The bridge to possible

Cisco 8000 Technical Update

Powered by Silicon One & IOS XR7

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BRKSPG-2944

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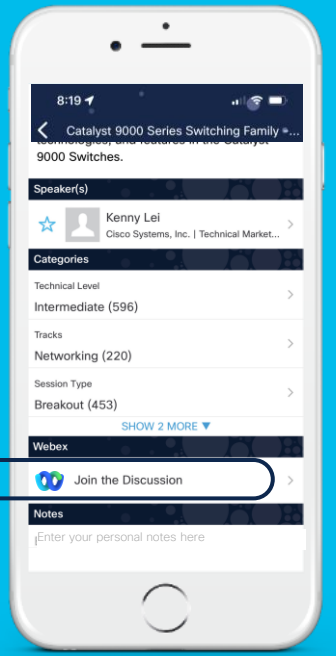
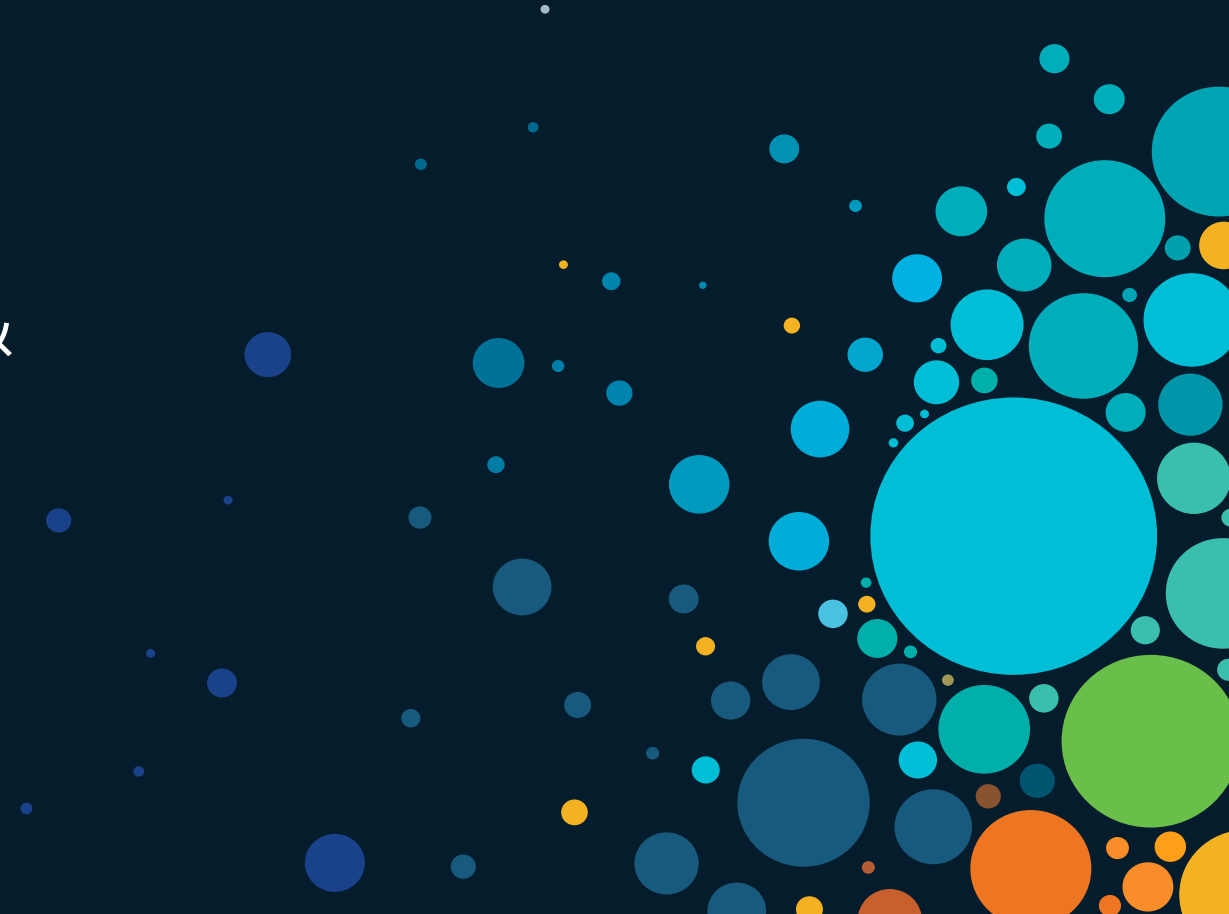


Agenda

- Introduction & Positioning
- Silicon One
- Portfolio
- 8800 Fabric
- Life of a Packet & Troubleshooting
- Cisco 8000 Optics
- IOS XR7
- Power Optimization
- 800G
- Conclusion

Introduction & Positioning



8000 Value Proposition

- 400G Optimized
- Powered by Silicon One
- Runs IOS XR
- Fixed, Distributed
- Power Efficient

Cisco 8000 Routers Positioning

Key Features

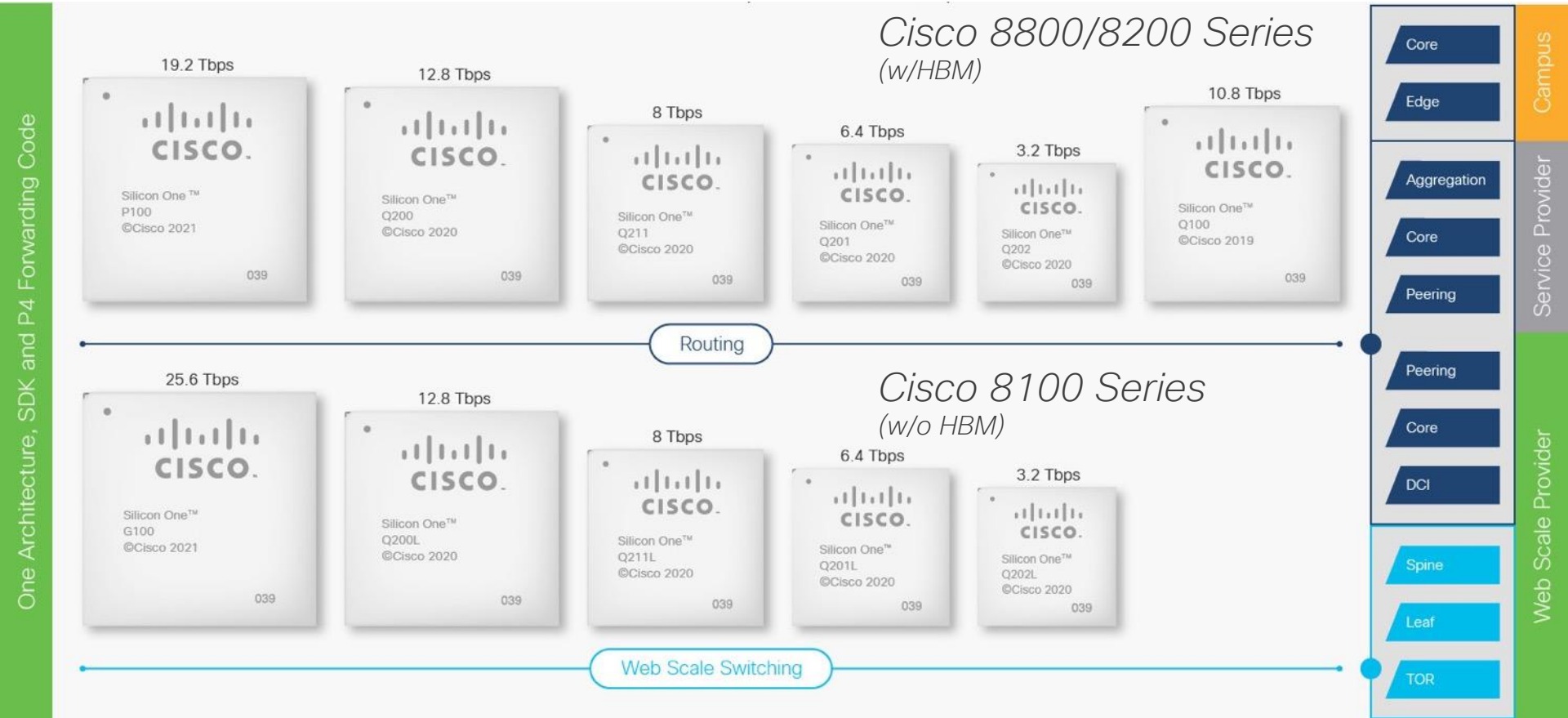
- 3.2T up to ~260 Tbps (& soon 518T)
- 400G & 800G Optimized, with support for 100G
- IP + Optical capabilities with 400G ZR/ZR+
- New Silicon One architecture: platform longevity, trade off bandwidth, scale, cost & power.

Target Use Cases

- Core LSR
- Cloud Aggregation
- DC ToR/Leaf
- SP Aggregation
- Peering

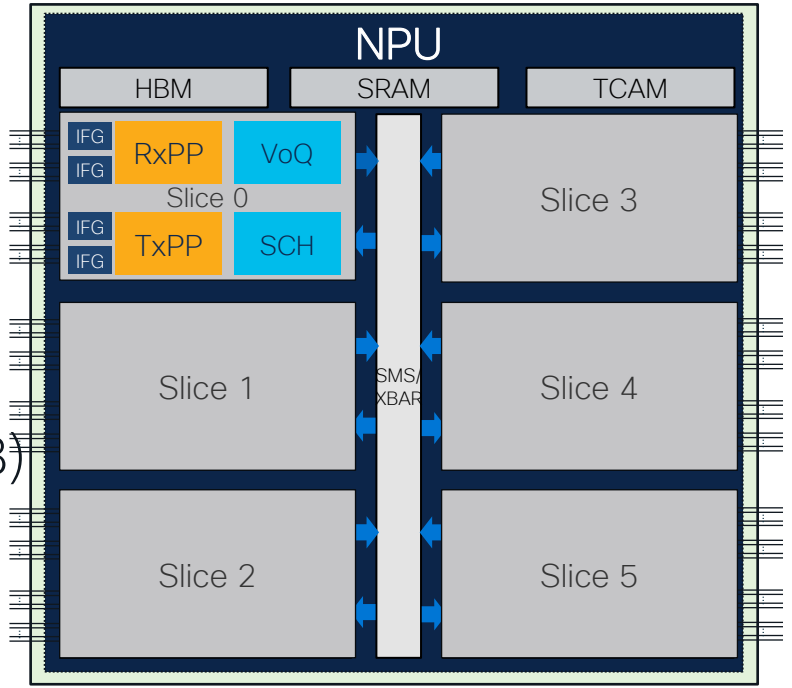
Silicon One

Cisco Silicon One Family



Cisco Silicon One Q200

- 12.8 Tbps capacity, 8.1 Bpps
- 256 x 56G SerDes
  - 6 slices per Q200
  - 2 Interface Groups (IFG) per slice
- 108MB shared on-die packet buffer
- Expandable packet buffer to HBM (8GB)

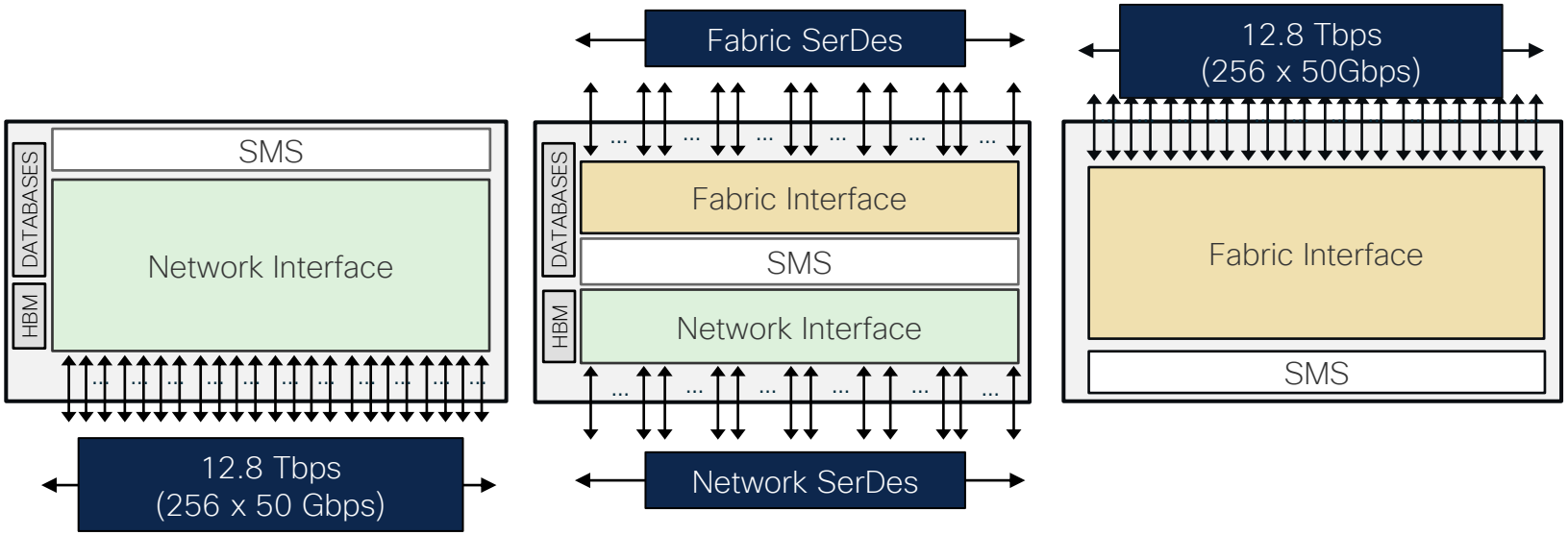


Cisco Silicon One Q200

Cisco Silicon One Q200

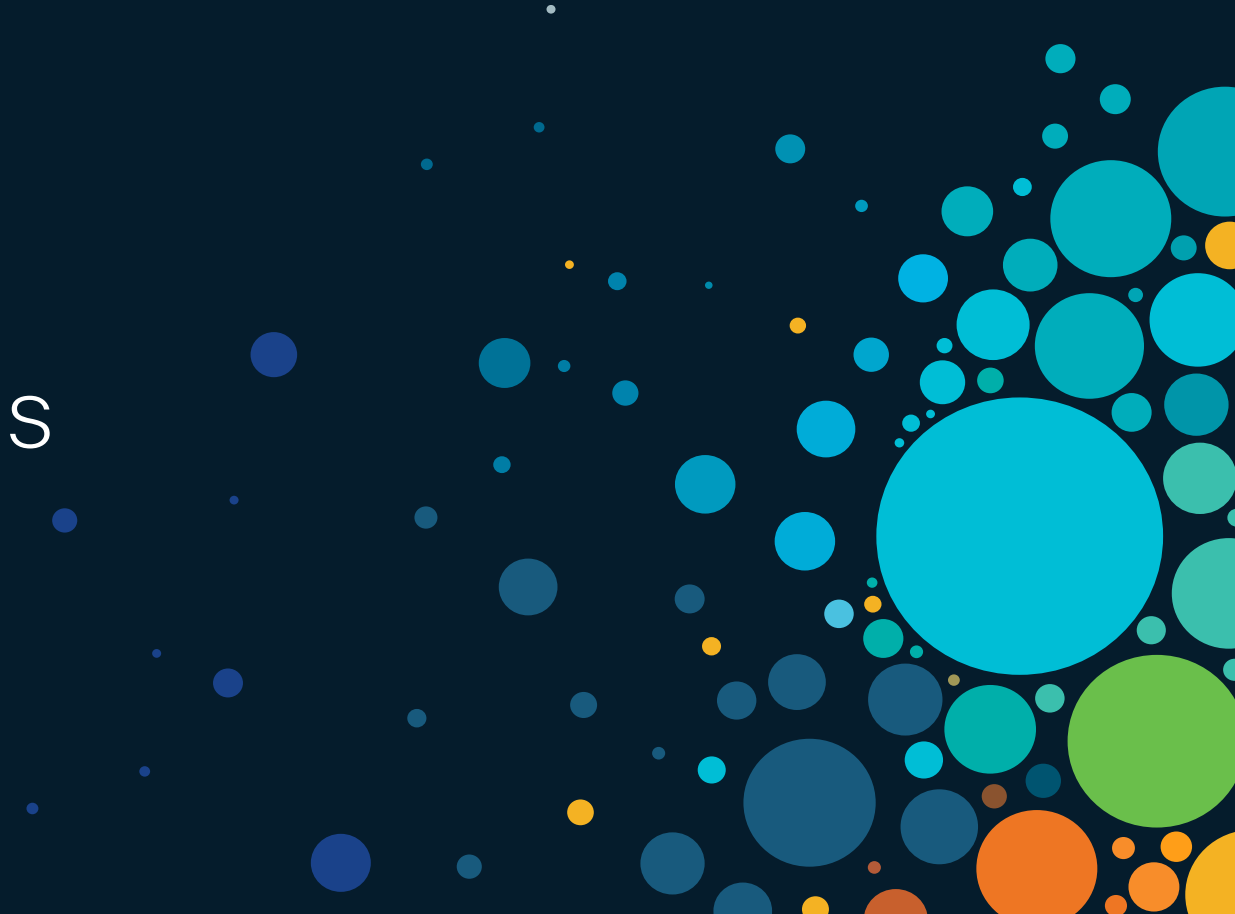
Mode of Operation

Cisco Silicon One with 3 roles



* Note: used 50 Gbps for SerDes BW calculation

Portfolio
Fixed Systems



Cisco 8100 Fixed Routers



	8101-32FH	8102-64H	8101-32H
ASIC	Q200L	Q201L	Q202L
Rack Units	1RU	2RU	1RU
MACsec	N	N	N
Ports	32xQSFP-DD	64xQSFP28	32xQSFP28
Total Throughput	12.8 Tbps	6.4 Tbps	3.2 Tbps
Typical Power	288W	256W	172W

Cisco 8200 Fixed Routers

Silicon One Q100

	8201	8202
ASIC	Q100	Q100
Rack Units	1RU	2RU
MACsec	N	N
Ports	24xQSFP-DD 12xQSFP28	12xQSFP-DD 60xQSFP28
Total Throughput	10.8 Tbps	10.8 Tbps
Typical Power	415W	700W

Cisco 8200 Fixed Routers

Silicon One Q200

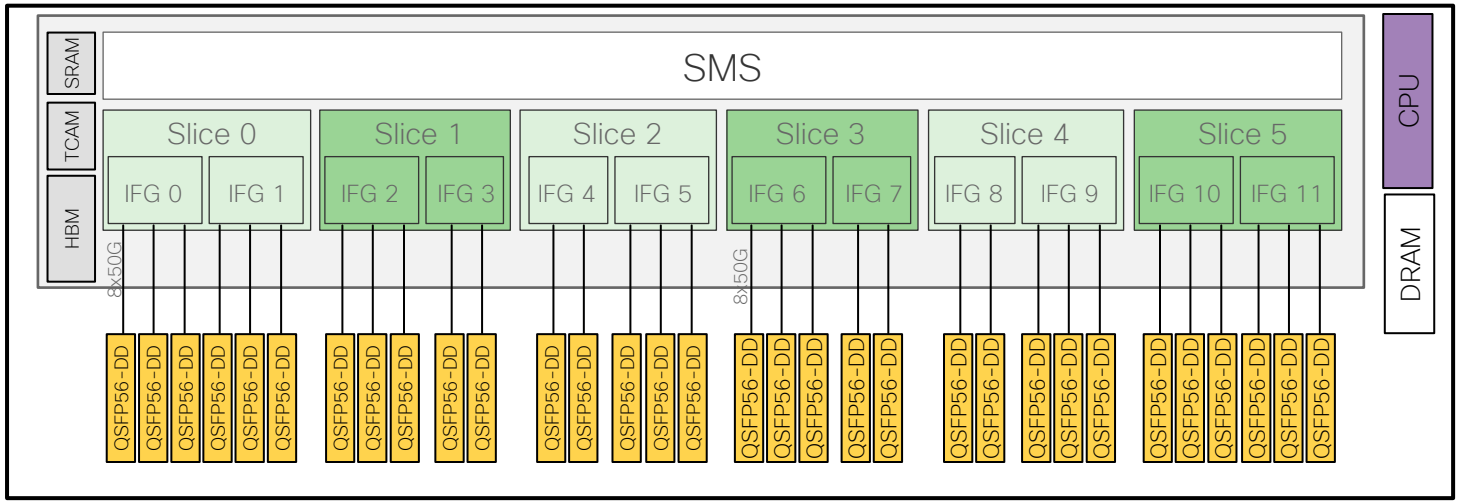


	8201-32FH	8202-32FH-M	8201-24H8FH
ASIC	Q200	Q200	Q200
Rack Units	1RU	2RU	1RU
MACsec	N	Y	N
Ports	32xQSFP-DD	32xQSFP-DD	8xQSFP-DD 24xQSFP28
Total Throughput	12.8 Tbps	12.8 Tbps	5.6 Tbps
Typical Power	288W	750W	205W

8201-32FH

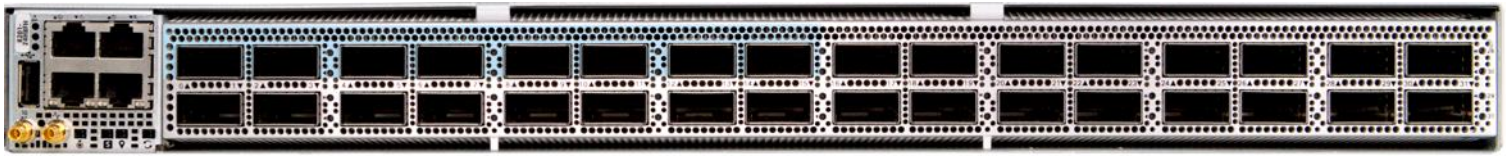
- 1 RU Fixed System, 32 x 400G QSFP-DD optics
- Cisco Silicon One Q200
- ZR/ZR+ support on all ports
- 6 Fan Trays (N+1), 2 Power Supplies (N+1)

8201-32FH Architecture



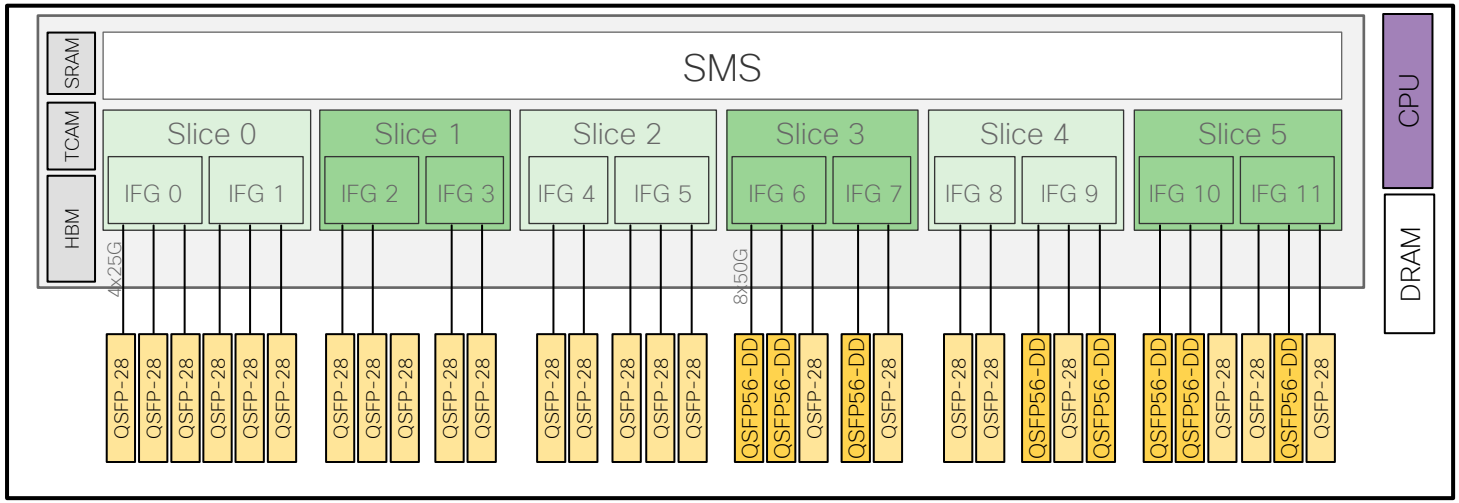
- Breakout capacity
  - 4x 100 GbE or 2x 100 GbE or 4x 10/25 GbE on all 400 GbE ports

8201-24H8FH



- 1 RU Fixed System, 24 x 100G QSFP28 + 8 x 400G QSFP-DD optics
- Cisco Silicon One Q200
- ZR/ZR+ support on all 400G ports
- 6 Fan Trays (N+1), 2 Power Supplies (N+1)

8201-24H8FH Architecture

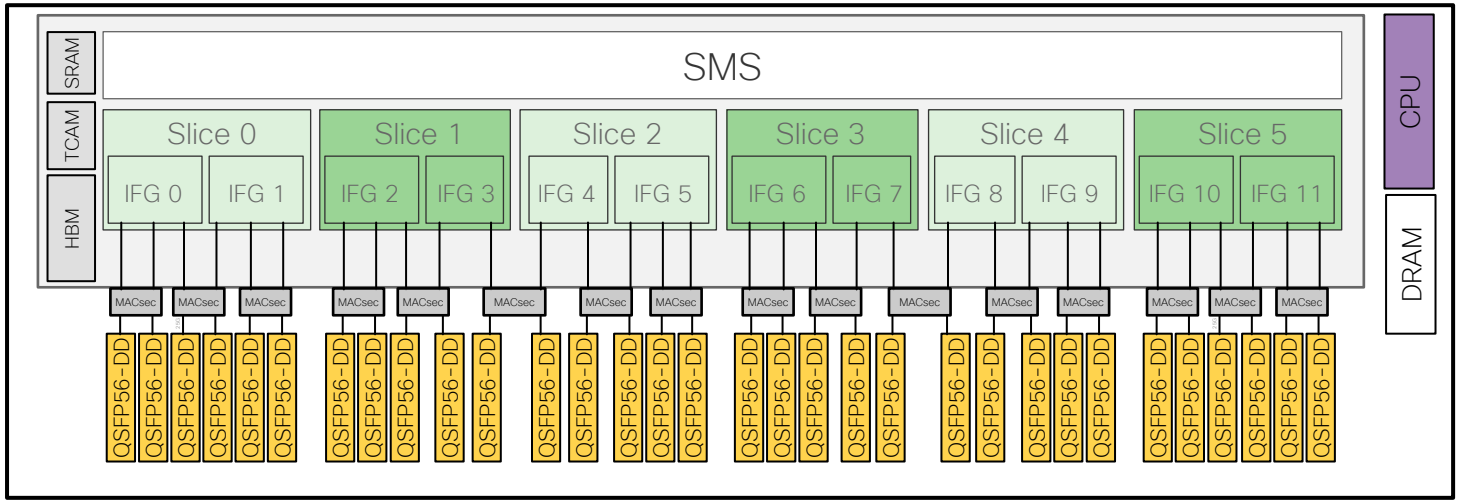


- Breakout capacity
  - 4x 100 GbE or 2x 100 GbE or 4x 10/25 GbE on all 400 GbE ports
  - 4x 10/25 GbE on all 100 GbE port

8202-32FH-M

- 2 RU Fixed System, 32x QSFP-DD optics
- Cisco Silicon One Q200
- ZR/ZR+ support on all ports
- MACsec on all ports

8202-32FH-M Architecture



- Breakout capacity:
  - 4x100 GbE or 2x 100 GbE or 4x10/25 GbE on all 400GbE ports

Portfolio
Distributed Systems

Cisco 8800 Modular Routers
Portfolio

8804

8808

8812

8818

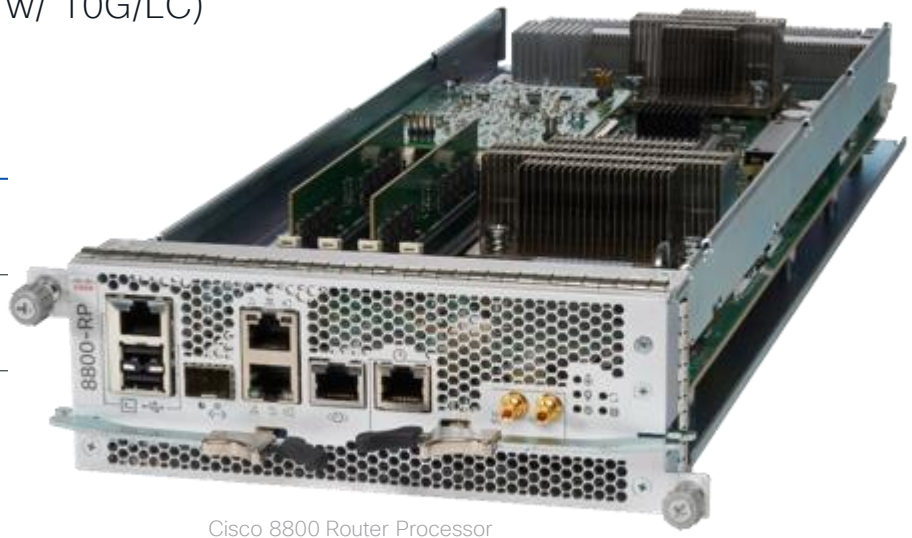
Rack Units	10 RU	16 RU	21 RU	33 RU
Slots	4	8	12	18
Ports & Line Cards	 48x100GbE w/ Q100 - MACsec  36x400GbE w/ Q100	 36x400GbE w/ Q200 - MACsec  36x400GbE w/ Q200	 34x100GbE & 14x400GbE w/ Q200	
Total Throughput	57.6 Tbps	115 Tbps	172 Tbps	259.2 Tbps
Typical Power	4.2 KW	9.3 KW	16.3 KW	22 KW

8800 Series Route Processor
8800-RP

- Common across all Cisco 8000 modular systems
- Not connected to fabric (small EOBC midplane w/ 10G/LC)

RP Specs

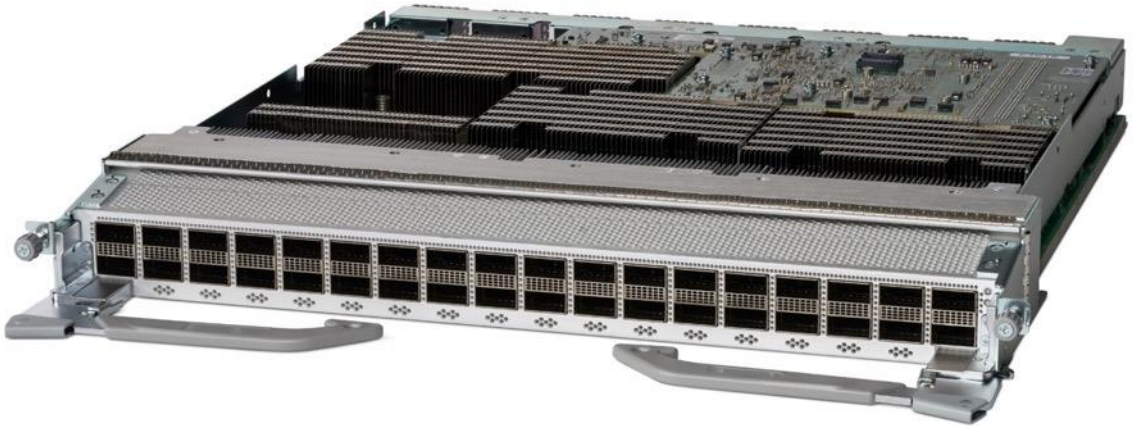
Ports	• Management Ethernet port • 2 x USB 2.0 1A ports
CPU, Memory and Disk	• 4-core 2.4 GHz Broadwell CPU • 32GB RAM, 128GB SSD
Other Features	• Timing Class B • IEEE 1588 • SyncE • TOD • 10 MHZ / 1 PPS



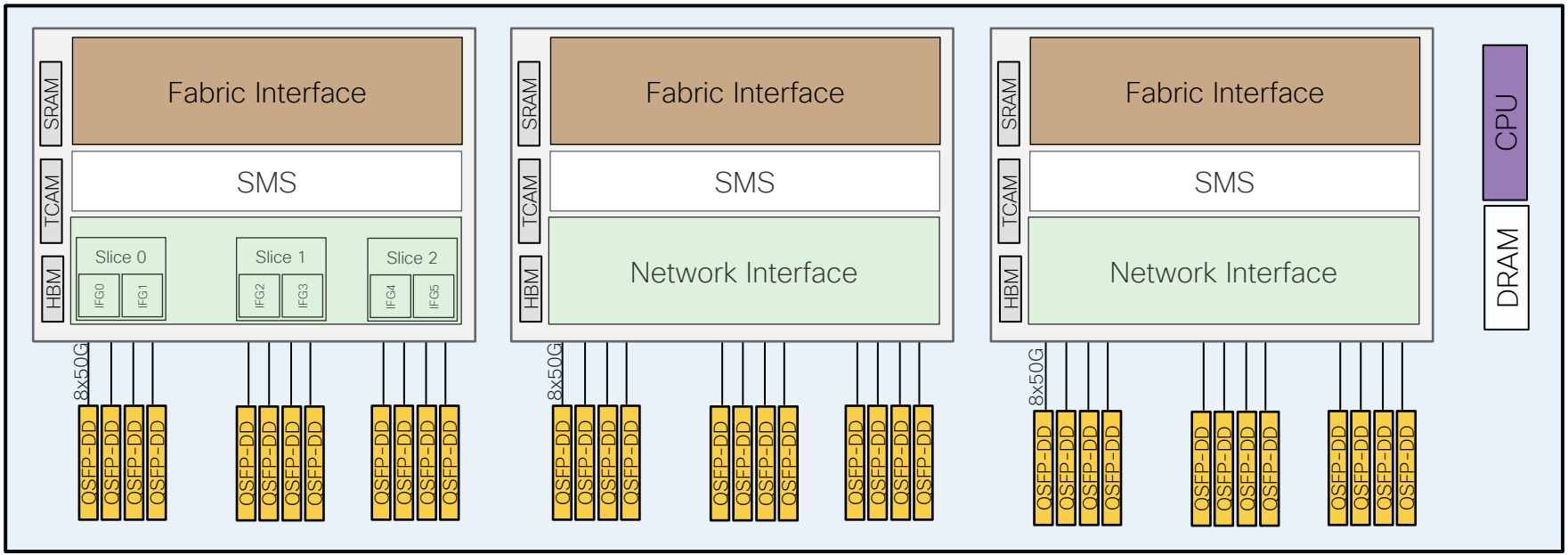
Cisco 8800 Router Processor

88-LC0-36FH & 88-LC0-36FH-M

- 14.4 Tbps capacity, 36 x 400G QSFP-DD
- Cisco Silicon One Q200
- MACsec support on –M variant (all ports)

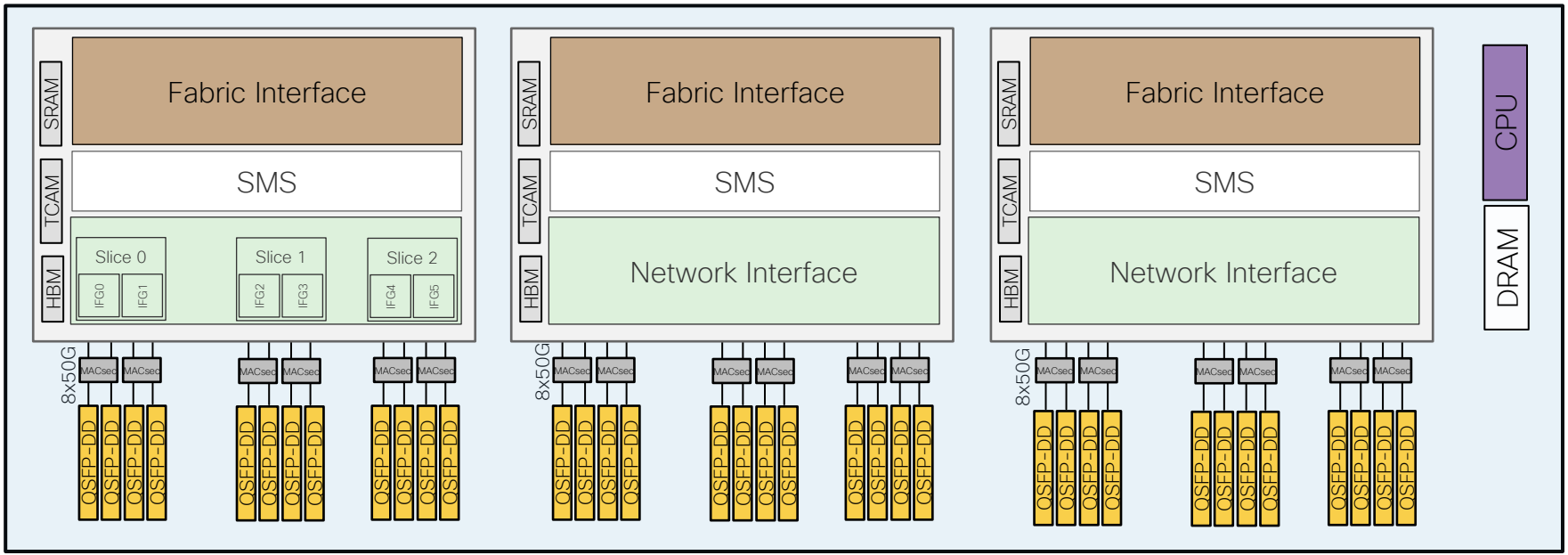


88-LC0-36FH Architecture



- Breakout capacity:
  - 4x100 GbE or 2x 100 GbE or 4x10/25 GbE on all 400GbE ports

88-LC0-36FH-M Architecture



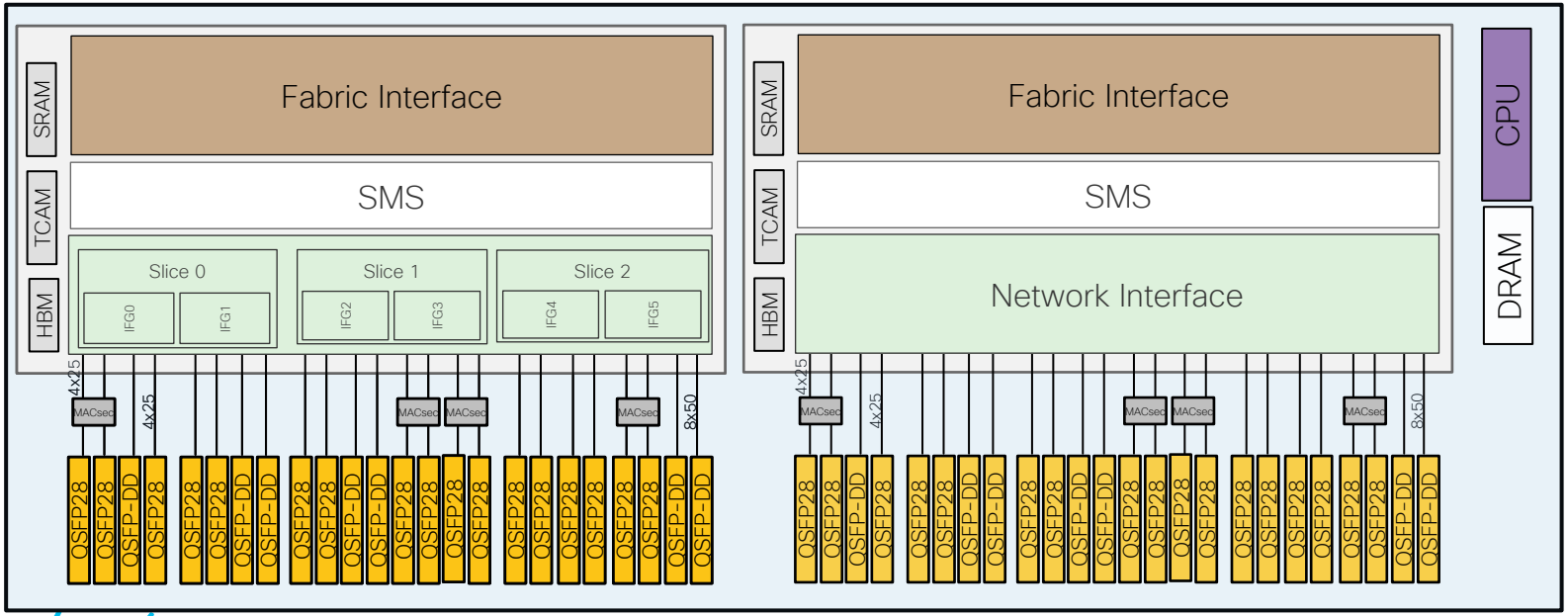
- Breakout capacity:
  - 4x100 GbE or 2x 100 GbE or 4x10/25 GbE on all 400GbE ports

88-LC0-34H14FH

- 9 Tbps capacity, 34 x 100G QSFP + 14 x 400G QSFP-DD
  - Possible to use as low-power 48 x 100G QSFP
- Cisco Silicon One Q200
- 100G MACsec support on upper row (16 ports)

88-LC0-34H14FH Architecture

- Low power mode supports only 100G
- Medium mode required to support 400G



8800 Fabric

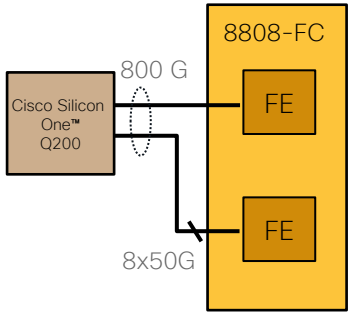
8800 Switch Fabric

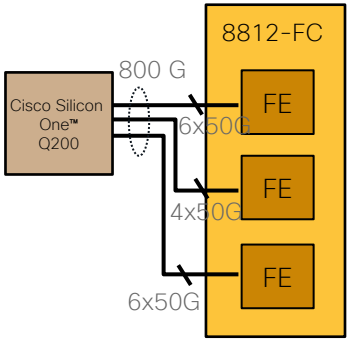
- Orthogonal direct-connect, specific to each chassis
- Up to 8 Fabric Cards between linecards and fan trays
  - 48x 100GbE linecard requires 5 fabric cards for N+1 redundancy
  - 36x 400GbE linecard requires 8 Fabric Cards for N+1 redundancy
- Cisco Silicon One Q100 or Q200 ASIC in fabric mode

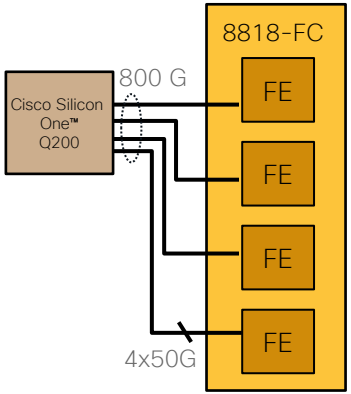
Fabric Element in FC

Example for 88-LC0-36FH linecard

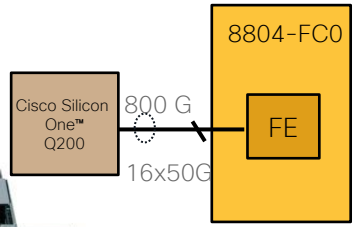
Q100 based FC

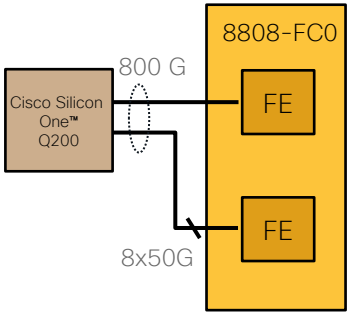


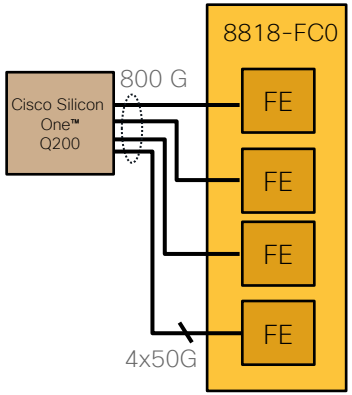




Q200 based FC



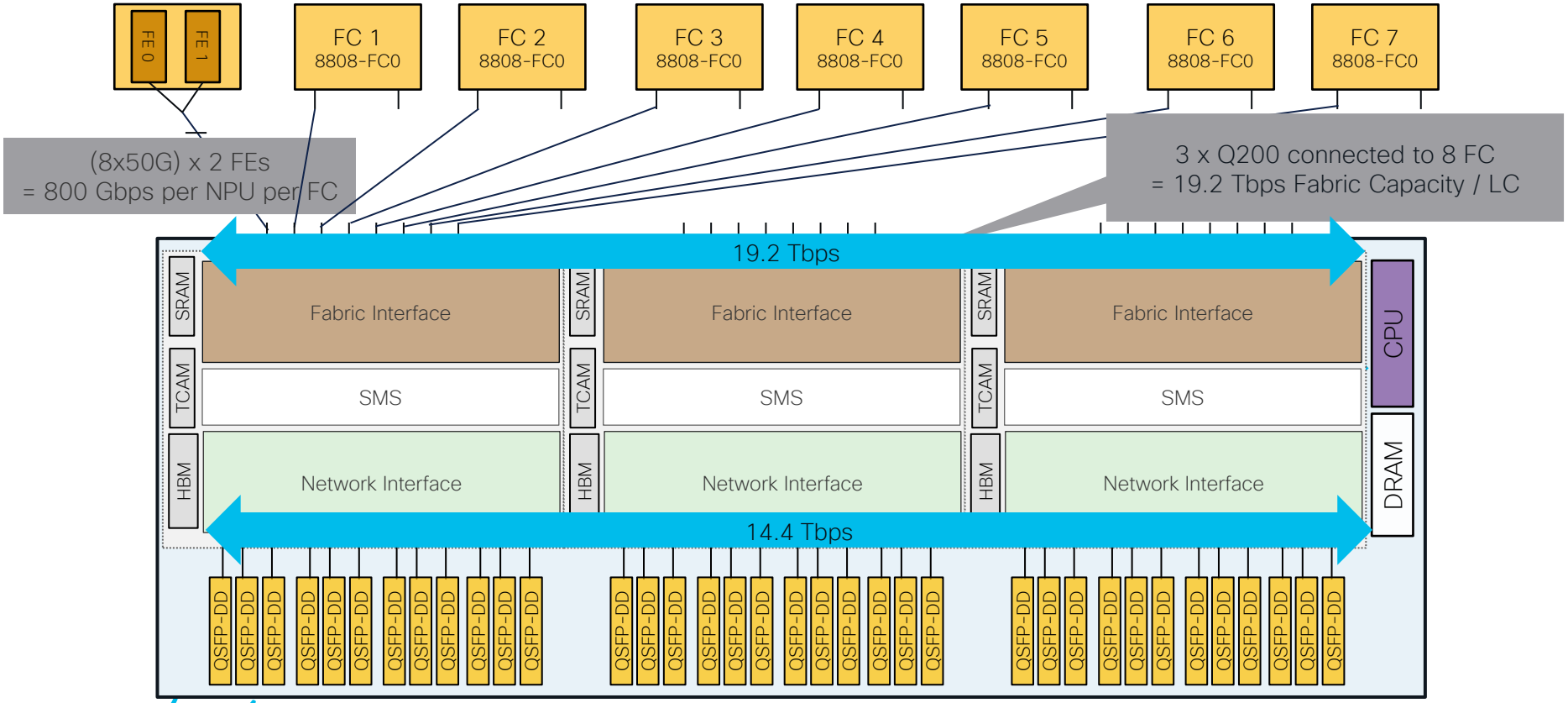




Note: 50 Gbps used for SerDes BW calculation.

88-LC0-36FH Linecard - FC connection

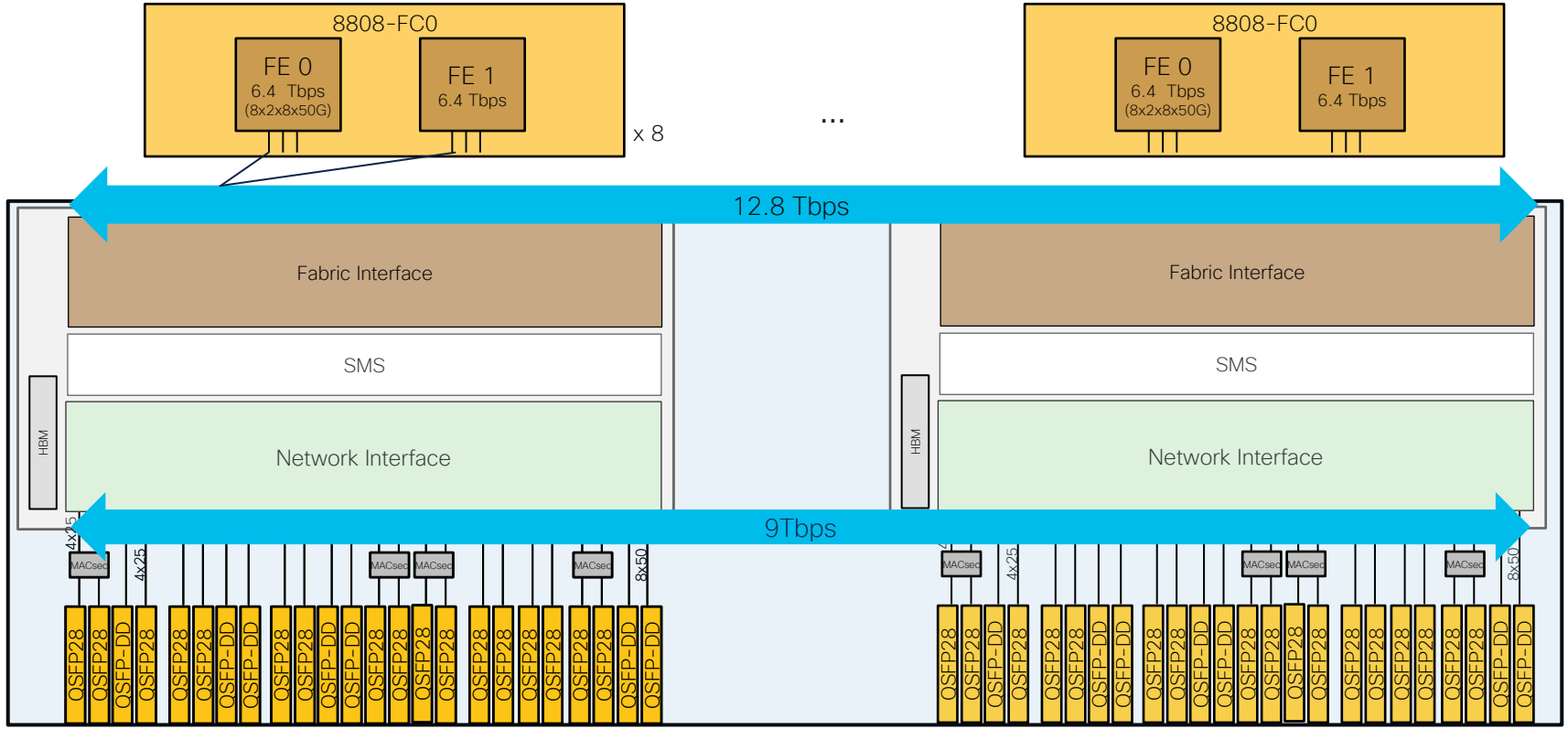
8FC Mode in 8808 Chassis



* Note: 50 Gbps used for SerDes BW calculation

88-LC0-34H14FH Linecard - FC connection

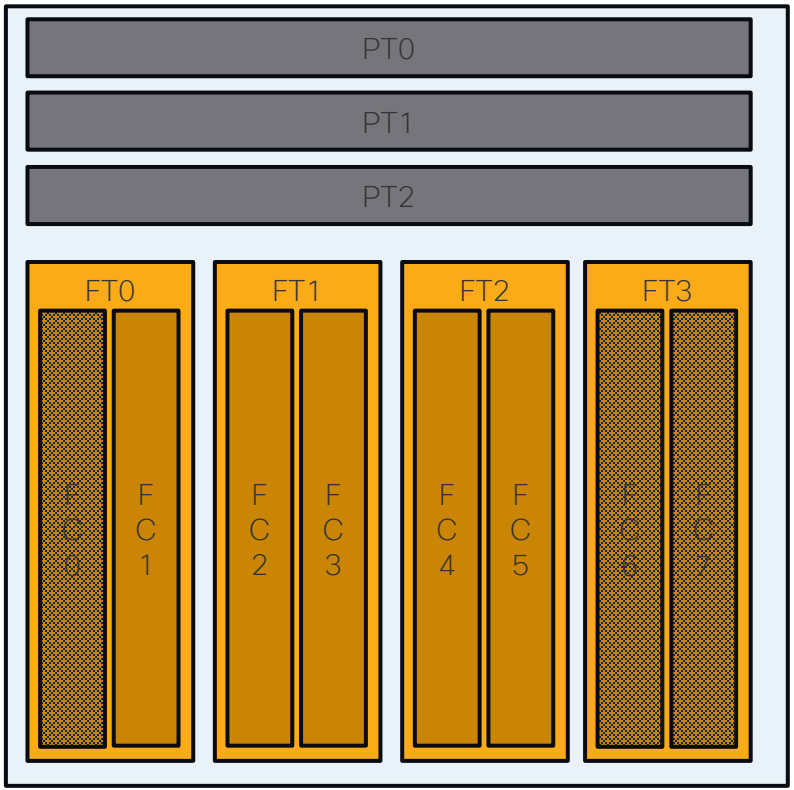
8FC Mode in 8808 Chassis



* Note: 50 Gbps used for SerDes BW calculation

5FC Mode

- Optimized mode when only 100G linecards are used
  - Not possible to insert 36x400G LC
  - For 88-LC0-34H14FH: use low power mode
- Fabric Cards must be inserted in FC slots:
  - 1, 2, 3, 4, and 5 (default)
  - 0, 2, 4, 5 and 6



8812 rear view

5FC Mode

- Router reload is needed for the configuration to get applied and take effect

```
RP/0/RP1/CPU0:8812-1(config)#controller fabric mode five-fc ?
  FC-0-2-4-5-6  FC Slots 0,2,4,5 and 6
  <cr>          FC Slots 1,2,3,4 and 5 (default)
RP/0/RP1/CPU0:8812-1(config)#controller fabric mode five-fc
In order to activate/deactivate mode config you must manually reload the chassis
RP/0/RP1/CPU0:8812-1(config)#commit
RP/0/RP1/CPU0:Dec 12 03:57:22.515 UTC: fsdbagg[247]: %FABRIC-FSDB_AGG-1-FABRIC_MODE_CHANGE :
[6940] : Required Router reload for fabric mode change, when all RP nodes are Operational
```

- If present, other FCs are shutdown and never used even in the event of a failure of an active FC

```
RP/0/RP0/CPU0:Dec 12 04:05:03.632 UTC: shelfmgr[212]: %PLATFORM-SHELFMGR-4-CARD_SHUTDOWN :
Shutting down 0/FC0: fabric_fsdb raised: 5FC mode(FC-1-2-3-4-5) detected, Shutting down 0/FC0
```

Fabric Bandwidth Threshold

hw-module profile bw-threshold

- If available bandwidth goes below threshold, then the network interfaces of the linecard are shut down
- Default value is 5%.

```
RP/0/RP0/CPU0:8812-1(config)#hw-module profile bw-threshold 90
Mon Dec 12 04:43:32.304 UTC
After commit, INTF bring UP/DN will require 90%/(90-10)% of total Fabric BW capacity of Asic.
RP/0/RP0/CPU0:8812-1(config)#
```

When available fabric bandwidth falls below <configured value>-10%, interfaces are brought down.

Fabric Bandwidth Threshold

hw-module profile bw-threshold: practical example

- Example on 8812-FC with 88-LC0-34H14FH linecard
  - 6.4 Tbps per NPU with all FCs
  - hw-module profile bw-threshold 90: 5.76 Tbps required
  - With 2 x FC down

```
LC/0/0/CPU0:Dec 12 13:44:53.285 UTC: npu_drvr[194]: %FABRIC-NPU_DRVR-4-
FABRIC_BANDWIDTH_LOW_THRESHOLD : Fabric available bandwidth below low threshold for R/S/A=0/0/1
LC/0/0/CPU0:Dec 12 13:44:53.286 UTC: npu_drvr[194]: %PKT_INFRA-FM-4-FAULT_MINOR : ALARM_MINOR
:Fabric BW below threshold, interfaces will be down :DECLARE :: Asic: 1, Interfaces DOWN Alarm.
Fabric BW below threashold.
LC/0/0/CPU0:Dec 12 13:44:53.739 UTC: npu_drvr[194]: %PKT_INFRA-FM-4-FAULT_MINOR : ALARM_MINOR
:Fabric BW below threshold, interfaces will be down :DECLARE :: Asic: 0, Interfaces DOWN Alarm.
Fabric BW below threashold.

LC/0/0/CPU0:Dec 12 13:44:53.287 UTC: ifmgr[130]: %PKT_INFRA-LINEPROTO-5-UPDOWN : Line protocol
on Interface HundredGigE0/0/0/47, changed state to Down
```

Fabric Bandwidth Threshold

hw-module profile bw-threshold: 2 FCs down

```
RP/0/RP0/CPU0:8812-2#sh controllers fabric health
<snip>
PLA Health:
---------------
Description:
   planes       : p0-p7
   plane mask   : Asic #0-3
   Asic value  1: destination reachable via asic
               .: destination unreachable via asic
               x: asic not connected to LC (for S3)
               -: plane not configured (for S2) or asic missing
==============================
Destination   p0     p1     p2     p3     p4     p5     p6     p7     Reac
Address       mask   mask   mask   mask   mask   mask   mask   mask   link
Fapid(R/S/A)  0123   0123   0123   0123   0123   0123   0123   0123   Mn/M
-------------------------------------------------------------------------
0(0/0/0)      111    111    111    111    111    111    ...    ...     4/6
1(0/0/1)      111    111    111    111    111    111    ...    ...     4/6
Fabric Reachability Health:
-------------------------------------------------------------------------
| R/S/A  | Fabric Enabled | Fabric BW Below | Total BW | Avail BW | Req BW |
|        |                |                 |  (Gbps)  |  (Gbps)  | (Gbps) |
-------------------------------------------------------------------------
| 0/0/0  |TRUE            |TRUE             |      6400|      4800|     5760|
| 0/0/1  |TRUE            |TRUE             |      6400|      4800|     5760|
-------------------------------------------------------------------------
```

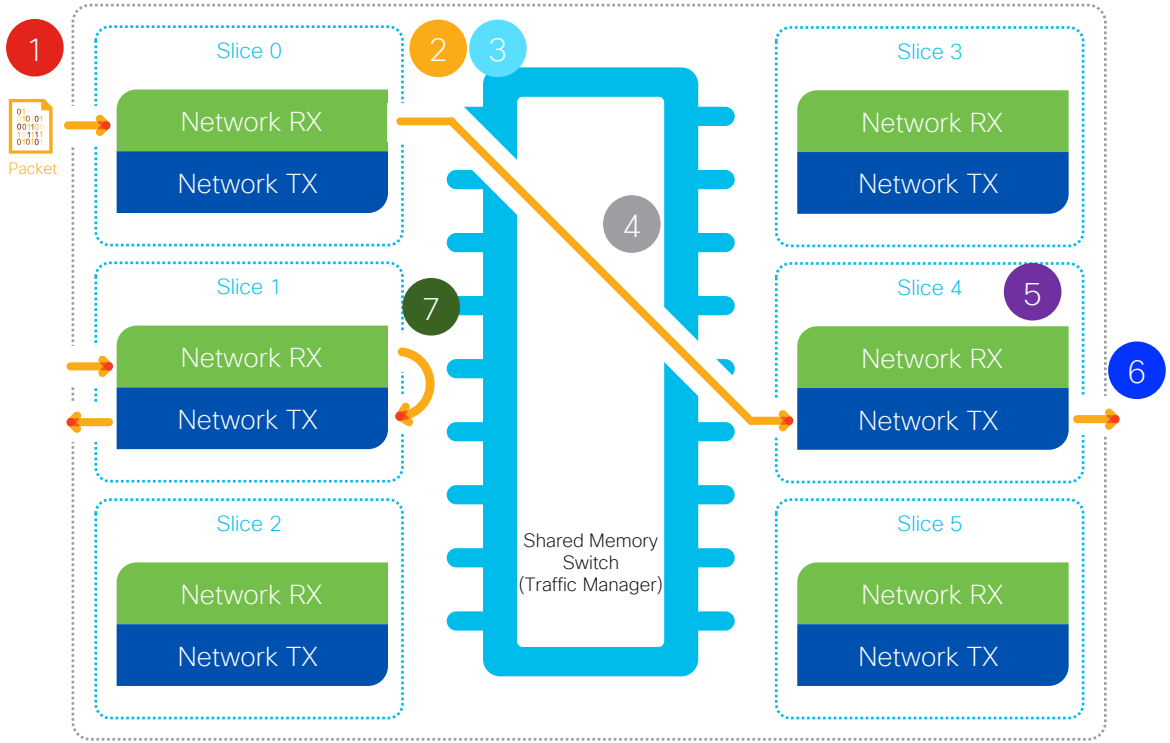
Network interfaces on linecard are active only when “Available bandwidth” is more than “Total required bandwidth”.

Life of a Packet

Life of a Unicast Packet

Cisco 8200 & 8100

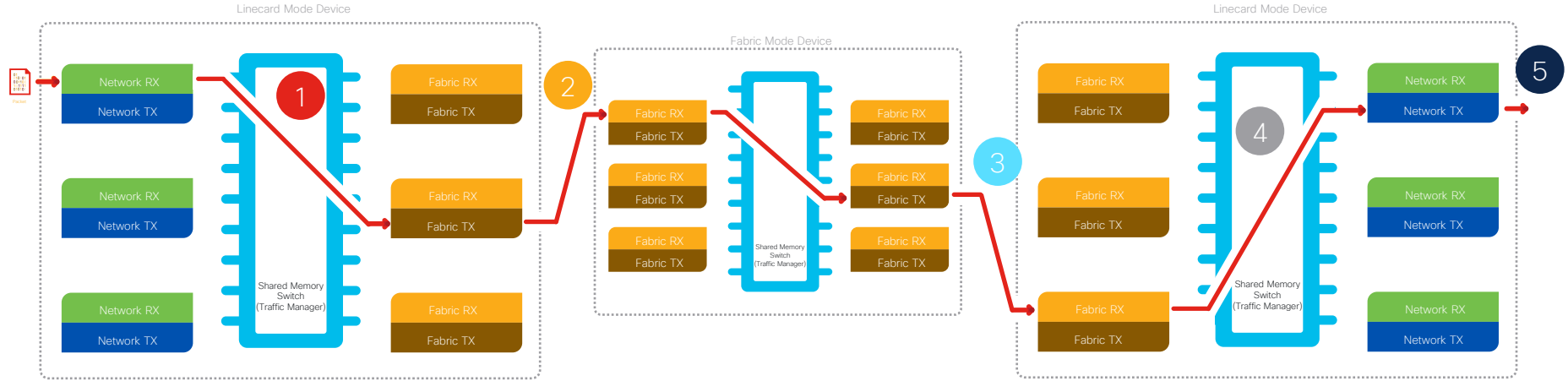
1. Packets arrive on the input slice of the receive device.
2. The NPU performs the packet lookup, feature checks, and identifies the destination for the packet.
3. The ingress NPU enqueues the packet on the corresponding VoQ for the {destination, traffic class}
4. When credits are available for the destination VoQ, the packet is switched across the SMS to the destination (egress) slice.
5. On the egress slice, the transmit direction lookups and feature checks are performed.
6. The final encapsulations are added to the packet and it's transmitted from the TX NPU out the physical interface
7. All packets are switched through the same SMS regardless of whether they are bound for the same NPU slice or a different NPU slice.



Life of a Unicast Packet
Cisco 8800

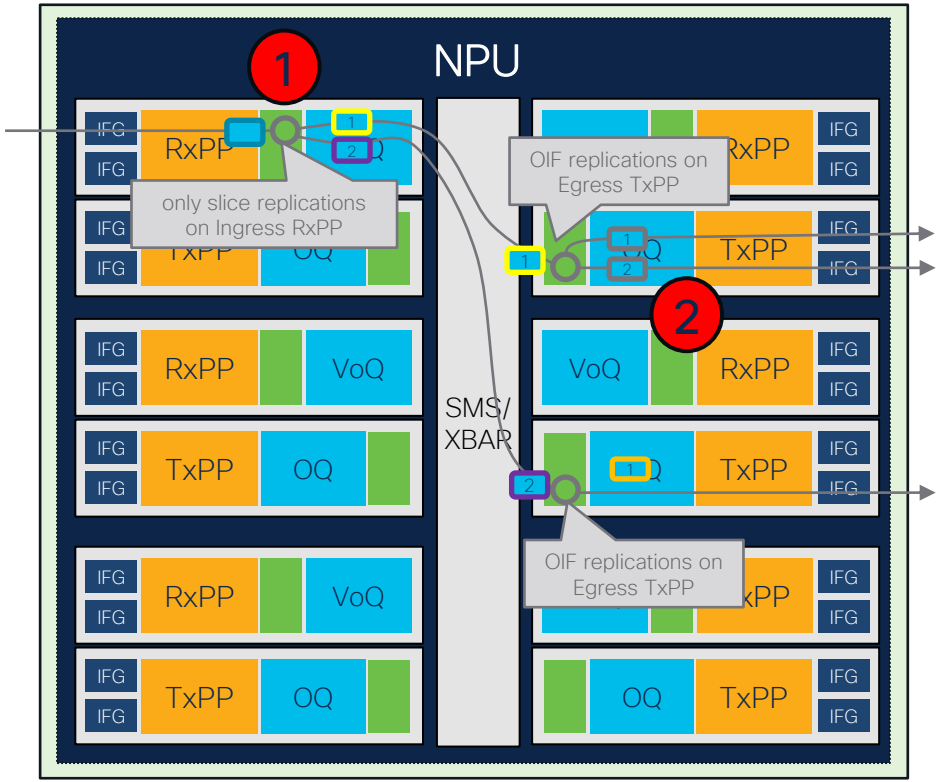
Packets are assigned on the ingress NPU to a VoQ that represents the destination {interface, traffic class}, and credits are still allocated by the TM scheduler in the same manner.

1. Packets are dequeued from the TM on the ingress NPU, switched across the local SMS onto a slice that operates in fabric mode.
2. Packets are switched to fabric devices (exist physically on the dedicated fabric cards).
3. Packets are switched to the correct destination NPU and the address is encoded in the internal fabric header.
4. Packets are received by the fabric facing slice of the transmit side NPU and switched to the output NPU slice.
5. Output lookups/features are done in the transmit NPU slice, and the packet is transmitted to the output interface.



Life of a Multicast Packet

Cisco 8200 & 8100

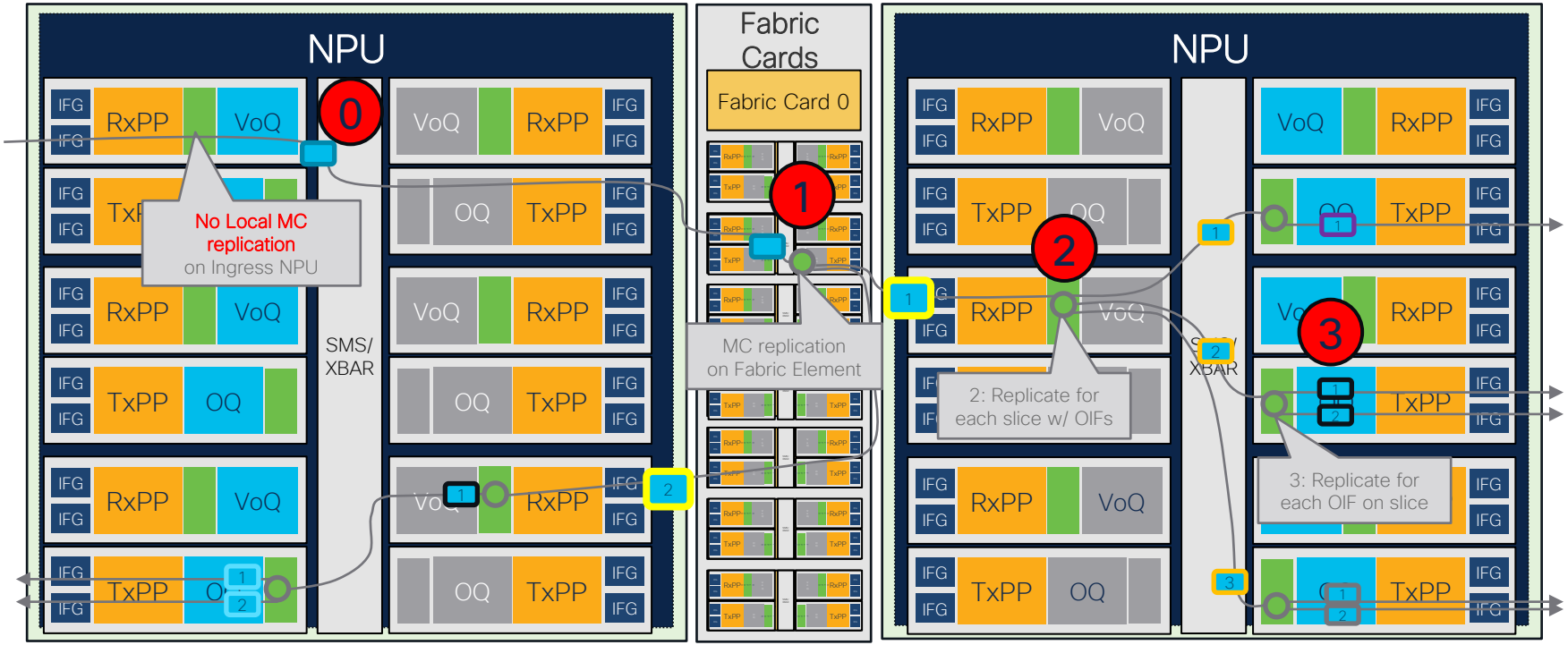


- 2 stages Multicast replication
  - Source →Ingress RxPP → Egress TxPP → OIF

Life of a Multicast Packet

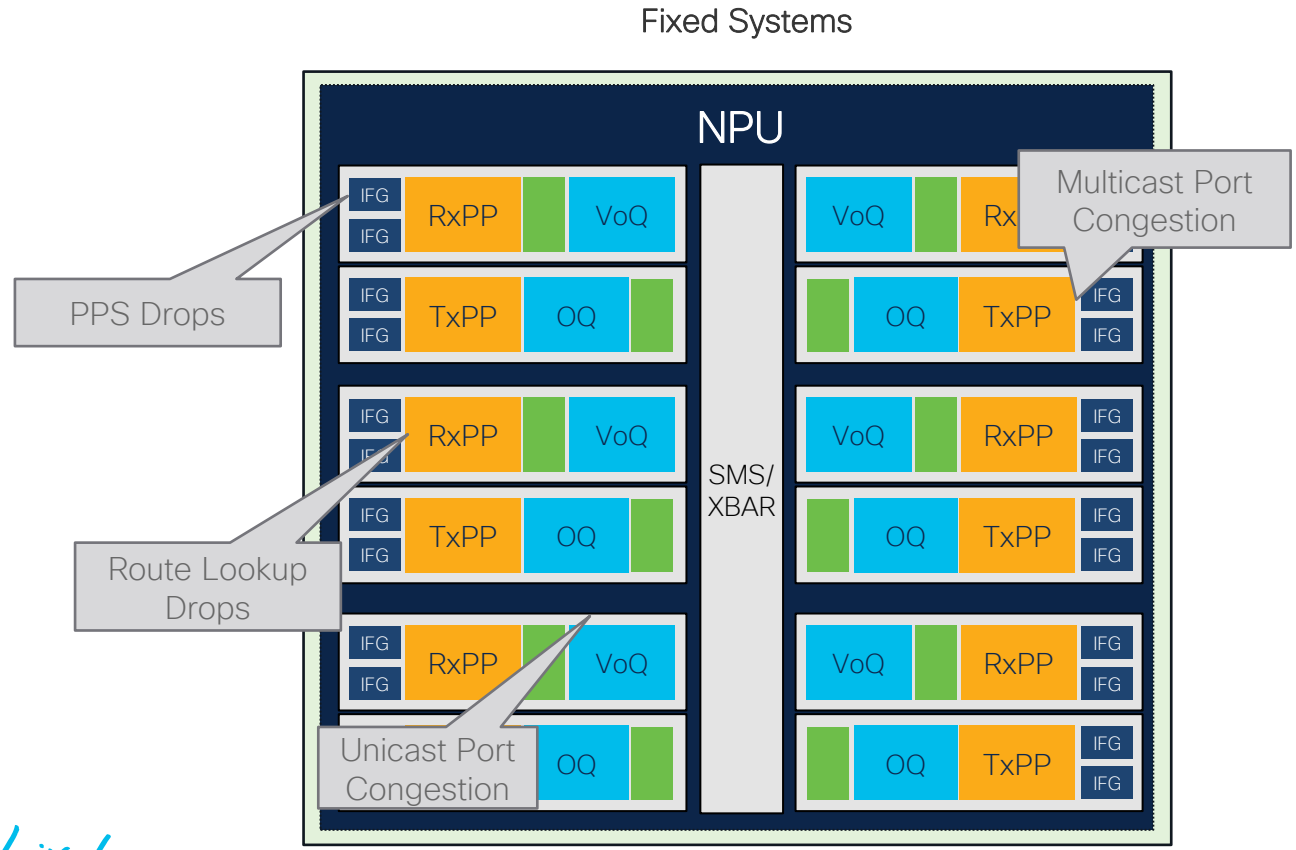
Cisco 8800

- 3 stages Multicast replication
  - Source → Fabric Element → Egress NPU → Output Interfaces (OIF)



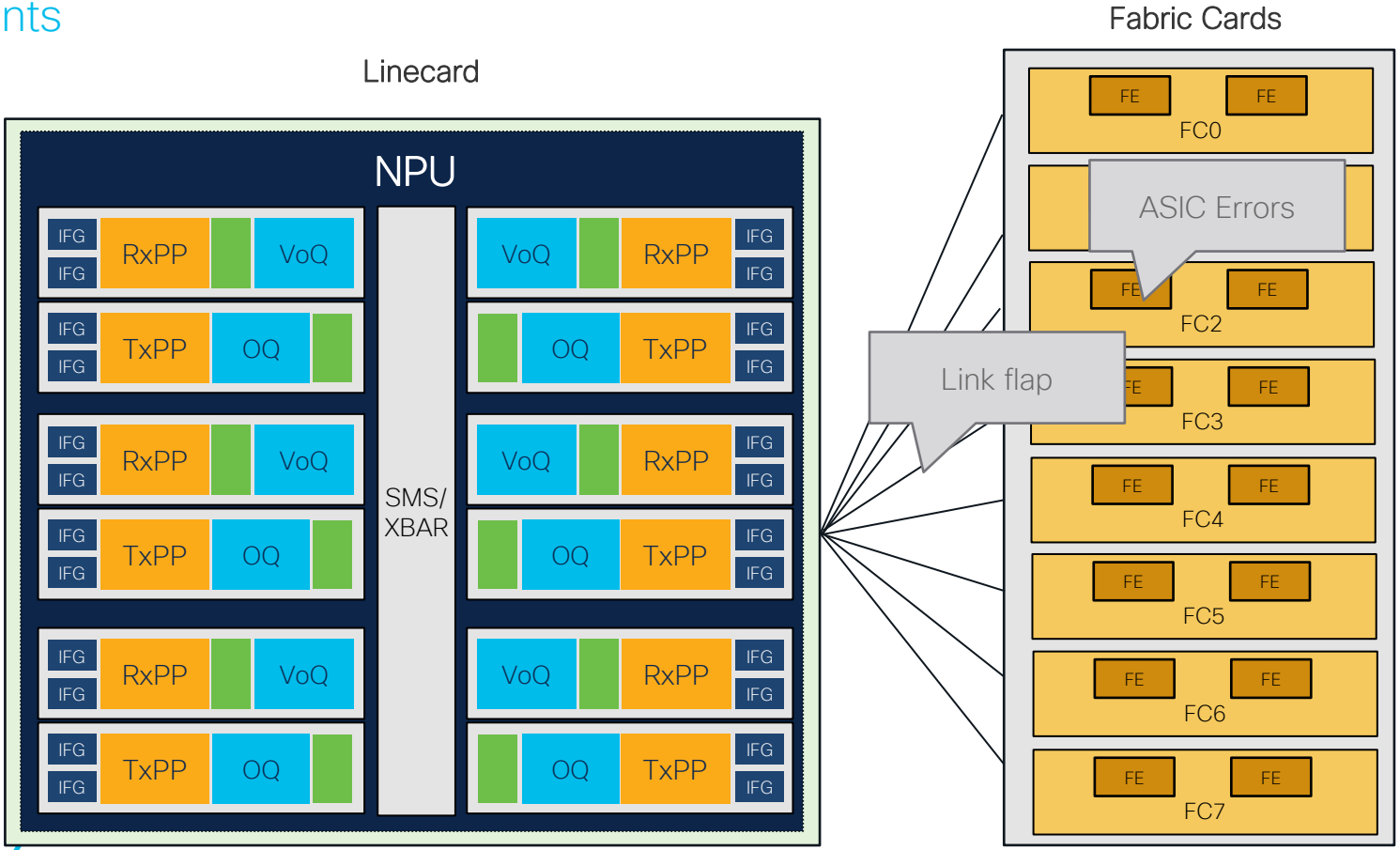
Packet Drop Troubleshooting

Drop Points



Packet Drop Troubleshooting

Drop Points



Packet Drop Troubleshooting

Keep Calm and show drops all

- Macro executing multiple show commands to summarize ongoing or cumulated packet drop

```
show arp traffic
show controllers <interface> stats
show controllers npu stats traps-all instance <instance>
location <loc>
show controllers npu stats voq ingress interface <intf>
instance all location <loc>
show cef drops location <loc>
show controllers fabric plane <plane> statistics detail
show lpts pifib hardware police location <loc>
show spp node-counters location <loc> | inc drop
```

Packet Drop Troubleshooting

Keep Calm and show drops all

- Sample Output

```
RP/0/RP0/CPU0:8201#sh drops all location all
-----------------------------------------------
Printing Drop Counters for node 0/RP0/CPU0
-----------------------------------------------

------------------
MODULE arp
------------------
  IP Packet drop count for node 0/RP0/CPU0: 79
------------------
MODULE mac
------------------

------------------
MODULE npu_traps
------------------
Trap Type                                NPU  Trap  Punt       Punt  Punt  Punt Configured Hardware   Policer Avg-Pkt
Packets      Packets
                                         ID   ID    Dest       VoQ   VLAN  TC   Rate(pps)  Rate(pps)  Level   Size
Accepted     Dropped
=============================================================================================================================
=================
NOT_MY_MAC(D*)                           0    6     RPLC_CPU   200   1586  0    67         135        IFG     64      0
30
<snip>
```

Cisco 8000 Optics

Cisco 8000 Optics

All-in-QSFP: QSFP56-DD

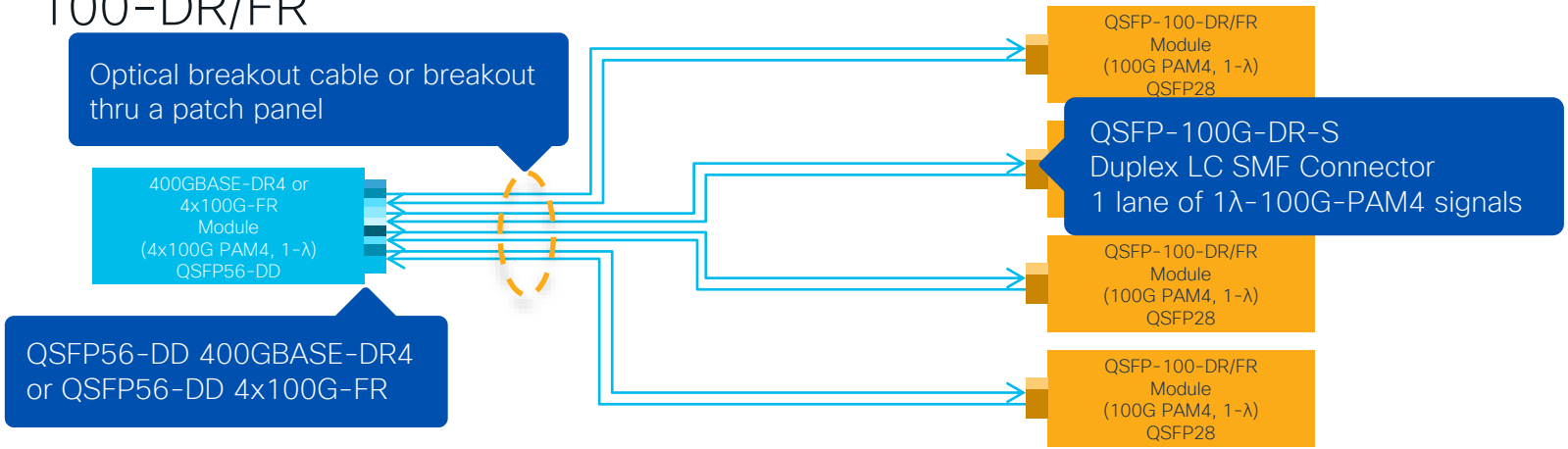
- QSFP-DD for 400G
  8 electrical lanes @ 50G (56Gbps raw)
- QSFP-DD for 200G or 2x100G
  8 electrical lanes @ 25G (28Gbps raw)

PMD	Reach	Media	Lasers	Modulation
LR8	10Km (6dBm)	Duplex SM	8	PAM4
FR4	2Km (5dBm)	Duplex SM	4	PAM4
DR4	500m (4dBm)	PSM	4	PAM4
ZR	40~80Km	Duplex SM	1	DP 16QAM
ZR+	Varies	Duplex SM	1	Varies
DAC	3m	Copper	N/A	PAM4
AOC	100m	Fiber Cable	Black Box	PAM4

400G Breakout Options

400GBASE-DR4 example

- Provides 4 lanes for 1λ-100G-PAM4 (100GBASE-DR) optical signal (up to 500m)
- Can be used for high density 100G interface with breakout QSFP-100-DR/FR

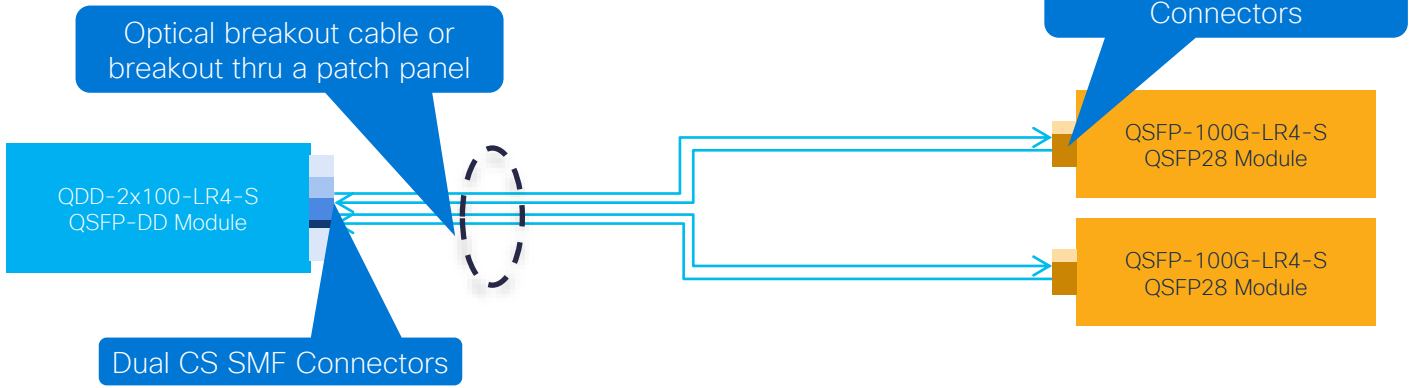


- 4x100G-FR: 4 x 1λ-100G-PAM4 (100G-FR) optical signal (Up to 2km)

200G Breakout Options

QDD-2x100G-LR4-S example

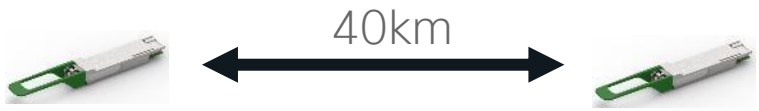
- Pros: connect “legacy” 100G modules to QSFP-DD ports, smooth transition to 400G, pay-as-you-grow model

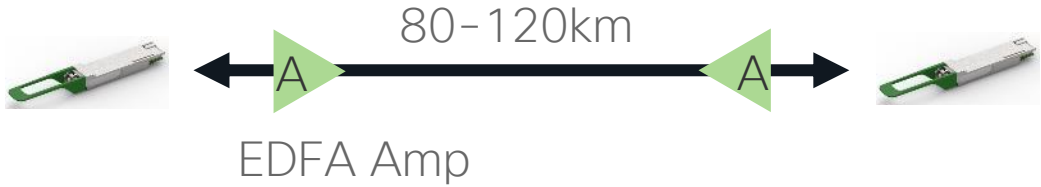


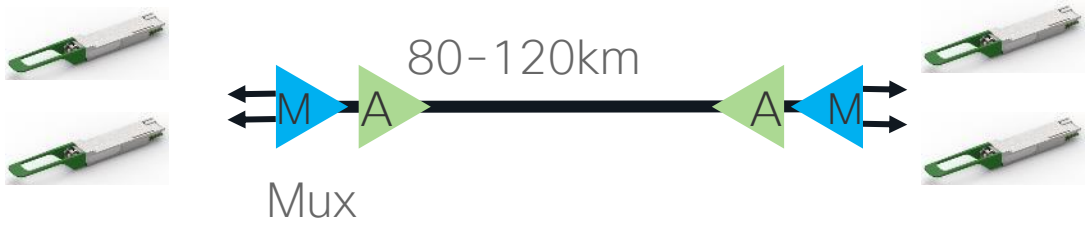
PID	Reach	Power	Connector	Media
QDD-2x100G-CWDM4	2km	7W	Dual Duplex CS	Duplex SMF
QDD-2x100G-LR4-S	10km	8W	Dual Duplex CS	Duplex SMF
QDD-2x100G-SR4	100m	5W	MPO-24	MMF

400G ZR Use Cases

- Only 400G
- 15W per QSFP-DD ZR
- C-Band tunable

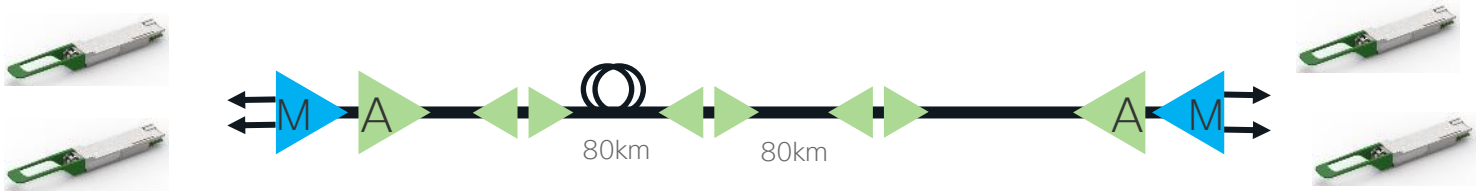






400G ZR+ Use Cases

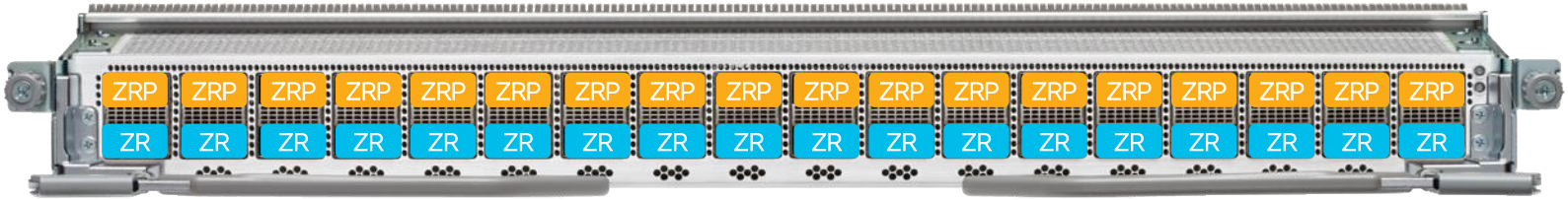
- Flexible modulations
  - 400G 16QAM
  - 200G QPSK
  - 300G 8QAM
- 24W per QDD-400G-ZRP
- C-Band tunable
- Acacia Bright 400ZR+
  - +1dBm Tx power
  - High transmit OSNR
  - Coming in XR 7.9.1 on 8000



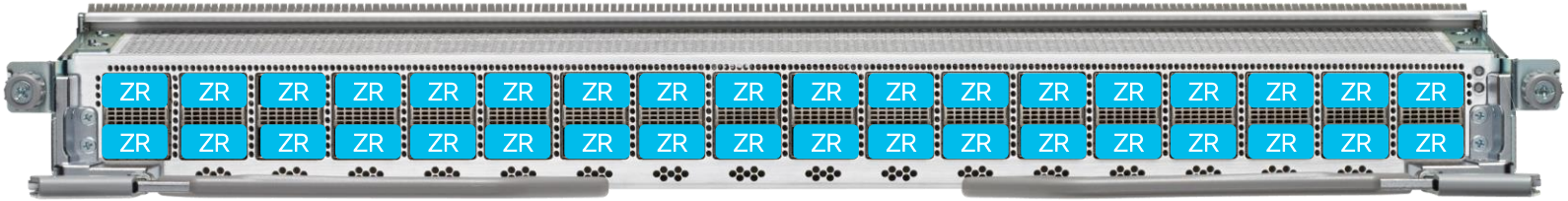
400G ZR/ZR+ Support on 8800

Example for 88-LC0-36FH and 88-LC0-36FH-M

- ZR+: upper row only*, can additionally support ZR on lower row



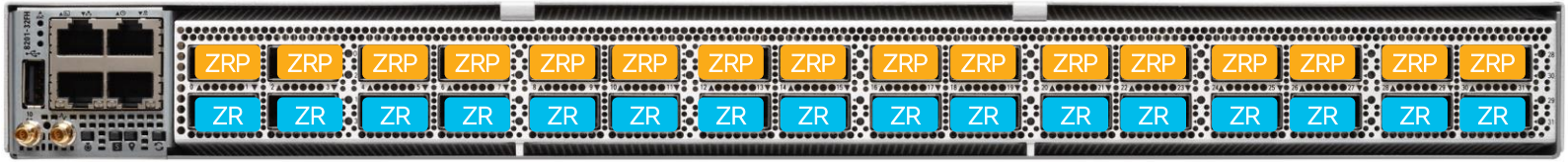
- ZR: all QSFP-DD cages



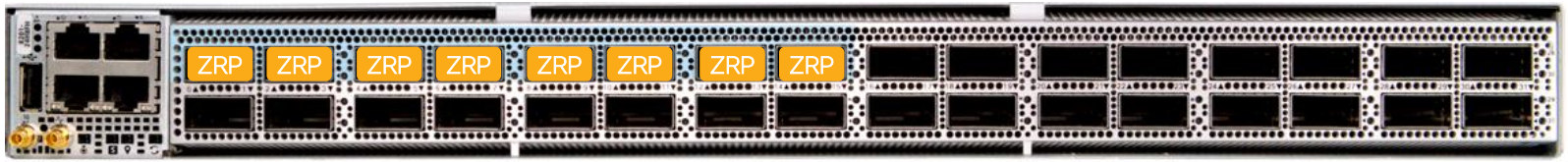
- 88-LC0-34H14FH: support in upcoming release

* lower row ZR+ support under evaluation

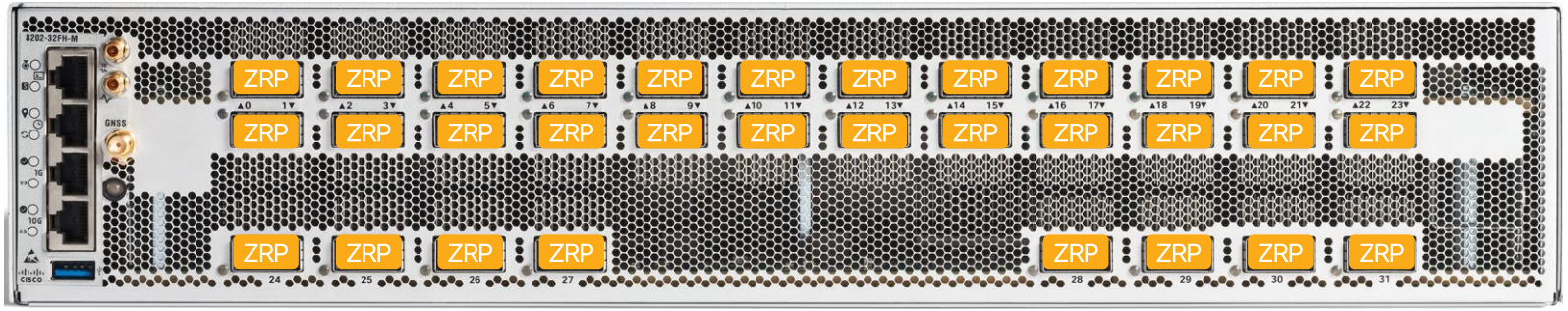
400G ZR/ZR+ Support on 8200



8201-32FH, upper row only*



8201-24H8FH

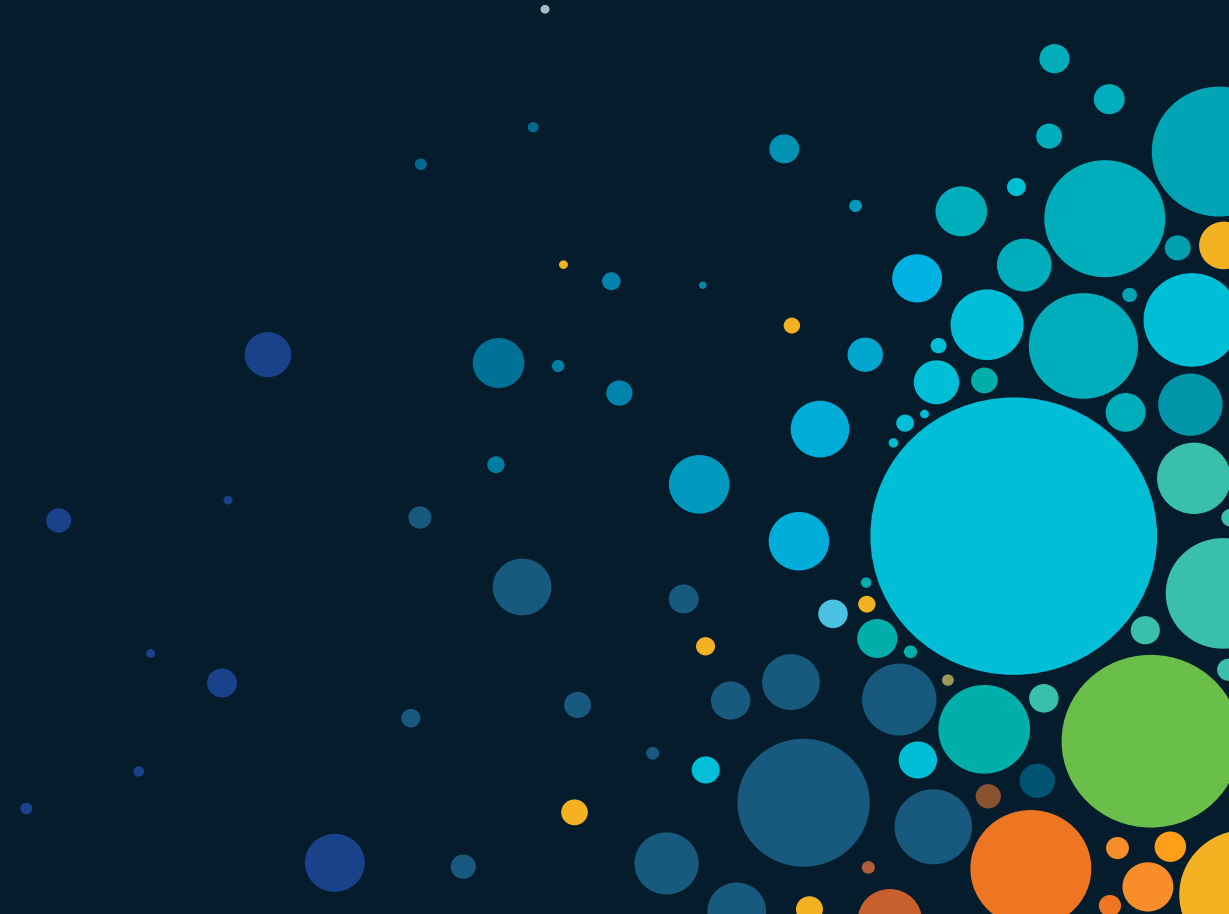


8201-32FH-M

* lower row ZR+ support in upcoming release

- ZR: all QSFP-DD cages

IOS XR7



The IOS XR Evolution Journey

IOS XR

- 32-bit QNX-based
- SMU based patches
- Highly reliable, large scale routing
- Core and edge use cases

IOS XR 64-Bit

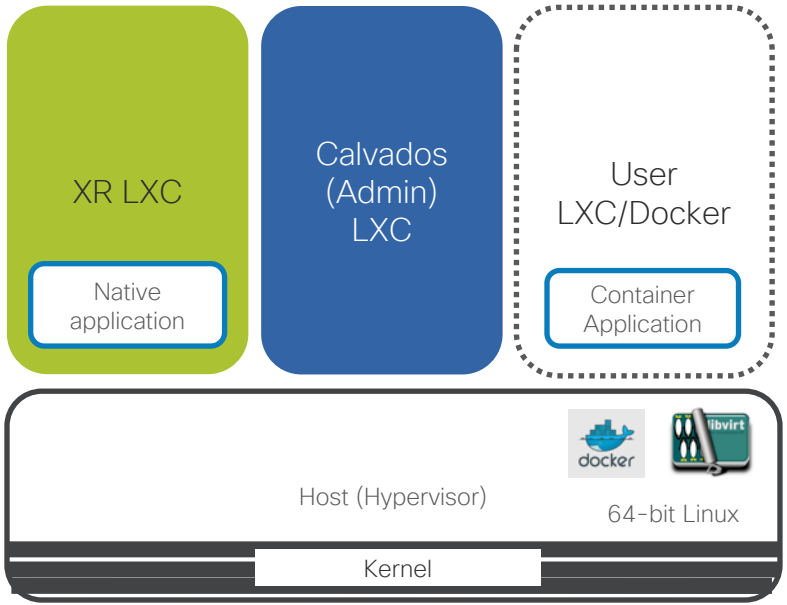
- 64-Bit Linux-based
- Merchant and Cisco silicon
- Cloud-Scale Ready!
  - ✓ Model-driven management + Telemetry
  - ✓ Automated device onboarding – ZTP, iPXE
  - ✓ Hosted third-party software

IOS XR7

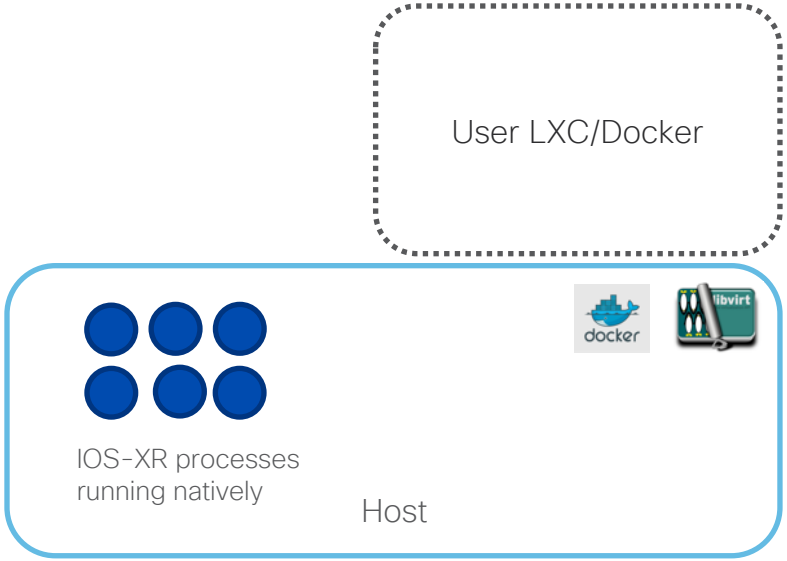
- Advanced flexibility for custom use cases
  - ✓ Model-driven APIs at all layers
- Security enhancements – Establish trust in the HW, SW & Network
- Simplification & Flexible Consumption
  - ✓ Disaggregated SW Offer
  - ✓ Optional SW packages

OS Evolution

Faster Boot, Lightweight, Simpler Architecture



IOS-XR 6.0.0+



IOS XR7

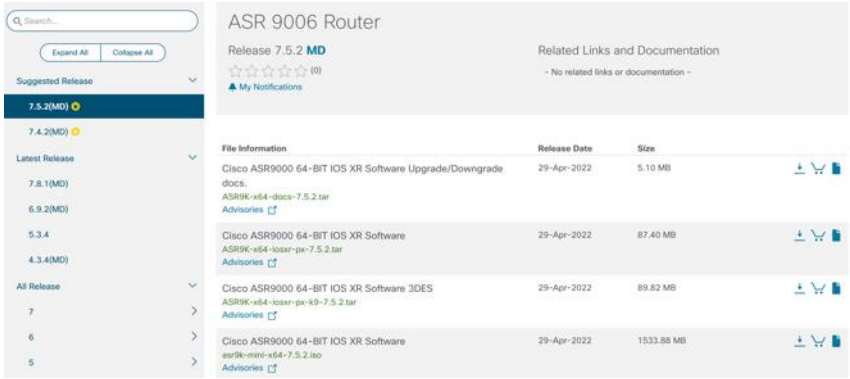
Supported Platforms

In addition to Cisco 8000

- All NCS 540*

- NCS 1010

- NCS-57B1

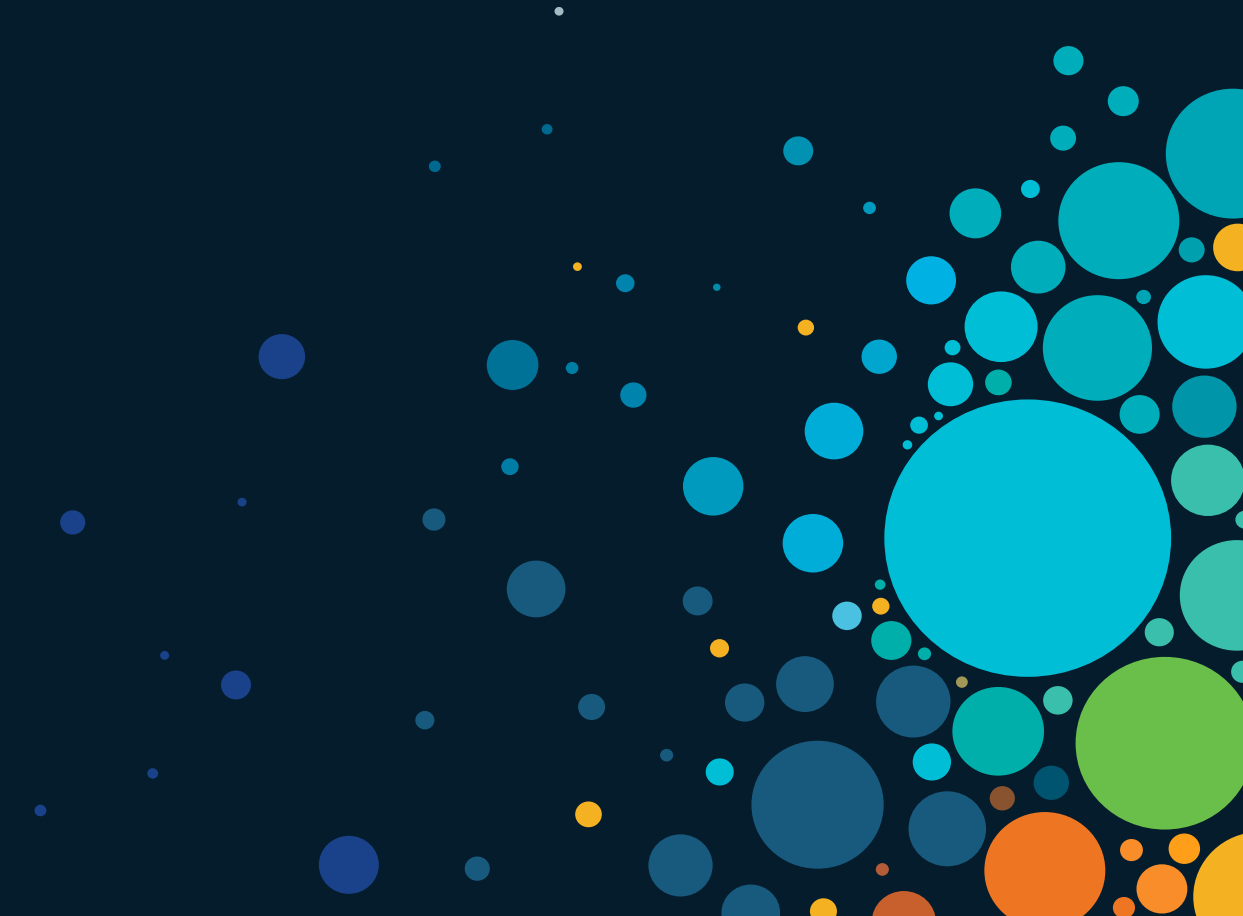


IOS XR7 Architecture !=

IOS-XR 7 Release

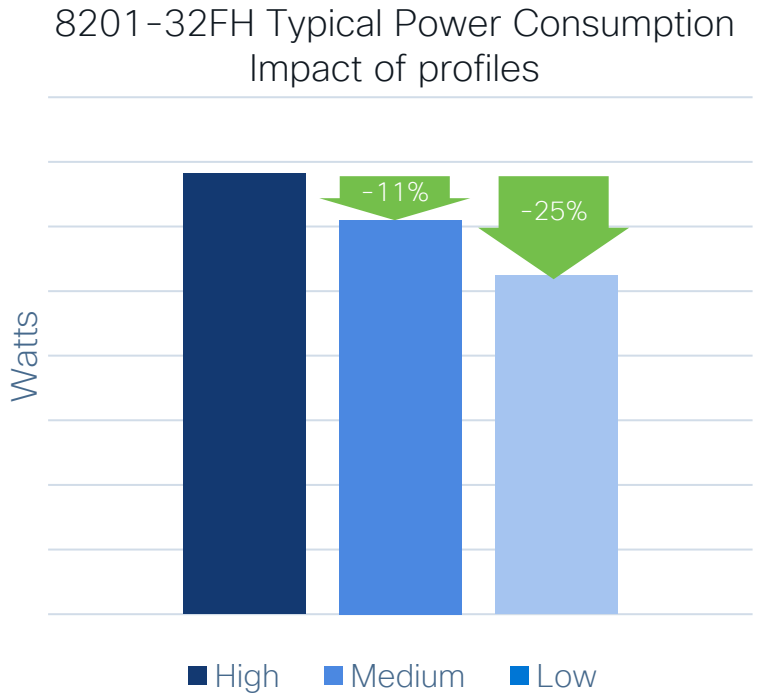
*Exception: N540ACC, N540X-ACC, N540-24Z8Q2C

Power Optimization



NPU Power Profiles

- Reduce power consumption by running NPU in a predefined mode
- Choice done based on network traffic and power consumption requirements
- Supported on Q200 PIDs only



NPU Power Optimization
Configuration – Fixed Systems

For 8000 fixed systems, location is always 0/RP0/CPU0

```
RP/0/RP0/CPU0:8200(config)#hw-module npu-power-profile high
```

```
RP/0/RP0/CPU0:8200#show controllers npu driver location 0/RP0/CPU0
Mon Aug 24 23:29:34.302 UTC
==============================================
NPU Driver Information
==============================================
Driver Version: 1 SDK Version: 1.32.0.1
Functional role: Active, Rack: 8203, Type: lcc, Node: 0
Driver ready : Yes
NPU first started : Mon Aug 24 23:07:41 2020
Fabric Mode:
NPU Power profile: High
Driver Scope: Node Respawn count : 1
Availablity masks : card: 0x1, asic: 0x1, exp asic: 0x1
...
```

NPU Power Optimization

Configuration – Distributed Systems

Configures fabric power mode, applies to all FC

FC power profile is checked on active RP

```
RP/0/RP0/CPU0:8808(config)#hw-module npu-power-profile card-type FC low
RP/0/RP0/CPU0:8808#sh controllers npu driver location 0/RP0/CPU0
Mon May  2 07:49:16.001 PDT
==========================================
NPU Driver Information
==========================================
Driver Version: 1
SDK Version: 1.52.0.1

Functional role: Active,     Rack: 8808, Type: lcc, Node: 0/RP0/CPU0
Driver ready      : Yes
NPU first started : Fri Apr 29 16:19:58 2022
Fabric Mode: FABRIC/8FC
NPU Power profile: Low
Driver Scope: Rack
Respawn count     : 1
Availablity masks :
        card: 0xff,     asic: 0xffff,    exp asic: 0xffff
```

NPU Power Optimization

Configuration – Distributed Systems

Configures fabric power mode, applies to specific LC

LC power profile is checked on LC

```
RP/0/RP0/CPU0:8808(config)#hw-module npu-power-profile LC low location 0/4/cpu0
RP/0/RP0/CPU0:8808#sh controllers npu driver location 0/4/CPU0
Mon May  2 07:54:00.606 PDT
==============================================
NPU Driver Information
==============================================
Driver Version: 1
SDK Version: 1.52.0.1

Functional role: Active,     Rack: 8808, Type: lcc, Node: 0/4/CPU0
Driver ready      : Yes
NPU first started : Fri Apr 29 16:29:34 2022
Fabric Mode: FABRIC/8FC
NPU Power profile: Low
Driver Scope: Node
Respawn count     : 1
Availablity masks :
        card: 0x1,     asic: 0x3,    exp asic: 0x3
```

Introducing 800G

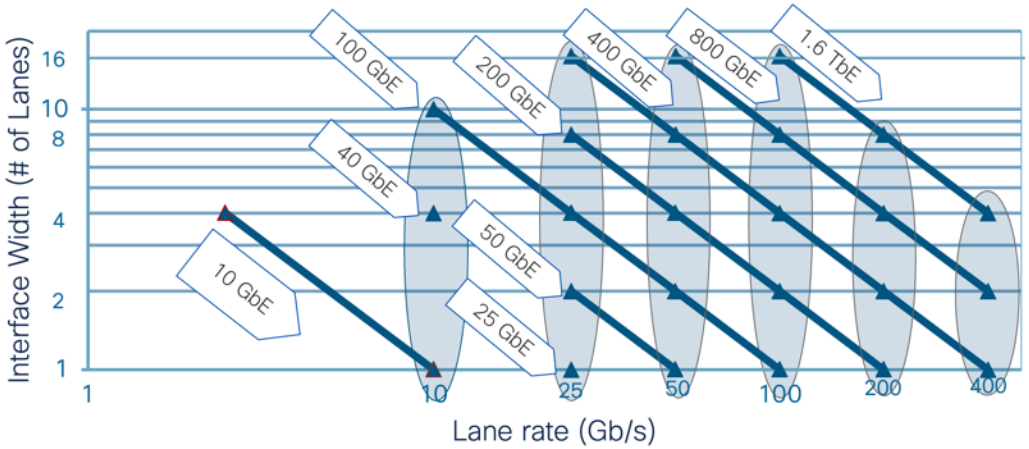
SerDes: What is it?

- Serializer/Deserializer (*SerDes*)
- Speeds: 28G, 56G, 112G

  Interface width (# of Lanes)

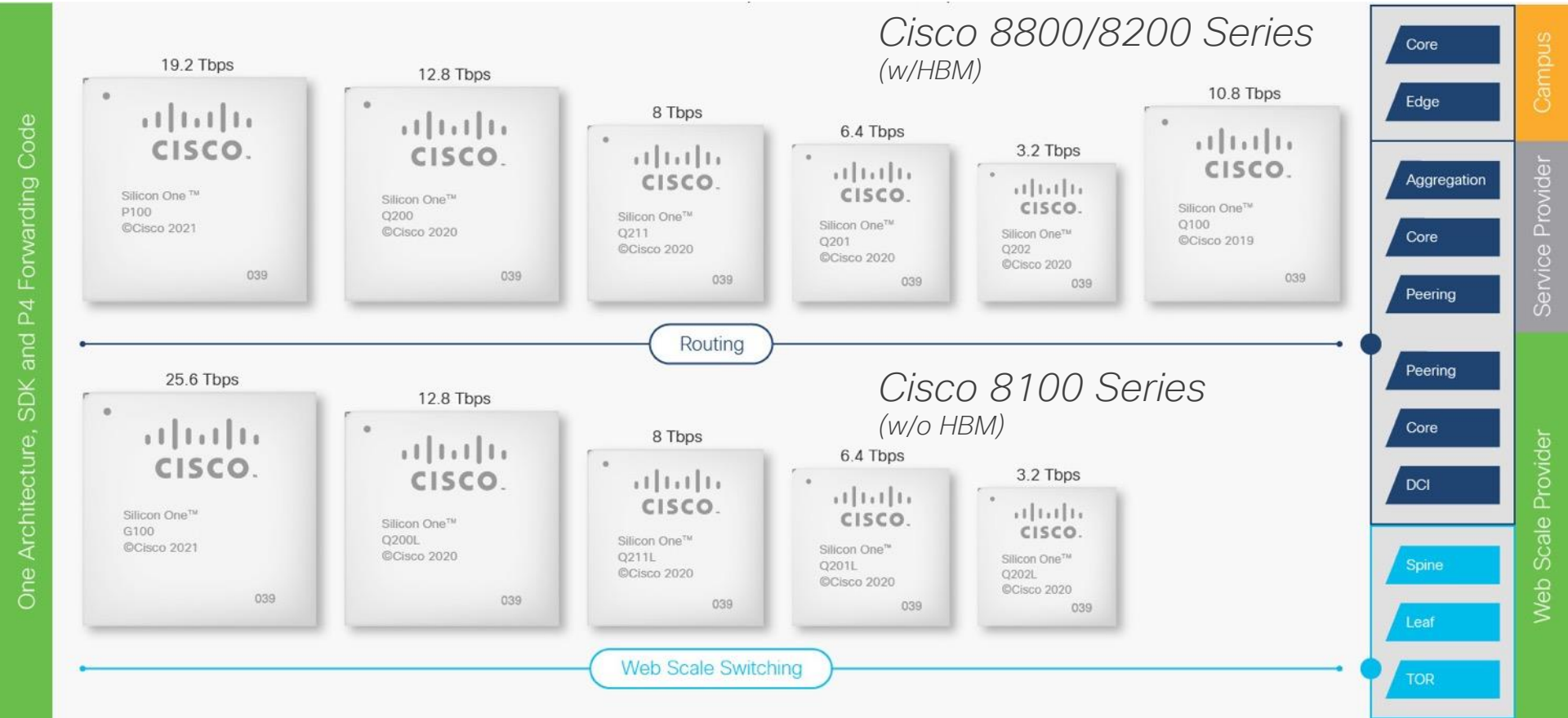
  x Lane rate

  = Interface Speed
- 400G = 8 x 50G
- 800G = 8 x 100G



Different from optical lanes (λ)

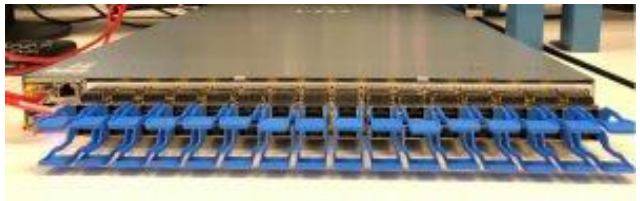
Cisco Silicon One Family



800G Optics & Connectors

- Optics: QSFP-DD800

  - Backward compatibility
  - Designed for coherent:



Fixed system with 32 QSFP-DD800 thermals modules running @ 30W

- Other options possible

- Connectors:

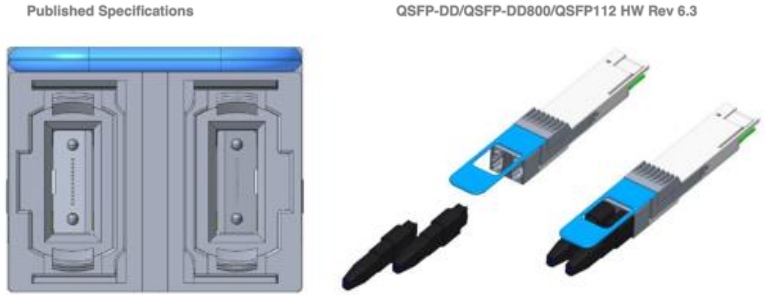


Figure 40: Dual MPO module receptacle (in support of breakout applications)

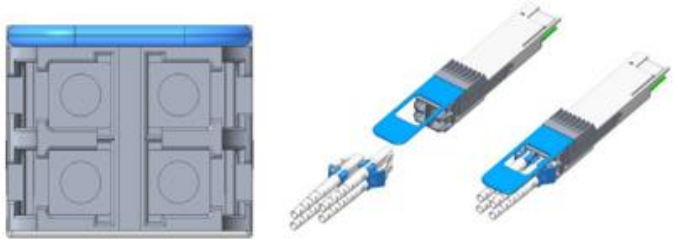
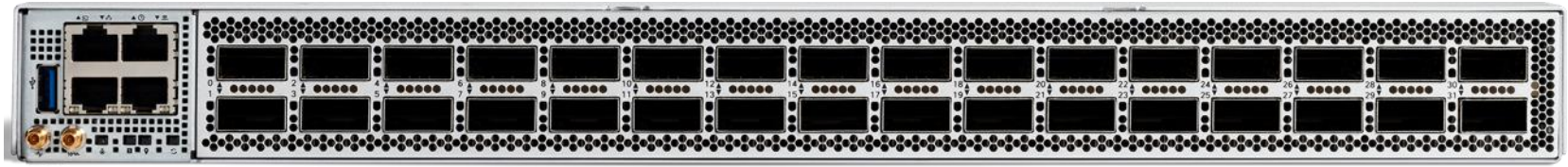


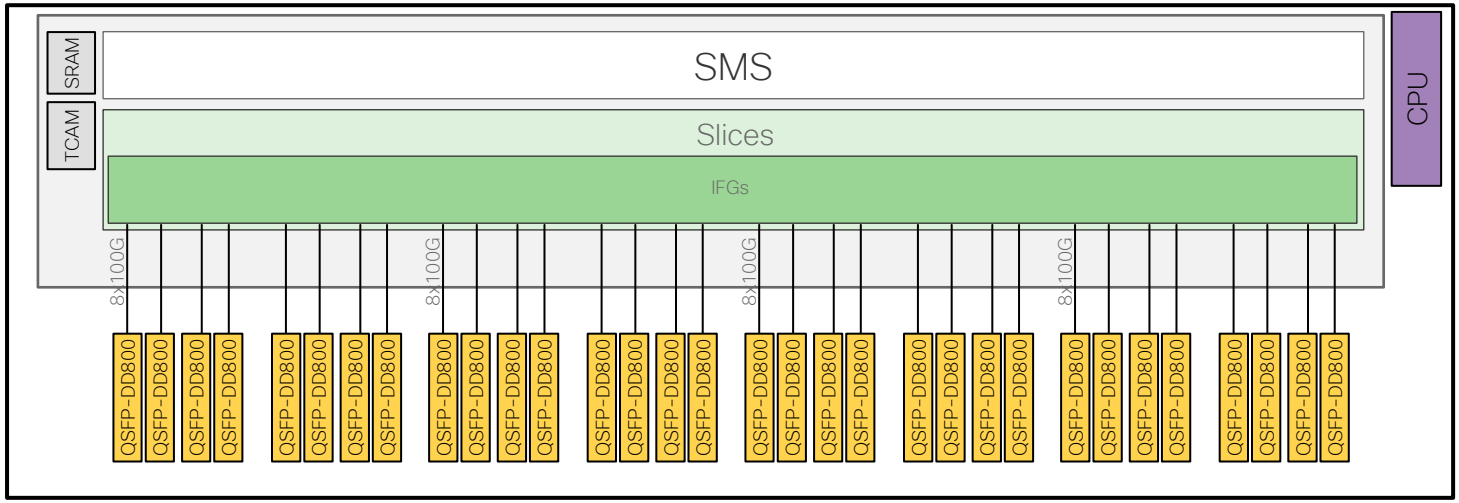
Figure 37: Dual Duplex LC module receptacle (in support of breakout applications)

8111-32EH



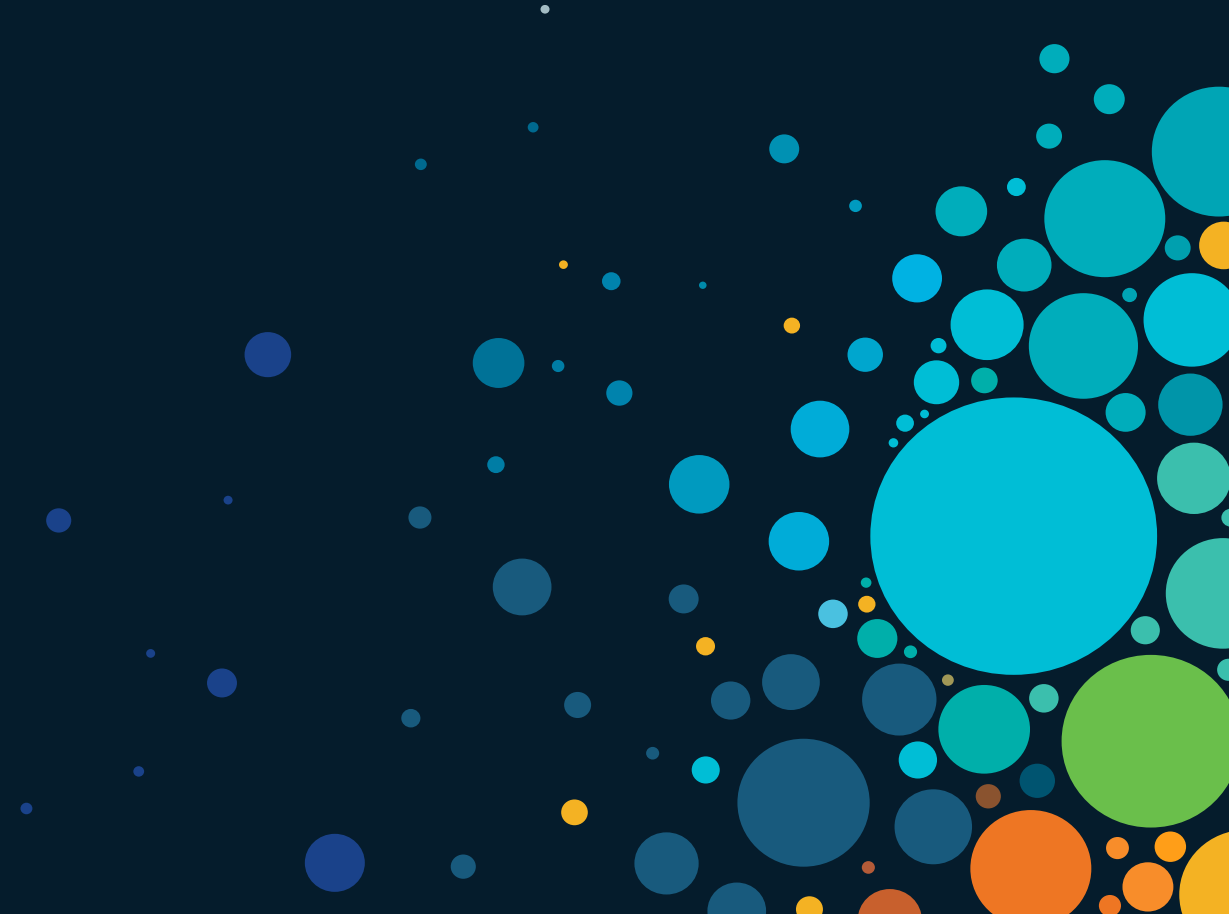
- 1 RU Fixed System, 32x QSFP-DD800 optics
- Cisco Silicon One G100
- Intel Broadwell-DE (4 cores @ 2.4 GHz), 32 GB DDR4 DRAM, 128 GB SSD
- 6 Fan Trays (N+1), 2 Power Supplies (N+1)

8111-32EH Architecture



- Breakout capable to 2x400 GbE or 8x 100 GbE or 4x100 GbE
  - Other options in roadmap

Conclusion

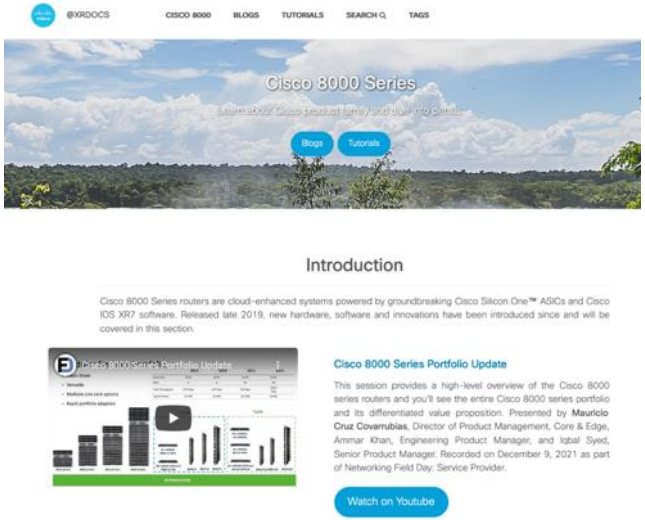


Acknowledgements

- Ahmad Bilal Siddiqui, CS Lee, Eddie Chami, Lane Wigley, LJ Wobker, Ram Mohan, Mark Nowell

References

- Public References & Press Releases available on The Newsroom
- xrdocs.io 8000 section is live!



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