

Cisco Catalyst 8500 Series Edge Platform Deep Dive

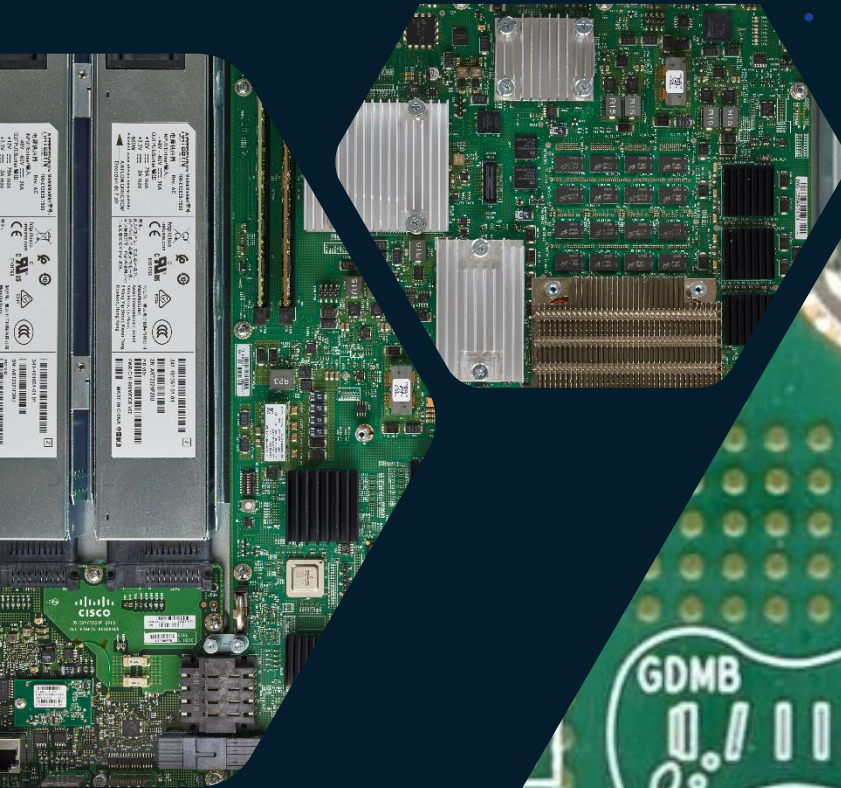
Highly Capable WAN Aggregation Platforms

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@sumantmali



*“Want to be
‘the Catalyst 8500 Expert’?”*

I promise to reveal all the secrets for you today! 😊




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Cisco Webex App

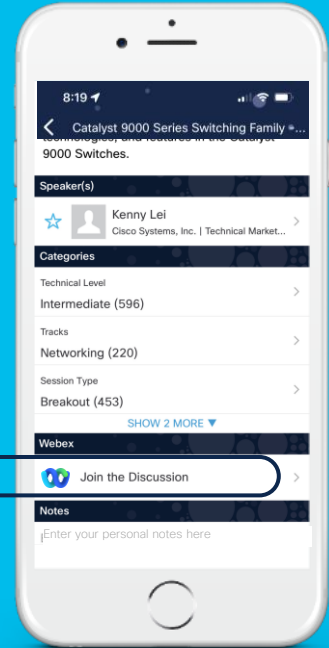
Questions?

Use Cisco Webex App to chat with the speaker after the session

How

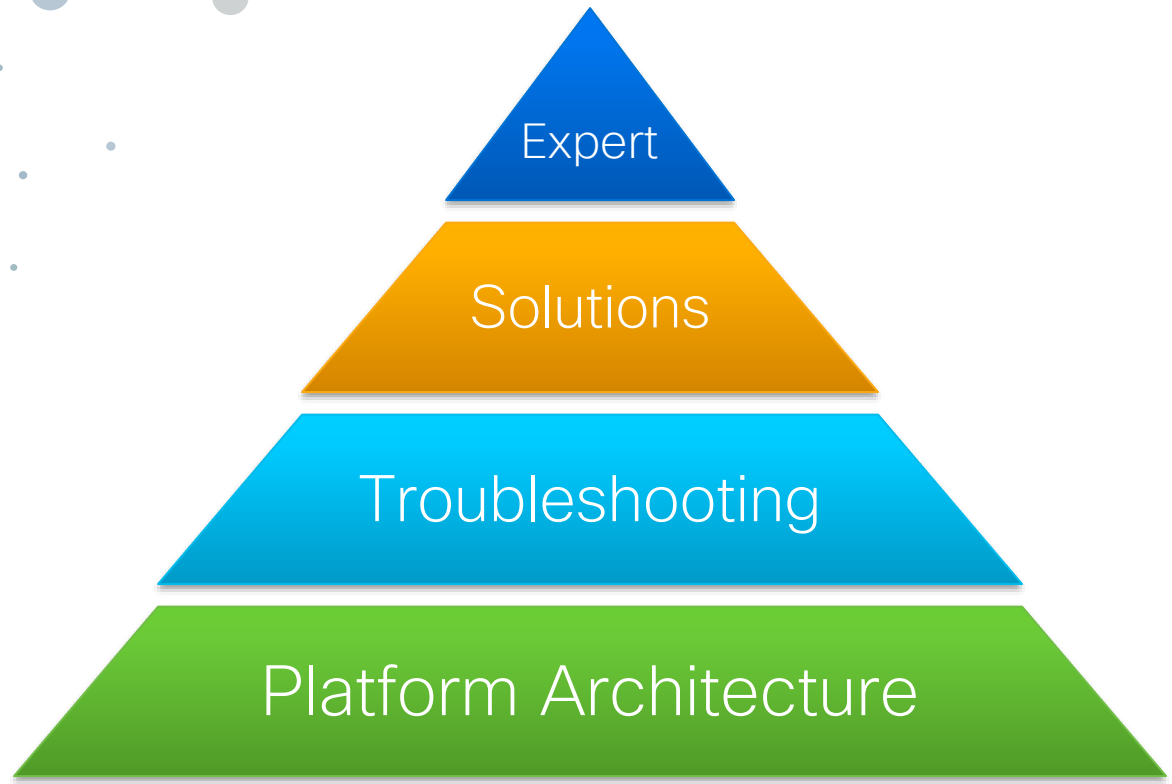
- 1 Find this session in the Cisco Live Mobile App
- 2 Click “Join the Discussion”
- 3 Install the Webex App or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

Webex spaces will be moderated until February 24, 2023.





Agenda

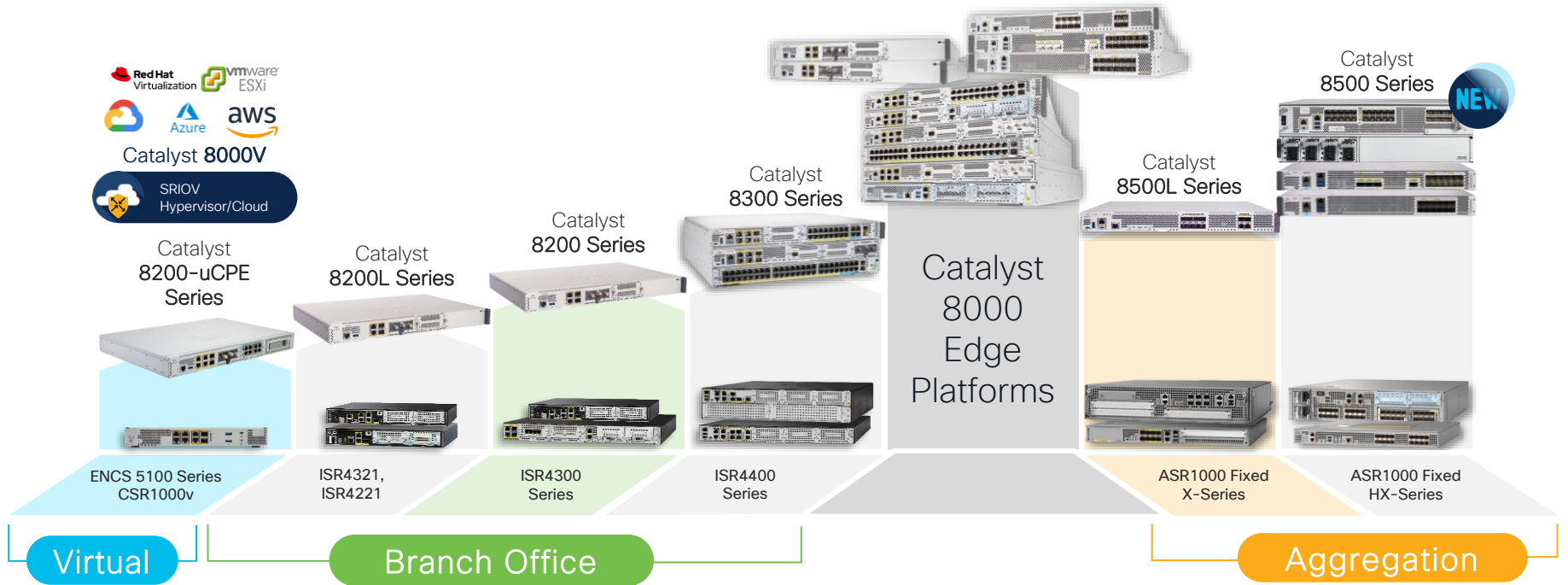


Catalyst 8500 Series Edge Platforms



Cisco Catalyst 8000 Series Portfolio

Ready to refresh the Enterprise Networks for Branch, Aggregation and Cloud



Catalyst 8500, 8500L Series Edge Platforms

100G, 40G
'C' 'Q'



C8500-12X4QC

12 SFP+,
4 QSFP

10G, 1G
'X'



C8500-12X

12 SFP+

10G, 1G
'X' 'S'



C8500L-8S4X

8 SFP,
4 SFP+

Catalyst 8500-20X6C Series Edge Platform

High Performance driven by 4x Packet Processing Engines

100/40G
'C'

10/1G
'X'



Up to 500 Gbps CEF,
High Performance IPsec

4x 3rd Generation QFP,
Hardware Accelerated Services

User Centric Design,
RFID, FRUs



Cisco Catalyst 8500 Series Edge Platforms

Highly Capable SD-WAN Headend



Performance



C8500-20X6C



CEF: up to 500 Gbps
IPsec: up to 150 Gbps
SD-WAN IPsec: up to 100 Gbps

C8500-12X4QC



CEF: up to 200 Gbps
IPsec: up to 35 Gbps
SD-WAN IPsec: up to 29 Gbps

C8500-12X



CEF: up to 120 Gbps
IPsec: up to 32 Gbps
SD-WAN IPsec: up to 24 Gbps

C8500L-8S4X



CEF: up to 20 Gbps
IPsec: up to 12 Gbps
SD-WAN IPsec: up to 10 Gbps

IMIX traffic

CEF: Autonomous mode
IPsec: Autonomous/Controller mode

All Throughput numbers are Aggregate IMIX values

Catalyst 8500 Platform Architecture



Cisco Third Generation QFP

Exceptional Data Path ASIC



Multi-Core Parallel Processing
Scalable for Future



High Scale Feature Velocity
Improved Performance, Programmable



Hardware Accelerated IPsec
In-Line Encryption, Decryption



Built-in Layer 2 Sub-system
Better Traffic Management

Third Generation QFP Architecture



Multi-threaded Parallel Processing

- 28 clusters of 8 PPEs each
- 224 PPEs, 4 threads each → 896 threads

Hardware Accelerated Crypto

- 16 Crypto Engines with dedicated resources
- Flow queues for complex stateful features

Layer-2 Aggregation

- 240Gbps of aggregation
- Per Port Classification and Accounting



QFP 3.0

QFP 3.0 Traffic Manager

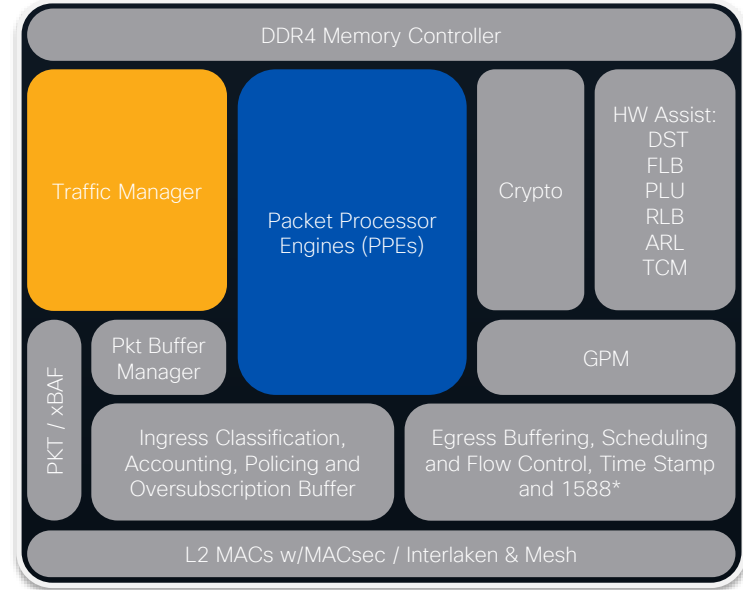


Improved Queuing Capabilities

- 256K queues
- 5-layer MQC-compatible QoS
- 134K scheduling nodes
- Single queue maximum rate of 60 Mpps for single chip
 - 75 Mpps for multi-QFP complex

Flow Control, GEC

- Event Driven (Xon/Xoff) flow control support on all egress queues
- Ether-channel support for bundled ports supported for single and multi-QFP complexes



QFP 3.0 In-line Crypto

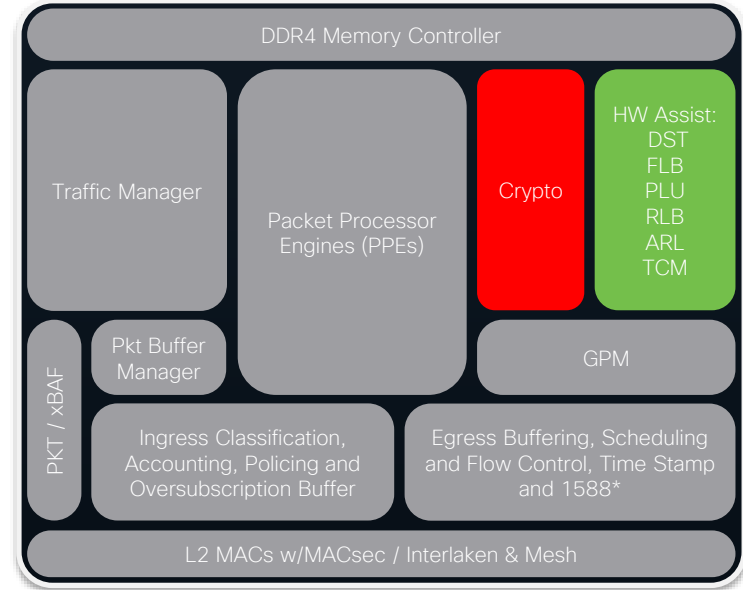


Integrated 16 Crypto Engines

Each Crypto Engine contains

- Packet input buffer, cipher, digest, and checksum engines
- Fully capable cipher engines for supported cipher algorithms
- Fully capable digest engines for underlying digest algorithms

Digest Cipher	SHA1	SHA2-256/384/512	MD5	GCM
AES	✗	✓	✗	✓
DES/3DES	✗	✗	✗	N/A



QFP 3.0 Layer 2 Sub-system

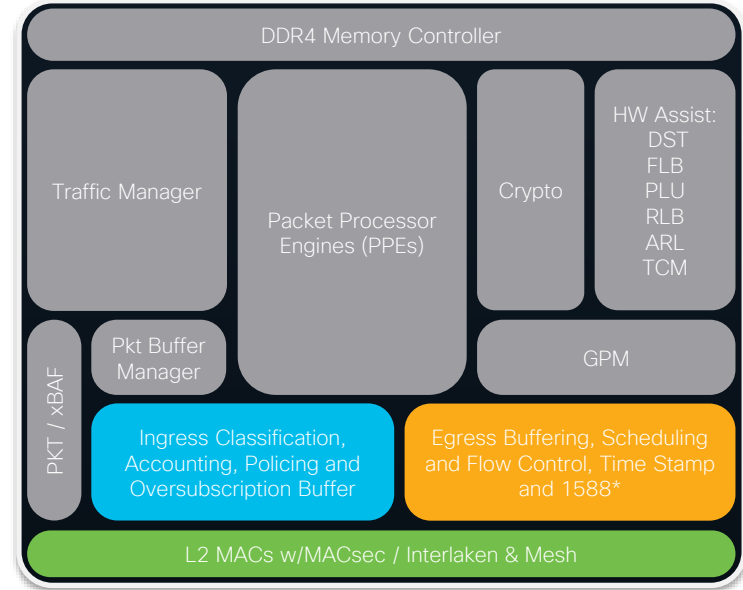


Layer 2 Aggregation

- 240Gpbs ethernet port aggregation
- Per port 12.5ms Ingress Oversubscription Buffers

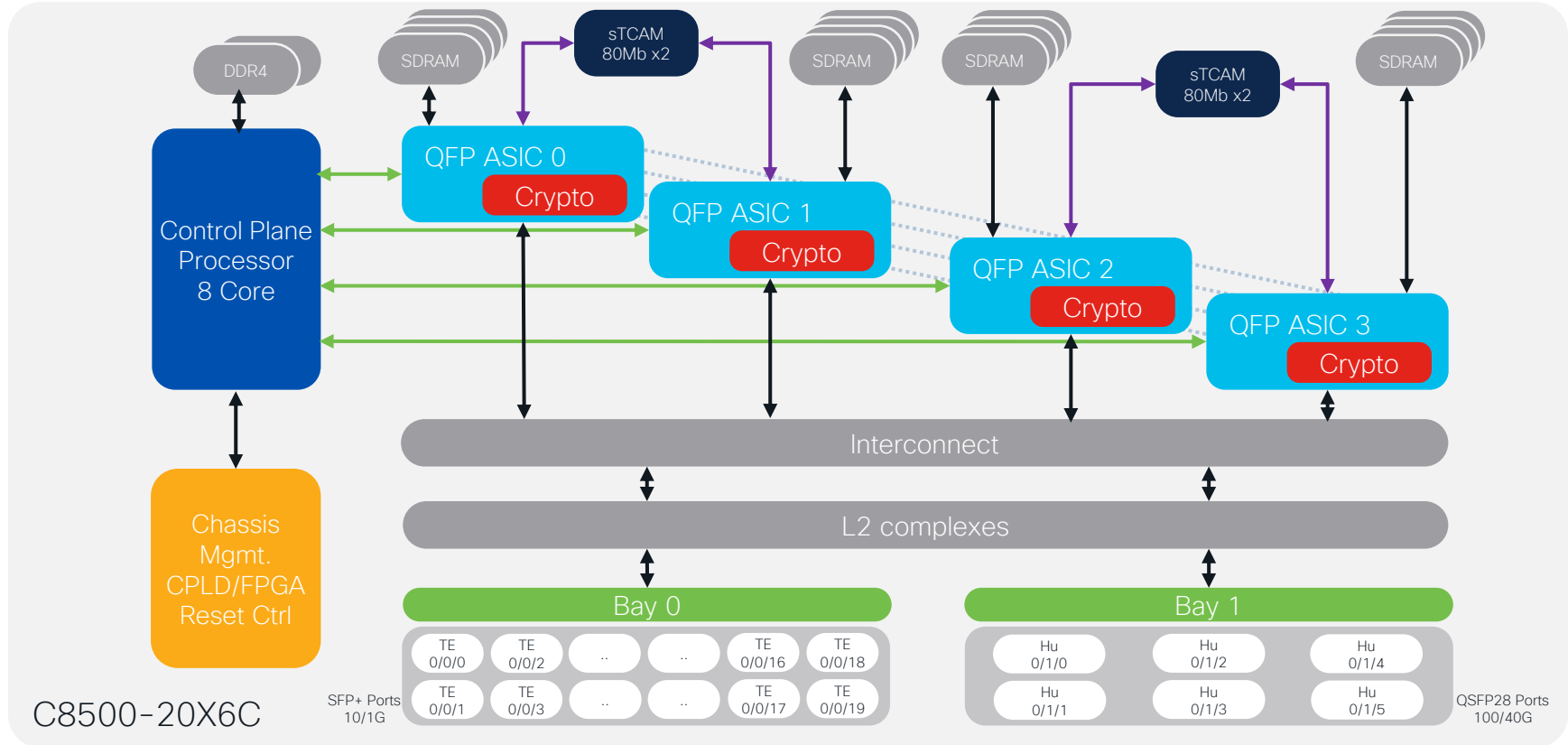
Classification, Accounting

- Supports per port, L2/L3, TCAM based classification
- Supports Ingress sub-intf classification
- Supports Ingress and Egress per Port High, Low priority accounting

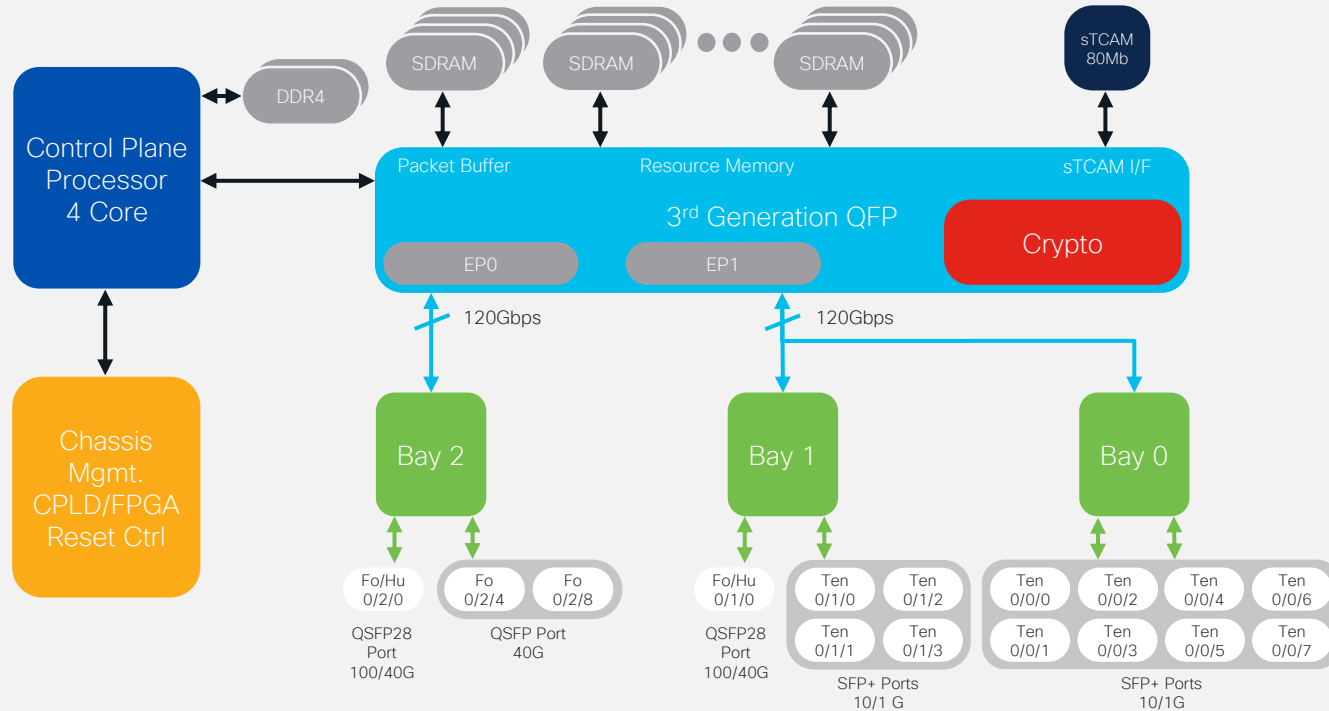


**In C8500, MACsec is implemented in PHY, not in QFP
*1588 is not supported feature at this moment

C8500-20X6C Block Diagram

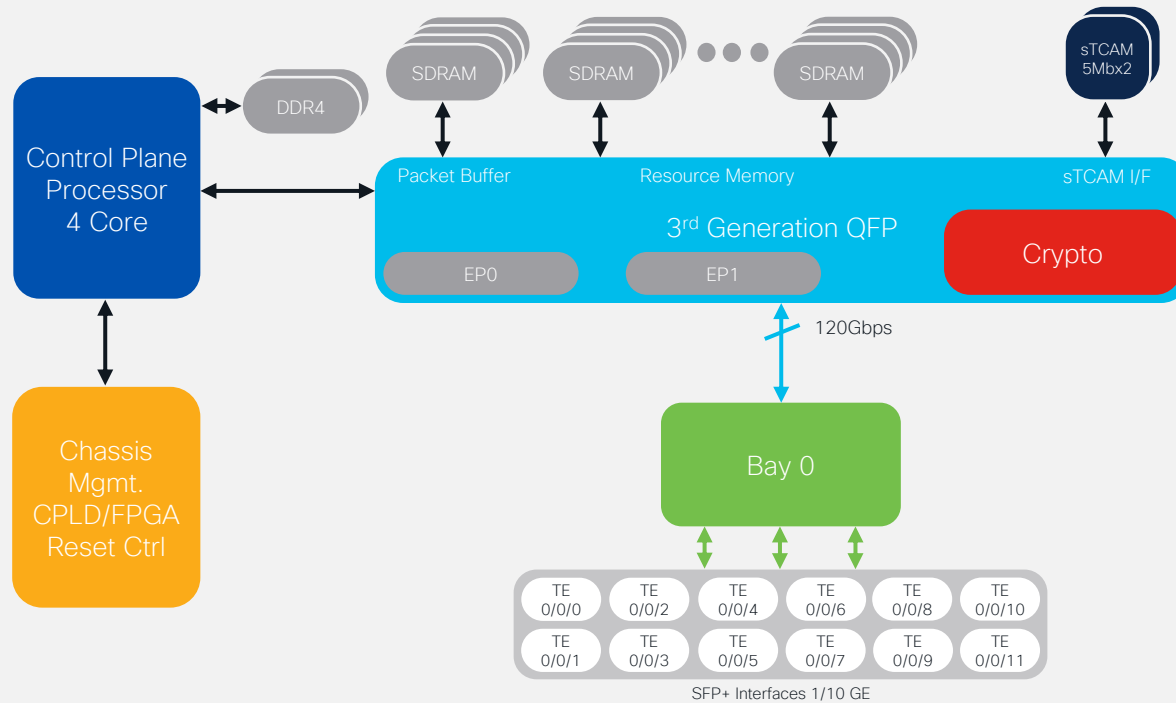


C8500-12X4QC Block Diagram



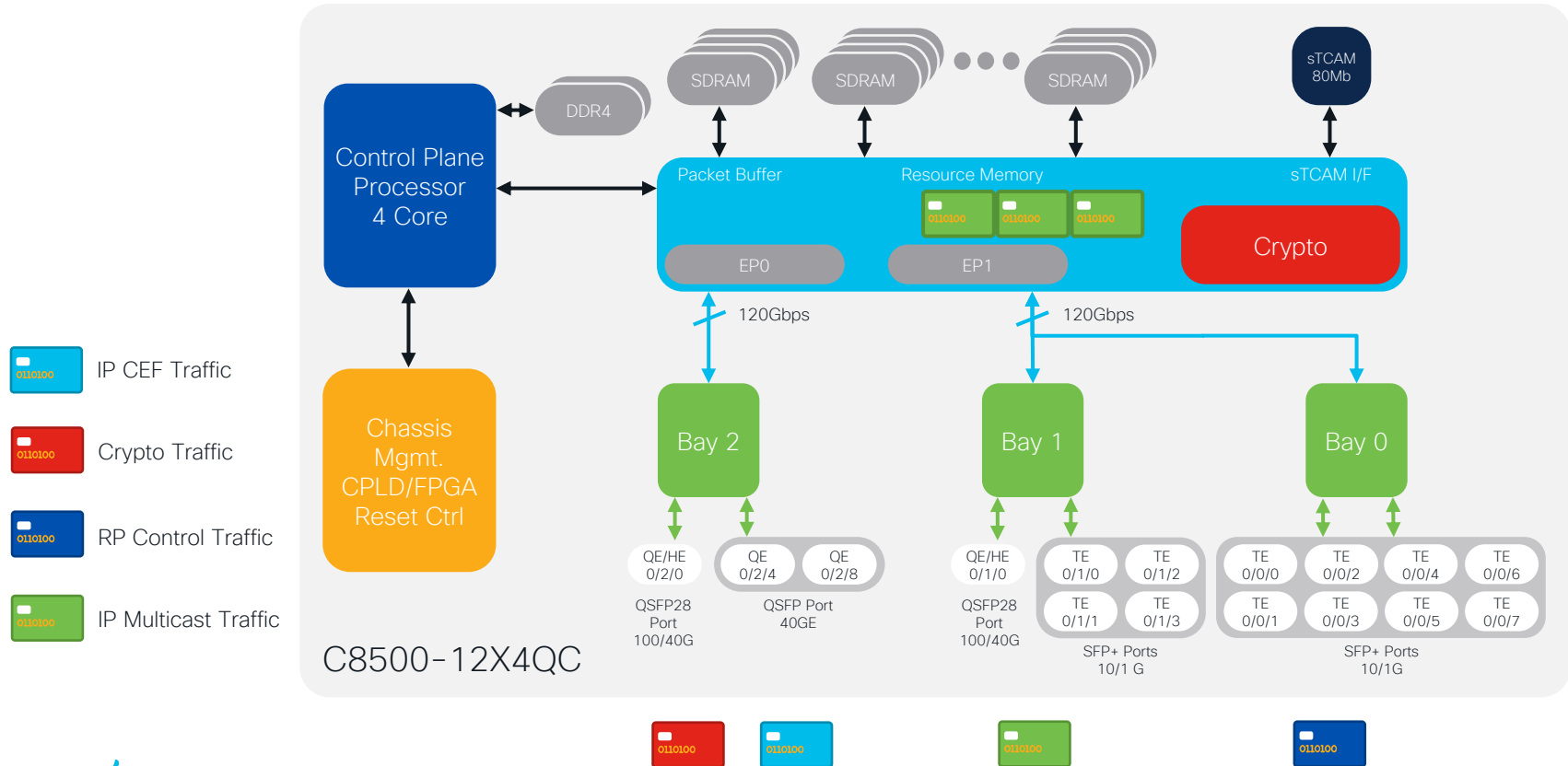
C8500-12X4QC

C8500-12X Block Diagram



C8500-12X

Life of a Packet

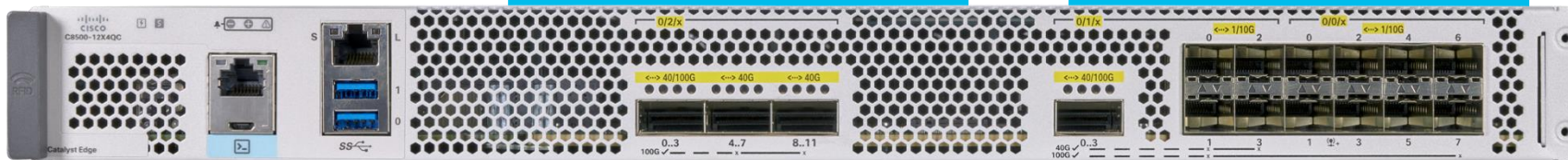


C8500-12X4QC Port Connectivity

Purpose-built 100GE, 40GE Port SD-WAN 1RU Platform

Max 120G of ports from Bay 2

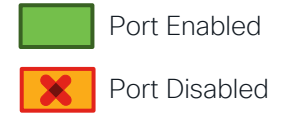
Max 120G of ports across Bay 0 + Bay 1



Option	Port Speed	Maximum Port Configuration
1	100GE	2x100G
2	100/40GE	1x100GE + 3x40GE
3	100/40GE	1x100GE + 12x10GE
4	40/10GE	4x40GE + 8x10GE
5	40/10GE	3x40GE + 12x10GE
6	100/40/10GE	1x100GE + 1x40GE + 8x10GE
7	10GE	12x10GE + 12x10GE (using breakout* cable)
8	1GE	12x1GE

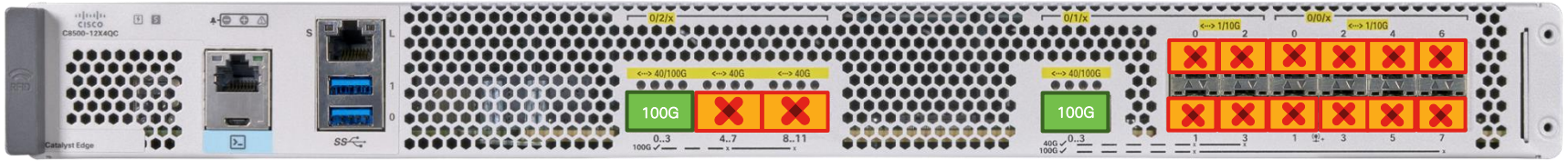
100GE, 40GE Connectivity Options (i)

C8500-12X4QC



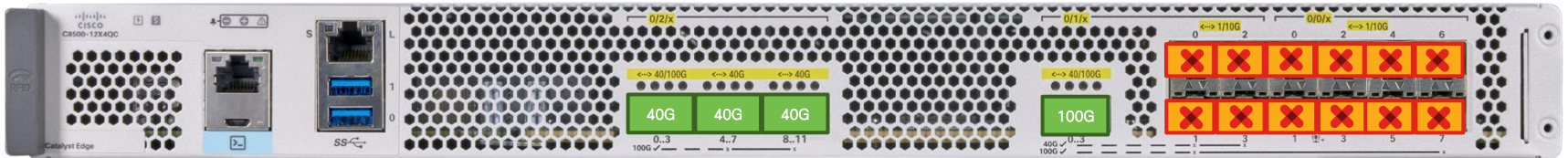
Option 1

2 x 100GE



Option 2

1 x 100GE + 3 x 40GE Ports



Note: For port speed change on any bay; there is an expected 1 sec traffic disruption due to backplane reset

100GE, 40GE Connectivity Options (ii)

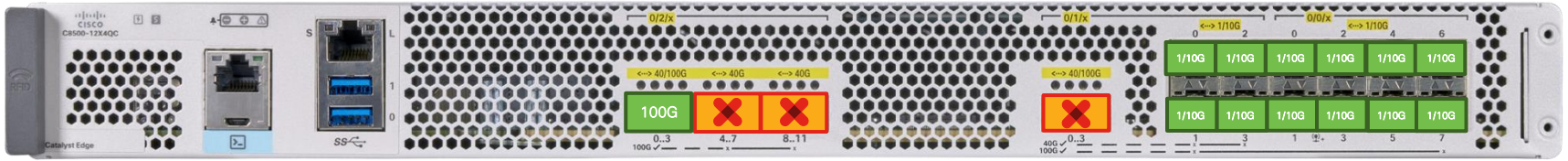
C8500-12x4QC

 Port Enabled

 Port Disabled

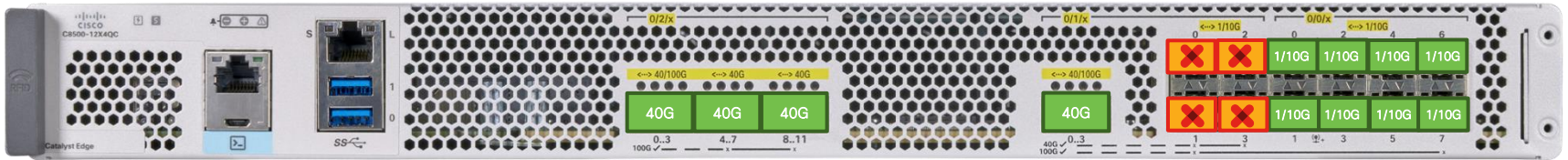
Option 3

1 x 100GE + 12 x 10GE



Option 4

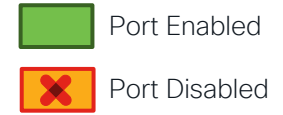
4 x 40GE + 8 x 10GE



Note: For port speed change on any bay; there is an expected 1 sec traffic disruption due to backplane reset

100GE, 40GE Connectivity Options (iii)

C8500-12x4QC



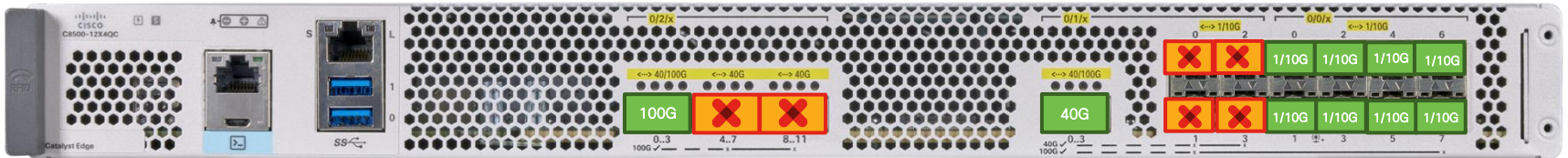
Option 5

3 x 40GE + 12 x 10GE



Option 6

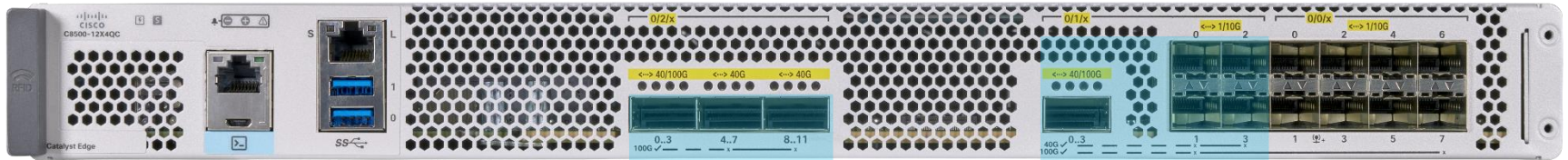
1 x 100GE + 1 x 40GE + 8 x 10GE



Note: For port speed change on any bay; there is an expected 1 sec traffic disruption due to backplane reset

C8500-12X4QC, Bay Speed Configuration

Autonomous Mode



```
C8500(config)# hw-module subslot 0/1 mode ?
  100G  configure EPA to 100G mode
  10G   configure EPA to 10G mode
  40G   configure EPA to 40G mode

Router(config)#hw-module subslot 0/1 mode 100G
Present configuration of this subslot will be erased and will not be
restored.
CLI will not be available until mode change is complete and EPA
returns to OK state.
Do you want to proceed? [confirm]
<snip>
```

C8500-12X4QC, Bay Speed Configuration

Controller Mode

The screenshot shows the Cisco vManage interface for configuring a C8500-12X4QC switch. The breadcrumb navigation is: Feature Template > Add Template > Dynamic Interface Mode. The main view shows a physical switch with a subslot mode configuration table below it.

SUBSLOT MODE PARAMETERS	
Bay 0	8*10g
Bay 1	1*40G
Bay 2	1*100G

Buttons: Save, Cancel

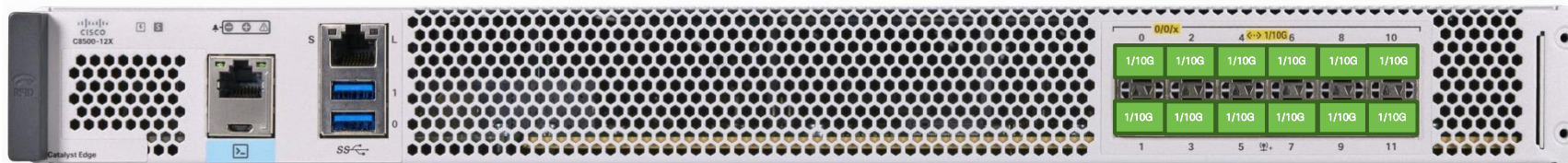
High Density 10GE, 1GE Connectivity Options

C8500-12X and C8500-12x4QC

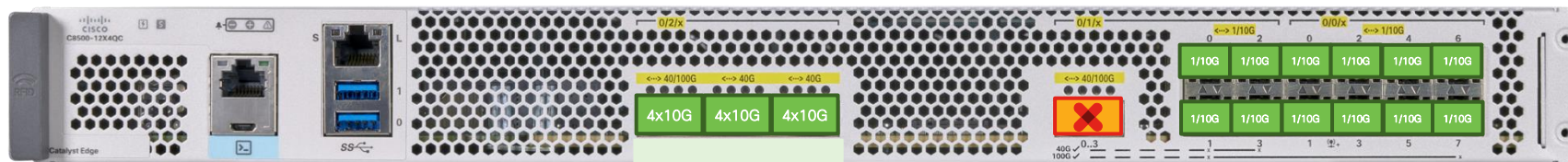
 Port Enabled

 Port Disabled

Option 7, 8 C8500-12X: 12 x 1/10GE



Option 7, 8 C8500-12X4QC: 12 x 1/10GE + 12 x 10GE*

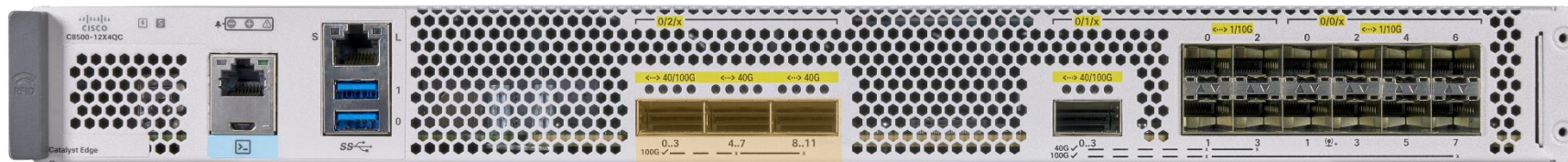


12 x 10GE using Breakout Cable

*C8500-12X4QC breakout cable is supported from 17.4.1 and on Autonomous mode only.

C8500-12X4QC Breakout Cable

40GE Speed Interfaces in bay-2 → breakout into 4 x 10GE ports each



*Support on Autonomous mode only

```
Router(config)#hw-module subslot 0/2 mode 40g
Router(config)#
Router(config)#hw-module subslot 0/2 breakout 10G port ?
all          configure all native ports in breakout mode
native_port_0  configure native port 0 in breakout mode
native_port_4  configure native port 4 in breakout mode
native_port_8  configure native port 8 in breakout mode
```

C8500L - Performance enhancements using advanced flow-based forwarding



Multi-Core Parallel Processing



High Scale Feature Velocity
Improved Performance, Programmable



High speed IPsec, with QAT
In-Line Encryption, Decryption



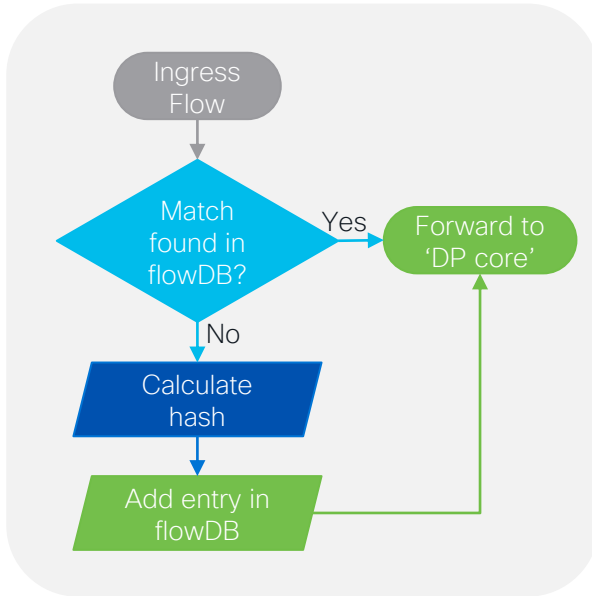
Advanced flow-based
forwarding algorithm

Advanced Flow-based Forwarding

Re-imagined x86 Forwarding Architecture

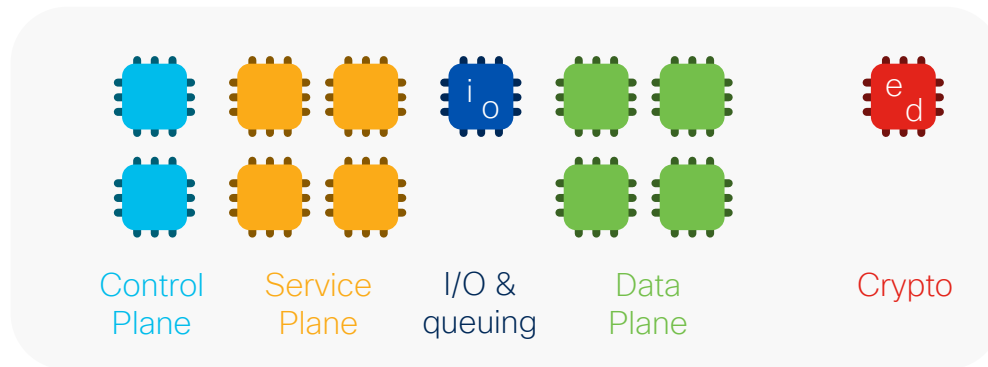
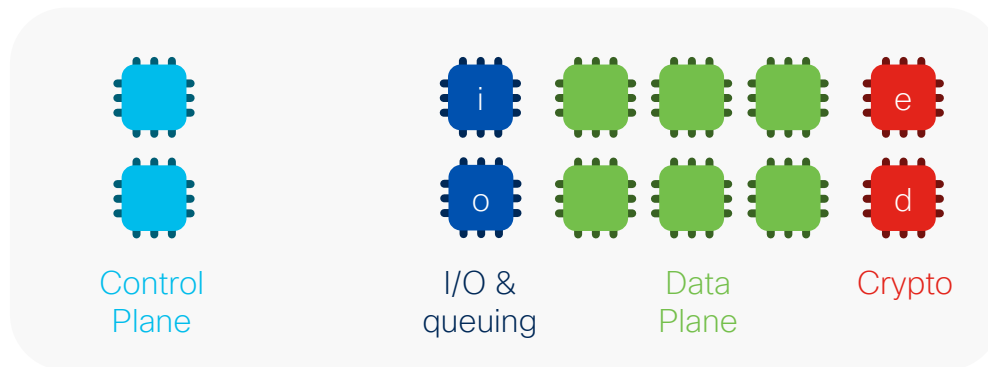


Quick Assist Technology



Protocol	Tuple hashing elements
TCP/UDP	srcIP, dstIP, protocol, srcPort, dstPort, vrfID
ESP	srcIP, dstIP, protocol, vrfID
All other Protocols	srcIP, dstIP, protocol, vrfID

Data Plane vs Service Plane Heavy



CLI configuration and reboot required to change modes. Roadmap for future software to not require reboot.

C8500L Data Plane Heavy

Configure, Verify



```
C8500L(config)#platform resource data-plane-heavy
C8500L(config)# do show platform software cpu allocation
CPU alloc information:
```

```
Control plane cpu alloc: 0-1,12-13
```

```
Data plane cpu alloc: 2-11
```

```
Service plane cpu alloc: 0
```

```
Template used: CLI-data_plane_heavy
```

```
C8500L(config)#
```

All cores allocated
for Data Plane

DP heavy is the default mode for IOS XE Routing 'autonomous' mode operation

C8500L Service Plane Heavy

Configure, Verify



```
C8500L(config)#platform resource service-plane-heavy
C8500L(config)# do show platform software cpu allocation
CPU alloc information:
```

```
Control plane cpu alloc: 0-1,12-13
```

```
Data plane cpu alloc: 6-11
```

```
Service plane cpu alloc: 2-5,14-17
```

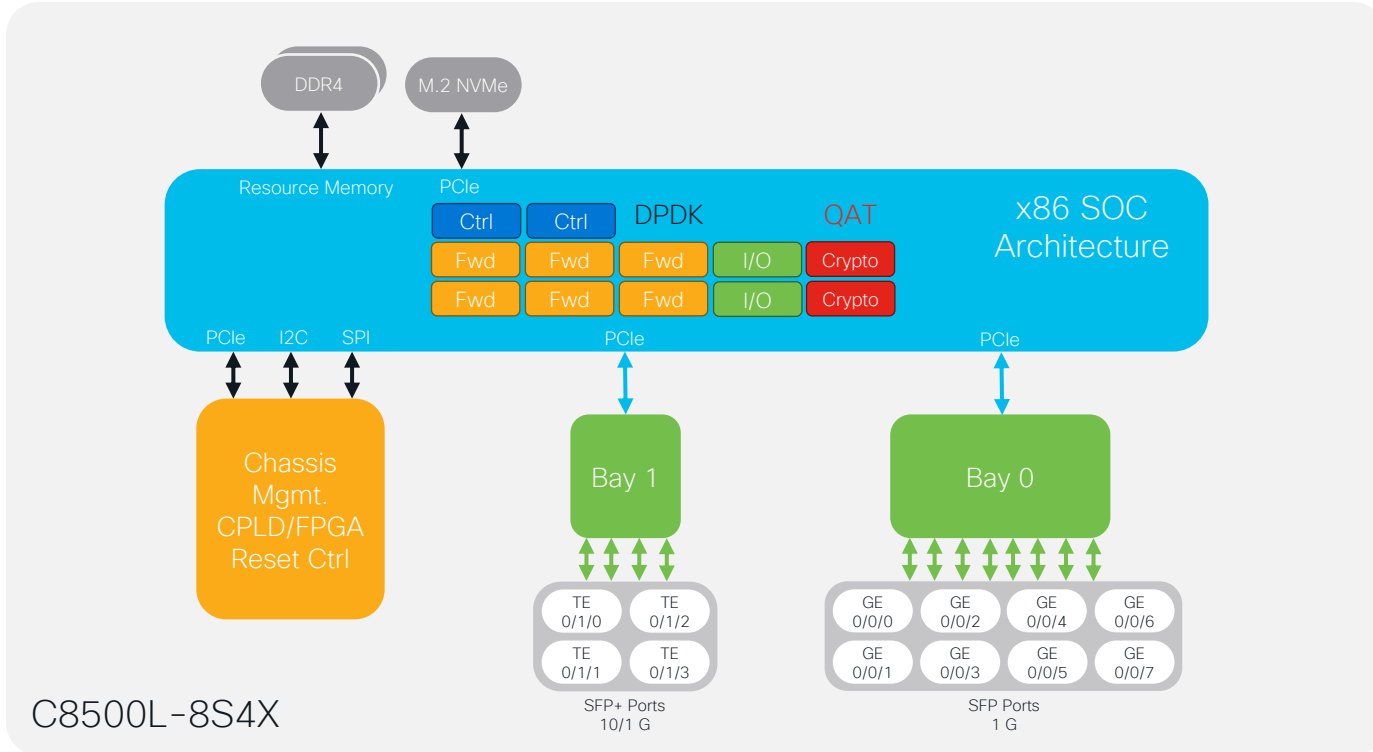
```
Template used: CLI-service_plane_heavy
```

```
C8500L(config)#
```

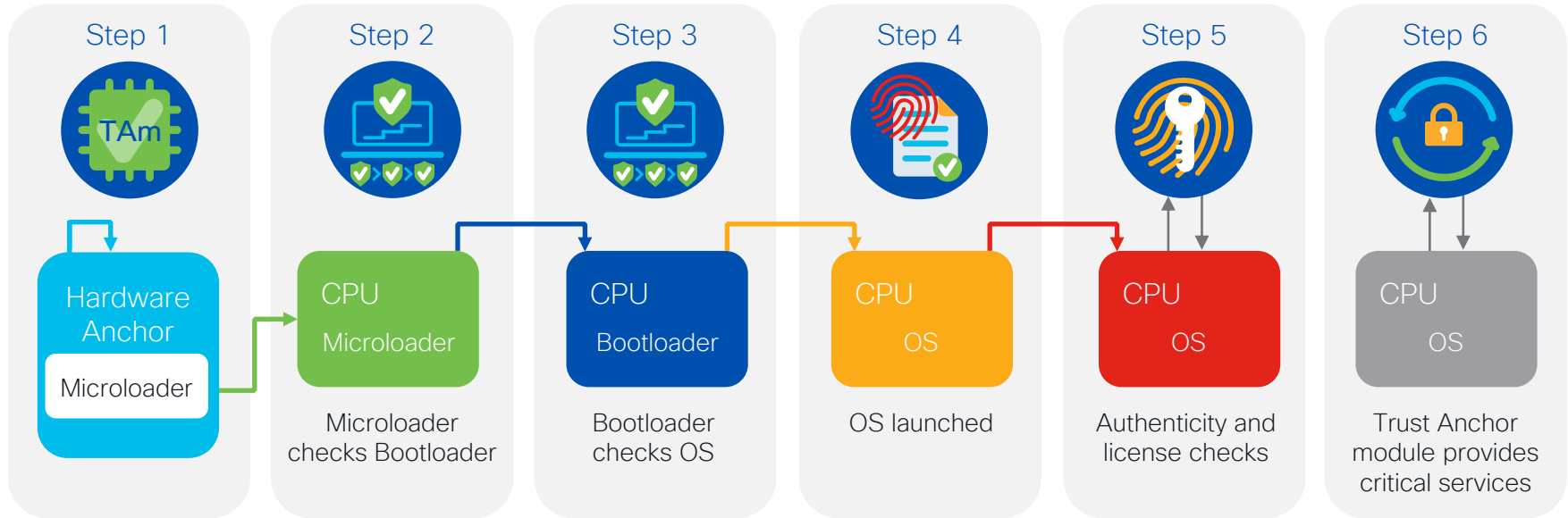
4 x 2 hyperthreaded
cores for Service Plane

SP heavy is the default mode for Cisco SD-WAN 'controller' mode operation

C8500L-8S4X Block Diagram



Secure Platform with Trustworthy Technologies



First instructions run on CPU stored in TAmper-resistant hardware

Confidentiality

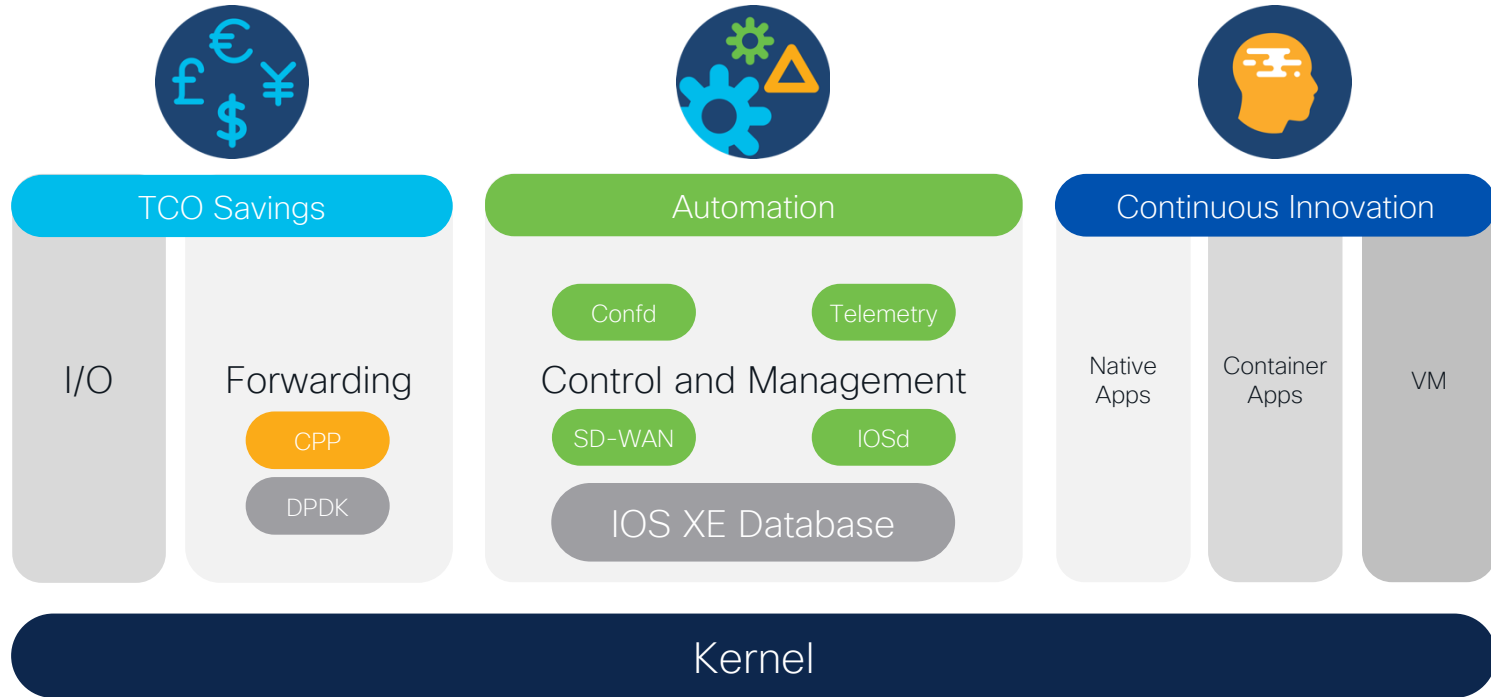
Integrity

Authenticity

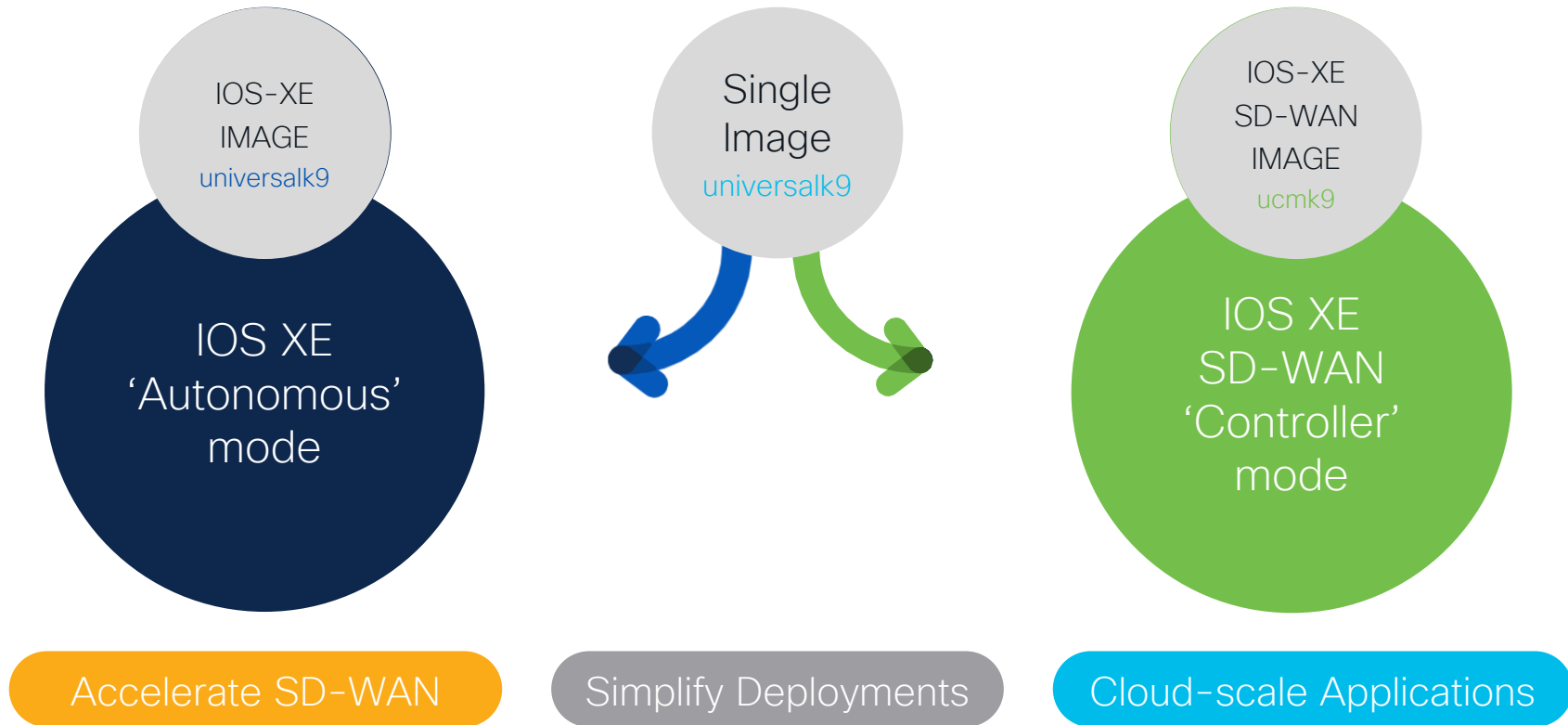
Catalyst 8500 Software Architecture



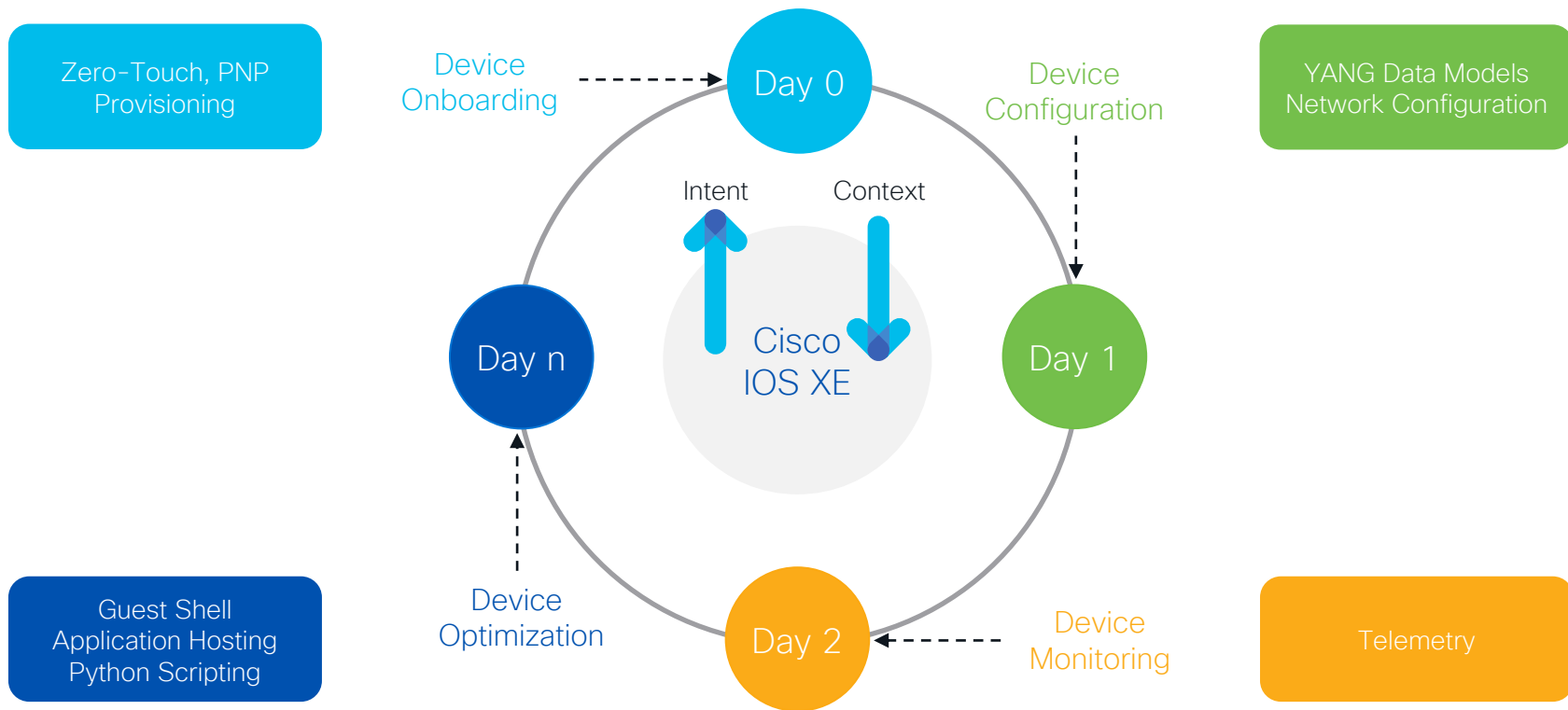
Open IOS XE – A Modern Operating System



Easy Operations with Single Image



Catalyst 8500 Programmability



Catalyst 8500 Product Comparison



ASR1002-HX vs C8500-12X4QC

Product Comparison

Up to 18Gbps SD-WAN, 6000 tunnels

Up to 100Gbps CEF, 25Gbps Crypto

8M NAT/PAT, 12M CGN Sessions

4GB DP Memory, 232K Queues

Ports: 8x 1G, 8x 10G, One EPA Slot

16GB to 32GB upgradable DRAM

QFP 2.0, 124 Cores, extra Crypto HW

Up to 29Gbps SD-WAN, 8000 tunnels

Up to 200Gbps CEF, 35Gbps Crypto

16M NAT/PAT, 32M CGN Sessions

32GB DP Memory, 256K Queues

Ports: 12x 1/10G, 2x 40/100G, 2x 40G

16GB to 64GB upgradable DRAM

QFP 3.0, 224 Cores, Inbuilt Crypto, L2



All perf numbers are aggregate IMIX throughput

ASR1001-HX vs C8500-12X

Product Comparison

Up to 11Gbps SD-WAN, 6000 tunnels

Up to 60Gbps CEF, 16Gbps Crypto

2M NAT/PAT, 4M CGN Sessions

1GB DP Memory, 116K Queues

Ports: 8x 1G, 4x 10G, 4x 1/10G

16GB to 32GB upgradable DRAM

QFP 2.0, 124 Cores, extra. Crypto HW

Up to 24Gbps SD-WAN, 8000 tunnels

Up to 120Gbps CEF, 32Gbps Crypto

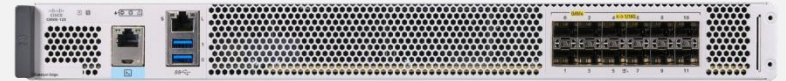
12M NAT/PAT, 24M CGN Sessions

32GB DP Memory, 256K Queues

Ports: 12x 1/10G

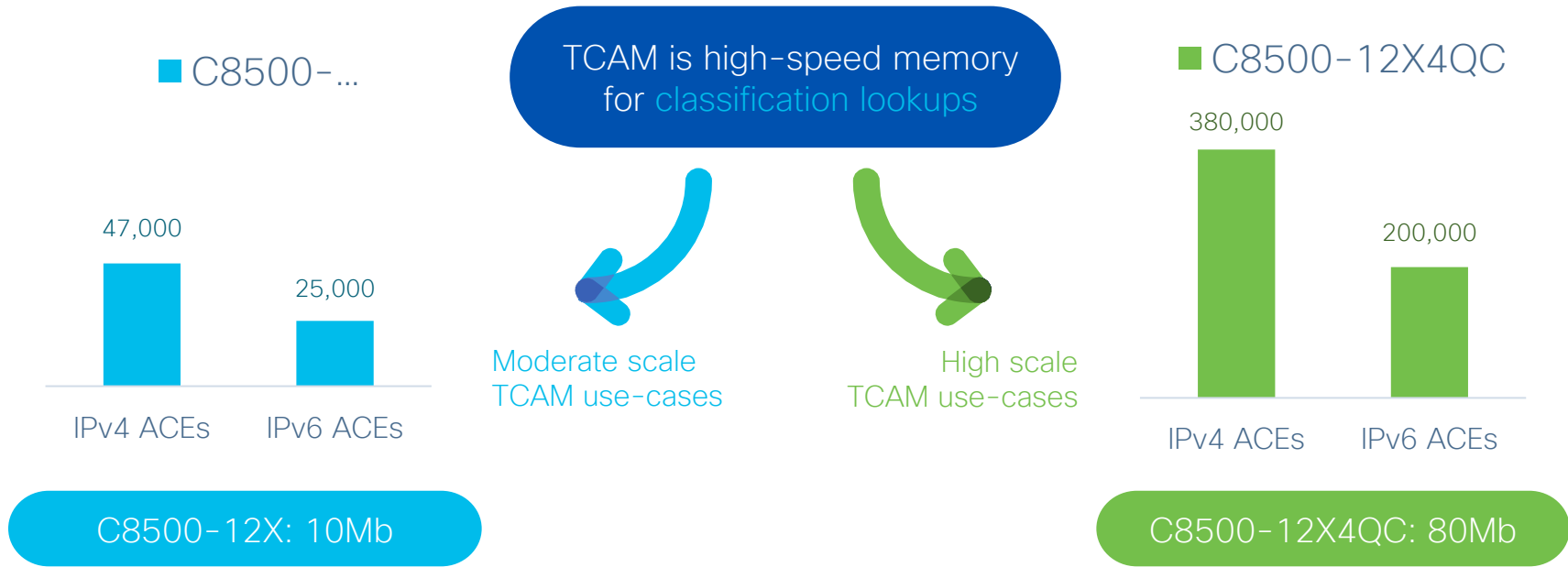
16GB to 64GB upgradable DRAM

QFP 3.0, 224 Cores, Inbuilt Crypto, L2



All perf numbers are aggregate IMIX throughput

Catalyst 8500 TCAM Capacity



C8500-12X4QC is better choice for high scale TCAM use-cases

ASR1001-X vs C8500L-8S4X

Product Comparison

Up to 4.5 Gbps SD-WAN, 6000 tunnels

Up to 20Gbps CEF, 5.5Gbps Crypto

2M NAT/PAT, 15 Gbps NAT perf

4GB DP Memory, 16K Queues

Ports: 6x 1G, 2x 10G

8GB to 32GB upgradable DRAM

QFP 2.0, 31 Cores

Up to 10Gbps SD-WAN, 6000 tunnels

Up to 20Gbps CEF, 12Gbps Crypto

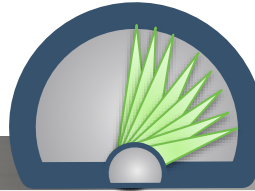
2M NAT/PAT, 17 Gbps NAT perf

Max 4GB DP Memory, 16K Queues

Ports: 8x 1G, 4x 1/10G

16GB to 64GB upgradable DRAM

x86, 12 Cores, Flow Based Architecture



All perf numbers are aggregate IMIX throughput

Solutions, Use-Cases



C8500 for Cloud-scale SD-WAN

100 / 40 / 10 / 1 GE Ports

High Speed DIA, DCA

Headend Multicast Replication

SASE, Cloud Edge Platform

8000 SD-WAN Tunnels

Remote Workforce Aggregation

High IPsec Throughput

High Performance Services

SD-WAN

Cisco
Umbrella

salesforce



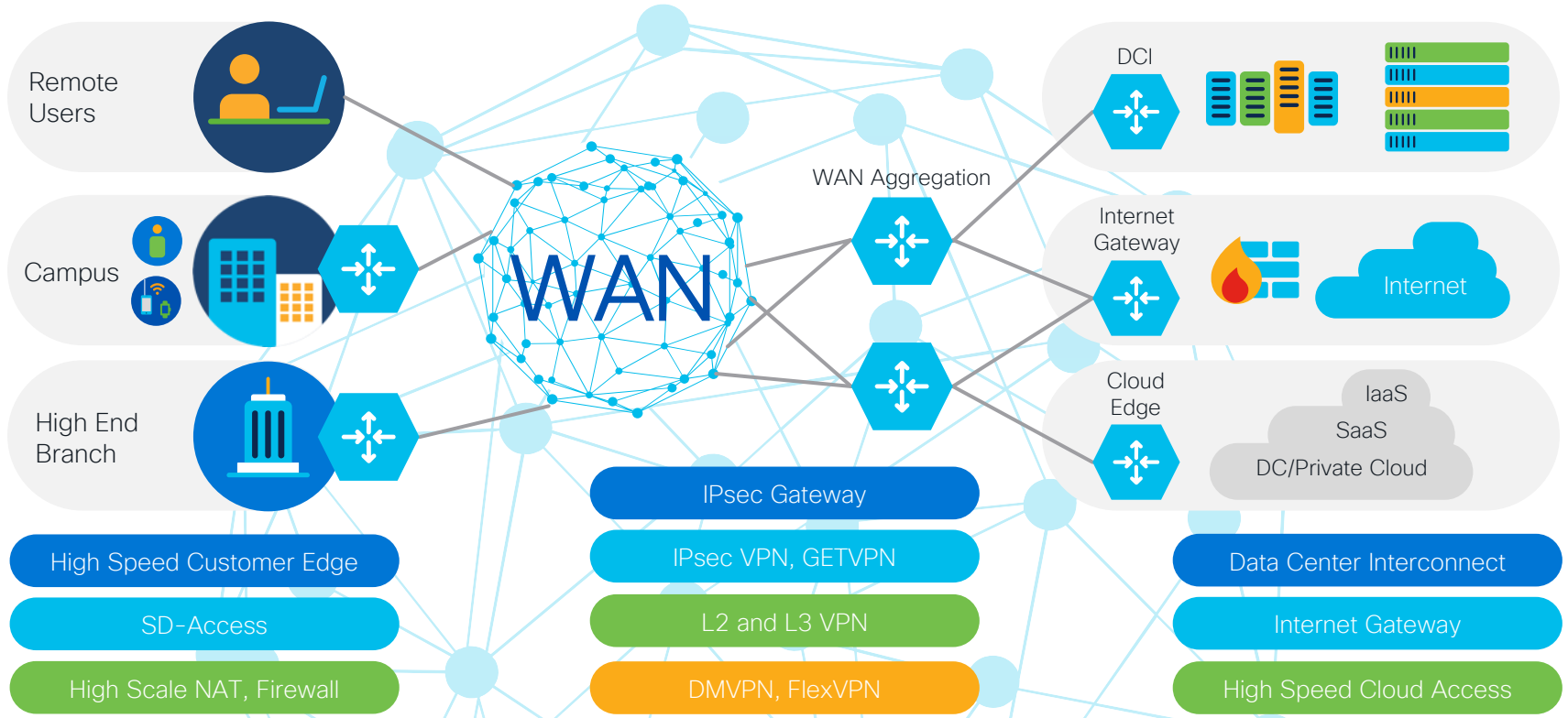
Data Center Hub



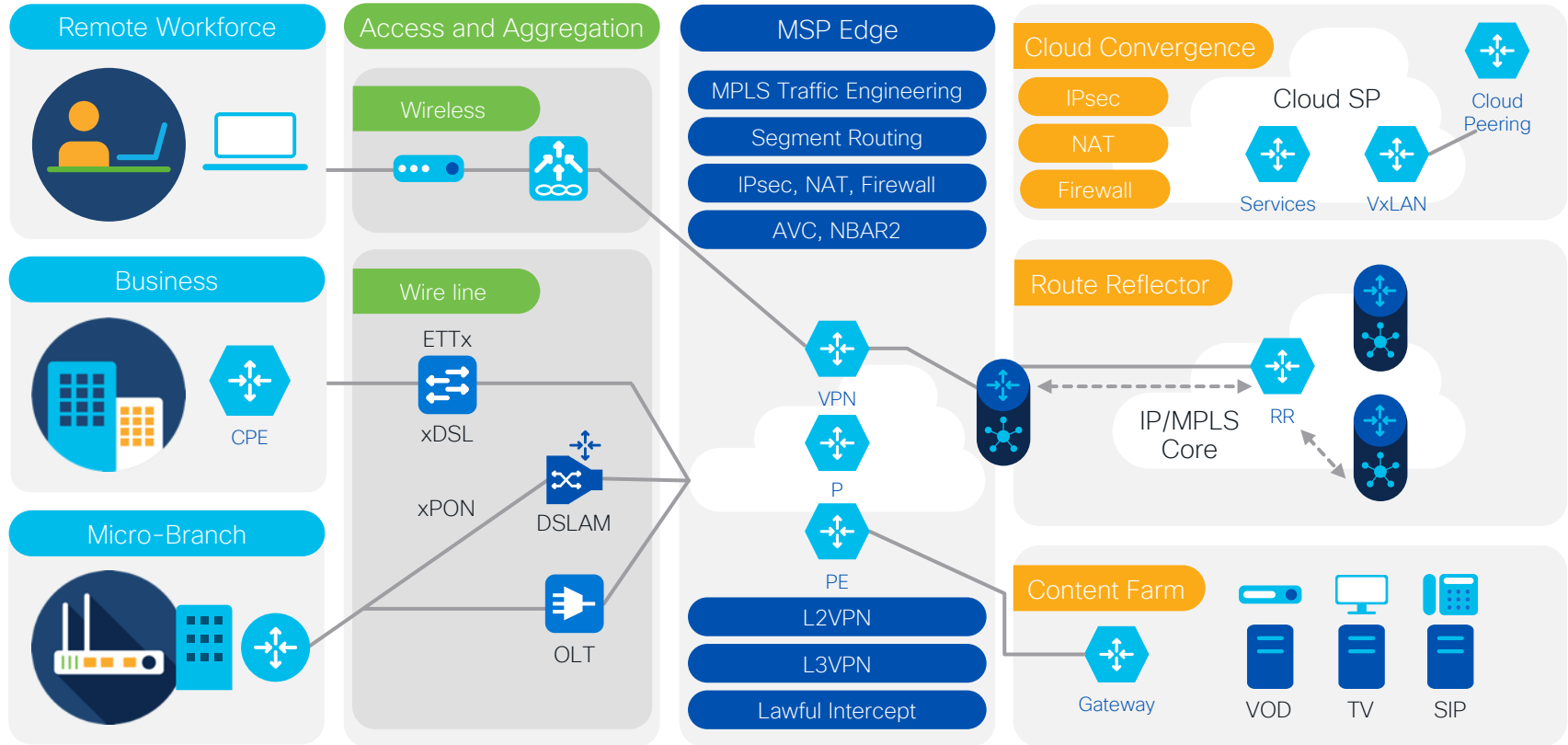
Campus Edge



C8500 for Enterprise Networks



C8500 for Service Provider Networks



Catalyst 8500: One Platform, Many Solutions

SD-WAN

High Speed DIA, DCA
Multi-Region Fabric BR
Multi-Tenant Edge/Gateway
SD-WAN Remote Access
Multicast Replication

Internet Gateway

High Throughput Performance
NAT44/NAT64/NAT66
AVC, Firewall
High Speed DIA, DCA
Dynamic Application Policy
Routing (DAPR)

Cloud GW, CoLo

Multi-Tenant, VRF Aware
High Scale NAT, AVC, Firewall
Inter VRF Services- VASI
Stateful B2B High Availability
MACsec, IPsec

Secure WAN

Site-to-site, Remote
Access VPN
GETVPN, DMVPN, FlexVPN,
IPsec over GRE, sVTI
High Scale NAT, AVC, Firewall
WAN MACsec

SD-Access

Control-Plane Node
Border Node
SD-Access, SD-WAN
Multi-Domain

DCI

EoMPLS, L2TPv3,
VPLS, MPLS
Overlay Transport Virtualization
EVPN VXLAN
Cisco WAN MACsec

Network Infra

MPLS, Segment Routing
L2VPN, L3VPN
mVPN
MPLS-TE
AVC, H-QoS
Route Reflector

Cloud MSP

Multi-Tenant, VRF Aware
VXLAN
Route Scale
IPsec, NAT, Firewall
Stateful B2B High Availability

Catalyst 8500

Inherits Cisco ASR 1000 features for IOS XE and IOS XE SD-WAN use-cases

Best Practices, Troubleshooting



Platform Resource Summary



```
C8500# show platform resources
```

```
**State Acronym: H - Healthy, W - Warning, C - Critical
```

Resource	Usage	Max	Warning	Critical	State

RP0 (ok, active)					H
Control Processor	2.82%	100%	80%	90%	H
DRAM	3014MB (19%)	15565MB	88%	93%	H
bootflash	1287MB (5%)	25725MB	88%	93%	H
harddisk	0MB (0%)	0MB	88%	93%	H
ESP0(ok, active)					H
QFP					H
TCAM	8cells (0%)	131072cells	65%	85%	H
DRAM	356927KB (1%)	20971520KB	85%	95%	H
IRAM	16597KB (12%)	131072KB	85%	95%	H
CPU Utilization	0.00%	100%	90%	95%	H
Pkt Buf Mem (0)	1152KB (0%)	164864KB	85%	95%	H
Pkt Buf CBlk (0)	14544KB (1%)	986112KB	85%	95%	H

```
C8500#
```

A system wide platform resource summary command- show platform resources. It covers most of the critical resources.

Software Status- Control Processor



```
C8500# show platform software status control-processor brief
```

Load Average

Slot	Status	1-Min	5-Min	15-Min
RP0	Healthy	0.27	0.21	0.16

Memory (kB)

Slot	Status	Total	Used (Pct)	Free (Pct)	Committed (Pct)
RP0	Healthy	15939320	3081200 (19%)	12858120 (81%)	9046624 (57%)

CPU Utilization

Slot	CPU	User	System	Nice	Idle	IRQ	SIRQ	IOwait
RP0	0	0.60	0.40	0.00	99.00	0.00	0.00	0.00
	1	0.09	0.19	0.00	99.60	0.00	0.09	0.00
	2	0.49	0.39	0.00	99.00	0.00	0.09	0.00
	3	0.20	0.20	0.00	99.59	0.00	0.00	0.00
	4	0.50	0.40	0.00	99.10	0.00	0.00	0.00
	5	0.10	0.20	0.00	99.69	0.00	0.00	0.00
	6	0.20	0.20	0.00	99.59	0.00	0.00	0.00
	7	2.40	0.70	0.00	96.80	0.00	0.10	0.00

```
C8500#
```

Alerts

%PLATFORM-4-ELEMENT_WARNING

→ Look out for committed memory

%OOM-0-NO_MEMORY_RESET:

→ System is completely out of memory

%OOM-3-NO_MEMORY_AVAIL:

→ System is low on available memory

IOSd CPU Consumption



```
C8500# show processes cpu sorted
CPU utilization for five seconds: 5%/1%; one minute: 4%; five minutes: 6%
  PID Runtime(ms)   Invoked    uSecs   5Sec   1Min   5Min  TTY Process
  547   2834655      39762575     71  1.59%  1.49%  2.26%  0 DHCP Client
  132   1162320      63935111     18  0.39%  0.38%  0.52%  0 IOSXE-RP Punt Se
   16   202269       14022331     14  0.23%  0.11%  0.15%  0 ARP Background
  136   34870        9778096      3  0.07%  0.01%  0.00%  0 L2 LISP Punt Pro
  193   15778        4899375      3  0.07%  0.01%  0.00%  0 IP ARP Retry Age
  287   192338       9226684     20  0.07%  0.10%  0.15%  0 IP Connected Rou
   87   166228       1074530    154  0.07%  0.09%  0.12%  0 IOSD ipc task
  312   47348        9226664      5  0.07%  0.02%  0.04%  0 static
    8      0            1            0  0.00%  0.00%  0.00%  0 RO Notify Timers
    7      0            1            0  0.00%  0.00%  0.00%  0 EDDRI_MAIN
    9   56128       21294       2635  0.00%  0.02%  0.00%  0 Check heaps
   10    122        2618        46  0.00%  0.00%  0.00%  0 Pool Manager
   13     1         519         1  0.00%  0.00%  0.00%  0 WATCH_AFS
   11     0            1            0  0.00%  0.00%  0.00%  0 DiscardQ Backgro
   15   17481       624562      27  0.00%  0.00%  0.00%  0 ARP Input
   12     0            2            0  0.00%  0.00%  0.00%  0 Timers
   14     0            1            0  0.00%  0.00%  0.00%  0 MEMLEAK PROCESS
   18     0            1            0  0.00%  0.00%  0.00%  0 ATM ASYNC PROC
--More--
```

'show process cpu history' CLI can be used to check CPU history for last 60 sec, 60 min and 72 hr timeframe.

IOSd Memory Consumption



```
C8500# show processes memory sorted
Processor Pool Total: 6992665708 Used: 292428256 Free: 6700237452
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	396181608	150330672	227209592	0	0	*Init*
6	0	20375344	83272	20248296	0	0	RF Slave Main Th
87	0	15950264	4032	10648104	0	0	IOSD ipc task
407	0	4130152	60792	4111304	849828	0	EEM ED Syslog
0	0	25398869344	24998765496	3705144	26263479	0	*Dead*
428	0	1800720	43416	1787248	0	0	EEM Server
1	0	1221440	0	1251384	0	0	Chunk Manager
172	0	4257424	1186136	1149320	0	0	CWAN OIR Handler
83	0	12819728	11931096	942200	0	0	SASRcvWQWrkl
291	0	938720	55456	934344	0	0	CEF: IPv4 proces
192	0	802472	0	856416	0	0	IP ARP Adjacency
388	0	2085144	1421248	665960	0	0	Crypto CA
197	0	838704	344792	493320	0	0	mDNS
408	0	396968	9584	429328	72316	0	EEM ED Generic
145	0	3615981024	3615601760	422512	0	0	SAMsgThread

--More--

This CLI helps to identify the process level memory consumption within IOS daemon.

Linux level (top) CPU, Memory Usage

```
C8500# show platform software process slot rp active monitor
top - 23:30:18 up 1 day, 20:26,  0 users,  load average: 0.12, 0.06, 0.06
Tasks: 321 total,  2 running, 319 sleeping,  0 stopped,  0 zombie
%Cpu(s):  0.0 us,  0.8 sy,  0.0 ni, 99.2 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem : 15565.7 total, 10045.3 free,  1572.0 used,  3948.4 buff/cache
MiB Swap:   0.0 total,   0.0 free,   0.0 used. 13419.9 avail Mem
```

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
14821	root	20	0	303276	35012	29148	S	6.2	0.2	0:51.70	psd
1	root	20	0	10088	8088	5592	S	0.0	0.1	0:29.54	systemd
2	root	20	0	0	0	0	S	0.0	0.0	0:00.05	kthreadd
3	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	rcu_gp
4	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	rcu_par_gp
6	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	kworker/0+
8	root	0	-20	0	0	0	I	0.0	0.0	0:00.00	mm_percpu+
9	root	20	0	0	0	0	S	0.0	0.0	0:01.26	ksoftirqd+
10	root	20	0	0	0	0	I	0.0	0.0	1:04.07	rcu_sched
11	root	20	0	0	0	0	I	0.0	0.0	0:00.03	rcu_bh
12	root	rt	0	0	0	0	S	0.0	0.0	0:00.47	migration+
13	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cpuhp/0
14	root	20	0	0	0	0	S	0.0	0.0	0:00.00	cpuhp/1

--More--

This CLI helps to verify Linux level memory and CPU consumption like 'top' command.

Data Plane: TCAM Consumption



```
C8500# show platform hardware qfp active tcam resource-manager usage
QFP TCAM Usage Information
```

80 Bit Region Information

```
Name : Leaf Region #1
Number of cells per entry : 1
Current 80 bit entries used : 0
Current used cell entries : 0
Current free cell entries : 0
```

160 Bit Region Information

```
Name : Leaf Region #2
Number of cells per entry : 2
Current 160 bits entries used : 4
Current used cell entries : 8
Current free cell entries : 4088
```

320 Bit Region Information

```
Name : Leaf Region #2
Number of cells per entry : 4
Current 320 bits entries used : 0
Current used cell entries : 0
Current free cell entries : 0
```

Total TCAM Cell Usage Information

```
Name : TCAM #0 on CPP #0
Total number of regions : 3
Total tcam used cell entries : 8
Total tcam free cell entries : 131064
Threshold status : below critical limit
```

```
C8500#
```

Note: C8500L platform does not have dedicated TCAM memory.

TCAM is very important resource for classification configuration, should always be below critical limit.
%CPP_FM-3-CPP_FM_TCAM_WARNING → TCAM exhaustion warning syslog

Data Plane: QFP Memory Statistics



```
C8500# show platform hardware qfp active infrastructure exmem statistics
QFP exmem statistics
```

```
Type: Name: DRAM, QFP: 0
  Total: 21474836480
  InUse: 365493248
  Free: 21109343232
  Lowest free water mark: 21108950016
Type: Name: IRAM, QFP: 0
  Total: 134217728
  InUse: 16995328
  Free: 117222400
  Lowest free water mark: 117222400
Type: Name: SRAM, QFP: 0
  Total: 0
  InUse: 0
  Free: 0
  Lowest free water mark: 0
```

```
C8500#
```

Alerts

%CPPDRV-3-FATAL_MEM_SIZE

→ Software failed to acquire memory

%CPPEXMEM-3-NOMEM

→ CPP memory resource exhaustion

%CPPEXMEM-4-LOWMEM

→ CPP memory resource dropped below critical level

%CPPEXMEM-5-MEM

→ CPP memory resource has recovered

Data Plane: BQS DRAM Utilization



```
C8500# show platform hardware qfp active bqs 0 packet-buffer utilization
```

```
Packet buffer memory utilization details:
```

```
QFP.0:
```

```
Total:      161.00 MB
           :      963.00 MB cblk
Used :      1152.00 KB
           :     14544.00 KB cblk
Free :       159.88 MB
           :       948.80 MB cblk
```

```
Utilization:  0 %
              :  1 % cblk
```

```
Threshold Values:
```

```
Vital           :      160.94 MB, Status: False
                :      962.91 MB cblk
Packet Priority  :      159.44 MB, Status: False
                :      953.39 MB cblk
Priority         :      152.94 MB, Status: False
                :      914.81 MB cblk
Non-Priority    :      136.81 MB, Status: False
                :      818.44 MB cblk
```

```
C8500#
```

Alerts

```
%CPPBQS-4-QLIMITEXCEEDED
```

```
→ Max number of queues exceeded
```

```
%CPPBQS-6-QLIMITOK
```

```
→ Queues usage is within platform limit
```

```
%CPP_BQS-3-CARVE
```

```
→ BQS proxy failed to initialize software  
memory region
```

Data Plane: BQS Queue and Schedules



```
C8500# show platform hardware qfp active infrastructure bqs status
BQS-RM Status :
=====
Object Counts:
  Recycle Object Count:           148
  Recycle Schedule Count:         26
  Recycle Queue Count:            88
  # of Active Queues:             517
  # of Active Schedules:          533
  # of Active Roots:              12
  # of Active Min Profiles:        12
  # of Active Max Profiles:         6
  # of Active Exs Profiles:         8
Configuration Status:
  Pending Config Deferred:         False
  Pending Config Deferred Cnt:     4109
  OOR defer processing              False
<snip>
```

This CLI helps to to check current active queues in use and scheduler nodes associated with it.

Data Plane: QFP Utilization

```
C8500# show platform hardware qfp active datapath utilization
CPP 0: Subdev 0          5 secs          1 min           5 min           60 min
Input: Priority (pps)    0                0                0                0
      (bps)             0                0                0                0
      Non-Priority (pps) 844658           844653           844655           844646
      (bps)             851392584        851385576        851387240        851383656
      Total (pps)       844658           844653           844655           844646
      (bps)             851392584        851385576        851387240        851383656
Output: Priority (pps)   31               37               39               28
      (bps)             24264            28504            29872            21696
      Non-Priority (pps) 844781           844702           844703           844692
      (bps)             975232920        974111680        974112760        974106624
      Total (pps)       844812           844739           844742           844720
      (bps)             975232920        974111680        974112760        974106624
Processing: Load (pct) 975
```

CISCO-ENTITY-QFP-MIB
 Cisco-IOS-XE-qfp-stats-oper.yang
 Cisco-IOS-XE-qfp-stats.yang
 Cisco-IOS-XE-qos.yang

C8500#

```
C8500# show platform hardware qfp active datapath utilization summary
CPP 0:          5 secs          1 min           5 min           60 min
Input:  Total (pps)    844647           844657           844657           844646
      (bps)           851382464        851388832        851389088        851383528
Output:  Total (pps)    844801           844744           844744           844720
      (bps)           975243928        974144656        974144784        974127888
Processing: Load (pct) 4                4                4                4
```

C8500#

Data Plane: Crypto Utilization



```
C8500# show platform hardware crypto-device statistics
Forwarding Manager Encryption-processor Statistics
```

(P) - # of packets; (B) - # of bytes

```
STX1 disabled
TOTAL_CORES      : 0x0000006
ENABLED_CORES    : 00000000
AVAILABLE_CORES  : 00000000
OK SPI1 RX(P)    :
ERR SPI1 RX(P)   :
DROP SPI1 RX(P)  :
OK PCI RX(P)     :
PROCESSED(P)     :
ENCRYPTED(P)      :
DECRYPTED(P)      :
GEN. PURPOSE(P) :
```

```
C8500#
```

Dedicated commands to check Crypto device statistics, utilization on the platform.

```
C8500# show platform hardware crypto-device utilization
Past crypto device utilization:
utilization is for each crypto device, pkts are combined number.
 1 min (percentage) : 0%
      (decrypt pkt): 0
      (encrypt pkt): 0
 5 min (percentage) : 0%
      (decrypt pkt): 0
      (encrypt pkt): 0
15 min (percentage) : 0%
      (decrypt pkt): 0
      (encrypt pkt): 0
```

```
C8500#
```

Data Plane: x86 Per Core Utilization



```
C8500L#show platform hardware qfp active datapath infrastructure sw-cio
Credits Usage:
```

```
ID Port Wght Global WRKR0 WRKR1 WRKR2 WRKR3 WRKR4 WRKR5 WRKR6 WRKR7 WRKR8
WRKR9 Total
```

```
1 rcl0 1: 6048 0 0 0 0 0 96 0 0 0 61
1 rcl0 128: 6048 0 0 0 0 0 96 0 0 0
2 ipc 1: 0 0 0 0 0 0 0 0 0 0 0
3 vxe_punti 1: 476 0 0 0 0 0 0 36 0 0
4 fpe0 1: 1952 0 0 0 0 0 96 0 0 0 20
4 fpe0 2: 1952 0 0 0 0 0 96 0 0 0 20
5 fpe1 1: 1952 0 0 0 0 0 96 0 0 0 20
5 fpe1 2: 1952 0 0 0 0 0 96 0 0 0 20
6 fpe2 1: 1952 0 0 0 0 0 96 0 0 0 20
6 fpe2 2: 1952 0 0 0 0 0 96 0 0 0 20
7 fpe3 1: 1953 0 0 0 0 0 95 0 0 0 20
7 fpe3 2: 1952 0 0 0 0 0 96 0 0 0 20
8 fpe4 1: 1952 0 0 0 0 0 96 0 0 0 20
8 fpe4 2: 1952 0 0 0 0 0 96 0 0 0 20
9 fpe5 1: 1952 0 0 0 0 0 96 0 0 0 20
9 fpe5 2: 1952 0 0 0 0 0 96 0 0 0 20
10 fpe6 1: 1952 0 0 0 0 0 96 0 0 0 2
```

```
10 fpe6 2: 1952 0 0 0 0 0 96 0 0 2048
11 fpe7 1: 1952 0 0 0 0 0 96 0 0 2048
11 fpe7 2: 1952 0 0 0 0 0 96 0 0 2048
12 fpe8 1: 2012 0 0 0 0 0 36 0 0 2048
12 fpe8 2: 1952 0 0 0 0 0 96 0 0 2048
13 fpe9 1: 1952 0 0 0 0 0 96 0 0 2048
13 fpe9 2: 1952 0 0 0 0 0 96 0 0 2048
14 fpe10 1: 1952 0 0 0 0 0 96 0 0 2048
14 fpe10 2: 1952 0 0 0 0 0 96 0 0 2048
15 fpe11 1: 1979 0 0 0 0 0 69 0 0 2048
15 fpe11 2: 1952 0 0 0 0 0 96 0 0 2048
```

PP: Packet Processing
 RX: Receive core
 TM: Traffic Manager core
 COFF: Crypto core

Core Utilization over preceding 604610.7457 seconds

```
-----
ID: 0 1 2 3 4 5 6 7 8 9
% PP: 36.58 69.20 74.43 39.66 72.78 76.07 0.00 0.00 0.00 0.00
% RX: 0.00 0.00 0.00 0.00 0.00 0.00 28.43 4.86 0.00 0.00
% TM: 0.00 0.00 0.00 0.00 0.00 0.00 70.81 17.48 0.00 0.00
% COFF: 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.27 0.27
% IDLE: 63.42 30.80 25.57 60.34 27.22 23.93 0.76 77.65 99.73 99.73
```



Data Plane: QFP drops

Global vs Interface level

```
C8500# show platform hardware qfp active statistics drop
Last clearing of QFP drops statistics : Sat Feb 13 00:56:12 2021
(1d 22h 44m 54s ago)
```

```
-----
Global Drop Stats                               Packets                               Octets
-----
BadUidbSubIdx                                 1885726                               120686464
Ipv4NoRoute                                   2022                                   295166
Ipv6NoRoute
NatIn2out
QosPolicing
TailDrop
UnconfiguredIpv4Fia
UnconfiguredIpv6Fia
Wred
```

Observe data path packet drops using these two CLIs to associate them to interface and eventually to flow for a given reason of drop.

```
C8500# show platform hardware qfp active interface all statistics drop
```

```
-----
Drop Stats Summary:
note: 1) these drop stats are only updated when PAL
       reads the interface stats.
       2) the interface stats include the subinterface
```

```
Interface                               Rx Pkts                               Tx Pkts
-----
TenGigabitEthernet0/0/1                 0                                       1596360
TenGigabitEthernet0/0/2                 0                                       2
TenGigabitEthernet0/0/3                 0                                       23814997
TenGigabitEthernet0/1/0                 3453118                                0
```

```
C8500#
```

Data Plane: Software Object-Manager



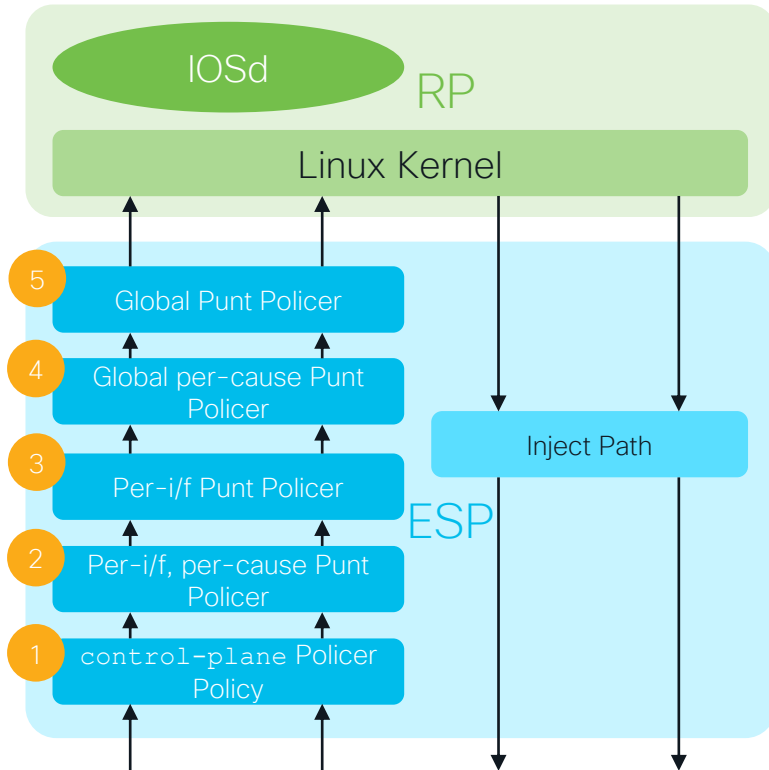
```
C8500#show platform software object-manager fp active statistics
Forwarding Manager Asynchronous Object Manager Statistics
```

```
Object update: Pending-issue: 0, 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: 166
Stale-objects: 0
Resolve-objects: 0
Childless-delete-objects: 0
Error-objects: 0
Paused-types: 3
```

```
C8500#
```

This CLI helps to confirm there are no programming issues from Control-plane (RP) to data plane (ESP). Pending-issue, Pending-acknowledgement count should always be 0.

Control Plane Policing- CoPP



Classification Criteria for CoPP

- match access-group
- match dscp
- match ip dscp
- match ip precedence
- match precedence
- match protocol arp
- match protocol ipv6
- match protocol pppoe
- match protocol pppoe-discovery
- match qos-group
- match ipv6 acl hbh

Control-Plane CoPP Policer (rate based)



```
C8500# show policy-map control-plane
```

```
Control Plane
```

```
Service-policy input: test
```

```
Class-map: p0 (match-all)
```

```
0 packets, 0 bytes
```

```
5 minute offered rate 0000 bps, drop rate
```

```
Match: precedence 0
```

```
police:
```

```
    cir 100000 bps, bc 3125 bytes
```

```
    conformed 0 packets, 0 bytes; actions:
```

```
        transmit
```

```
    exceeded 0 packets, 0 bytes; actions:
```

```
        drop
```

```
    conformed 0000 bps, exceeded 0000 bps
```

```
Class-map: p1 (match-all)
```

```
0 packets, 0 bytes
```

```
5 minute offered rate 0000 bps, drop rate
```

```
Match: precedence 1
```

```
police:
```

```
    cir 100000 bps, bc 3125 bytes
```

```
    conformed 0 packets, 0 bytes; actions:
```

```
        transmit
```

```
    exceeded 0 packets, 0 bytes; actions:
```

```
        drop
```

```
    conformed 0000 bps, exceeded 0000 bps
```

```
Class-map: class-default (match-any)
```

```
6 packets, 317 bytes
```

```
5 minute offered rate 0000 bps, drop rate 0000 bps
```

```
Match: any
```

```
police:
```

```
    cir 200000 bps, bc 6250 bytes
```

```
    conformed 6 packets, 317 bytes; actions:
```

```
        transmit
```

```
    exceeded 0 packets, 0 bytes; actions:
```

```
        drop
```

```
    conformed 0000 bps, exceeded 0000 bps
```

Per-interface, per-cause drops

2 *Oct 11 10:13:09.582: %IOSXE-5-PLATFORM: R0/0: cpp_cp: QFP:0.0 Thread:000
 TS:00000086653236084292 %PUNT_INJECT-5-DROP_PUNT_INTF: punt interface
 policer drop packet from GigabitEthernet2/0/0, cause bfd-control (0x2d)

3 *Oct 11 10:13:05.411: %IOSXE-5-PLATFORM: R0/0: cpp_cp: QFP:0.0 Thread:000
 TS:00000086653236084292 %PUNT_INJECT-5-DROP_PUNT_INTF: punt interface policer
 drop packet from GigabitEthernet2/0/0

```
C8500# show platform hardware qfp active statistics drop
```

Global Drop Stats	Packets	Octets
PuntPerIntfPolicerDrops	257	274166

```
C8500#
```

The statistic above is the total of per-interface and per-cause per-interface drops on the system.

Global per-cause Punt Policer



4

```
C8500# show platform software punt-policer
```

Per Punt-Cause Policer Configuration and Packet Counters

Punt Cause	Description	Config Rate (pps)		Conform Packets		Dropped Packets		Config Burst (pkts)		Config Alert	
		Normal	High	Normal	High	Normal	High	Normal	High	Normal	High
2	IPv4 Options	4000	3000	0	0	0	0	4000	3000	Off	Off
3	Layer2 control and legacy	40000	10000	0	0	0	0	40000	10000	Off	Off
4	PPP Control	2000	1000	0	0	0	0	2000	1000	Off	Off
5	CLNS IS-IS Control	40000	10000	0	0	0	0	40000	10000	Off	Off
6	HDLN keepalives	2000	1000	0	0	0	0	2000	1000	Off	Off
7	ARP request or response	2000	1000	0	0	0	0	2000	1000	Off	Off
8	Reverse ARP request or repso	2000	1000	0	0	0	0	2000	1000	Off	Off
9	Frame-relay LMI Control	2000	1000	0	0	0	0	2000	1000	Off	Off
10	Incomplete adjacency	2000	1000	0	0	0	0	2000	1000	Off	Off
11	For-us data	40000	5000	0	0	0	0	40000	5000	Off	Off
12	Mcast Directly Connected Sou	2000	1000	0	0	0	0	2000	1000	Off	Off
13	Mcast IPv4 Options data pack	2000	1000	0	0	0	0	2000	1000	Off	Off
15	MPLS TTL expired	5120	2000	0	0	0	0	5120	2000	Off	Off
16	MPLS Reserved label (ie: 0-1	5120	2000	0	0	0	0	5120	2000	Off	Off
18	IPV6 Hop-by-hop Options	2000	1000	0	0	0	0	2000	1000	Off	Off
19	Mcast Internal Copy	2000	1000	0	0	0	0	2000	1000	Off	Off
23	Mcast IGMP Unroutable	2000	1000	0	0	0	0	2000	1000	Off	Off
24	Glean adjacency	2000	5000	0	0	0	0	2000	5000	Off	Off

<snip>

Global Punt Policer



5

```
C8500# show platform hardware qfp active infrastructure punt statistics type global-drop
Global Drop Statistics
```

```
Number of global drop counters = 22
```

Counter ID	Drop Counter Name	Packets
000	INVALID_COUNTER_SELECTED	0
001	INIT_PUNT_INVALID_PUNT_MODE	0
002	INIT_PUNT_INVALID_PUNT_CAUSE	0
003	INIT_PUNT_INVALID_INJECT_CAUSE	0
004	INIT_PUNT_MISSING_FEATURE_HDR_CALLBACK	0
005	INIT_PUNT_EXT_PATH_VECTOR_REQUIRED	0
006	INIT_PUNT_EXT_PATH_VECTOR_NOT_SUPPORTED	0
007	INIT_INJ_INVALID_INJECT_CAUSE	0
008	INIT_INJ_MISSING_FEATURE_HDR_CALLBACK	0
009	PUNT_INVALID_PUNT_CAUSE	0
010	PUNT_INVALID_COMMON_HDR_VERSION	0
011	PUNT_INVALID_PLATFORM_HDR_VERSION	0

<snip>

Sample CoPP Configuration



```
ip access-list extended Catch-All-IP
 10 permit tcp any any
 20 permit udp any any
 30 permit icmp any any
 40 permit ip any any
ip access-list extended Management
 remark NOC traffic for trusted management
ip access-list extended Undesirable
 10 remark deny Undesirable traffic
 10 permit icmp any any fragments
```

```
class-map match-all Catch-All-IP
 match access-group name Catch-All-IP
class-map match-all Management
 match access-group name Management
class-map match-all ARP
 match protocol arp
class-map match-all Undesirable
 match access-group name Undesirable
```

```
policy-map CONTROL-PLANE-POLICY
 class Management
  police rate 100 pps burst 100 packets
  conform-action transmit
  exceed-action drop
 class Undesirable
  police rate 1 pps burst 1 packets
  conform-action drop
  exceed-action drop
 class ARP
  police rate 1 pps burst 50 packets
  conform-action transmit
  exceed-action drop
 class Catch-All-IP
  police rate 1 pps burst 100 packets
  conform-action transmit
  exceed-action drop
 class class-default
  police rate 100 pps burst 100 packets
  conform-action transmit
  exceed-action transmit
```

```
control-plane
 service-policy input CONTROL-PLANE-POLICY
```

Punt Path drops, statistics



```
C8500# show platform hardware qfp active infrastructure punt statistics type queue-stats
Queue Statistics
```

Interface Name	Queue ID	Queue Pri	Queue Limit	Queue Depth	Enqueued Packets	Tail Drop Packets
internal0/0/rp:0	0c90	Lo	6250002	0	80	0

```
C8500# show platform hardware qfp active infrastructure punt statistics type global-drop
C8500#
Global Drop Statistics
```

```
Number of global drop counters = 22
```

Counter ID	Drop Counter Name	
000	INVALID_COUNTER_SELECTED	
001	INIT_PUNT_INVALID_PUNT_MODE	0
002	INIT_PUNT_INVALID_PUNT_CAUSE	0
003	INIT_PUNT_INVALID_INJECT_CAUSE	0
004	INIT_PUNT_MISSING_FEATURE_HDR_CALLBACK	0
005	INIT_PUNT_EXT_PATH_VECTOR_REQUIRED	0

```
<snip>
```

These are very useful CLIs to associate control-plane packet drop in situation of excess control plane destined traffic, DoS attacks, etc. You will be able to understand what protocol traffic is flooding the control plane/punt path.

Embedded Packet Capture



```
C8500(config)#ip access-list extended test
C8500(config-ext-nacl)#permit ip any any
C8500(config-ext-nacl)#end
C8500#
C8500#monitor capture my_capture access-list test
C8500#monitor capture my_capture limit duration 10
C8500#monitor capture my_capture interface Te0/0/0 both
C8500#monitor capture my_capture buffer circular size 10
C8500#monitor capture my_capture start
Started capture point : my_capture
C8500#
*Feb 15 03:00:39.747: %BUFCAP-6-ENABLE: Capture Point my_capture enabled.
C8500#
C8500#monitor capture my_capture export bootflash:test.pcap
Exported Successfully
```

- Captures received or sent packets
- Shows what packets look like
- Hex dump analysis or export to decoder (sniffer)
- Does not tell us what happened to the packet

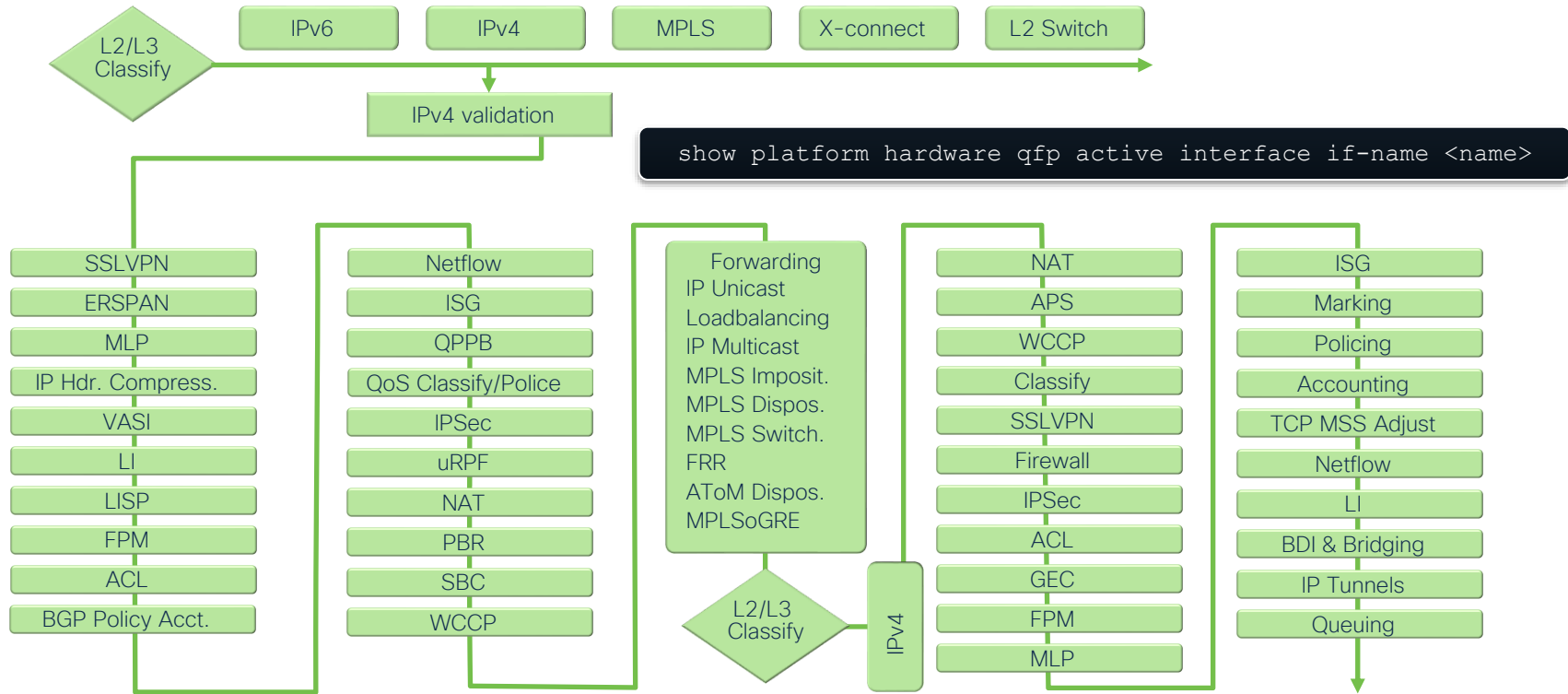
```
C8500#monitor capture my_capture stop
Stopped capture point : my_capture
C8500#
```

```
C8500# show monitor capture mycap buffer dump
```

```
0
0000: 01005E00 00020000 0C07AC1D 080045C0  ..^.....E.
0010: 00300000 00000111  CFDC091D 0002E000  .0.....
0020: 000207C1 07C1001C 802A0000 10030AFA  .....*.....
0030: 1D006369 73636F00 0000091D 0001      ..example.....
<snip>
```


IOS XE Data Path

Feature Invocation Array - FIA



Per Interface FIA



```
C8500# show platform hardware qfp active interface if-name TenGigabitEthernet0/0/1
```

```
General interface information
```

```
Interface Name: TenGigabitEthernet0/0/1
```

```
Interface state: VALID
```

```
Platform interface handle: 7
```

```
QFP interface handle: 6
```

```
Rx uidb: 62
```

```
Tx uidb: 262138
```

```
Channel: 7
```

```
Interface Relationships
```

```
BGPPA/QPPB interface configuration information
```

```
Ingress: BGPPA/QPPB not configured. flags: 0000
```

```
Egress : BGPPA not configured. flags: 0000
```

```
ipv4_input enabled.
```

```
ipv4_output enabled.
```

```
layer2_input enabled.
```

```
layer2_output enabled.
```

```
ess_ac_input enabled.
```

```
Features Bound to Interface:
```

```
2 GIC FIA state
```

```
65 PUNT INJECT DB
```

```
51 ethernet
```

```
50 SPA/Marmot server
```

```
1 IFM
```

```
42 icmp_svr
```

```
44 ipfrag_svr
```

```
45 ipreass_svr
```

```
47 ipvfr_svr
```

```
19 nat_svr
```

```
Protocol 0 - ipv4_input
```

```
FIA handle - CP:0x55945b1419a0 DP:0x3ffe0000
```

```
IPV4_INPUT_DST_LOOKUP_ISSUE (M)
```

```
IPV4_INPUT_ARL_SANITY (M)
```

```
IPV4_INPUT_DST_LOOKUP_CONSUME (M)
```

```
IPV4_INPUT_FOR_US_MARTIAN (M)
```

```
IPV4_INPUT_VFR
```

```
IPV4_NAT_INPUT_FIA
```

```
<snip>
```

Gives the feature invocation array information on ingress and egress of forwarding plane configuration for the interface

Conditional FIA Tracing Steps



```
C8500#debug platform condition ?
application  Debug Application conditions
both        Simultaneous ingress and egress debug
egress      Egress only debug
feature     For a specific feature
ingress     Ingress only debug
interface   Set interface for condition
ipv4       Debug IPv4 conditions
ipv6       Debug IPv6 conditions
mac        Debug MAC conditions
match      Describe inline acl filter
mpls      Debug MPLS conditions
start      Start conditional debug
stop       Stop conditional debug
```

```
C8500#debug platform packet-trace ?
copy        Copy packet data
drop       Trace drops only
inject     Trace injects only
packet     Packet count
punt       Trace punts only
statistics enable packet trace statistics
```

```
C8500#
```

FIA trace helps visibility of complex services application in data plane of C8500 platforms.
Also helps nano second level traffic processing insights per FIA.

```
Step 1: Enable QFP packet trace
C8500# debug platform packet-trace packet 128 circular fia-trace
C8500# debug platform packet-trace copy packet input size 2048 L2

Step 2: Set platform debug condition
C8500# debug platform condition ipv4 access-list temp both

Step 3: Start the debug- trigger the packet tracing
C8500# debug platform condition start

Step 4: Stop the debug
C8500# debug platform condition stop

Step 5: Collect the packet trace information
C8500# show platform packet-trace summary
C8500# show platform packet-trace packet all
```

Conditional FIA Tracing



```
C8500# show platform packet-trace statistics
Packets Traced: 5
Ingress 5
Inject 0
Forward 5
Punt 0
Drop 0
Consume 0
```

```
C8500#show platform packet-trace summary
Pkt Input Output State Reason
0 Gi0/0/1 Gi0/0/0 FWD
1 Gi0/0/1 Gi0/0/0 FWD
2 Gi0/0/1 Gi0/0/0 FWD
3 Gi0/0/1 Gi0/0/0 FWD
4 Gi0/0/1 Gi0/0/0 FWD

C8500#
```

Summary level and per packet level FIA tracing possible
Also enables to get hex dump of ingress and egress packet as seen by QFP

```
C8500# show platform packet-trace packet 0

Packet: 0 CBUG ID: 4
Summary
Input : GigabitEthernet0/0/1
Output : GigabitEthernet0/0/0
State : FWD
Timestamp
    Start   : 1819281992118 ns (05/17/2014 06:42:01.207240
UTC)
    Stop    : 1819282095121 ns (05/17/2014 06:42:01.207343
UTC)
Path Trace
Feature: IPV4
Source : 172.16.10.2
Destination : 172.16.20.2
Protocol : 1 (ICMP)
```

Key Takeaways

Cisco Catalyst 8500 Series Edge Platforms

Best Platforms for Cloud-scale Enterprise Networks



01 Powerful Data Plane

02 Highly Scalable Control Plane

03 High Speed Multi-Cloud Access

04 Accelerated SD-WAN Services

“C8500 Platforms offer best in class hardware with rich software features for high performance use-cases!”



Powerful Data Plane
QFP 3.0, x86 FBD*

Hardware Accelerated Services



High Speed DIA, DCA
100/40/10/1GE Ports



High Scale SD-WAN
IPsec Tunnels



*FBD: Flow Based Distribution

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