You make **possible**

Catalyst 9500 Series Switch Architecture

Transitioning to 100-Gbps Networking

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CCIE R&S

BRKARC-2007

Cisco live!
June 9-13, 2019 • San Diego, CA
#CLUS

Agenda

- Need for Higher Speeds in Campus
- Catalyst 9500 High Performance Switch Portfolio
- Catalyst 9500 Switch Portfolio
- C9500 User Centric Platform Design
- Cisco UADP 3.0 Architecture
- Cisco 9500 Hardware Capabilities
- Cisco 9500 HA Capabilities
- Cisco 100G/40G/25G Optics

Cisco Webex Teams

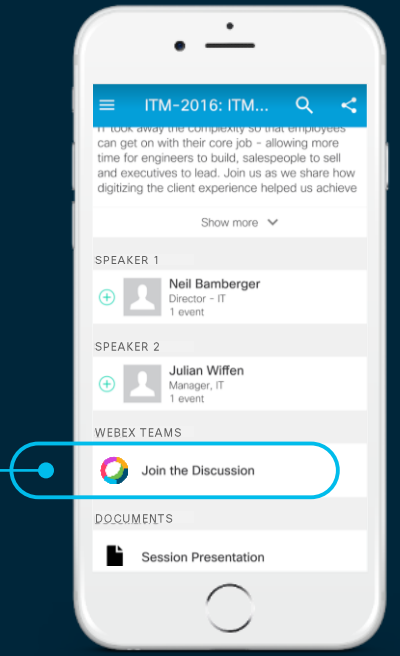
Questions?

Use Cisco Webex Teams 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 Webex Teams or go directly to the team space
4. Enter messages/questions in the team space

Webex Teams will be moderated by the speaker until June 16, 2019.



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Need for Higher Speeds in Campus
Network Infrastructure ready?

802.11ax

4K Video

Virtual Reality

Augmented Reality

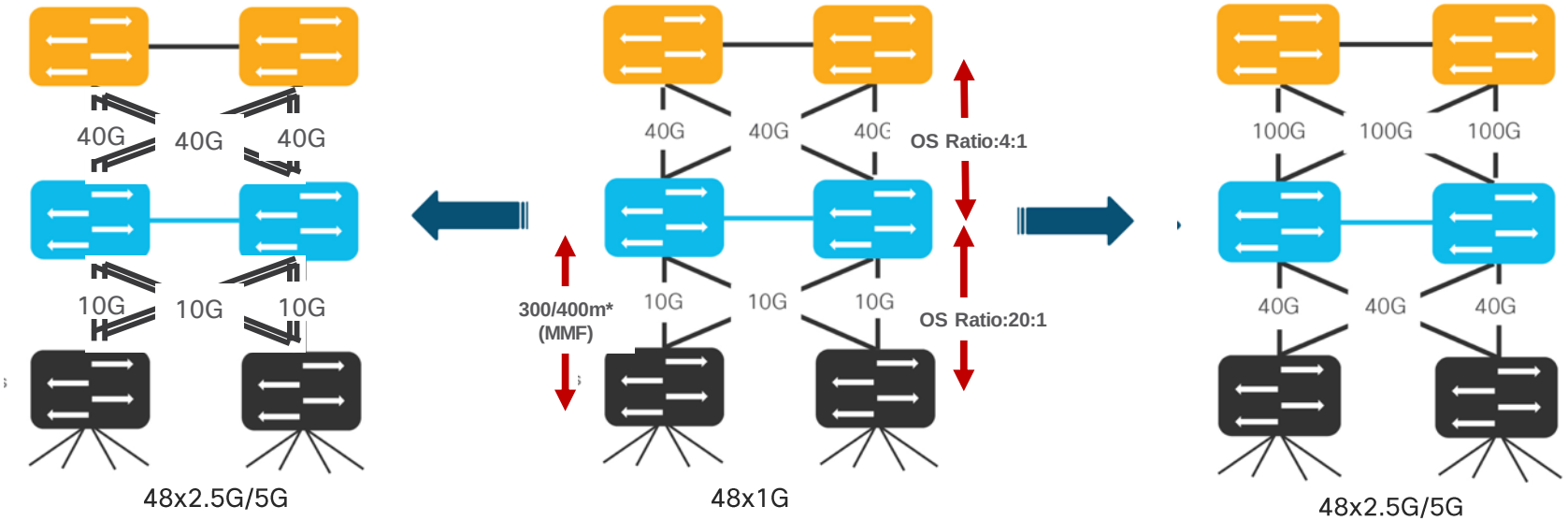
Rapid Growth of Powerful Endpoints

Advanced wireless connectivity technologies such as 802.11ax

Newer Technologies Push Connectivity Requirements

Multiple links of 10G/40G

Higher Bandwidth 40G/100G



Challenges with 10G to 40G migration

MPO Assemblies for Short Reach 40G

- Significant costs (transceivers and cables)

10G Backward Compability with 1G

- 10G X2/XFP presented a form factor conundrum
- SFP+ backward compatibility with 1G SFP and 100-Mbps SFP has enabled that speed transition

Lower Port Densities

QSFP+

(H x W x D) 13.5 x 18.4 x 72.4 mm

SFP+

(H x W x D): 8.5 x 13.4 x 56.5mm

- Single-lane serial optics, providing a port density similar to that of 10G switches

25GE - A better alternative

Provides seamless migration path from 10GE

Catalyst 9500

C9500-48Y4C

C9500-24Y4C

Catalyst 9400

C9400-SUP1XL-25G

Catalyst 9300

C9300-NM-2Y

Cisco 25G Optics

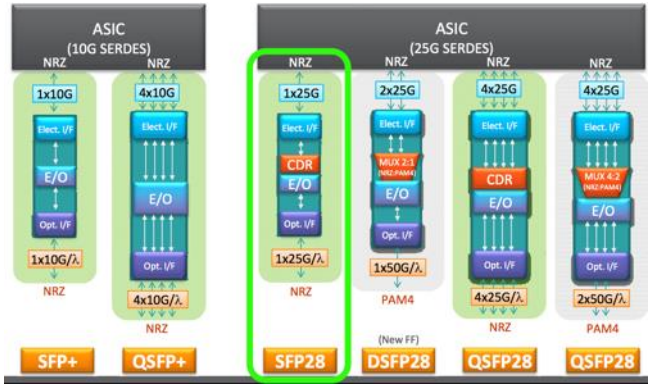
10/25G CSR/LR

- Reduced Capex through reuse of existing cabling
- Single Lan serial optics providing port densities similar to 10G Switches
- Gradual Migration options with support of Dual Rate Optics
- Reduced OpEx through savings in power and cooling

Economics of 25G

Optimized high-speed technologies

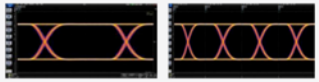
25G derived from 100G



Increase baud rate

Example: 10G → 25G

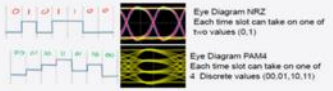
Optics: SR, LR



Modulation formats

Example: NRZ → PAM4

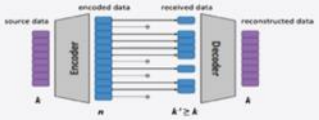
Optics: 40/100-SRBD



Enhance bit error rate with

Forward Error Correction (FEC)

Example: All optics that support FEC



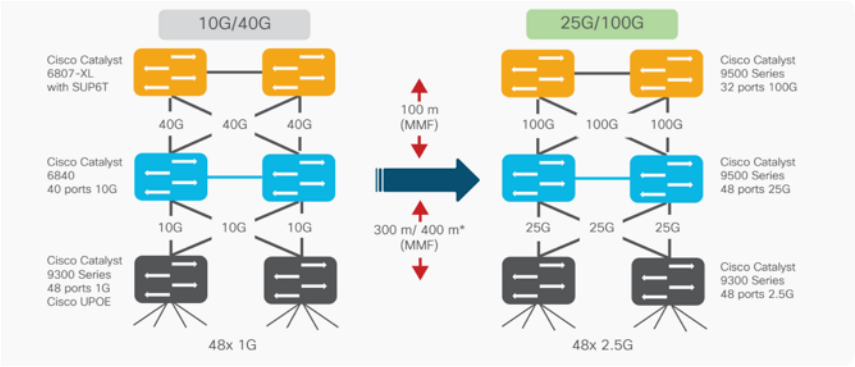
Same port density as 10G for 25G

	10G	25G
Form factor	SFP+	SFP28
Modulation	NRZ	NRZ
Lane scheme	1x 10G	1x 25G

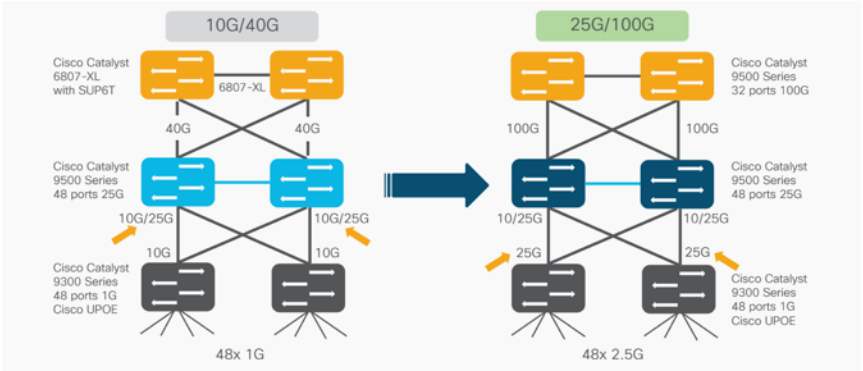
IEEE 25G standards

Project	Interfaces	Description
IEEE P802.3by	25GBASE-CR	Passive copper cables up to 5 m
	25GBASE-SR	Short reach over MMF (OM3/OM4)
IEEE P802.3cc	25GBASE-LR	Long reach 10 km over SMF
	25GBASE-ER	Long reach 40 km over SMF

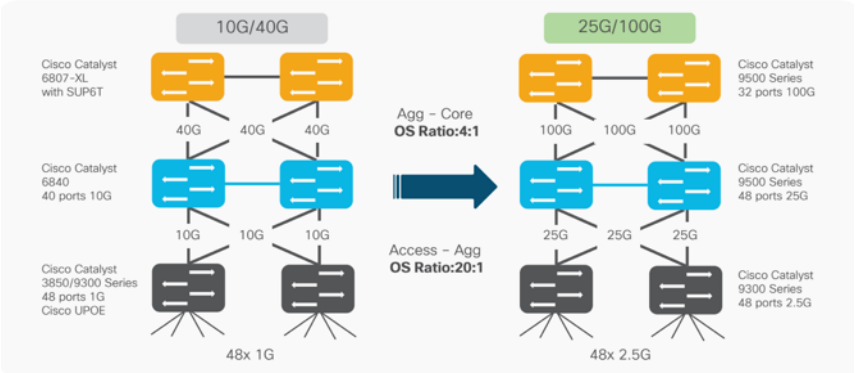
Enabling Architectural Transformation



Campus-optimized distance with Speed transition



Speed migration with dual-rate optics



Speed transition with similar oversubscription ratio

Cisco Catalyst 9500 Series

New generation of purpose-built fixed core/aggregation

UADP 2.0XL

- 40G at the price of 10G
- Industry's first 40G enterprise switch
- Optimized 10G switch for midsize backbone

C9500-16X
C9500-40X
C9500-24Q
C9500-12Q

UADP 3.0

- Industry's first 100G enterprise switch
- 1TB SSD storage
- Flexible Templates

C9500-24Y4C
C9500-48Y4C
C9500-32QC
C9500-32C

Modular fans

Modular uplinks

Modular
power supplies

Storage for
application hosting

Extending Cisco® Catalyst® 4500x and 6800 Series leadership in fixed core
13x throughput (3.2 Tbps)
6x performance (1 Bpps)
No oversubscription
8x 40G density
Pluggable SSD storage
USB 3.0
4x memory and flash
2x CPU cores
Customizable templates
Cisco StackWise® Virtual

Cisco Catalyst 9500-32C
High-level overview

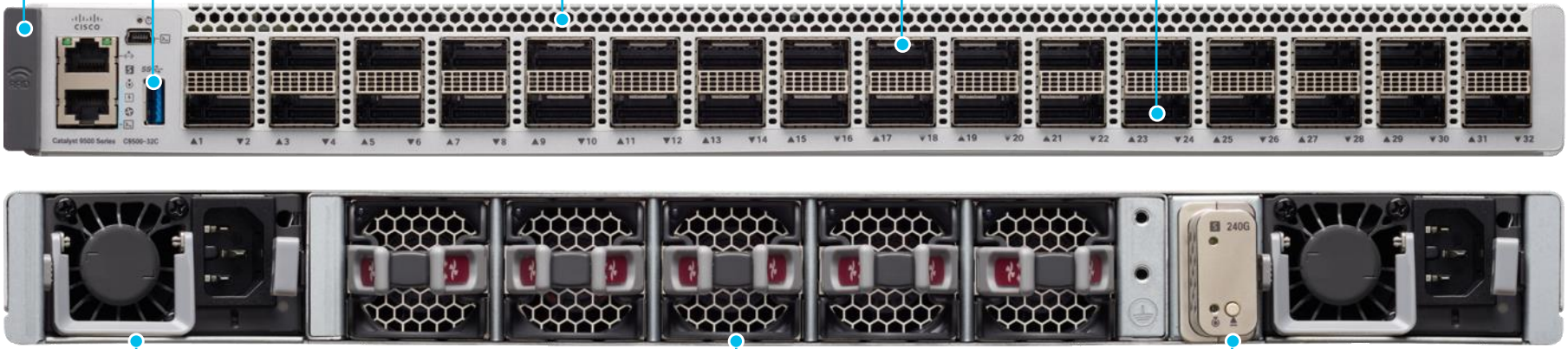
Built-in RFID (passive)

USB 3.0 flash drive

2.4-GHz quad-core x86 CPU
16 GB of DDR4 DRAM
16 GB flash
72 MB unified packet buffer

Dual Next-generation UADP 3.0 ASIC

Every port 100G, 40G, 10G* and 1G* capable



Redundant 1+1 1600W AC/DC power supplies

5 standalone fans – N+1 redundancy

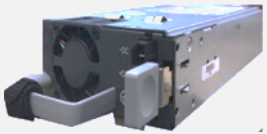
240-, 480-, or 960-GB SATA SSD storage

* With QSA adapter

Cisco Catalyst 9500-32C
Environmental overview

High-efficiency **24,000 rpm** redundant fans

AC PSU



DC PSU

Platinum efficient **1.6 KW AC / DC** power supplies

Height
1.75 in (1RU)

Depth 21.2 in

Width 17.50 in

Cisco Catalyst 9500-32C

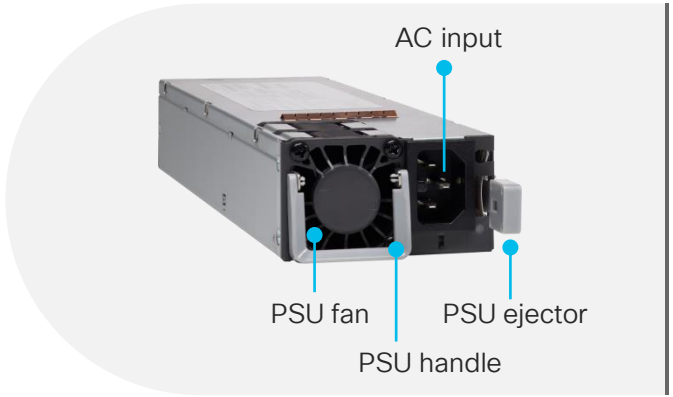
Power supply redundancy and inputs

Power supply highlights:

- Maximum output is 1600W at 220V and 1000W at 110V
- More than 90% power efficiency at 50% to 100% of load
- Redundant load sharing (1+1) mode only
- Dual hot-swappable AC/DC/mixed power supplies supported
- Power hold-up time is ~20 ms at 100% load

- C9K-PWR-1600WAC-R
- C9K-PWR-1600WDC-R

LED	Color	Status	Description
Green		OFF	No input
Green		Blinking	12V main off, 12V standby power ON
Green		Solid	12V main ON
Yellow		OFF	No warnings/error
Yellow		Blinking	Warning detected, 12V main
Yellow		Solid	Critical error detected

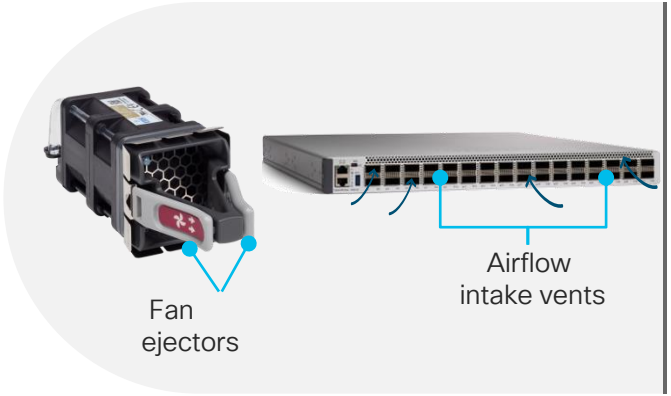


Cisco Catalyst 9500-32C
Fan redundancy and airflow

Highlights:

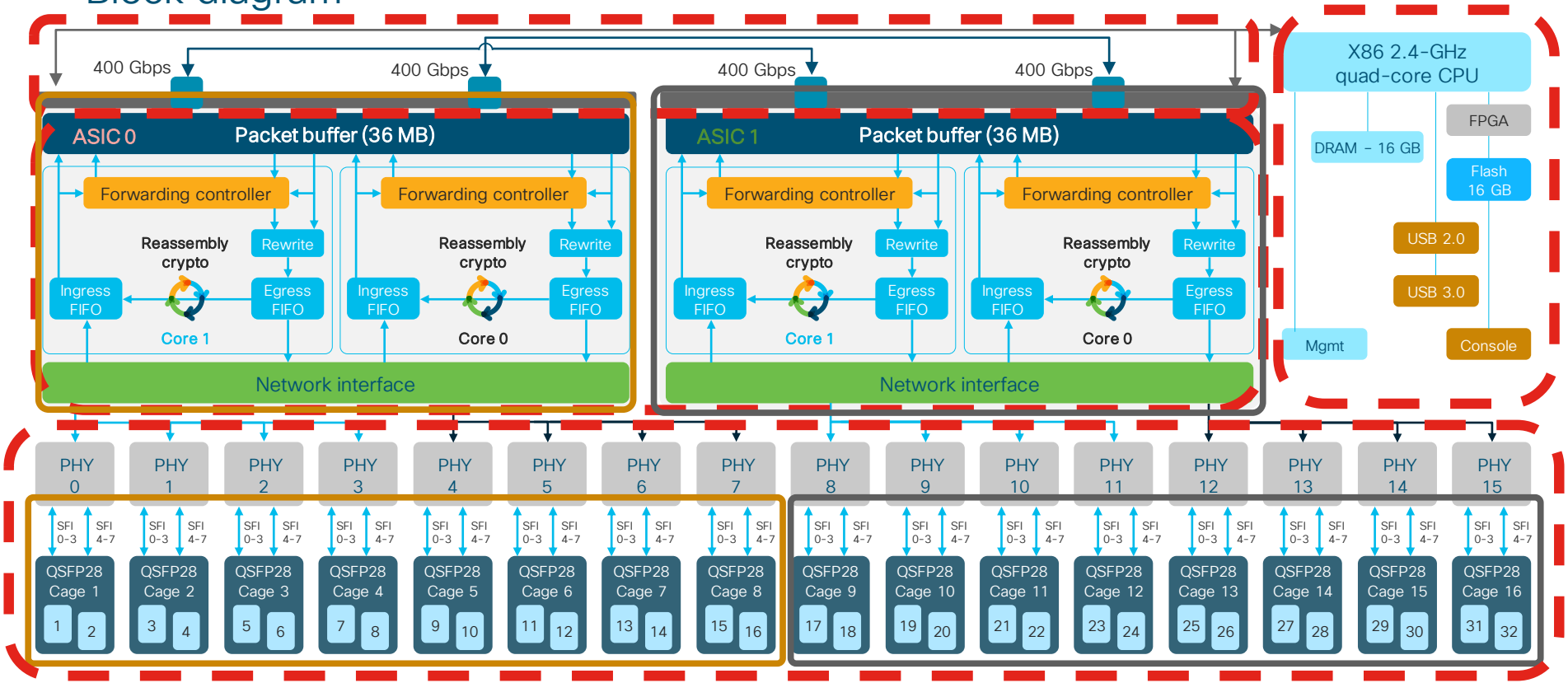
- 5 variable-speed high-efficiency fans at rear of chassis
- Thermal sensor to detect ambient temperature and adjust fan speeds
- Can still operate with one fan unit failure
- Fans are hot-swappable
- Airflow: Front-to-back only

LED	Color	Status	Description
Fan		Solid	All fans OK
Fan		Solid	One fan faulty
Fan		Solid	One or more fans faulty Exceeded limit

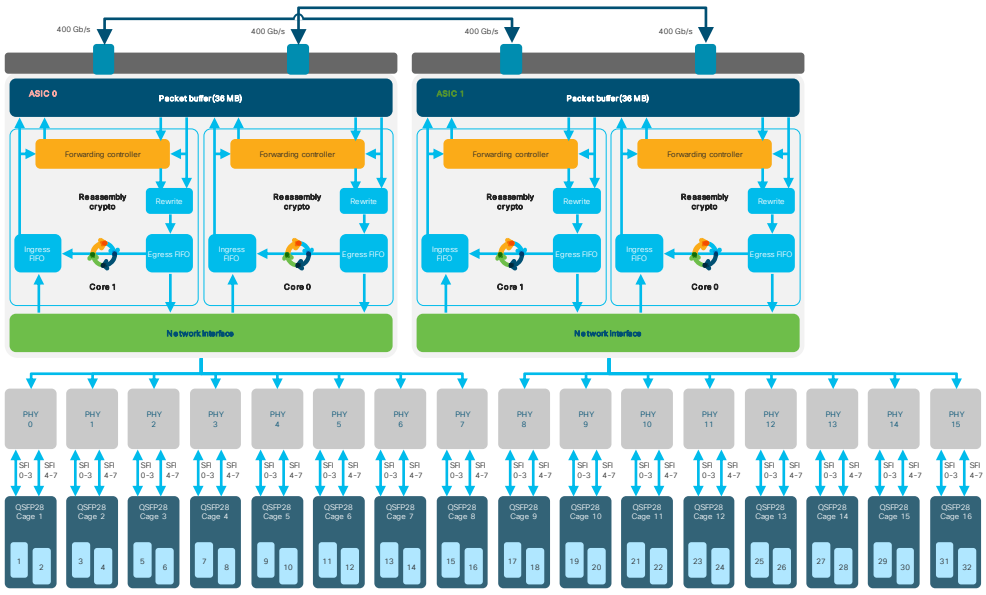


Cisco Catalyst 9500-32C

Block diagram



Cisco Catalyst 9500-32C
Port-to-ASIC mapping




```
C9500H-32C#show platform software fed active ifm mapping
Interface            IF_ID    Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Activ
HundredGigE1/0/1     0x6      1    0    1    16   0       16   2    1    101  NIF  Y
HundredGigE1/0/2     0x7      1    0    1    17   0       20   6    2    102  NIF  Y
HundredGigE1/0/3     0x8      1    0    1    18   0       24   10   3    103  NIF  Y
HundredGigE1/0/4     0x9      1    0    1    19   0       28   14   4    104  NIF  Y
HundredGigE1/0/5     0xa      1    0    1    0    0       0    2    5    105  NIF  Y
HundredGigE1/0/6     0xb      1    0    1    1    0       4    6    6    106  NIF  Y
HundredGigE1/0/7     0xc      1    0    1    2    0       8    10   7    107  NIF  Y
HundredGigE1/0/8     0xd      1    0    1    3    0       12   14   8    108  NIF  Y
HundredGigE1/0/9     0xe      0    0    0    16   0       28   2    9    109  NIF  Y
HundredGigE1/0/10    0xf      0    0    0    17   0       24   6    10   110  NIF  Y
HundredGigE1/0/11    0x10     0    0    0    18   0       20   10   11   111  NIF  Y
HundredGigE1/0/12    0x11     0    0    0    19   0       16   14   12   112  NIF  Y
HundredGigE1/0/13    0x12     0    0    0    0    0       12   2    13   113  NIF  Y
HundredGigE1/0/14    0x13     0    0    0    1    0       8    6    14   114  NIF  Y
HundredGigE1/0/15    0x14     0    0    0    2    0       4    10   15   115  NIF  Y
HundredGigE1/0/16    0x15     0    0    0    3    0       0    14   16   116  NIF  Y
HundredGigE1/0/17    0x16     3    1    1    16   0       16   2    17   117  NIF  Y
HundredGigE1/0/18    0x17     3    1    1    17   0       20   6    18   118  NIF  Y
HundredGigE1/0/19    0x18     3    1    1    18   0       24   10   19   119  NIF  Y
HundredGigE1/0/20    0x19     3    1    1    19   0       28   14   20   120  NIF  Y
HundredGigE1/0/21    0x1a     3    1    1    0    0       0    2    21   121  NIF  Y
HundredGigE1/0/22    0x1b     3    1    1    1    0       4    6    22   122  NIF  Y
HundredGigE1/0/23    0x1c     3    1    1    2    0       8    10   23   123  NIF  Y
HundredGigE1/0/24    0x1d     3    1    1    3    0       12   14   24   124  NIF  Y
HundredGigE1/0/25    0x1e     2    1    0    16   0       28   2    25   125  NIF  Y
HundredGigE1/0/26    0x1f     2    1    0    17   0       24   6    26   126  NIF  Y
HundredGigE1/0/27    0x20     2    1    0    18   0       20   10   27   127  NIF  Y
HundredGigE1/0/28    0x21     2    1    0    19   0       16   14   28   128  NIF  Y
HundredGigE1/0/29    0x22     2    1    0    0    0       12   2    29   129  NIF  Y
HundredGigE1/0/30    0x23     2    1    0    1    0       8    6    30   130  NIF  Y
HundredGigE1/0/31    0x24     2    1    0    2    0       4    10   31   131  NIF  Y
HundredGigE1/0/32    0x25     2    1    0    3    0       0    14   32   132  NIF  Y
```

Command to verify the port-to-ASIC mapping:
show platform software fed active ifm mappings

Cisco Catalyst 9500-32QC
High-level overview

Built-in RFID (passive)

USB 3.0 flash drive

2.4-GHz quad-core x86 CPU
16 GB of DDR4 DRAM
16 GB flash
36 MB of unified packet buffer

Next-generation
UADP 3.0 ASIC

Upper ports: 100G, 40G, 10G* or 1G*
Lower ports: 40G, 10G,* or 1G **

Redundant 1+1 650W AC/930W DC power supplies

Redundant 1+1 fan tray

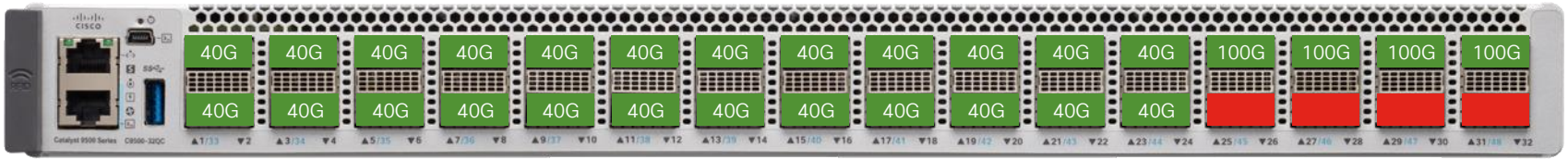
240-, 480-, or 960-GB SATA SSD storage

* With QSA adapter

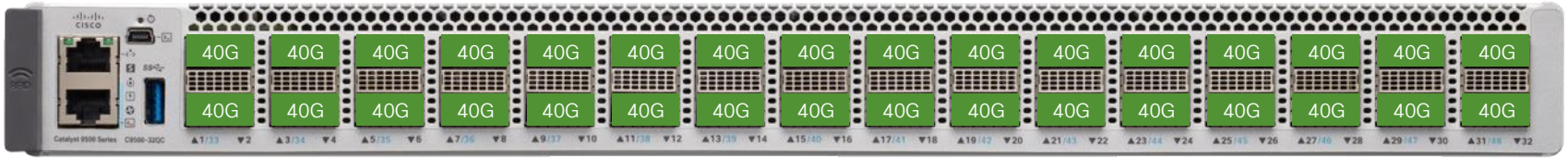
Cisco Catalyst 9500-32QC

Configuration modes

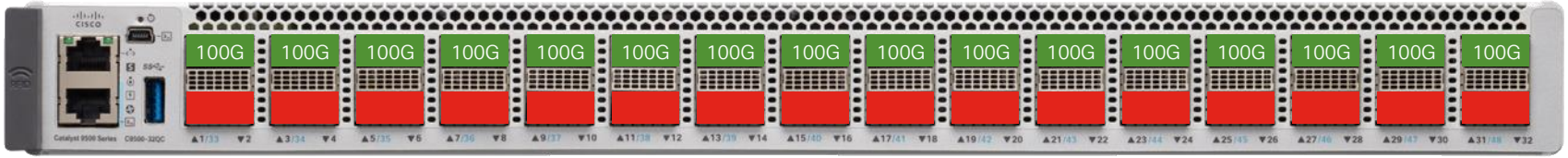
24P 40G + 4P 100G – default configuration



32P 40G

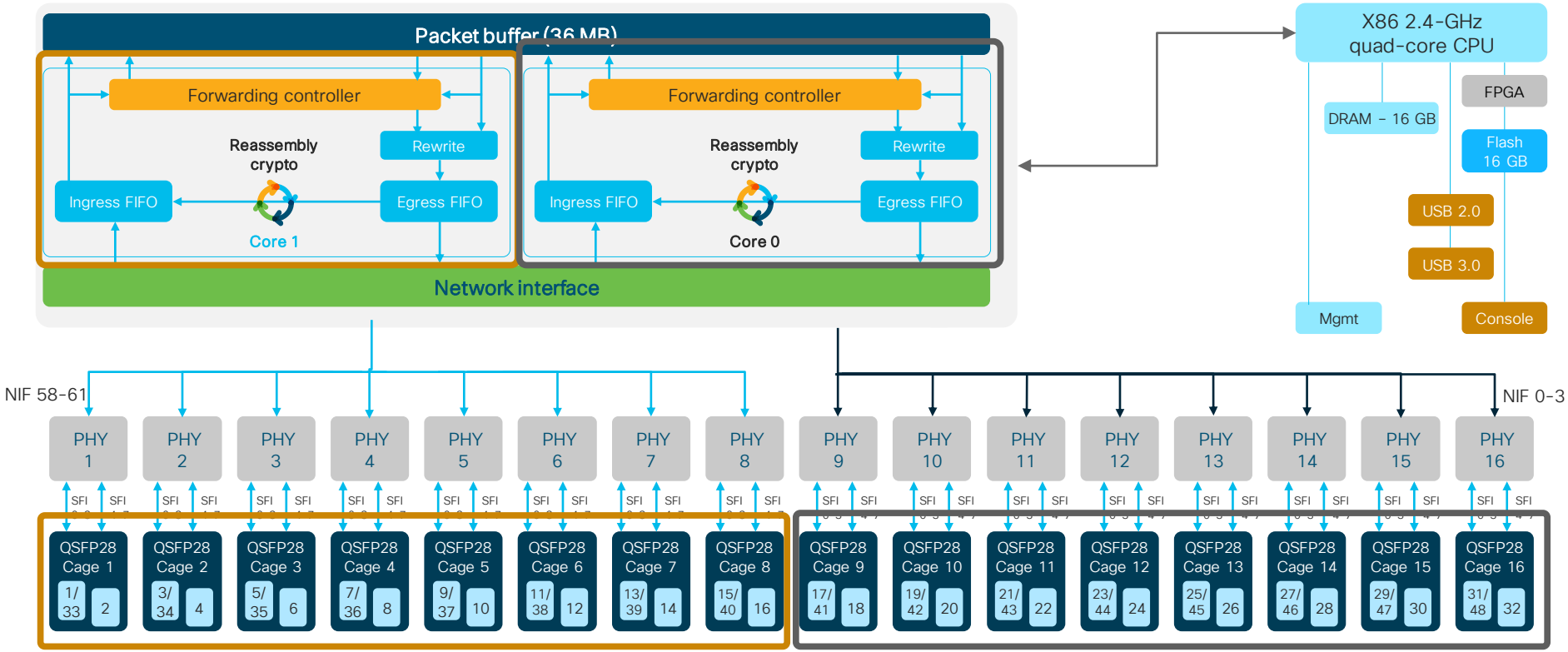


16P 100G



Note: Other configuration options are supported, including mix and match of speeds

Cisco Catalyst 9500-32QC
Block diagram



Cisco Catalyst 9500-48Y4C / 9500-24Y4C

High-level overview

Built-in RFID (passive)

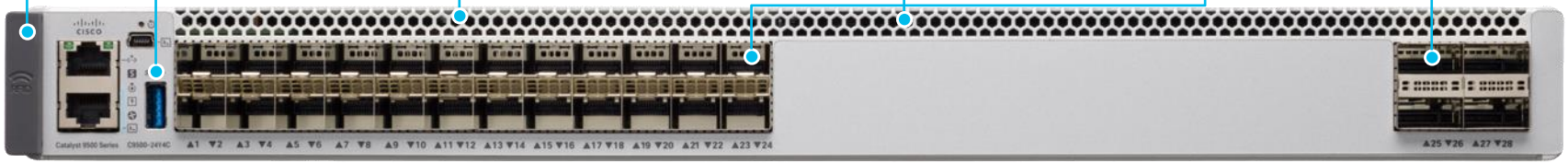
USB 3.0 flash drive

2.4-GHz quad-core x86 CPU
16 GB of DDR4 DRAM
36 MB of unified packet buffer

Next-generation
UADP 3.0 ASIC

Every port 25G, 10G, and 1G capable

Uplinks 100G,40G and 10G* capable



Redundant 1+1
650W AC and 930W DC
power supplies

Redundant 1+1
fan tray

240-, 480-, or 960-GB
SATA SSD storage

* With QSA adapter

Cisco Catalyst 9500-24Y4C
High-level overview

Built-in RFID (passive)

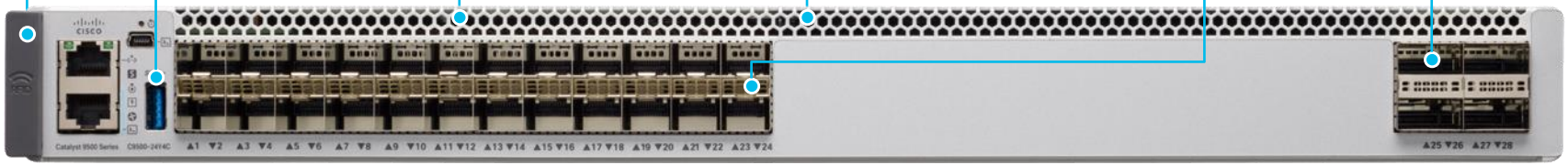
USB 3.0 flash drive

2.4-GHz quad-core x86 CPU
16 GB of DDR4 DRAM
36 MB of unifed packet buffer

Next-generation
UADP 3.0 ASIC

Every port 25G, 10G, and 1G* capable

Uplinks 100G ,40G and 10G* capable



Redundant 1+1
650W AC and 930W DC
power supplies

Redundant 1+1
fan tray

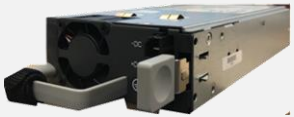
240-, 480-, or 960-GB
SATA SSD storage

* With QSA adapter

Cisco Catalyst 9500-32QC/48Y4C/9500-24Y4C
Environmental overview

High-efficiency **20,000 rpm** redundant fans

AC power supply



DC power supply

Platinum efficient **650W/930W** power supplies

Height
1.75 in (1RU)

Depth 18.00 in

Width 17.50 in

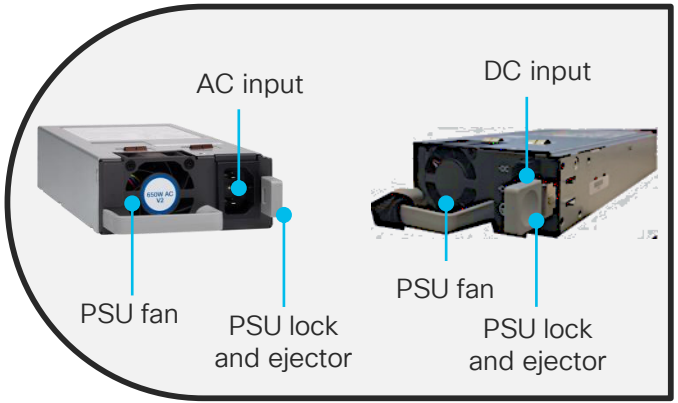
Cisco Catalyst 9500-32QC/48Y4C/24Y4C
Power supply redundancy and inputs

Power supply highlights:

- Dual hot-swappable AC/DC/mixed power supplies supported
- **Maximum output 12V/650W at 220V/110V AC Input**
- More than 90% power efficiency at 50% to 100% of load
- Power hold-up time is <20 ms at 90% load
- Redundant load sharing (1+1) mode only

- C9K-PWR-650WAC-R
- C9K-PWR-930WDC-R

LED	Color	Status	Description
Green		OFF	No input
Green		Blinking	12V main off, 12V standby power ON
Green		Solid	12V main ON
Yellow		OFF	No warnings/error
Yellow		Blinking	Warning detected, 12V main
Yellow		Solid	Critical error detected

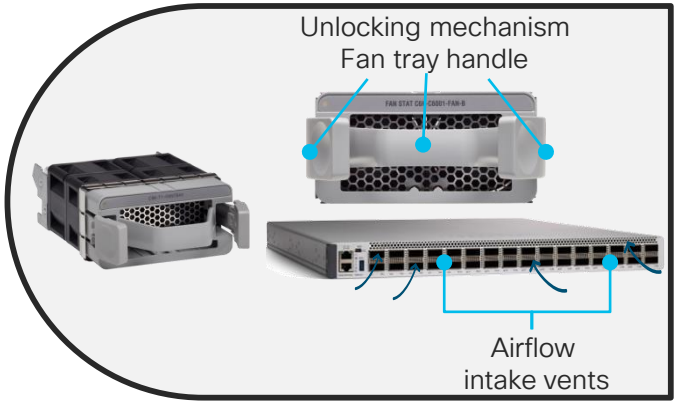


Cisco Catalyst 9500-32QC/48Y4C/9500-24Y4C
Fan redundancy and airflow

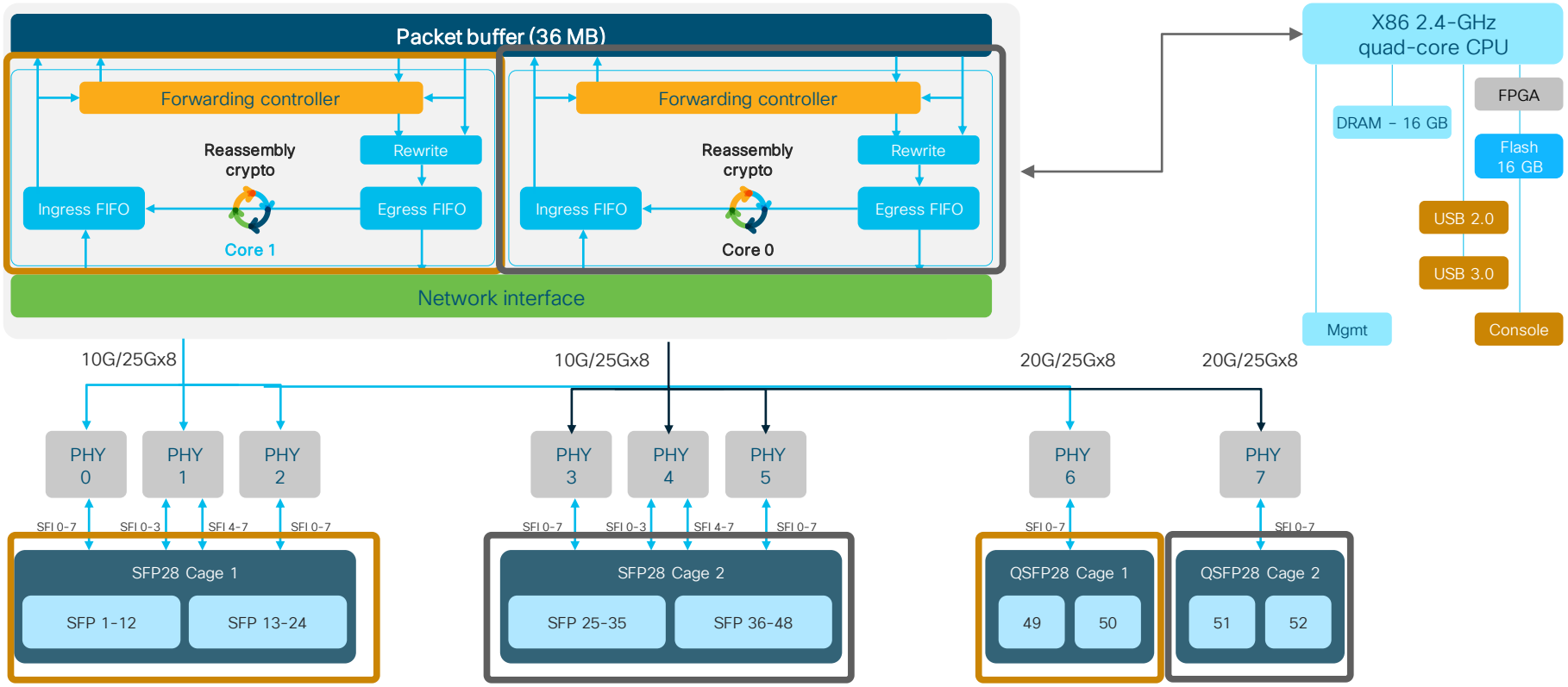
Highlights:

- **Dual variable-speed high-efficiency fan trays**
- Thermal sensor to detect ambient temperature and adjust fan speeds
- Fan trays are hot-swappable
- Front-to-back airflow
- **Can still operate with individual fan tray failure**

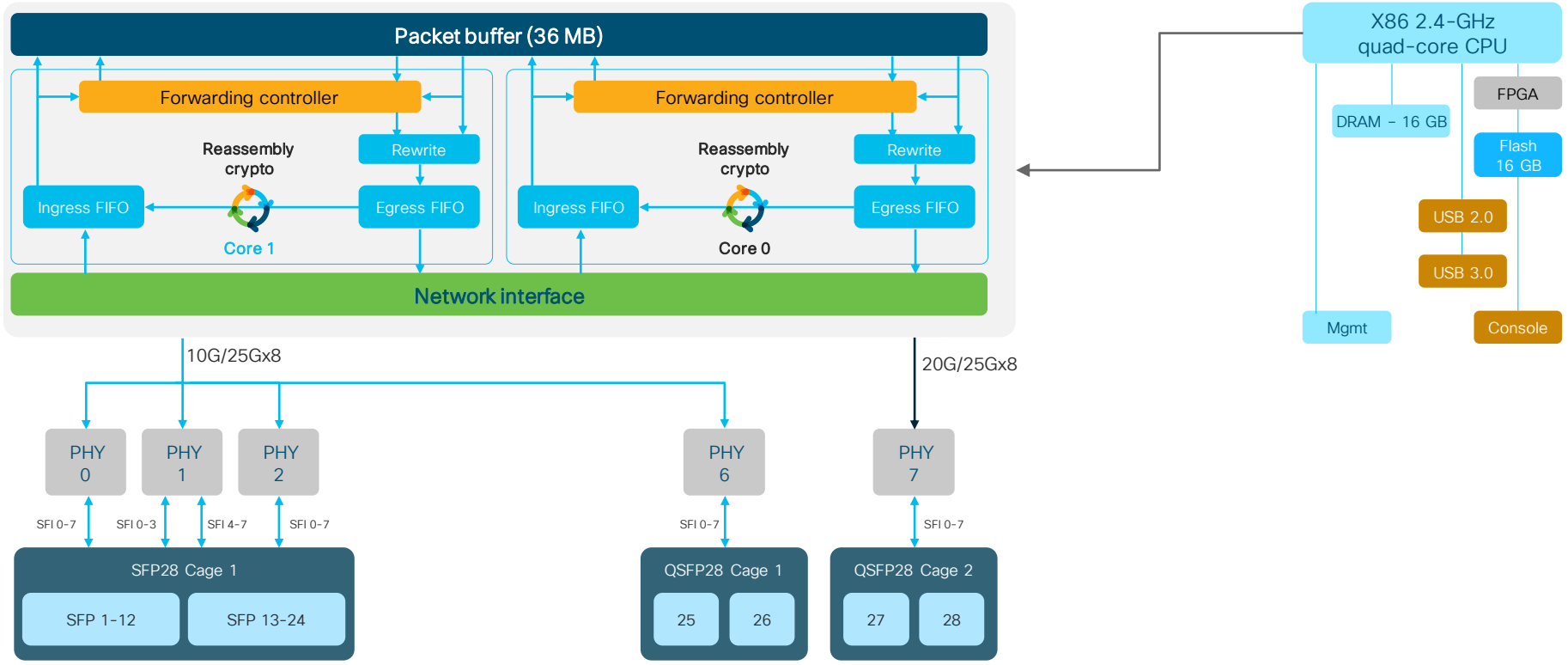
LED	Color	Status	Description
FAN		Solid	Fan tray OK
FAN		Solid	Fan tray fault



Cisco Catalyst 9500-48Y4C
Block diagram



Cisco Catalyst 9500-24Y4C
Block diagram



Cisco Catalyst 9500 Switches

You make networking **possible**

Cisco live!

Cisco Catalyst 9500-24Q

High-level overview

Built-in RFID (passive)

USB 2.0 flash drive

2.4-GHz quad-core x86 CPU
16 GB of DDR4 DRAM
128 MB of shared packet buffer

4 x UADP 2.0 ASIC

Every port 40G,10G*, and 1G* capable

Redundant 1+1 950W AC / DC power supplies

120 GB USB 3.0storage

Redundant N+1 fans

* With QSA Adaptor

Cisco Catalyst 9500-12Q
High-level overview

Built-in RFID (passive)

USB 2.0 flash drive

2.4-GHz quad-core x86 CPU
16 GB of DDR4 DRAM
64 MB of shared packet buffer

2 x UADP 2.0 ASIC

Every port 40G,10G*, and 1G* capable

Redundant 1+1
950W AC / DC power supplies

120 GB
USB 3.0storage

Redundant N+1
fans

* With QSA Adaptor

Cisco Catalyst 9500-40X
High-level overview

Built-in RFID (passive)

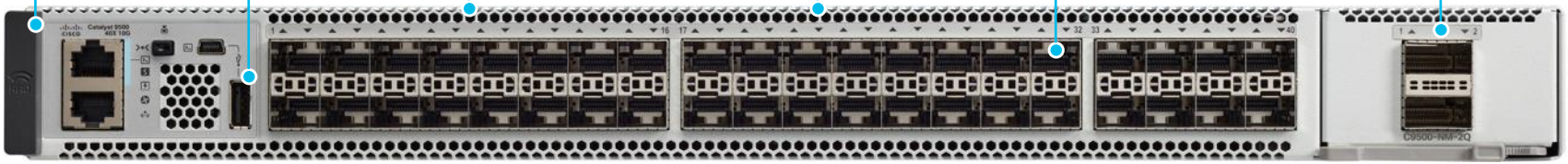
USB 2.0 flash drive

2.4-GHz quad-core x86 CPU
16 GB of DDR4 DRAM
64 MB of shared packet buffer

2 x UADP 2.0 ASIC

Every port 10G, and 1G capable

40G and 10G Network Module



Redundant 1+1
950W AC / DC power supplies

120 GB
USB 3.0storage

Redundant N+1
fans

* With QSA Adaptor

Cisco Catalyst 9500-16X

High-level overview

Built-in RFID (passive)

USB 2.0 flash drive

2.4-GHz quad-core x86 CPU
16 GB of DDR4 DRAM
32 MB of shared packet buffer

1 x UADP 2.0 ASIC

Every port 10G, and 1G capable

40G or 10G Network Module

Redundant 1+1
950W AC / DC power supplies

120 GB
USB 3.0storage

Redundant N+1
fans

* With QSA Adaptor

Cisco Catalyst 9500
Network Modules

C9500-NM-2Q
Cisco Catalyst 9500 Series Network Module
2-port 40 Gigabit Ethernet with QSFP+

C9500-NM-8X
Cisco Catalyst 9500 Series Network Module
8-port 1/10 Gigabit Ethernet with SFP/SFP+

- Uplink modules are supported on the C9500-40X and C9500-16X SKUs only
- Line-rate on every port with 10G single-flow traffic processing
- Modules are automatically powered upon insertion
- OIR-capable
- ACT2 authenticated
- Speed is auto-negotiated depending on the optics inserted

Cisco Catalyst 9500
Environmental overview

High-efficiency **24,000 rpm** redundant fans

AC power supply

DC power supply

Platinum efficient **950W/950W** AC/DC power supplies

Height
1.75 in (1RU)

Depth 21.52 in

Width 17.50 in

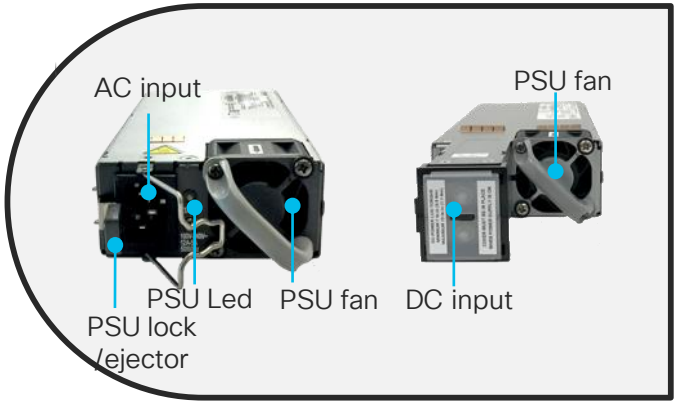
Cisco Catalyst 9500-24Q/12Q/40x/16x
Power supply redundancy and inputs

Power supply highlights:

- Dual hot-swappable AC/DC/mixed power supplies supported
- **Maximum output 12V/950W at 220V/110V AC input**
- More than 90% power efficiency at 50% to 100% of load
- Redundant load sharing (1+1) mode only
- 1 **power supply** sufficient to power up switch
- Single Bi-Color Led to indicate PSU Status
- Variable Speed Fan with Inside to Outside/Front to Back airflow

- PWR-C4-950WAC-R
- PWR-C4-950WDC-R

LED	Color	Status	Description
Green		Solid	PSU operating Normally, 12V main ON
Amber		Solid	PSU Input Loss
Red		Solid	PSU Output Failure

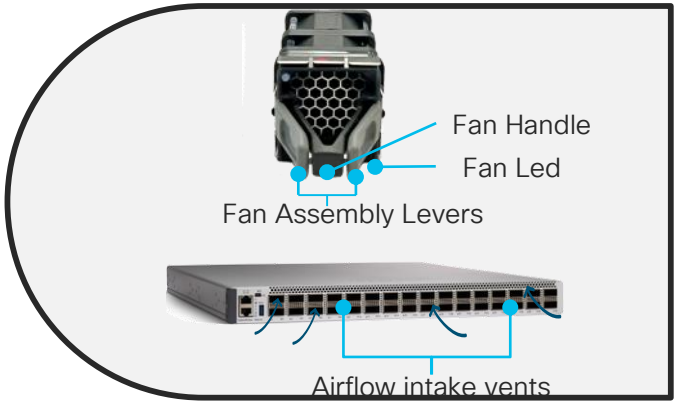


Cisco Catalyst 9500-24Q/12Q/40x/16x
Fan redundancy and airflow

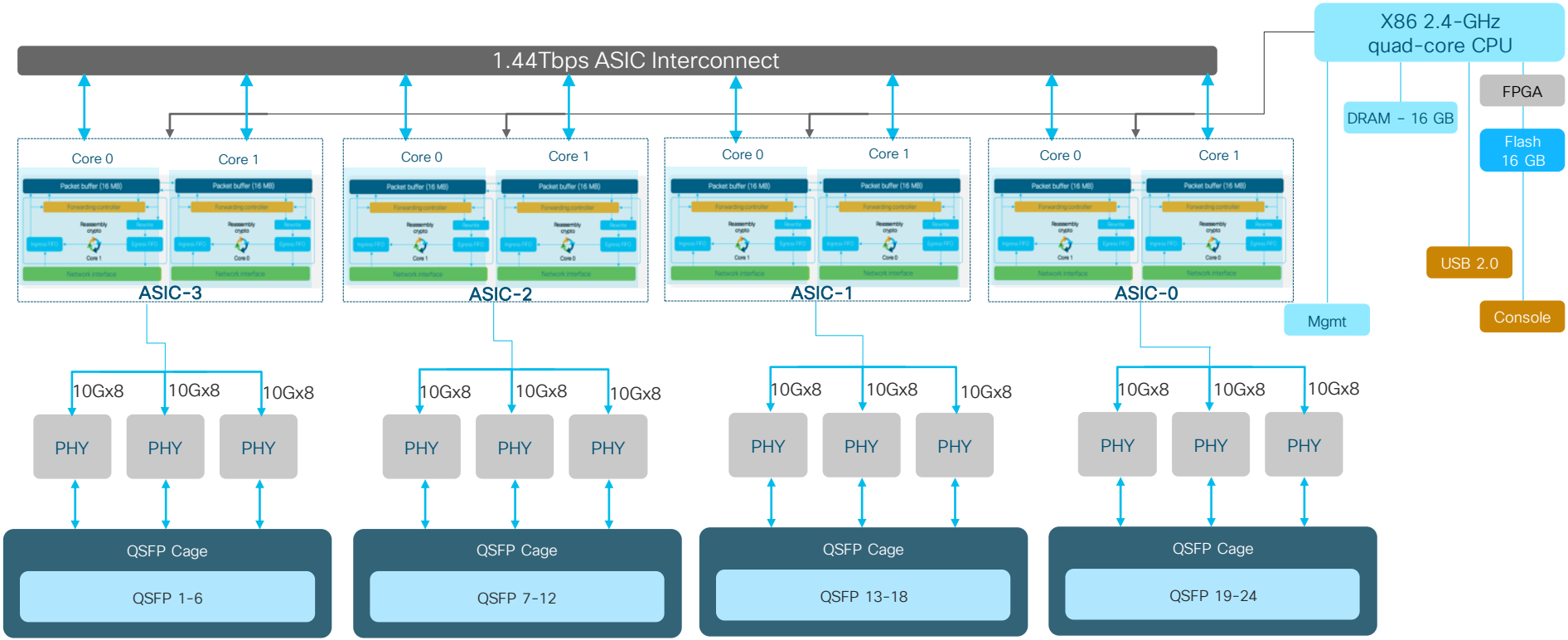
Highlights:

- N+1 variable-speed high-efficiency fans
- Thermal sensor to detect ambient temperature and adjust fan speeds
- Individual Fan are OIR capable up to 120 secs
- Front-to-back airflow
- Can still operate with individual fan tray failure

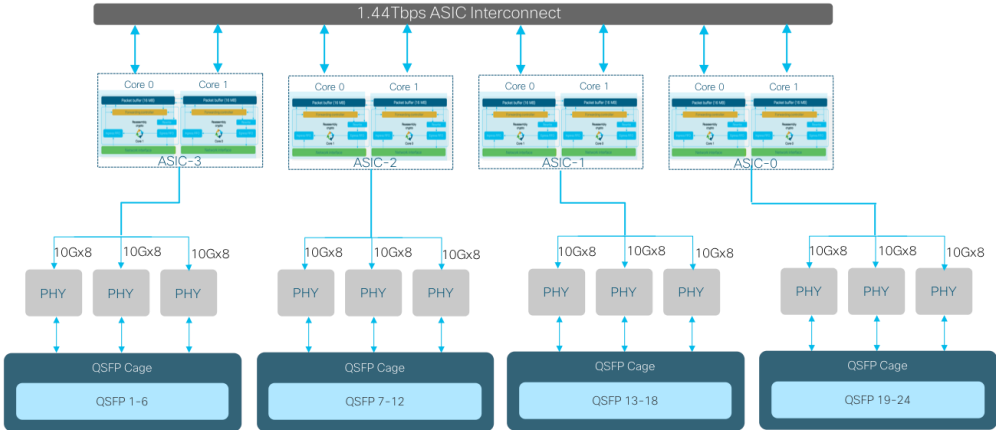
Color	Status	Description
	Off	The fan tray is not receiving power; the fans have stopped
	Solid	All Fans operating normally
	Solid	One or more fans have encountered tachometer faults
	Solid	One or more fans' tachometer faults have exceeded the maximum limit



Cisco Catalyst 9500-24Q
Block diagram



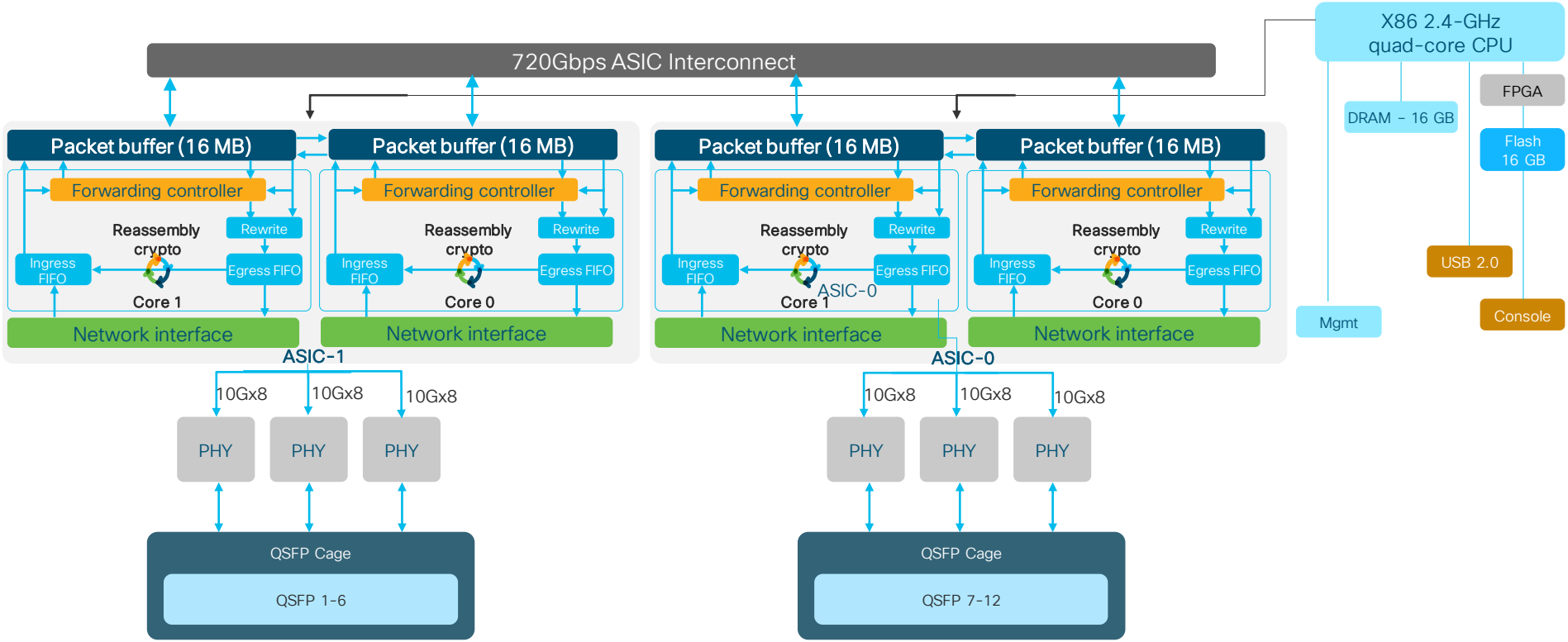
Cisco Catalyst 9500-24Q
Port-to-ASIC mapping



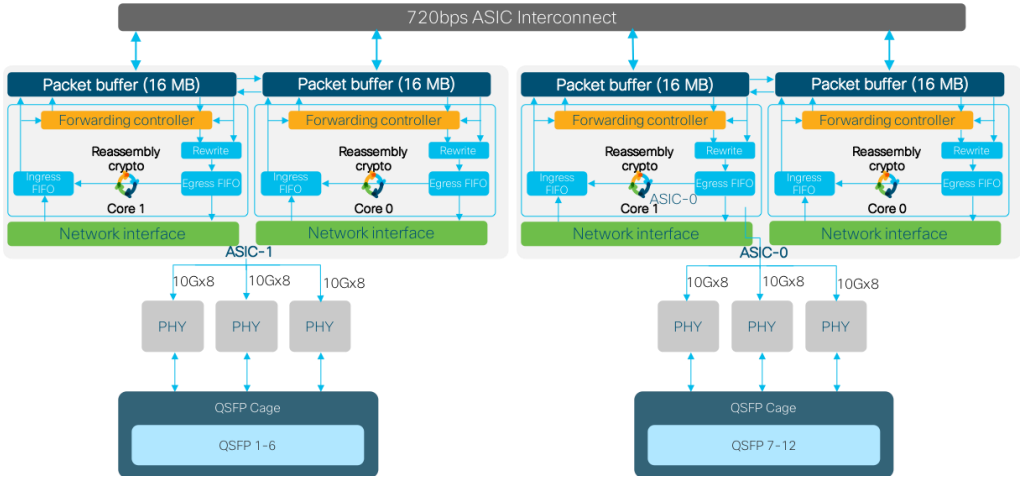

```
C9500-24Q#sh platform software fed switch active ifm mappings lpn
Mappings Table

LPN         ASIC  Port  Interface                IF_ID       Active
-----------------------------------------------------------------------
1           3     0     FortyGigabitEthernet1/0/1   0x00000007  Y
2           3     1     FortyGigabitEthernet1/0/2   0x00000008  Y
3           3     2     FortyGigabitEthernet1/0/3   0x00000009  Y
4           3     3     FortyGigabitEthernet1/0/4   0x0000000a  Y
5           3     4     FortyGigabitEthernet1/0/5   0x0000000b  Y
6           3     5     FortyGigabitEthernet1/0/6   0x0000000c  Y
7           2     6     FortyGigabitEthernet1/0/7   0x0000000d  Y
8           2     7     FortyGigabitEthernet1/0/8   0x0000000e  Y
9           2     8     FortyGigabitEthernet1/0/9   0x0000000f  Y
10          2     9     FortyGigabitEthernet1/0/10  0x00000010  Y
11          2     10    FortyGigabitEthernet1/0/11  0x00000011  Y
12          2     11    FortyGigabitEthernet1/0/12  0x00000012  Y
13          1     12    FortyGigabitEthernet1/0/13  0x00000013  Y
14          1     13    FortyGigabitEthernet1/0/14  0x00000014  Y
15          1     14    FortyGigabitEthernet1/0/15  0x00000015  Y
16          1     15    FortyGigabitEthernet1/0/16  0x00000016  Y
17          1     16    FortyGigabitEthernet1/0/17  0x00000017  Y
18          1     17    FortyGigabitEthernet1/0/18  0x00000018  Y
19          0     18    FortyGigabitEthernet1/0/19  0x00000019  Y
20          0     19    FortyGigabitEthernet1/0/20  0x0000001a  Y
21          0     20    FortyGigabitEthernet1/0/21  0x0000001b  Y
22          0     21    FortyGigabitEthernet1/0/22  0x0000001c  Y
23          0     22    FortyGigabitEthernet1/0/23  0x0000001d  Y
24          0     23    FortyGigabitEthernet1/0/24  0x0000001e  Y
```

Command to verify the port-to-ASIC mapping:
show platform software fed switch active ifm mappings lpn

Cisco Catalyst 9500-12Q
Block diagram



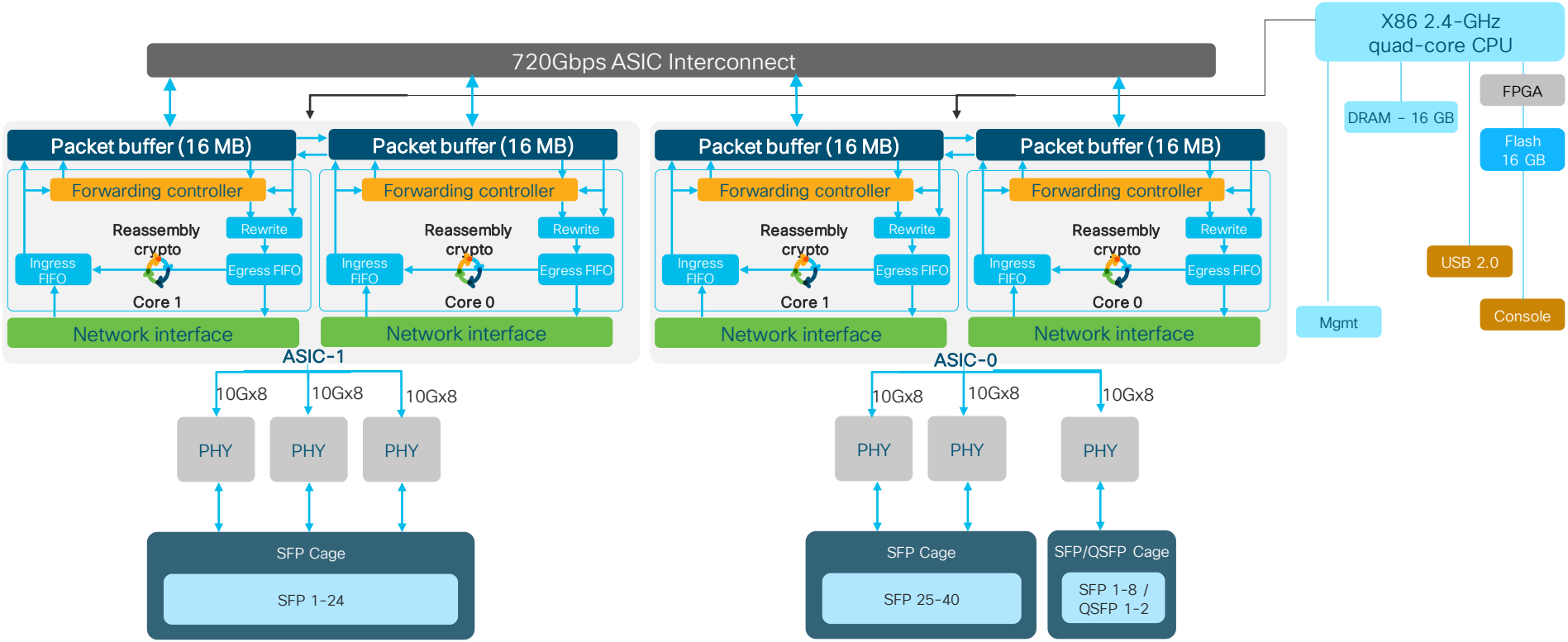
Cisco Catalyst 9500-12Q
Port-to-ASIC mapping



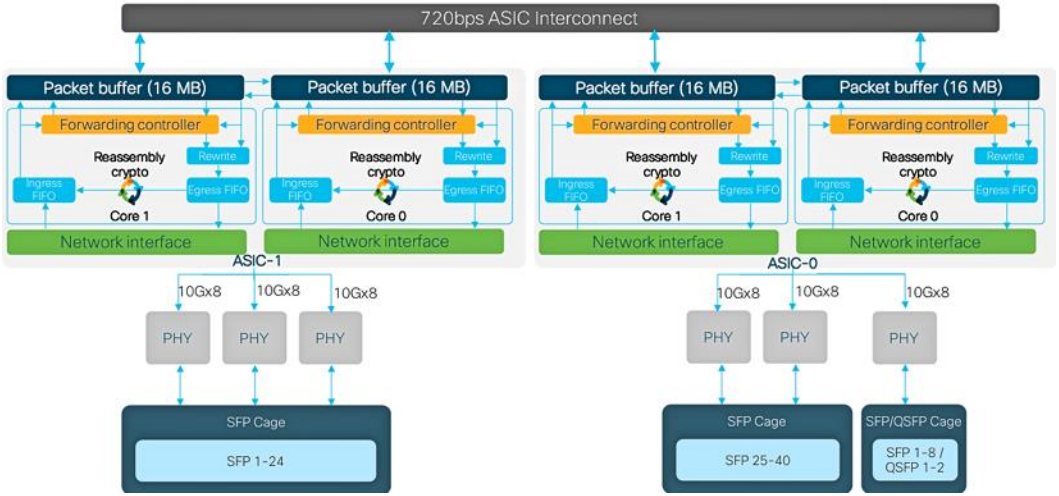

```
C9500-12Q#show platform software fed switch active ifm mappings lpn
Mappings Table


LPN         ASIC  Port  Interface                IF_ID                Active
-------------------------------------------------------------------------------
1           1     0     FortyGigabitEthernet1/0/1  0x00000031         Y
2           1     1     FortyGigabitEthernet1/0/2  0x00000032         Y
3           1     2     FortyGigabitEthernet1/0/3  0x0000000b         Y
4           1     3     FortyGigabitEthernet1/0/4  0x0000000c         Y
5           1     4     FortyGigabitEthernet1/0/5  0x00000033         Y
6           1     5     FortyGigabitEthernet1/0/6  0x0000000e         Y
7           0     6     FortyGigabitEthernet1/0/7  0x0000000f         Y
8           0     7     FortyGigabitEthernet1/0/8  0x00000010         Y
9           0     8     FortyGigabitEthernet1/0/9  0x00000011         Y
10          0     9     FortyGigabitEthernet1/0/10 0x00000012         Y
11          0     10    FortyGigabitEthernet1/0/11 0x00000013         Y
12          0     11    FortyGigabitEthernet1/0/12 0x00000014         Y
```

Command to verify the port-to-ASIC mapping:
show platform software fed switch active ifm mappings lpn

Cisco Catalyst 9500-40X
Block diagram



Cisco Catalyst 9500-40X
Port-to-ASIC mapping



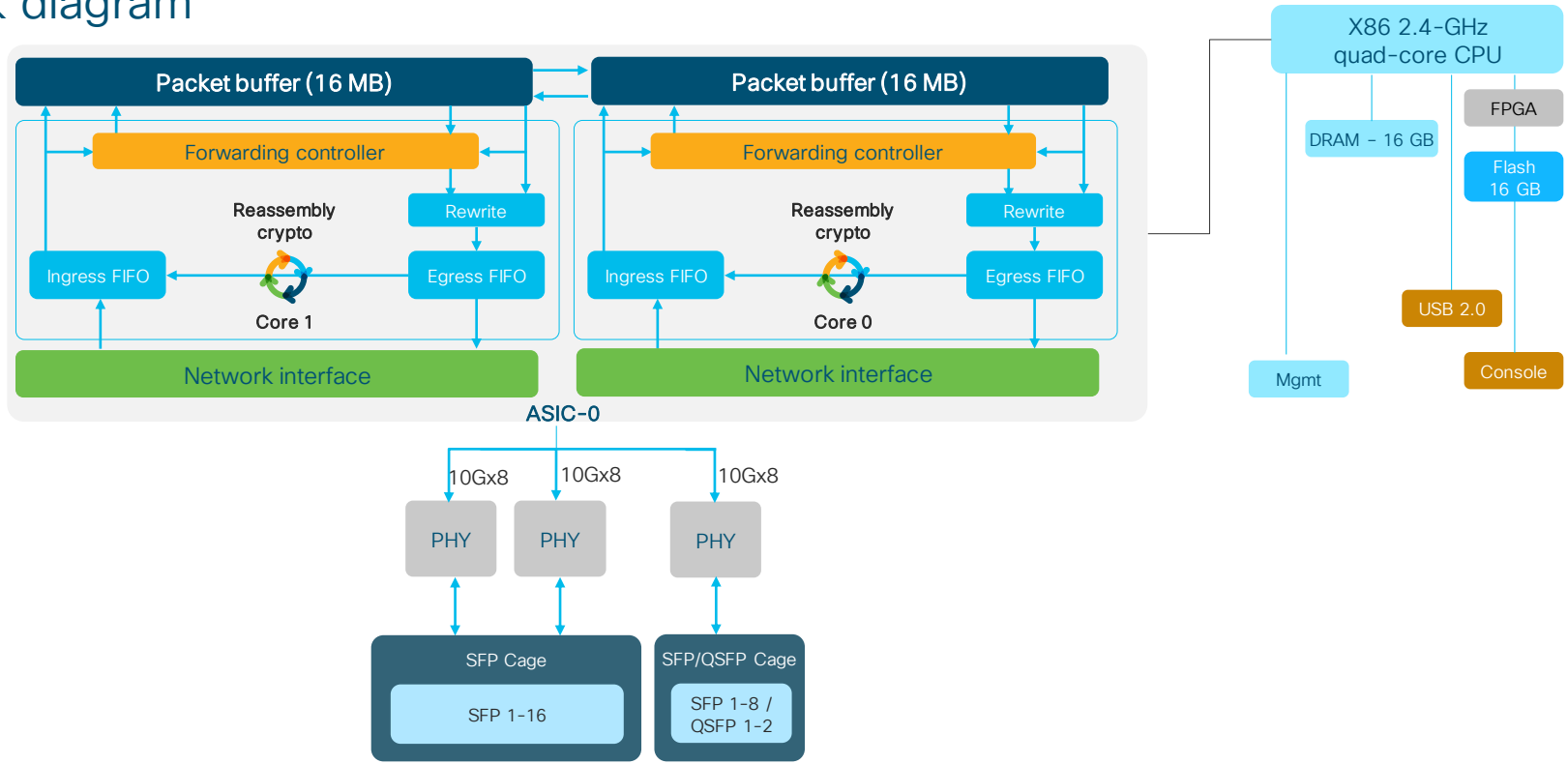

```
C9500-40X#show platform software fed switch active ifm mappings lpn
Mappings Table

LPN         ASIC  Port  Interface                IF_ID                Active
-----------------------------------------------------------------------------
1           1     0     TenGigabitEthernet1/0/1  0x00000009           Y
2           1     1     TenGigabitEthernet1/0/2  0x0000000a           Y
3           1     2     TenGigabitEthernet1/0/3  0x0000000b           Y
4           1     3     TenGigabitEthernet1/0/4  0x0000000c           Y
5           1     4     TenGigabitEthernet1/0/5  0x0000000d           Y
6           1     5     TenGigabitEthernet1/0/6  0x0000000e           Y
7           1     6     TenGigabitEthernet1/0/7  0x0000000f           Y
8           1     7     TenGigabitEthernet1/0/8  0x00000010           Y
9           1     8     TenGigabitEthernet1/0/9  0x00000011           Y
10          1     9     TenGigabitEthernet1/0/10 0x00000012           Y
11          1     10    TenGigabitEthernet1/0/11 0x00000013           Y
12          1     11    TenGigabitEthernet1/0/12 0x00000014           Y
13          1     12    TenGigabitEthernet1/0/13 0x00000015           Y
14          1     13    TenGigabitEthernet1/0/14 0x00000016           Y
15          1     14    TenGigabitEthernet1/0/15 0x00000017           Y
16          1     15    TenGigabitEthernet1/0/16 0x00000018           Y
17          1     16    TenGigabitEthernet1/0/17 0x00000019           Y
18          1     17    TenGigabitEthernet1/0/18 0x0000001a           Y
19          1     18    TenGigabitEthernet1/0/19 0x0000001b           Y
20          1     19    TenGigabitEthernet1/0/20 0x0000001c           Y
21          1     20    TenGigabitEthernet1/0/21 0x0000001d           Y
22          1     21    TenGigabitEthernet1/0/22 0x0000001e           Y
23          1     22    TenGigabitEthernet1/0/23 0x0000001f           Y
24          1     23    TenGigabitEthernet1/0/24 0x00000020           Y
25          0     24    TenGigabitEthernet1/0/25 0x00000021           Y
26          0     25    TenGigabitEthernet1/0/26 0x00000022           Y
27          0     26    TenGigabitEthernet1/0/27 0x00000023           Y
28          0     27    TenGigabitEthernet1/0/28 0x00000024           Y
29          0     28    TenGigabitEthernet1/0/29 0x00000025           Y
30          0     29    TenGigabitEthernet1/0/30 0x00000026           Y
31          0     30    TenGigabitEthernet1/0/31 0x00000027           Y
32          0     31    TenGigabitEthernet1/0/32 0x00000028           Y
33          0     32    TenGigabitEthernet1/0/33 0x00000029           Y
34          0     33    TenGigabitEthernet1/0/34 0x0000002a           Y
35          0     34    TenGigabitEthernet1/0/35 0x0000002b           Y
36          0     35    TenGigabitEthernet1/0/36 0x0000002c           Y
37          0     36    TenGigabitEthernet1/0/37 0x0000002d           Y
38          0     37    TenGigabitEthernet1/0/38 0x0000002e           Y
39          0     38    TenGigabitEthernet1/0/39 0x0000002f           Y
40          0     39    TenGigabitEthernet1/0/40 0x00000030           Y
41          0     40    TenGigabitEthernet1/1/1  0x00000031           N
42          0     41    TenGigabitEthernet1/1/2  0x00000032           N
43          0     42    TenGigabitEthernet1/1/3  0x00000033           N
44          0     43    TenGigabitEthernet1/1/4  0x00000034           N
45          0     44    TenGigabitEthernet1/1/5  0x00000035           N
46          0     45    TenGigabitEthernet1/1/6  0x00000036           N
47          0     46    TenGigabitEthernet1/1/7  0x00000037           N
48          0     47    TenGigabitEthernet1/1/8  0x00000038           N
49          0     48    FortyGigabitEthernet1/1/1 0x00000039          Y
50          0     49    FortyGigabitEthernet1/1/2 0x0000003a          Y
```

Command to verify the port-to-ASIC mapping:

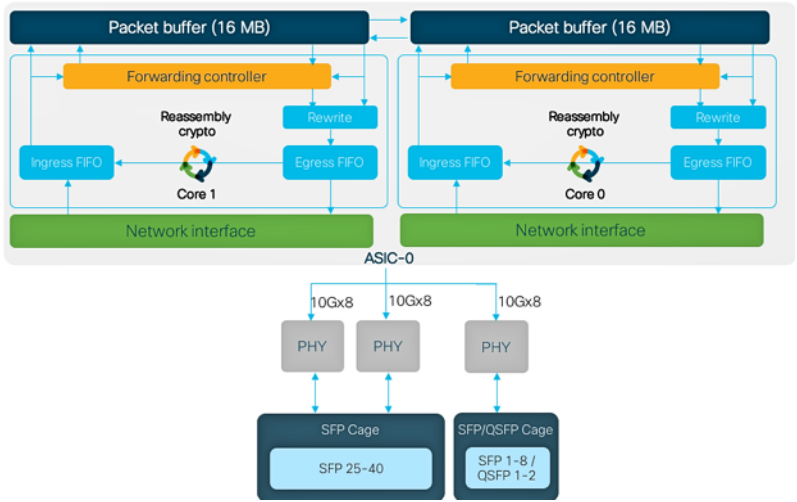
show platform software fed switch active ifm mappings lpn

Cisco Catalyst 9500-16X

Block diagram



Cisco Catalyst 9500-16X
Port-to-ASIC mapping




```
C9500-16X#show platform software fed switch 1 ifm mappings lpn
Mappings Table

LPN         ASIC  Port  Interface                IF_ID                Active
-----------------------------------------------------------------------------
1           0     0     TenGigabitEthernet1/0/1  0x00000025           Y
2           0     1     TenGigabitEthernet1/0/2  0x00000026           Y
3           0     2     TenGigabitEthernet1/0/3  0x00000027           Y
4           0     3     TenGigabitEthernet1/0/4  0x00000028           Y
5           0     4     TenGigabitEthernet1/0/5  0x00000029           Y
6           0     5     TenGigabitEthernet1/0/6  0x0000002a           Y
7           0     6     TenGigabitEthernet1/0/7  0x0000002b           Y
8           0     7     TenGigabitEthernet1/0/8  0x0000002c           Y
9           0     8     TenGigabitEthernet1/0/9  0x0000002d           Y
10          0     9     TenGigabitEthernet1/0/10 0x0000002e           Y
11          0     10    TenGigabitEthernet1/0/11 0x0000002f           Y
12          0     11    TenGigabitEthernet1/0/12 0x00000030           Y
13          0     12    TenGigabitEthernet1/0/13 0x00000031           Y
14          0     13    TenGigabitEthernet1/0/14 0x00000032           Y
15          0     14    TenGigabitEthernet1/0/15 0x00000033           Y
16          0     15    TenGigabitEthernet1/0/16 0x00000034           Y
```

Command to verify the port-to-ASIC mapping:
show platform software fed switch active ifm mappings lpn

Catalyst 9500 User Centric Platform Design

You make customer experience **possible**

Cisco live!

Cisco Catalyst 9500 Series
Blue beacon

- Blue beacon LED allows easy identification of the switch being accessed
- Color/state – Solid Blue(ON)/Black(OFF)
- Blue beacon can be turned on using Exec mode CLI

Cisco Catalyst 9500 High Performance

C9500-32QC#**hw-module beacon RP active?**
Off Turn off
on Turn on
status Slot Beacon Status

C9500-32QC#**hw-module beacon RP active on**
*Jan 23 22:39:05.972: %PLATFORM_LED-6-BEACON_LED_TURNED: Slot 1 Beacon LED turned ON

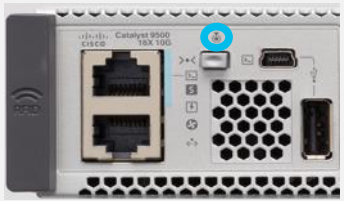
C9500-32QC#**hw-module beacon RP active status**
BLUE

C9500-32QC#**hw-module beacon RP active off**
*Jan 23 22:40:39.660: %PLATFORM_LED-6-BEACON_LED_TURNED: Slot 1 Beacon LED turned OFF

C9500-32QC#**hw-module beacon RP active status**
BLACK

C9500-32C#hw-module beacon ssd on

Cisco Catalyst 9500



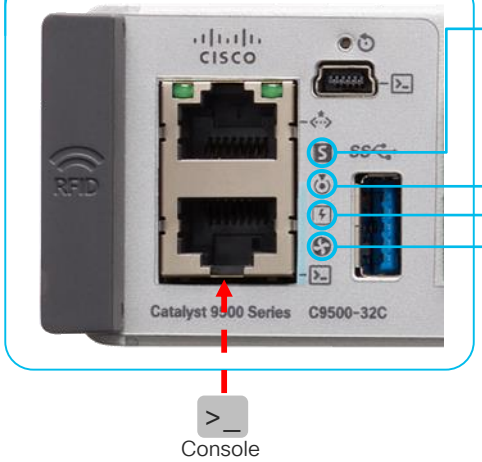
C9500-24Q(config)#**hw-module beacon on switch 1**
*Apr 4 23:59:36.610: %PLATFORM_LED-6-BEACON_LED_TURNED: Switch 1 Beacon LED turned ON

C9500-24Q #**show hardware led | in BEACON**
BEACON: BLUE

C9500-24Q(config)#**hw-module beacon off switch 1**
*Apr 5 00:03:33.336: %PLATFORM_LED-6-BEACON_LED_TURNED: Switch 1 Beacon LED turned OFF

C9500-24Q #**show hardware led | in BEACON**
BEACON: BLACK

Cisco Catalyst 9500 Series
LEDs



System LED	Off	System is not powered on
	Green	System is operating normally
	Blinking green	System is Rommon mode
	Amber	System temperature is exceeding minor/major threshold
	Blinking amber	Faulty hardware
Beacon LED	Solid blue	The operator has indicated that the system needs attention
PSU LED	Green	Both PSUs in bay with active power
	Amber	Missing PSU or no power feed
Fan LED	Green	Fans operating normally
	Red	Fan or fans faulty

Cisco Catalyst 9500 Storage options
SSD storage

Cisco Catalyst 9500 High Performance

M2 SATA SSD

Capabilities	
Form factor	M2 SATA
Capacity	240 GB, 480 GB or 960 GB
Performance	300 MB/s read, 290 MB/s write
Power write	4.5W
Security	Hardware-based AES-256-bit
Filesystem type	ext4

Product ID	Release
C9K-F1-SSD-240G	16.8.1 – general-purpose storage only
C9K-F1-SSD-480G	
C9K-F1-SSD-960G	

Cisco Catalyst 9500

USB 3.0 120G SSD

Capabilities	
Form factor	USB 3.0
Capacity	120 GB
Performance	400 MB/s read, 140 MB/s write
Power write	4.5W maximum
Security	Hardware-based AES-256-bit & Password Authentication
Filesystem type	ext4

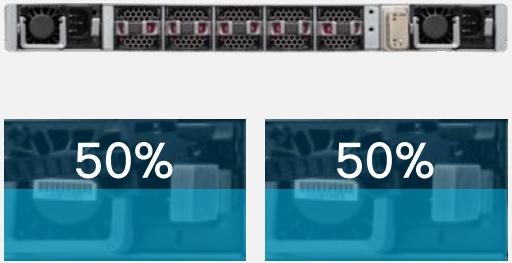
Product ID	Release
SSD-120G / SSD-120G=	16.8.1 – general-purpose storage only

Use Cases

- App hosting
- General-purpose storage
- Packet Captures
- GIR Snapshots
- SMU Files
- Logging local NetFlow record storage

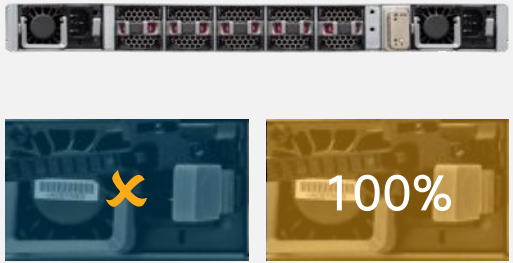
Cisco Catalyst 9500 Series
Power supply redundancy

Redundant mode (default)



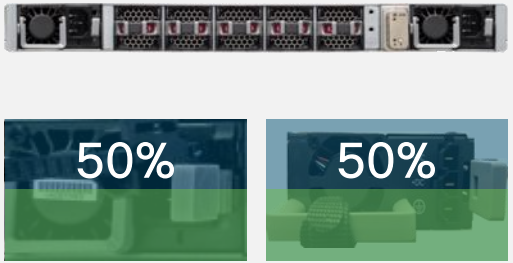
- Load sharing and redundancy are enabled automatically
- Each power supply provides ~50% of capacity
- This is the recommended and only mode

Redundant mode (failure)



- In case of power supply or power feed failure, active power supply operates at 100% capacity

AC – DC power supplies



- Mix of AC and DC power supplies supported

Cisco UADP 3.0 Architecture

You make the power of data **possible**

UADP 3.0

~20B transistors
16-nm technology

Customizable ASIC templates

36-MB unified buffer

IP v4/v6

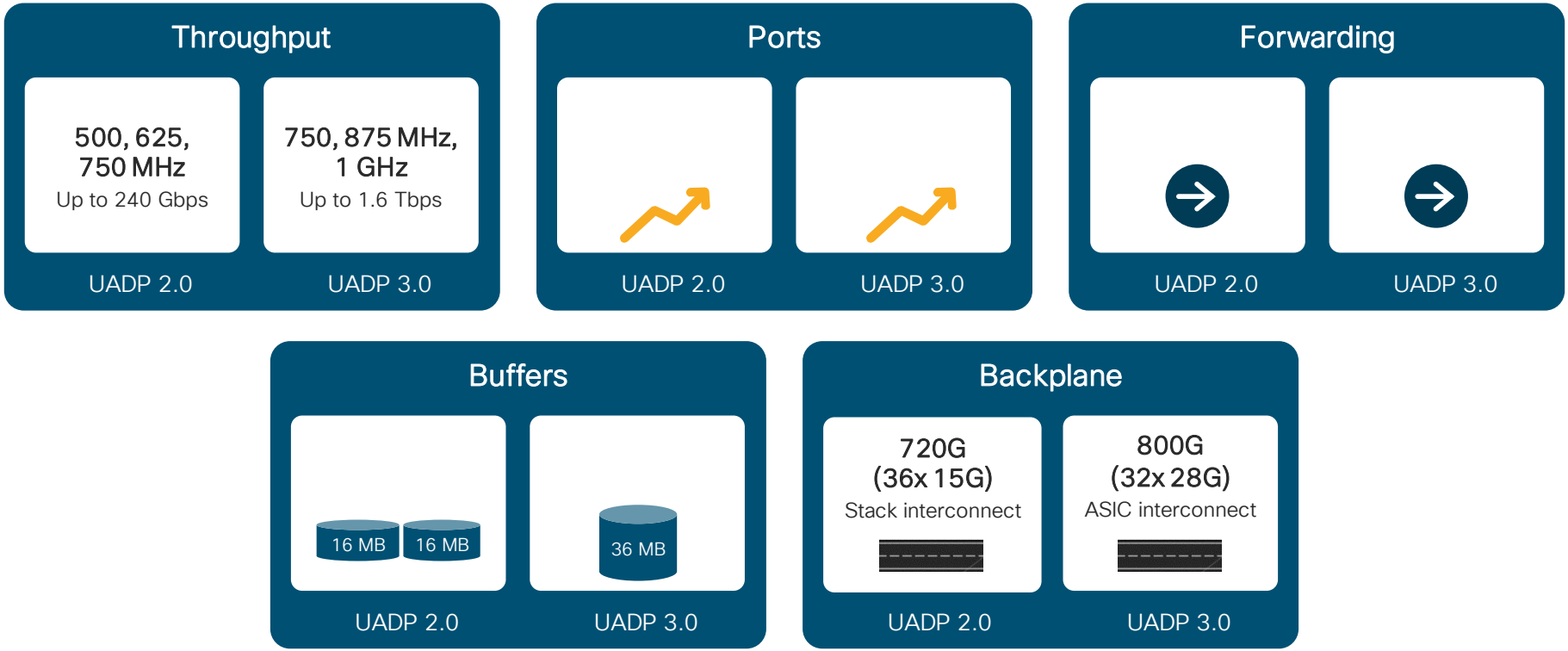
Double-width tables

3x more FIB scale

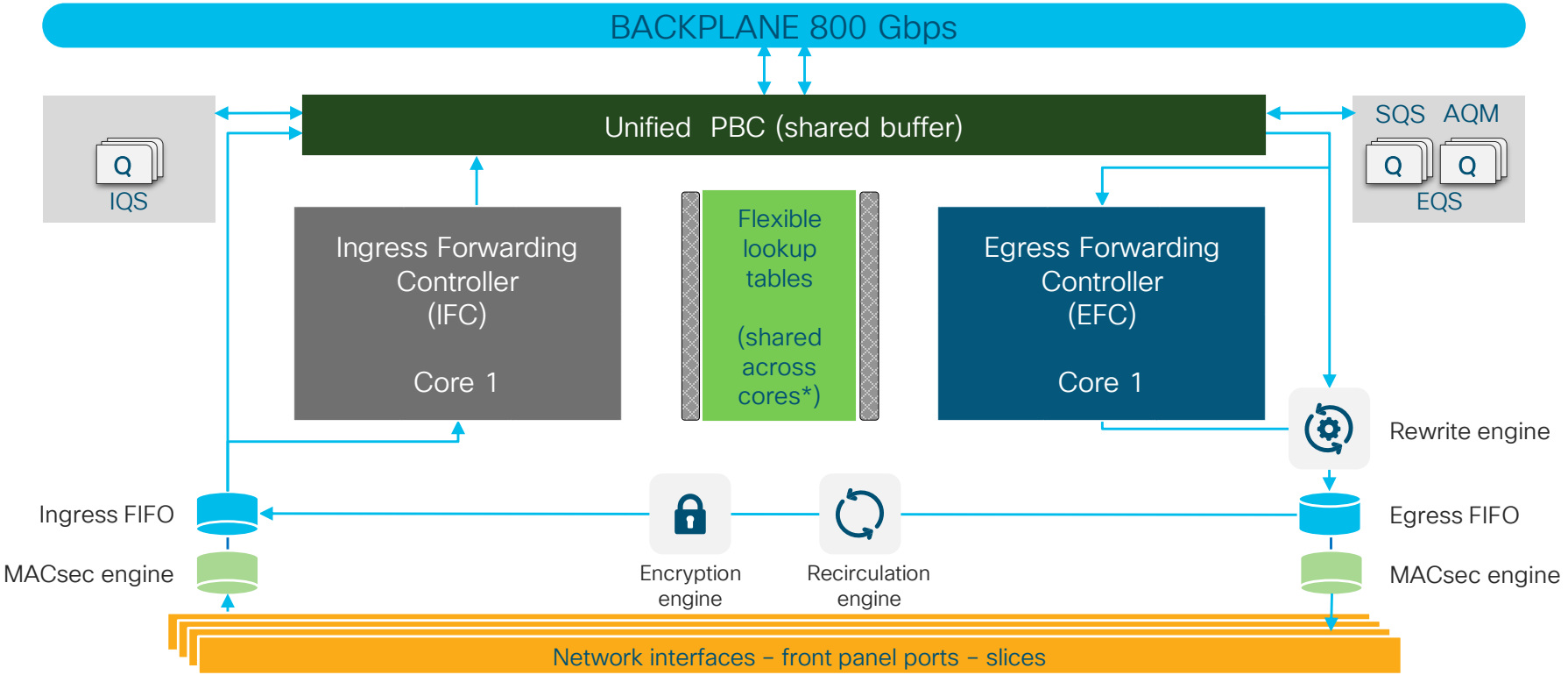
Up to 1.6 TB bandwidth

1G, 10G 25G, 40G, and 100G speeds

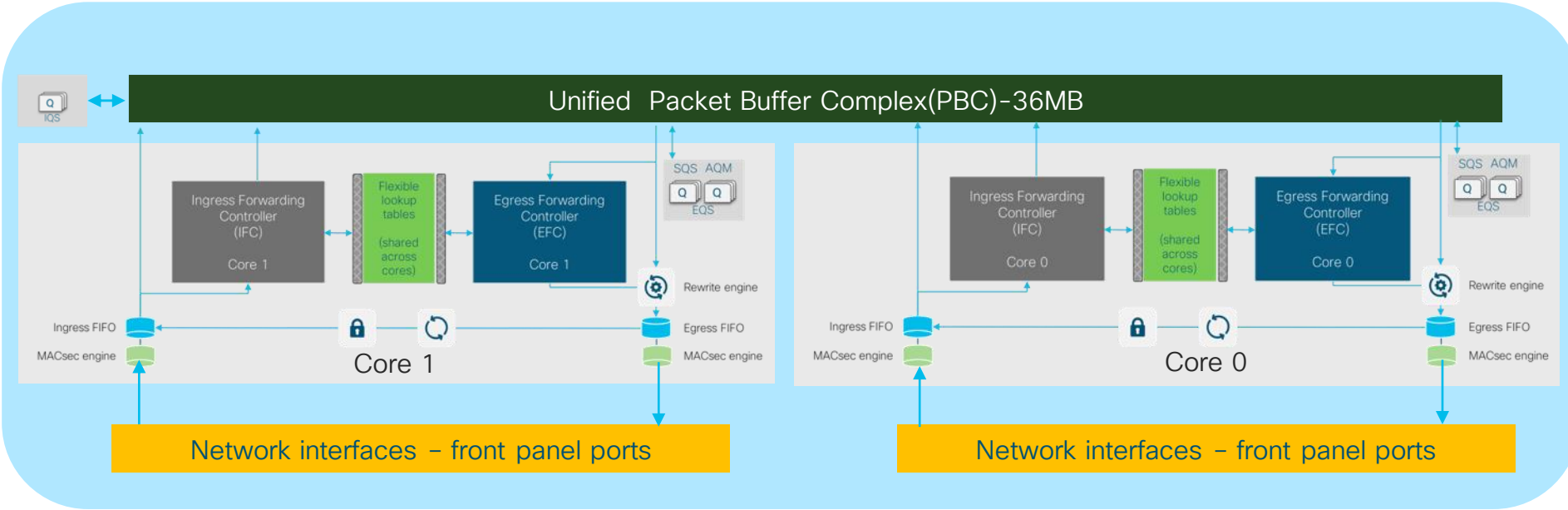
UADP evolution
UADP 2.0 vs. 3.0 per-ASIC capabilities



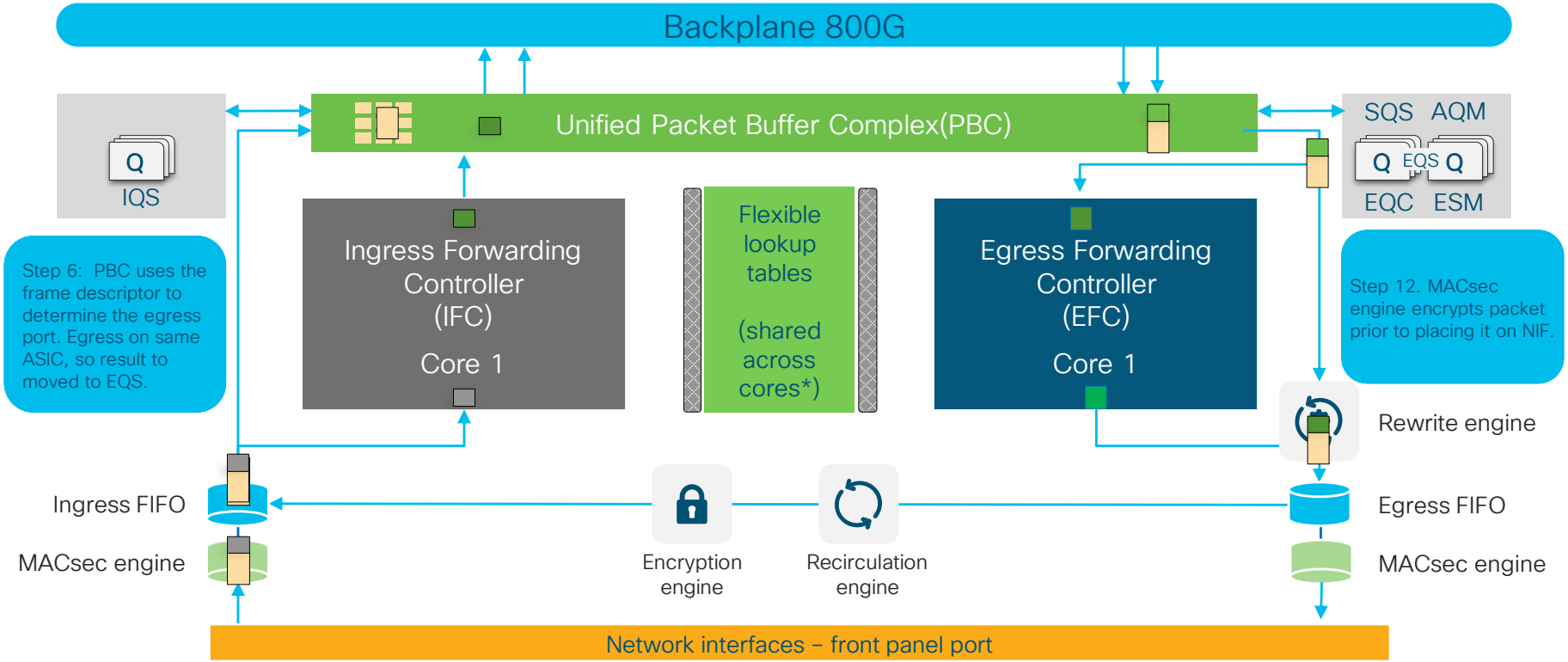
Cisco Catalyst 9500 Series
UADP 3.0 – Under the covers



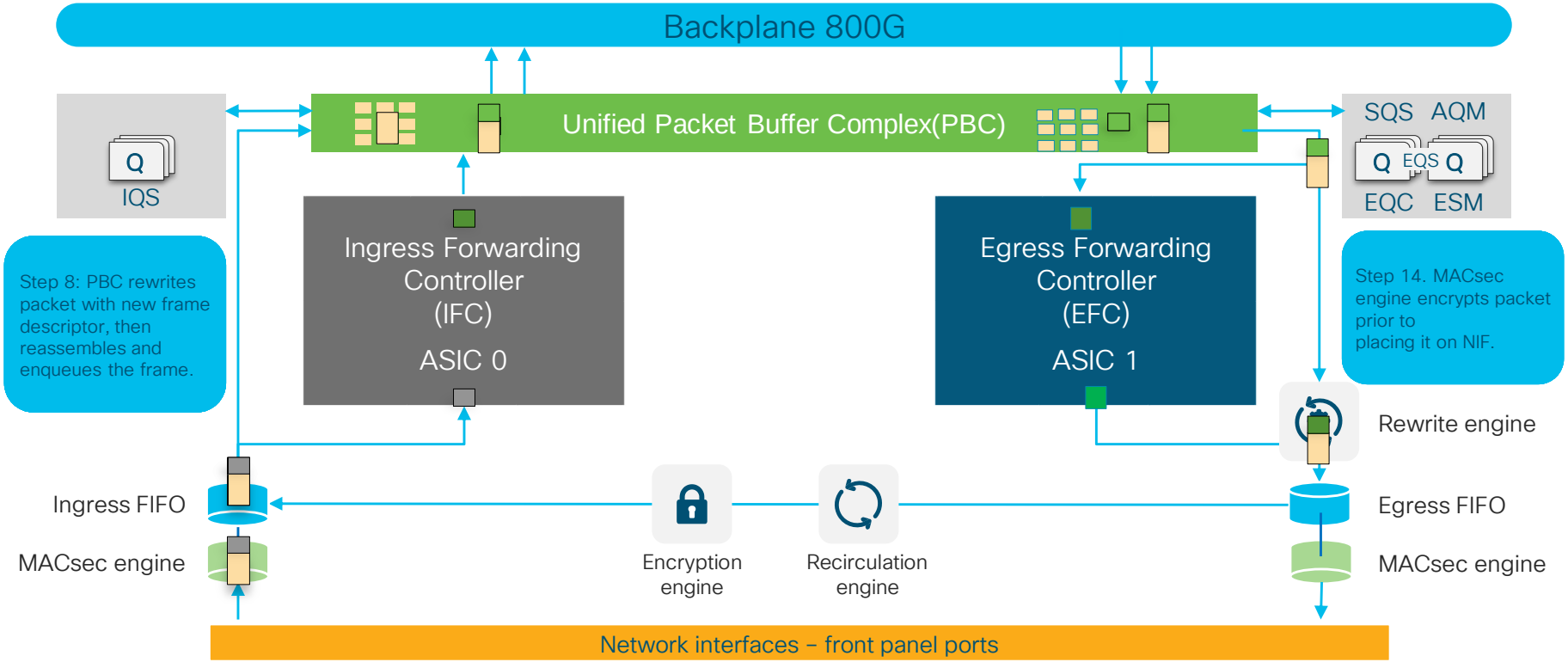
UADP 3.0 – Under the covers



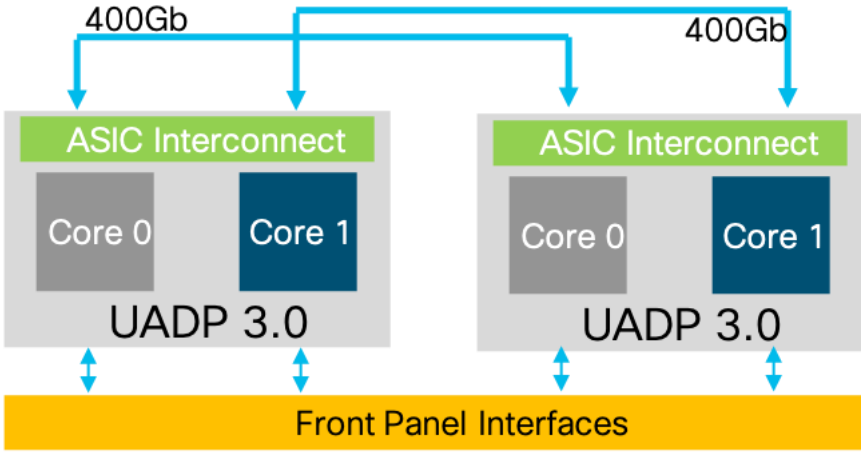
Cisco Catalyst 9500 Series
Unicast forwarding within ASIC (ingress and egress)



Cisco Catalyst 9500 Series
Unicast forwarding across ASIC (ingress and egress)

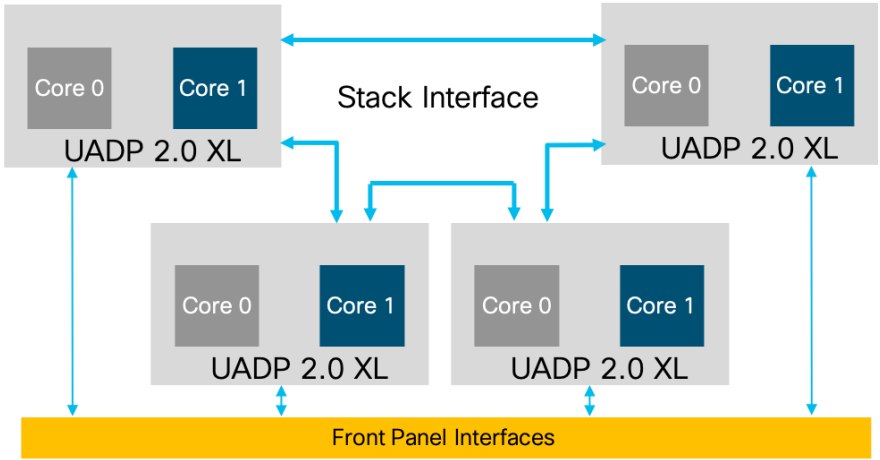


ASIC Interconnects



C9500 High Performance

- 2x400G packet bandwidth P2P links
- Credit-based mechanism



C9500

- 2x360G independent rings

Cisco Catalyst 9500 Series ASIC comparison

Capabilities (per ASIC)	Cisco® Catalyst® 9500 Series (UADP 2.0)	Cisco Catalyst 9500 High Performance (UADP 3.0)
Switching and forwarding capacity	240 Gbps/360 Mpps	1.6 Tbps/1 Bpps
Stack/Backplane bandwidth	2x 360 Gbps	2x 400 Gbps
Buffer capability	**2x 16 MB**	**36 MB shared buffer**
Switch Database Management (SDM) template	**Fixed templates**	**Customizable templates**
NetFlow capabilities	Dedicated NetFlow table	Shared NetFlow table
v4 FIB scale	Total 228,000*	Total 412,000*
v4 and v6 scale	**v6 reduced by half**	**v4 and v6 same scale**

* Maximum ASIC Capability

System Management

You make the power of data **possible**

Cisco Catalyst 9500 Series
Switching Database Manager (SDM) template

Core template
Maximizes system resources for unicast and multicast routing and security
(Default: C9500 High Performance)

User-customizable template
Allows customizable* ACL TCAM resources

Cisco® Catalyst® 9500 Series

Distribution template
Maximizes system resources for MAC and security
(Default: C9500 Switches)

SD-Access template
Maximizes system resources for security to support fabric deployment

NAT template
Maximizes the NAT configurations on the switch

* Cisco Catalyst 9500 High Performance Switch Security ACL TCAM only

Cisco Catalyst 9500 High Performance Series
SDM templates and scale numbers

Feature		Distribution template	Core template (default)	SDA template	NAT template
Routes (IPv4/IPv6)		114K / 114K	**212K / 212K**	212K / 212K	212K / 212K
Multicast routes (IPv4/IPv6)		16K / 16K	32K / 32K	32K / 32K	32K / 32K
MAC address table		**82K**	32K	32K	32K
Flexible netflow		**98K**	64K	64K	64K
SGT label		32K	32K	32K	32K
Security ACL	Ingress	12K		8K	12K
	Egress	15K		**19K**	8K
QOS ACL	Ingress	8K		8K	4K
	Egress	8K		8K	4K
Netflow ACL	Ingress	1K		1K	1K
	Egress	1K		1K	1K
SPAN	Ingress	0.5K		0.5K	0.5K
	Egress	0.5K		0.5K	0.5K
PBR/NAT		3K		2K	**15.5K**
CPP		1K		1K	1K
Tunnel termination and MACSEC		3K		3K	2K
LISP		1K		2K	1K

Customizable ACL TCAM resources

Cisco Catalyst 9500 Series
SDM template – CLI

```
C9500-32C#sh sdm prefer
Showing SDM Template Info

This is the Core template.
  Security Ingress IPv4 Access Control Entries*:      6656  (current) - 9728  (proposed)
  Security Ingress Non-IPv4 Access Control Entries*:  5632  (current) - 3584  (proposed)
  Security Egress IPv4 Access Control Entries*:       6656  (current) - 10752 (proposed)
  Security Egress Non-IPv4 Access Control Entries*:   8704  (current) - 3584  (proposed)
  QoS Ingress IPv4 Access Control Entries*:           4608  (current) - 4608  (proposed)
  QoS Ingress Non-IPv4 Access Control Entries*:       3584  (current) - 3584  (proposed)
  QoS Egress IPv4 Access Control Entries*:            4608  (current) - 4608  (proposed)
  QoS Egress Non-IPv4 Access Control Entries*:        3584  (current) - 3584  (proposed)
  Netflow Input Access Control Entries*:              1024  (current) - 1024  (proposed)
  Netflow Output Access Control Entries*:             1024  (current) - 1024  (proposed)
  Flow SPAN Input Access Control Entries*:            512   (current) - 512   (proposed)
  Flow SPAN Output Access Control Entries*:           512   (current) - 512   (proposed)
```

* - Only on Cisco 9500 High Performance SKU's

Cisco Catalyst 9500 Series
SDM Customizable template – CLI

Command to modify ACL TCAM Allocation

```
C9500-32C-2(config)#sdm prefer template-modification ?
  default       Default prefered template
  fspan         Filter Span
  nfl           NFL ACLs
  qos           QOS
  security-acl  Security ACLs
```

```
C9500-32C-2(config)# sdm prefer template-modification security-acl input allowed-range
Total_size : 27648 Suggested split percentage for input : 29 33 37 40 48 49 52 60 63 67 71
```

```
C9500-32C-2(config)#sdm prefer template-modification security-acl input 25 input-ipv4 75 output-ipv4 75
Allocated Security Acl Input (IPv4:4608, Non-IPv4:3584) entries, Output (IPv4:13824, Non-IPv4:5632) entries input=29.63 input_ipv4=56.25,
output_ipv4=71.05
```

Modifications to preferred template have been stored, but cannot effect until the next reload. Allocations will be an approximation of user specified percentages. Use 'show sdm prefer' to see proposed values.

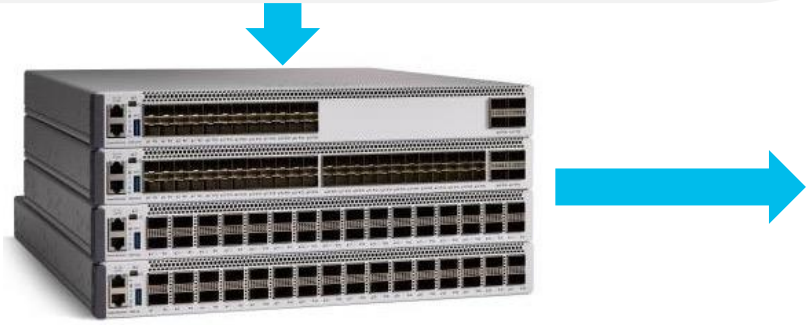
Cisco Catalyst 9500 Series
SDM Customizable template – CLI

Command to modify ACL TCAM Allocation

C9500-32C-2(config)#sdm prefer template-modification security-acl input 25 input-ipv4 75 output-ipv4 75

*Allocated Security Acl Input (**IPv4:4608, Non-IPv4:3584**) entries, Output (**IPv4:13824, Non-IPv4:5632**) entries*
input=29.63 input_ipv4=56.25, output_ipv4=71.05

Modifications to preferred template have been stored, but cannot effect until the next reload. Allocations will be an approximation of user specified percentages. Use 'show sdm prefer' to see proposed values.



Security-ACL Allocation	Input=25% Input V4 – 75% Output v4 – 75%	
27K	8K(Input)	4.5K(v4)
		3.5K(non-v4)
	19K(Output)	13.5K(v4)
		5.5K(non-v4)

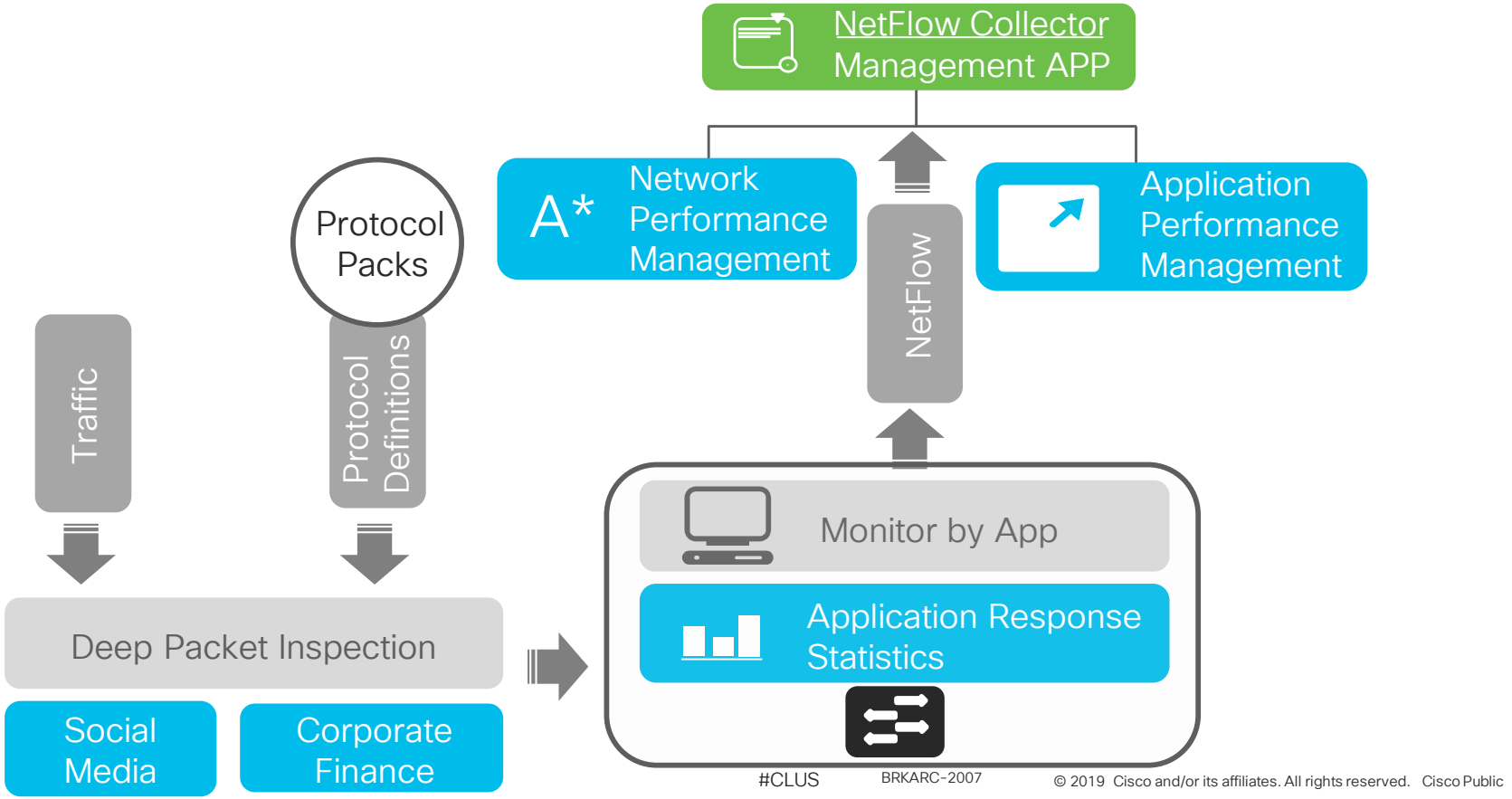
Security-ACL Allocation	Input=50% Input V4 – 75% Output v4 – 75%	
27K	13K(Input)	9.5K(v4)
		3.5K(non-v4)
	14K(Output)	10.5K(v4)
		3.5K(non-v4)

Security-ACL Allocation	Input=75% Input V4 – 75% Output v4 – 75%	
27K	19K(Input)	13.5K(v4)
		5.5K(v4)
	8K(Output)	4.5K(v4)
		3.5K(non-v4)

Cisco Catalyst 9500 Series
SDM templates and scale numbers

Feature		Distribution template (default)	Core template	SDA template	NAT template
Indirect/LPM Routes (IPv4/IPv6)		64K / 32K	64K / 32K	64K / 32K	64K / 32K
Direct/Host Routes (IPv4/IPv6)		48K / 24K	32K / 16K	**80K / 40K**	48K / 24K
Multicast routes (IPv4/IPv6)		16K / 8K	16K / 8K	16K / 8K	16K / 8K
MAC address table		**65K**	16K	16K	16K
Flexible netflow		128K/ASIC	128K/ASIC	128K/ASIC	128K/ASIC
SGT label		8K	8K	8K	8K
Security ACL	Ingress	18K			18K
	Egress				
QOS ACL	Ingress	18K			3K
	Egress				
Netflow ACL	Ingress	1K			1K
	Egress	2K			2K
SPAN	Ingress	1K			1K
	Egress				
PBR/NAT		2K			16K
CPP		1K			1K
Tunnel termination and MACSEC		1K			1K
LISP		1K			1K

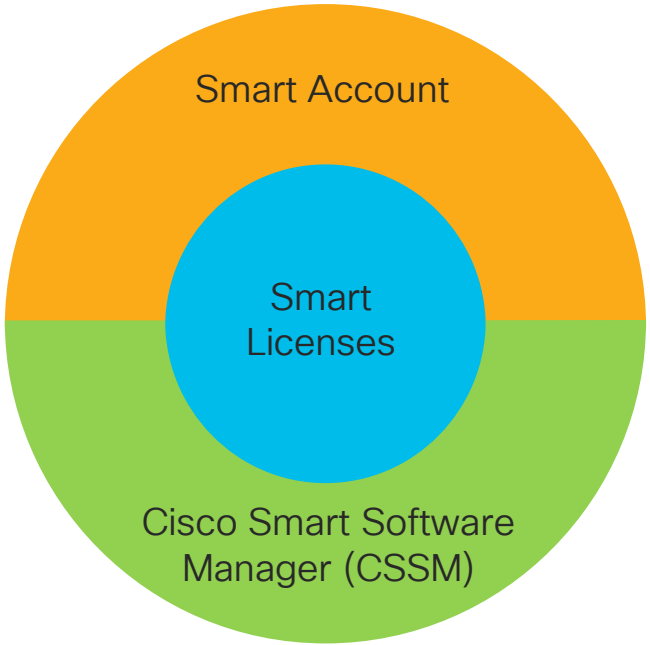
Cisco Application Visibility and Control(AVC)



Network Based Application Recognition 2 (NBAR2)

- Optimize the Application experience in the network
- Hitless Protocol Pack update allows adding more applications.
- 1500+ Apps recognition & ~140 Encrypted
- Supported devices from 16.6(3): **Catalyst 9500**
- **Not supported on Catalyst 9500 High Performance SKU's**

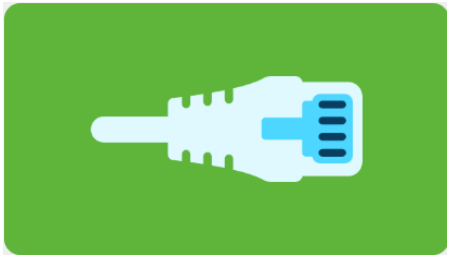
Cisco Smart Software Licensing



What makes Smart Licenses different?

Classic Licenses:	**Smart Licenses:**
Limited View	Complete View
PAK registration	Easy Registration
Device Specific	Company-Specific

Smart Licensing Deployment Options



Direct

Direct cloud access with Cisco Smart Software Manager (CSSM).

On-Premises

On-premises access with Cisco Smart Software Manager satellite.

Offline

Offline access through License Reservation.

Cisco Catalyst 9500 Security and Identity Overview

You make security **possible**

Cisco live!

Cisco Catalyst 9500 Series – Default configuration

Feature	Default state
Spanning Tree mode	RPVST+
VTP	Mode transparent
Error disable recovery	Auto
Port-channel load balance	Src-Dst-IP
SSH	Version 2
Interfaces	Layer 2, Shutdown */ Layer 3,no shutdown **
Routing	Enabled
QoS	2 queues per port, default trust (DSCP), Auto-QOS policy defined
CoPP	Enabled always
Cisco® Plug and Play	Enabled
Cisco Discovery Protocol	Enabled

* C9500
** C9500 High Performance

Cisco Catalyst 9000 Platform Trustworthy Systems

Design/ Develop → Plan/ Order → Source → Make → Quality → Delivery → Service/End of Life(EOL)

Physical security practices + security technology innovations + logical security processes

PnP SUDI support
Two-way trust

Image signing
Authentic OS

Hardware authenticity
Genuine hardware

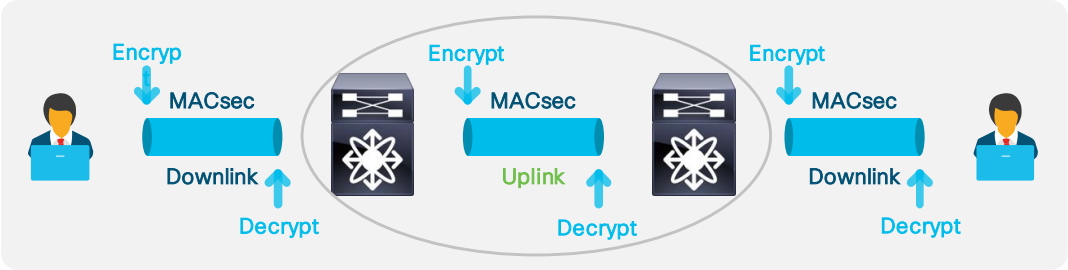
Secure boot
Boot sequence check

Integrity verification
Malware protection

Runtime defenses
64-bit ASLR

Cisco® trustworthy systems use industry best practices to help ensure full development lifecycle integrity and end-to-end security

MACsec
Hop-by-hop encryption via 802.1AE



- Packets are encrypted on egress, decrypted on ingress
- Offers line-rate encryption all Ports/Speeds (1G, 10G, 25G, 40G, and 100G)
- Transparent to all upper-layer protocols
- **Supports switch-to-switch & switch-to-host MACsec(128/256bit)**
- 256-bit MACsec capable between Switch-to-Switch
- Manual or 802.1X modes supported
- XPN Cipher suite for 40G & 100G Links to avoid to frequent Rekeys

Benefits

Complete Access Security

Complete cross platform alignment with Uplink/Downlink support

Protection against "Inside threats"

Securing campus infra

Hop by Hop Ethernet Encryption

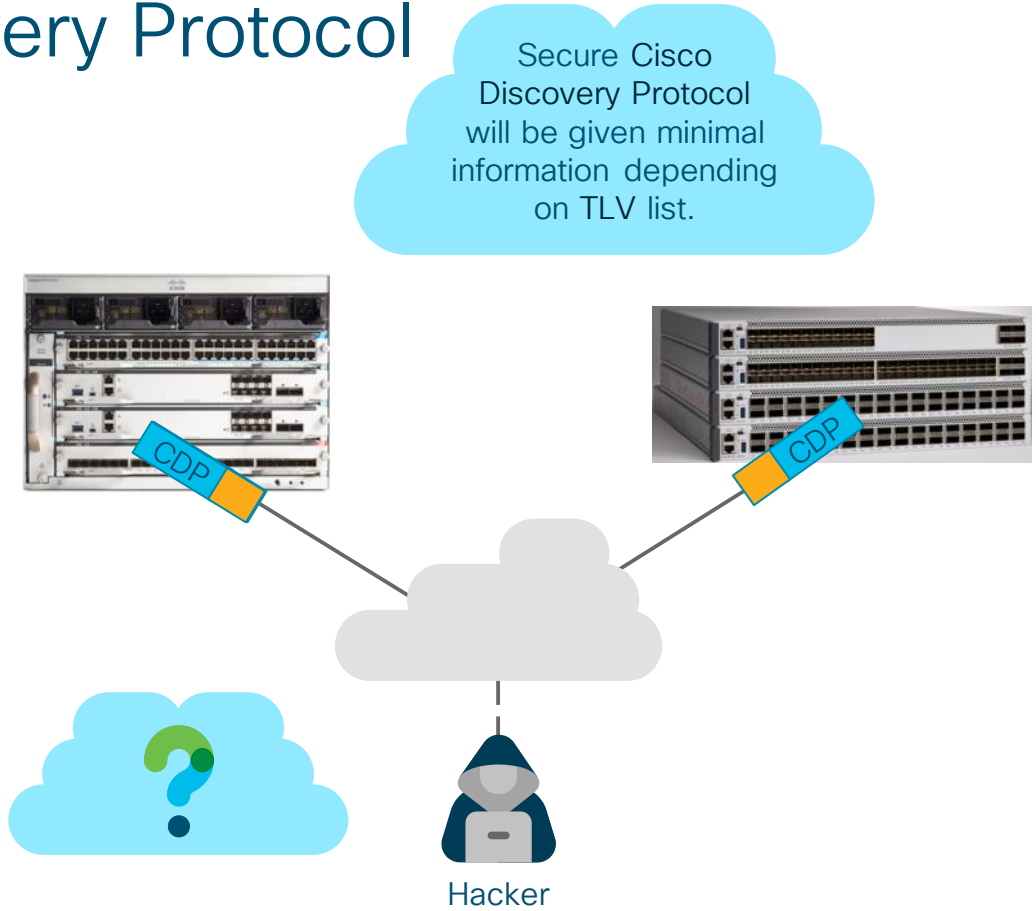
Line Rate Performance on all ports

256bit MACsec – Network Advantage

128bit MACsec – Network Essentials

Secure Cisco Discovery Protocol

- Cisco® Discovery Protocol doesn't possess inherent security
- Secure Cisco Discovery Protocol provides security with TLV fields
- Global or interface specific TLV configurable
- TLV will be blocked on sending side and has no effect on receiving side

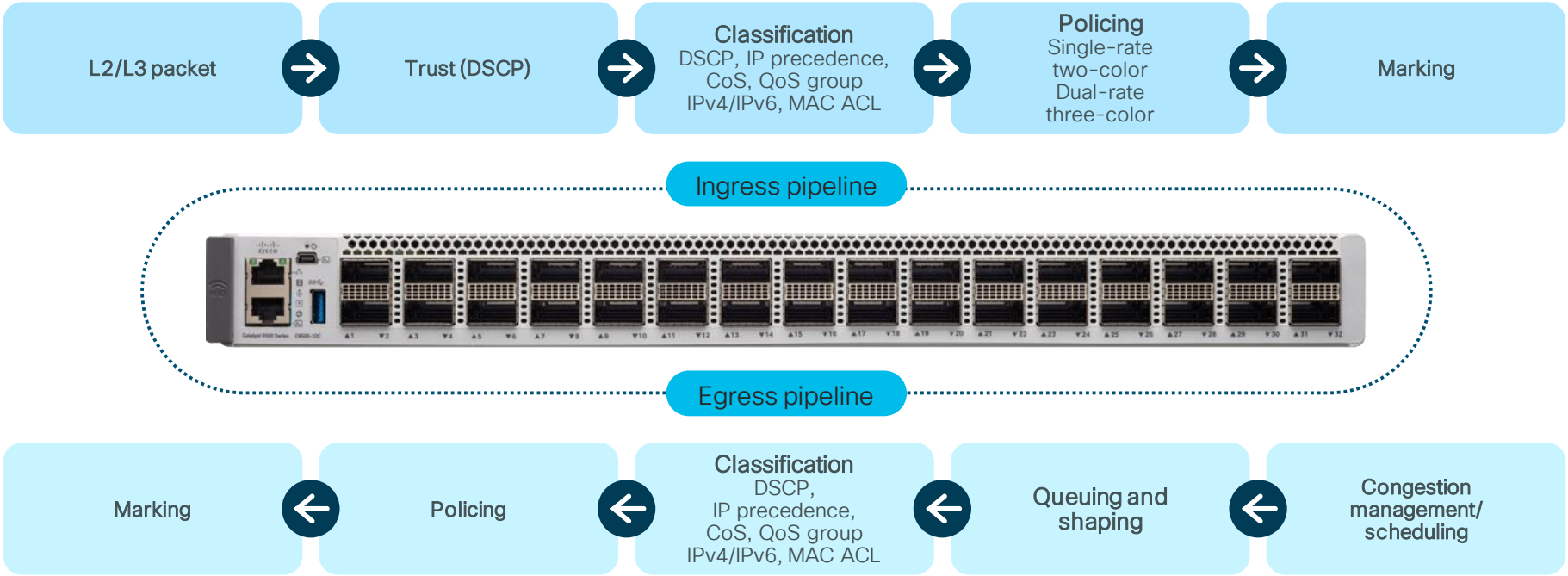


Quality of service

You make customer experience **possible**

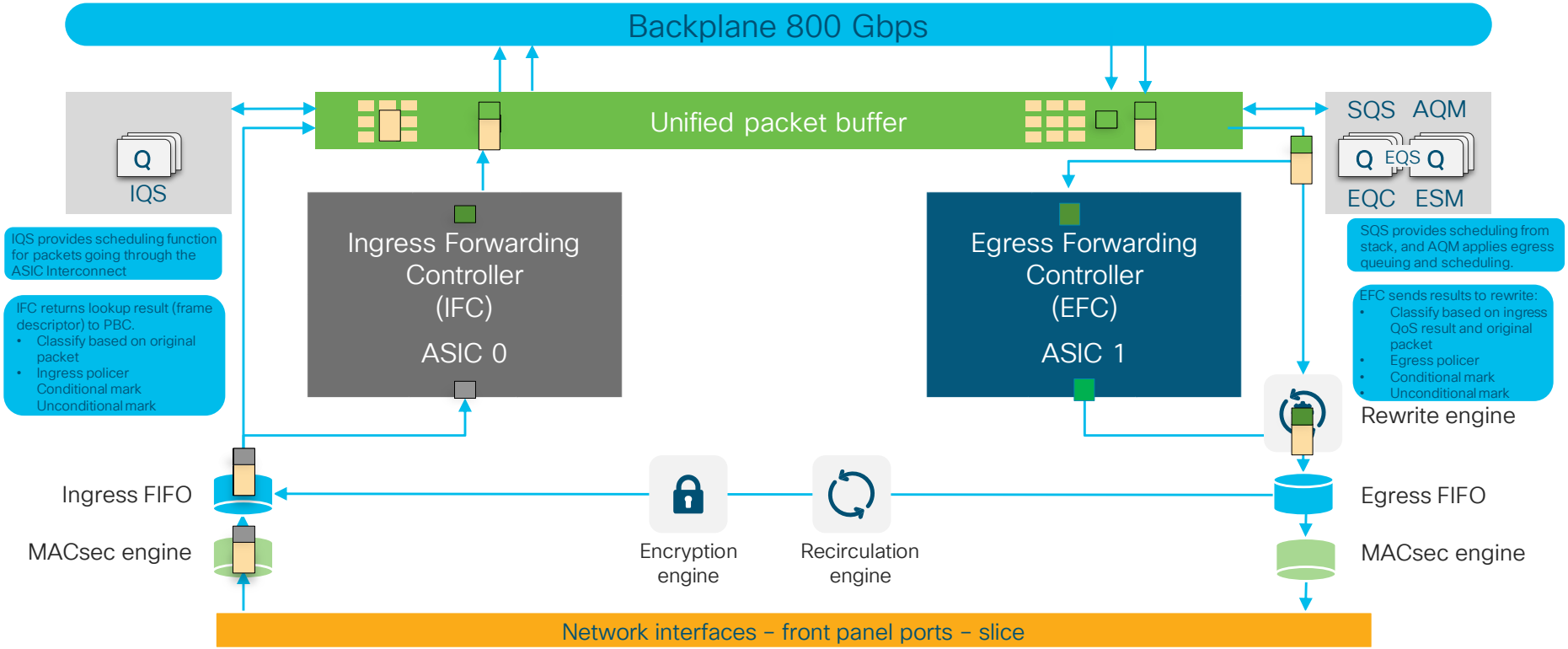
Cisco Catalyst 9500 Series – Quality of Service

- QoS is enabled by default
- All ports are trusted at Layer 2 and Layer 3 by default

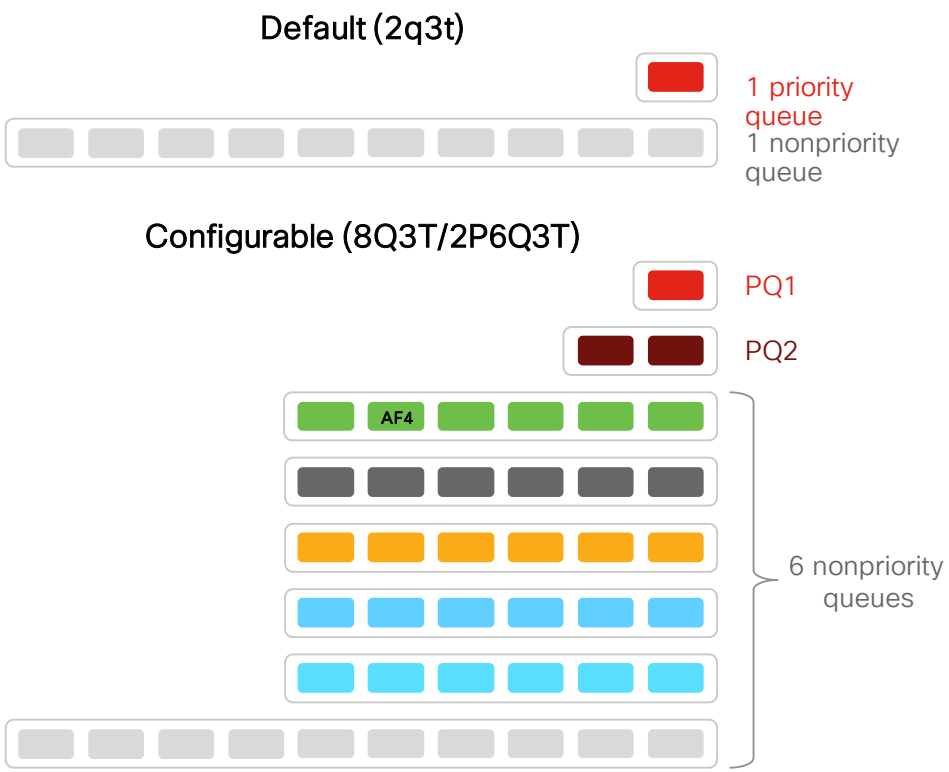


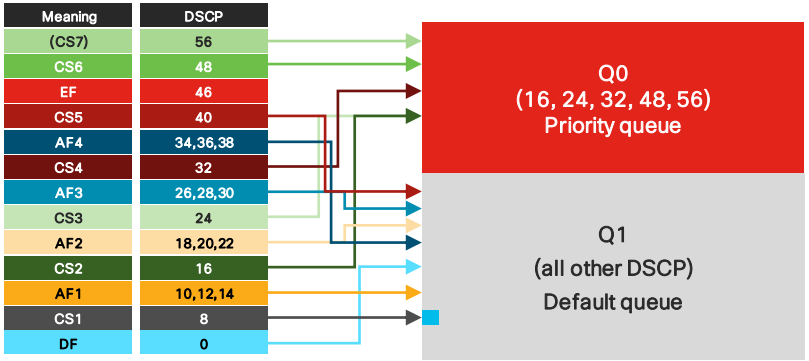
Cisco Catalyst 9500 Series

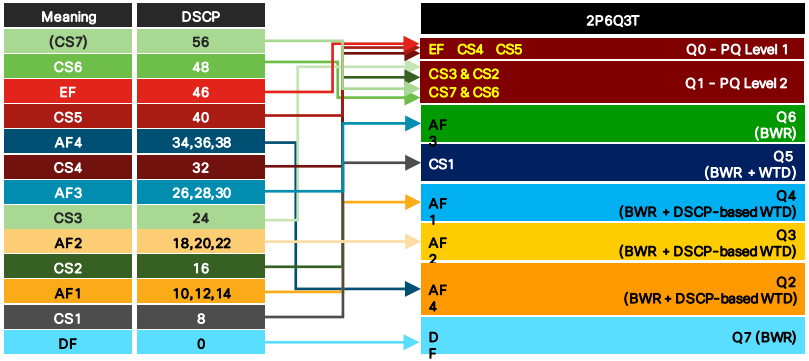
QoS forwarding (ingress and egress)



Cisco Catalyst 9500 Series
Hardware queues

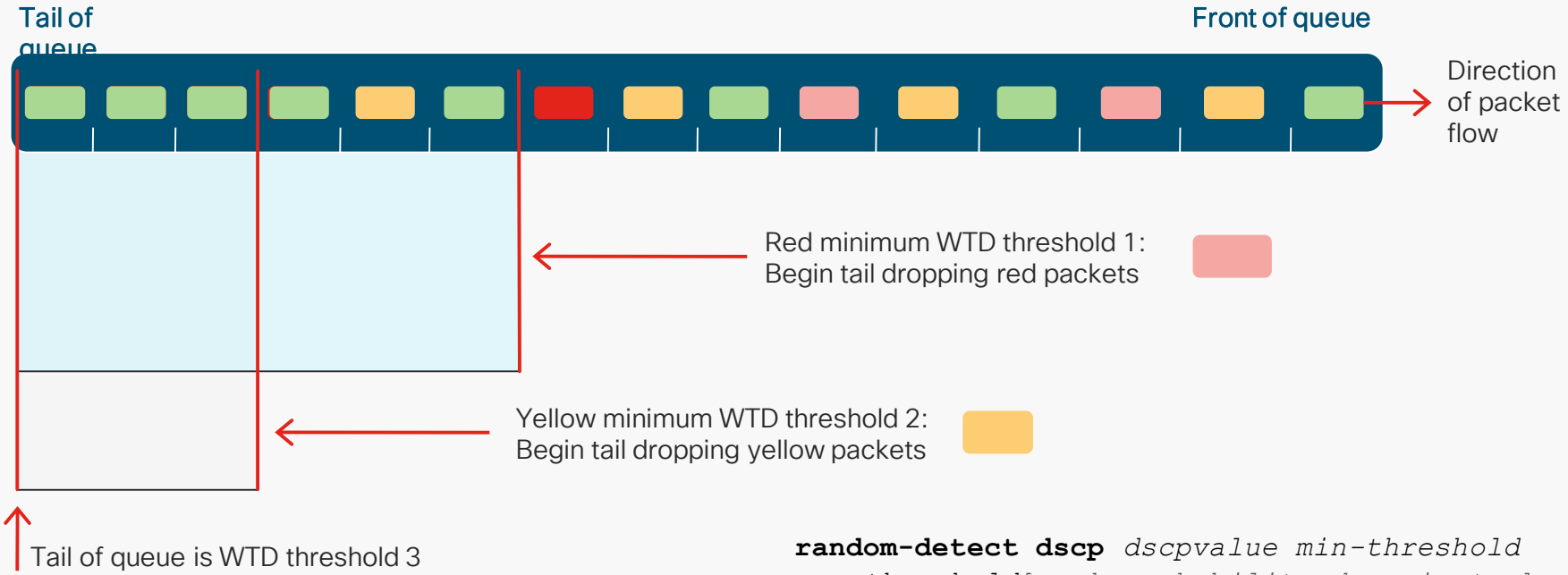






Cisco Catalyst 9500 Series –congestion avoidance

Weighted Random Early Detection (WRED) – 3T WTD




```
random-detect dscp dscpvalue min-threshold
max-threshold[mark-probability-denominator]
```

Cisco Catalyst 9500 Series
2P6Q3T+WTD wired port egress queuing configuration

```
class-map match-any VOICE-PQ1
match dscp ef
class-map match-any VIDEO-PQ2
match dscp cs4
match dscp cs5
class-map match-any CONTROL-MGMT-QUEUE
match dscp cs7 cs6 cs3 cs2
class-map match-any MULTIMEDIA-CONFERENCING-QUEUE
match dscp af41 af42 af43
class-map match-any MULTIMEDIA-STREAMING-QUEUE
match dscp af31 af32 af33
class-map match-any TRANSACTIONAL-DATA-QUEUE
match dscp af21 af22 af23
class-map match-any SCAVENGER-BULK-DATA-QUEUE
match dscp cs1 af11 af12 af13
```

Cisco Catalyst 9500 Series
2P6Q3T+WTD wired port egress queuing configuration

```
policy-map 2P6Q3T
 class VOICE-PQ1
  priority level 1
  police rate percent 10
 class VIDEO-PQ2
  priority level 2
  police rate percent 20
 class CONTROL-MGMT-QUEUE
  bandwidth remaining percent 10
  queue-buffers ratio 10
 class MULTIMEDIA-CONFERENCING-QUEUE
  bandwidth remaining percent 10
  queue-buffers ratio 10
  queue-limit dscp af43 percent 80
  queue-limit dscp af42 percent 90
```

Two levels of priority queuing are supported

```
interface range Hu1/0/1
 service-policy output 2P6Q3T
```

```
[continued]
 class MULTIMEDIA-STREAMING-QUEUE
  bandwidth remaining percent 10
  queue-buffers ratio 10
  queue-limit dscp af33 percent 80
  queue-limit dscp af32 percent 90
 class TRANSACTIONAL-DATA-QUEUE
  bandwidth remaining percent 10
  queue-buffers ratio 10
  queue-limit dscp af23 percent 80
  queue-limit dscp af22 percent 90
 class SCAVENGER-BULK-DATA-QUEUE
  bandwidth remaining percent 5
  queue-buffers ratio 10
  queue-limit dscp values af13 cs1 percent 80
  queue-limit dscp values af12 percent 90
 class class-default
  bandwidth remaining percent 25
  queue-buffers ratio 25
```

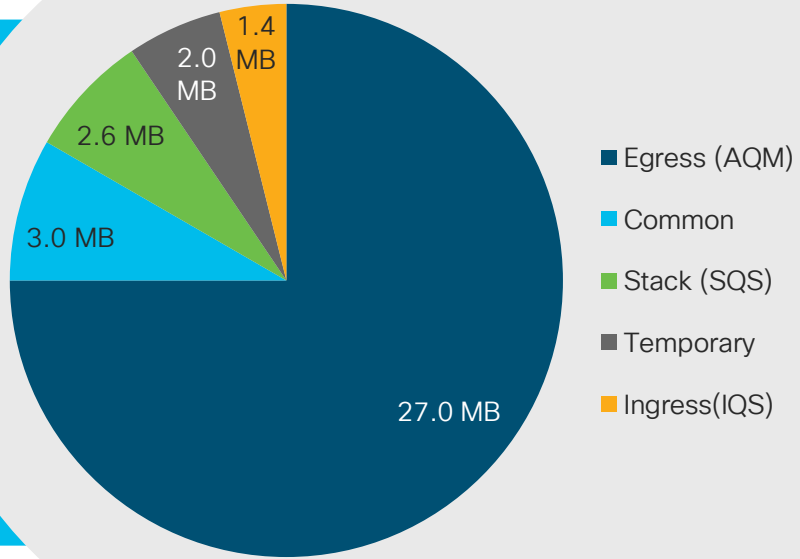
If a PQ is enabled, then non-PQs must use **bandwidth remaining**

Allocates buffers to queues

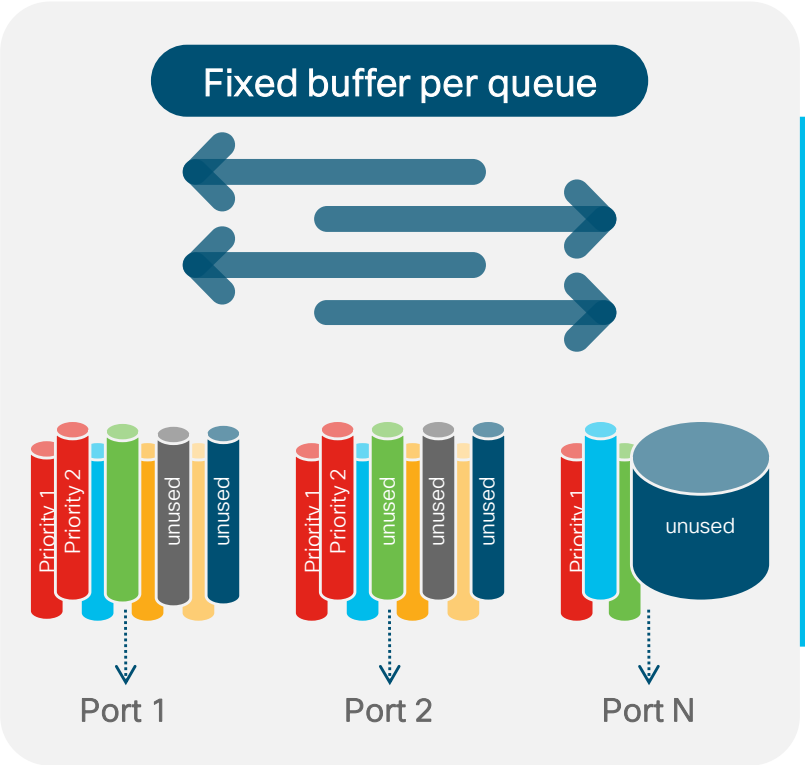
Tunes WTD to align to an AF PHB

Cisco Catalyst 9500 Series – unified packet buffer complex

- 36-MB unified packet buffer is shared by ingress and egress data paths and between both cores
- Resources consuming packet buffer
  - Ingress buffers (IQS)
  - Egress stack buffers (SQS)
  - Egress port buffers (AQM)
  - Temporary buffers
  - Common buffers



Dynamic Threshold Scalability (DTS)

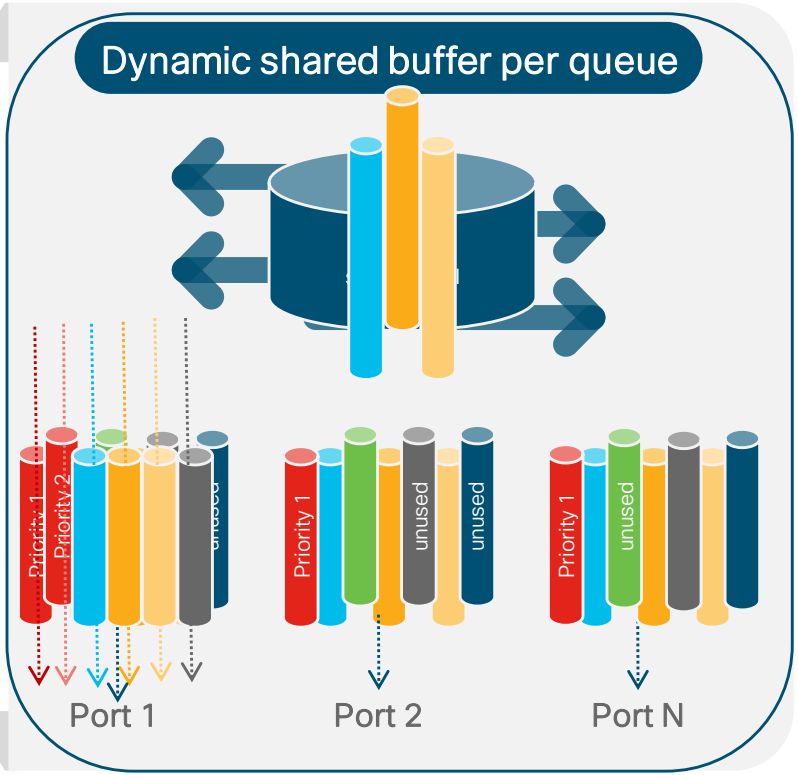


- Reserved buffers are statically allocated for each queue
- Regardless of whether this queue is active or not, these buffers are held up by this queue
- For more queues, the portion of the reserved buffers allocated for each queue can become smaller and smaller

Dynamic Threshold Scalability (DTS)

Dynamic shared buffer pool is memory space that all of the ports on the switch share dynamically as they need buffers

- Dedicated buffer is good for predicated performance for each port
- Shared buffer is good for burst absorption
- DTS provides fair and efficient allocation of buffers: dedicated plus shared
- Configurable dedicated threshold per port or queue
- Configurable global maximum shared threshold
- Automatically adjusted depending on the available shared pool



Default buffer allocation per port speed

Platform	Port speed	100 Mbps, 1, 2.5, 5 Gbps		10 Gbps		25 Gbps		40 Gbps		100 Gbps	
	Queue	**Hard max**	**Soft max**	**Hard max**	**Soft max**	**Hard max**	**Soft max**	**Hard max**	**Soft max**	**Hard max**	**Soft max**
Cisco® Catalyst® 9300 Series	Q0	100	400	600	2400	–	–	2400	9600	–	–
Cisco Catalyst 9400 Series	Q0	176	700	176	700	–	–	176	700	–	–
Cisco Catalyst 9500 Series	Q0	200	800	1200	4800	–	–	4800	19,200	–	–
Cisco Catalyst 9500 High End	Q0	112	448	240	960	480	1920	720	2880	1920	7680
		Soft min	**Soft max**	**Soft min**	**Soft max**	**Soft min**	**Soft max**	**Soft min**	**Soft max**	**Soft min**	**Soft max**
Cisco Catalyst 9300 Series	Q1	150	600	300	1200	–	–	3600	14,400	–	–
Cisco Catalyst 9400 Series	Q1	225	3600	264	1056	–	–	337	10,800	–	–
Cisco Catalyst 9500 Series	Q1	800	3600	1800	7200	–	–	7200	28,800		–
Cisco Catalyst 9500 High End	Q1	168	672	360	1440	720	2880	1080	4320	2880	11,520

Port speed	Buffer (KB)	Number of buffers
100G	1200	4800
40G	450	1800
25G	300	1200
10G	150	600
1GE	70	280

Notes:
All allocation in units (each unit is 256-byte storage)
Q0: Soft max = 4x hard max
Q1: Soft max = 4x soft min
Hard max (hard buffer allocation): Do not participate in DTS/priority queue only

Cisco Catalyst 9500 Series – device trust

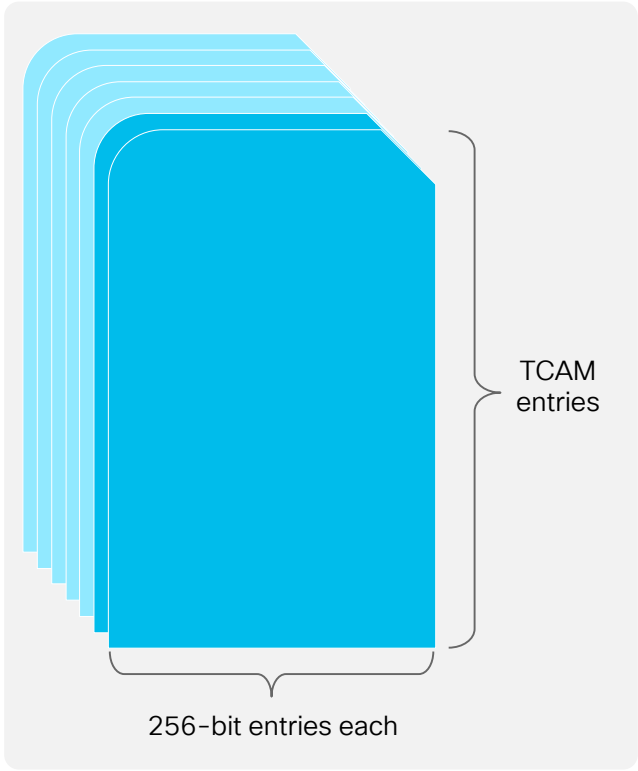
- Cisco® Catalyst® 9500 Series trusts all ports by default (DSCP, CoS, IP precedence based)
- Default trust mode for a port is DSCP based
- Trust mode falls back to CoS for pure Layer 2 packet
- Keep uplink interfaces as trusted

Trust behavior

Incoming packet	Outgoing packet	Trust behavior	Queuing behavior
Layer 3	Layer 3	Preserve DSCP/precedence	Based on DSCP
Layer 2	Layer 2	Not applicable	Based on CoS
Tagged	Tagged	Preserve DSCP and CoS	Based on DSCP (trust DSCP takes precedence)
Layer 3	Tagged	Preserve DSCP, CoS is set to 0	Based on DSCP
MPLS	Layer 3	Preserve EXP	Based on DSCP
MPLS	MPLS	Preserve EXP	Based on EXP

Cisco Catalyst 9500 Series – TCAM resources

QoS TCAM resources	Cisco® Catalyst® 9500 Series
IPv4 entries	16,000* (256-bit) entries
IPv6 entries	Half the IPv4 (512 bits)
Class maps (ingress)	255
Class maps (egress)	255
Policy maps	1599
Table maps (ingress)	16
Table maps (egress)	16
Aggregate policers	16,000 total, 63 policers per port per direction
Default queue per port	2 queues (1 priority, 1 standard)
Wired queues/port configurable	8 queues (2 can be priority)



* With default SDM template

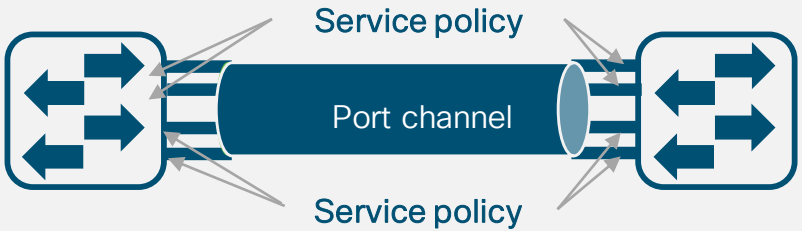
Cisco Catalyst 9500 Series – TCAM resources

Resource consumption per match field

Field	TCAM resources consumed (IPv4)	TCAM resources consumed (non-IPv4)
Match DSCP	1	2
Match IP precedence	1	2
Match CoS	1	2
Match QoS group	1	2
Match discard class	Not supported	Not supported
Match VLAN	1	2
Match access group	1	2

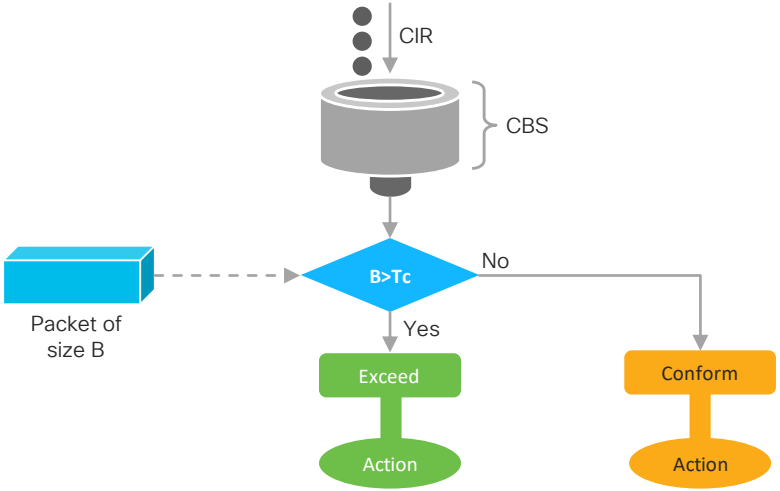
Cisco Catalyst 9500 Series – TCAM Resources
Etherchannel QoS

- EtherChannel comprise logical (port-channel) interfaces and physical (port-member) interfaces
- **Ingress and egress QoS policies are applied only to the physical port-member interfaces**
- **Auto-QoS is NOT supported on physical port-member interfaces**
- All port-member interfaces must have the same ingress or egress QoS policy to achieve required results



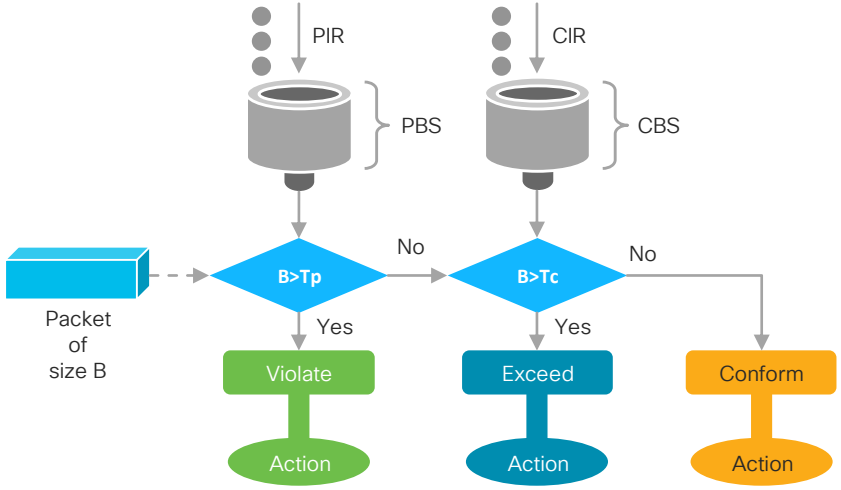
Cisco Catalyst 9500 Series – Traffic policing

1 rate 2 color




```
police cir 100000000 bc 3125000
  conform-action set-dscp-transmit af41
  exceed-action drop
```

2 rate 3 color




```
police cir percent 10 pir percent 50
  conform-action transmit
  exceed-action set-dscp-transmit dscp table MARKDOWN
  violate-action drop
```

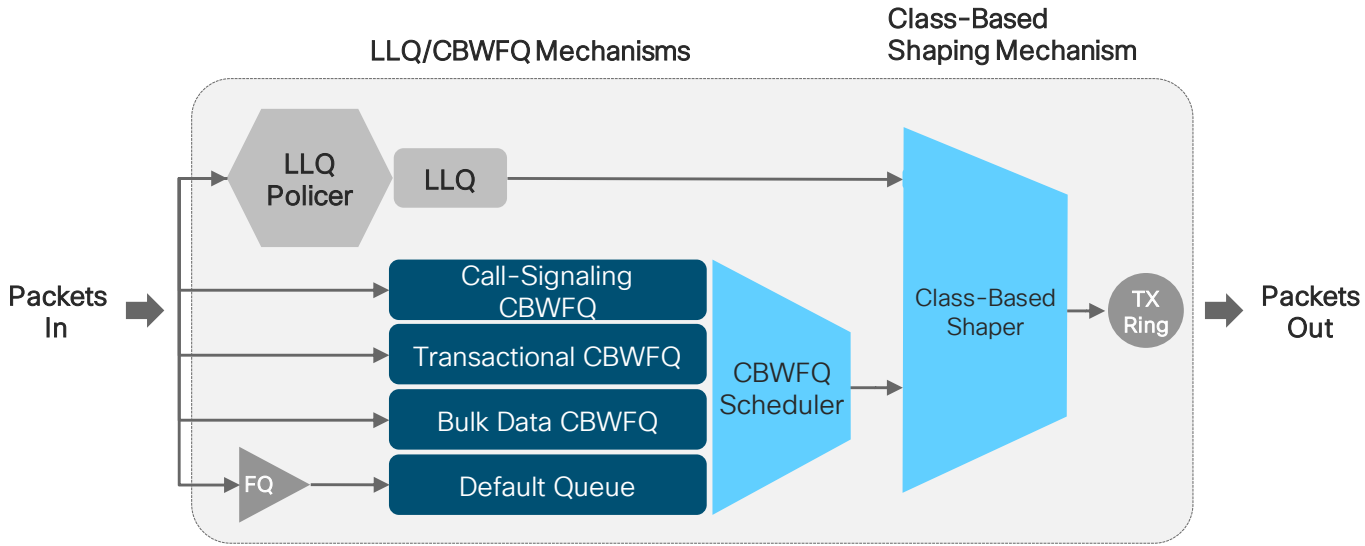
CIR – Committed Information Rate
PIR – Peak Information Rate

PBS- Peak Burst Size
CBS – Committed Burst Size

Cisco Catalyst 9500 Series – Hierarchical QoS (HQoS)

HQoS (two-level hierarchy) allows you to perform the following functions:

- Classification
- Policing
- Shaping




```
class-map c1
  match dscp 30
Exit
class-map c2
  match precedence 4
Exit
class-map c3
Exit

policy-map CHILD
  class c1
       priority level 1
       police rate percent 20
       conform-action
            transmit exceed action drop
  exit
  class c2
       bandwidth 20000
  exit
  class class-default
       bandwidth 20000
  exit
Exit

policy-map PARENT
  class class-default
       shape average 1000000
  service-policy CHILD
End

Interface Fo1/0/1
service-policy output PARENT
```

Cisco Catalyst 9500 Series

Hierarchical QoS restrictions

- No more than two levels are supported in a QoS hierarchy
- Policing in both the parent and child is not supported in a QoS hierarchy
- Marking in both the parent and child is not supported in a QoS hierarchy
- If parent configured with policing action, child can have only marking action
- Same queuing (priority, BW, or shaping) action can't be applied on a child class if parent class has a policing action
- Same action can't be applied to both parent and child policies except for port shaper
  - Only class default is allowed for shaping on parent policy
  - No other action is allowed in a parent policy
- Applies to physical ports with conversation to a single-level policy in hardware

Access Control Lists

You make security **possible**

Cisco Catalyst 9500 Series access control lists
Four forms of security ACLs

The Cisco Catalyst 9500 Series supports four forms of security ACL: SG ACL, RACL, VACL, and PACL

Router ACL (RACL)	VLAN ACL (VACL)	Port ACL (PACL)	Security group ACL (SG ACL)
Used to permit or deny the movement of traffic between Layer 3 subnets	Used to permit or deny the movement of traffic between Layer 3 subnets and VLANs or within a VLAN	Used to permit or deny the movement of traffic between Layer 3 subnets and VLANs or within a VLAN	Used to permit or deny the movement of traffic based on the SGTs that are assigned
Applied as an input or output policy to a **Layer 3 interface, SVI, or Layer 3 EtherChannel interface**	Applied as a policy to a VLAN; is inherently applied to **both inbound and outbound traffic**	Applied as a policy to a **Layer 2 switch port interface or EtherChannel interface;** is applied **to inbound & outbound traffic**	Applied as a policy to a Layer 2 switch port interface; is applied to inbound traffic only
Standard/extended ACLs	Standard/extended ACLs	Standard/extended/ MAC ACLs	Standard/extended/ MAC ACLs

Cisco Catalyst 9500 Series access control lists

Router ACL (RACL)

```
access-list 2 permit 36.48.0.3
access-list 2 deny 36.48.0.0 0.0.255.255
access-list 2 permit 36.0.0.0 0.255.255.255

interface gigabitethernet2/0/1
  ip access-group 2 in
```

Port ACL (PACL)

```
access-list 2 permit 36.48.0.3
access-list 2 deny 36.48.0.0 0.0.255.255
access-list 2 permit 36.0.0.0 0.255.255.255

interface gigabitethernet2/0/1
  switchport
  ip access-group 2 in
```

VLAN ACL (VACL)

VLAN ACLs

```
ip access-list extended SERVER1_ACL
  permit ip 10.1.2.0 0.0.0.255 host 10.1.1.100
  permit ip host 10.1.1.4 host 10.1.1.100
  permit ip host 10.1.1.8 host 10.1.1.100
  exit
```

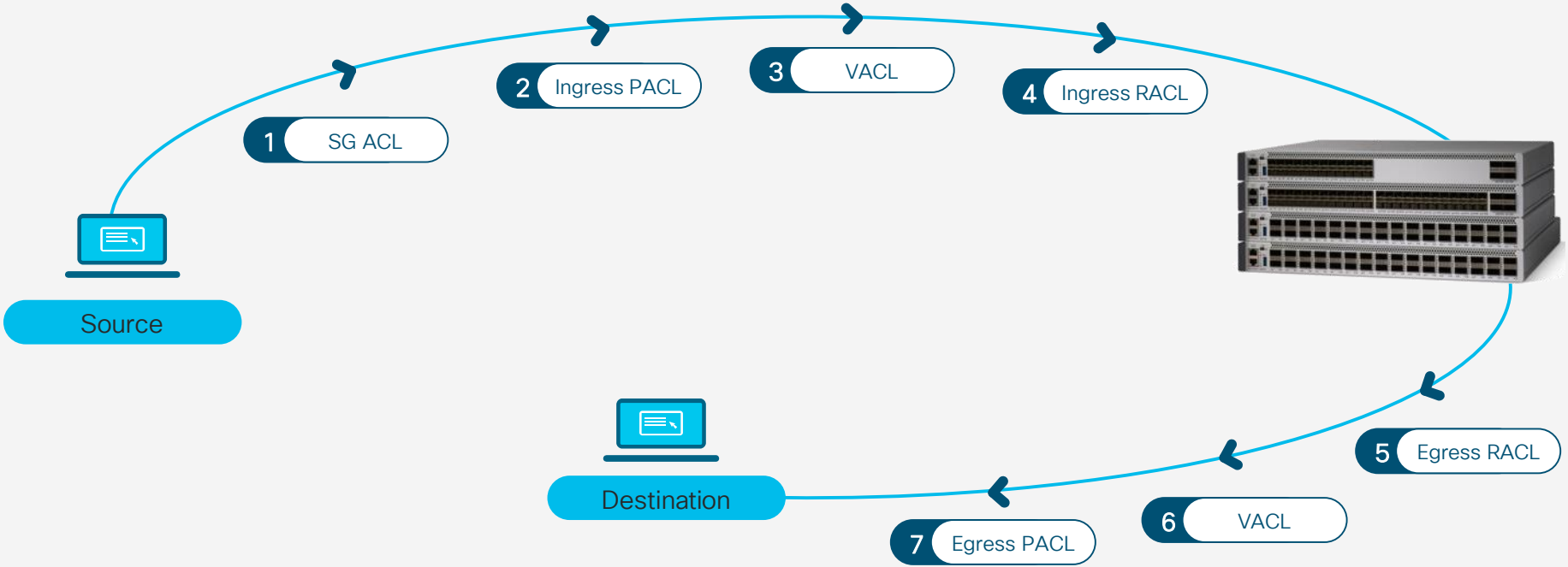
Define a VLAN map that will drop IP packets that match SERVER1_ACL and forward IP packets that do not match the ACL.

```
vlan access-map SERVER1_MAP
  match ip address SERVER1_ACL
  action drop
vlan access-map SERVER1_MAP 20
  action forward
exit
```

Apply the VLAN map to VLAN 10.

```
vlan filter SERVER1_MAP vlan-list 10
```

Cisco Catalyst 9500 Series access control lists
Order of processing



Cisco Catalyst 9500 Series – access control lists
Hardware support

Create an ACL or classification policy, using the CLI or Network Management system (NMS)

```
ip access-list extended Internet
 permit ip any host 10.2.2.4
 permit ip any host 10.5.2.33
 permit ip any host 10.11.0.0
 permit ip any host 10.4.0.0
```

1

2 No hardware resources
Drop packet*

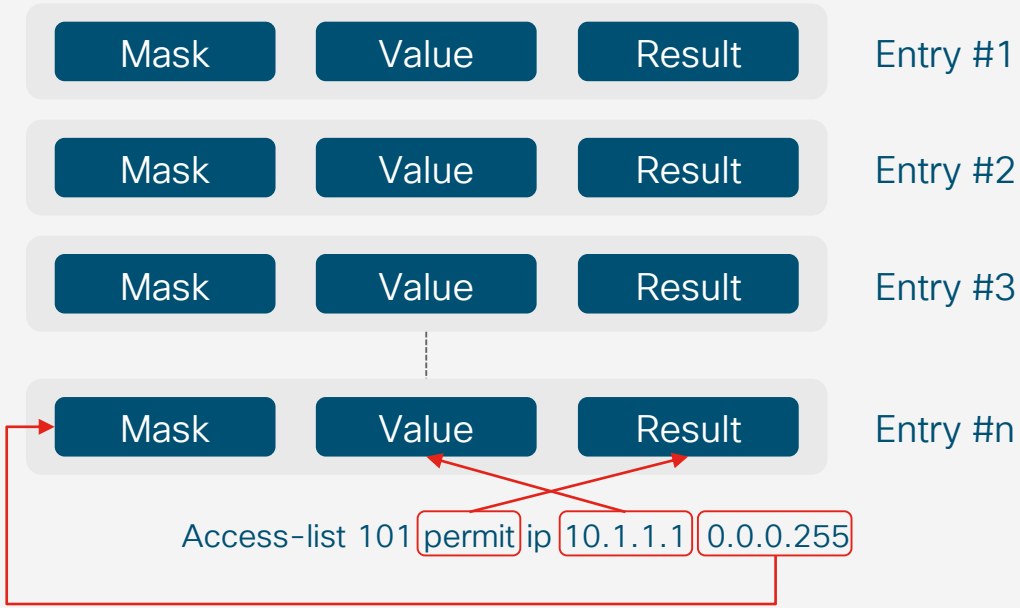
3 Full hardware support
- Router ACLs
- VLAN ACLs
- Port-based ACLs
- Role-based ACLs

4 Hardware-assisted ACL features
- NetFlow
- NAT and PAT
- PBR
- WCCP
- Cisco TrustSec®

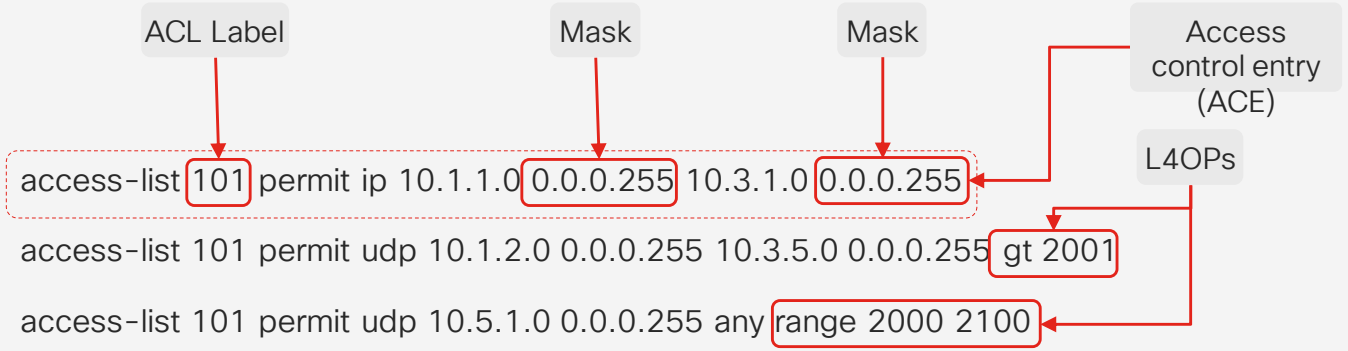
Hardware ACL Statistics
show platform software fed switch { *switch_num* | active | standby } acl counters hardware

Value Mask Result (VMR)

The TCAM entry contains a **VMR,** also known as **V**alue, **M**ask, **R**esult



Access Control List Terminologies



What is an L4OPs?	GT (greater than)	LT (less than)	NE (not equal to)	RANGE (from - to)
What is **NOT** an L4OPs?	EQ (equal to)			

Cisco Catalyst 9500 Series
ACL resource utilization examples

Example 1

```
access-list 101 permit ip any 10.1.1.0 0.0.0.255
access-list 101 permit ip any 10.1.2.0 0.0.0.255
access-list 101 permit ip any 10.1.4.0 0.0.0.255
access-list 101 permit ip any 10.1.5.0 0.0.0.255
access-list 101 permit ip any 10.1.8.0 0.0.0.255
```

	TCAM entries	L4OPs/VCU
Consumption	6	0

Example 2

```
Ip access-list extended MYACL
Permit tcp 192.168.1.0 0.0.0.255 any ne 3465
Permit tcp 10.0.0.0 0.255.255.255 any range 3000 3100
Permit tcp 172.16.0.0 0.0.255.255 any range 4000 8000
Permit tcp 191.1.1.0 0.0.0.255 gt 10000 any eq 20000
```

	TCAM entries	L4OPs/VCU
Consumption	12	6

Example 3

```
ipv6 access-list iacl
deny ipv6 any 2001:0DB8:C18::/48 fragments
deny ipv6 2001:0DB8::/32 any
permit tcp host 2001:0DB8:C19:2:1::F host 2001:0DB8:C18:2:1::1 eq bgp
permit tcp host 2001:0DB8:C19:2:1::F eq bgp host 2001:0DB8:C18:2:1::1
```

	TCAM Entries	L4OPs/VCU
Consumption	14	0

Time-based ACLs

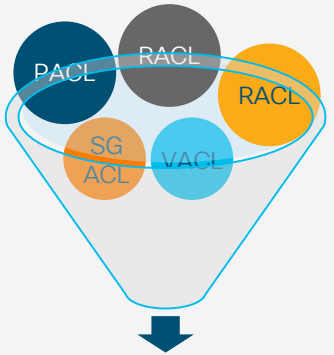
- Time-based ACL permits or denies traffic based on a configurable time
- Time period is based upon switch's clock
- CPU resources due to merge into hardware memory

```
Device(config)# time-range no-http
Device(config)# periodic weekdays 8:00 to 18:00
!
Device(config)# time-range udp-yes
Device(config)# periodic weekend 12:00 to 20:00
!
Device(config)# ip access-list extended strict
Device(config-ext-nacl)# deny tcp any any eq www time-range no-http
Device(config-ext-nacl)# permit udp any any time-range udp-yes
!
Device(config-ext-nacl)# exit
Device(config)# interface gigabitethernet2/0/1
Device(config-if)# ip access-group strict in
```

Catalyst 9500– Hitless TCAM update

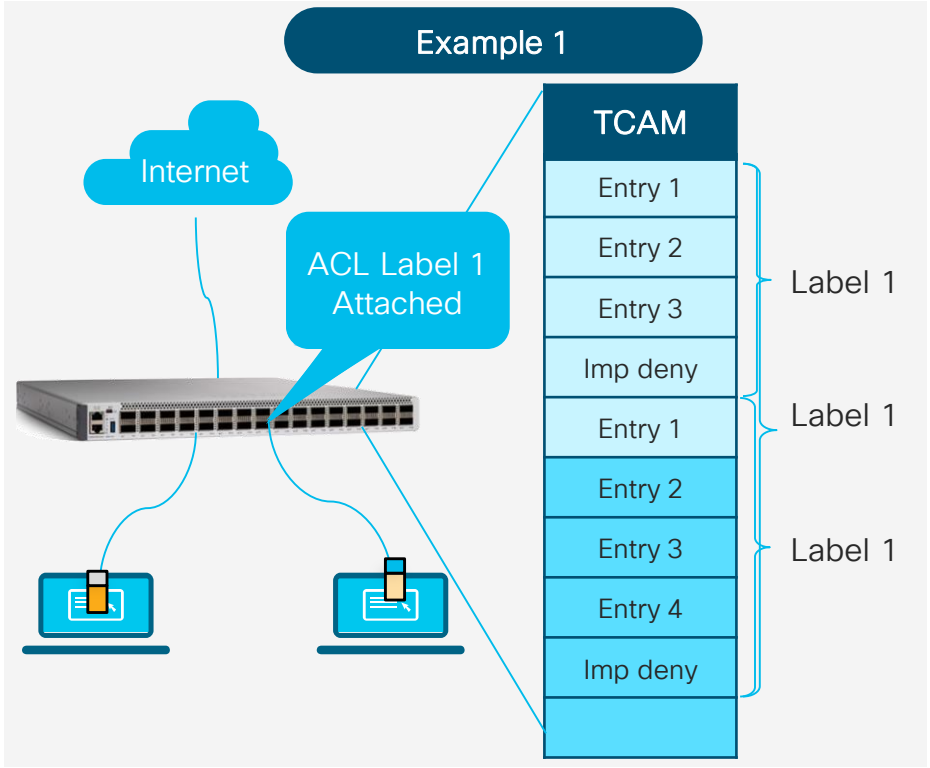
Starting 16.8.1

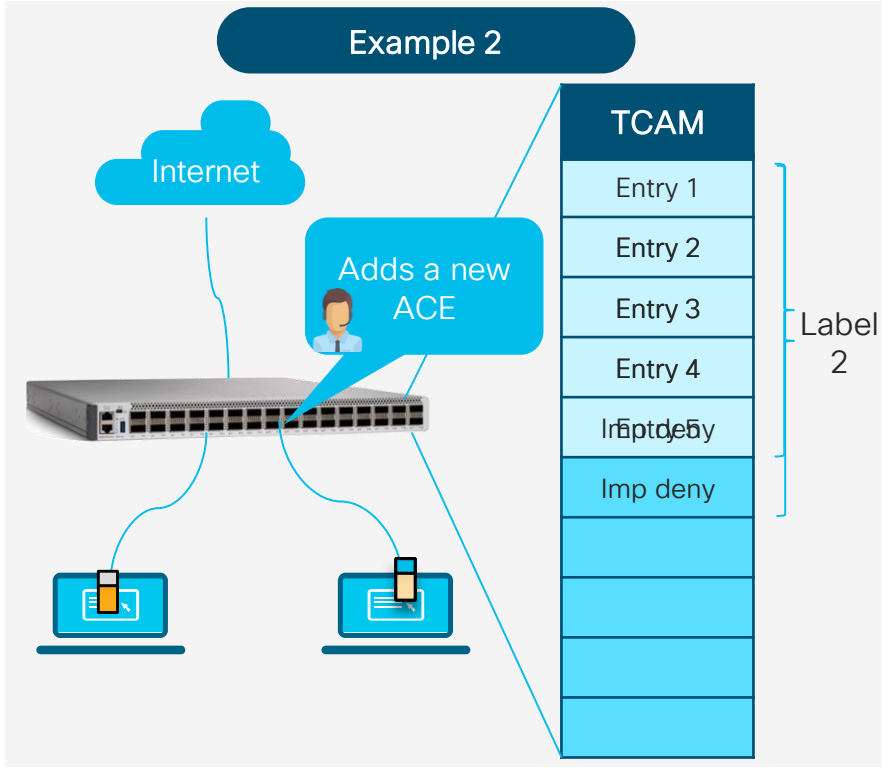
- **Allows updates to an ACL without interrupting traffic**
- Multiple features updated at once
  - IPv4, IPv6, MAC
  - PACL, RACL, VACL, and SG ACL
- Hitless update is enabled by default; can't be disabled
- Hitless update feature requires free ACL TCAM space for reprogramming but does consume any additional TCAM resources
- If not enough space in TCAM, falls back to old ACL method



ACL updates

Cisco Catalyst 9500 Series– Hitless TCAM update

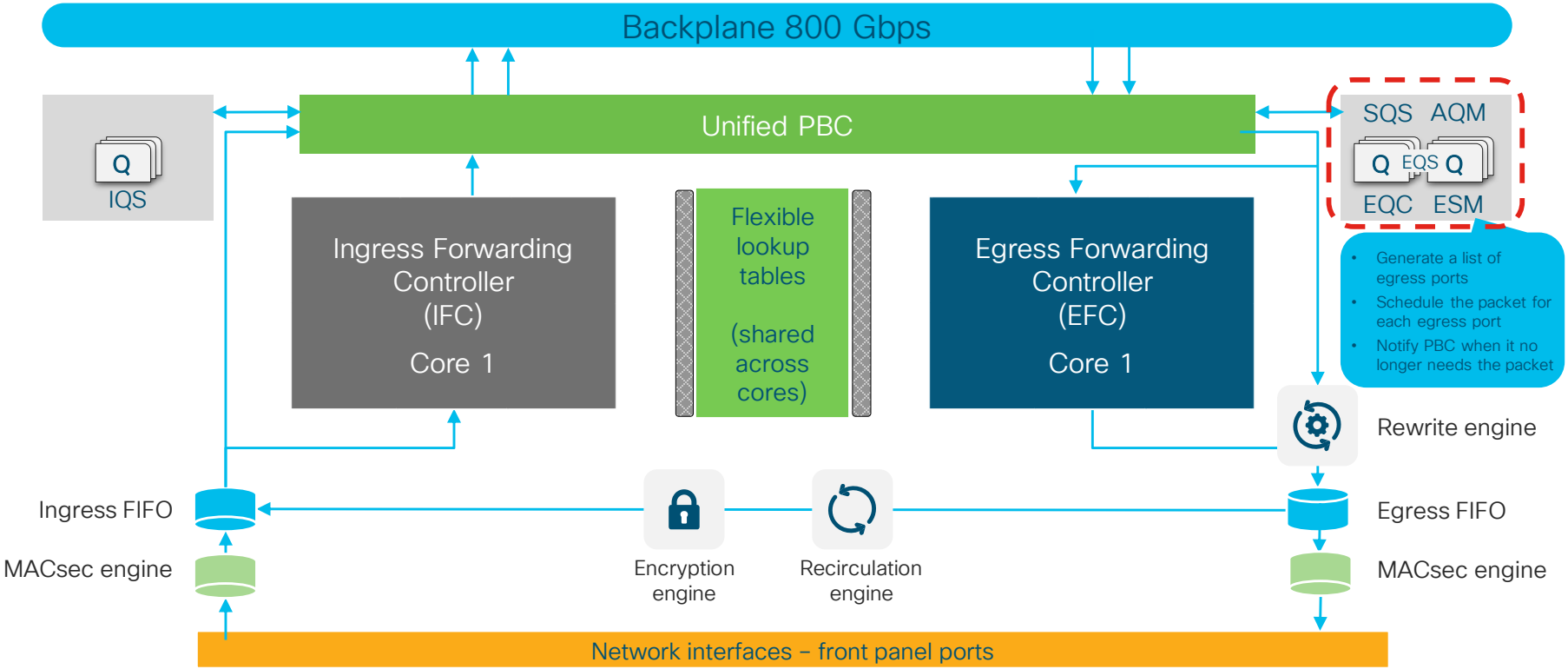




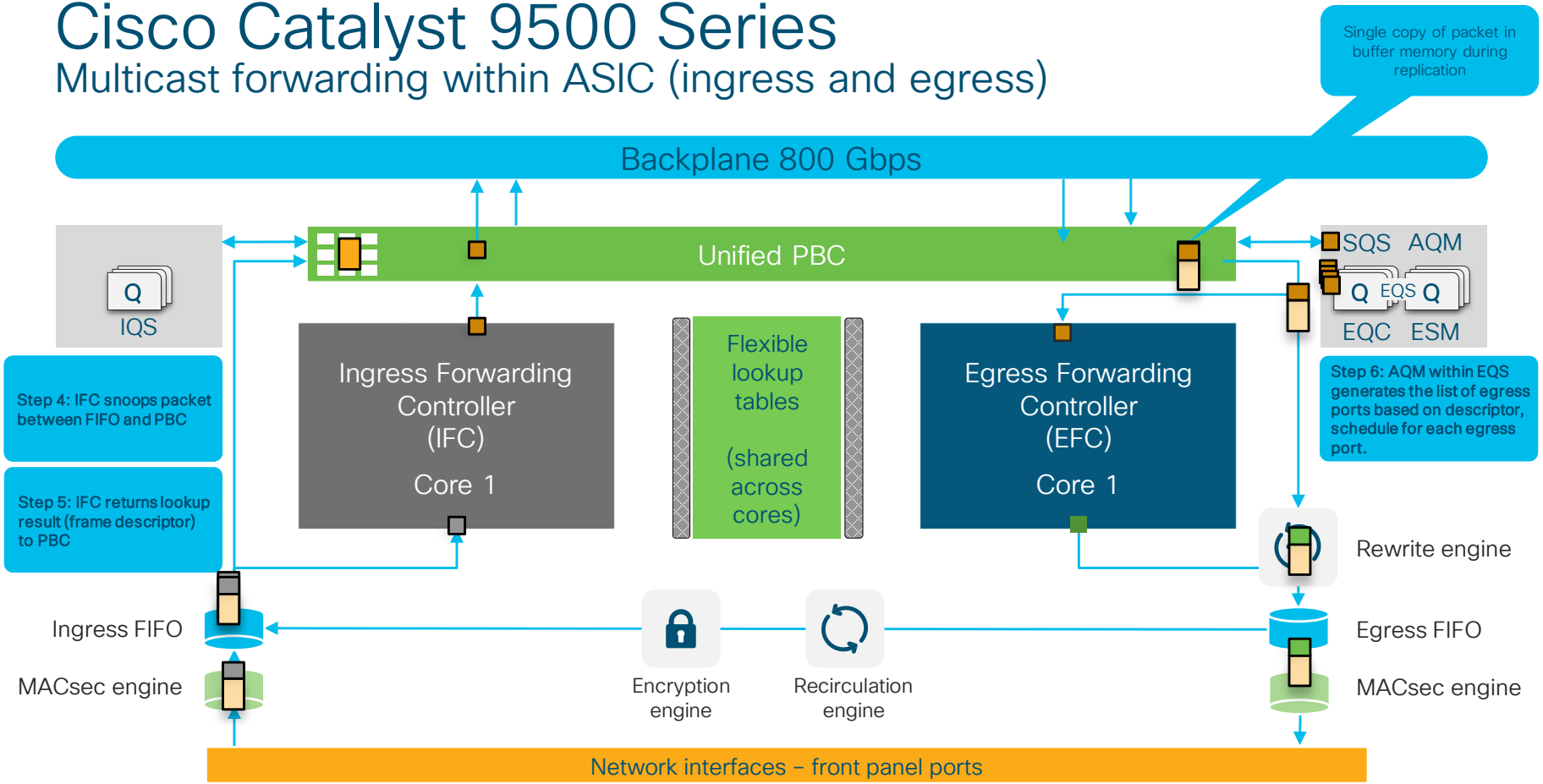
Multicast

You make the power of data **possible**

Cisco Catalyst 9500 Series
Unicast forwarding within ASIC (ingress and egress)



Cisco Catalyst 9500 Series
Multicast forwarding within ASIC (ingress and egress)



Cisco Catalyst 9500 Series – IPv4 and IPv6 multicast

IPv4 multicast

Core

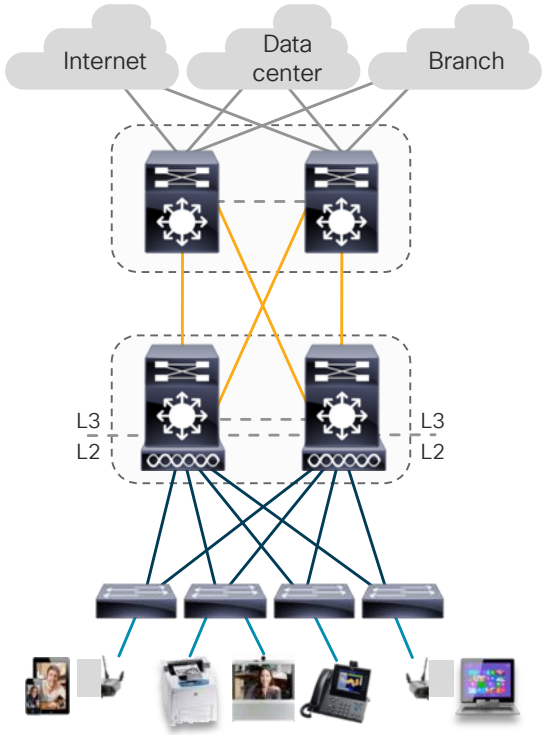
- MSDP
- IPv4 AutoRP, BSR RP
- PIM-DM/SM/SDM, SSM, and bidir
- IPv4 multicast HA
- Multicast VRF-Lite
- Multicast load splitting
- Multicast Routing over GRE – SM & SSM only

Distribution

- Dual-stack IPv4 / IPv6
- PIM-SM, SSM, and bidir
- IGMPv2,v3 and PIM snooping
- IGMP throttling
- Stub IP multicast routing
- PIM BFD
- IPv4 multicast HA

Access

- IGMP v1,v2,v3 and PIM snooping*
- IPv4 multicast QoS and ACL
- IGMP v1,v2 filtering



IPv6 multicast

Core

- IPv6 BSR RP
- PIM-SM, SSM, and bidir
- IPv6 embedded RP
- IPv6 multicast HA

Distribution

- Dual-stack IPv4 / IPv6
- PIM-SM, SSM, and bidir
- MLDv1,v2 and PIM snooping
- Hardware register and RPF
- HSRP-aware PIM
- IPv6 multicast HA

Access

- MLDv1,v2 and PIM snooping
- IPv6 multicast QoS and ACL

* Only on C9500 High performance SKU's

High Availability

You make networking **possible**

Cisco live!

Platform Resilience
Sub Second
Convergence

1+1 L2 Redundancy
Active and Standby
SSO/NSF

ISSU

Highly Available
Networks

Stackwise Virtual
GIR
HSRP/VRRP

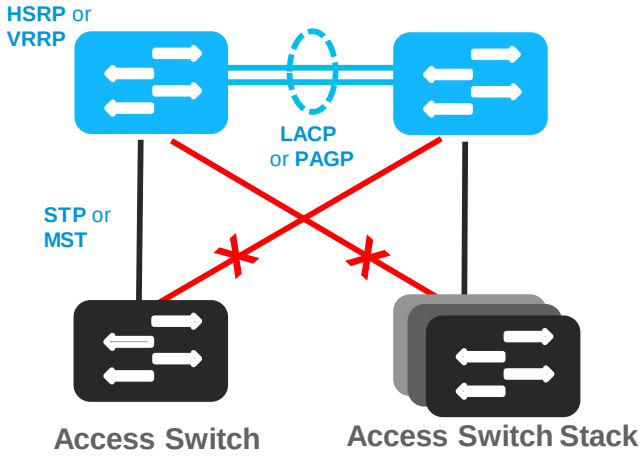
Software Upgrade
Instant Fix

TODAY OUR NETWORKS ARE MOST RESILIENT

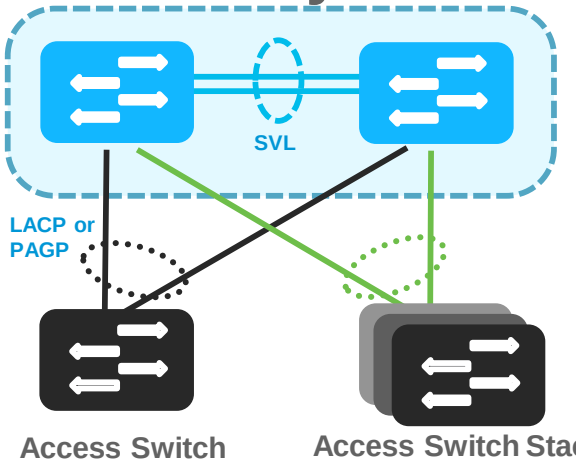
Stackwise Virtual
Topology Comparisons

16.9.3- C9500
&
16.10.1
C9500 High Perf

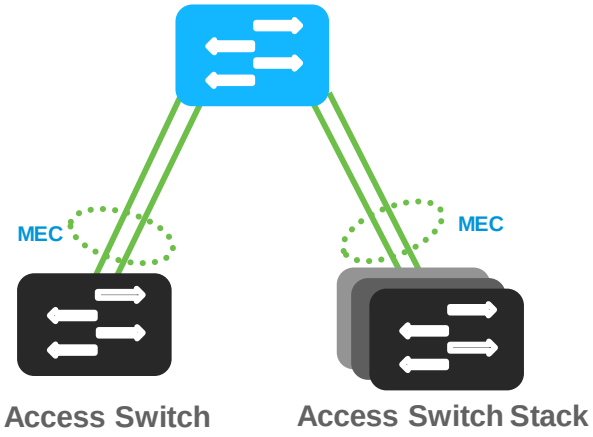
Traditional



SV - Physical



SV - Logical



Benefits of Stackwise Virtual

- Simplify Operations by Eliminating STP, FHRP and Multiple Touch-Points
- Double Bandwidth & Reduce Latency with Active-Active Multi-chassis EtherChannel (MEC
- Minimizes Convergence with Sub-second Stateful and Graceful Recovery (SSO/NSF)

SVL Platform Support and Limitations

Platform / Model	SVL Ports	DAD Ports
9500-16X/40X	Any ports (downlink:10G; uplink:10G/40G) No breakout/QSA Support	Any ports (downlink:1G/10G; uplink:1G/10G/40G) No breakout/QSA Support
9500-12/24Q	Any ports (40G) No breakout/QSA Support	Any ports (40G) No breakout/QSA Support
C9500-24Y4C, C9500-48Y4C	Any port (downlink: 10G/25G; uplink: 10G*/40G/100G)	Any port (downlink: any speed; uplink:1G*/10G*/40G/100G)
C9500-32QC	Any port in default mode (10G*/40G/100G)	Any port in default mode (1G*/10G*/40G/100G)
C9500-32C	Port 1-16 (10G*/40G/100G) No breakout support	Port 1-16 (1G*/10G*/40G/100G) No breakout support

* With QSA adapter

Stackwise Virtual ISSU Upgrade Steps

3 Step Process

- Install add file <tftp/ftp/flash/disk:*.bin>
- Install activate ISSU
- Install commit

Granular Control on the upgrade process with ability to rollback

1 Step Process

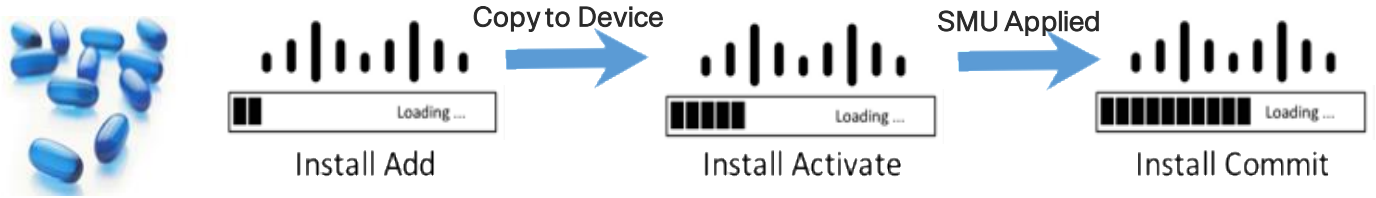
- Install add file <tftp/ftp/flash/disk:*.bin>activate ISSU commit

Single Command to perform complete ISSU

Software Maintenance Updates (SMUs)

SMU is an emergency point fix positioned for expedited delivery to a customer in case of a network down or revenue affecting scenario.

Cold Patching: Install of a SMU will require a system reload.
Hot Patching**: Install of a SMU will not require a system reload



- Quick (able to deliver point fixes much faster than possible in IOS)
- Effective (does not require a monolithic code upgrade)
- Focused (target the specific area of code which has the issue)

** - 9200 does not support Hot Patching

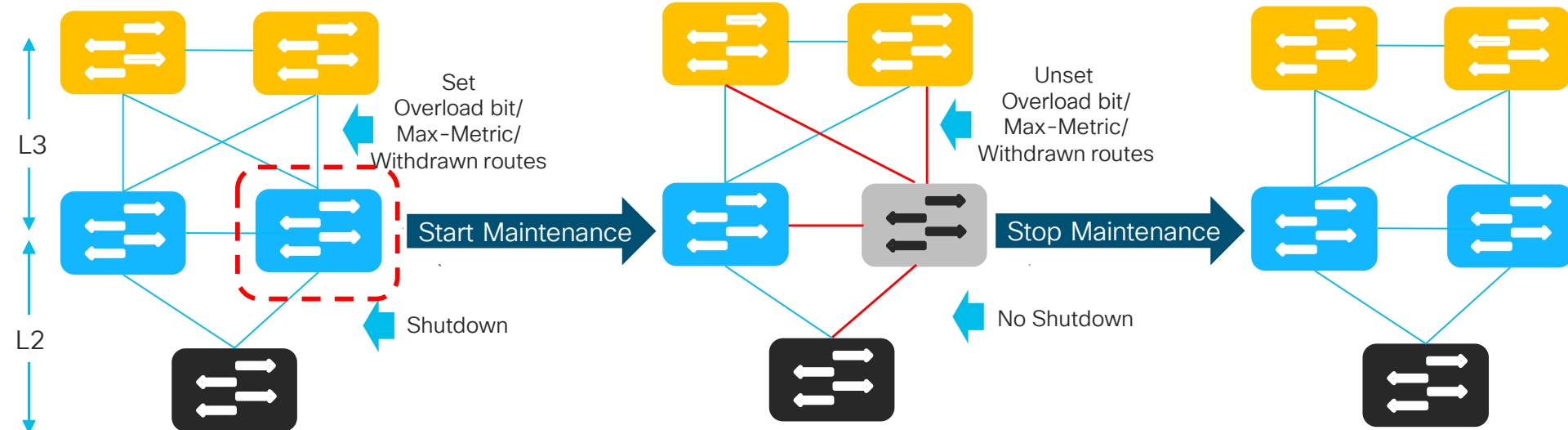
Graceful Insertion and Removal(GIR)

Overview

- Graceful removal of the node from network.
- Performing maintenance on the device.
- Graceful insertion into the network

Benefits

- Hardware Replacement
- Software Upgrades
- Configuration Changes
- Debugging



Optics

You make networking **possible**

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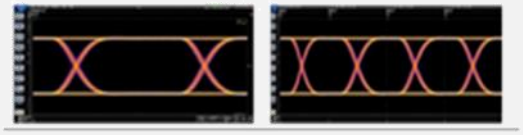
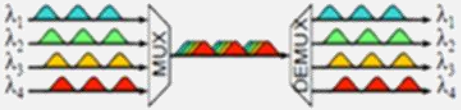
Cisco Catalyst 9500 Series optics
Optical tools for increasing the data rates

Increase Baud Rate
Eg: 10G → 25G
Optics: SR, LR...

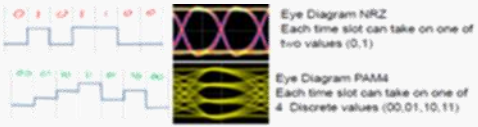


Increase number of Fibers (Parallel links)
Eg: 10G → 40G or 40G → 100G
Optics: SR4, FET, CSR4, PSM4

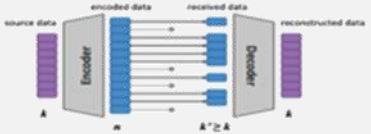
Increase number of Wavelengths
Optics: LR4, ER4, BiDi, CWDM4



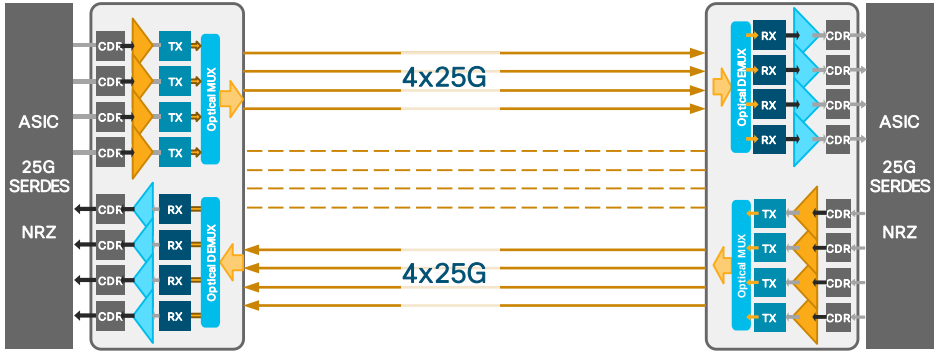
Modulation Formats
Eg: NRZ to PAM4
Optics: 40/100-SRBD

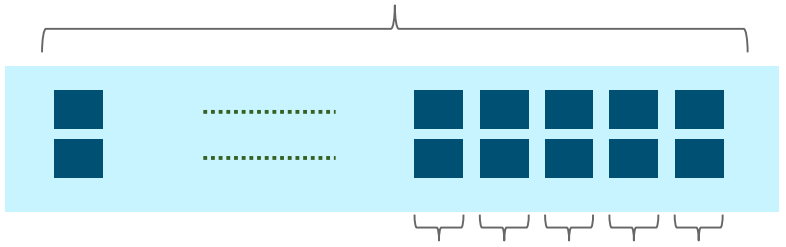


Enhanced Bit Error Rate with
Forward Error Correction (FEC)
Eg: All Optics which supports FEC



Cisco Catalyst 9500 Series Switches
100G in campus



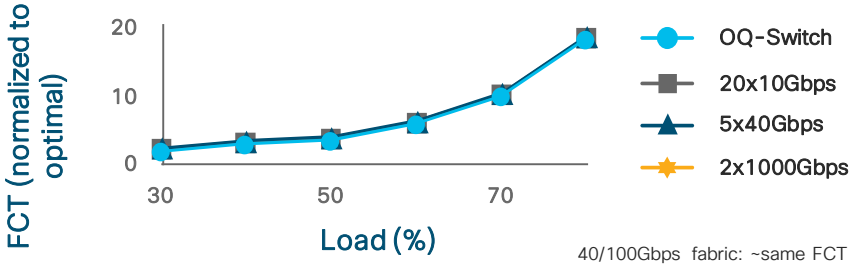


Each 100G port supports multiple speed and break-out options

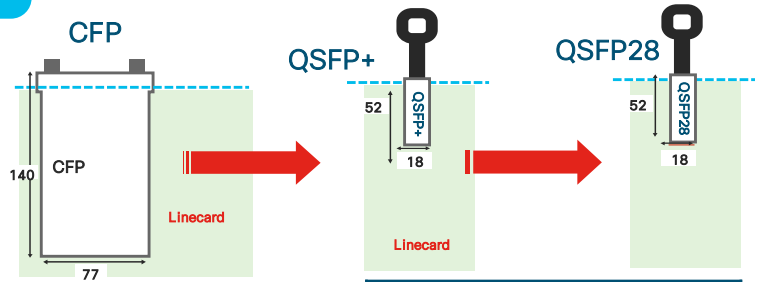
*(QSA in a future SW release)

100G

Avg FCT: Large (10MB, ∞) background flows



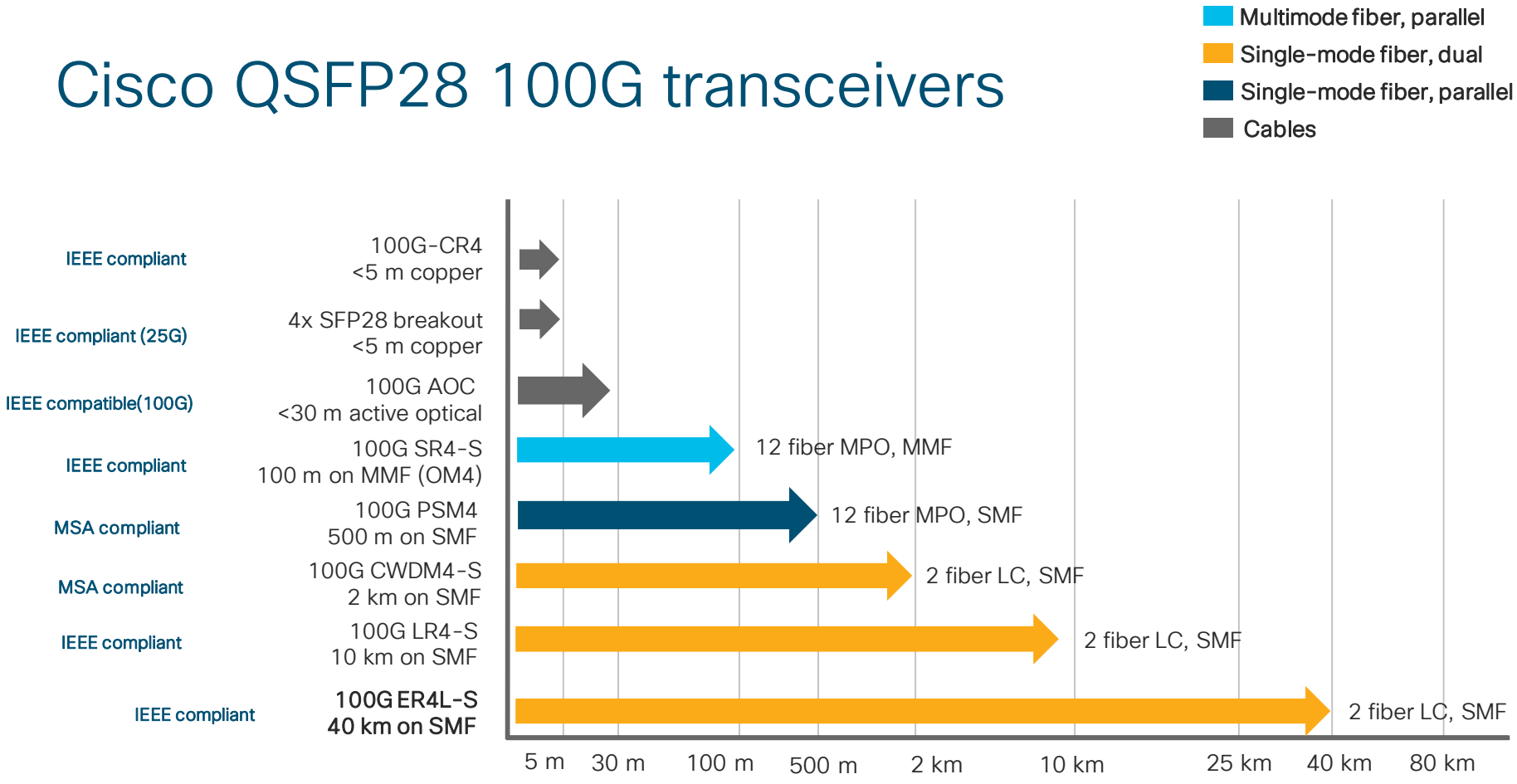
40/100Gbps fabric: ~same FCT as OQ
10Gbps fabric: FCT up 40% worse than OQ



QSFP28
½ the power & 1/5 the size of CPAK
44% the size of CFP4

	QSFP+	QSFP28
Power (W)	3.5	~3.5
Electrical	4x10G	4x25G

Cisco QSFP28 100G transceivers



Cisco Catalyst 9500 Series – 100G optics
Support for 100G optics (QSFP28)

100 m, MMF
SR4 QSFP28

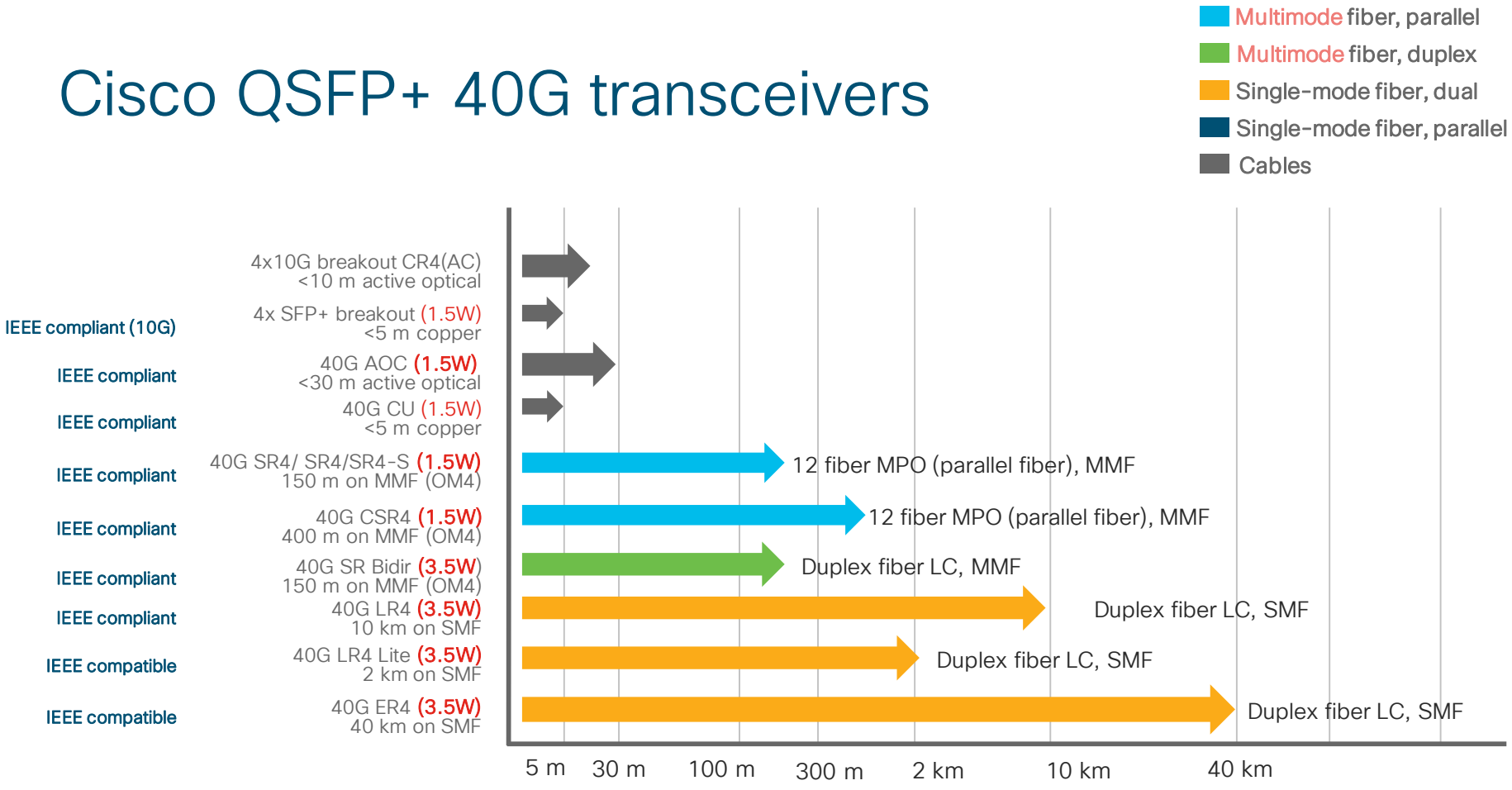
10 km, SMF
LR4 QSFP28

500 m to
2 km, SMF
SM-SR QSFP28
CWDM QSFP28

1, 2, 3, 5 m, copper
CU QSFP28
Built-in cable/optics

1, 2, 3, 5, 7, 10, 15
20, 25, 30 m, optical
AOC QSFP28
Built-in cable/optics

Cisco QSFP+ 40G transceivers



Cisco Catalyst 9500 Series – 40G optics
Support for 40G optics

100 m, MMF
SR4 QSFP+

10 km, SMF
LR4 QSFP+

40 km, SMF
ER4 QSFP+

150 m,
MMF
BD
QSFP+

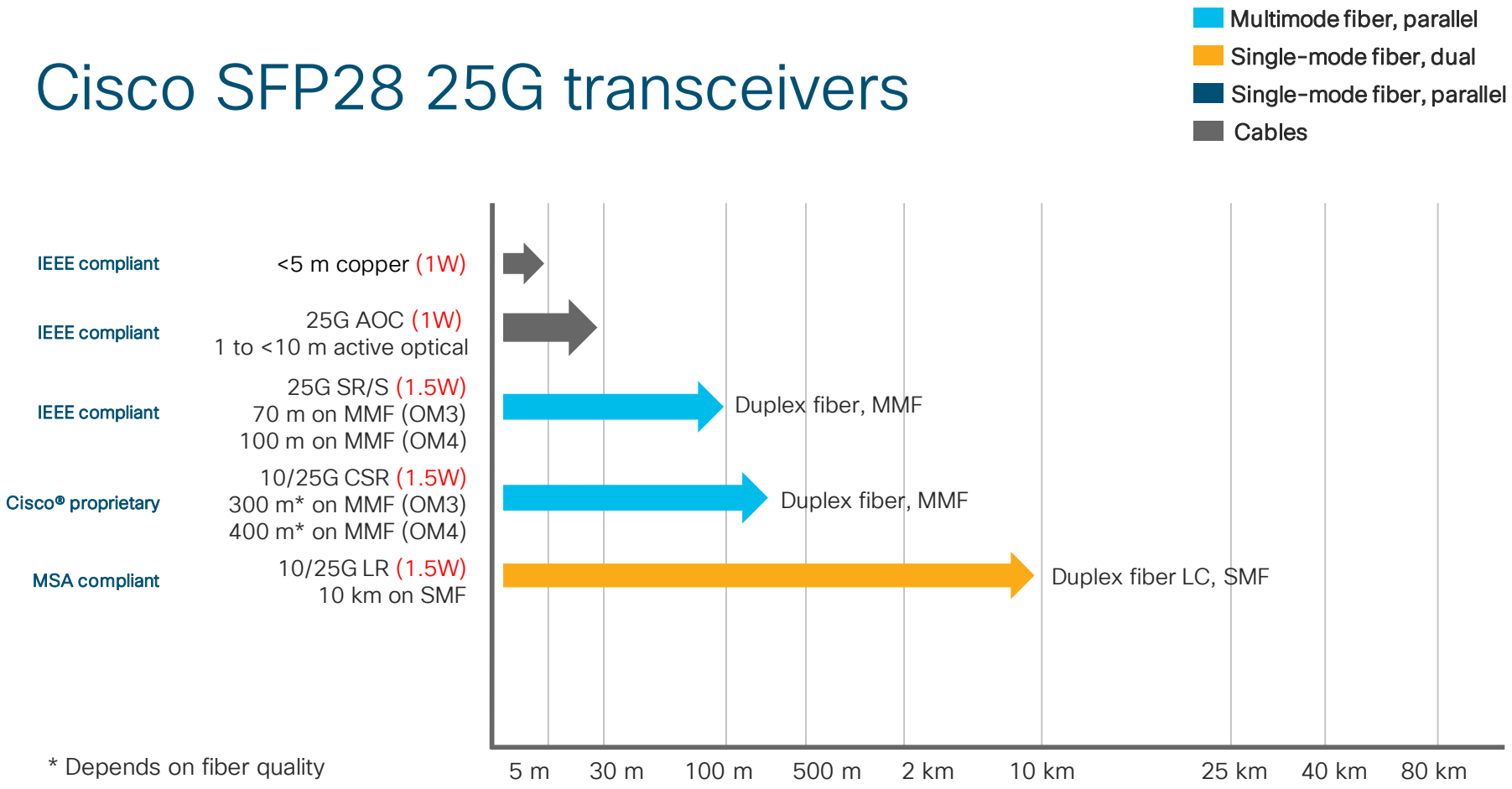
2 km, SMF
WSP-
Q40GLR4L
QSFP+

10 m,
AOC optical
CU/AC/AOC
QSF+s

QSA
ADAPTER

10 m, copper
4x10G
CU/AC

Cisco SFP28 25G transceivers



* Depends on fiber quality

Cisco Catalyst 9500 Series – 25G optics
Support for 25G optics

100 m, MMF
SR SFP28

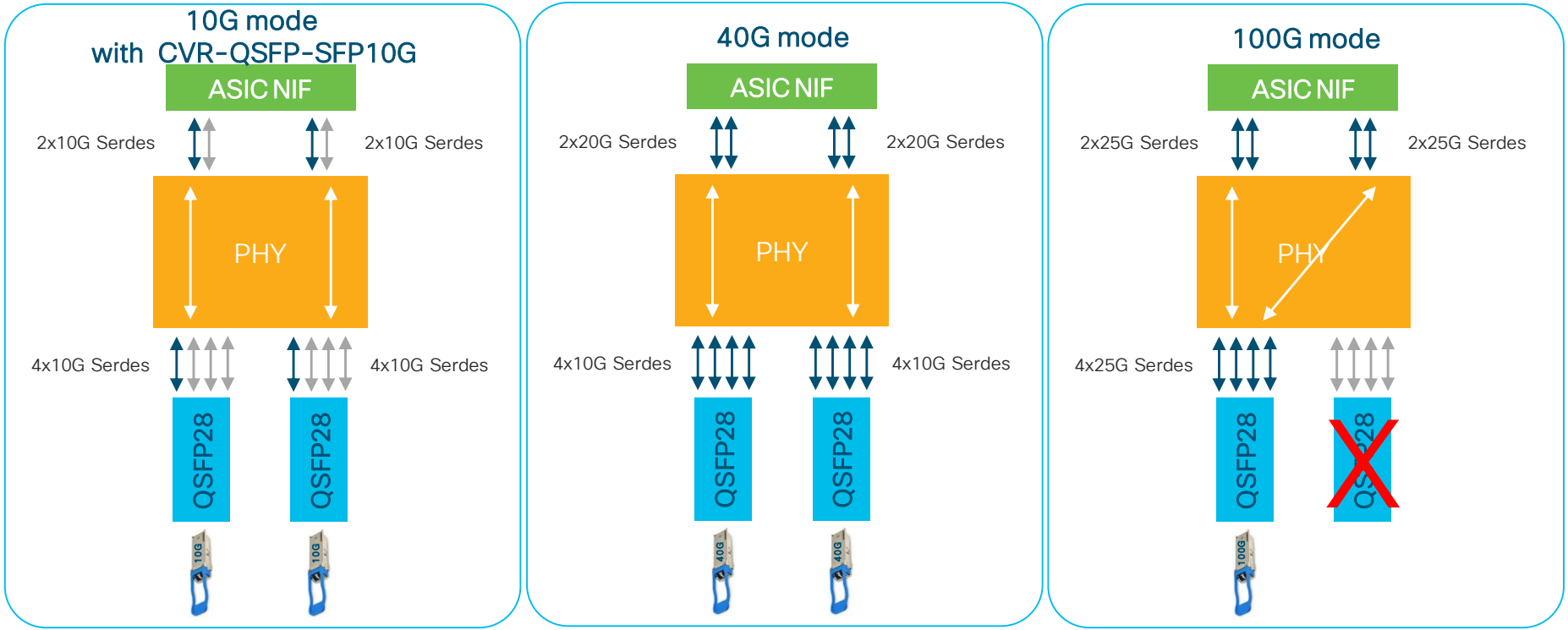
300 m/400 m, MMF
10/25G CSR SFP28

10 km, SMF
10/25G LR SFP28

10 m fiber
AOC cables

10 m, copper
CU cables

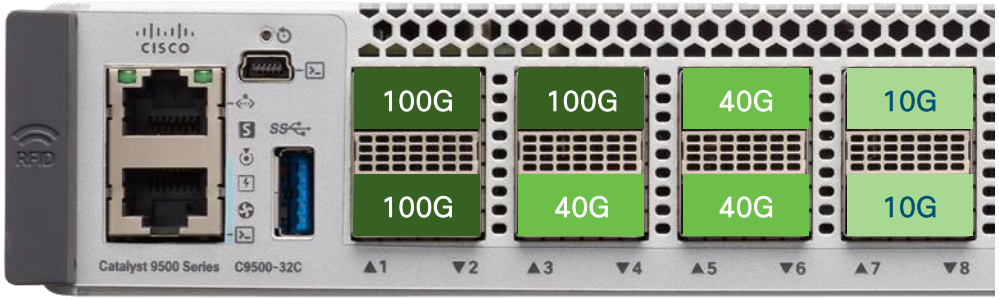
Cisco Catalyst 9500 High Performance Series PHY capabilities (QSFP28)



Cisco Catalyst 9500-32C
Port mode – insertion

- Ports speeds supported: 100G, 40G, 10G, 1G
- Default speed 100G
- 100G QSFP supported on all ports
- Line rate on every port above 187-bit** packet size
- Interface port speeds updated based on transceivers inserted
- Mix and match of 10G/40G and 100G speeds allowed on all ports

100G

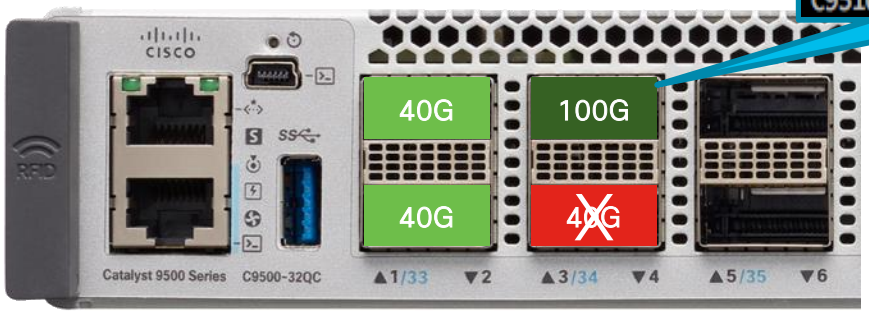


** 100G speed

Cisco Catalyst 9500-32QC
Mode conversation – CLI based

- Port speeds supported: 10G, 40G, 100G
- Default port speed 40G (ports 1 to 24) and 100G (ports 28 to 32)
- Line rate on every port above 187-bit packet size
- **100G QSFP supported only on upper 16 ports (ports 1 to 16)**
- 100G ports are enabled using an interface CLI command disabling lower 40G ports
- Mix and match of 10G/40G and 100G ports speeds allowed

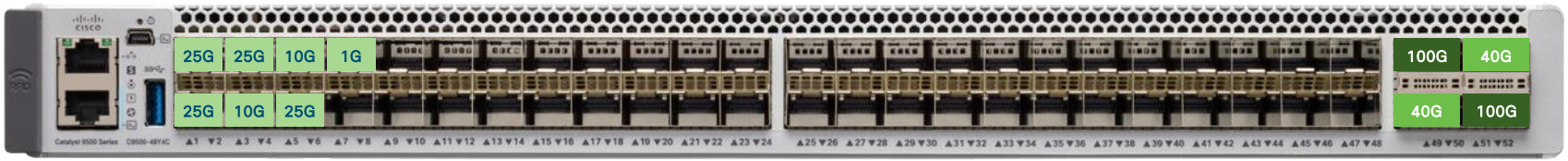
```
C9510-32QC(config)#int Hu1/0/34
C9510-32QC(config-if)#enable
C9510-32QC(config-if)#
```



Cisco Catalyst 9500-48Y4C

Mode conversation – insertion based

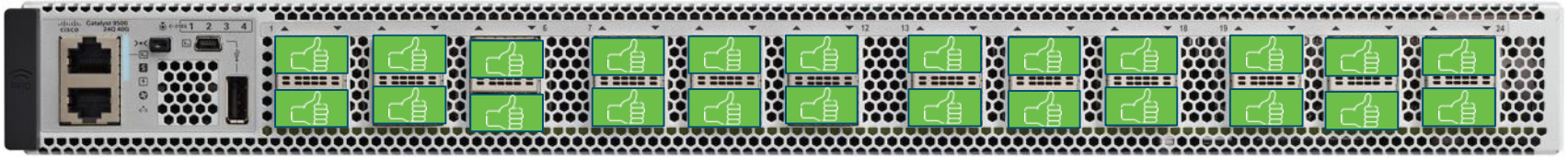
- Ports speeds supported: 1G, 10G, 25G, 40G,* 100G*
- Default downlink port speed: 25G
- Default uplink port speed: 100G
- 100G QSFP supported on uplink ports only
- Line rate on every port above 187-bit* packet size
- Interface port speeds updated based on transceivers inserted
- Mix and match of 1G, 10G, and 25G on downlink ports and 40G and 100G on uplink supported



* Uplink only

Cisco Catalyst 9500 Series
Breakout cable support

C9500-24Q**



C9500-12Q*

C9500-NM-2Q

* Starting **16.9.1** all ports
** Starting **16.10.1** all ports

Breakout cable supported

White paper
Cisco public

25GE and 100GE – Enabling Higher Speeds in Enterprise with Investment Protection

Summary

Enterprise campus networks are facing an imminent need to support ever-increasing bandwidth demand. They need to support the rapid growth of powerful endpoints that can deliver richer content such as HD video and wireless access points that deliver advanced wireless connectivity technologies such as 802.11ax. To support the increase in connected devices and high data volumes moving toward the cloud, enterprises are looking for ways to minimize infrastructure upgrades that require substantial installation costs, time, and disruption to the physical infrastructure. Until recently, campus migrations have been from 1G to 10G to 40G. While 1G and 10G still represent a significant share of the enterprise market's Ethernet ports, a transition to 25G, and to 100G for large and high-end enterprises, is expected to happen more quickly than the previous transition to 10G. Furthermore, support for 25G adapters that can also run at 10G with existing fiber cabling can help accelerate that migration, providing opportunities to migrate to a 100G switch infrastructure while supporting significant investment protection.

Cisco has been pioneering several initiatives to bring new Ethernet technologies to market. These include Cisco® 25GBASE Small Form-Factor Pluggable SFP28, Cisco 100GBASE Quad Small Form-Factor Pluggable QSFP28, and more importantly, dual-rate optics along with the latest Cisco Catalyst® 9000 switching family to facilitate such network speeds and architecture transformations. These innovations enable flexible options and backward compatibility to drive network speeds beyond the current 10G and 40G capabilities while minimizing cost and real estate changes. With a prevalidated architecture, Cisco's Enterprise Networks portfolio can help forward-thinking enterprises that wish to build a network infrastructure that offers flexibility and scale. This white paper highlights some of the key aspects of these new Ethernet standards, and the benefits of 25G and 100G in campus networks. It also documents use cases involving high-speed network transitions that are extending link lengths for 25G to 300m over duplex Multi Mode Fiber (MMF) optical Mode 3(OM3) (400m over OM4) as well as provides details of supported Cisco's platforms.

https://www.cisco.com/c/dam/en/us/products/collateral/switches/catalyst-9000/nb-09-25ge-100ge-wp-cte-en.pdf

White paper
Cisco public

Cisco Catalyst 9500 Architecture

https://www.cisco.com/c/dam/en/us/products/collateral/switches/catalyst-9500-series-switches/white-paper-c11-741484.pdf

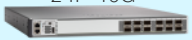
Summary

Offering a comprehensive high-density portfolio on campus with 100G, 40G, 25G, 10G

Architectural flexibility
- Broad support for 10G, 25G, 40G, 100G from aggregation to core

Infrastructure investment protection
- Non disruptive migration from 10G to 25G and beyond

Cost-effective optics
- Innovation in standards to support high-density, multilane optics

	10G	25G	40G	100G
> 24 ports	 40P 10G (Uplinks: 8P 10G, 2P 40G)	 48P 25G (Uplinks: 4P 100G)	 32P 40G	 32P 100G
<= 24 ports	 16P 10G (Uplinks: 8P 10G/2P 40G)	 24P 25G (Uplinks: 4P 100G)	 24P 40G  12P 40G	 16P 100G

Platform benefits

Up to 1TB SSD storage


Customizable ASIC templates


Same Cisco IOS® image


N+1 fan redundancy


1:1 power supply redundancy

Cisco Catalyst 9500 Series switch scale comparison

Model	9500-16X	C9500-40X	C9500-12Q	C9500-24Q	C9500-32C	C9500-32QC	C9500-48Y4C/ C9500-24Y4C
Switching capacity	240G	480G	480G	960G	3.2T	1.6T	1.6T
Forwarding rate	320 Mpps	720 Mpps	720 Mpps	1440 Mpps	2 Bpps	1 Bpps	1 Bpps
MAC addresses	64,000*	64,000*	64,000*	64,000*	82,000*	82,000*	82,000*
LPM/host routes (IPv4/v6 routes)	64,000/32,000* 32,000/16,000	64,000/32,000* 32,000/16,000	64,000/32,000* 32,000/16,000	64,000/32,000* 32,000/16,000	212,000/ 212,000*	212,000/ 212,000*	212,000/ 212,000*
Multicast routes	48,000*	48,000*	48,000*	48,000*	32,000*	32,000*	32,000*
Security ACLs	18,000*	18,000*	18,000*	18,000*	27,000*	27,000*	27,000*
QOS ACLs	18,000*	18,000*	18,000*	18,000*	16,000*	16,000*	16,000*
Flexible NetFlow	128,000 per ASIC	128,000 per ASIC	128,000 per ASIC	128,000 per ASIC	96,000*	96,000*	96,000*
Spanning Tree instances**	256	256	256	256	256	256	256

* Depends on SDM template
** For 16.8,1 release

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