port Overview

```
Switch#show switch stack-ports summary
Sw#/Port#   Port Status   Neighbor   Cable Length   Link OK   Link Active   Sync OK   #Changes to LinkOK   In Loopback
-------------------------------------------------------------------------------------------------------------
1/1         OK            3          50cm           Yes       Yes           Yes       1                    No
1/2         OK            2          50cm           Yes       Yes           Yes       1                    No
2/1         OK            1          50cm           Yes       Yes           Yes       1                    No
2/2         OK            3          50cm           Yes       Yes           Yes       1                    No
3/1         OK            2          50cm           Yes       Yes           Yes       1                    No
3/2         OK            1          50cm           Yes       Yes           Yes       1                    No
```

Neighbor switch on port

Cable length should be showing

All stack links should be Active and in sync. Changes to LinkOK should be low

Stack numbers are NOT allocated based on physical presense. Renumber switches or bring up sequentially

# Switch Stacks

```
Switch#show switch detail
Switch/Stack Mac Address : 58bf.eab6.7f80 - Local Mac Address
Mac persistency wait time: Indefinite
                                             H/W    Current
Switch#    Role      Mac Address      Priority Version  State
------------------------------------------------------------
 1         Member    58bf.eab6.4200     1        V01      Ready
*2         Active    58bf.eab6.7f80     4        V01      Ready
 3         Standby   58bf.eab7.5800     3        V01      Ready
         Stack Port Status              Neighbors
Switch#  Port 1      Port 2           Port 1   Port 2
--------------------------------------------------------
  1         OK          OK               3        2
  2         OK          OK               1        3
  3         OK          OK               2        1
```

Every stack has 1 Active switch. Standby and members are optional

Set Priority to designate Active/Standby Switches with switch x priority x

SVI interfaces take the mac address of stack.
Layer 2 interfaces of the switch

**Show tech fabric** command prints out stack related information as well as stack related registers and counters

# Consoles

- On switch stacks all console ports are active, redirection occurs to active switch
- Redirected session is a vty(telnet), console on Active is con (console)
- *  indicates current active session in use, internal IPs are not in routing tables

```
FE2050#show users
    Line       User       Host(s)              Idle       Location
*  0 con 0     cisco      idle                 00:00:00
   3 vty 2     cisco      idle                 00:01:30 192.168.1.5
FE2050#show tcp brief
TCB          Local Address              Foreign Address            (state)
7FF9CC3DEE20  192.168.1.6.23               192.168.1.5.43170           ESTAB
```

- Chassis based switches do not use console redirection, use “active” Supervisor
- Standby console can be enabled
- Functionality limited on standby

```
9407R#sh run | sec redundancy
redundancy
 mode sso
 main-cpu
  standby console enable
```

# Unexpected Reloads

- When Switch (active/standby/member) unexpectedly reloads a system_report is generated in local crashinfo:
- Crashinfo file contains core file , traces, crashinfo files
- Crashinfo of member switches reachable via dir crashinfo-x:

```
guest@estg-bru-tftp:/tftpboot/cl$ tar -xzvf system-report_1_20190802-112928-UTC.tar.gz
/bootflash/.prst_sync/reload_info
/tmp/FE2050_1_RP_0-bootuplog-20190802-112928-UTC.log
/flash/core/FE2050_1_RP_0_x86_64_crb_linux_iosd_ngwc-universalk9-ms_9699_20190802-UTC.core.gz
/crashinfo/crashinfo_RP_00_00_20190802-112859-UTC
guest@estg-bru-tftp:/tftpboot/cl$ cat bootflash/.prst_sync/reload_info
ReloadReason=Critical software exception, check crashinfo:crashinfo_RP_00_00_20190802-112859-
UTC RET_2_RCALTS=1564745340 RET_2_RTS=11:29:00 UTC Fri Aug 2 2019
```

# Crashinfo File

- Part of Crashinfo file contains:
  - Last interactions on CLI
  - Syslog messages

```
guest@estg-bru-tftp:/tftpboot/cl/crashinfo$ more crashinfo_RP_00_00_20190802-112859-UTC

CMD: 'sh device-tracking counters ' 11:28:53 UTC Fri Aug 2 2019
CMD: 'sh device-tracking counters vlan 1021' 11:28:57 UTC Fri Aug 2 2019
*Aug  2 11:28:57.445: %HA_EM-6-LOG: catchall: show device-tracking counters vlan 1021
CMD: 'sh device-tracking counters vlan 1022' 11:28:58 UTC Fri Aug 2 2019
*Aug  2 11:28:57.445: %HA_EM-6-LOG: catchall: show device-tracking counters vlan 1021
CMD: 'sh device-tracking counters vlan 1022' 11:28:58 UTC Fri Aug 2 2019
Exception to IOS Thread:
Frame pointer 0x7FD1C728CA28, PC = 0x562DFBC20D36
```

CSCvp72220 crash at sisf_show_counters after entering show device-tracking counters command

  - Memory Utilization
  - Buffer Pool Utilization
  - Uptime and IOS-XE version

- Looking through Crashinfo file can give clues about the state of the system prior to the unexpected reload

# Packet Drops

# Ethernet controller Statistics

```
9500_1#show controllers ethernet-controller te 1/0/1
Transmit                  TenGigabitEthernet1/0/1    Receive
  38633194582 Total bytes               130046767680 Total bytes
     92351261 Unicast frames               100227375 Unicast frames
  34062623315 Unicast bytes             116307995084 Unicast bytes
       689338 Multicast frames               2043062 Multicast frames
   4570570691 Multicast bytes            13738772084 Multicast bytes
            9 Broadcast frames                     8 Broadcast frames
          576 Broadcast bytes                    512 Broadcast bytes
            0 System FCS error frames              0 IpgViolation frames
            0 MacUnderrun frames                   0 MacOverrun frames


..
       2241744 65 to 127 byte frames         11667872 65 to 127 byte frames
      2838336 128 to 255 byte frames         3177806 128 to 255 byte frames
     80722296 256 to 511 byte frames         1593500 256 to 511 byte frames
```

Ethernet Statistics also in show tech

```
Switch#show  interfaces gigabitEthernet 1/0/1 counters errors
Port        Align-Err     FCS-Err    Xmit-Err     Rcv-Err  UnderSize  OutDiscards
Gi1/0/1             0           0           0           0          0            0
Port       Single-Col   Multi-Col    Late-Col  Excess-Col  Carri-Sen        Runts
Gi1/0/1             0           0           0           0          0            0
```

Error statistics from interface

# Ethernet Interface Utilization

```
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
GigabitEthernet1/0/1 is up, line protocol is up (connected)
  5 minute input rate 103000 bits/sec, 174 packets/sec
  5 minute output rate 3879000 bits/sec, 324 packets/sec
GigabitEthernet1/0/2 is down, line protocol is down (notconnect)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bi
GigabitEthernet1/0/3 is dow
  5 minute input rate 0 bit
  5 minute output rate 0 bi
```

Average rate over interval set with load interval

Does not always reflect current load

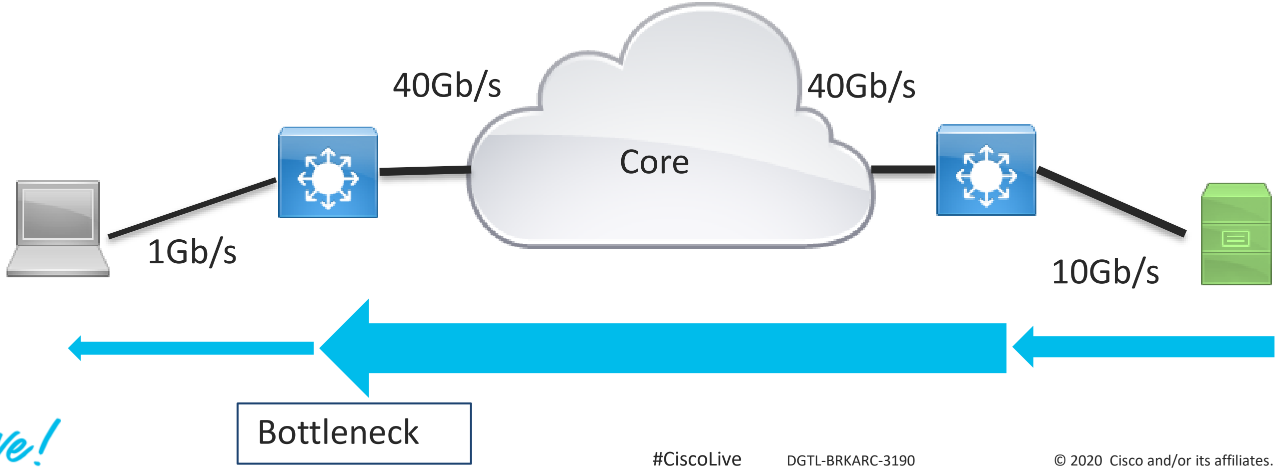
```
9500 show controllers utilization
Port          Receive Utilization   Transmit Utilization
Te1/0/1                         3                    2
Te1/0/2                         2                    3
.
Te1/0/16                        0                    0
Fo1/1/1                         0                    0
Fo1/1/2                         0                    0
Total Ports : 18
Total Ports Receive Bandwidth Percentage Utilization  : 0
Total Ports Transmit Bandwidth Percentage Utilization : 0
Average Switch  Percentage Utilization : 0
```

Bandwidth in %

Current load

# Drops due to egress buffering

- WTD drops due to buffering most common cause of drops
- Data center servers typically high bandwith 10Gb/s+
- Increasing number of buffers could lead to Jitter and Latency
- Protocols like TCP increase window size till congestion experienced



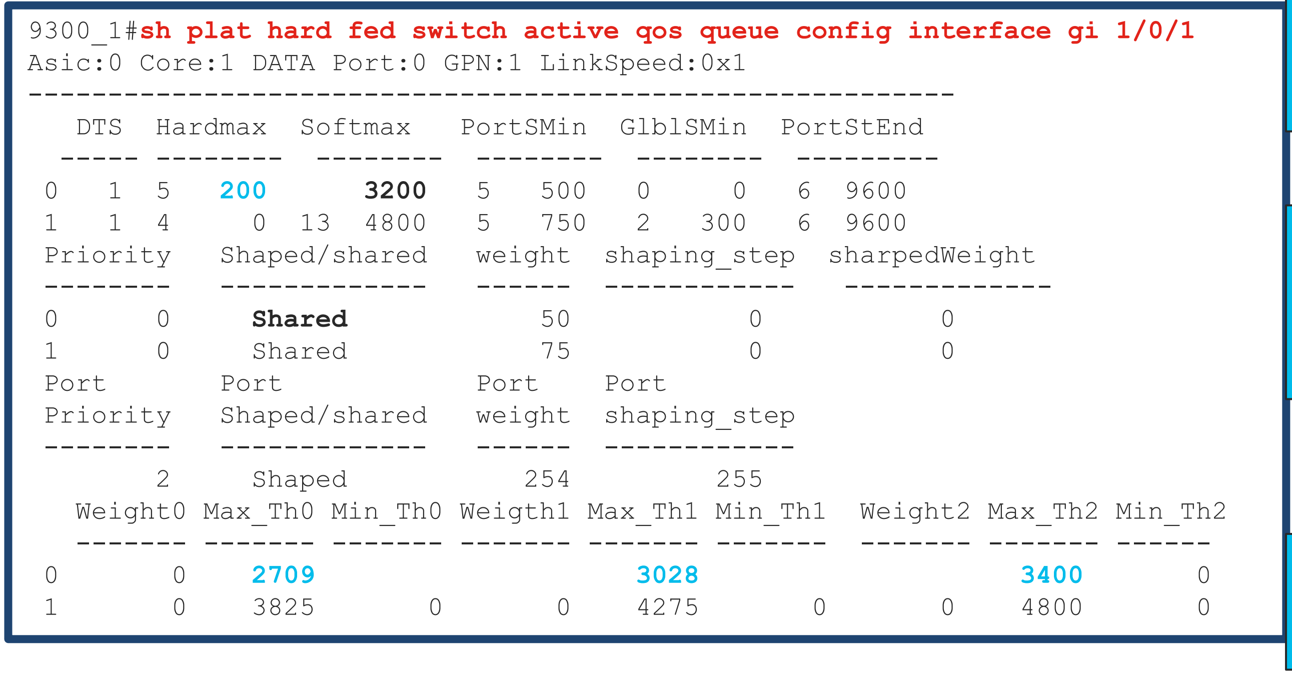
# Tail Drops

- Tail drops occur when exceeding buffer thresholds.

```
9300_1#show interfaces gigabitEthernet 1/0/1 | inc output drops
  Input queue: 0/2000/0/0 (size/max/drops/flushes); Total output drops: 1277
9300_1#show controllers ethernet-controller gig 1/0/1 | inc Excess Def
         1277 Excess Defer frames                  0 Collision fragments
SNMP:
SNMPv2-SMI::enterprises.9.2.2.1.1.27.8 = INTEGER: 1277
```

- Buffer allocation per class can be changed inside service-policy
- Global multiplier to increase buffers up to 1200%  
  qos softmax-queue-multiplier <percentage>
- Increasing buffers increases maximum, buffers allocated based on availability
- 17.1.1 introduces CLI to monitor high watermark utilization on ports

# QoS Hardware configuration



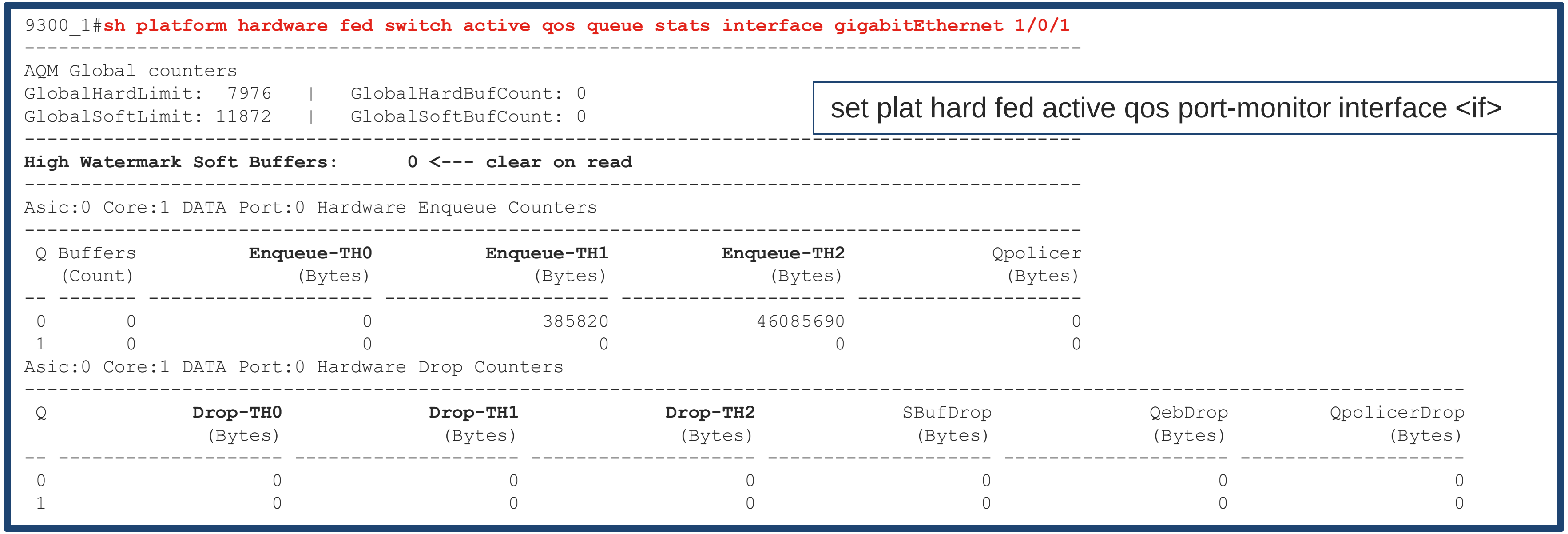
```
9300_1#sh plat hard fed switch active qos queue config interface gi 1/0/1
Asic:0 Core:1 DATA Port:0 GPN:1 LinkSpeed:0x1
----------------------------------------------------------
   DTS  Hardmax  Softmax   PortSMin  GlblSMin  PortStEnd
  ----- --------  --------  --------  --------  ---------
 0   1  5   200      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                    3028                    3400       0
 1       0    3825       0       0    4275       0       0    4800       0
```

- Hardmax.
  Reserved buffers
- Softmax.
  From Global Pool

- Queue mode
- Queue limit:
  Step/weight * speed

- Drop thresholds
  per queue in buffers

# QoS hardware statistics



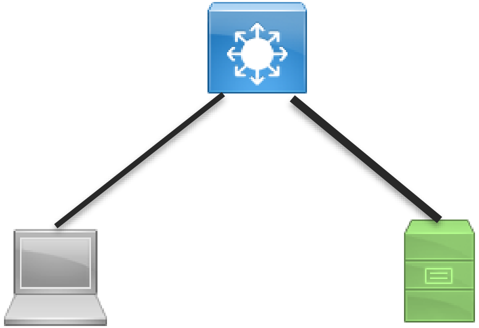
```
9300_1#sh platform hardware fed switch active qos queue stats interface gigabitEthernet 1/0/1
----------------------------------------------------------------------------------------------
AQM Global counters
GlobalHardLimit:  7976   |   GlobalHardBufCount: 0
GlobalSoftLimit: 11872   |   GlobalSoftBufCount: 0
----------------------------------------------------------------------------------------------
High Watermark Soft Buffers:      0 <--- clear on read
----------------------------------------------------------------------------------------------
Asic:0 Core:1 DATA Port:0 Hardware Enqueue Counters
----------------------------------------------------------------------------------------------
 Q Buffers          Enqueue-TH0          Enqueue-TH1          Enqueue-TH2              Qpolicer
   (Count)              (Bytes)              (Bytes)              (Bytes)               (Bytes)
-- ------- -------------------- -------------------- -------------------- --------------------
 0       0                    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                    0                    0                    0                    0
 1                    0                    0                    0                    0                    0                    0
```

set plat hard fed active qos port-monitor interface <if>

- At UADP 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)
- High water mark counter (17.x) shows highest watermark since last output

# Buffer tuning , lab setup

- 10Gb/s Server, Debian 8.5
- 1Gb/s Client, Debian 8.5
- Interfaces on 9300 default
- Client and server use iperf3
- Both OS & iperf3 using default settings

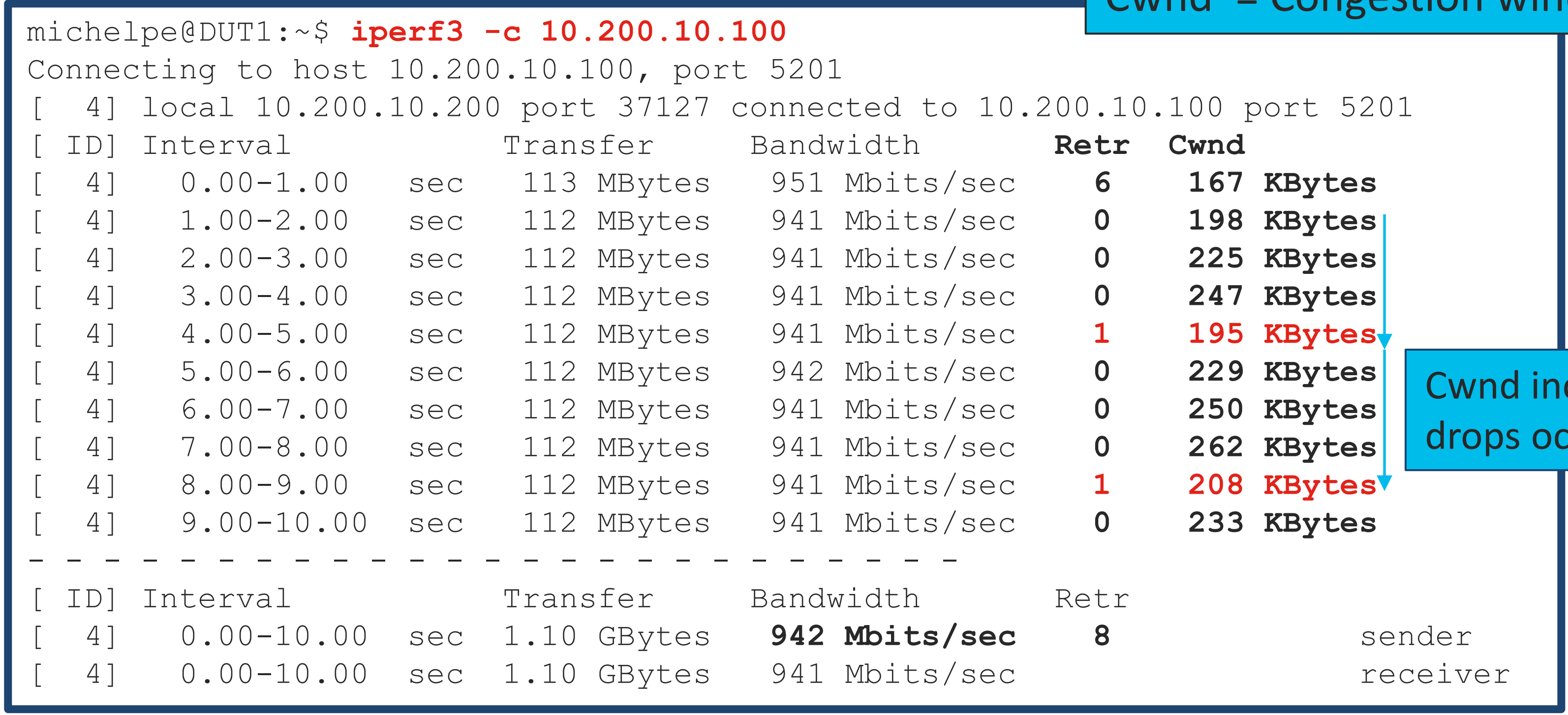


- Achieved bandwidth , drops, high watermark  & max Congestion window noted and

```
michelpe@DUT1:~$ iperf3 -v
iperf 3.1.3
Linux debian1 3.16.0-4-amd64 #1 SMP Debian 3.16.7-ckt25-2 (2016-04-08) x86_64
```

# Buffer tuning , example

Cwnd = Congestion window



```
michelpe@DUT1:~$ iperf3 -c 10.200.10.100
Connecting to host 10.200.10.100, port 5201
[  4] local 10.200.10.200 port 37127 connected to 10.200.10.100 port 5201
[ ID] Interval           Transfer     Bandwidth       Retr  Cwnd
[  4]   0.00-1.00   sec   113 MBytes   951 Mbits/sec    6    167 KBytes
[  4]   1.00-2.00   sec   112 MBytes   941 Mbits/sec    0    198 KBytes
[  4]   2.00-3.00   sec   112 MBytes   941 Mbits/sec    0    225 KBytes
[  4]   3.00-4.00   sec   112 MBytes   941 Mbits/sec    0    247 KBytes
[  4]   4.00-5.00   sec   112 MBytes   941 Mbits/sec    1    195 KBytes
[  4]   5.00-6.00   sec   112 MBytes   942 Mbits/sec    0    229 KBytes
[  4]   6.00-7.00   sec   112 MBytes   941 Mbits/sec    0    250 KBytes
[  4]   7.00-8.00   sec   112 MBytes   941 Mbits/sec    0    262 KBytes
[  4]   8.00-9.00   sec   112 MBytes   941 Mbits/sec    1    208 KBytes
[  4]   9.00-10.00  sec   112 MBytes   941 Mbits/sec    0    233 KBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  4]   0.00-10.00  sec  1.10 GBytes   942 Mbits/sec    8             sender
[  4]   0.00-10.00  sec  1.10 GBytes   941 Mbits/sec                  receiver
```

Cwnd increases till drops occur

# Test Results

| | No Service Policy | | | | | AutoQos Policy | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Default | 200 | 400 | 800 | 1200 | Default | 200 | 400 | 800 | 1200 |
| Cwnd | 273 | 421 | 990 | 1840 | 2003 | 117 | 233 | 421 | 762 | 1200 |
| Drops | 18 | 22 | 19 | 50 | 47 | 23 | 20 | 12 | 20 | 38 |
| Speed | 942 | 944 | 945 | 945 | 945 | 933 | 938 | 938 | 940 | 941 |
| Buffers | 1200 | 2400 | 4800 | 9600 | 14400 | 500 | 1000 | 2000 | 4000 | 6000 |
| Watermark | 1197 | 2394 | 4795 | 9499 | 10171 | 497 | 994 | 1195 | 3997 | 5999 |

- Increasing number of buffers increases max achieved congestion window
- Drops happen in burst, most drops happen at initial ramp up of Cwnd

# Packet Parting packet drops

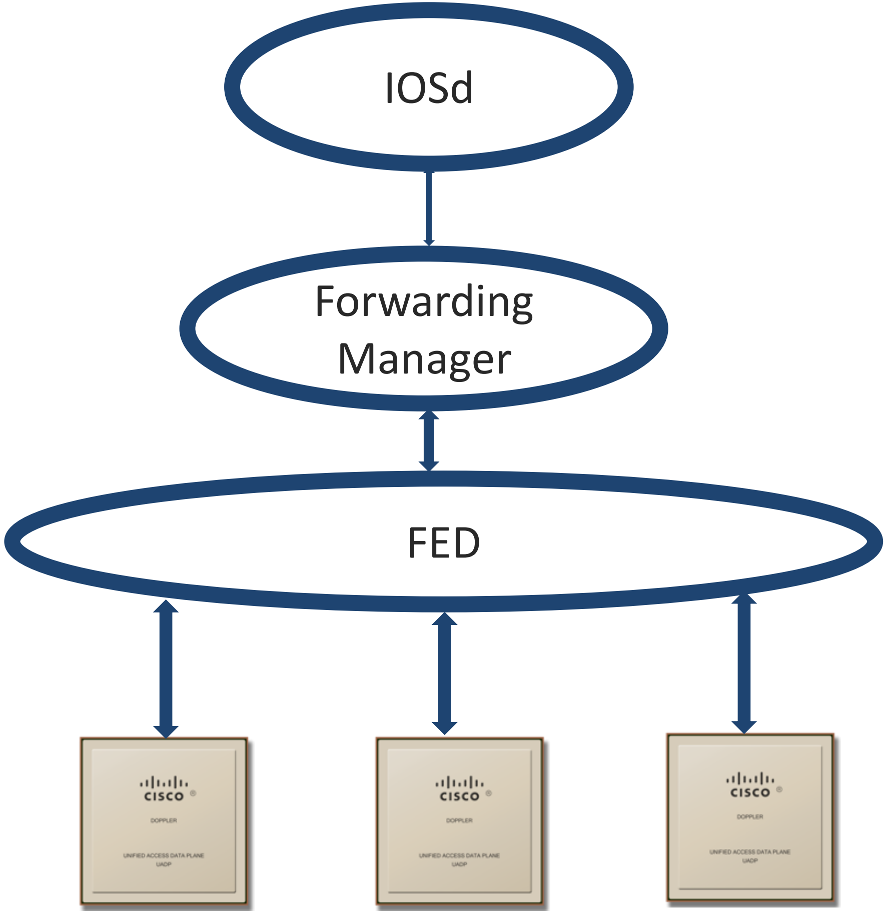
```
9300_1#sh platform hardware fed switch active fwd-asic drops exceptions
****EXCEPTION STATS ASIC INSTANCE 0 (asic/core 0/0)****
================================================================================
 Asic/core |                  NAME                         |   prev     |   current   |   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  SIA_TTL_ZERO                                         0           0            0
0   0  ALLOW_NATIVE_EXCEPTION_COUNT                         0           0            0
0   0  ALLOW_DOT1Q_EXCEPTION_COUNT                          0           0            0
0   0  ALLOW_PRIORITY_TAGGED_EXCEPTION_COUNT                0           0            0
0   0  ALLOW_UNKNOWN_ETHER_TYPE_EXCEPTION                   0           0            0
0   0  IP_SOURCE_GUARD_VIOLATION                            0           0            0
```

- Every packet passing through Port Asic gets parsed,
  Layer 2 switched packets also get fully parsed
- Exception drops are counted per Asic , no per port statistics

# Forwarding Issues

# Troubleshooting Forwarding

- UADP responsible for all hardware forwarding. CPU is not directly involved in forwarding.
- IOS-XE 16+  uses Forwarding manager, Forwarding manager process manages forwarding related information but only on a Platform Independent level. Forwarding manager is on all platforms running IOS-XE16+
- FED (Forwarding Engine Driver) process is Platform Dependant layer, interfaces with Forwarding manager and responsible for all tables on UADP asics


IOSd
Forwarding Manager
FED
cisco
DOPPLER
UNIFIED ACCESS DATA PLANE
UADP
cisco
DOPPLER
UNIFIED ACCESS DATA PLANE
UADP
cisco
DOPPLER
UNIFIED ACCESS DATA PLANE
UADP

# Forwarding troubleshooting, the easy way

- Show forward supported since 2900/3500XL switches , upto 3750 family only software emulation of forwarding results were used
- UADP introduced HW captures of lookup results during various stages of packet forwarding
- CLI: *“Show platform hardware fed switch <ingress switch> forward … “*
- Supports Input using packet capture file or packet parameters
- Readability of results greatly improved since 16.9 with summary option
- Packets introduced for captures inserted at Ingress and removed at Egress before sending out on the wire.

# Running Show platform hardware fed forward

```
9300_1#sh monitor capture file flash:icmp.pcap packet-number 11
Starting the packet display ........ Press Ctrl + Shift + 6 to exit
  11   5.006009 10.100.10.100 b^F^R 10.200.10.200 ICMP 98 Echo (ping) request  id=0x262f
```

Verify capture

- Using the packet capture the show forward can be executed
- Always execute it on the switch where the packet ingresses

```
9300_1#sh plat hard fed 1 forward int gi 1/0/1 pcap flash:icmp.pcap num 11 data
Show forward is running in the background. After completion, syslog will be generated.
```

- Once completed a syslog gets generated and results will be available
- Can only run one show forward  at a time

```
*Jan 27 10:07:35.009: %SHFWD-6-PACKET_TRACE_DONE: Switch 1 R0/0: fed: Packet Trace
Complete:  Execute (show platform hardware fed switch <> forward last summary|detail)
```

# Show platform forward results

```
9300_1#sh platform hardware fed switch active forward last summary
Input Packet Details:
###[ Ethernet ]###
  dst         = a0:f8:49:10:48:51
  src         = 00:0c:29:4d:9e:16
  type        = 0x800
###[ IP ]###
     version     = 4L
     ihl         = 5L
     tos         = 0x0
     len         = 84
     id          = 46165
     flags       = DF
     frag        = 0L
     ttl         = 64
     proto       = icmp
     chksum      = 0x5bfc
     src         = 10.100.10.100
     dst         = 10.200.10.200
     options     = ''
```

First section shows the exact packet being send for analysis

# Show platform forward results

```
Ingress:
   Port                      : GigabitEthernet1/0/1
   Global Port Number        : 1
   Local Port Number         : 1
   Asic Port Number          : 0
   Asic Instance             : 1
   Vlan                      : 100
   Mapped Vlan ID            : 6
   STP Instance              : 4
   BlockForward              : 0
   BlockLearn                : 0
   L3 Interface              : 50
       IPv4 Routing          : enabled
       IPv6 Routing          : enabled
       Vrf Id                : 0
   Adjacency:
       Station Index         : 185
       Destination Index     : 21358
       Rewrite Index         : 34
       Replication Bit Map   : 0x10   ['coreData']
```

Next section shows associated data

Ingress port

Vlan and STP info

IPv4/v6 setting.
Vrf-id 0 = GRT

# Show platform forward results

Forwarding Decision

```
Adjacency:
      Station Index           : 185
      Destination Index       : 21358
      Rewrite Index           : 34
      Replication Bit Map     : 0x10    ['coreData']
  Decision:
      Destination Index       : 21358
      Rewrite Index           : 34
      Dest Mod Index          : 0       [IGR_FIXED_DMI_NULL_VALUE]
      CPU Map Index           : 0       [CMI_NULL]
      Forwarding Mode         : 3       [Other or Tunnel]
      Replication Bit Map     :         ['coreData']
      Winner                  :         L3FWDIPV4 LOOKUP
      Qos Label               : 1
      SGT                     : 0
      DGTID                   : 0
```

Destination Index, where to send

Rewrite Index, how to rewrite

Forwarding mode, how to treat the packet

# Show platform forward results

```
Egress:
   Possible Replication      :
       Port                  : TenGigabitEthernet1/1/7
   Output Port Data          :
     Port                    : TenGigabitEthernet1/1/7
       Global Port Number    : 59
       Local Port Number     : 59
       Asic Port Number      : 58
       Asic Instance         : 0
       Unique RI             : 34
       Rewrite Type          : 9      [L3_UNICAST_IPV4]
       Mapped Rewrite Type   : 9      [L3_UNICAST_IPV4]
       Vlan                  : 0
       Mapped Vlan ID        : 0
```

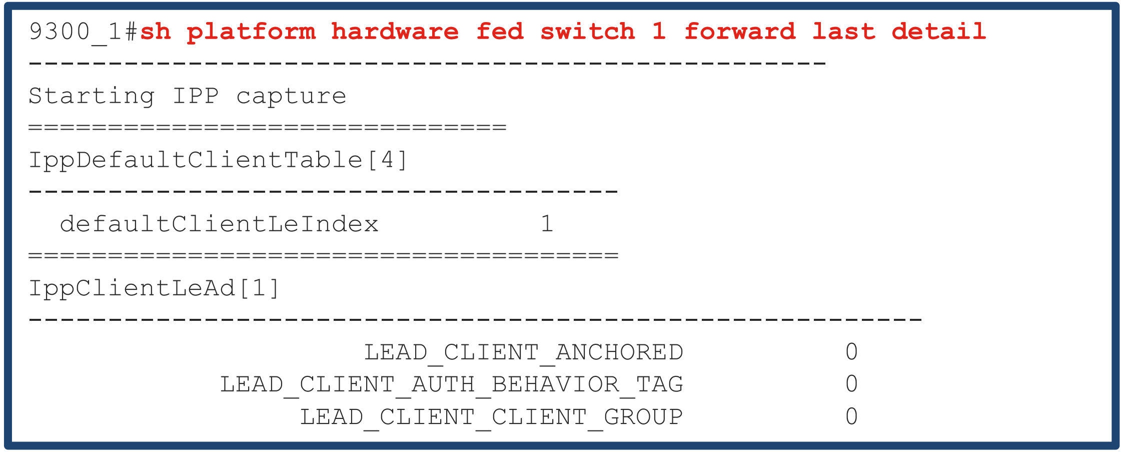
Last section showing Egress Packet

```
Output Packet Details:
   Port                       : TenGigabitEthernet1/1/7
###[ Ethernet ]###
  dst       = 00:50:56:92:48:d8
  src       = a0:f8:49:10:48:66
  type      = 0x800
###[ IP ]###
     version   = 4L
     ihl       = 5L
 tos       = 0x0
     len       = 84
     id        = 46165
     flags     = DF
     frag      = 0L
     ttl       = 63
     proto     = icmp
     chksum    = 0x5cfc
     src       = 10.100.10.100
     dst       = 10.200.10.200
     options   = ''
```

Packet removed before sending out to the wire.

# Show platform hardware fed forward detail results

- Flash contains shfwd<>.log with detailed information
- Same information gathered with
  **show platform hardware fed switch <switch> forward last detail**
- Detail info containing raw information regarding lookups



```
9300_1#sh platform hardware fed switch 1 forward last detail
--------------------------------------------------
Starting IPP capture
==============================
IppDefaultClientTable[4]
-------------------------------------
  defaultClientLeIndex          1
=====================================
IppClientLeAd[1]
--------------------------------------------------------
                     LEAD_CLIENT_ANCHORED          0
            LEAD_CLIENT_AUTH_BEHAVIOR_TAG          0
                 LEAD_CLIENT_CLIENT_GROUP          0
```

# Layer 2 Forwarding. Verifying 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 will be tagged or untagged
- Flood list indicates what Ports will receive flooded traffic on this switch

```
9300_1#show platform hardware fed switch 1 vlan 100 egress
VLAN STP State in hardware
vlan id is:: 100
Interfaces in forwarding state: : Te1/1/7(Untagged), Gi1/0/1(Untagged)
9300_1#show platform hardware fed switch 1 vlan 100 ingress
VLAN STP State in hardware
vlan id is:: 100
Interfaces in forwarding state: : Te1/1/7(Untagged), Gi1/0/1(Untagged)
flood list: : Te1/1/7, Gi1/0/1
```

# Layer 2 Forwarding, IOSd mac address tables

```
9300_1#sh mac address-table vlan 100
          Mac Address Table
-------------------------------------------
Vlan    Mac Address       Type        Ports
----    -----------       --------    -----
 100    000c.294d.9e16    DYNAMIC     Gi1/0/1
 100    0050.5692.adb3    DYNAMIC     Gi1/0/1
 100    0050.5692.e9aa    DYNAMIC     Gi1/0/1
 100    a0f8.4910.4851    STATIC      Vl100
Total Mac Addresses for this criterion: 4
```

- Show mac address table contains a system wide mac table on IOSd
- Types can be static, dynamic, drop
- Mac Address of SVI interfaces also showing in 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
------------------------------------------------------------------------------------------------------------------------------------------
100    a0f8.4910.4851        0x8002     0   99817     64  0x7f91986dfcd8      0x7f9198dadb78    0x0                    0        0    Vlan100
100    0050.5692.e9aa           0x1   347       0      0  0x7f9199054668      0x7f9199020798    0x7f91986e4a58       300      234   Gi1/0/1
100    0050.5692.adb3           0x1   352       0      0  0x7f91990144a8      0x7f9199020798    0x7f91986e4a58       300      71    Gi1/0/1
100    000c.294d.9e16           0x1   364       0      0  0x7f919900e9d8      0x7f9199070018    0x7f91986e4a58       300      290   Gi1/0/1

*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
```

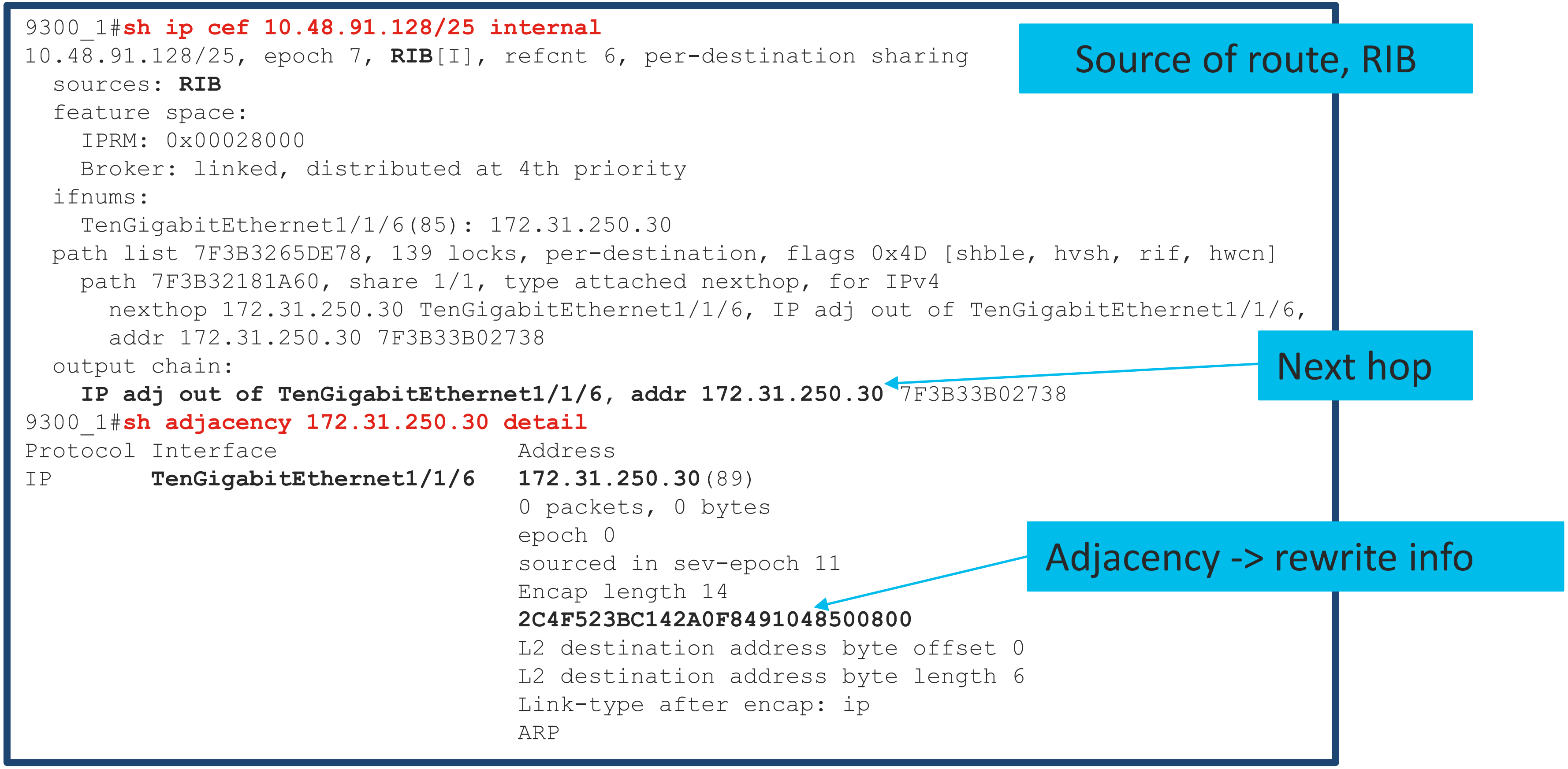
- Every FED has its own Mac address table.
- Type Field indicates the type of mac address using a bitmap
- Sequence number of an entry changing would indicated relearning

# Layer 3 Forwarding. Routing protocols

```
9300_1#ping 10.48.91.151
Sending 5, 100-byte ICMP Echos to 10.48.91.151, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
9300_1#sh ip route 10.48.91.151
Routing entry for 10.48.91.128/25
  Known via "isis", distance 115, metric 40, type level-2
  Redistributing via isis
  Last update from 172.31.250.30 on TenGigabitEthernet1/1/6, 6d22h ago
  Routing Descriptor Blocks:
  * 172.31.250.30, from 172.31.255.21, 6d22h ago, via TenGigabitEthernet1/1/6
      Route metric is 40, traffic share count is 1
9300_1#sh ip arp 172.31.250.30
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  172.31.250.30          56   2c4f.523b.c142  ARPA   TenGigabitEthernet1/1/6
```

- Check Routing Table for correct next hop (Routing Information Base)
- ARP table display rewrite information for next hop (destination mac)

# Cisco Express Forwarding (the FIB)



```
9300_1#sh ip cef 10.48.91.128/25 internal
10.48.91.128/25, epoch 7, RIB[I], refcnt 6, per-destination sharing
  sources: RIB
  feature space:
    IPRM: 0x00028000
    Broker: linked, distributed at 4th priority
  ifnums:
    TenGigabitEthernet1/1/6(85): 172.31.250.30
  path list 7F3B3265DE78, 139 locks, per-destination, flags 0x4D [shble, hvsh, rif, hwcn]
    path 7F3B32181A60, share 1/1, type attached nexthop, for IPv4
      nexthop 172.31.250.30 TenGigabitEthernet1/1/6, IP adj out of TenGigabitEthernet1/1/6,
      addr 172.31.250.30 7F3B33B02738
  output chain:
    IP adj out of TenGigabitEthernet1/1/6, addr 172.31.250.30 7F3B33B02738
9300_1#sh adjacency 172.31.250.30 detail
Protocol Interface                 Address
IP       TenGigabitEthernet1/1/6   172.31.250.30(89)
                                   0 packets, 0 bytes
                                   epoch 0
                                   sourced in sev-epoch 11
                                   Encap length 14
                                   2C4F523BC142A0F8491048500800
                                   L2 destination address byte offset 0
                                   L2 destination address byte length 6
                                   Link-type after encap: ip
                                   ARP
```

Source of route, RIB

Next hop

Adjacency -> rewrite info

# Platform CEF tables (RP)

```
9300_1#sh platform software ip switch ac R0 cef prefix 10.48.91.128/25
Forwarding Table
Prefix/Len                        Next Object      Index
-----------------------------------------------------------------
10.48.91.128/25                   OBJ_ADJACENCY    0x24
9300_1#sh platform software adjacency switch active R0 index 0x24
Number of adjacency objects: 17
Adjacency id: 0x24 (36)
  Interface: TenGigabitEthernet1/1/6, IF index: 85, Link Type: MCP_LINK_IP
  Encap: 2c:4f:52:3b:c1:42:a0:f8:49:10:48:50:8:0
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 9100
  Flags: no-l3-inject
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 172.31.250.30
  IP FRR MCP_ADJ_IPFRR_NONE 0
  OM handle: 0x348066bc48
```

Prefix points to Adjacency 0x24

Similar output should be present on standby RP and the FP processes

# FED Routing tables

```
9300_1#sh platform software fed switch 1 ip route 10.48.91.128/25
vrf   dest               htm            flags   SGT   DGID MPLS Last-modified
---   ----               ---            -----   ---   ---- ---- ------------------------
0     10.48.91.128/25    0x7f9199010f78 0x0     0     0         2020/01/14 13:49:42.054
  FIB: prefix_hdl:0x5a00026d, mpls_ecr_prefix_hdl:0
  ========== OCE chain =====
  ADJ:objid:36 {link_type:IP ifnum:0x55, si:0x9b00003d, IPv4:   172.31.250.30 }
  ===============
  MPLS info: mpls_ecr_scale_prefix_adj:0, mpls_lspa_hdl:0
9300_1#sh platform software fed switch 1 ip adj | inc dest|--|172.31.250.30
dest             if_name     dst_mac            si_hdl   ri_hdl   pd_flags adj_id   Last-modified
----             -------     -------            ------   ------   -------- -----    -------------------------
172.31.250.30    Te1/1/6     2c4f.523b.c142     0x7f9198 0x7f9198 0x0       0x24    14:09:12.058
```

- FED layer has its own copy of the IP routing table and rewrite information
- In a stacked enviroment every switch has its own FED process.
  Important to check Ingress and Egress switch
- FED programs TCAM to facilitate forwarding
- Every VRF has its own unique number, 0 is Global Routing Table

# Thank you

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# Possibilities

#CiscoLive