Nexus 9000 Architecture

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BRKDCN-3939

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Session Abstract

This session presents an in-depth study of the architecture of the latest generation of Nexus 9000 modular and top-of-rack data center switches. Topics include forwarding hardware, switching fabrics, and other physical design elements, as well as a discussion of key hardware-enabled features and capabilities that combine to provide high-performance data center network services.

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What this session covers

- Latest generation of Nexus 9000 switches with Cloud Scale ASICs
- Nexus 9500 modular switches with Cloud Scale linecards
- Nexus 9300 Cloud Scale top-of-rack (TOR) switches
- System and hardware architecture, key forwarding functions, packet walks

Not covered:

- First generation and merchant-silicon based Nexus 9000 ASIC/platform architectures
- Nexus 9800 architectures
- Other Nexus platforms
- *Catalyst* 9000 platform

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Agenda

- Data Center and Silicon Strategy
- Cloud Scale ASIC Architecture
- Cloud Scale Switching Platforms
- Packet Walks
- Key Takeaways

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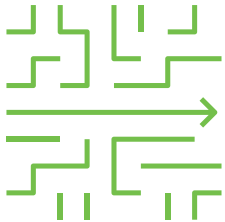
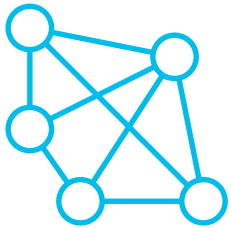
Cisco Data Center network strategy



Operational Simplicity



Sustainable Data Center Networking

Networking for AI/ML

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Nexus 9000 cloud scale switching portfolio

Key Elements of the Data Center Strategy

Nexus 9300-FX2/FX3, GX/GX2, H1/H2R and 9408

Premier TOR platforms

Nexus 9500 with X9700-FX/FX3 and X9700-GX Modules

Flagship switching modules for Nexus 9500 modular chassis

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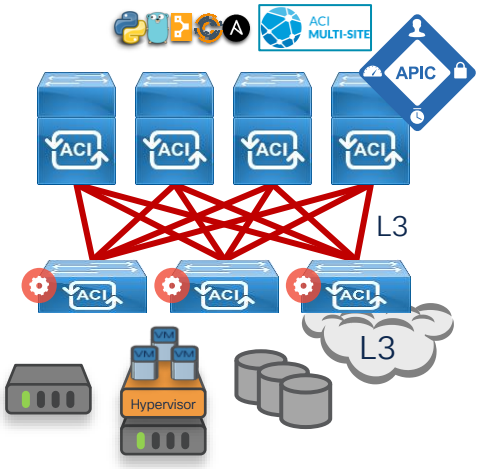
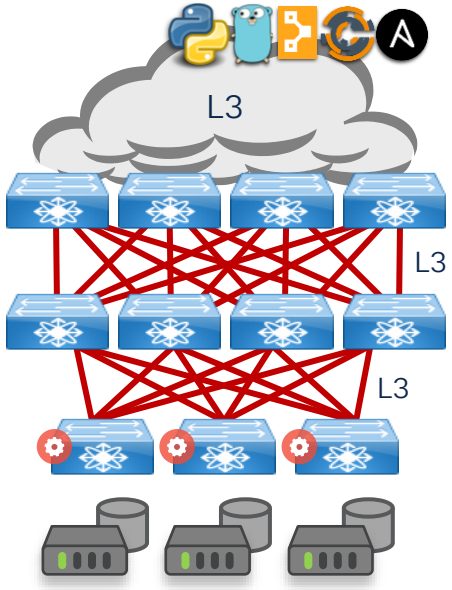
Building Data Center fabrics with Nexus 9000

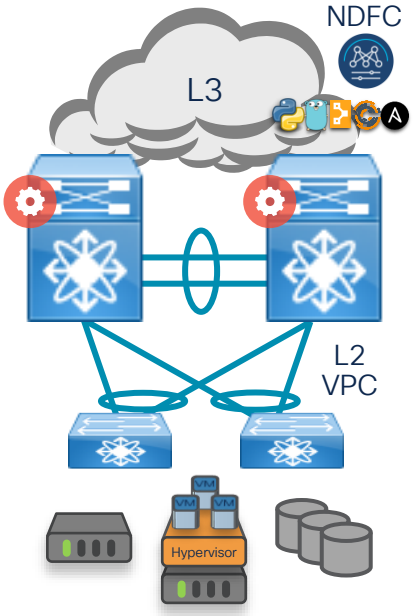


ACI – Turnkey fabric

Standalone – Programmable fabric with VXLAN+EVPN



Standalone – Programmable IP Network



Standalone – Traditional Data Center Network

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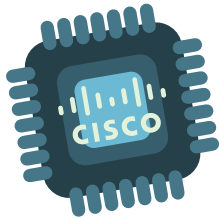
Why Custom Silicon?



- Cisco competitive advantage – vehicle for differentiating innovations
  - ACI policy model
  - Flexible forwarding tiles
  - Single-pass tunnel encapsulations
  - In-built encryption technologies
  - Intelligent buffers
  - Streaming hardware telemetry
- Tight integration between hardware / software / marketing / sales / support
- Closely aligns hardware designs with software innovations, strategic product direction, competitive differentiators, serviceability

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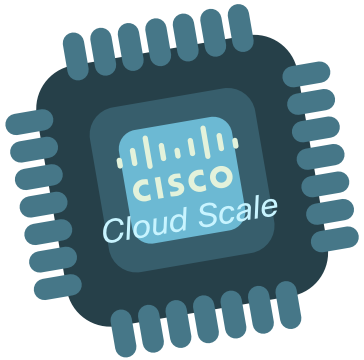
Cisco cloud scale ASIC family

- **Ultra-high port densities** → Reduces equipment footprint, enables device consolidation, denser fabric designs
- **Multi-speed 100M/1/10/25/40/50/100G/400G** → Flexibility and future proofing
- **Rich forwarding feature-set** → ACI, Segment Routing, single-pass L2/L3 VXLAN routing
- **Flexible forwarding scale** → Single platform, multiple scaling alternatives
- **Intelligent buffering** → Shared egress buffer with dynamic, advanced traffic optimization
- **In-built analytics and telemetry** → Real-time network visibility for capacity planning, security, and debugging



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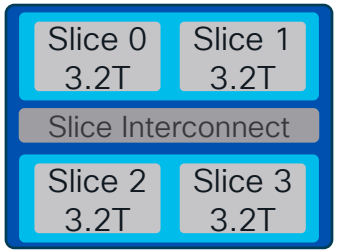
Key cloud scale family members

LS25600GX2A – 64 x 400G

25.6T chip – 4 slice pairs of 8 x 400G

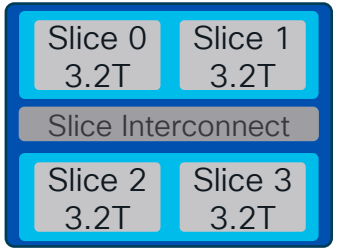
9300-GX2A TORs; 9408 centralized modular TOR



LS12800GX2B – 32 x 400G

12.8T chip – 2 slice pairs of 8 x 400G

9300-GX2B TOR



LS12800 H2R – 32 x 400G

12.8T chip – 2 slice pairs of 8 x 400G, 8GB HBM

9300-H2R TOR

LS6400H1 – 16 x 400G

6.4T chip – 2 slices of 8 x 400G

9300-H1 TORs

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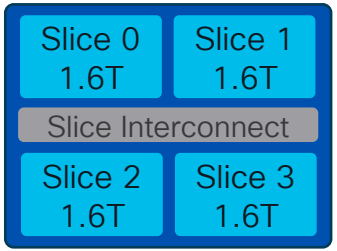
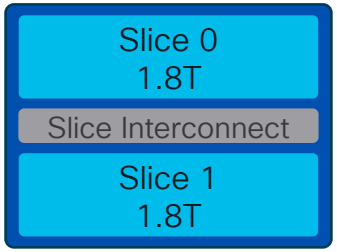
Key cloud scale family members



LS6400GX – 16 x 400G

6.4T chip – 4 slices of 4 x 400G
X9700-GX modular linecards;
9300-GX TORs



LS3600FX2 – 36 x 100G

3.6T chip – 2 slices of 18 x 100G
with MACsec 9300-FX2 TORs

LS1800FX/FX3 – 18 x 100G

1.8T chip – 1 slice of 18 x 100G
with MACsec X9700-FX/FX3 modular linecards;
9300-FX3 TORs

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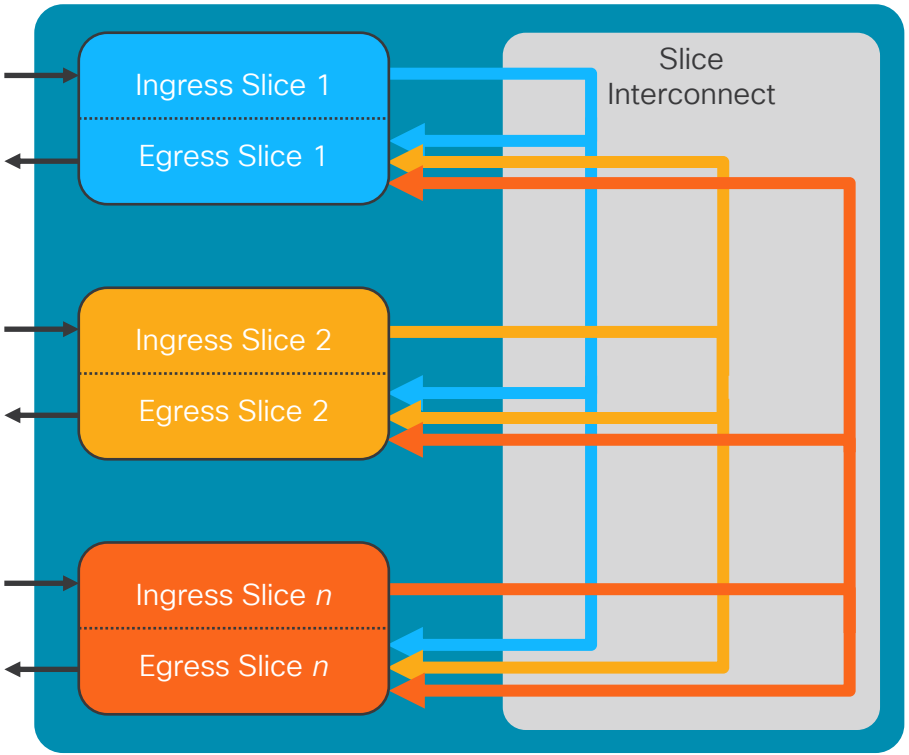
What is a “Slice”?

- Self-contained forwarding complex controlling subset of ports on single ASIC
- Separated into Ingress and Egress functions
- Ingress of each slice connected to egress of all slices
- Slice interconnect provides non-blocking any-to-any interconnection between slices



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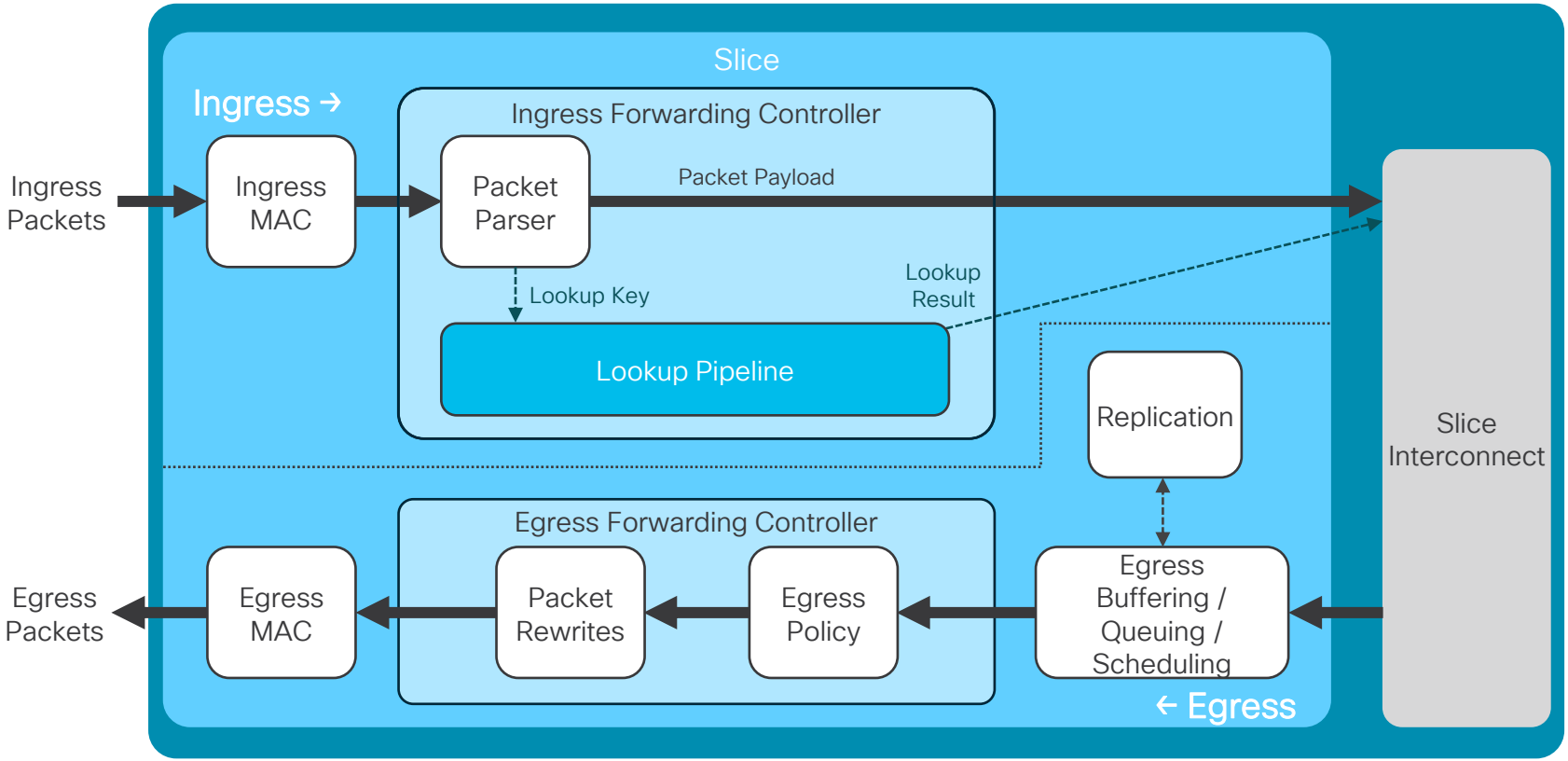
Slice forwarding path



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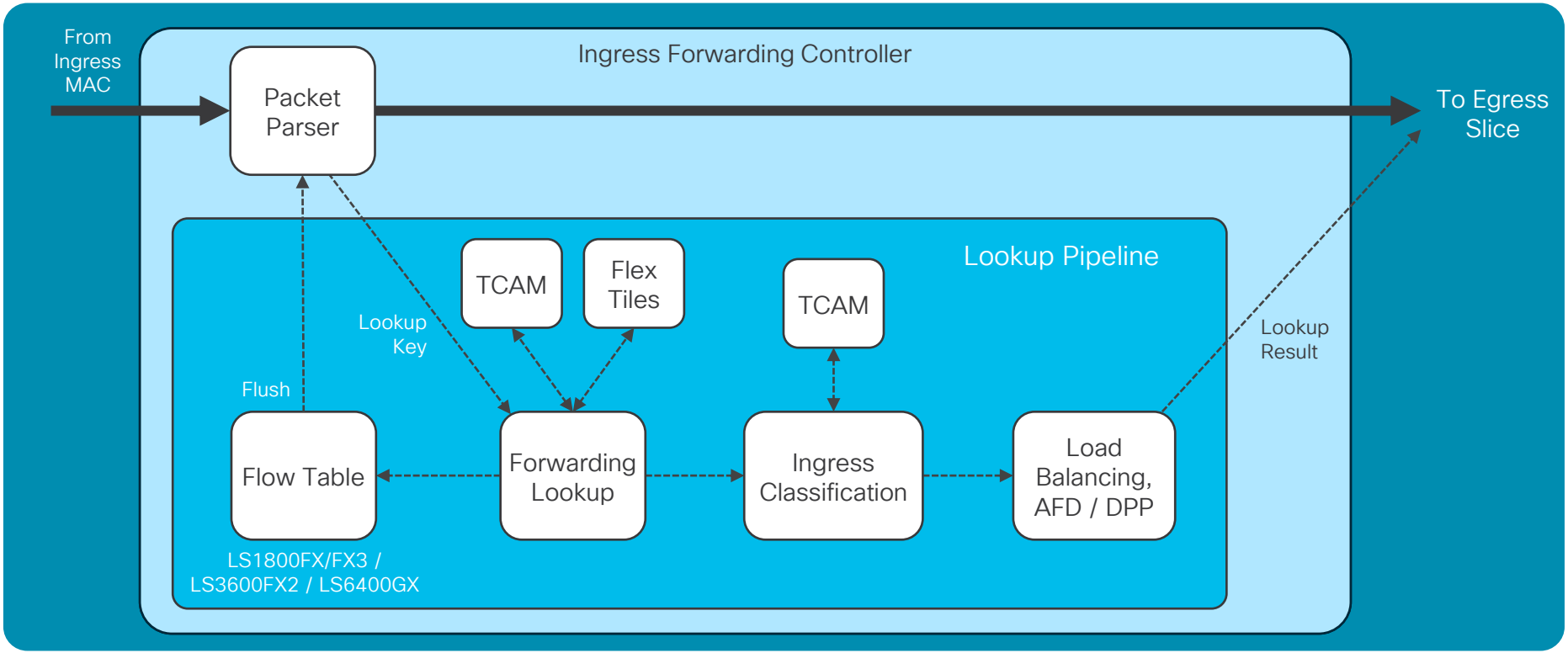
Ingress lookup pipeline



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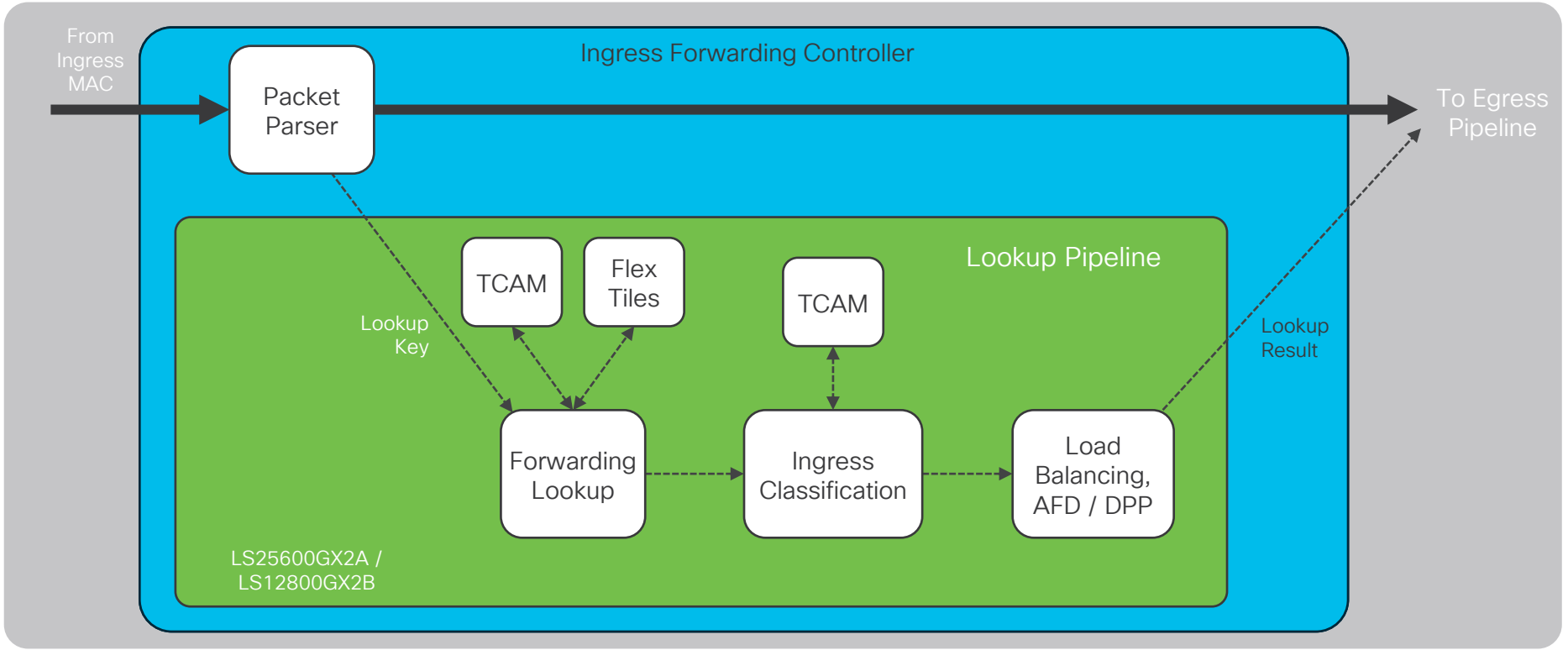
Ingress lookup pipeline – 9300-GX2/H



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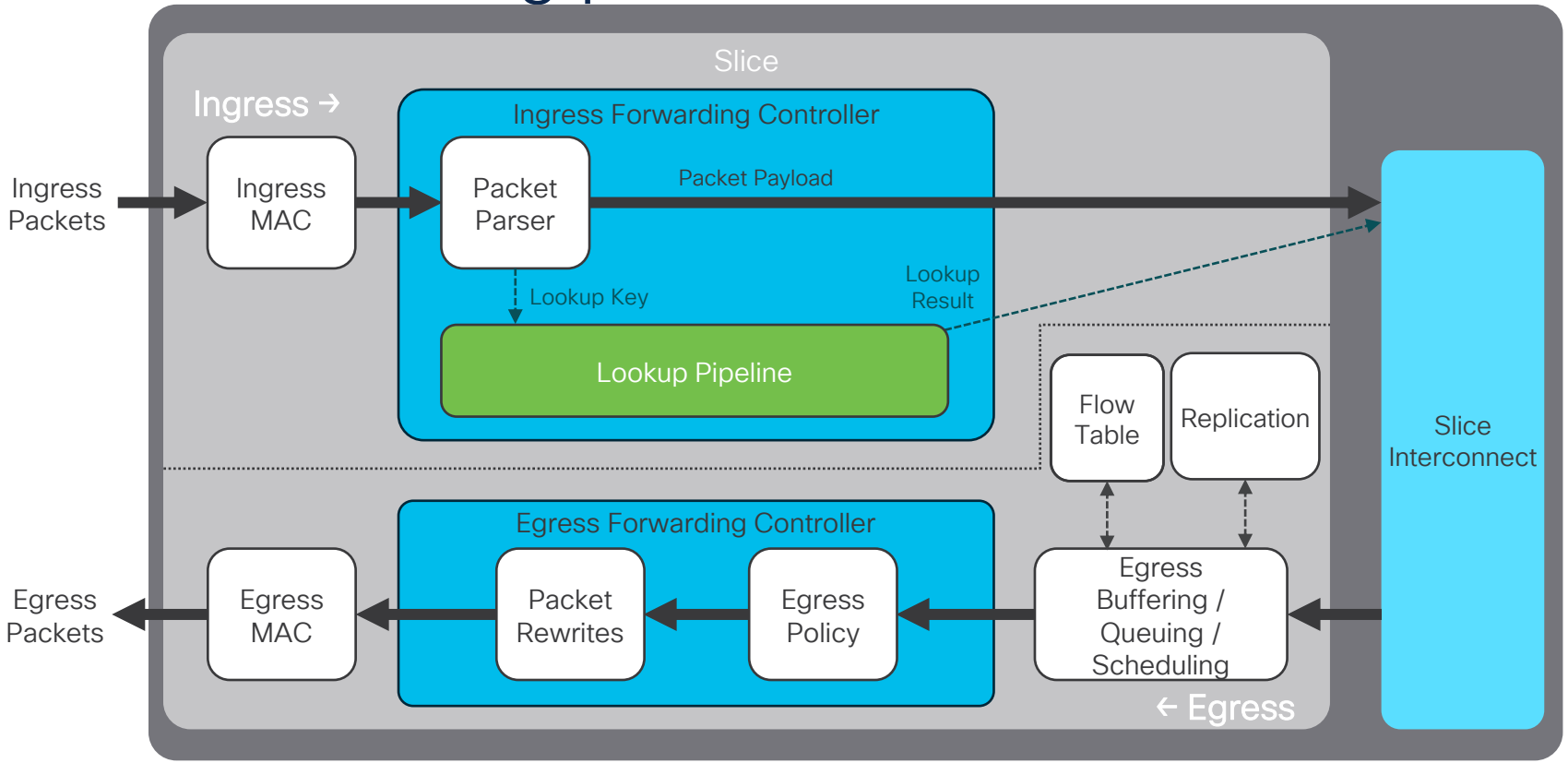
Slice forwarding path – 9300-GX2/H



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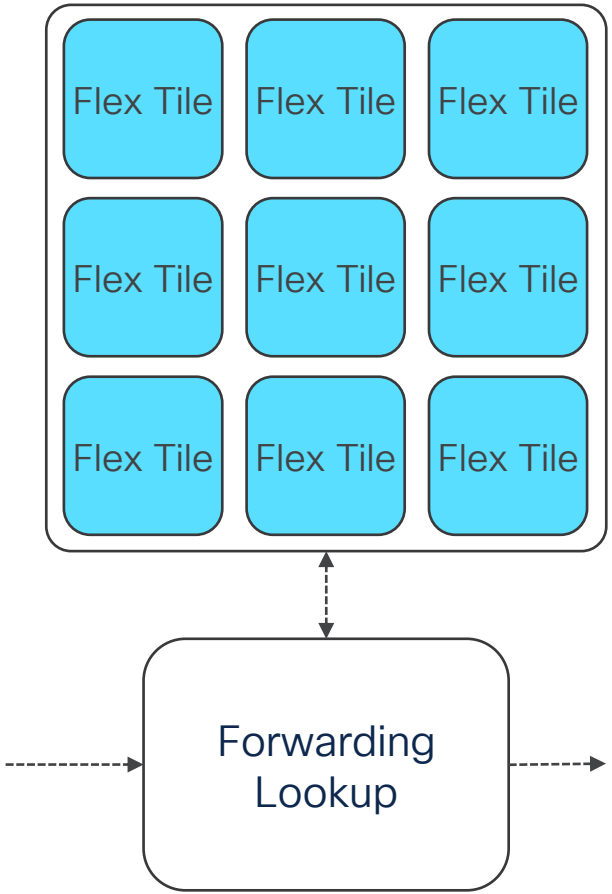
Flexible forwarding tiles

- Provide fungible pool of table entries for lookups
- Number of tiles and number of entries in each tile varies between ASICs
- Variety of functions, including:
  - IPv4/IPv6 unicast longest-prefix match (LPM)
  - IPv4/IPv6 unicast host-route table (HRT)
  - IPv4/IPv6 multicast (*,G) and (S,G)
  - MAC address/adjacency tables
  - ECMP tables
  - ACI policy



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Flex tile routing templates

- Configurable forwarding templates determine flex tile functions
  - “system routing template” syntax
- Templates as of NX-OS 10.5(2):
  - Default
  - Dual-stack host scale*†
  - Dual-stack multicast
  - Internet peering*
  - LPM heavy
  - L2-heavy
  - L3-heavy
  - MPLS heavy*
  - Multicast heavy
  - Multicast extra-heavy
  - Service provider
- Defined at system initialisation – reboot required to change profile

* Template does not support IP multicast
† Template not supported on modular Nexus 9500
** Template not supported on TORs

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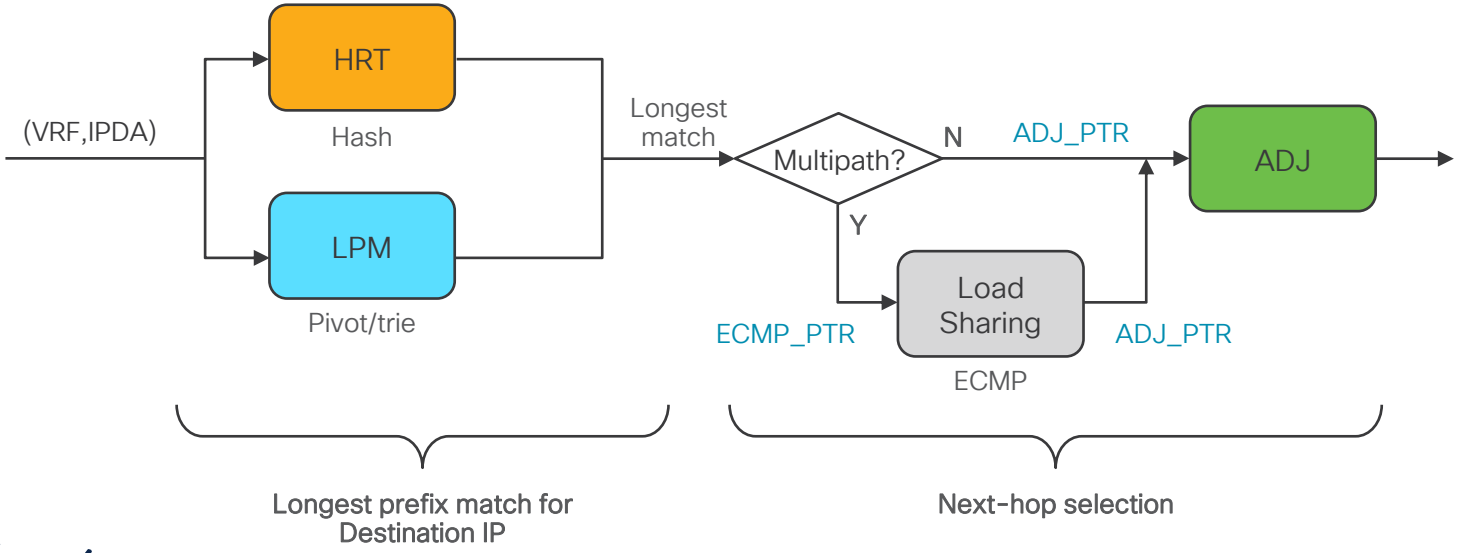
IP unicast forwarding

- Hardware lookup in flex tiles based on (VRF, IPDA)
- Longest-match from hash-based exact match (**HRT**) + pivot/trie match (**LPM**)
- Lookup result returns **adjacency** – directly or via **load-sharing** decision (ECMP)



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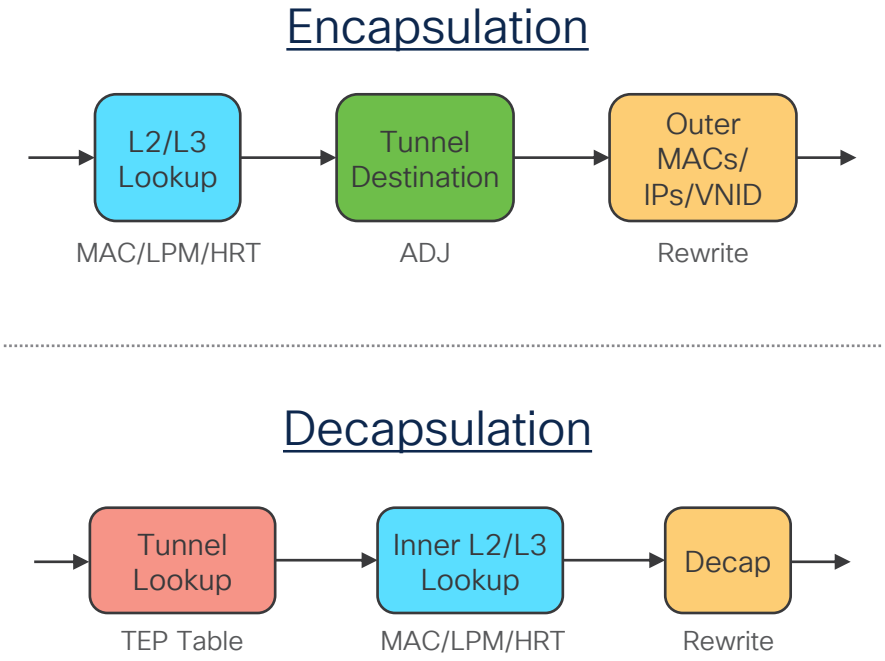
VXLAN forwarding

- VXLAN and other tunnel encapsulation/ decapsulation performed in single pass
- Encapsulation
  - L2/L3 lookup drives tunnel destination
  - Rewrite block drives outer header fields (tunnel MACs/IPs/VNID, etc.)
- Decapsulation
  - Outer lookup determines if tunnel is transit or terminated on local TEP
  - Inner lookup determines final output port and rewrites



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Load sharing

Equal-Cost Multipath (ECMP)

- Static flow-based load-sharing
- Picks ECMP next-hop based on hash of packet fields and universal ID
  - Source / destination IPv4 / IPv6 address (L3)
  - Source / destination TCP / UDP ports (L4)
  - L3 + L4 (default)
  - GRE key field
  - GTP TEID
  - User Defined Field

Dynamic Load-Balancing (DLB)

- Congestion aware, flow-based or flowlet-based – rebalances flows/flowlets based on path congestion
- Works in overlay and native IP networks
- Useful for heavy flows load-balancing

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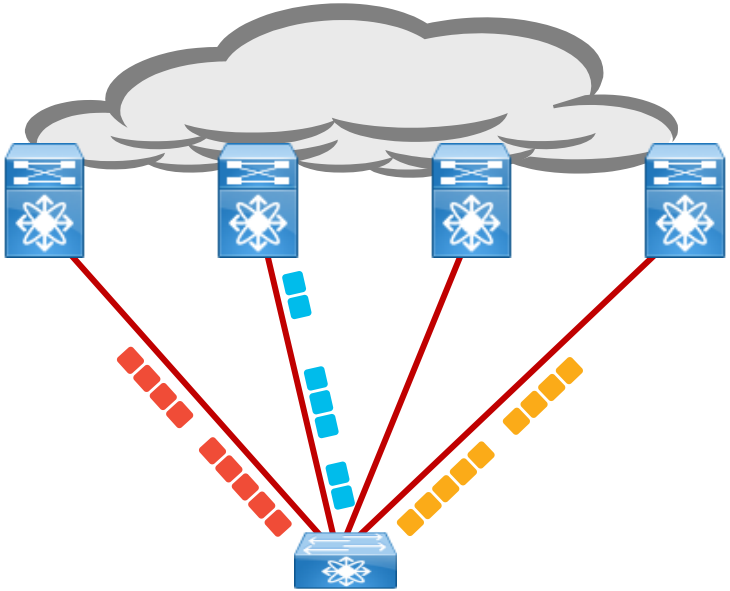
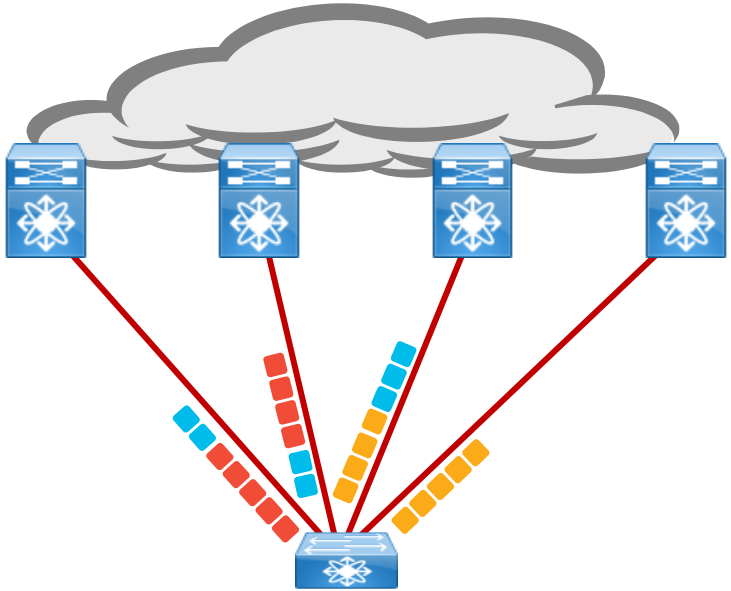
ECMP versus DLB load-sharing



ECMP



DLB

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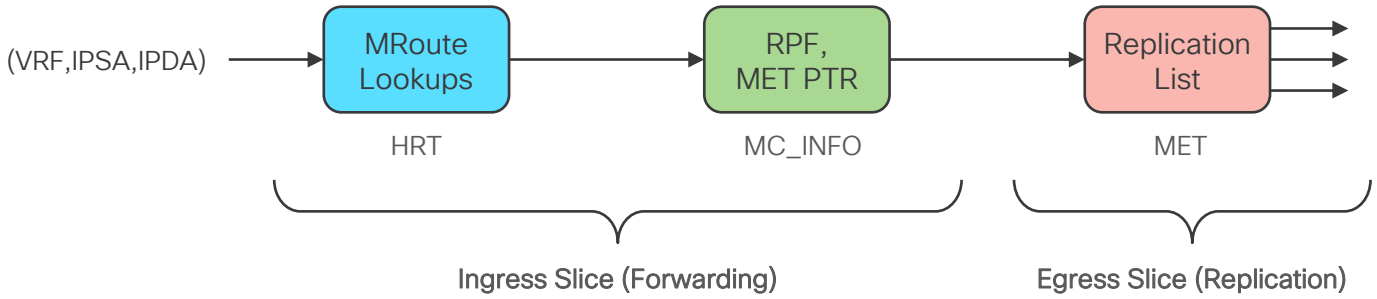
Multicast forwarding

- Hardware performs multicast lookups in **HRT**
- Additional, secondary table for multicast also provisioned (“MC_INFO”) from flex tiles – **RPF check** and **MET pointer**
- **MET** in egress slice holds local output interface list (OIL)
- Replication is single copy, multiple reads



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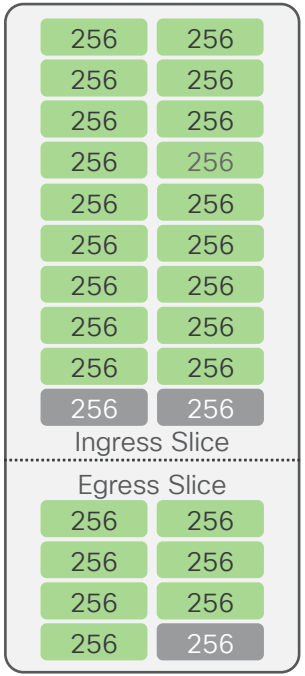
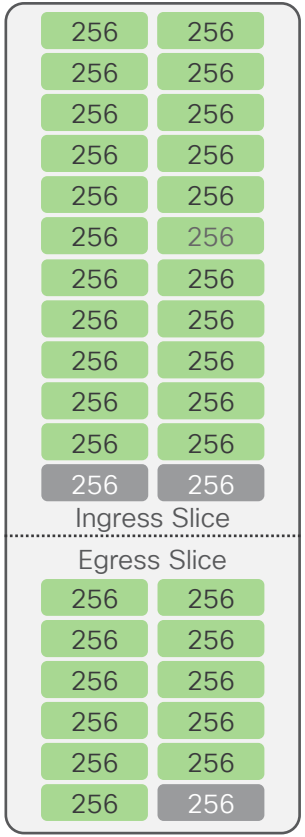
Classification TCAM

- Dedicated TCAM for packet classification
- Capacity varies depending on platform
- Leveraged by variety of features:
  - RACL / VACL / PACL
  - L2/L3 QOS
  - SPAN / SPAN ACL
  - NAT
  - COPP
  - Flow table filter



LS1800FX3 / LS3600FX2 / LS6400GX

5K ingress ACEs / 2K egress ACEs per slice



LS12800GX2B / LS26500GX2A

6K ingress ACEs / 3K egress ACEs per slice

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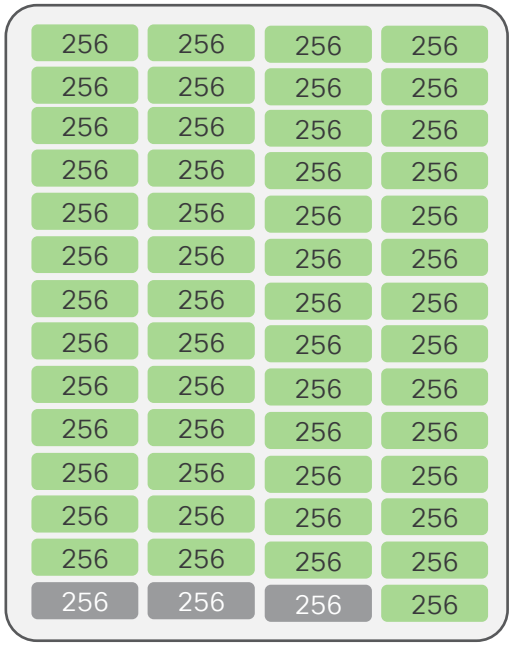
Classification TCAM

- Dedicated TCAM for packet classification
- Capacity varies depending on platform
- Leveraged by variety of features:
  - RACL / VACL / PACL
  - L2/L3 QOS
  - SPAN / SPAN ACL
  - NAT
  - COPP
  - Flow table filter



LS6400H1/LS12800H2R
14K shared ACEs per slice

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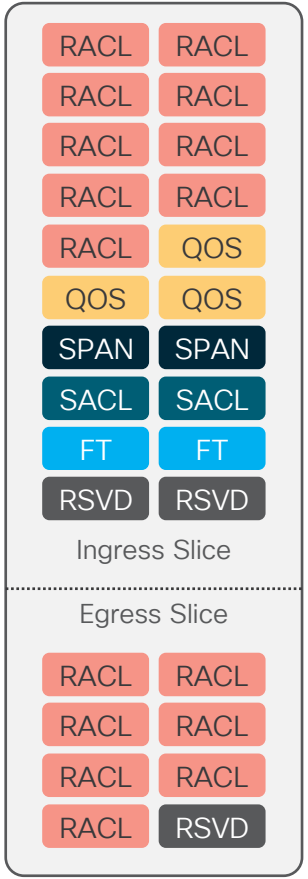
TCAM region resizing

- Default carving allocates 100% of TCAM and enables:
  - Ingress / Egress RACL
  - Ingress QOS
  - SPAN
  - SPAN ACLs
  - Flow table filter
  - Reserved regions
- Based on features required, user can resize TCAM regions to adjust scale
  - To increase size of a region, some other region must be sized smaller
- Region sizes defined at initialisation – changing allocation requires system reboot
  - Configure all regions to desired size (“hardware access-list tcam region”), save configuration, and reload



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Cloud scale hardware telemetry

Flow Table (FT)

- Captures full data-plane packet flow information, plus metadata

Flow Table Events (FTE)

- Triggers notifications based on thresholds / criteria met by data-plane packet flows

Data-Plane Flow Data

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Flow table

- Collects full flow information plus metadata
  - 5-tuple flow info
  - Interface/queue info
  - Flow start/stop time
  - Packet disposition (drop indicators)
  - Burst measurement
- 32K flow table entries per slice FX/FX2/FX3
- 64K flow table entries per slice on GX/GX2A
- 128K flow table entries per slice on GX2B/H1/H2R
- Direct hardware export
- Leveraged by Nexus Dashboard Insights, Netflow
- FX3 / FX2 / GX / GX2B / GX2A / H2R / H1 platforms support hardware flow table

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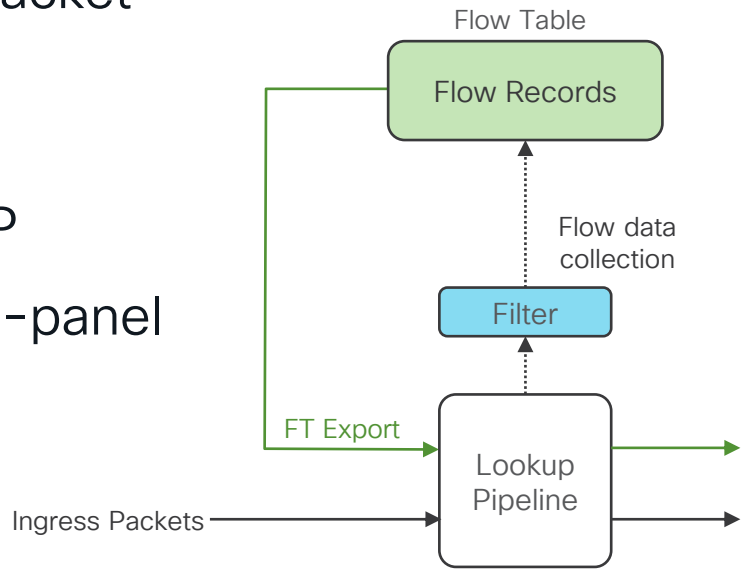
Flow table operation – ND insights

- Determine if collection enabled for packet (filter TCAM)
- If so, install FT record
- Flush records, encapsulate in IP/UDP
- Perform lookup and forward on front-panel port



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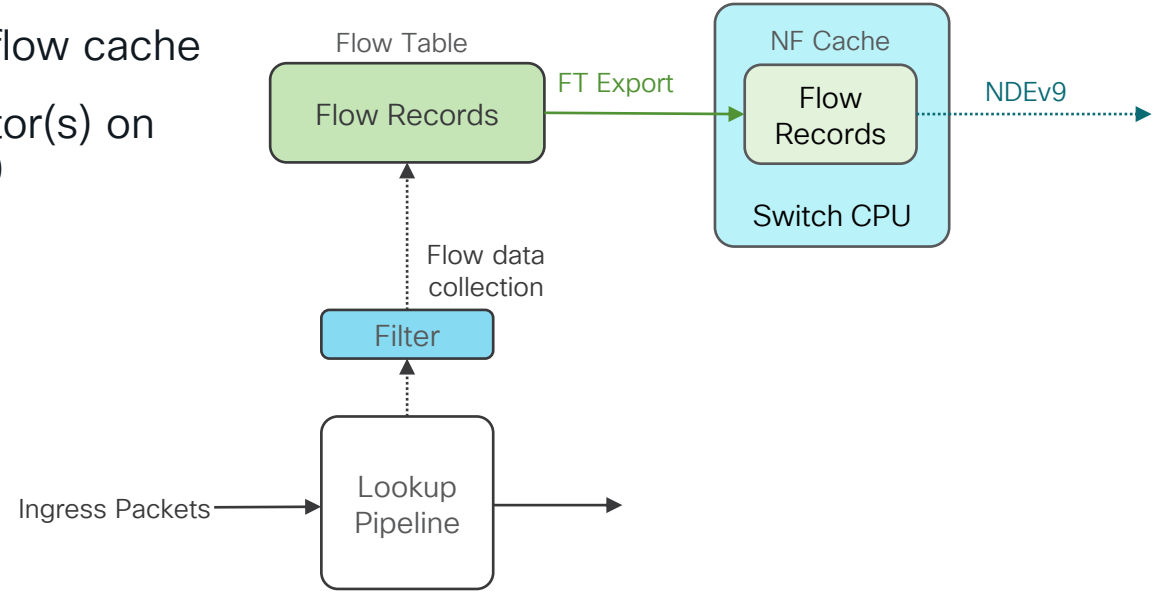
Flow table operation – Netflow

1. Install FT records as usual
2. Flush records to switch CPU
3. CPU builds traditional Netflow cache
4. NDEv9 exported to collector(s) on front-panel port or mgmt0



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Flow table events

- Triggers notifications based on criteria / thresholds met by data-plane packet flows
- Collects full flow information plus metadata
  - 5-tuple flow info with timestamp
  - Interface/queue info
  - Buffer drop indication
  - Forwarding drop, ACL drop, policer drop indication
  - Latency/burst threshold exceeded indication
- Direct hardware export, with flow-level and global throttling
- FX3 / FX2 / GX / GX2B / GX2A / H2R / H1 platforms support hardware flow table events

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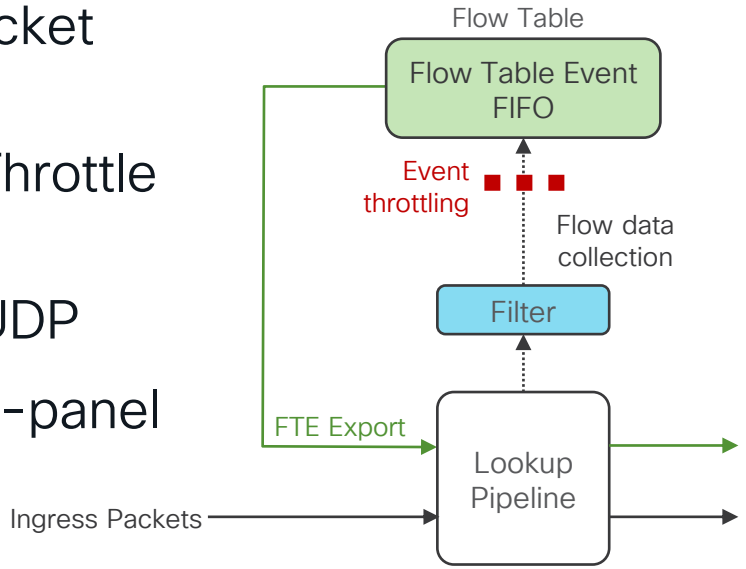
Flow table events operation

- Determine if event(s) enabled for packet (filter TCAM)
- If so, collect flow data in FTE FIFO; Throttle excess events
- Flush and encapsulate record in IP/UDP
- Perform lookup and forward on front-panel port



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Hardware telemetry platform support

Platform	ASIC	FT	FTE
9300-H2R	LS12800H2R	✓	✓
9300-H1	LS6400H1	✓	✓
9300-GX2A	LS25600GX2A	✓	✓
9300-GX2B	LS12800GX2B	✓	✓
9300-GX / X9700-GX	LS6400GX	✓	✓
9300-FX2	LS3600FX2	✓	✓
9300-FX3/ X9700-FX3	LS1800FX3	✓	✓
X9700-FX	LS1800FX	✓	✓

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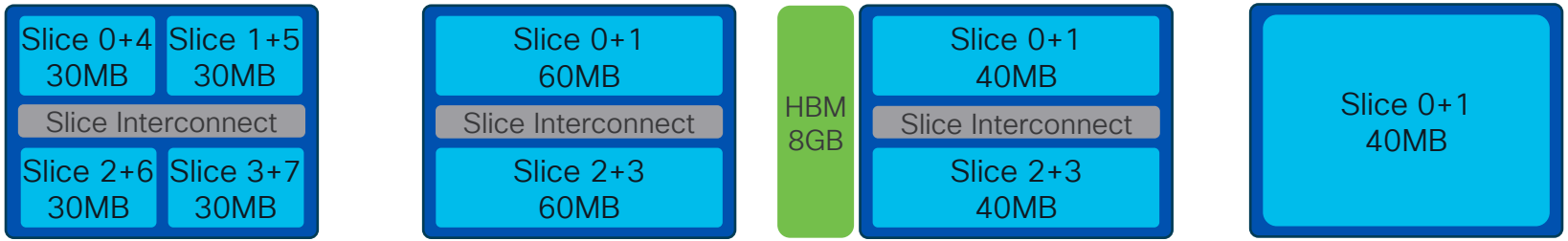
Buffering

- Cloud Scale platforms implement shared-memory egress buffered architecture
- Slices share pool of buffer – ports on a slice pairs can use that buffer
- Dynamic Buffer Protection adjusts max thresholds based on class and buffer occupancy
- Intelligent buffer options maximize buffer efficiency



LS25600GX2A
30MB/slice pair
(120MB total)

L12800GX2B
60MB/slice pair
(120MB total)

LS12800 H2R
40MB/slice pair
(80MB total)

LS6400H1
40MB/slice pair
(40MB total)

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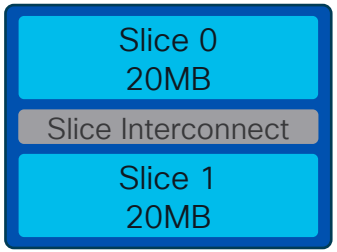
Buffering

- Cloud Scale platforms implement shared-memory egress buffered architecture
- Each ASIC slice has dedicated buffer – only ports on that slice can use that buffer
- Dynamic Buffer Protection adjusts max thresholds based on class and buffer occupancy
- Intelligent buffer options maximize buffer efficiency

LS6400GX
20MB/slice
(80MB total)



LS3600FX2
20MB/slice
(40MB total)

LS1800FX/FX3
40MB/slice
(40MB total)

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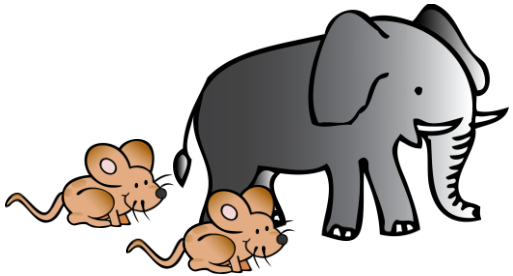
Intelligent buffering

Innovative Buffer Management for Cloud Scale switches

- **Dynamic Buffer Protection** (DBP) – Controls buffer allocation for congested queues in shared-memory architecture
- **Approximate Fair Drop** (AFD) – Maintains buffer headroom per queue to maximize burst absorption
- **Dynamic Packet Prioritization** (DPP) – Prioritizes short-lived flows to expedite flow setup and completion



Images courtesy of:
https://www.clker.com/clipart-206333.html
https://www.clker.com/clipart-catroon-mouse.html

Miercom Report: Speeding Applications in Data Center Networks
http://miercom.com/cisco-systems-speeding-applications-in-data-center-networks/

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Dynamic Buffer Protection (DBP)

- Prevents any output queue from consuming more than its fair share of buffer in shared-memory architecture
- Defines dynamic max threshold for each queue
  - If queue length exceeds threshold, packet is discarded
  - Otherwise, packet is admitted to queue and scheduled for transmission
- Threshold calculated by multiplying free memory by configurable, per-queue **Alpha** (α) value (weight)
  - Alpha controls how aggressively DBP maintains free buffer pages during congestion events

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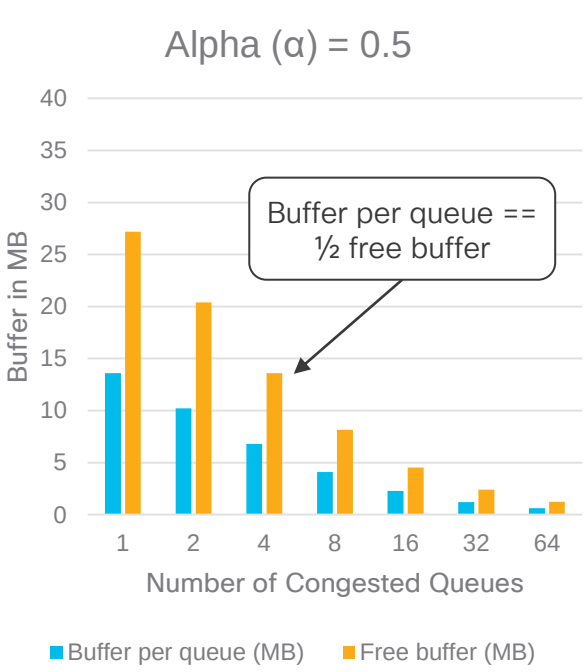
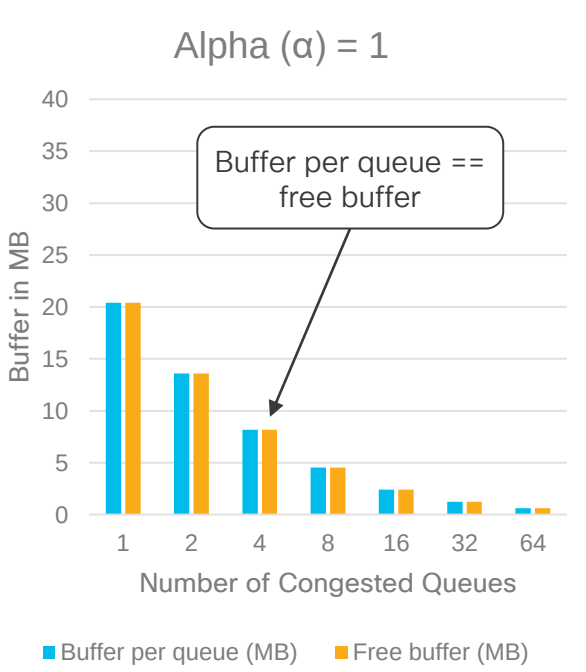
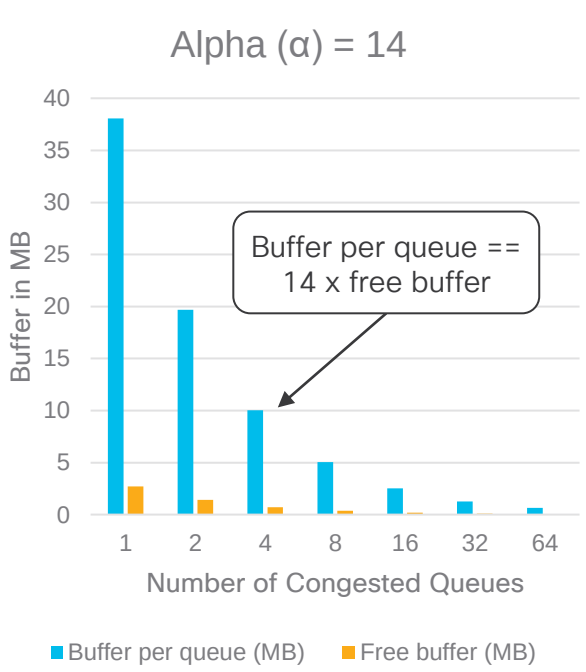
Alpha parameter examples

Default Alpha on Cloud Scale switches







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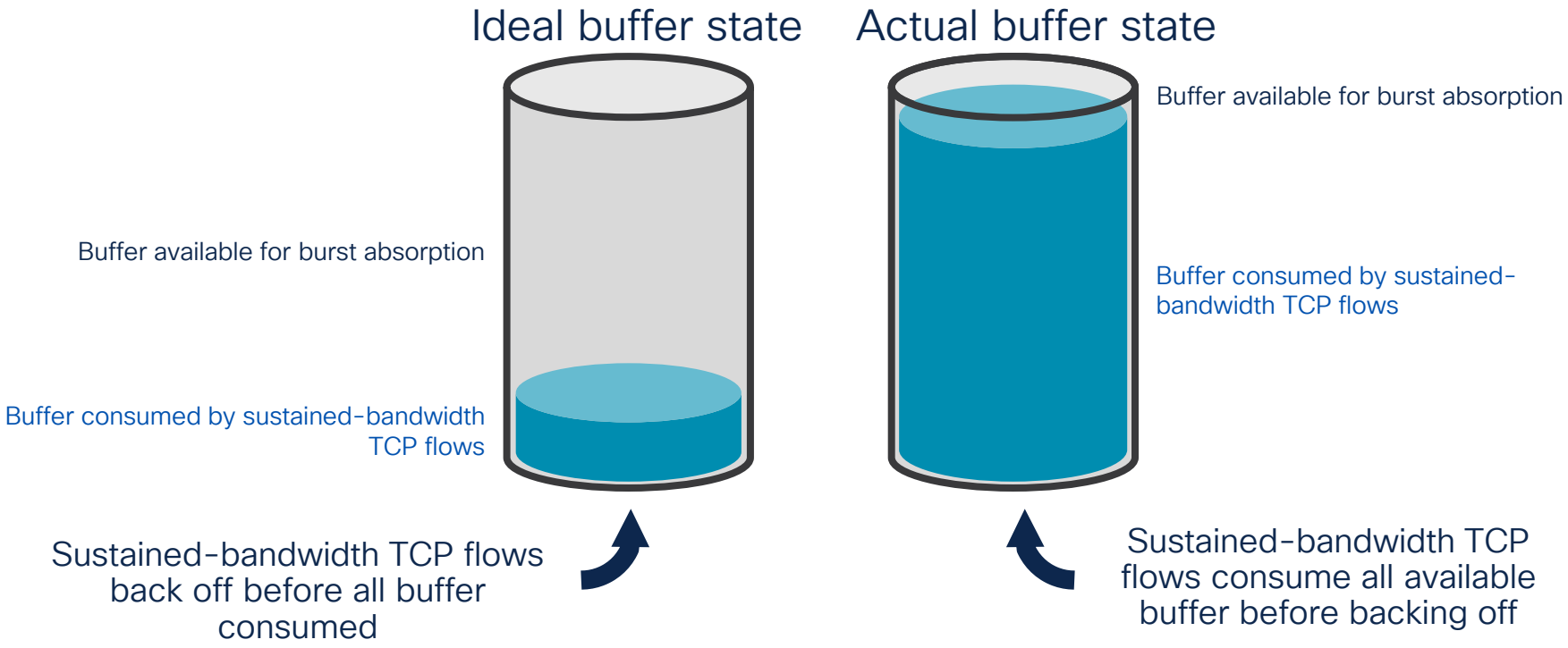
Buffering – ideal versus reality



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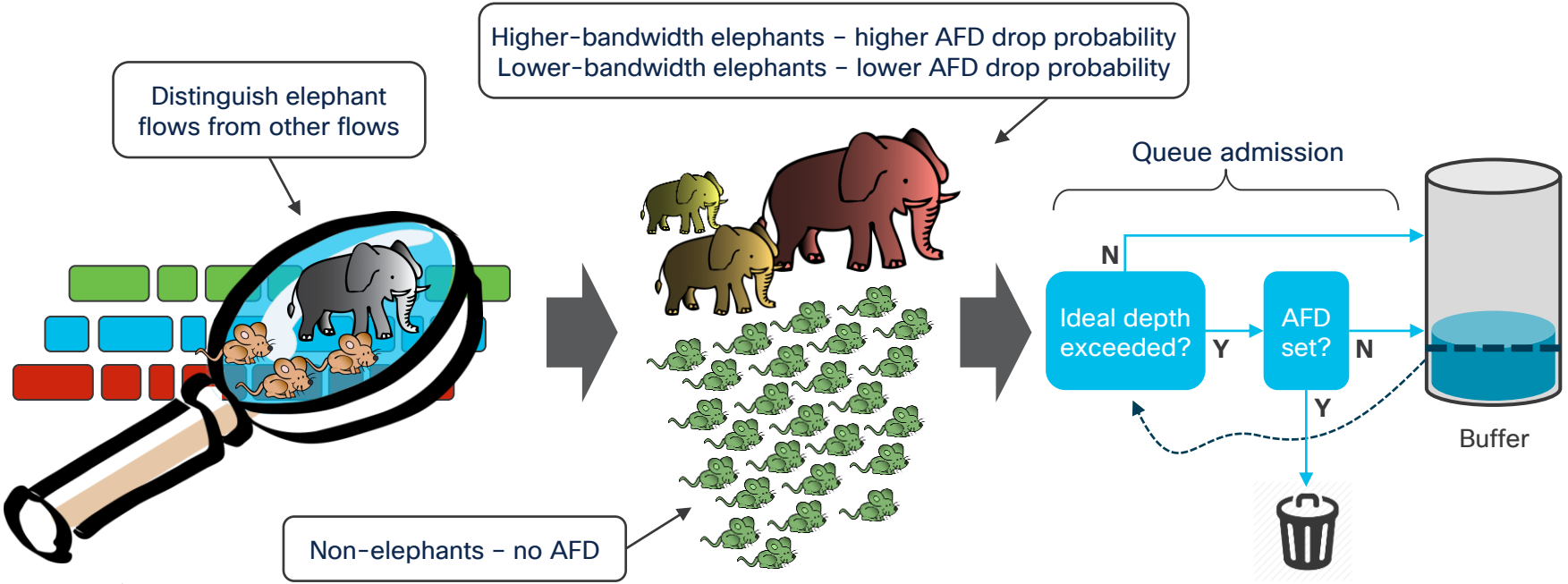
Approximate Fair Drop (AFD)

Maintain throughout while minimizing buffer consumption by elephant flows – **keep buffer state as close to the ideal as possible**



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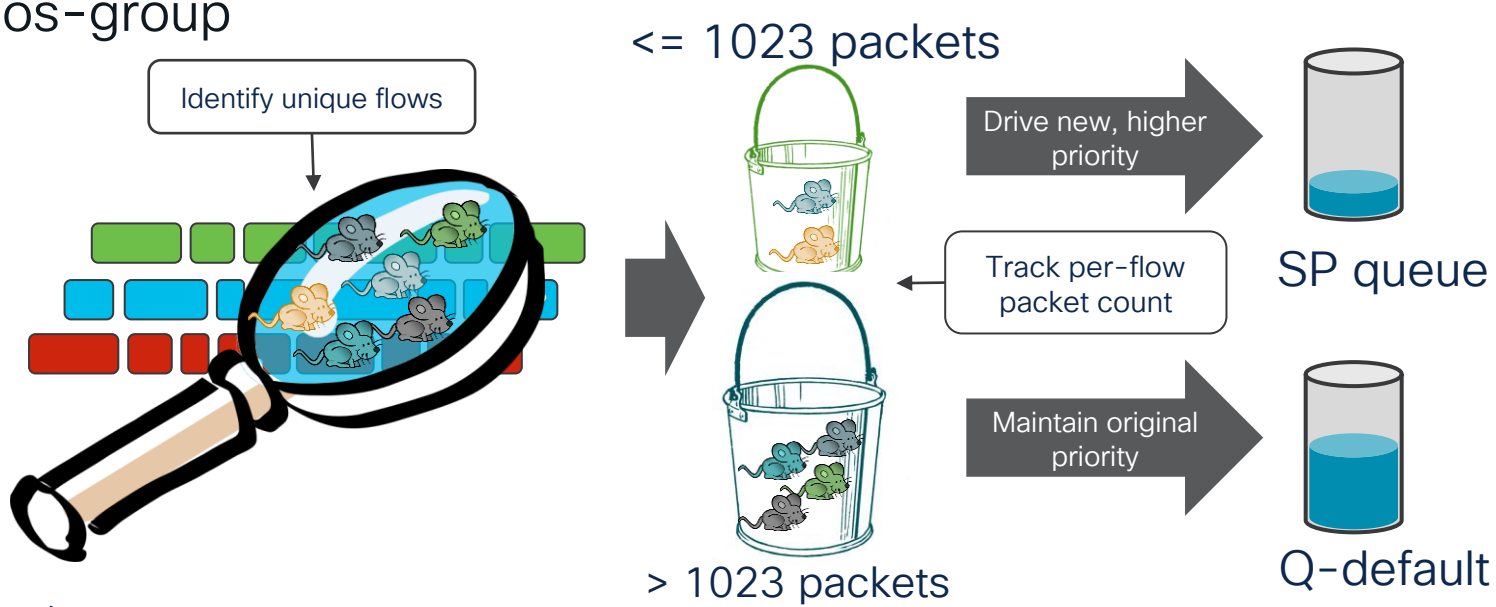
Dynamic Packet Prioritization (DPP)

- Prioritize initial packets of new / short-lived flows
- Up to first 1023 packets of each flow assigned to higher-priority qos-group



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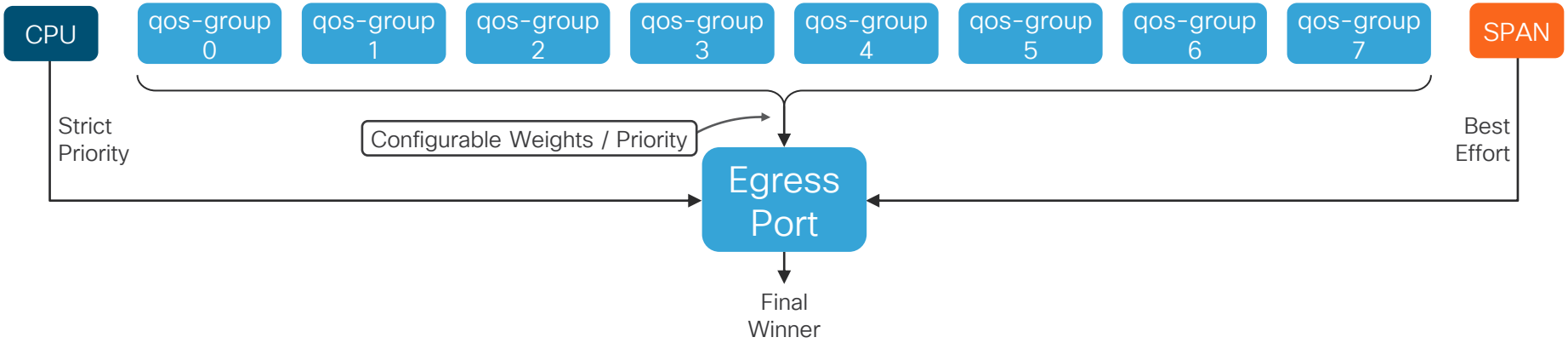
Queuing and scheduling



- 8 qos-groups per output port – shared by unicast and multicast traffic
- Egress queuing policy defines priority and weights
- Dedicated classes for CPU traffic and SPAN traffic

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Agenda

- Data Center and Silicon Strategy
- Cloud Scale ASIC Architecture
- Cloud Scale Switching Platforms
- Packet Walks
- Key Takeaways

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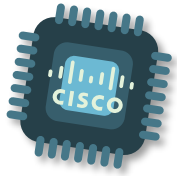
Cloud scale platforms



Nexus 9300-FX2/FX3, GX/GX2, H1/H2R and 9408

- Premier TOR platforms
- Full Cloud Scale functionality
- ACI leaf / standalone leaf or spine
- FX2 option with key enhancements using LS3600FX2 silicon
- GX option with 400G and SRv6
- GX2 high density 400G
- H1 key enhancement
- H2 deep buffer and advanced timing

Nexus 9500 with X9700-FX/FX3 and X9700-GX Modules

- Switching modules for Nexus 9500 modular chassis
- Full Cloud Scale functionality
- ACI spine / standalone aggregation or spine
- FX/FX3 option with MACsec using LS1800FX/FX3 silicon
- GX option with MACsec

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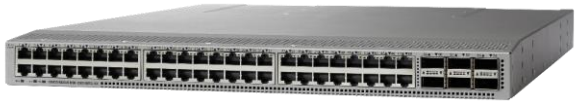
Nexus 9300-EX cloud scale TOR switches

48-port 10/25G SFP28 + 6-port 100G QSFP28
N9K-C93180YC-EX – LSE-based
ACI: 1.3(1)
NX-OS: 7.0(3)I4(2)



48-port 1/10GBASE-T + 6-port 100G QSFP28
N9K-C93108TC-EX – LSE-based
ACI: 2.0(1)
NX-OS: 7.0(3)I4(2)

Key Features

Dual capability – ACI and NX-OS mode

Flexible port configurations – 1/10/25/40/50/100G

Native 25G server access ports

Flow Table for ND Insights, Netflow

Smart buffer capability (AFD / DPP)

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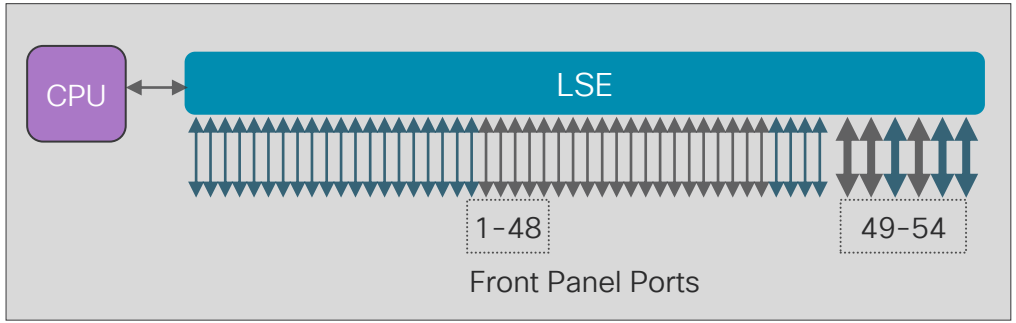
Nexus 9300-EX switch architectures



C93180YC-EX (10/25G + 100G) /
C93108TC-EX (10G + 100G)

Slice 0
Slice 1

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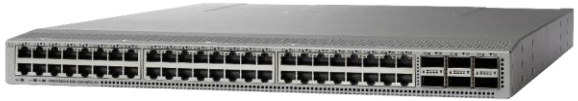
Nexus 9300-FX cloud scale TOR switches

Pervasive MACsec

48-port 10/25G SFP28 + 6-port 100G QSFP28
N9K-C93180YC-FX – LS1800FX-based
ACI: 2.2(2e)
NX-OS: 7.0(3)I7(1)



48-port 1/10GBASE-T + 6-port 100G QSFP28
N9K-C93108TC-FX – LS1800FX-based
ACI: 2.2(2e)
NX-OS: 7.0(3)I7(1)

48-port 100M/1GBASE-T + 4-port 10G/25G + 2-port 100G QSFP28
N9K-C9348GC-FXP – LS1800FX-based
ACI: 3.0(1)
NX-OS: 7.0(3)I7(1)

Key Features

- Dual capability – ACI and NX-OS mode
- Flexible port configurations – 100M/1/10/25/40/50/100G
- **Line-rate 256-bit encryption on all ports**
- **32G FC support on all SFP ports**
- Flow Table for ND Insights, Netflow
- Smart buffer capability (AFD / DPP)

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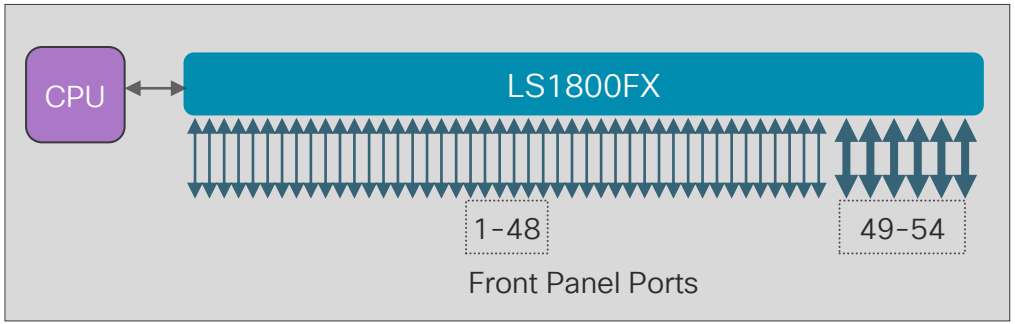
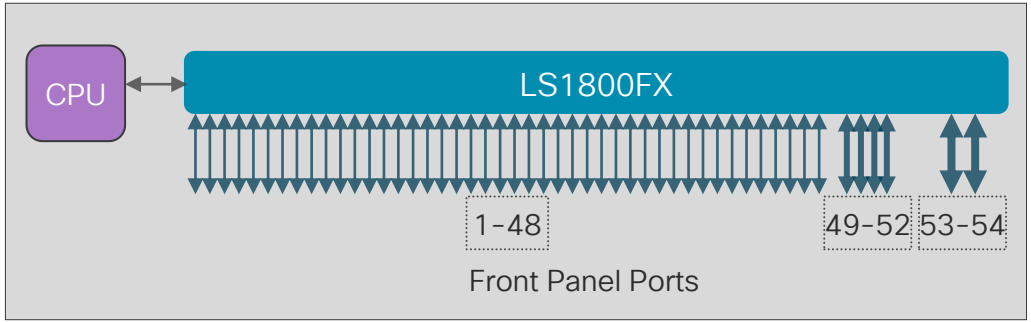
Nexus 9300-FX switch architectures



C93180YC-FX (10/25G + 100G) /
C93108TC-FX (10G + 100G)



C9348GC-FXP (100M/1G + 10/25G + 100G)

Slice 0

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Nexus 9300-FX3 cloud scale TOR switches

48-port 1/10/25G SFP28 + 6-port 100G QSFP28

N9K-C93180YC-FX3 –
LS1800FX3-based
ACI: 5.1(3)
NX-OS: 9.3(7)

Key Features

Dual capability – ACI and NX-OS mode

Flexible port configurations – 100M/1/10/25/40/50/100G

Flow Table for ND Insights, Netflow

MACsec on all ports

Smart buffer capability (AFD / DPP)

Telecom PTP and SyncE - N93180YC-FX3

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Nexus 9300-FX3 cloud scale TOR switches

48-port 100M/1/10GBASE-T + 6-port 100G QSFP28
N9K-C93108TC-FX3P –
LS1800FX3-based
ACI: 5.1(3)
NX-OS: 9.3(7)

48-port 100M/1/10GBASE-T + 6-port 100G QSFP28
N9K-C93108TC-FX3 –
LS1800FX3-based
ACI: 6.0(5)
NX-OS: 10.4(2)

Key Features

- Dual capability – ACI and NX-OS mode
- Flexible port configurations – 100M/1/10/25/40/50/100G
- Flow Table for ND Insights, Netflow
- **MACsec on all ports**
- Smart buffer capability (AFD / DPP)
- Telecom PTP and SyncE - N93180YC-FX3

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Nexus 9300-FX3 cloud scale TOR switches

48-port 10M/100M/1GBASE-T + 4-port 10G/25G + 2-port 100G QSFP28
N9K-C9348GC-FX3 – LS1800FX3-based
ACI: 6.0(5)
NX-OS: 10.4(1)

40-port 10/100M/1GBASE-T + 8-port 10/100M Half-Duplex + 4-port 10G/25G + 2-port 100G QSFP28
N9K-C9348GC-FX3PH – LS1800FX3-based
ACI: 6.0(5)
NX-OS: 10.4(1)

48-port 100M/1GBASE-T + 4-port 10G/25G + 2-port 100G QSFP28
N9K-C92348GC-FX3 – LS1800FX3-based
ACI: Not supported
NX-OS: 10.5(2)

Key Features

- Dual capability – ACI and NX-OS mode
- Flexible port configurations – 100M/1/10/25/40/50/100G
- Flow Table for ND Insights, Netflow
- **MACsec on all ports**
- Smart buffer capability (AFD / DPP)
- Telecom PTP and SyncE - N93180YC-FX3

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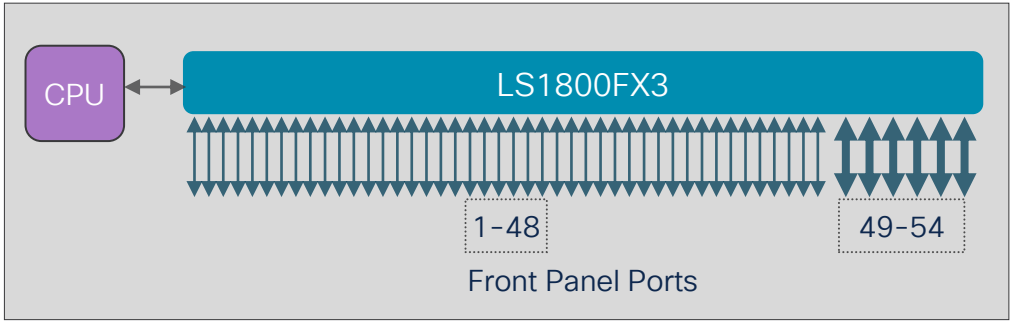
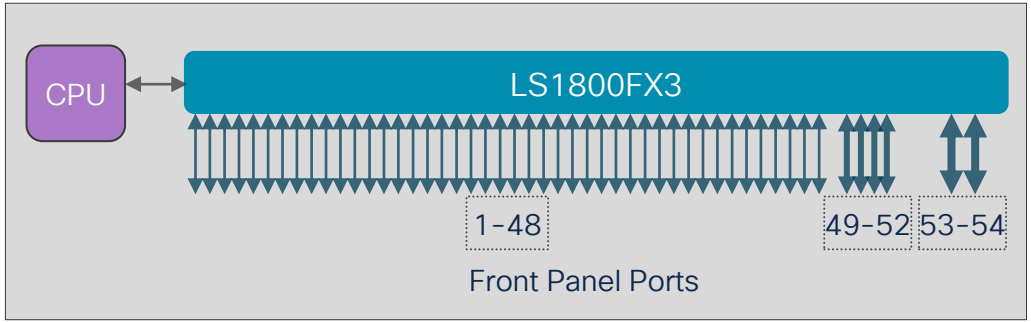
Nexus 9300-FX3 switch architectures



C93180YC-FX3 (10/25G + 100G) /
C93108TC-FX3P (10G + 100G)



C9348GC-FX3 (10M/100M/1G + 10/25G + 100G) /
C92348GC-FX3 (10M/100M/1G + 10/25G + 100G)

Slice 0

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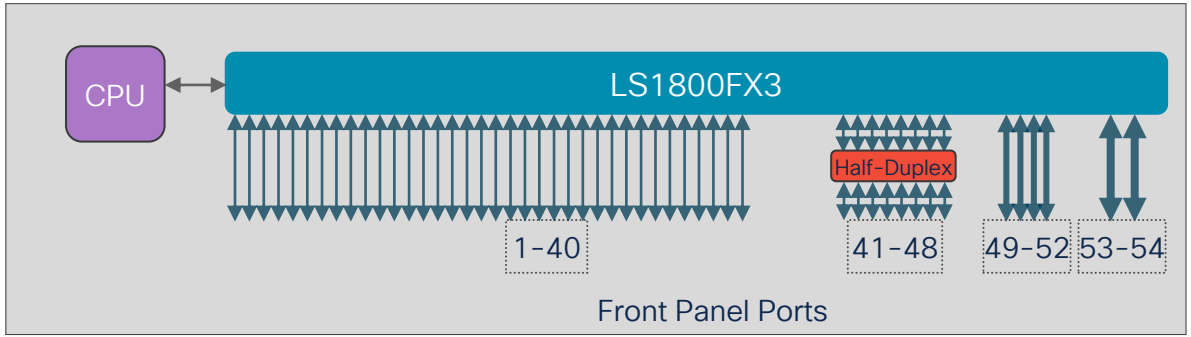
Nexus 9300-FX3 switch architectures



C9348GC-FX3PH (10M/100M/1G + 10/25G + 100G)

Slice 0

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Nexus 9300-FX2 cloud scale TOR switches

36-port 100G QSFP28
N9K-C9336C-FX2 – LS3600FX2-based
ACI: 3.1(2)
NX-OS: 7.0(3)I7(3)

48-port 10/25G SFP28 +
12-port 100G QSFP28
N9K-C93240YC-FX2 – LS3600FX2-based
ACI: 4.0(1)
NX-OS: 7.0(3)I7(3)

96-port 10/25G SFP28 +
12-port 100G QSFP28
N9K-C93360YC-FX2 – LS3600FX2-based
ACI: 4.1(2)
NX-OS: 9.3(1)

96-port 1/10GBASE-T +
12-port 100G QSFP28
N9K-C93216TC-FX2 – LS3600FX2-based
ACI: 4.1(2)
NX-OS: 9.3(1)

Key Features

Dual capability – ACI and NX-OS mode

Versatile standalone 100G switch (9336C)

High-performance 100G ACI leaf switch (9336C)

100G/50G/40G/10G with breakout capability

2RU copper/fiber options for high density racks

Flow Table for Network Insights, Netflow

MACsec on all ports

Smart buffer capability (AFD / DPP)

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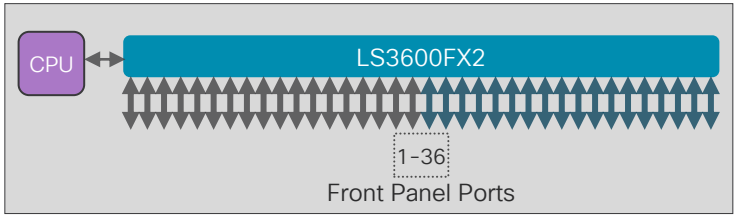
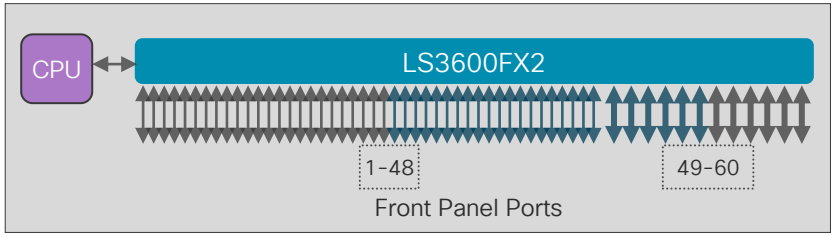
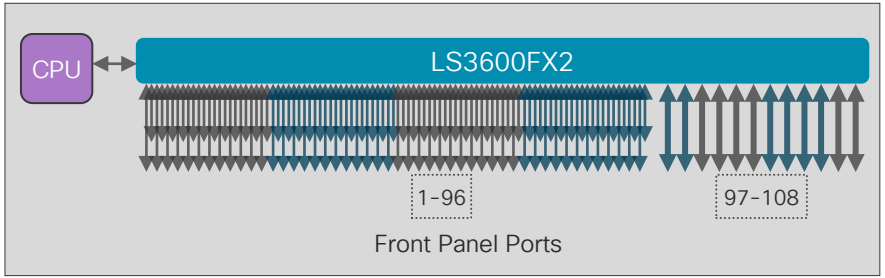
Nexus 9300-FX2 switch architecture



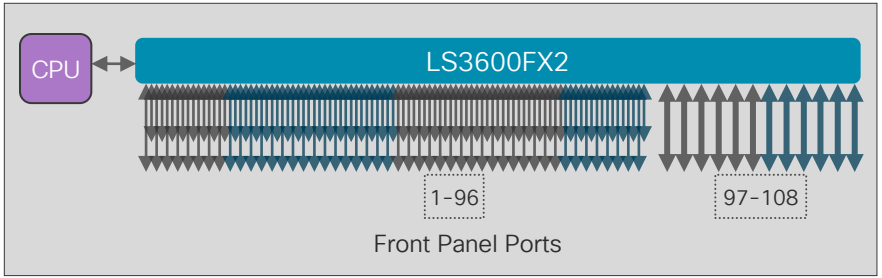
C9336C-FX2 (100G)



C93240YC-FX2 (10/25G + 100G)



N9K-C93360YC-FX2 (10/25G + 100G)



N9K-C93216TC-FX2 (1/10G + 100G)

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Nexus 9300-GX cloud scale TOR switches

16-port 400G QSFP-DD
N9K-C9316D-GX – LS6400GX-based
ACI: 4.2(2)
NX-OS: 9.3(3)

28-port 100G QSFP28 +
8-port 400G QSFP-DD
N9K-C93600CD-GX – LS6400GX-based
ACI: 4.2(2)
NX-OS: 9.3(3)

64-port 100G QSFP28
N9K-C9364C-GX – LS6400GX-based
ACI: 4.2(3l)
NX-OS: 9.3(3)

Key Features

- Dual capability – ACI and NX-OS mode
- First 400G-capable Cloud Scale platforms
- 400G ACI/standalone spine (9316D-GX)
- 100G leaf with 400G uplinks (93600CD)
- 64-port 100G fixed TOR
- 400G/100G/50G/40G/10G with breakout capability
- Flow Table for Network Insights, Netflow
- Smart buffer capability (AFD / DPP)

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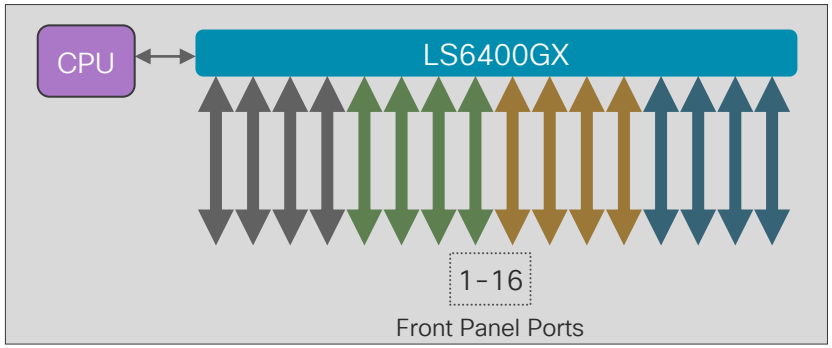
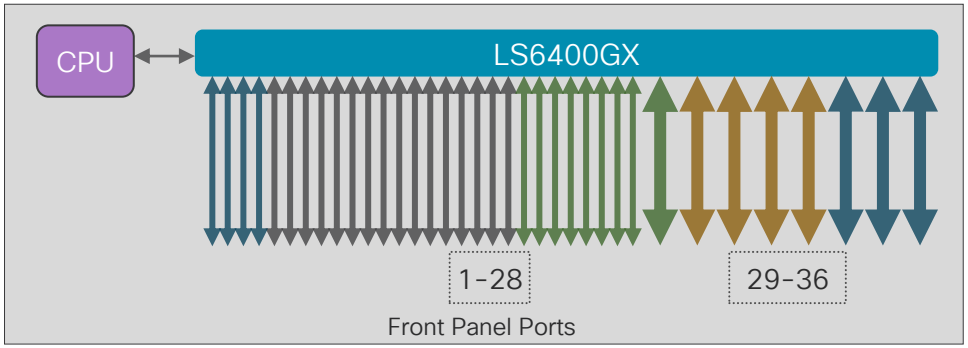
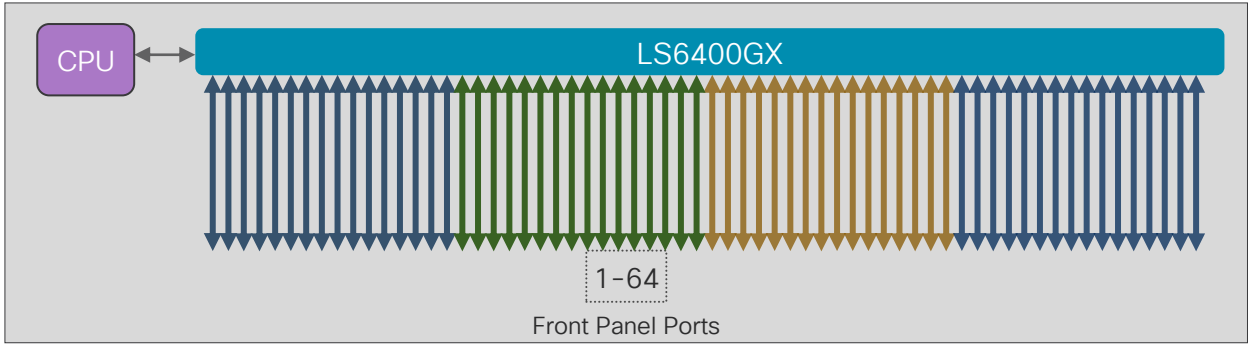
Nexus 9300-GX switch architecture



C9316D-GX (400G)



C93600CD-GX (100G + 400G)



C9364C-GX (100G)

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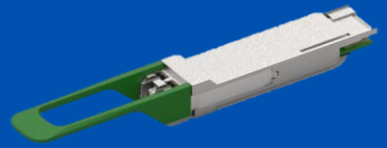
400G Transceivers – QSFP-DD

QSFP-DD



- ✓ Same front-panel dimensions as QSFP28
- ✓ Backward compatible with QSFP+ & QSFP28
- ✓ Can support 25G, 50G & 100G SERDES
- ✓ Supports all media (Fiber & Copper)
- ✓ Supports all reaches (3m – 100km)
- ✓ Meets thermal & signal integrity requirements for 400G

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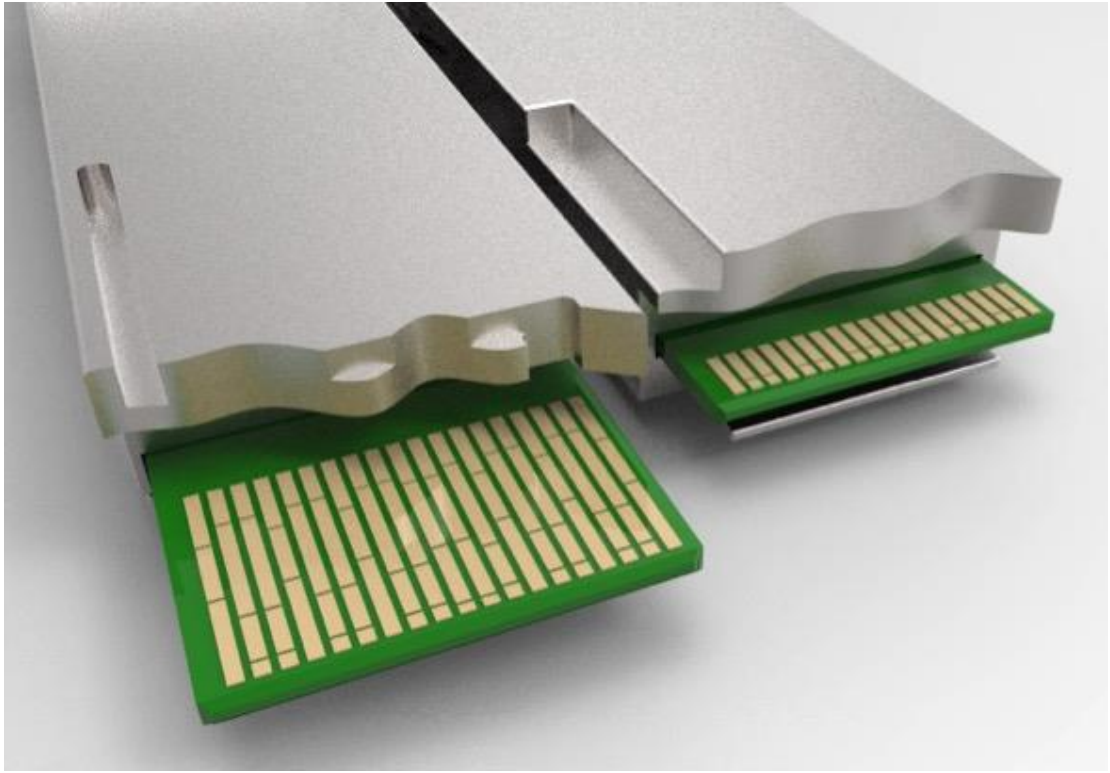
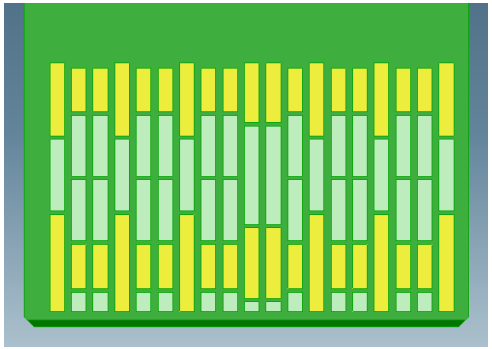
QSFP-DD module





Additional 4 lanes doubles the density

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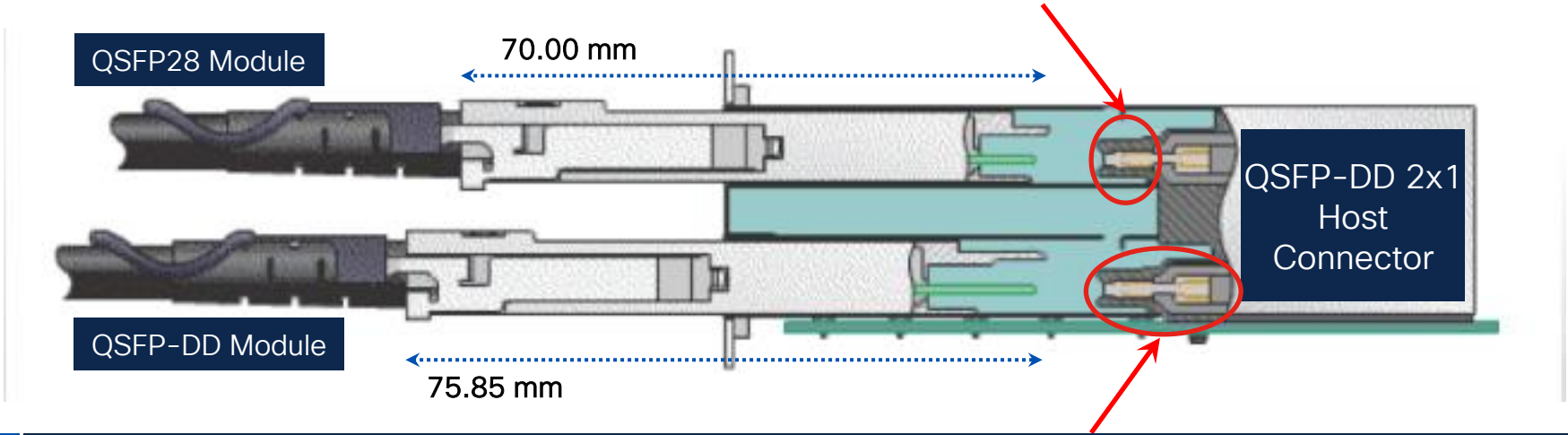
QSFP-DD compatibility with QSFP28

Inserting QSFP28 engages only the first row of contacts



Inserting QSFP-DD goes deeper & engages **both** rows of contacts

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Nexus 9300-GX2B cloud scale TOR switches

32-port 400G QSFP-DD
N9K-C9332D-GX2B
LS12800GX2B-based
ACI: 5.2(3)
NX-OS: 10.2(1q)

Key Features

Dual capability – ACI and NX-OS mode

400G-capable Cloud Scale platforms

400G ACI/standalone spine

400G/100G/50G/40G/10G with breakout capability

MACsec on last 8 ports

Flow Table for Network Insights, Netflow

Smart buffer capability (AFD / DPP)

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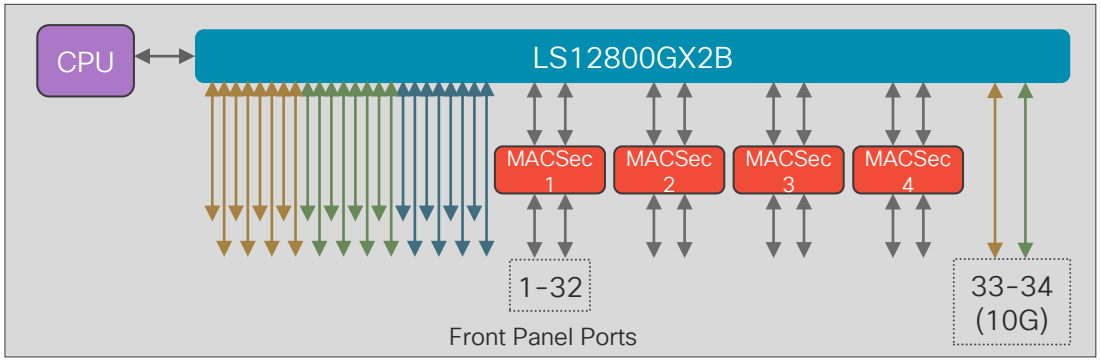
Nexus 9300-GX2B switch architecture



C9332D-GX2B (32x400G)

Slice 0 Slice 2
Slice 1 Slice 3

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Nexus 9300-GX2A cloud scale TOR switches

64-port 400G QSFP-DD
N9K-C9364D-GX2A – LS25600GX2A-based
ACI: 5.2(5)
NX-OS: 10.2(3)

48-port 400G QSFP-DD
N9K-C9348D-GX2A – LS25600GX2A-based
ACI: 5.2(5)
NX-OS: 10.2(3)

Key Features

Dual capability – ACI and NX-OS mode

400G-capable Cloud Scale platforms

400G/100G/50G/40G/10G with breakout capability

MACsec support:

- N9364D-GX2A: first 16 ports
- N9348D-GX2A: on all ports

Flow Table for Network Insights, Netflow

Smart buffer capability (AFD / DPP)

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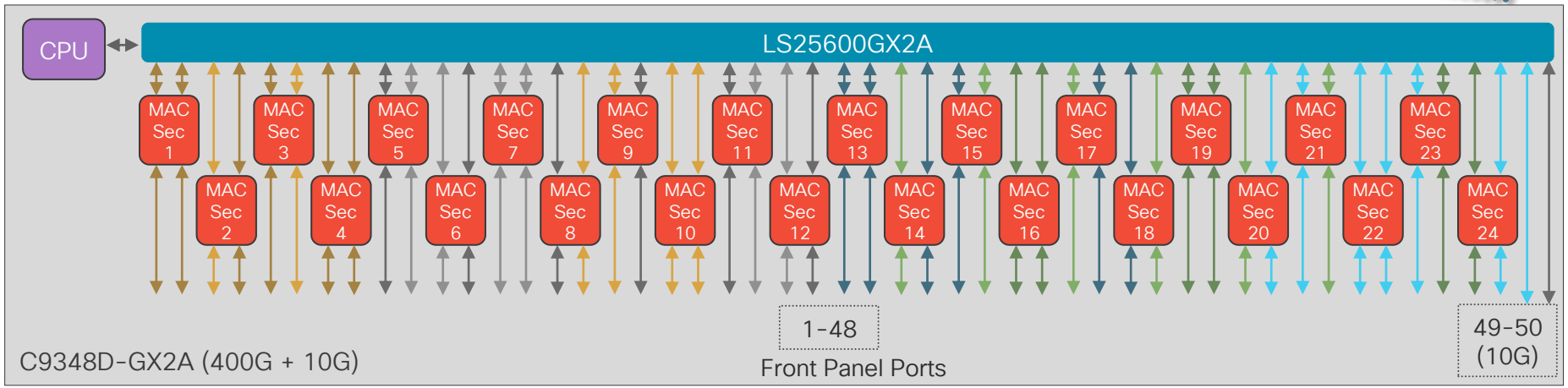
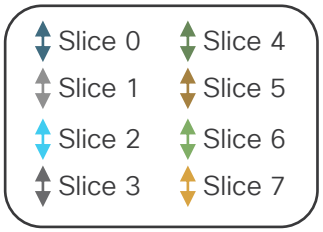
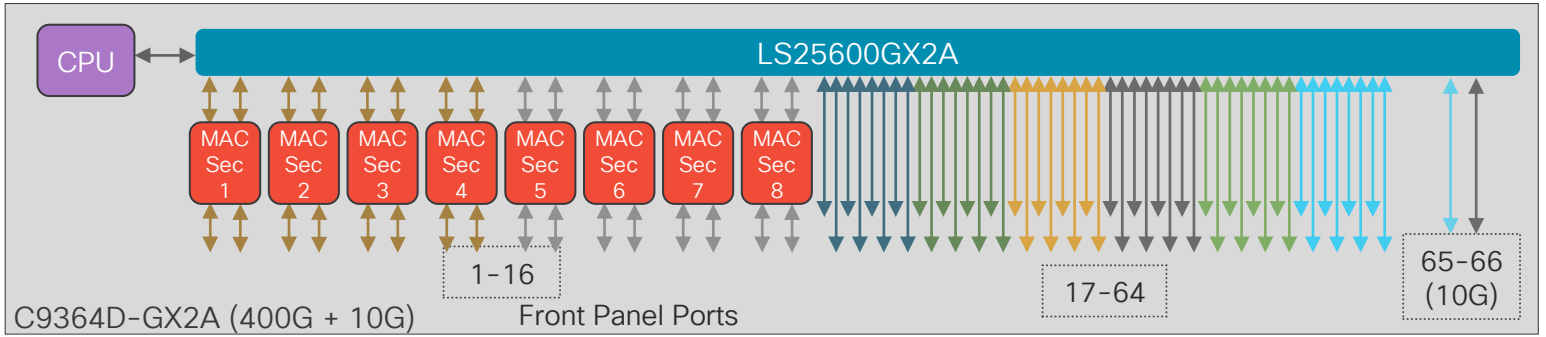
Nexus 9300-GX2A switch architecture







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Nexus 9300-H2R cloud scale TOR switches

32-port 400G QSFP-DD
N9K-C9332D-H2R LS12800H2R-based
ACI: Roadmap
NX-OS: 10.4(1)

Key Features

- Dual capability – ACI and NX-OS mode
- 400G-capable Cloud Scale platforms
- 400G ACI/standalone spine
- 400G/100G/50G/40G/10G with breakout capability
- **MACsec on all ports**
- Flow Table for Network Insights, Netflow
- Smart buffer capability (AFD / DPP)
- Off-Chip 8GB HBM Buffer
- Telecom PTP and SyncE

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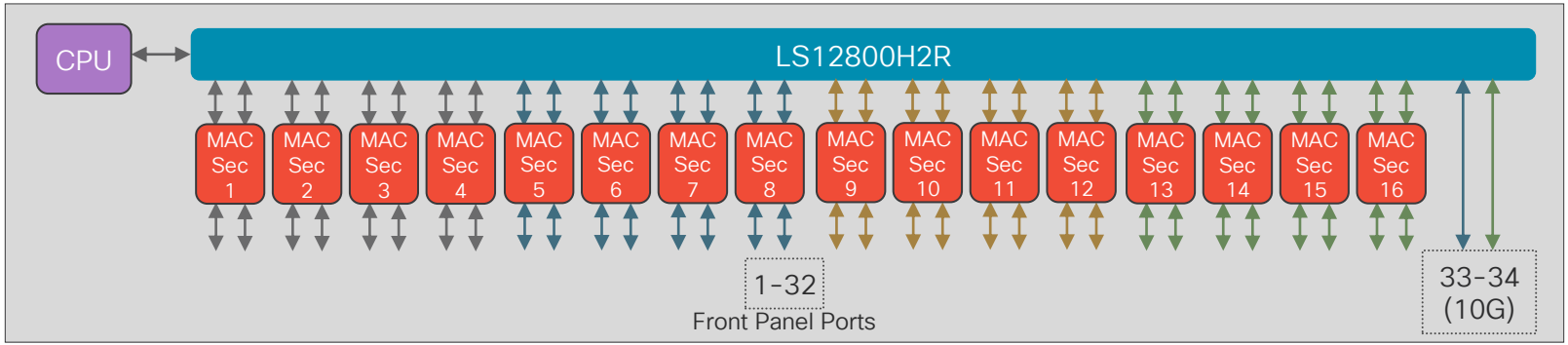
Nexus 9300-H2R switch architecture



C9332D-H2R (32x400G)

Slice 0 Slice 2
Slice 1 Slice 3

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Nexus 9300-H1 cloud scale TOR switches

48-port 50G SFP56
4-port 400G QSFP-DD
N9K-C93400LD-H1 LS6400H1-based
ACI: Roadmap
NX-OS: 10.4(2)

64-port 100G QSFP28
N9K-C9364C-H1 LS6400H1-based
ACI: Roadmap
NX-OS: 10.4(3)

Key Features

Dual capability – ACI and NX-OS mode

Flexible port configurations – 10/25/40/50/100/400G

Flow Table for ND Insights, Netflow

MACsec support:

- **N93400LD-H1: on all ports**
- **N9364C-H1: last 16 ports**

Smart buffer capability (AFD / DPP)

Telecom PTP and SyncE

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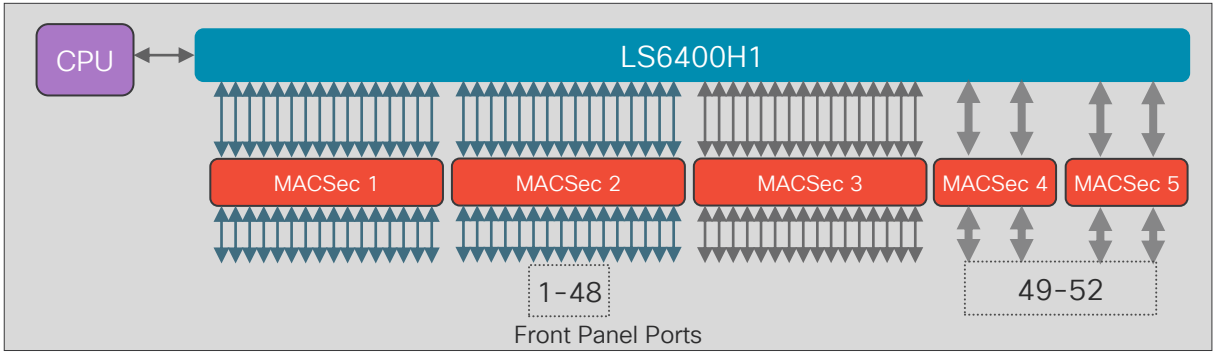
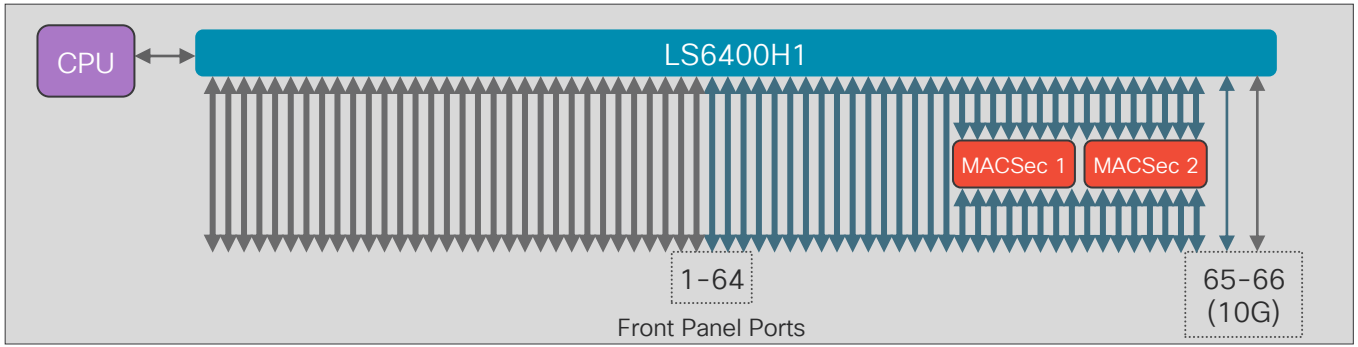
Nexus 9300-H1 switch architecture



C93400LD-H1 (10/25/50G + 400G)



C9364C-H1 (100G)

Slice 0
Slice 1

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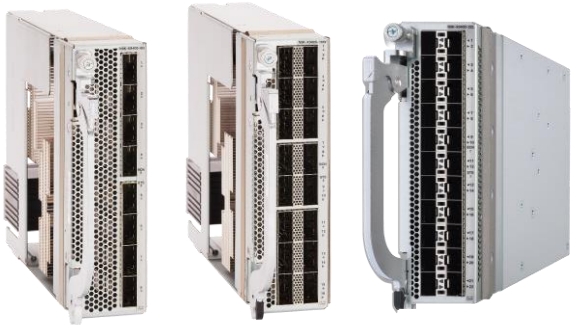
Nexus 9400 centralised modular switches

Nexus 9408

Chassis and Centralized Forwarding

+



Line-card Expansion-Module (LEM)

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Nexus 9408 cloud scale centralised modular

64-port 400G QSFP-DD
N9K-C9408 – LS25600GX2A-based
ACI: 6.0(2)
NX-OS: 10.3(2)

8-port 400G QSFP-DD
X9400-8D LEM

22-port 50G SFP56
X9400-22L LEM

16-port 200G QSFP56
X9400-16W LEM

Key Features

- Dual capability – ACI and NX-OS mode
- 400G-capable Cloud Scale platforms
- Based on LS25600GX2A ASIC
- 400G/100G/50G/40G/10G with breakout capability
- **MACsec support on all ports**
- Flow Table for Network Insights, Netflow
- Smart buffer capability (AFD / DPP)
- Field replicable switch card
- Telecom PTP and SyncE

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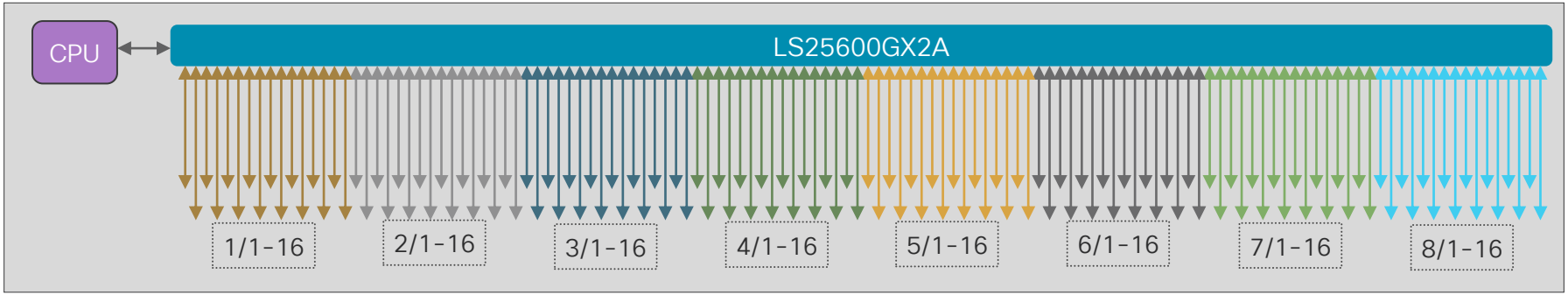
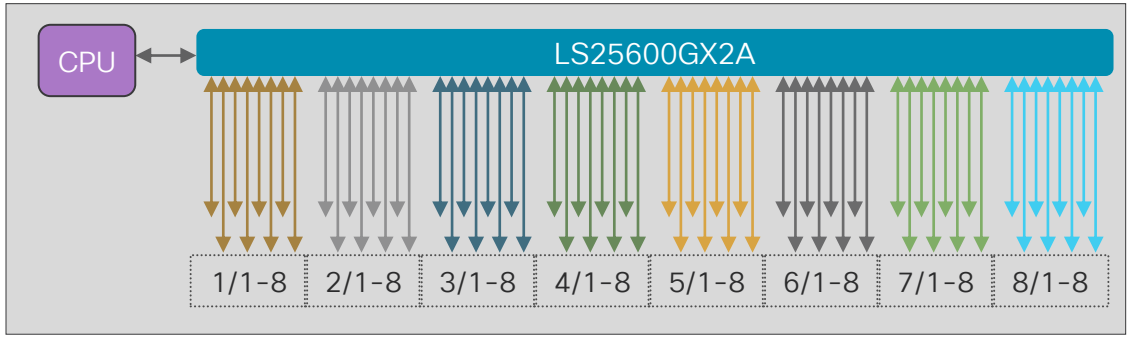
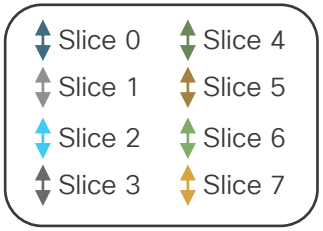
Nexus 9408 switch architecture



C9408 (128 x 200G)



C9408 (64 x 400G)



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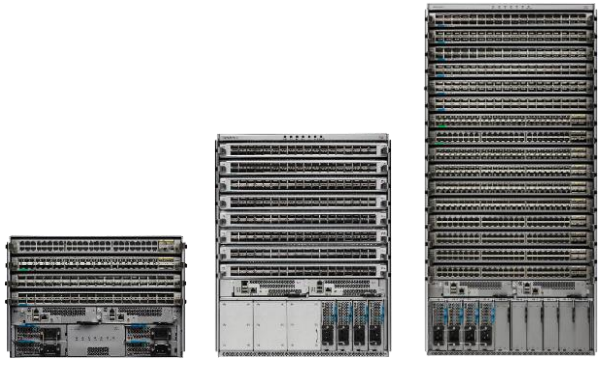
Nexus 9500 modular cloud scale switches



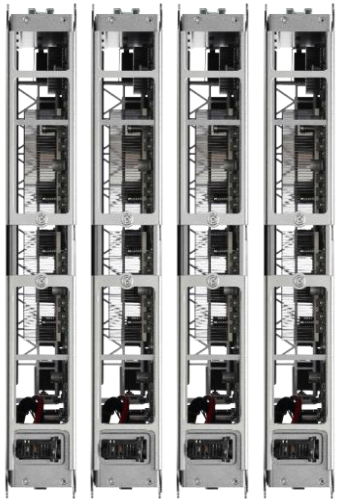
Nexus 9504 Nexus 9508 Nexus 9516

Common Equipment

+

FX/FX3/GX Series
Line Cards

+



E2 / G-Series
fabric Modules

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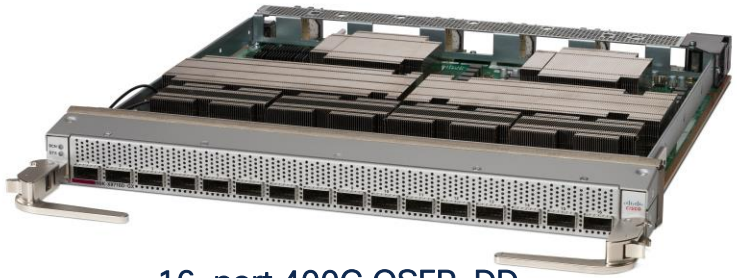
X9700-GX 400G cloud scale modules

N9K-X9716D-GX



16-port 400G QSFP-DD
X9716D-GX – LS6400GX-based
ACI: 5.1
NX-OS: 10.1(1)

Key Features

9716D-DX – Dual capability ACI and NX-OS

6.4Tbps capacity per module

Flexible port configurations – 10/25/40/50/100/400G with breakout

Line-rate MACsec on all ports

Flow Table for Network Insights, NetFlow

Smart buffer capability (AFD / DPP)

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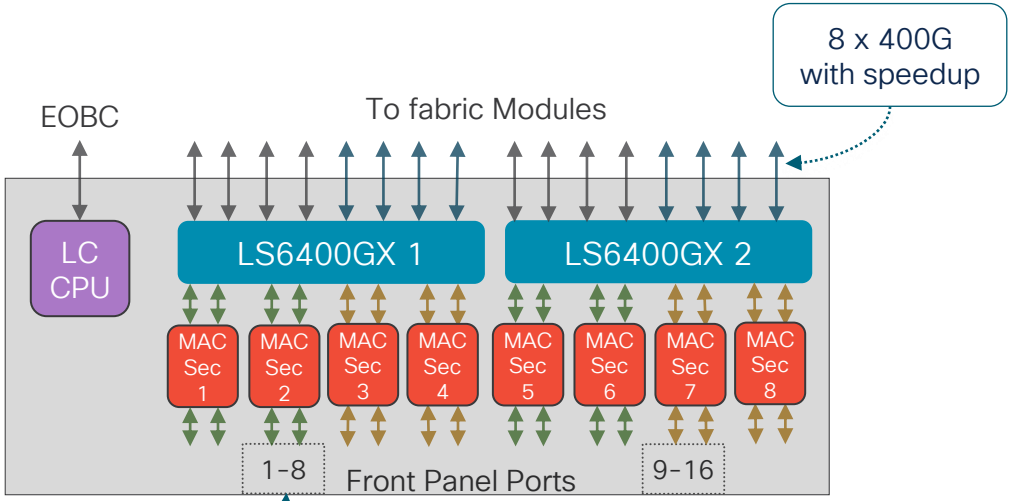
N9K-X9716D-GX architecture



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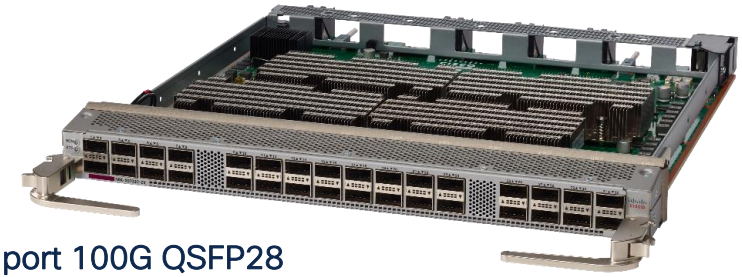
X9700-EX 100G cloud scale modules

N9K-X9732C-EX / N9K-X9736C-EX



32-port 100G QSFP28
X9732C-EX – LSE-based
ACI: 1.3(1)
NX-OS: 7.0(3)I4(2)

36-port 100G QSFP28
X9736C-EX – LSE-based
ACI: Not supported
NX-OS: 7.0(3)I6(1)

Key Features

- 9732C-EX – Dual capability ACI and NX-OS
- 9736C-EX – NX-OS only
- 3.2Tbps capacity per module
- Flexible port configurations – 10/25/40/50/100G with breakout
- Flow Table for Network Insights, Netflow
- Smart buffer capability (AFD / DPP)

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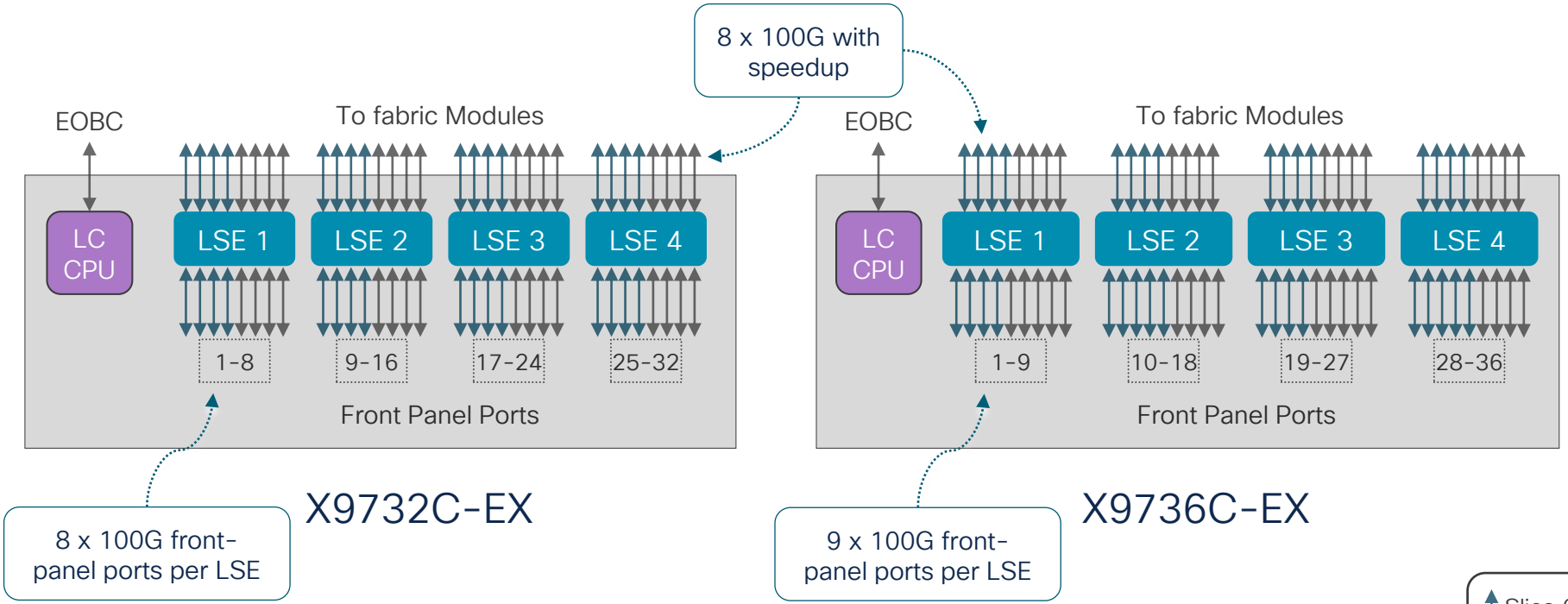
N9K-X9732C-EX / N9K-X9736C-EX architecture



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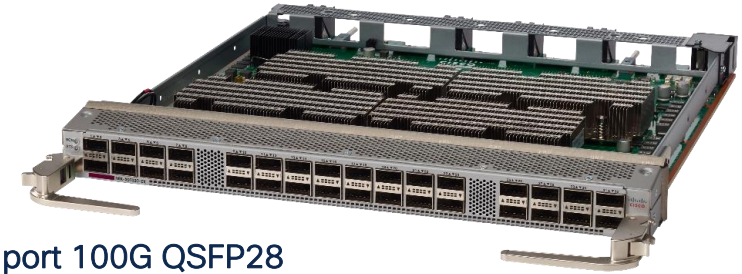
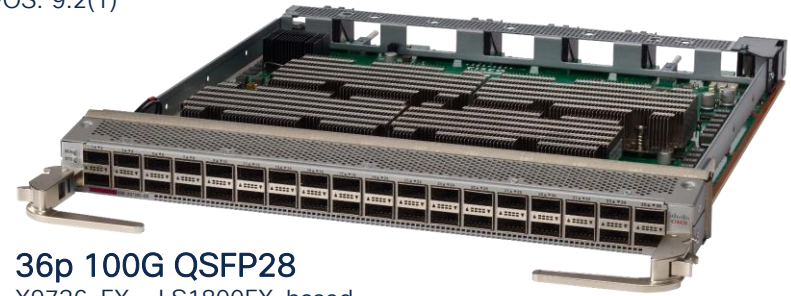
X9700-FX 100G cloud scale modules

N9K-X9732C-FX / N9K-X9736C-FX



32-port 100G QSFP28
X9732C-FX – LS1800FX-based
ACI: Not supported
NX-OS: 9.2(1)



36p 100G QSFP28
X9736-FX – LS1800FX-based
ACI: 13.0(1)
NX-OS: NX-OS: 7.0(3)I7(3)

Key Features

- 9732C-FX – NX-OS only
- 9736C-FX – Dual capability ACI and NX-OS
- 3.2Tbps capacity per module
- 3.6Tbps capacity with optional 5th fabric module on 9736C-FX
- N+1 fabric redundancy option on 9732C-FX
- Flexible port configurations – 10/25/40/50/100G with breakout
- **Line-rate MACsec on all ports**
- Flow Table for Network Insights, NetFlow
- Smart buffer capability (AFD / DPP)

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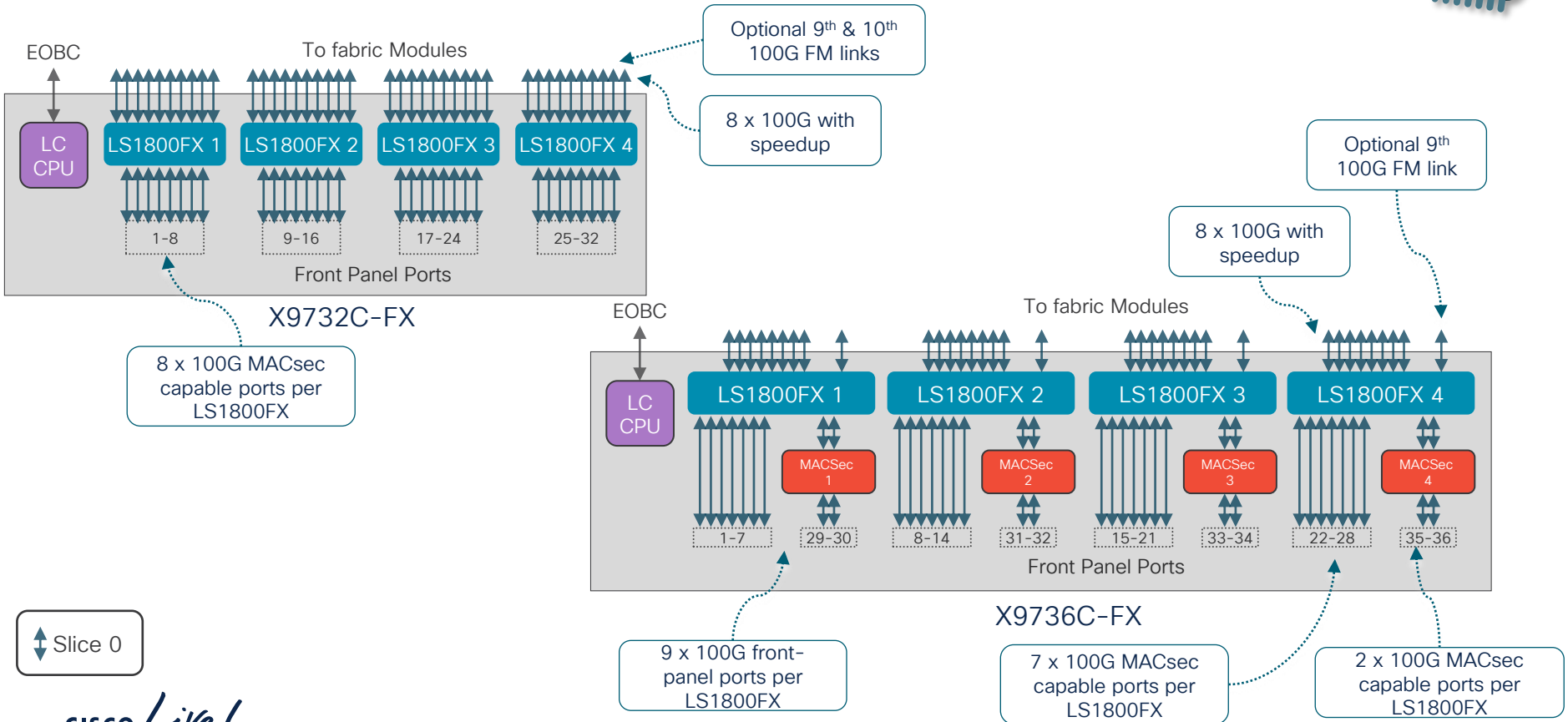
N9K-X9732C-FX / N9K-X9736C-FX architecture



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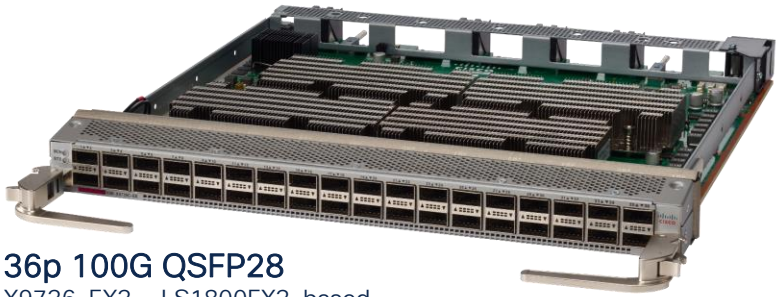
X9700-FX3 100G cloud scale module

N9K-X9736C-FX3



36p 100G QSFP28
X9736-FX3 – LS1800FX3-based
ACI: 16.1(4)
NX-OS: 10.5(2)

Key Features

9736C-FX3 – Dual capability ACI and NX-OS

3.6Tbps capacity with optional 5th fabric module on 9736C-FX3

Flexible port configurations – 10/25/40/50/100G with breakout

Line-rate MACsec on all ports

Flow Table for Network Insights, NetFlow

Smart buffer capability (AFD / DPP)

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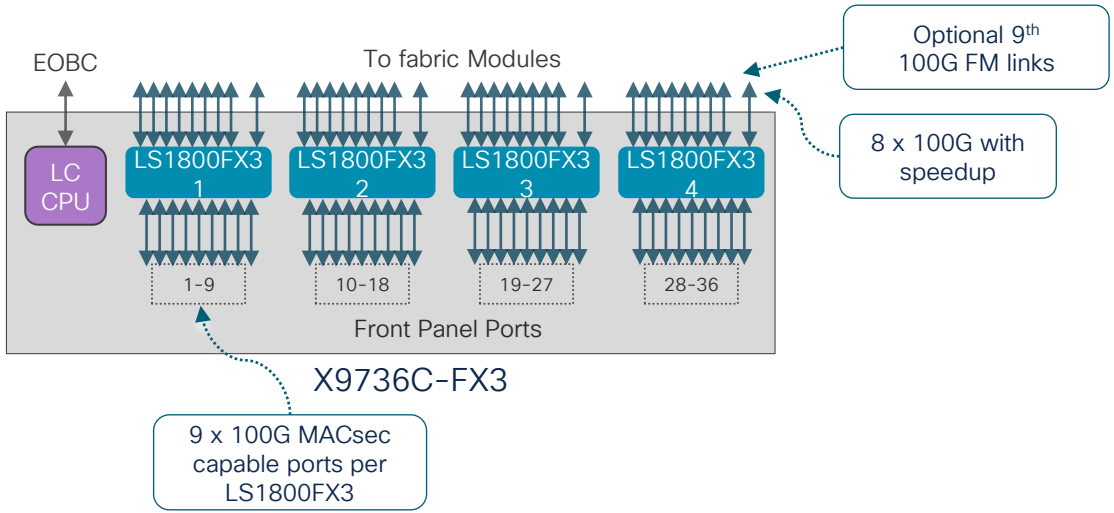
N9K-X9736C-FX3 architecture



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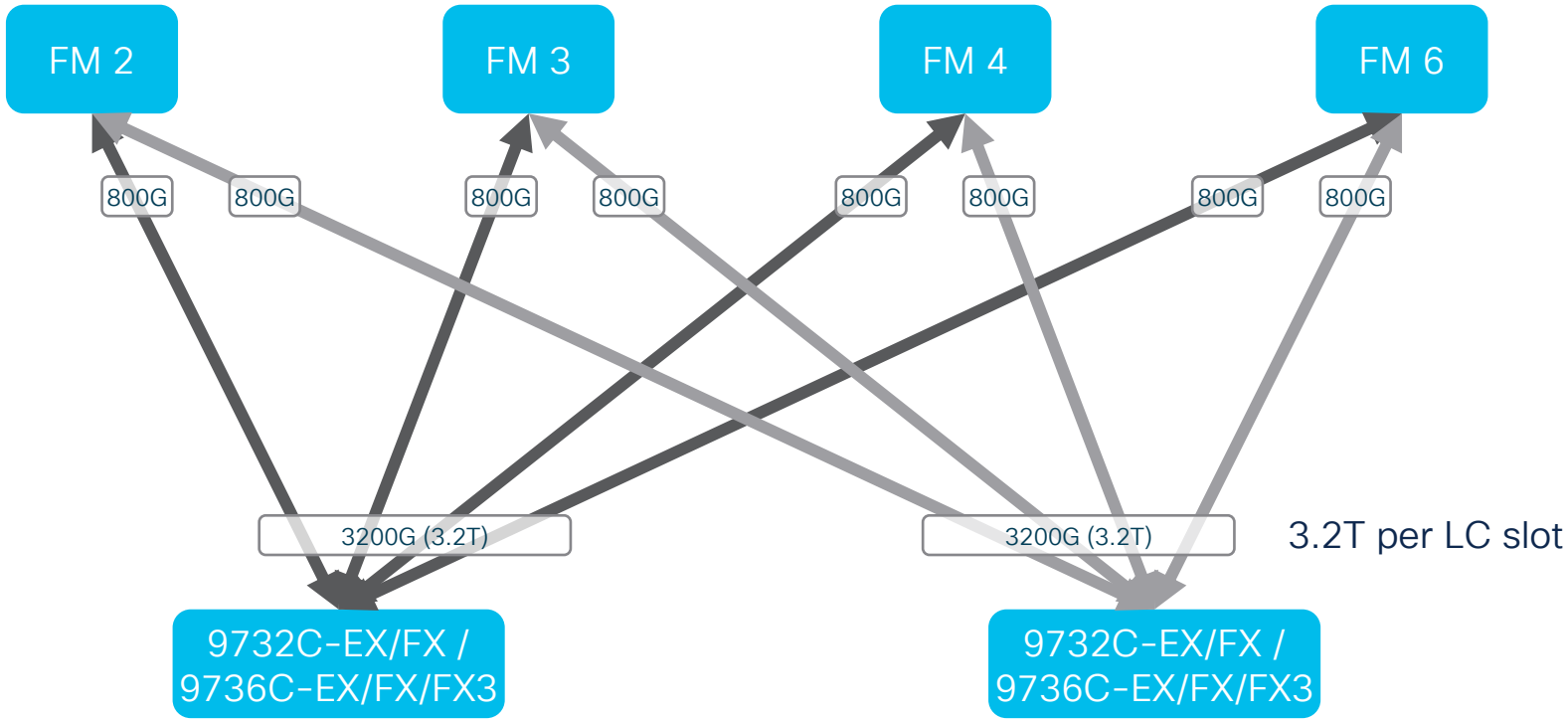
9732C-FX / 9736C-FX/FX3 fabric connectivity



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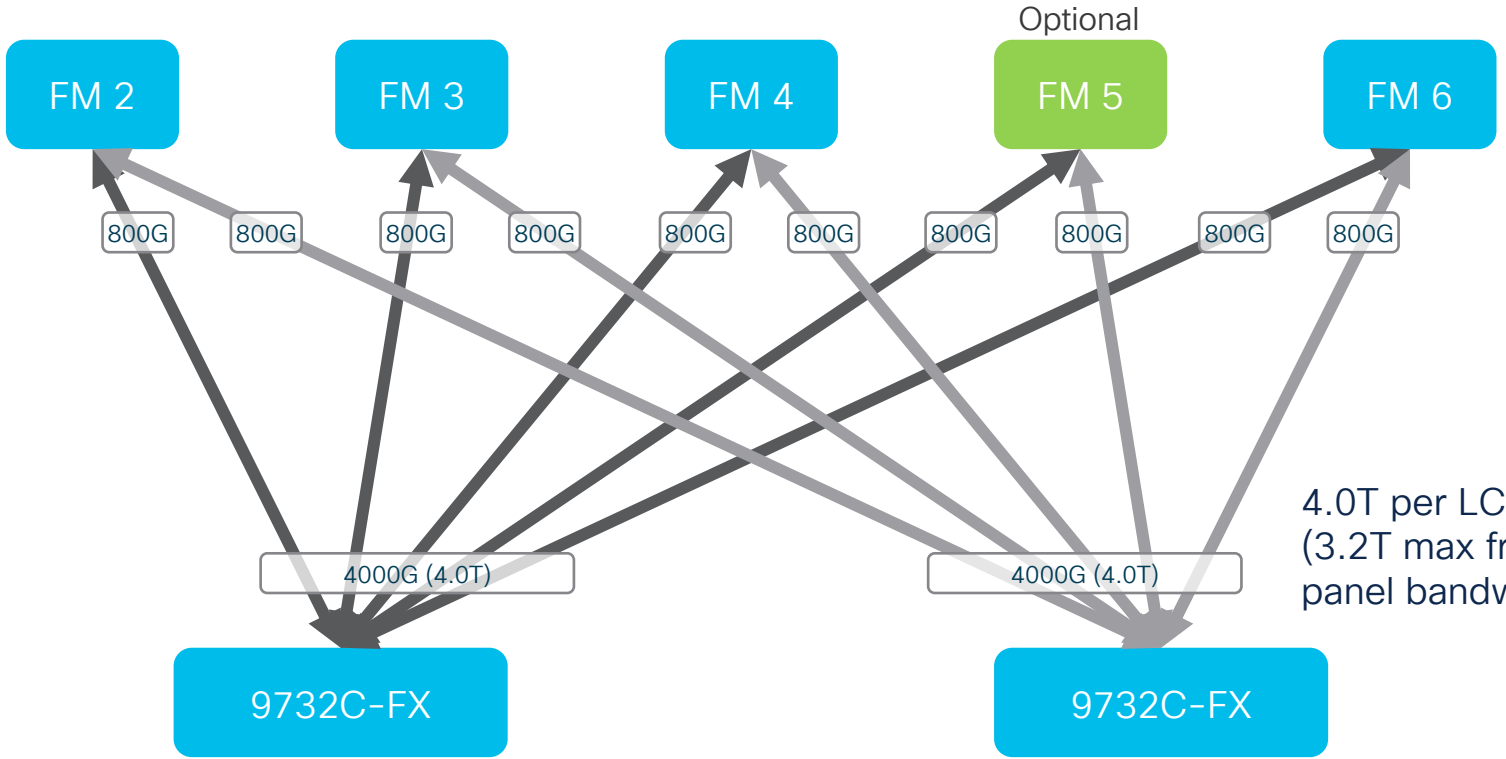
9732C-FX fabric connectivity – 5 FMs



4.0T per LC slot (3.2T max front panel bandwidth)

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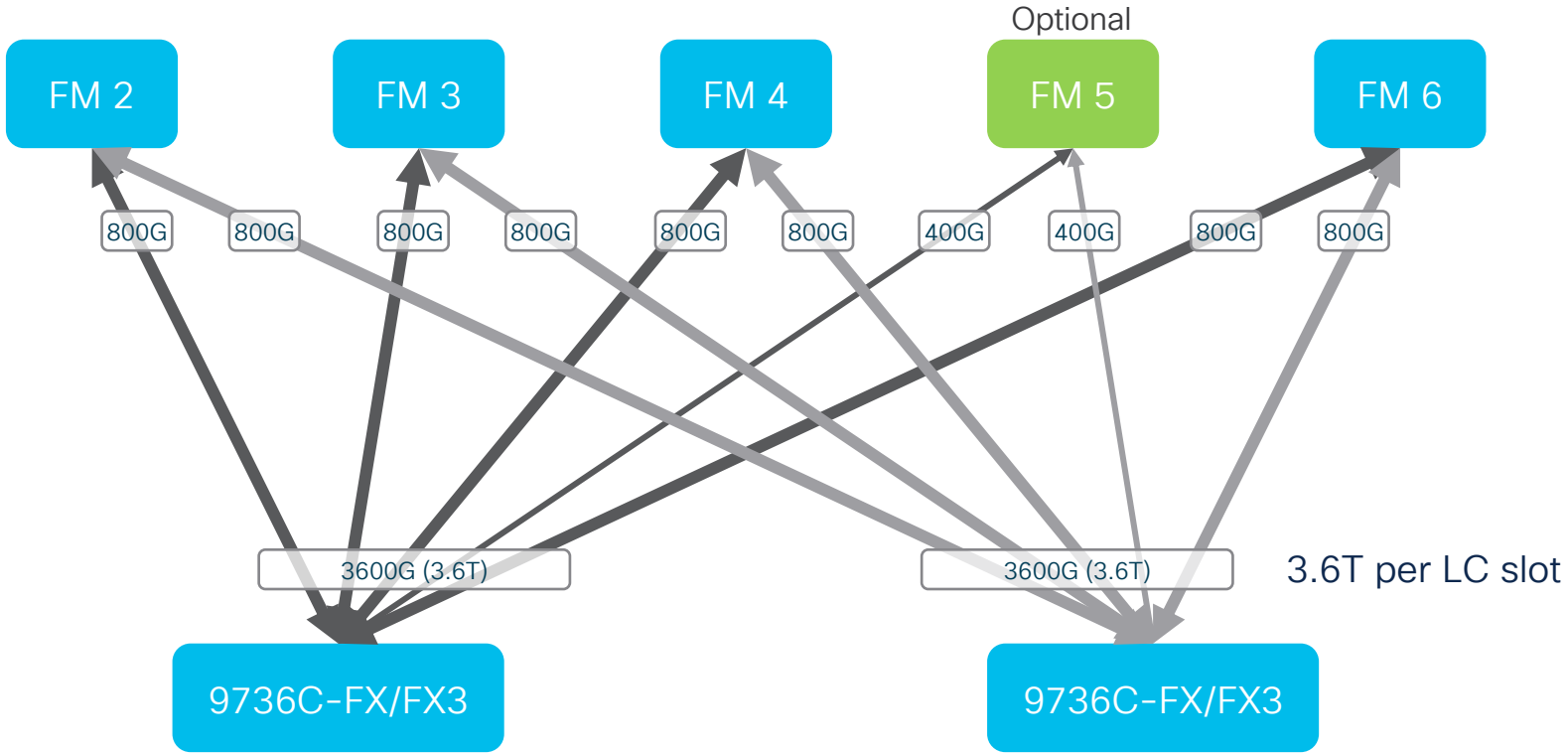
9736C-FX/FX3 fabric connectivity – 5 FMs



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Using 5 fabric modules

Limitations and Notes

- **All** modules installed in chassis must be either 9732C-FX or 9736C-FX/FX3 to use 5 FMs
  - If other module type installed, 5th FM powered off automatically
- **9732C-FX:**
  - 5 FMs required for N+1 fabric module redundancy
- **9736C-FX/FX3:**
  - 5 FMs required for full bandwidth
  - Bandwidth reduction on FM failure varies depending on which FM failed

Note: 5 x FMs supported on all chassis types in standalone from 7.0(3)I7(2). 5 x FMs with 9736C-FX supported from in ACI 13.2(2).

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X9700-EX/FX EOR/MOR cloud scale modules

N9K-X97160YC-EX / N9K-X9788TC-FX

48p 10/25G SFP+ and 4p 100G QSFP28

X97160YC-EX – LSE-based
ACI: Not supported
NX-OS: 7.0(3)I5(2)

48p 1/10GBASE-T and 4p 100G QSFP28

X9788TC-FX – LS1800FX-based
ACI: Not supported
NX-OS: 7.0(3)I7(3)

Key Features

NX-OS mode only

Flow Table for Network Insights, NetFlow

Smart buffer capability (AFD / DPP)

97160-EX:

- 1.6Tbps capacity with line-rate performance
- Flexible port configurations –1/10/25G SFP28 ports, 1/10/25/40/50/100G QSFP28 ports

9788-FX:

- 880Gbps capacity with line-rate performance
- Flexible port configurations –1/10GBASE-T ports, 1/10/25/40/50/100G QSFP28 ports
- **Line-rate MACsec on all ports**

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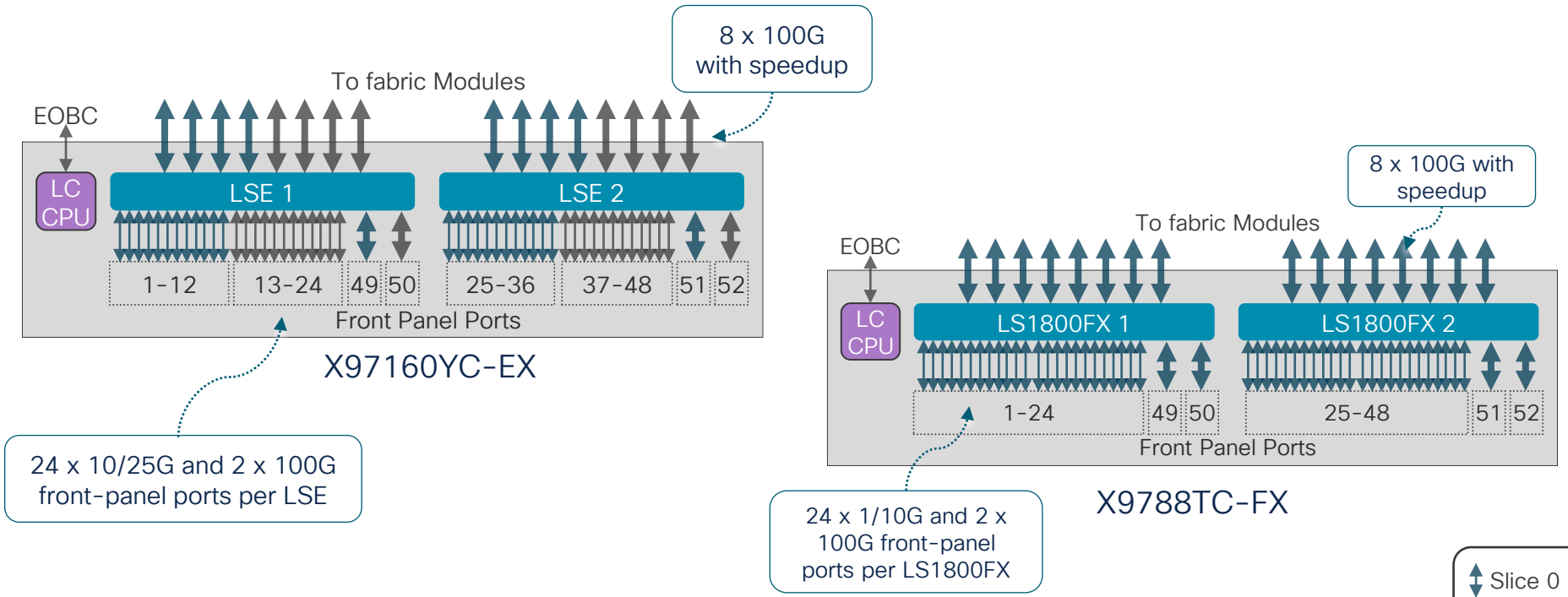
N9K-X97160YC-EX / N9K-X9788TC-FX architecture



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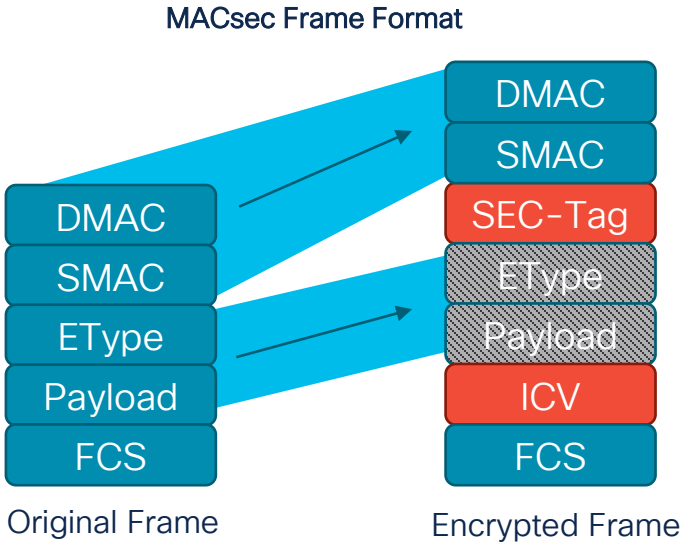
MACsec hardware encryption

- Provides link-level hop-by-hop encryption
- IEEE 802.1AE 128-bit and 256-bit AES encryption with MKA Key Exchange
- Native hardware support available on:
  - All ports on X9736C-FX linecard
  - All ports on Nexus 93180YC-FX / 93108TC-FX switches
  - 16 x 100G ports on Nexus 9364C switch
  - All ports on Nexus 9336C-FX2 / N9K-C93240YC-FX2 switches



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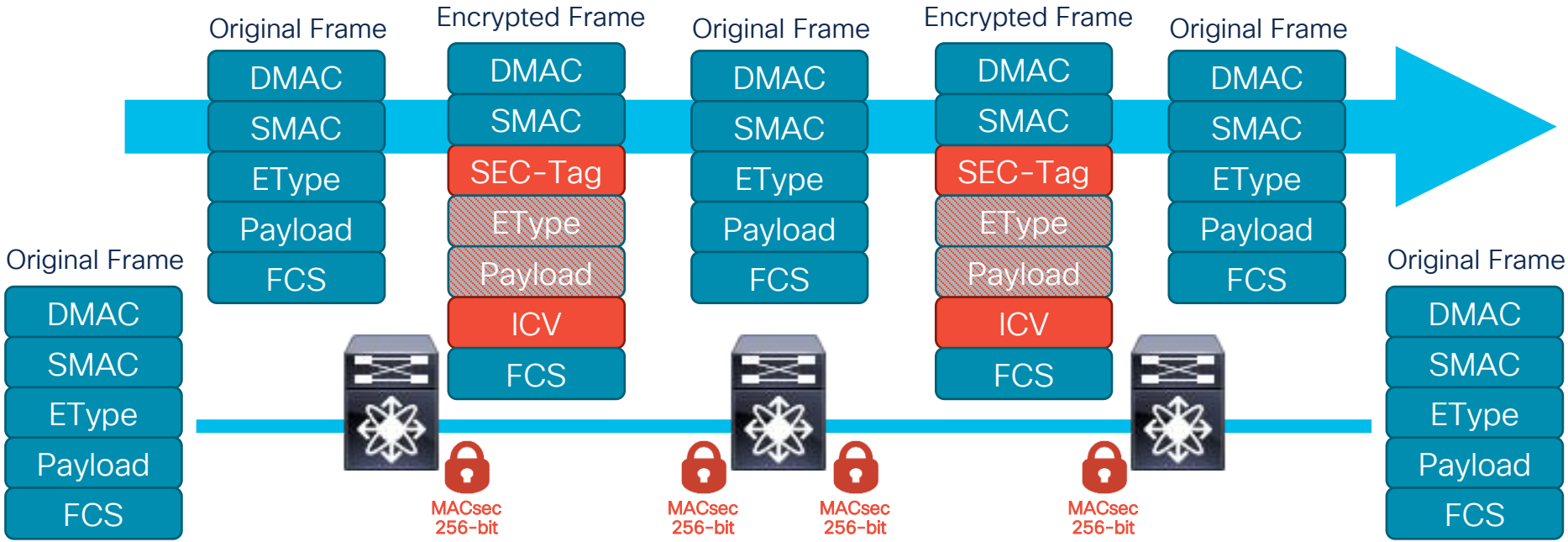
MACsec



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Agenda

- Data Center and Silicon Strategy
- Cloud Scale ASIC Architecture
- Cloud Scale Switching Platforms
- Packet Walks
- Key Takeaways

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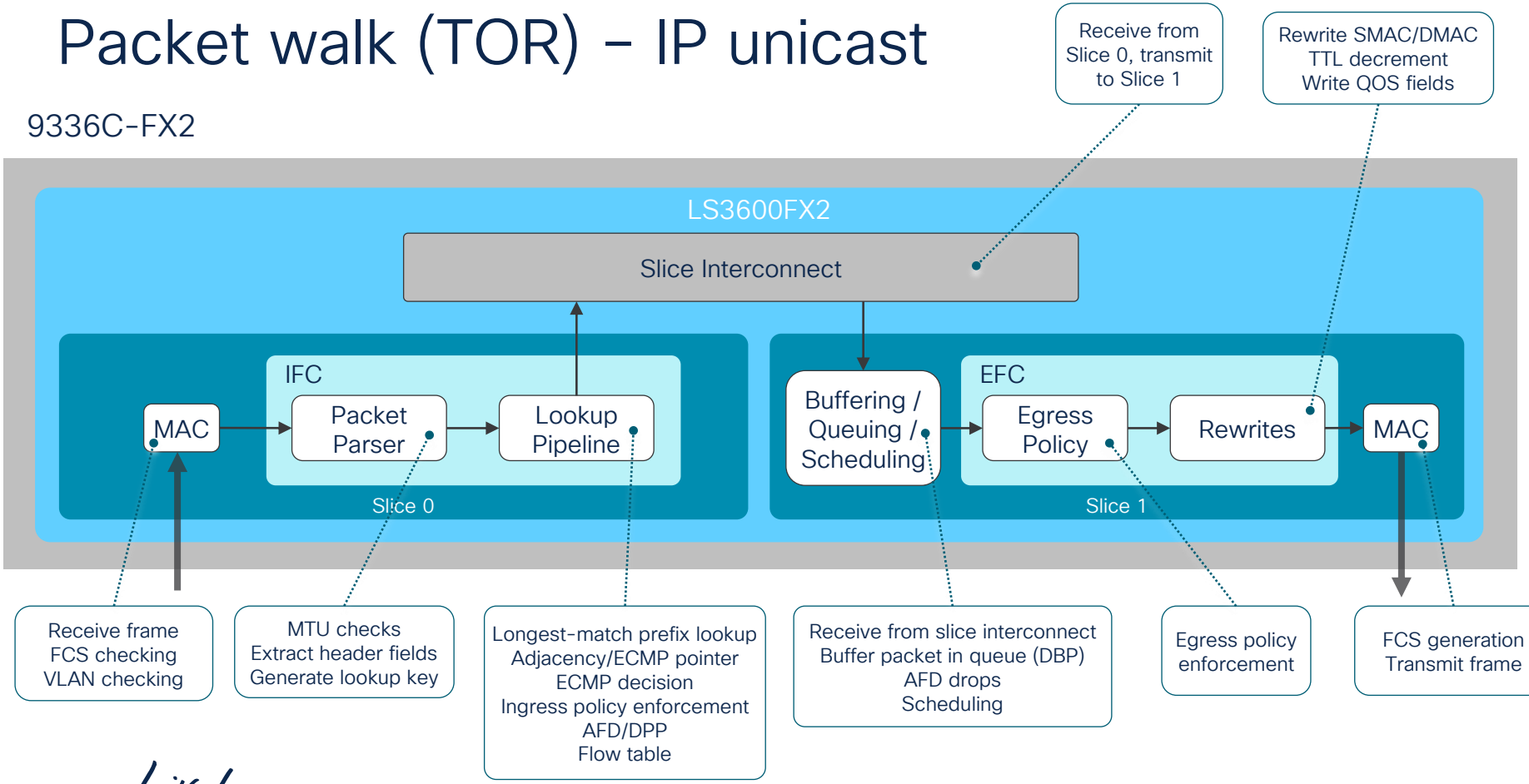
Packet walk (TOR) – IP unicast

9336C-FX2



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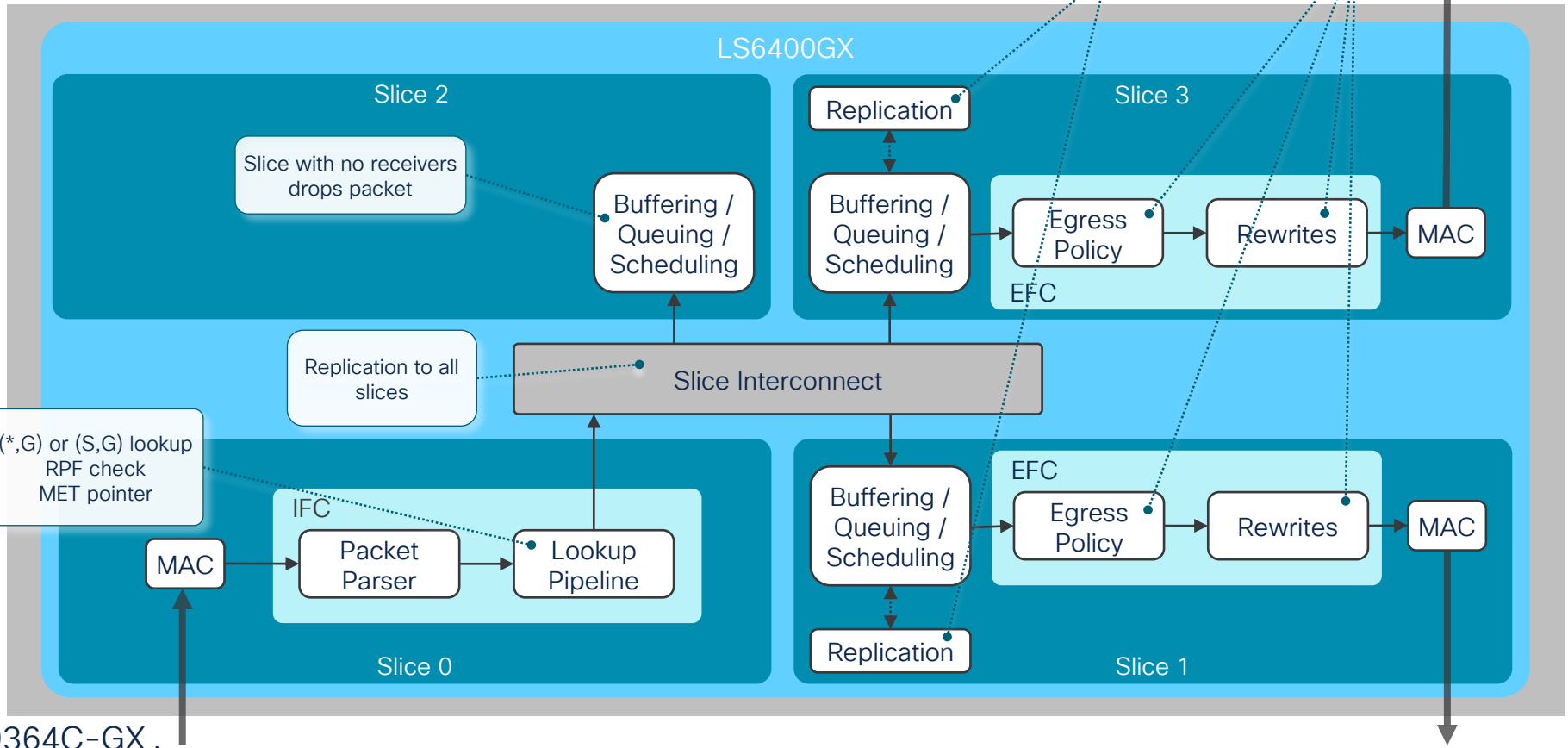
Packet walk (TOR) – multicast



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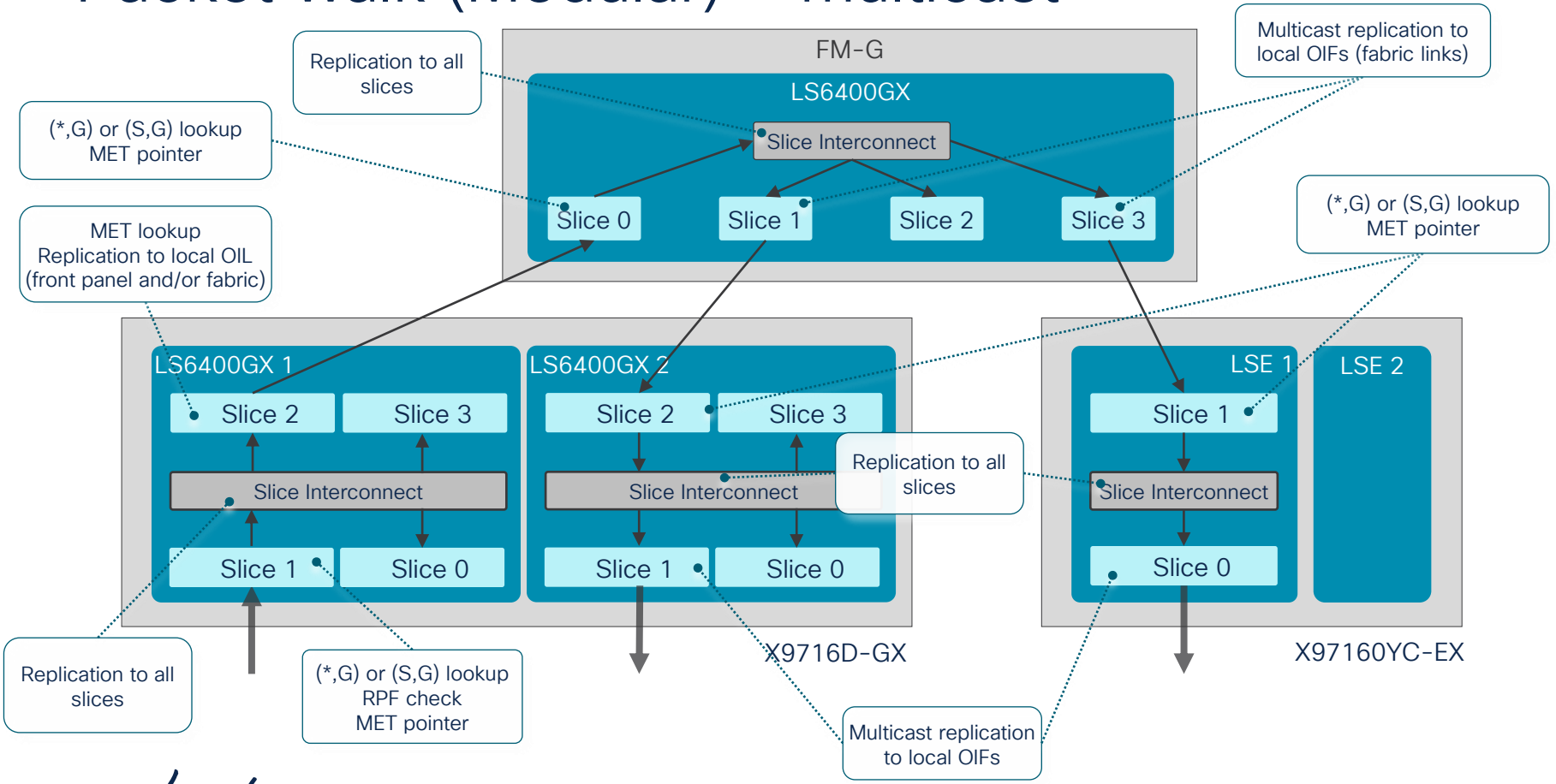
Packet walk (Modular) – multicast



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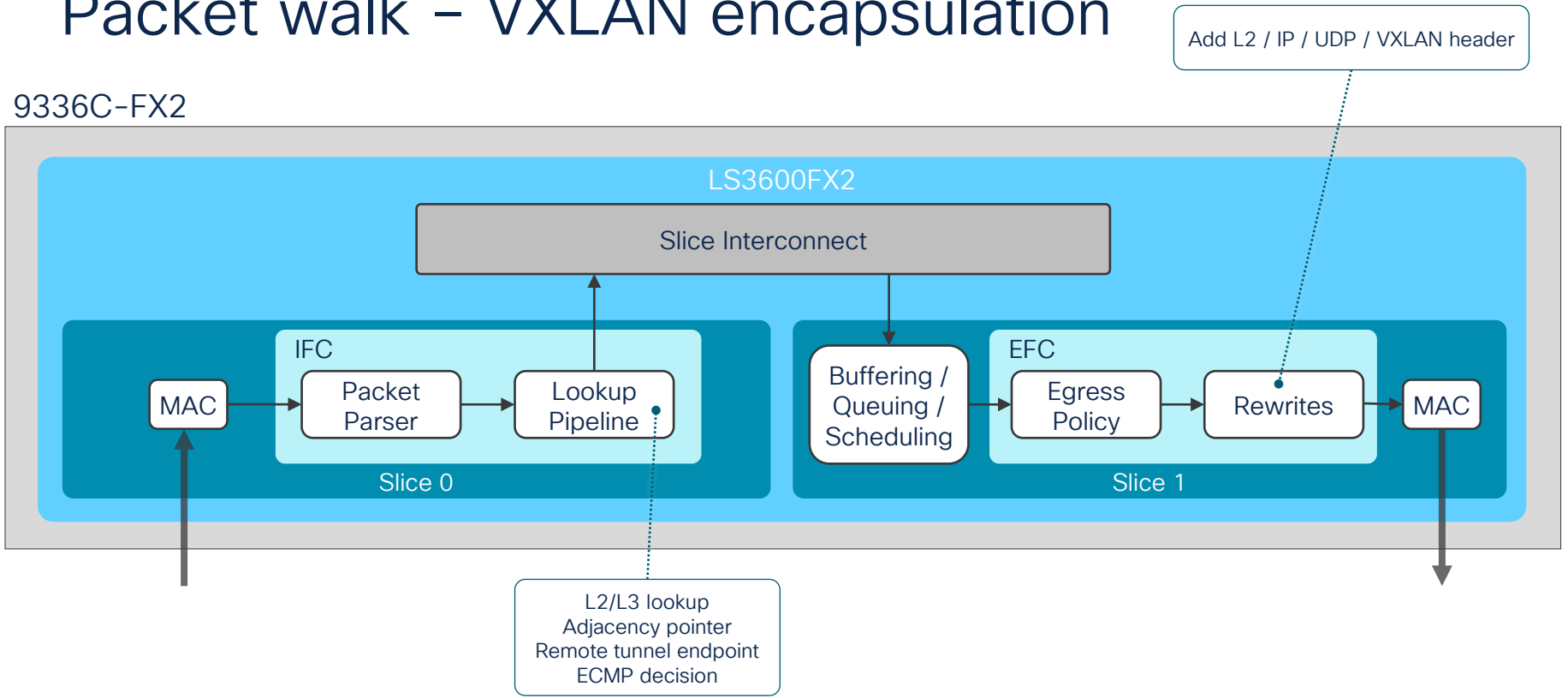
Packet walk – VXLAN encapsulation



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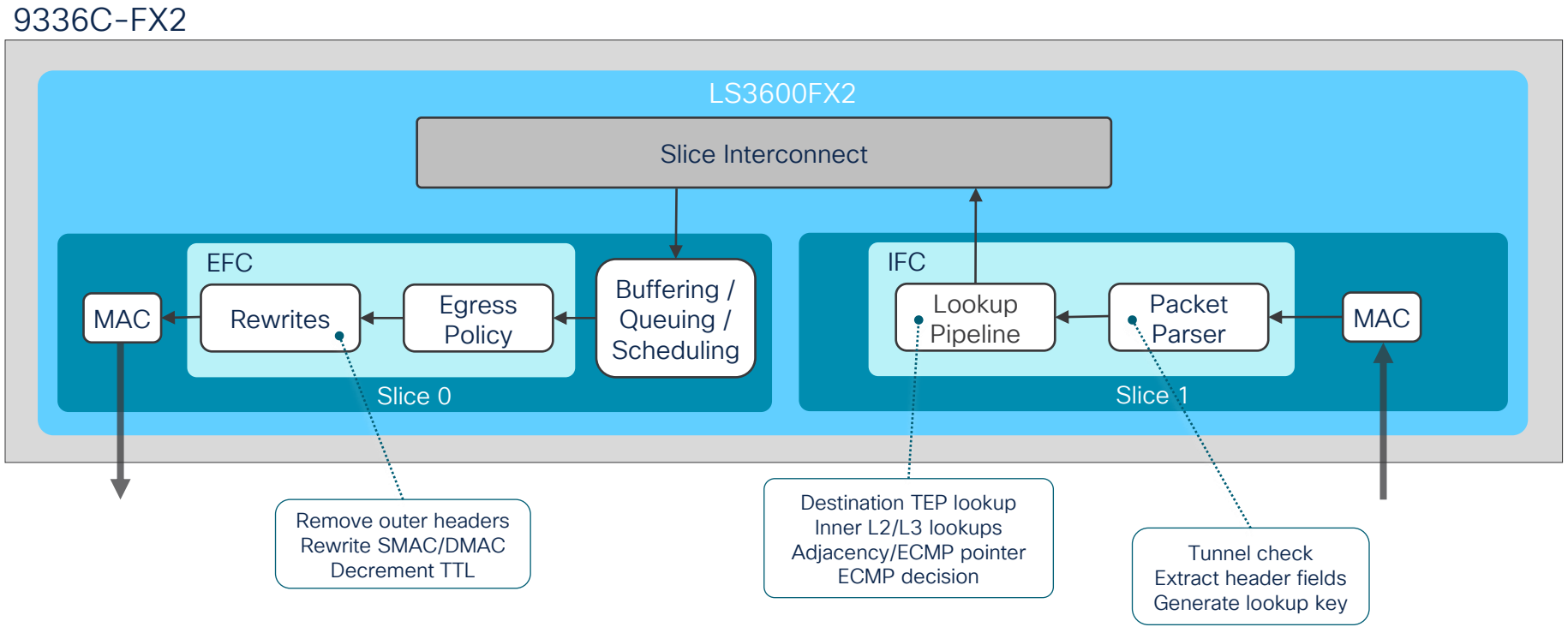
Packet walk – VXLAN decapsulation



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Agenda

- Data Center and Silicon Strategy
- Cloud Scale ASIC Architecture
- Cloud Scale Switching Platforms
- Packet Walks
- Key Takeaways

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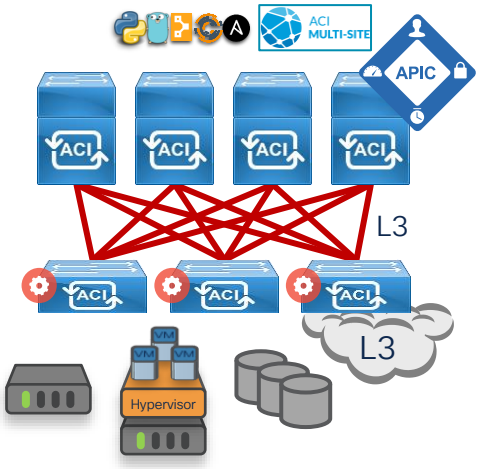
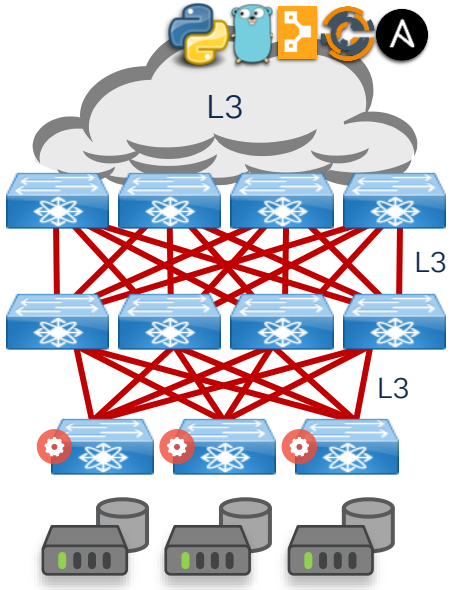
Building data center fabrics with Nexus 9000

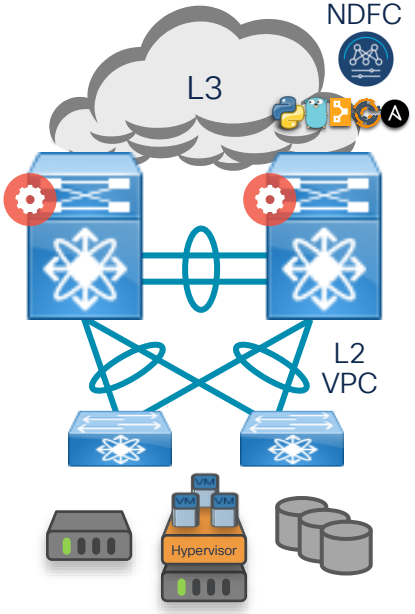


ACI – Turnkey fabric

Standalone – Programmable fabric with VXLAN+EVPN



Standalone – Programmable IP Network



Standalone – Traditional Data Center Network

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Key takeaways

- You should now have a thorough understanding of the Nexus 9000 Cloud Scale switching platform architecture
- Feature-rich, innovative switching platform addresses virtually every deployment scenario
- Nexus 9000 Cloud Scale platform forms foundation of Cisco Data Center strategy

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Recommended literature

- Flexible Forwarding Table on Nexus 9000 White Paper
- Classification TCAM with Cisco CloudScale ASICs for Nexus 9000 Series Switches White Paper
- Intelligent Buffer Management on Cisco Nexus 9000 Series Switches White Paper
- Cisco Nexus 9800 Series Switches White Paper
- Cisco Nexus 9300-H Series Switches White Paper
- Cisco Nexus 9500 Cloud Scale Line Cards and Fabric Modules White Paper

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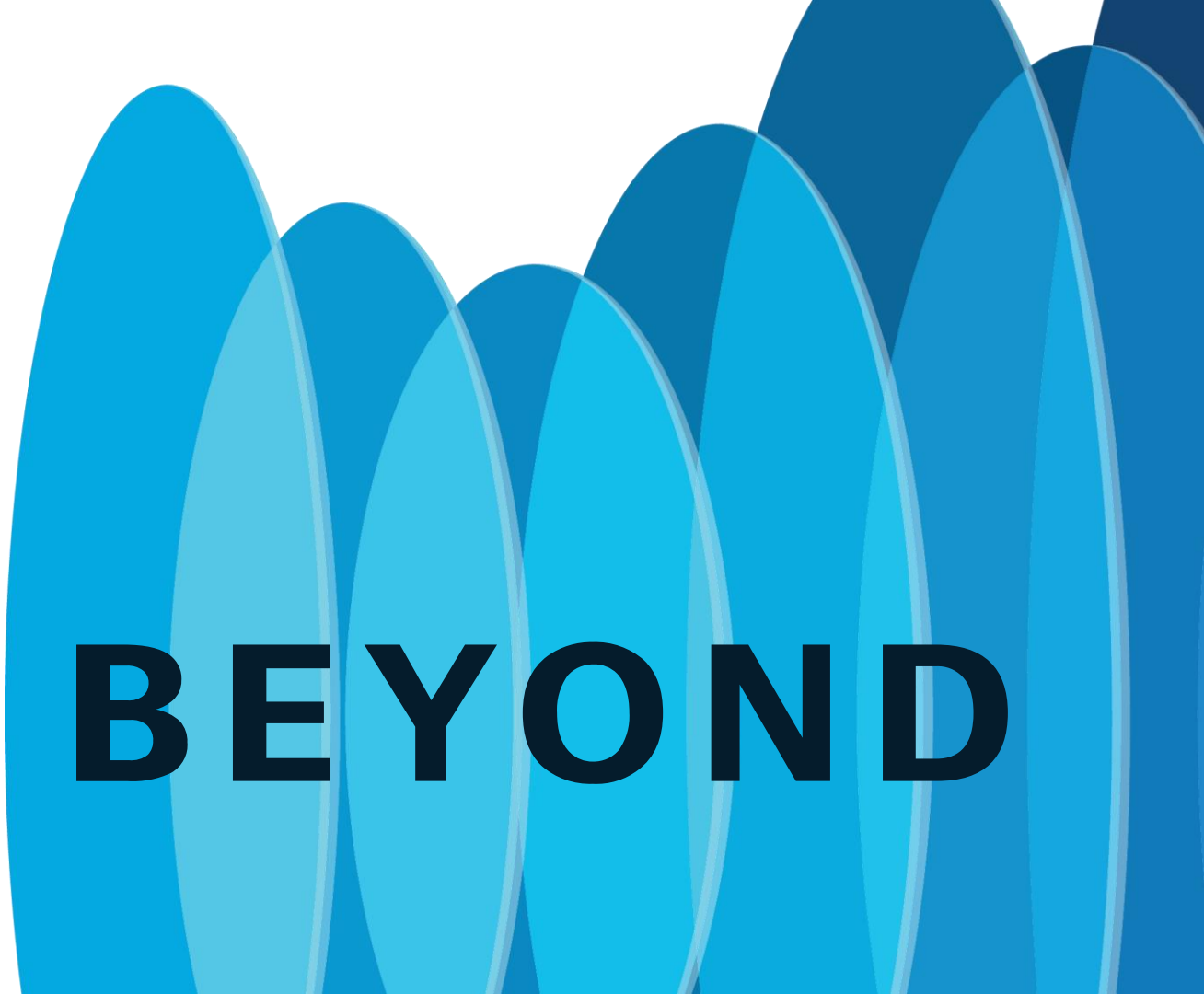

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