We’re ready.
Are you?

Nexus 7000/7700 Architecture and Deployment Models

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Cisco live!

Session Abstract

This session will discuss the foundations of the Nexus 7000 and 7700 series switches, including chassis, I/O modules, and NX-OS software. Examples will show common use-cases for different module types and considerations for module interoperability. The focus will then shift to key platform capabilities and features – including VPC,OTV, VDCs, and others – along with real-world designs and deployment models.

Session Goals

- To provide an understanding of the Nexus 7000 / Nexus 7700 switching architecture, which provides the foundation for flexible, scalable Data Centre designs
- To examine key Nexus 7000 / Nexus 7700 design building blocks and illustrate common design alternatives leveraging those features and functionalities
- To see how the Nexus 7000 / Nexus 7700 platform plays in emerging technologies and architectures

Agenda

- Introduction to Nexus 7000 / Nexus 7700
- Nexus 7000 / Nexus 7700 Architecture
  - Chassis, Supervisor Engines and NX-OS software, I/O modules (M2/F2E/F3)
  - I/O Module Interoperability
  - Fabric Architecture
  - Hardware Forwarding
- Generic Designs with Nexus 7000 / Nexus 7700
  - STP/VPC, L4-7 services integration, VDCs, VRF/MPLS VPNs, OTV

Introduction to Nexus 7000 / Nexus 7700 Platform

Data-centre class Ethernet switches designed to deliver high performance, high availability, system scale, and investment protection

Designed for wide range of Data Centre deployments, focused on feature-rich 10G/40G/100G density and performance

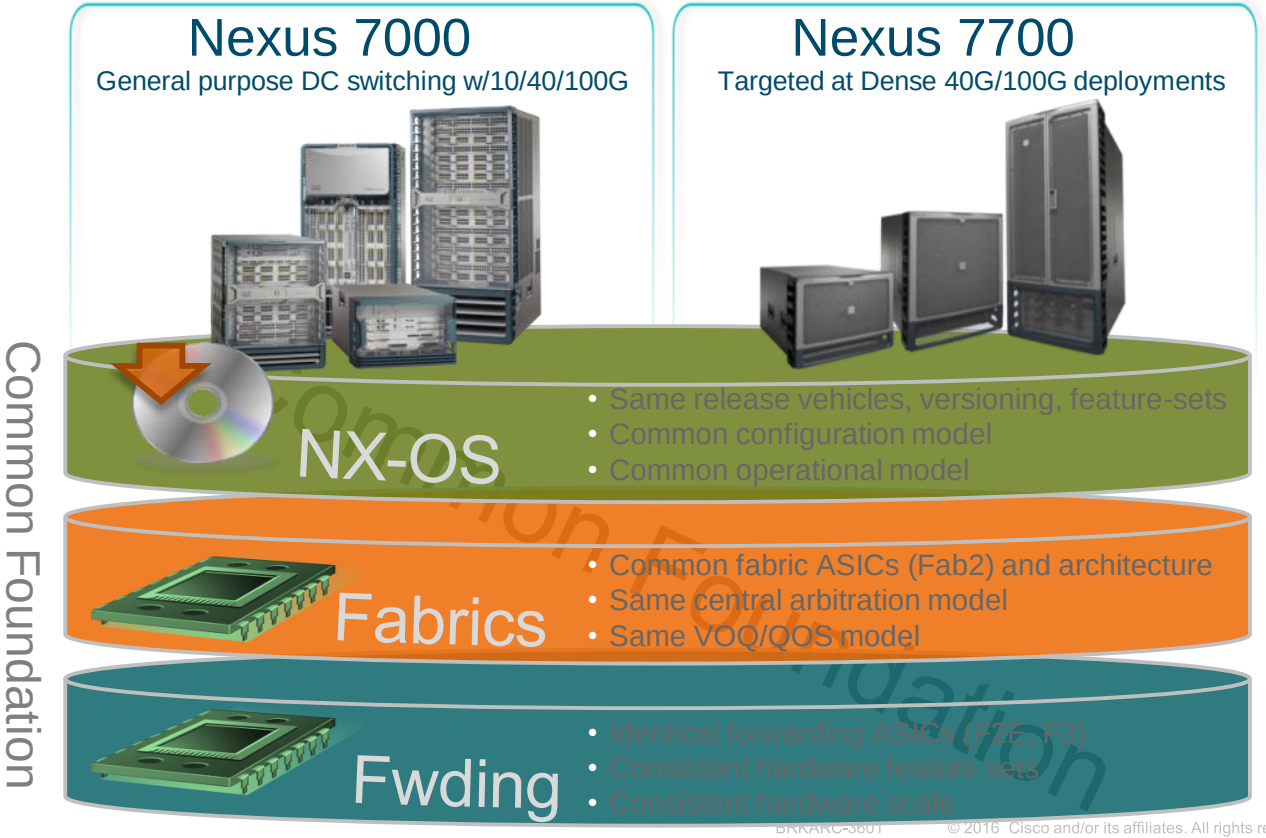
I/O Modules

Chassis

Supervisor Engines

Fabrics

Nexus 7000 / Nexus 7700 – Common Foundation



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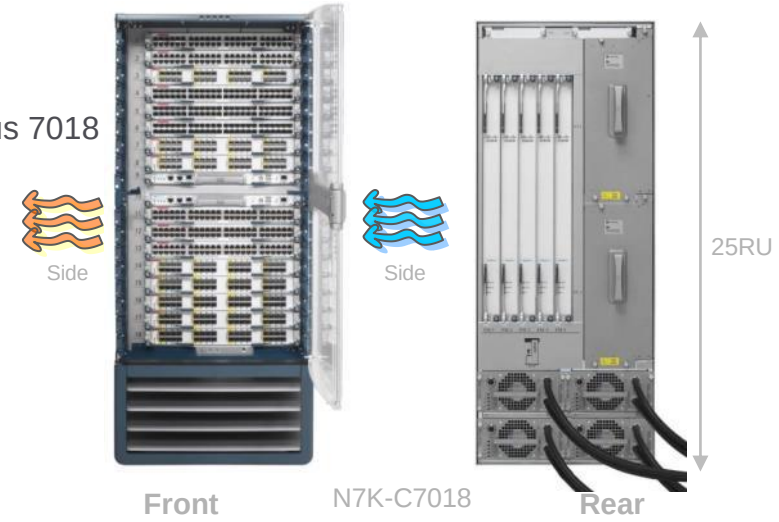
Nexus 7000 Chassis Family

Nexus 7010

Nexus 7018

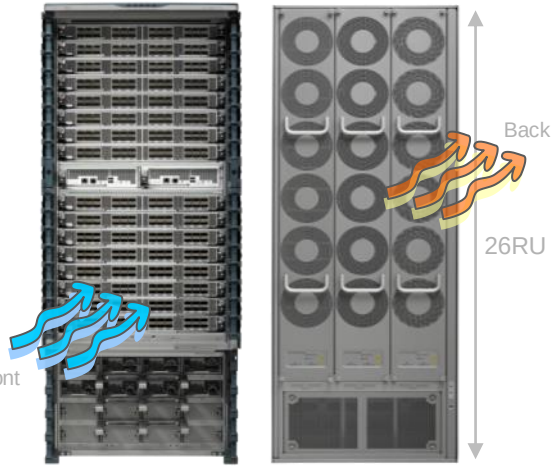


Nexus 7009

Nexus 7004

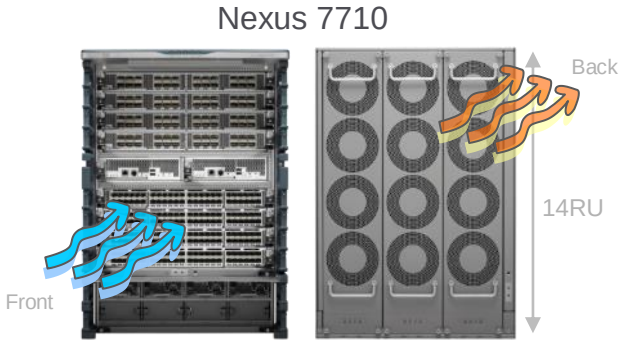
Nexus 7700 Chassis Family

Nexus 7718



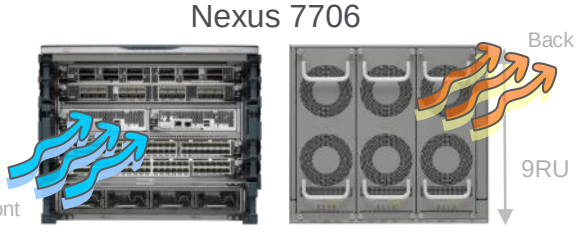
N77-C7718

Nexus 7710



N77-C7710

Nexus 7706



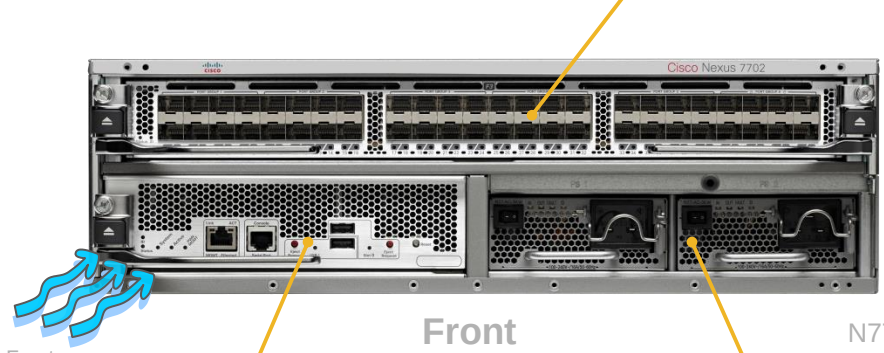
N77-C7706

Nexus 7702 Chassis

One F3 Series I/O Module

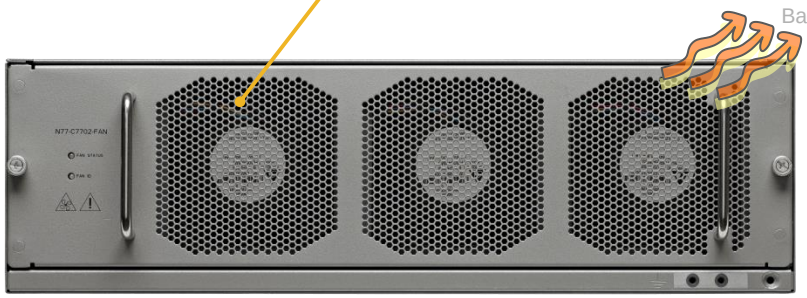
One Fan Tray (3 Fans)

NX-OS 7.2 and later



Front

N77-C7702



Rear

One Supervisor Engine

Two Power Supplies

No Fabric Modules!

Supervisor Engine 2 / 2E

- Provides all control plane and management functions

Supervisor Engine 2 (Nexus 7000)	Supervisor Engine 2E (Nexus 7000 / Nexus 7700)
Base performance	High performance
One quad-core 2.1GHz CPU with 12GB DRAM	Two quad-core 2.1GHz CPU with 32GB DRAM

- Connects to fabric via 1G inband interface
- Interfaces with I/O modules via 1G switched EOBC
- Onboard central arbiter ASIC
  Controls access to fabric bandwidth via dedicated arbitration path to I/O modules

N7K-SUP2/N7K-SUP2E

ID and Status LEDs

Console Port

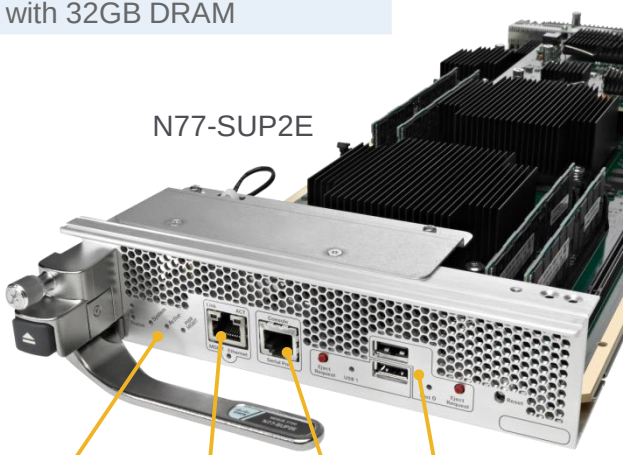
Management Ethernet

USB Host Ports

USB Log Flash

USB Expansion Flash

N77-SUP2E



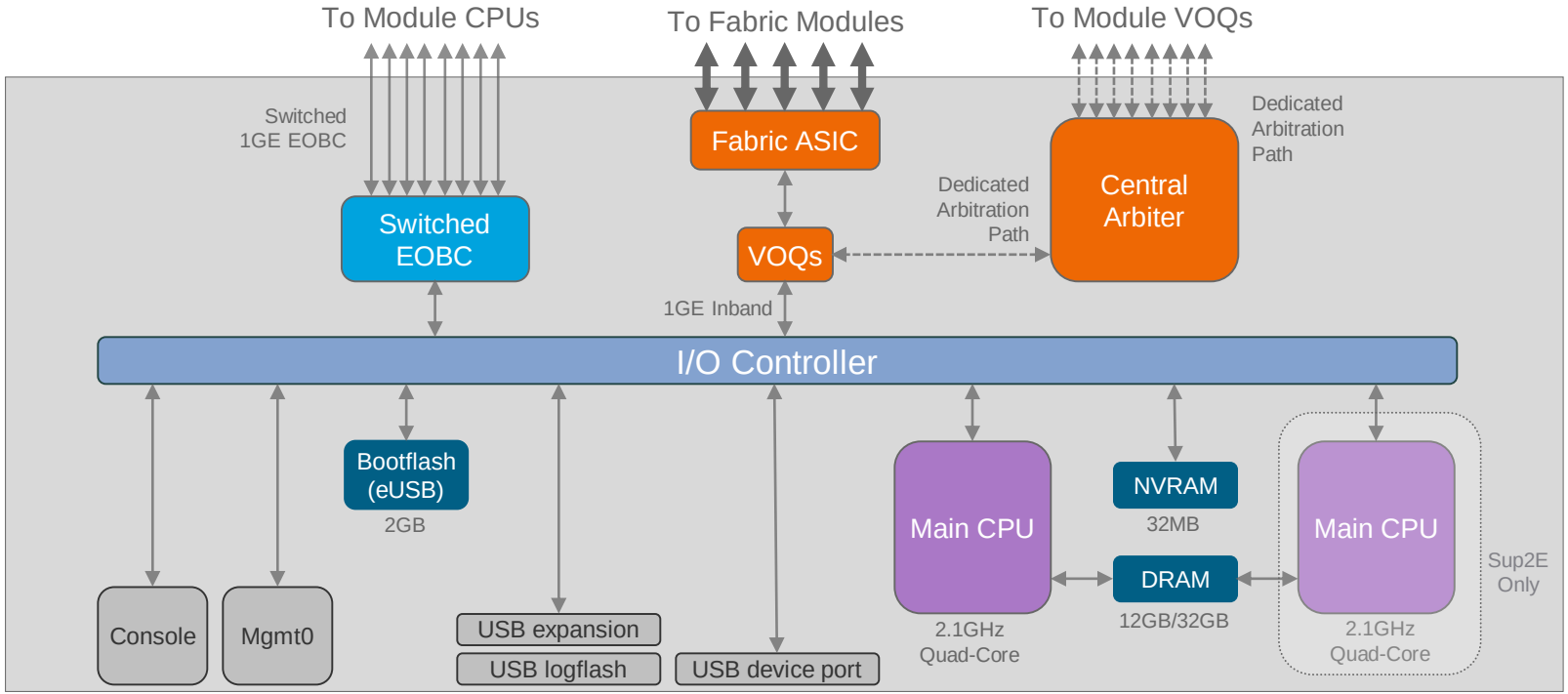
ID and Status LEDs

Console Port

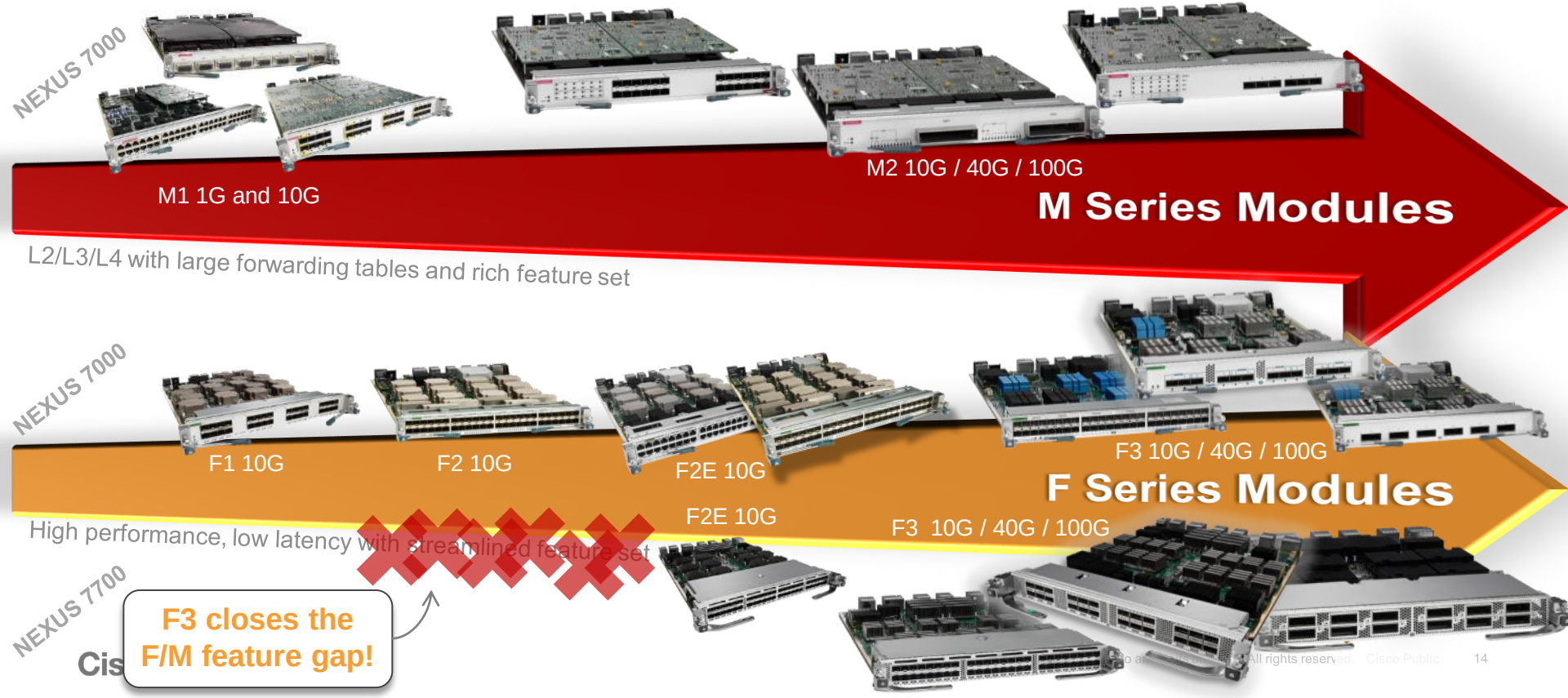
Management Ethernet

USB Expansion Flash

Supervisor Engine 2 / 2E Architecture



Nexus 7000 / 7700 I/O Module Families



Nexus 7000 M2 I/O Modules

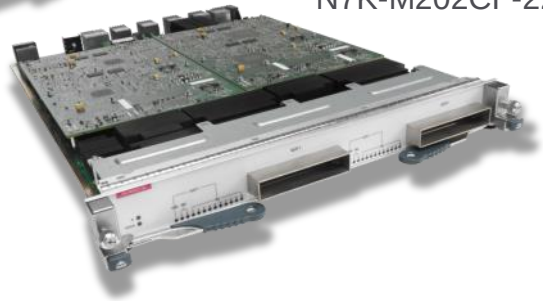
N7K-M224XP-23L / N7K-M206FQ-23L / N7K-M202CF-22L

- 10G / 40G / 100G M2 I/O modules
- Share common hardware architecture – multi-chipset
- Two integrated forwarding engines (120Mpps)
- Layer 2/Layer 3 forwarding with L3/L4 services (ACL/QOS) and advanced features (MPLS/OTV/GRE etc.)
- Large forwarding tables (900K FIB/ 128K ACL)

N7K-M224XP-23L

N7K-M206FQ-23L

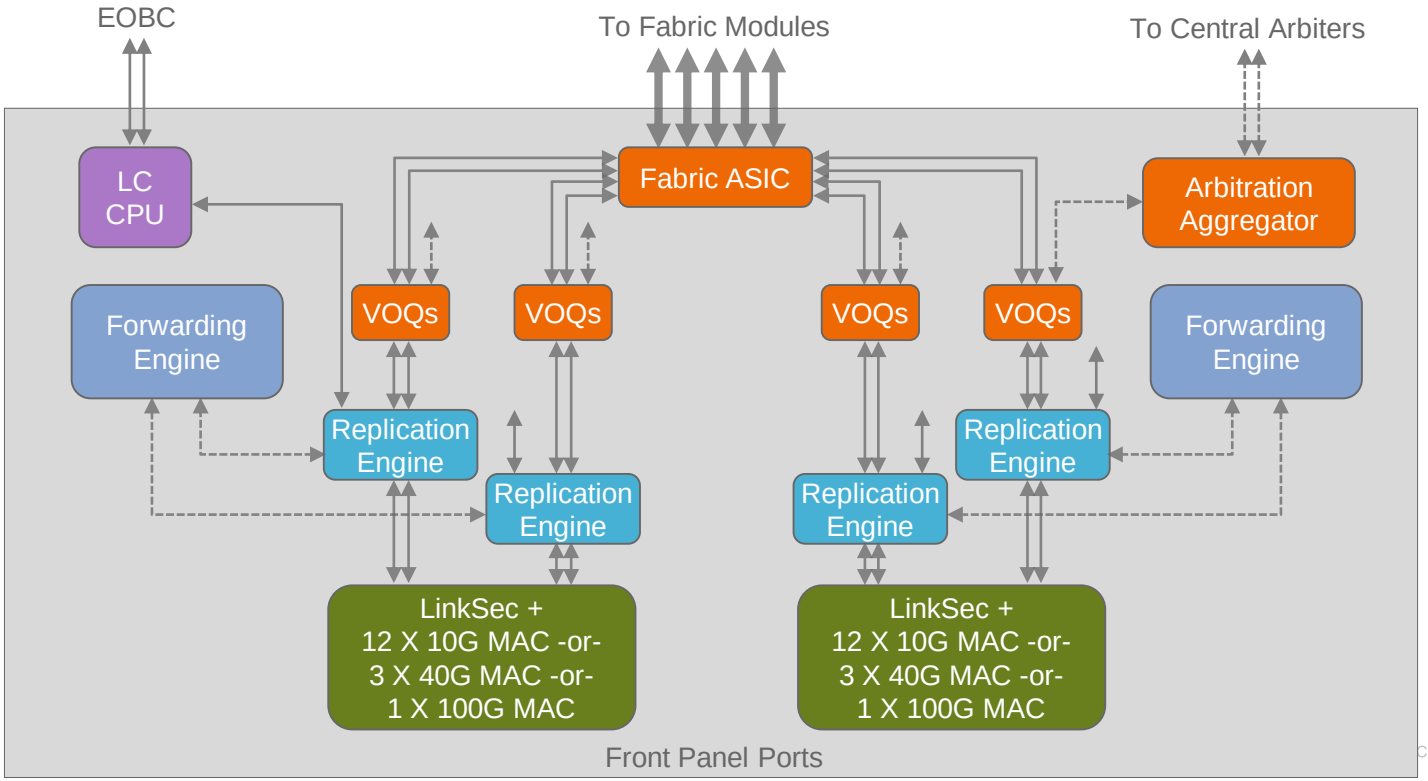
N7K-M202CF-22L



Module	Port Density	Optics	Bandwidth
M2 10G	24 x 10G (plus Nexus 2000 FEX support)	SFP+	240G
M2 40G	6 x 40G (or up to 24 x 10G via breakout)	QSFP+	240G
M2 100G	2 x 100G	CFP	200G

Nexus 7000 M2 I/O Module Architecture

N7K-M224XP-23L / N7K-M206FQ-23L / N7K-M202CF-22L



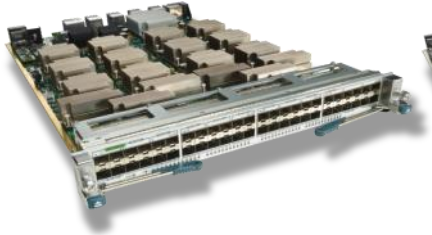
F Series

Nexus 7000 / Nexus 7700 F2E I/O Modules

N7K-F248XP-25E / N7K-F248XT-25E / N77-F248XP-23E

- 48-port 1G/10G with SFP/SFP+ transceivers
- 480G full-duplex fabric connectivity
- System-on-chip (SOC) forwarding engine design
  - 12 independent SOC ASICs
- Layer 2/Layer 3 forwarding with L3/L4 services (ACL/QOS)
- Interoperability with M1/M2, in Layer 2 mode on Nexus 7000
  - Proxy routing for inter-VLAN/L3 traffic

Nexus 7000
N7K-F248XP-25E



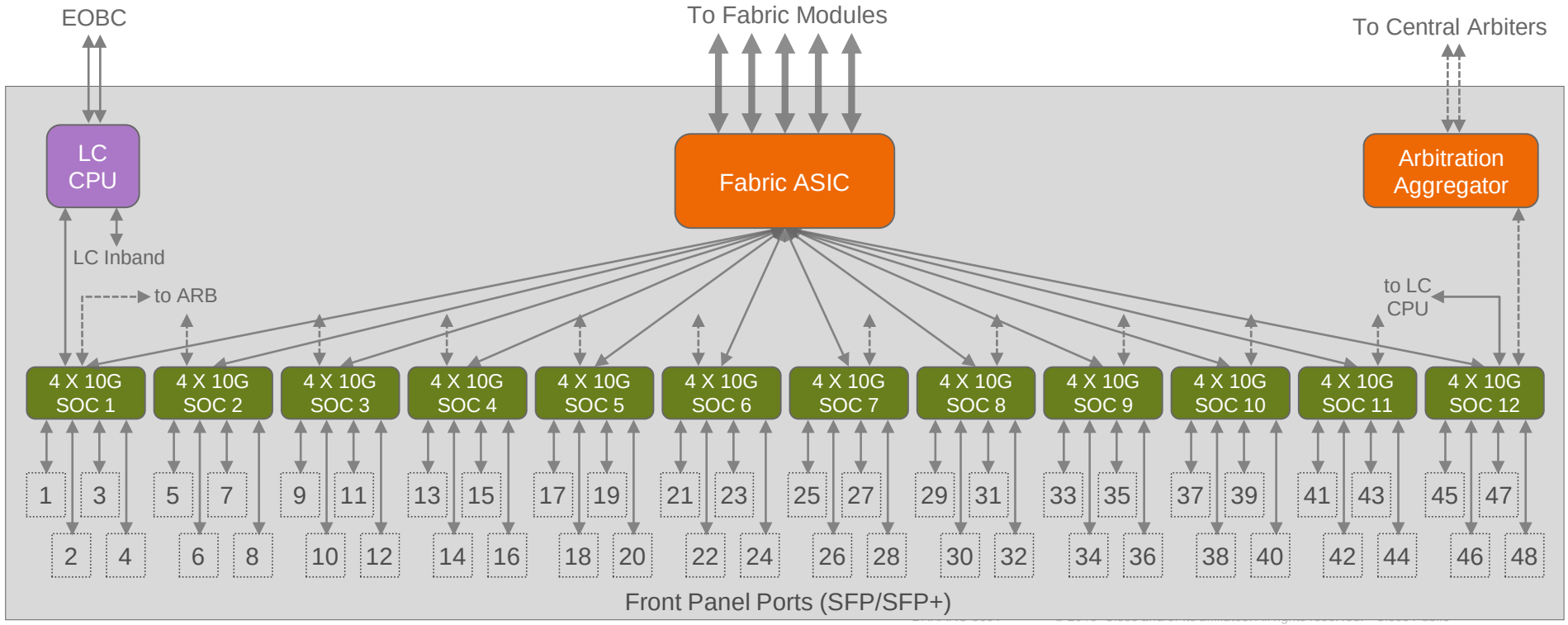
Nexus 7000
N7K-F248XT-25E

Nexus 7700
N77-F248XP-23E

F Series

Nexus 7000 F2E Module Architecture

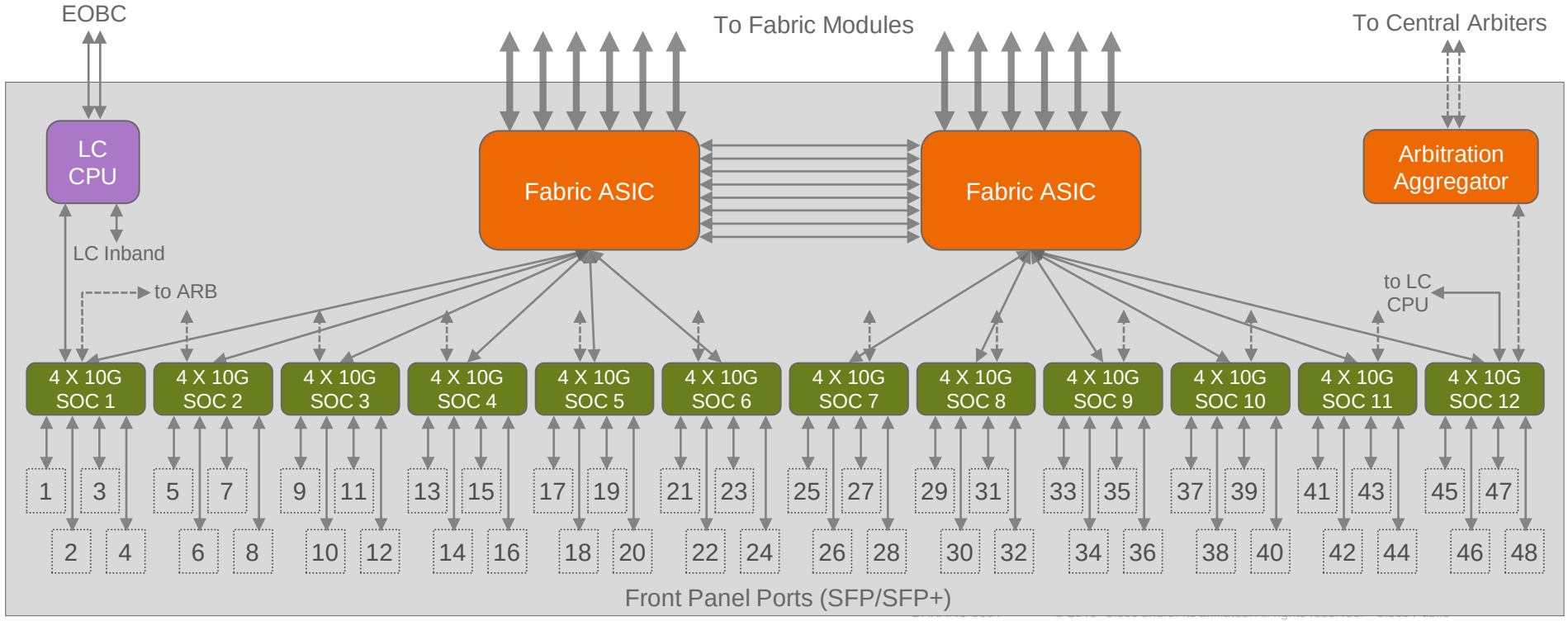
N7K-F248XP-25E / N7K-F248XT-25E



F Series

Nexus 7700 F2E Module Architecture

N77-F248XP-23E



F Series

Nexus 7000 F3 I/O Modules

N7K-F348XP-25 / N7K-F312FQ-25 / N7K-F306CK-25

- 10G / 40G / 100G F3 I/O modules
- Share common hardware architecture
- SOC-based forwarding engine design
  - 6 independent SOC ASICs per module
- Layer 2/Layer 3 forwarding with L3/L4 services (ACL/QOS) and advanced features (MPLS/OTV/GRE/VXLAN etc.)
- **Require Supervisor Engine 2 / 2E**

N7K-F348XP-25

N7K-F312FQ-25

N7K-F306CK-25

Module	Port Density	Optics	Bandwidth
F3 10G	48 x 1/10G (plus Nexus 2000 FEX support)	SFP+	480G
F3 40G	12 x 40G (or up to 48 x 10G via breakout)	QSFP+	480G
F3 100G	6 x 100G	CPAK	550G

F Series

Nexus 7700 F3 I/O Modules

N7K-F348XP-25 / N7K-F312FQ-25 / N7K-F306CK-25

- 10G / 40G / 100G F3 I/O modules
- Share common hardware architecture
- SOC-based forwarding engine design
  - 6 independent SOC ASICs per 10G module
  - 12 independent SOC ASICs per 40G/100G module
- Layer 2/Layer 3 forwarding with L3/L4 services (ACL/QOS) and advanced features (MPLS/OTV/GRE/VXLAN etc.)

N77-F348XP-23

N77-F324FQ-25

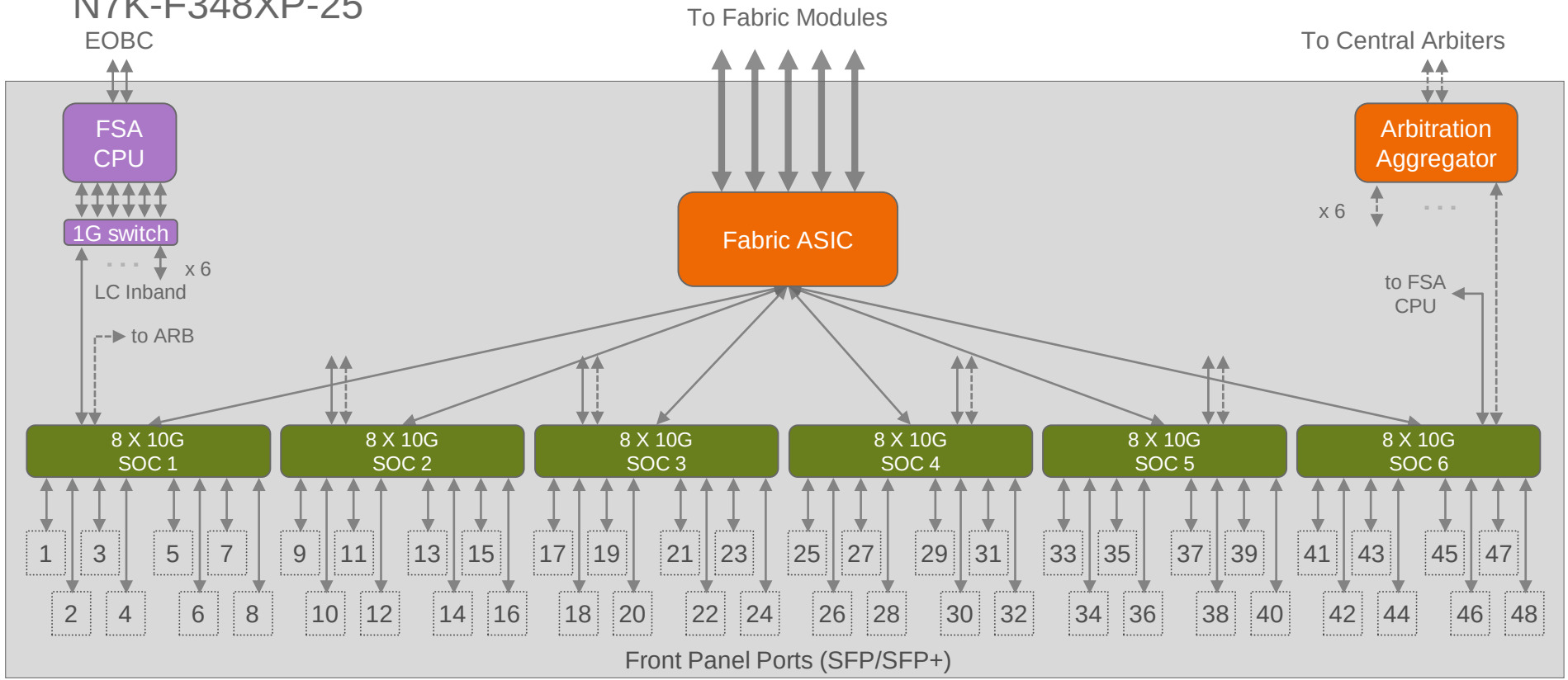
Module	Port Density	Optics	Bandwidth
F3 10G	48 x 1/10G (plus Nexus 2000 FEX support)	SFP+	480G
F3 40G	24 x 40G (or up to 76 x 10G + 5 x 40G via breakout)	QSFP+	960G
F3 100G	12 x 100G	CPAK	1.2T

N77-F312CK-26

F Series

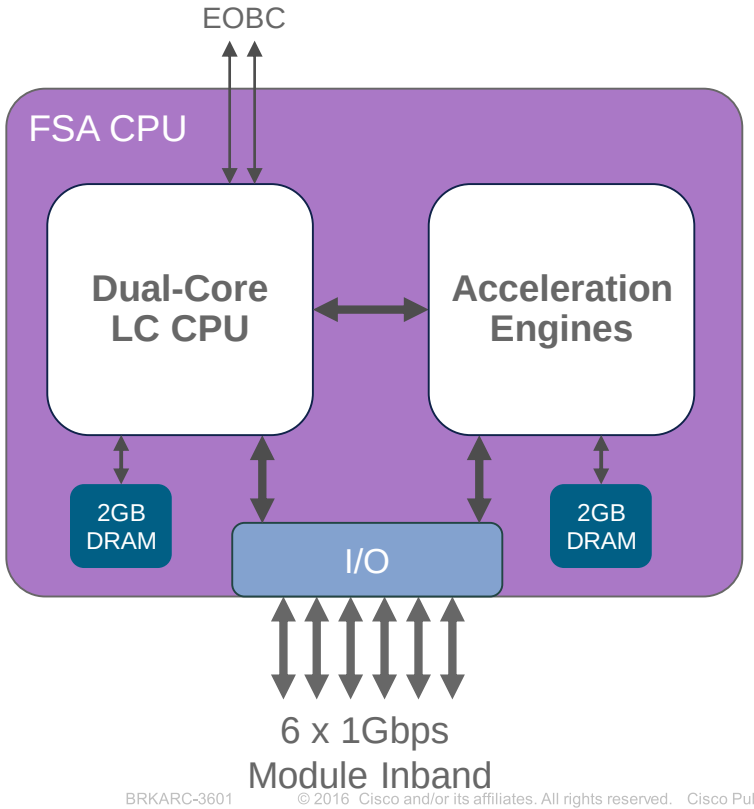
Nexus 7000 F3 48-Port 1G/10G Module Architecture

N7K-F348XP-25



Fabric Services Accelerator (FSA) for F3

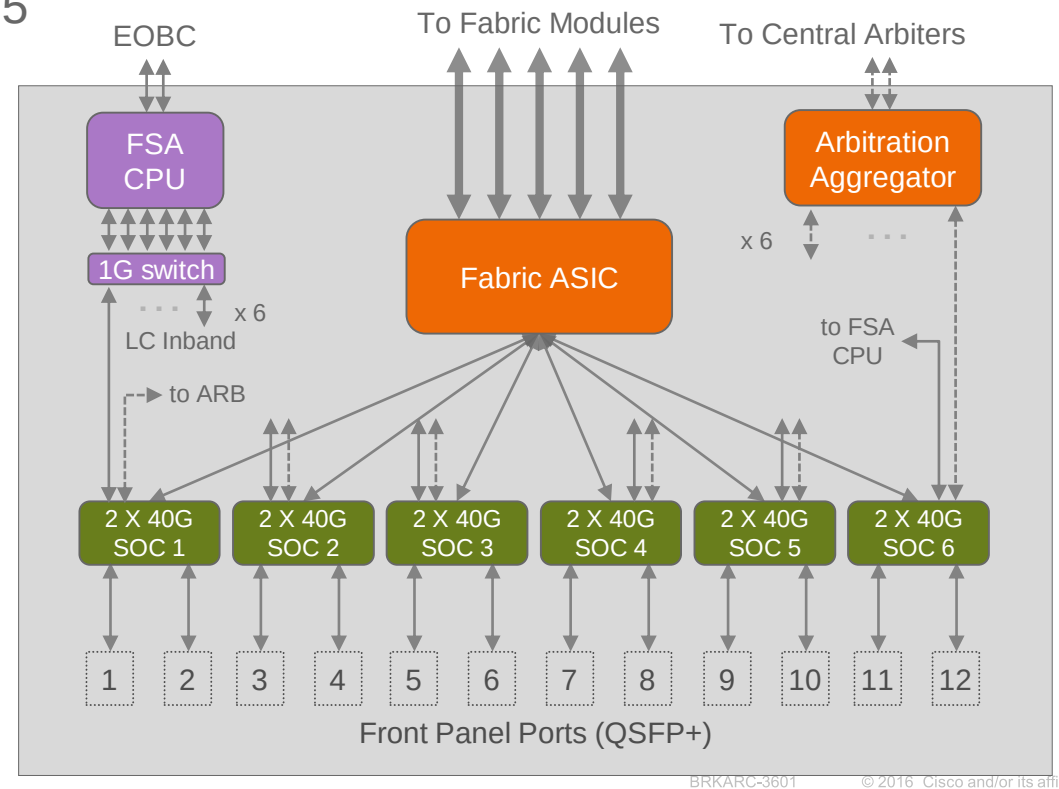
- High-performance module CPU with on-board acceleration engines
  - 6Gbps inband connectivity from SOCs to FSA
  - Multi-Mpps packet processing
  - 2 X 2GB dedicated DRAM
- Performance/scale boost for distributed fabric services, including sampled Netflow and BFD (roadmap)
- Other potential applications include distributed ARP/ping processing, data plane packet analysis (wireshark), network probing, etc.



F Series

Nexus 7000 F3 12-Port 40G Module Architecture

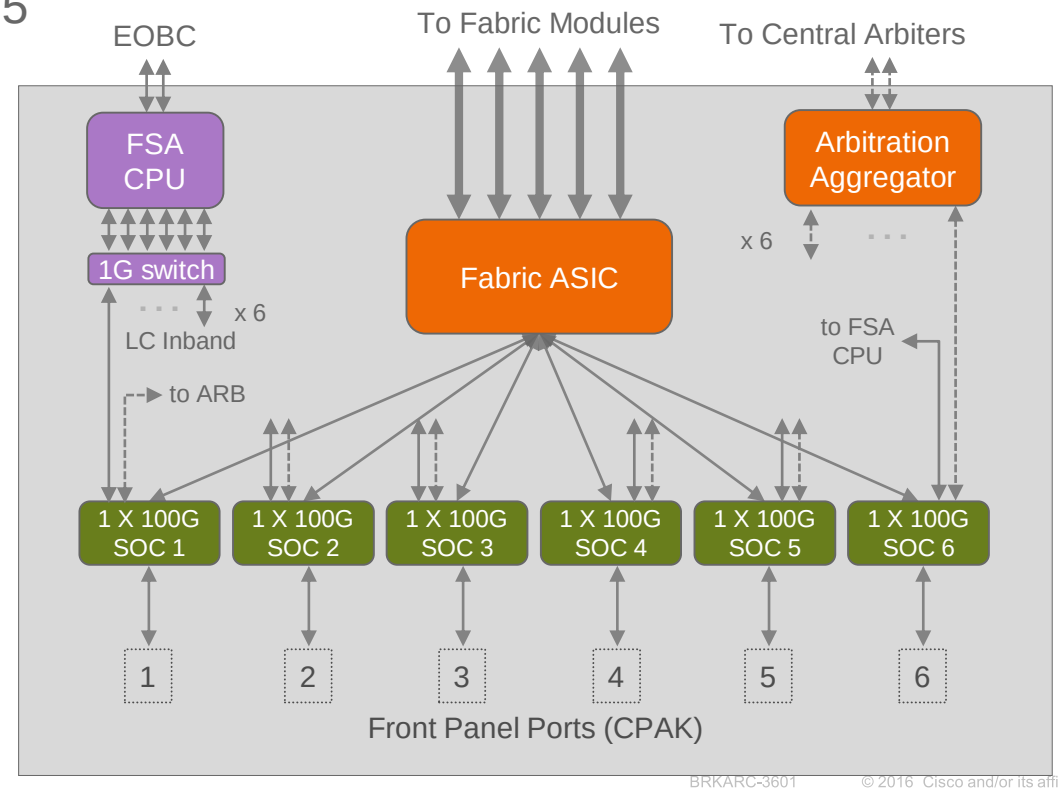
N7K-F312FQ-25



F Series

Nexus 7000 F3 6-Port 100G Module Architecture

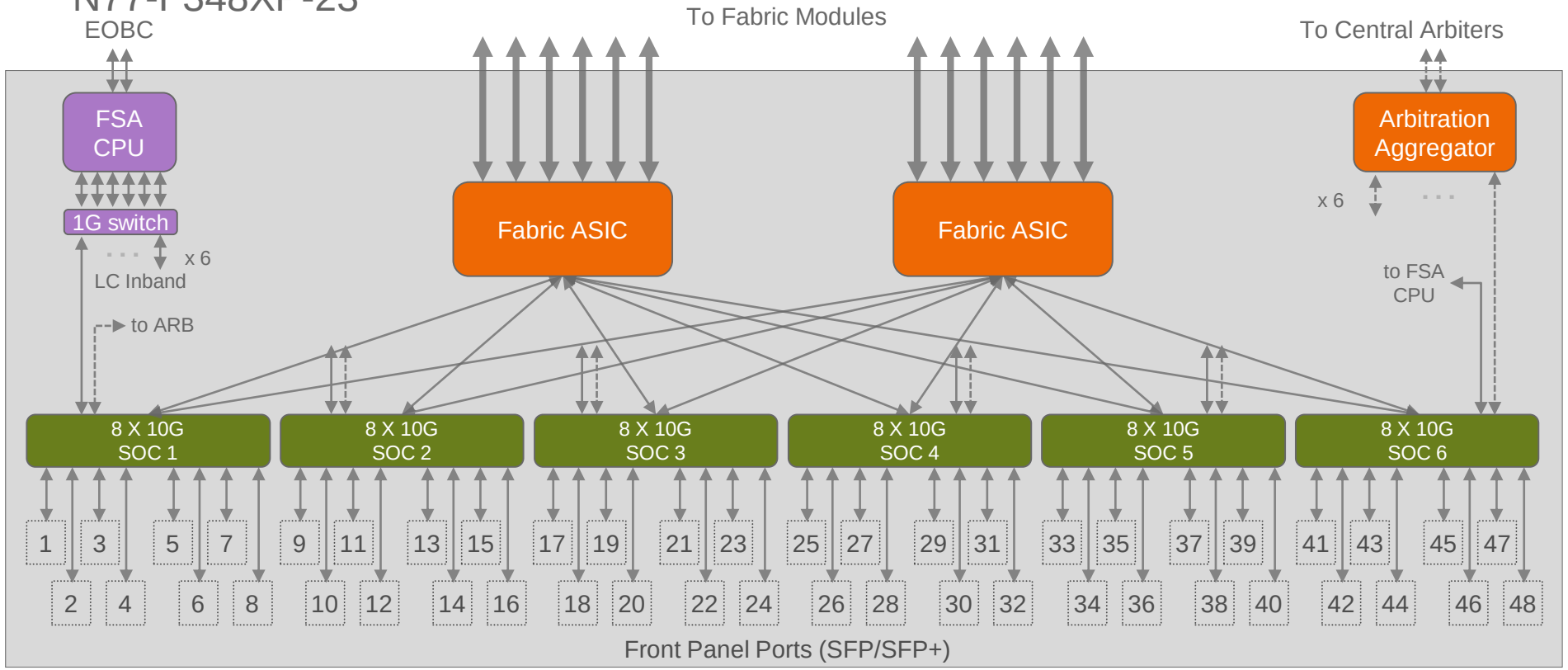
N7K-F306CK-25



F Series

Nexus 7700 F3 48-Port 1G/10G Module Architecture

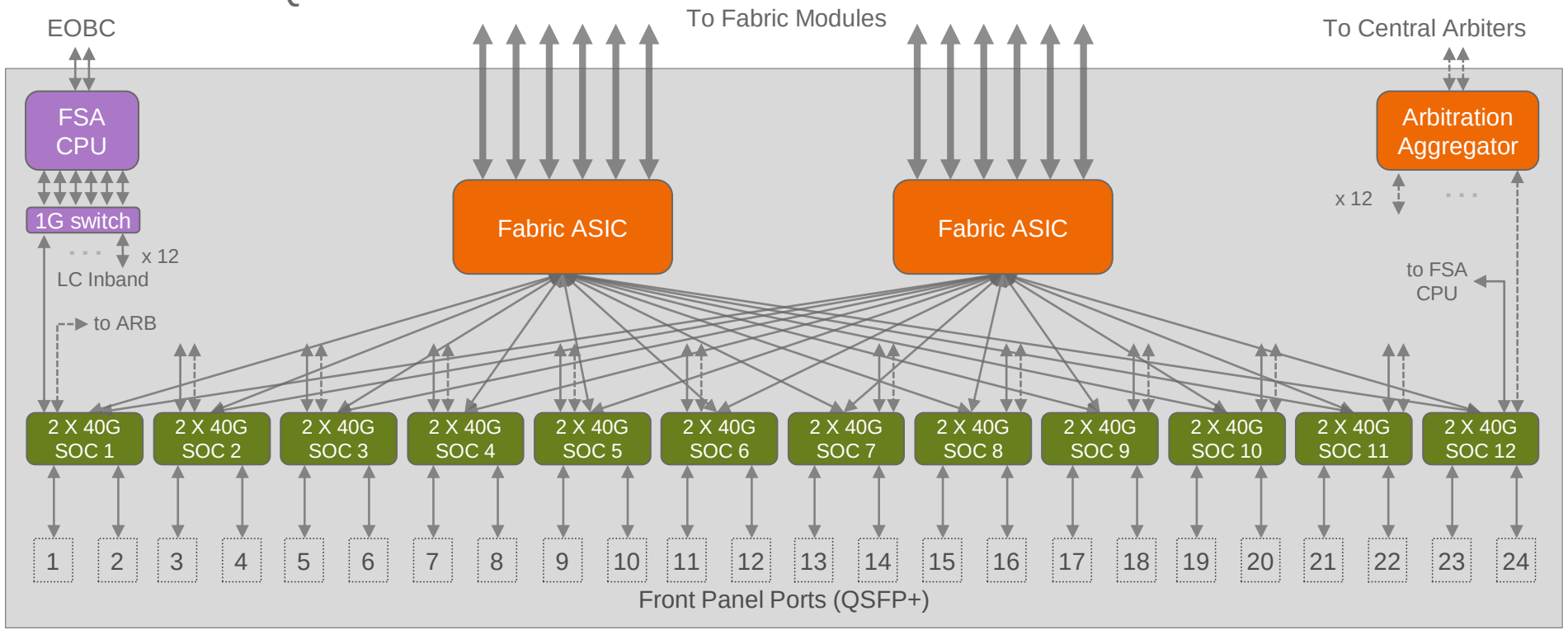
N77-F348XP-23



F Series

Nexus 7700 F3 24-Port 40G Module Architecture

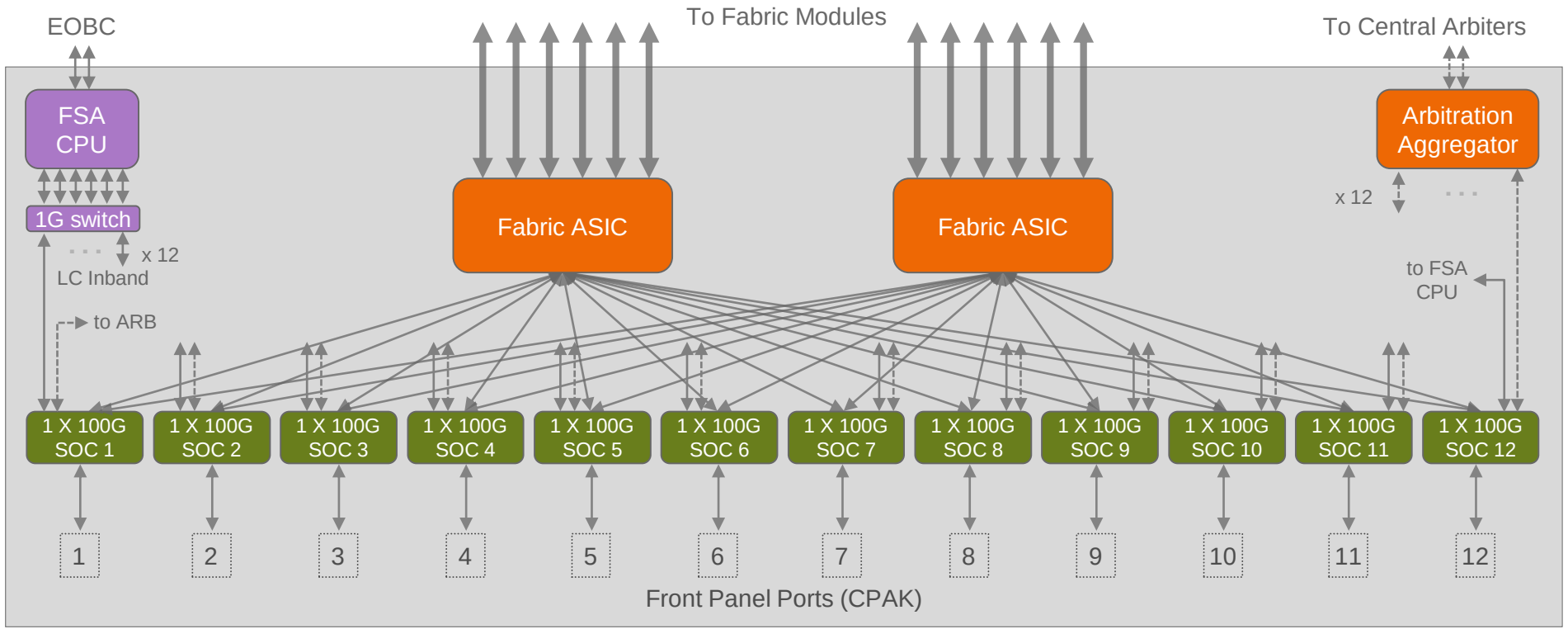
N77-F324FQ-25



F Series

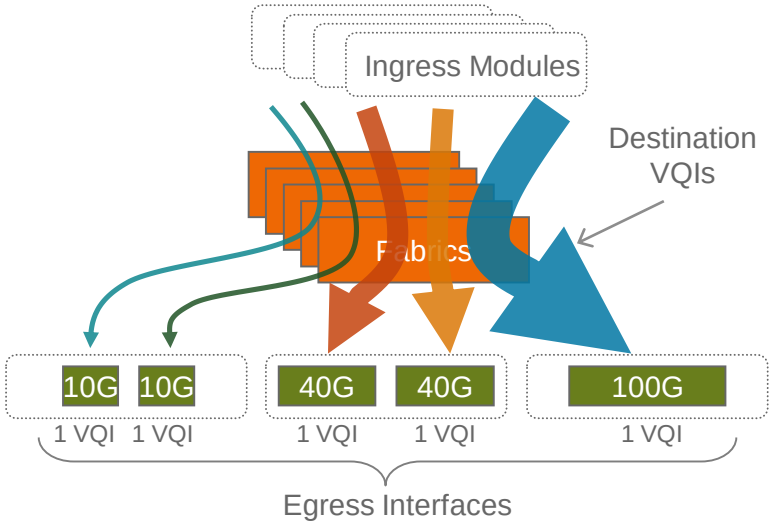
Nexus 7700 F3 12-Port 100G Module Architecture

N77-F312CK-26



F3 Module 40G and 100G Flows

- Virtual Queuing Index (VQI) sustains 10G, 40G, or 100G traffic flow based on destination interface type
- No single-flow limit – full 40G/100G flow support



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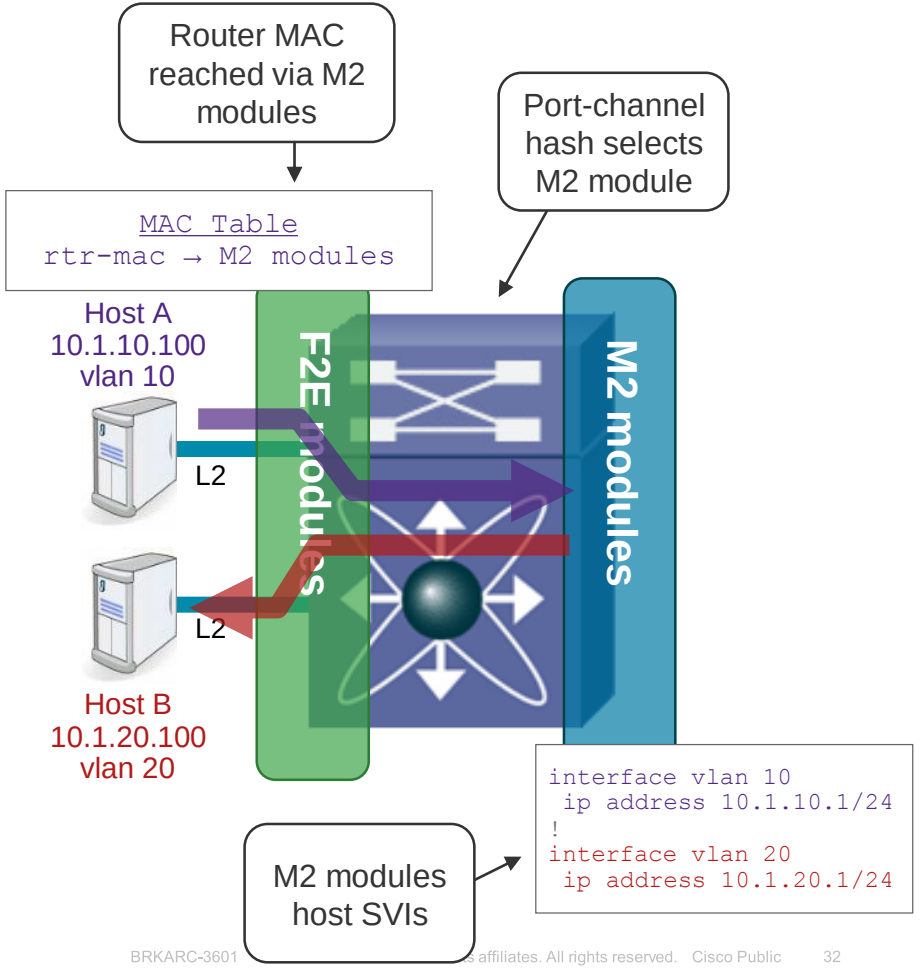
I/O Module Interoperability

- General module interoperability rule is: “+/-1 generation” in same Virtual Device Context (VDC)
- Layer 3 forwarding behaviour is key difference between interop models:
  - “Proxy Forwarding”
  - “Ingress Forwarding” with Lowest Common Denominator

Proxy Forwarding Model

M2 + F2E VDC

- F2E modules run in pure Layer 2 mode – all L3 functions disabled
- M2 modules host SVIs and other L3 functions
- From F2E perspective, Router MAC reachable via M2 modules
- All packets destined to Router MAC forwarded through fabric toward one M2 module, selected via port-channel hash
- M2 modules(s) perform all L3 forwarding and policy, pass packets back over fabric to output port
- **Key consideration:** M-series L3 routing capacity versus F-series front-panel port count – How much Layer 3 routing is required?



Ingress Forwarding with Lowest Common Denominator Model

F3 + M2 VDC *-or-* F3 + F2E VDC

- F3 module interoperability always “Ingress Forwarding” – NO proxy forwarding
  - Ingress module receiving packet makes all forwarding decisions for that packet
- Supported feature set and scale based on Lowest Common Denominator
  - Feature available if all modules support the feature
  - Table sizes based on lowest capacity

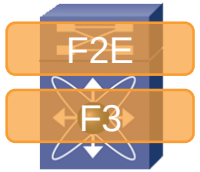
Not all features supported by software today…

Module Types in VDC	Layer 2	Layer 3	VPC	MPLS	OTV	Fabric Path	VXLAN	Table Sizes
F3	✓	✓	✓	✓	✓	✓	✓	F3 size
F3 + M2	✓	✓	✓	✓	✓	✗	✗	F3 size
F3 + F2E	✓	✓	✓	✗	✗	✓	✗	F2E size
M2 + F2E + F3	Not supported							

Module Interoperability Use Cases

- M2 + F2E VDC
  - Provide higher-density 1G/10G while supporting M2 features and L3 functions
  - Full internet routes, MPLS VPNs
  - FabricPath with increased MAC address scale (proxy L2 learning)

- F2E + F3 VDC
  - Introduction of 40G/100G into existing 10G environments
  - Migration to larger table sizes
  - Transition to additional features/functionality (OTV, MPLS, VXLAN, etc.)



- M2 + F3 VDC
  - Introduce higher 1G/10G/40G/100G port-density while maintaining feature-set
  - Avoid proxy-forwarding model for module interoperability
  - Migrate to 40G/100G interfaces with full-rate flow capability

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Crossbar Switch Fabric Modules

- Provide interconnection of I/O modules
- Nexus 7000 and Nexus 7700 fabrics based on Fabric 2 ASIC
- Each installed fabric increases available per-payload slot bandwidth

Fabric Module	Supported Chassis	Per-fabric module bandwidth	Max fabric modules	Total bandwidth per slot
Nexus **7000** Fabric 2	7009 / 7010 / 7018	110Gbps per slot	5	550Gbps per slot
Nexus **7700** Fabric 2	7706 / 7710 / 7718	220Gbps per slot	6	1.32Tbps per slot

N77-C7718-FAB-2
N77-C7710-FAB-2
N77-C7706-FAB-2

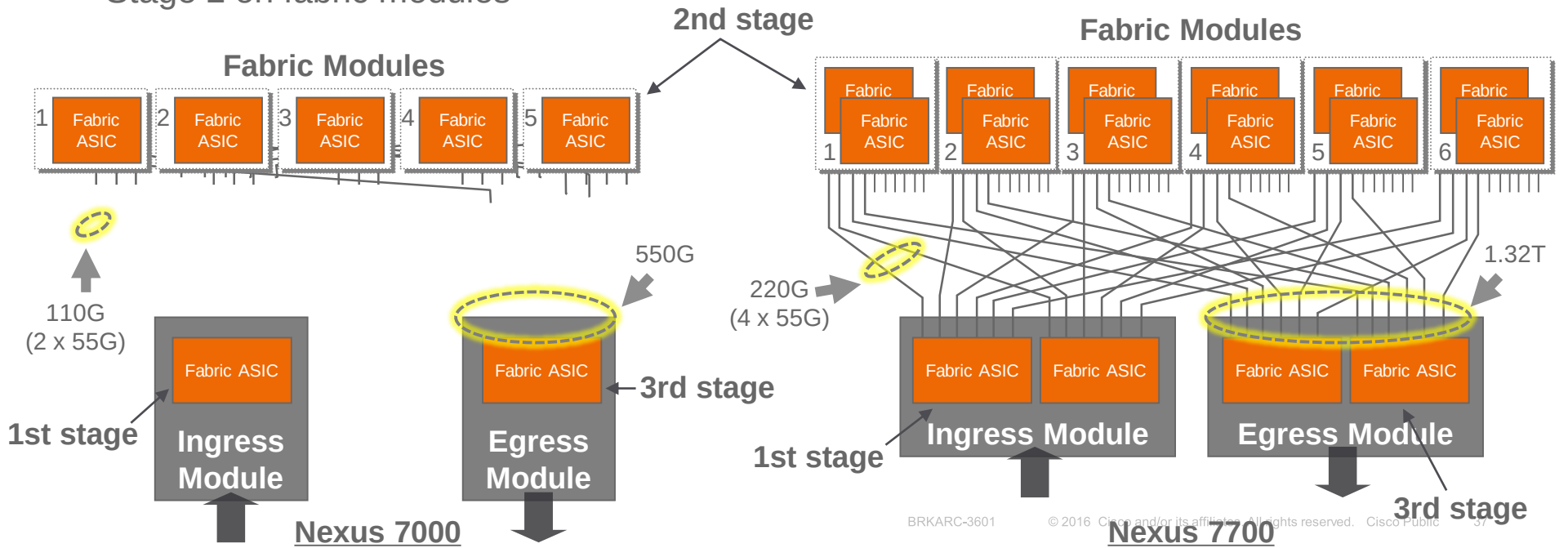
- Different I/O modules leverage different amount of available fabric bandwidth
- Access to fabric bandwidth controlled using QOS-aware central arbitration with VOQ

N7K-C7018-FAB-2
N7K-C7010-FAB-2
N7K-C7009-FAB-2

Multistage Crossbar

Nexus 7000 / Nexus 7700 implement 3-stage crossbar switch fabric

- Stages 1 and 3 on I/O modules
- Stage 2 on fabric modules



I/O Module Capacity – Nexus 7000

550Gbps

per slot bandwidth

One fabric:

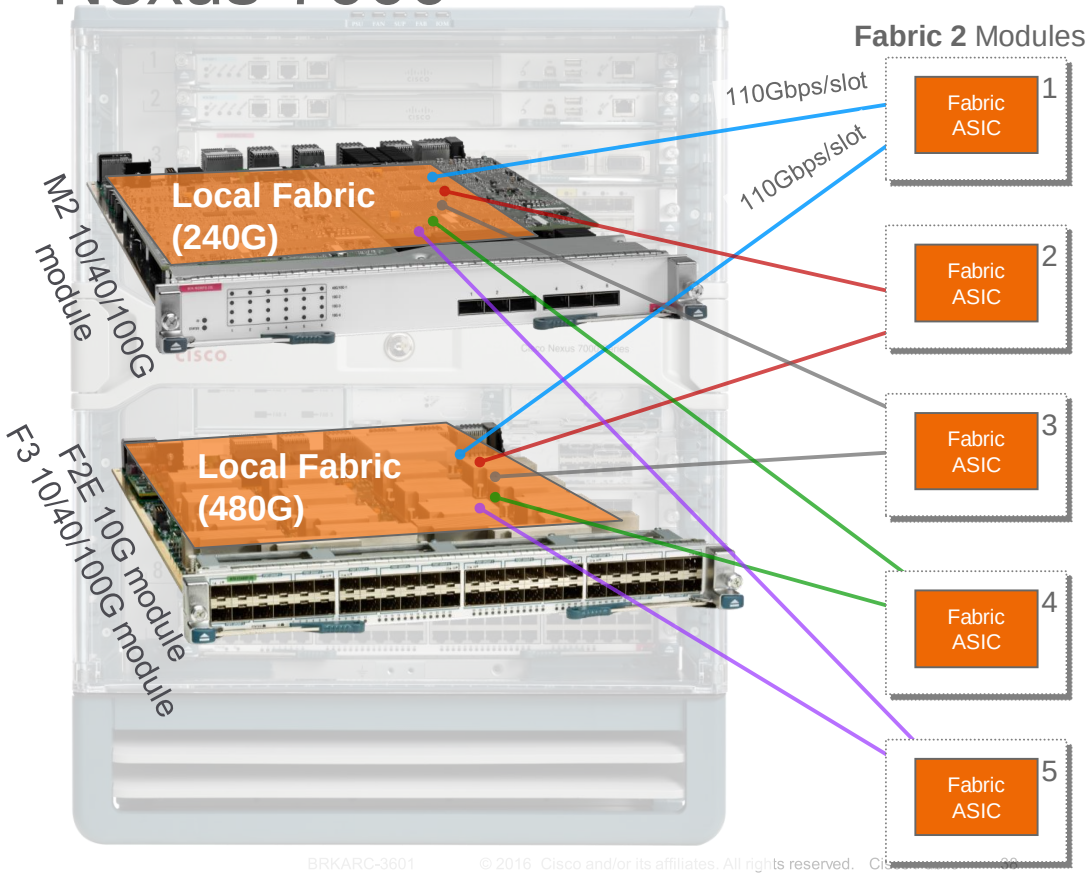
- **Any port** can pass traffic to **any other port** in VDC

Three fabrics:

- 240G M2 module has maximum bandwidth

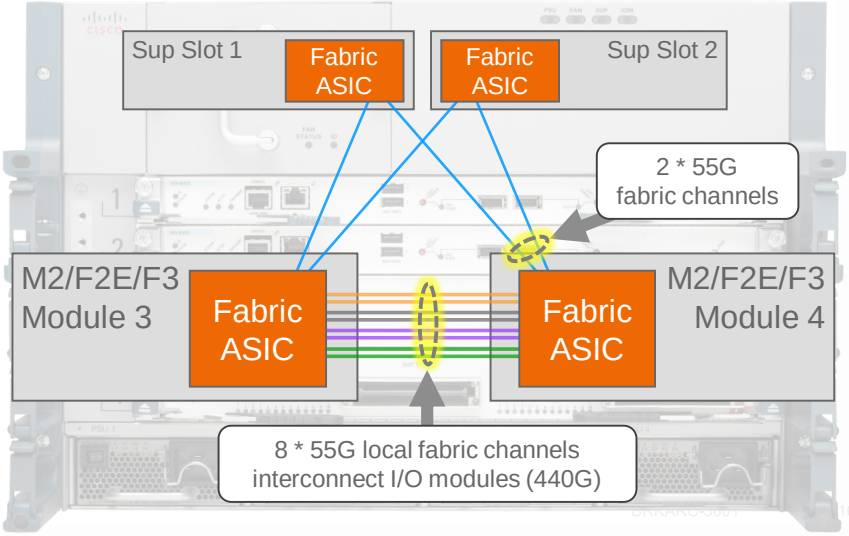
Five fabrics:

- 480G F2E/F3 module has maximum bandwidth



What About Nexus 7004?

- Nexus 7004 has no fabric modules
- Each I/O module has local fabric with 10 available fabric channels
  - I/O modules connect “back-to-back” via 8 fabric channels
  - Two fabric channels “borrowed” to connect supervisor engines



I/O Module Capacity – Nexus 7700

1320Gbps

per slot bandwidth

One fabric:

- **Any port** can pass traffic to **any other port** in VDC

Three fabrics:

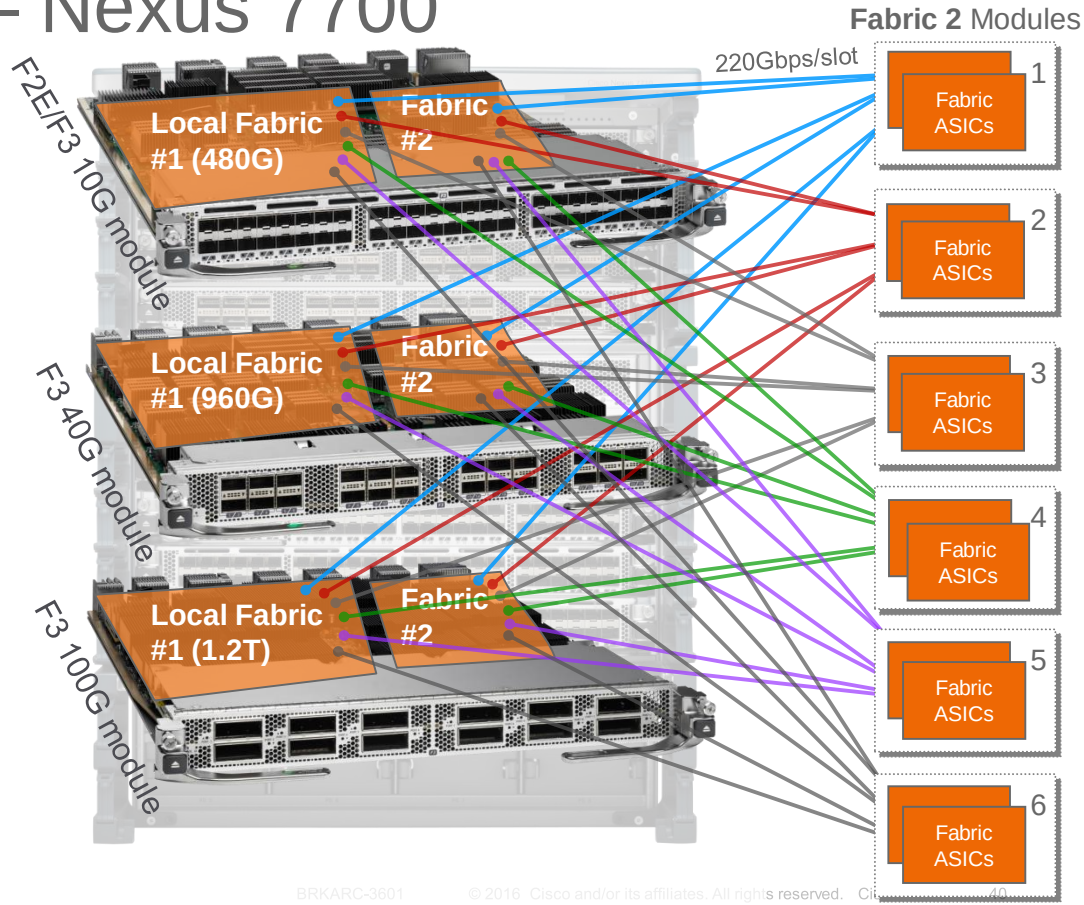
- 480G F2E/F3 10G module has maximum bandwidth

Five fabrics:

- 960G F3 40G module has maximum bandwidth

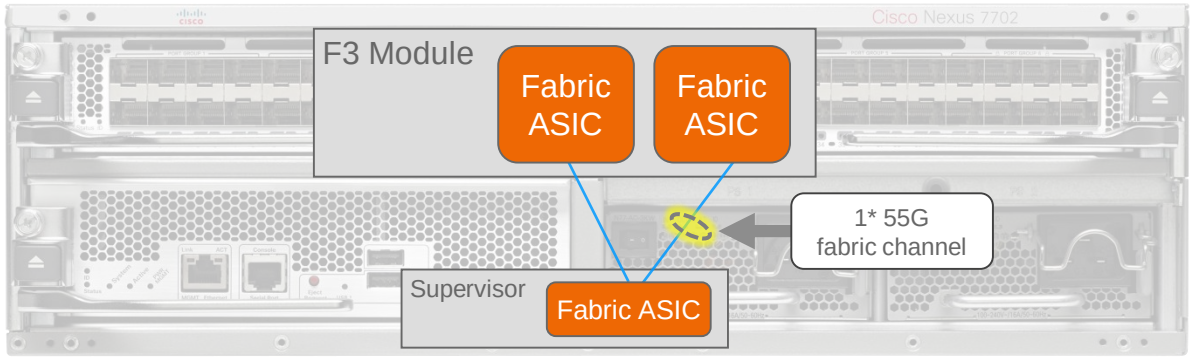
Six fabrics:

- 1.2T F3 100G module has maximum bandwidth



What About Nexus 7702?

- Nexus 7702 has no fabric modules
- Single I/O module – all traffic locally switched
- Two fabric channels connect to supervisor engine



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Hardware Forwarding Lookups

- Layer 2 and Layer 3 packet flow virtually identical in hardware
- Forwarding engine / decision engine pipeline provides consistent L2 and L3 lookup performance
- Pipelined architecture also performs ingress and egress ACL, QOS, and Netflow lookups, affecting final forwarding result

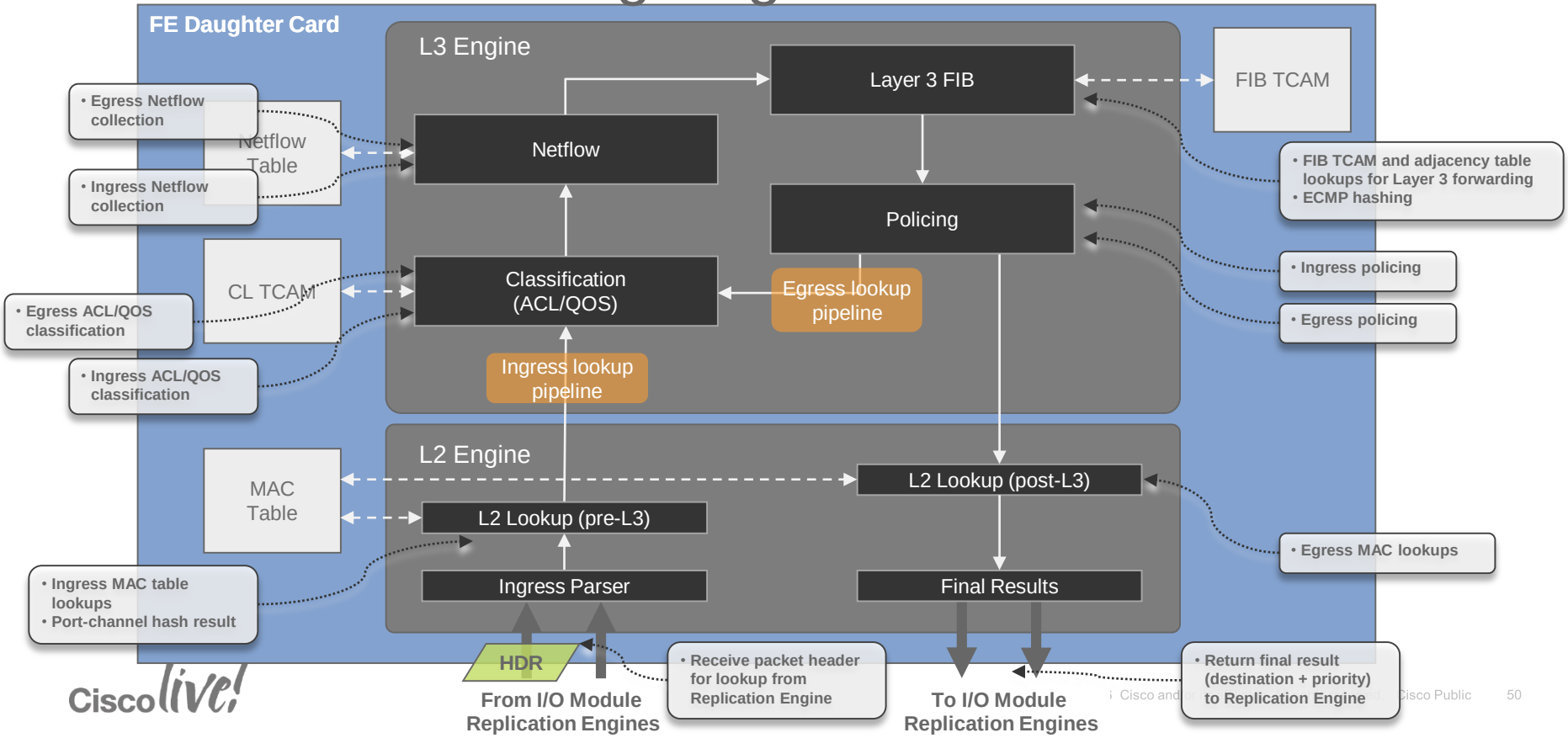
M2 Forwarding Engine Hardware

- Two hardware forwarding engines integrated on every M2 I/O module
- Layer 2 switching (with hardware MAC learning)
- Layer 3 IPv4/IPv6 unicast and multicast
- MPLS/VPLS/EoMPLS
- OTV / GRE
- RACL/VACL/PACL
- QOS remarking and policing policies
- Ingress and egress Netflow (full and sampled)

Hardware Table	M-Series Modules without Scale License	M-Series Modules with Scale License
MAC Address Table	128K	128K
FIB TCAM	128K IPv4 / 64K IPv6	**900K IPv4 / 350K IPv6**
Classification TCAM (ACL/QOS)	64K	**128K**
Netflow Table	1M	1M

M Series

M-Series Forwarding Engine Architecture



F2E Forwarding Engine Hardware

- 4 x 10G SOC with decision engine
- Layer 2 switching (with hardware MAC learning)
- Layer 3 IPv4/ IPv6 unicast and multicast
- FabricPath forwarding
- RACL/VACL/PACL
- QOS remarking and policing policies
- Ingress sampled Netflow

Hardware Table	F2E Capacity
MAC Address Table	16K
FIB TCAM	32K IPv4/16K IPv6
Classification TCAM (ACL/QOS)	16K

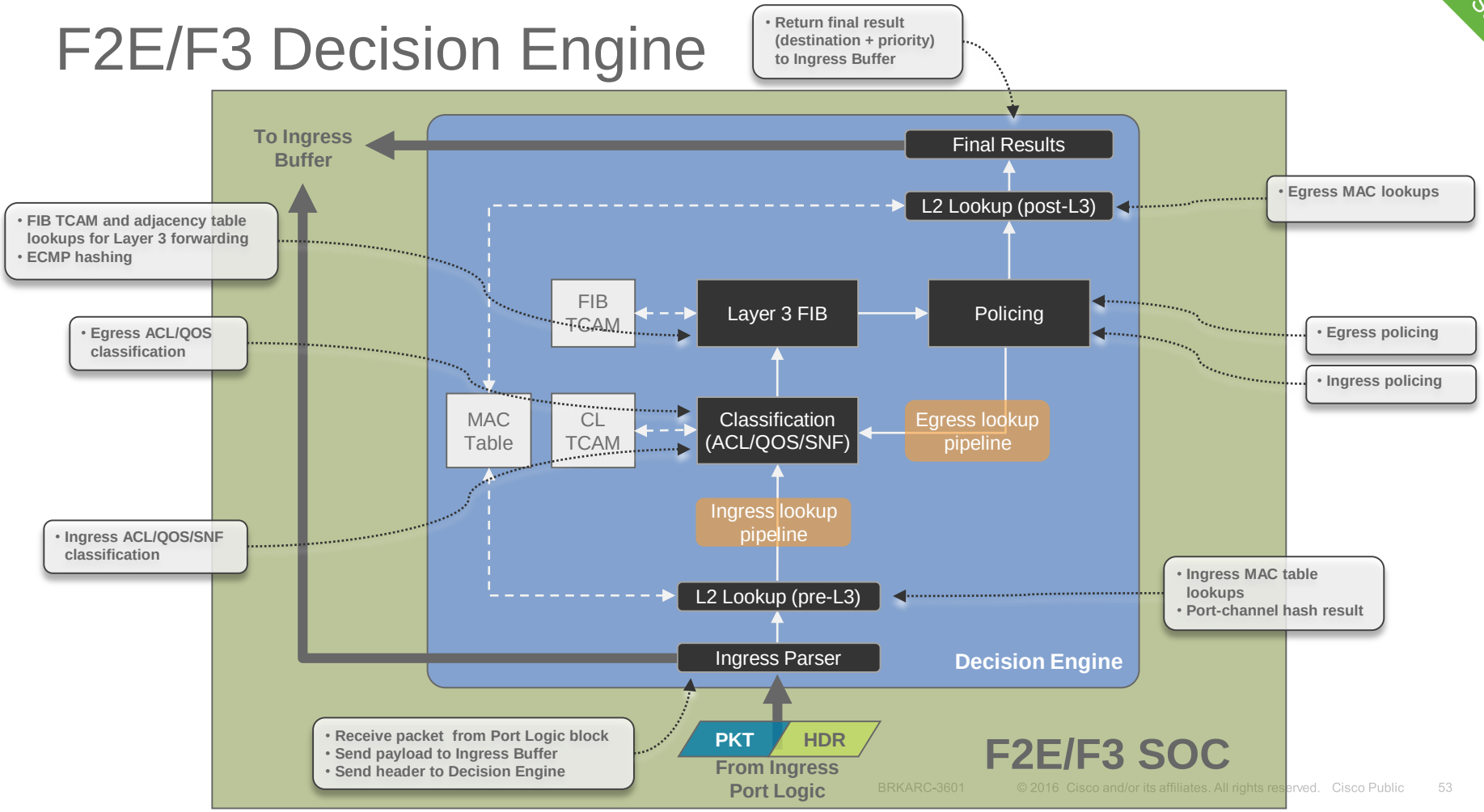
F3 Forwarding Engine Hardware

- 8 x 10G, 2 x 40G, or 1 x 100G SOC with decision engine
- Layer 2 switching (with hardware MAC learning)
- Layer 3 IPv4/ IPv6 unicast and multicast
- FabricPath forwarding

- RACL/VACL/PACL
- QOS remarking and policing policies
- Ingress sampled Netflow
- MPLS/VPLS/EoMPLS
- OTV / GRE tunnels
- LISP
- VXLAN

Hardware Table	F3 Capacity
MAC Address Table	**64K**
FIB TCAM	**64K IPv4/32K IPv6**
Classification TCAM (ACL/QOS)	16K

F2E/F3 Decision Engine



Agenda

- Introduction to Nexus 7000 / Nexus 7700

- Nexus 7000 / Nexus 7700 Architecture
  - Chassis, Supervisor Engines and NX-OS software, I/O modules (M2/F2E/F3)
  - I/O Module Interoperability
  - Fabric Architecture
  - Hardware Forwarding

- Generic Designs with Nexus 7000 / Nexus 7700
  - STP/VPC, L4-7 services integration, VDCs, VRF/MPLS VPNs, OTV

Nexus 7000 / Nexus 7700 Design Building Blocks

Foundational:

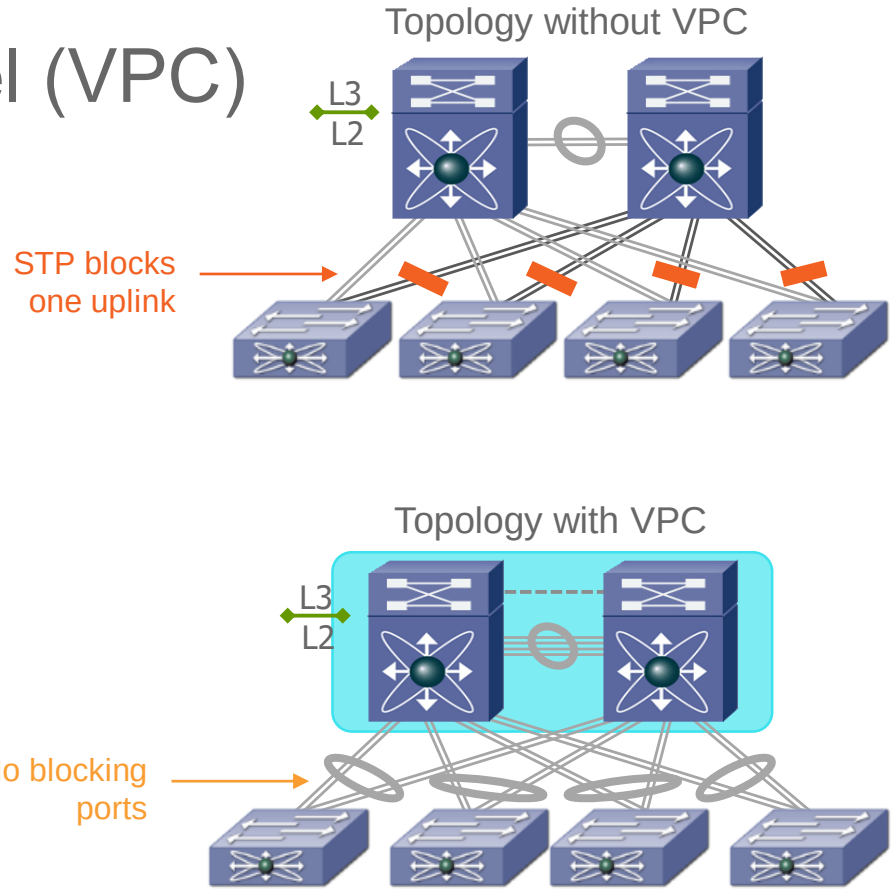
- Spanning Tree (RSTP+/MST)
- Virtual Port Channel (VPC)
- Virtual Routing and Forwarding (VRF) and MPLS VPNs

Innovative:

- Remote Integrated Service Engine (RISE)
- Virtual Device Context (VDC)
- Overlay Transport Virtualisation (OTV)

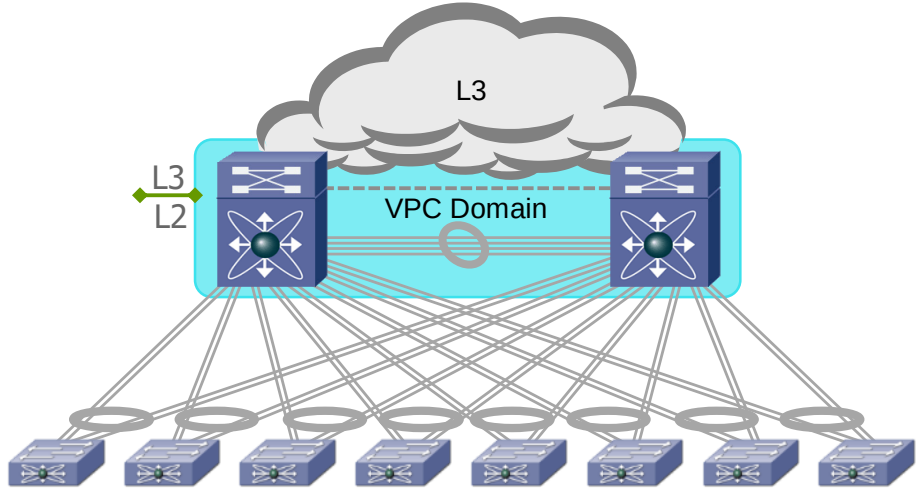
STP → Virtual Port Channel (VPC)

- Eliminates STP blocked ports, leveraging all available uplink bandwidth and minimising reliance on STP
- Provides active-active HSRP
- Works seamlessly with current network designs/topologies
- Works with any module type (M2/F2E/F3)
- Most customers have taken this step



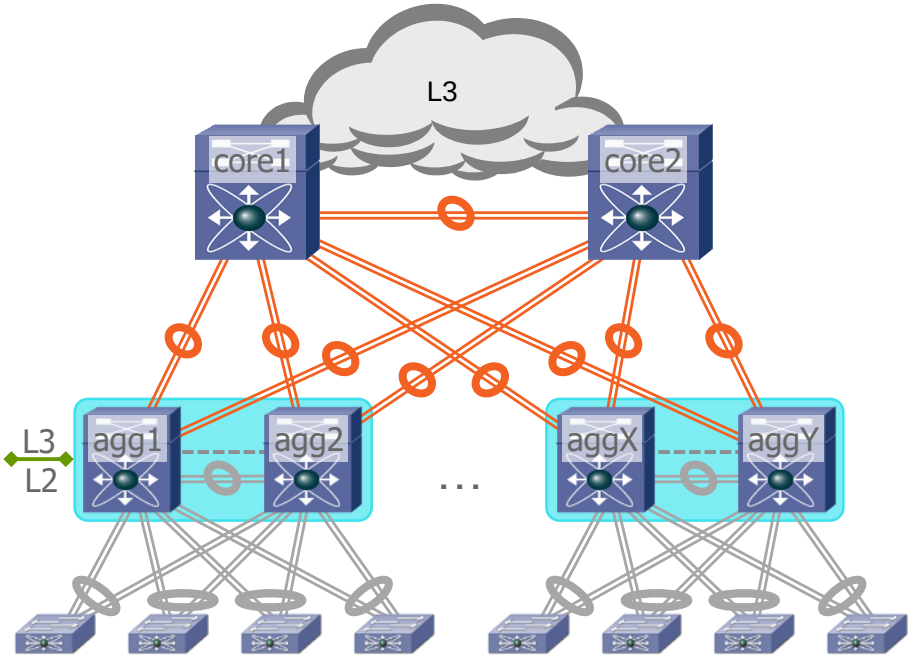
Collapsed Core/Aggregation

- Nexus 7000 / Nexus 7700 as Data Centre collapsed core/aggregation
- Consolidate multiple aggregation building blocks into single switch pair
- Reduce number of managed devices
- Simplify East-West communication path
- M-series or F-series I/O modules, depending on:
  - Port density, feature-set, and scale requirements
  - Desired level of oversubscription



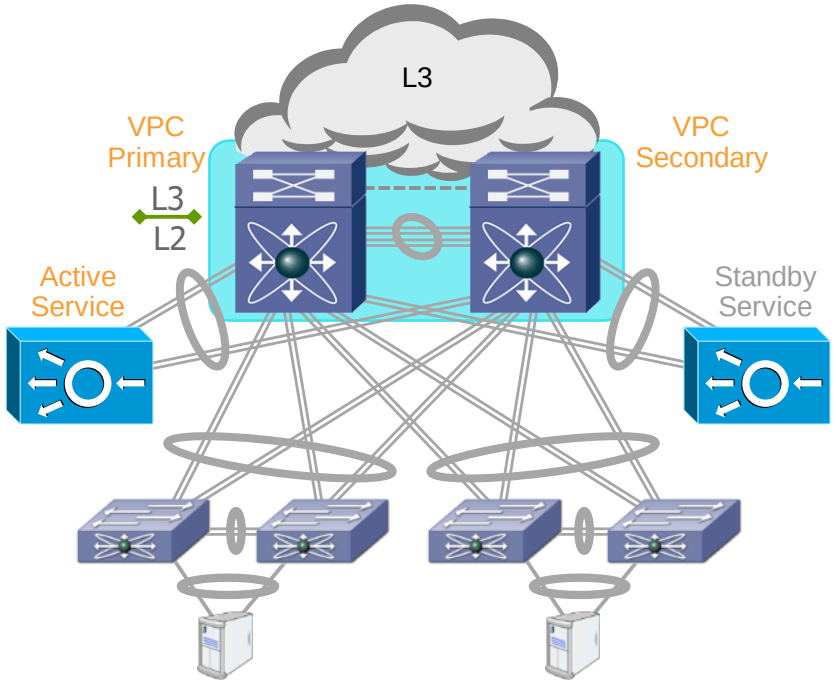
Traditional 3-Tier Hierarchical Design

- Extremely wide customer-deployment footprint
- Nexus 7000 / Nexus 7700 in both Data Centre aggregation and core
  - Provides high-density, high-performance 10G / 40G / 100G
  - Same module-type considerations as collapsed core – density, features, scale
- Scales well, but scoping of failure domains imposes some restrictions
  - VLAN extension / workload mobility options limited



L4-7 Services Integration – VPC Connected

- VPC designs well-suited for L4-7 services integration – pair of aggregation devices makes service appliance connections simple
- Multiple service types possible – transparent services, appliance as gateway, active-standby or active-active models
- VPC-connected appliances preferred:
  - Ensures that all traffic – data plane, fault-tolerance, and management – sent direct via VPC port-channels
  - Minimises VPC peer link utilisation in steady state
- Use orphan ports with “vpc orphan-port suspend” when services appliance does not support port-channels or Layer 3 peering to VPC peer required

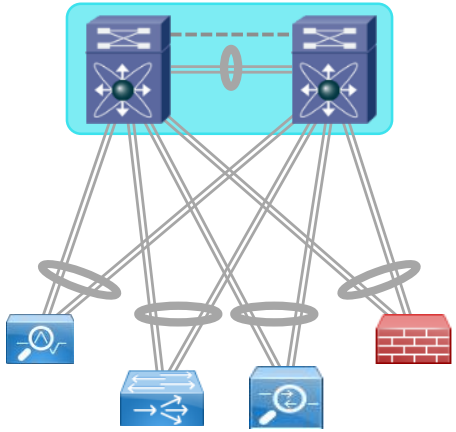


L4-7 Services Integration – RISE

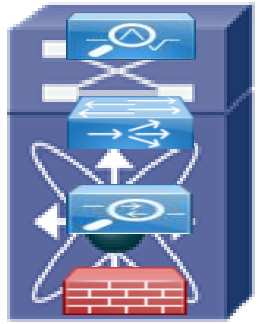
Remote Integrated Service Engine (RISE)

- Logical integration of external services appliance with Nexus 7000 / Nexus 7700
  - Citrix NetScaler and Cisco Prime NAM appliance supported today
- Enables tight services integration between services appliance and Nexus 7000 / Nexus 7700 switches, including:
  - Discovery and bootstrap
  - Automated Policy Based Routing (APBR)
  - Route Health Injection (RHI) (future)

Physical Topology

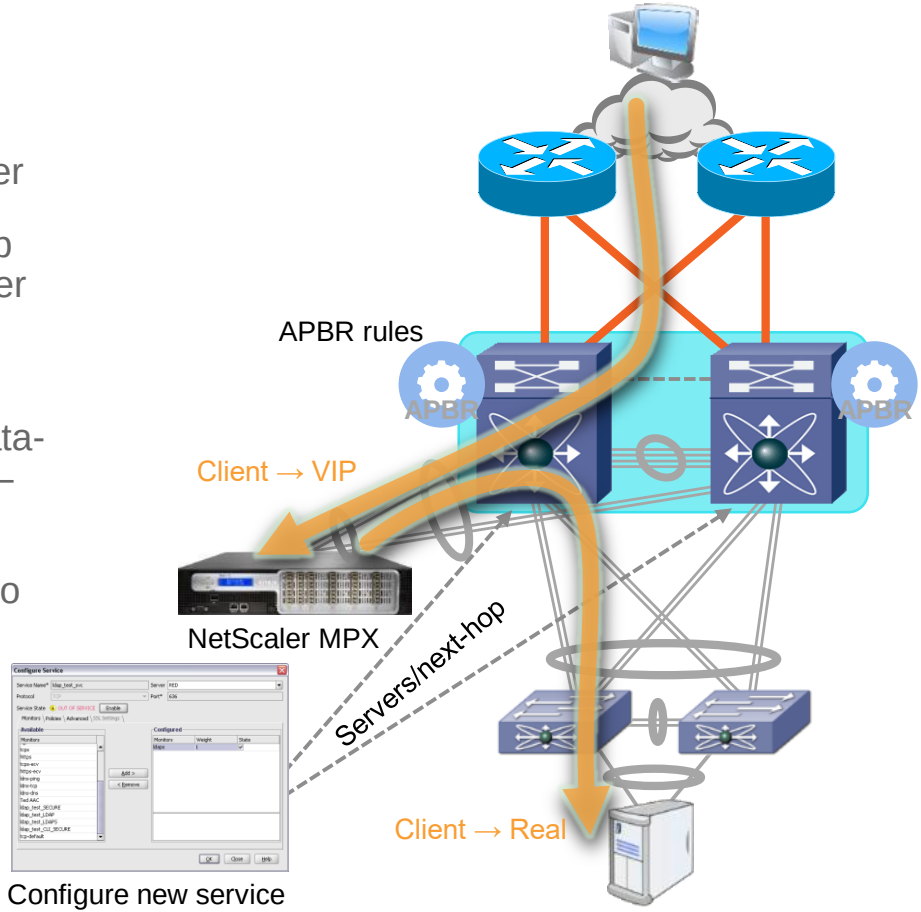


Logical Topology with RISE



RISE Auto-PBR

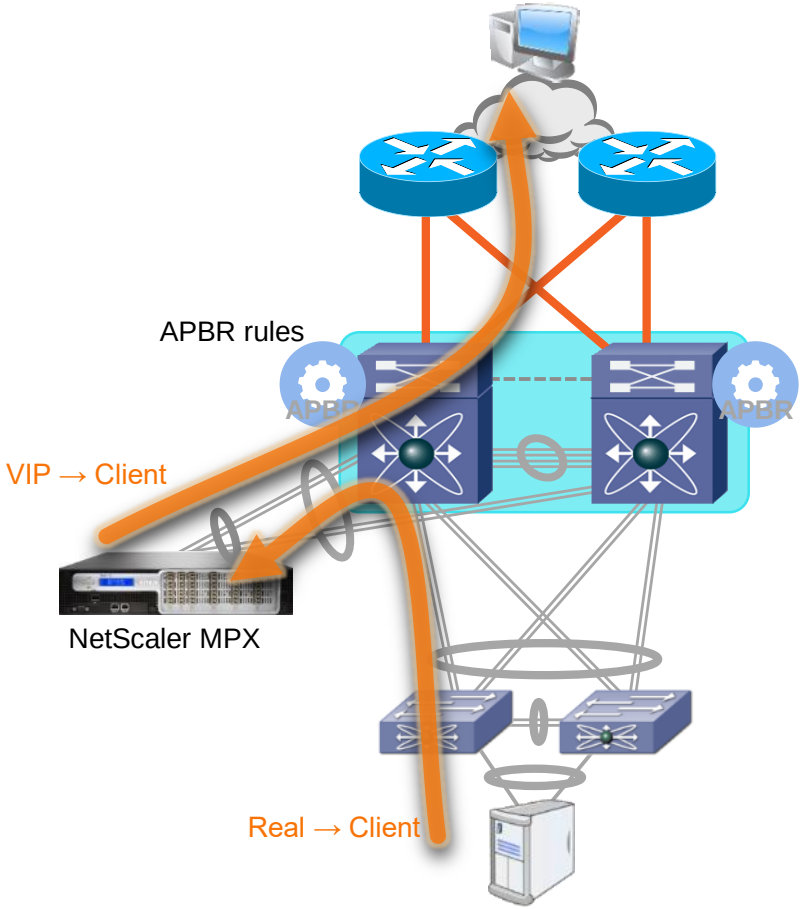
- User configures new service in NetScaler
- NetScaler sends server list and next-hop interface to Nexus 7000/7700 switch over RISE control channel
- Switch automatically generates PBR route-maps and applies PBR rules in data-plane hardware to redirect target traffic – no manual configuration on switch
- Client traffic destined to VIP redirected to NetScaler for processing, destination rewritten to Real server IP



Configure new service

RISE Auto-PBR

- User configures new service in NetScaler
- NetScaler sends server list and next-hop interface to Nexus 7000/7700 switch over RISE control channel
- Switch automatically generates PBR route-maps and applies PBR rules in data-plane hardware to redirect target traffic – no manual configuration on switch
- Client traffic destined to VIP redirected to NetScaler for processing, destination rewritten to Real server IP
- Return traffic redirected to rewrite Real IP to VIP

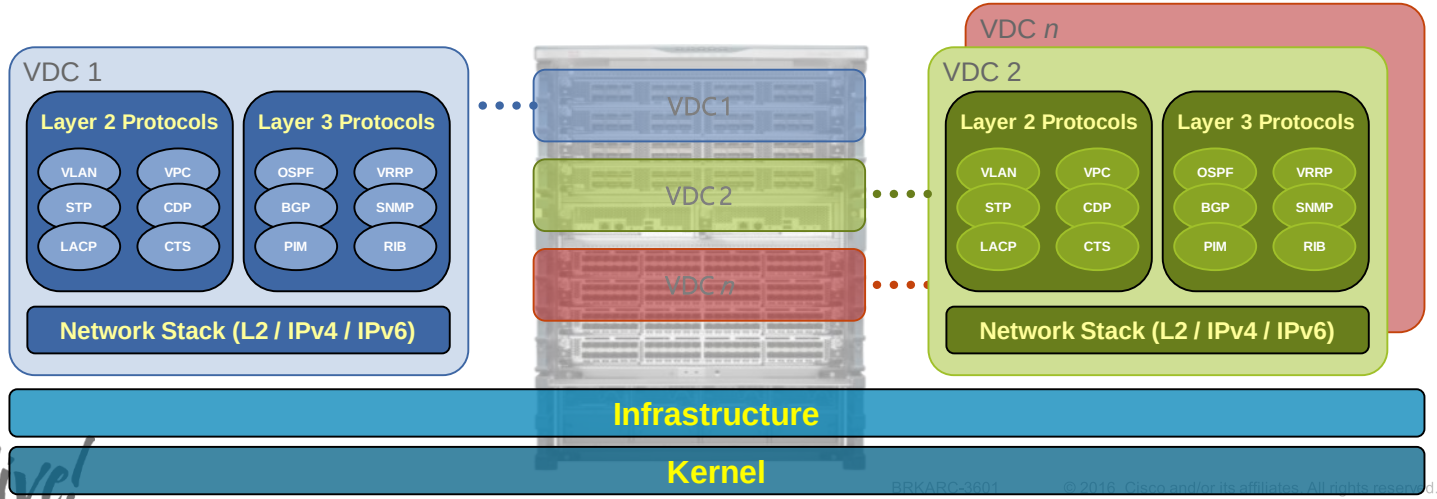


VDC Details

Note: VDCs do *not* provide a hypervisor capability, or ability to run different OS versions in each VDC

Virtual Device Contexts

- Create multiple logical devices out of one physical device
- Provide data-plane, control-plane, and management-plane separation
- Fault isolation and reduced fate sharing



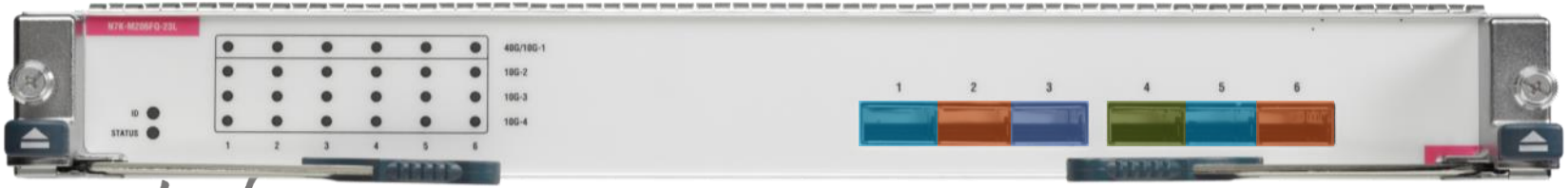
VDC Interface Allocation

- Physical interfaces assigned on per VDC basis, from default/admin VDC
- All subsequent interface configuration performed within the assigned VDC
- A single interface cannot be shared across multiple VDCs
- VDC type (“limit-resource module-type”) determines types of interfaces allowed in VDC
- VDC type driven by operational goals and/or hardware restrictions, e.g.:
  - Mix M2 and F2E in same VDC to increase MAC scale in FabricPath
  - Restrict VDC to F3 only to avoid lowest common denominator
  - Cannot mix M1 and F3 in same VDC

VDC Interface Allocation – M2

- Allocate any interface to any VDC
- But, be aware of shared hardware resources – backend ASICs may be shared by several VDCs
- Best practice: allocate entire module to one VDC to minimise shared hardware resources

M2-10G



M2-40G

VDC 1

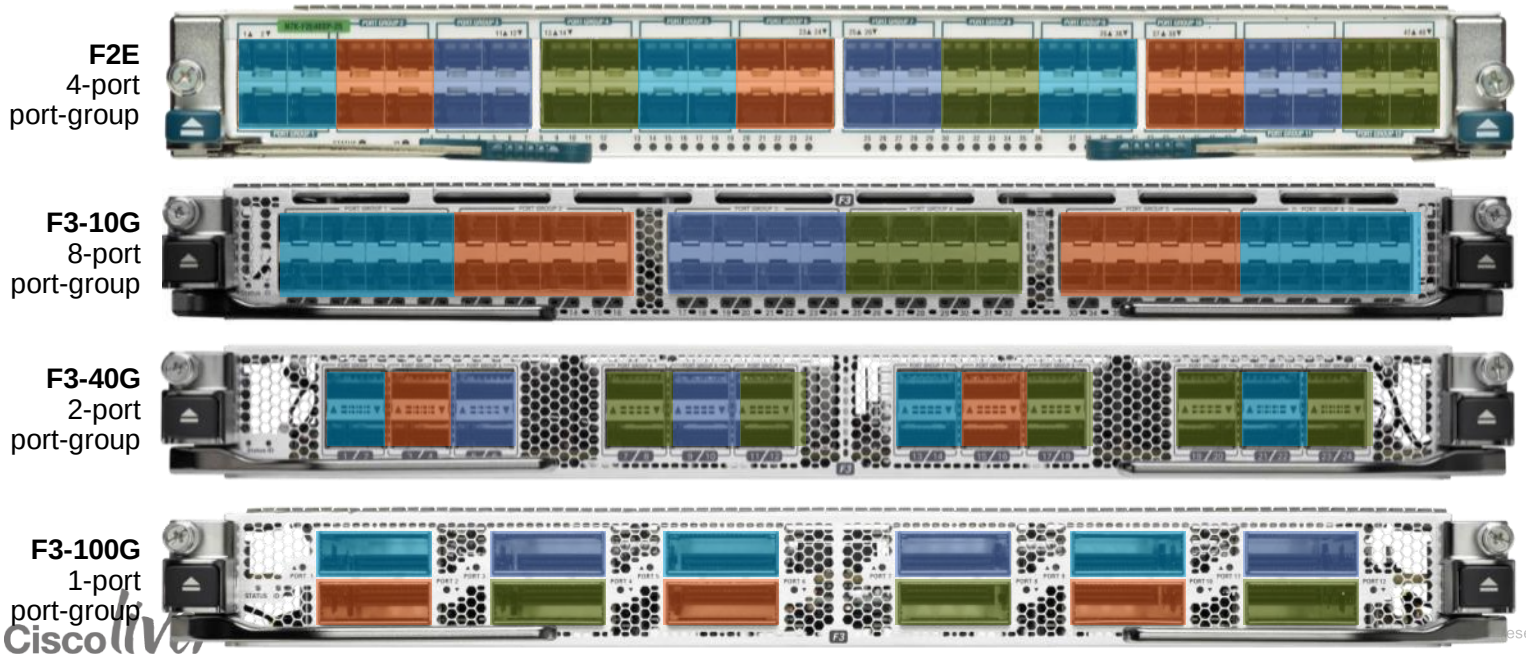
VDC 2

VDC 3

VDC 4

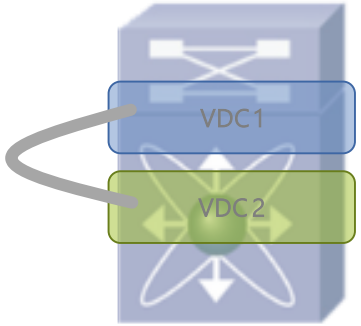
VDC Interface Allocation – F2E / F3 Modules

- Allocation on port-group boundaries – aligns ASIC resources to VDCs
- Port-group size varies depending on module type



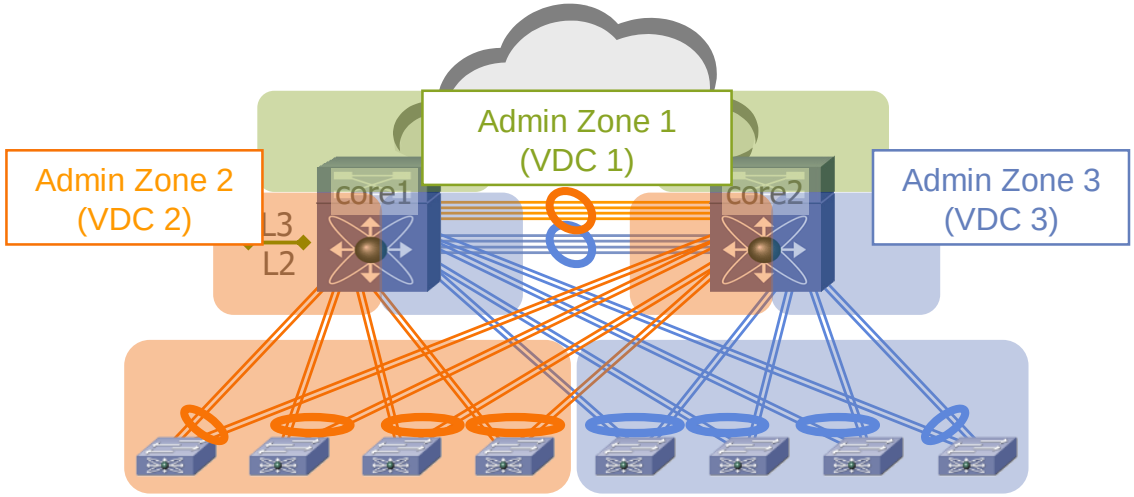
Communicating Between VDCs

- **Must** use front-panel ports to communicate between VDCs
  - No backplane inter-VDC communication
- No restrictions on L2/L3 configuration, module types, or physical media type – just like interconnecting two physical switches
  - Copper Twinax cables (CX-1) or 40G bidi optics provide low-cost interconnect options



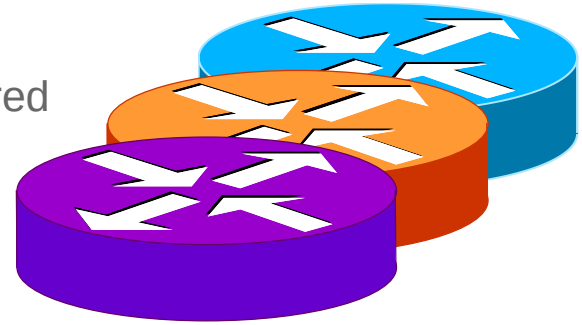
Collapsed Core Design with VDCs

- Maintain administrative segmentation while consolidating network infrastructure
- Maintain fault isolation between zones (independent L2, routing processes per zone)
- Firewalling between zones facilitated by VDC port membership model



VRF / MPLS VPNs

- Provides network virtualisation – One physical network supporting multiple virtual networks
  - While maintaining security/segmentation and access to shared services
- VRF-lite segmentation for simple/limited virtualisation environments
- MPLS L3VPN for larger-scale, more flexible deployments



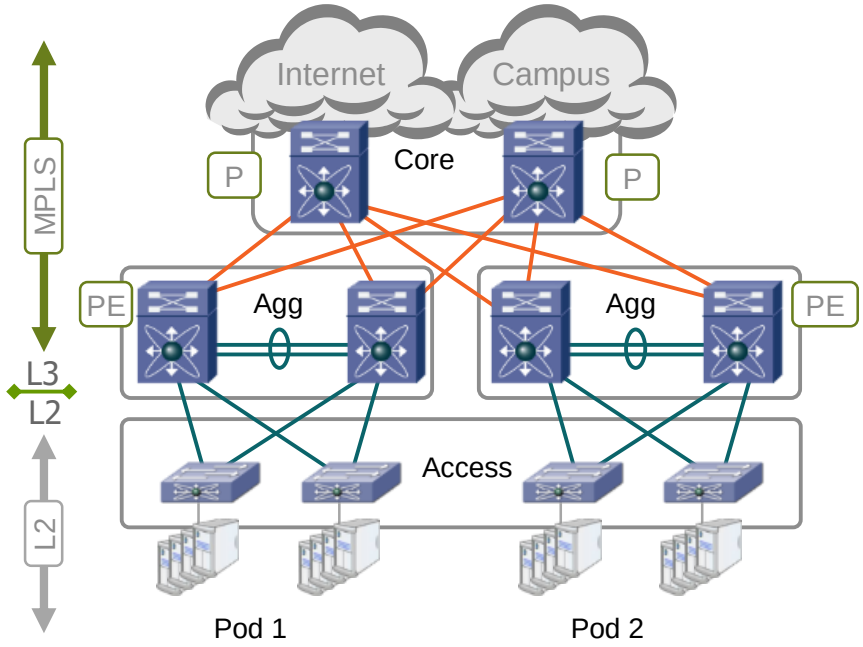
MPLS Layer 3 VPN – Secure Multi-Tenant Data Centre

Requirement:

- Secure segmentation for hosted / enterprise data centre

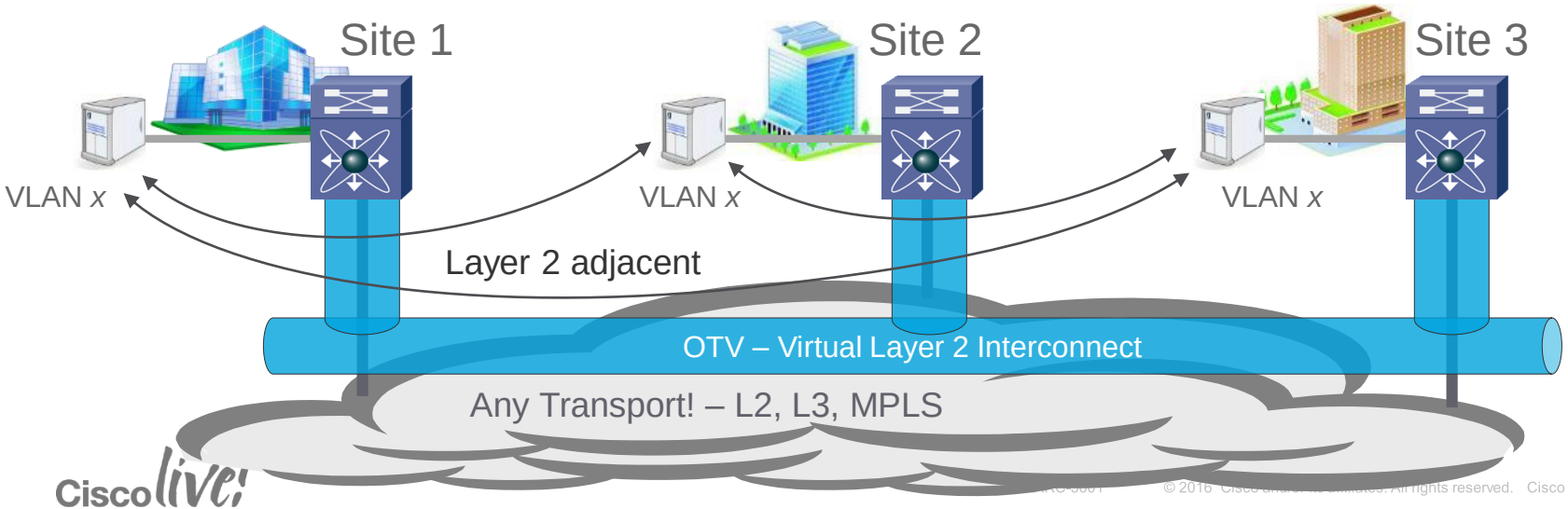
Solution:

- MPLS Layer 3 VPNs for segmentation
- MPLS PE boundary in Pod aggregation layer with VRF membership on SVIs
- Direct PE-PE or PE-P-PE interconnections in core
- Layer 2 with VLANs below MPLS boundary



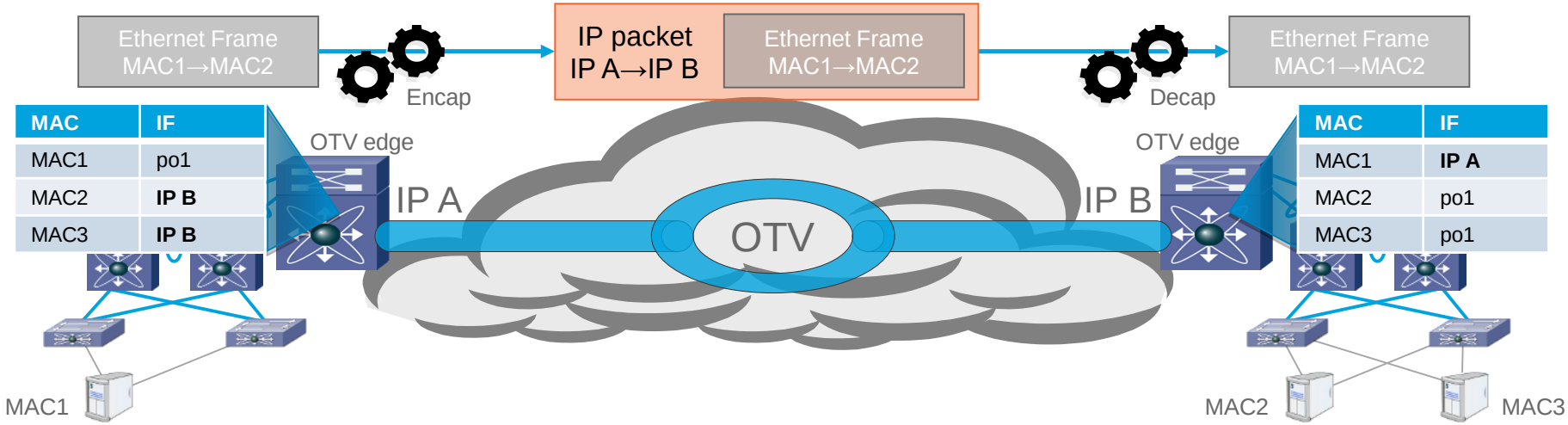
OTV for Multi-Site VLAN Extension

- Overlay Transport Virtualisation (OTV) provides multi-site Layer 2 Data Centre Interconnect (DCI)
- Dynamic “MAC in IP” encapsulation with forwarding based on MAC “routing” table
- No pseudo-wire or tunnel state maintained



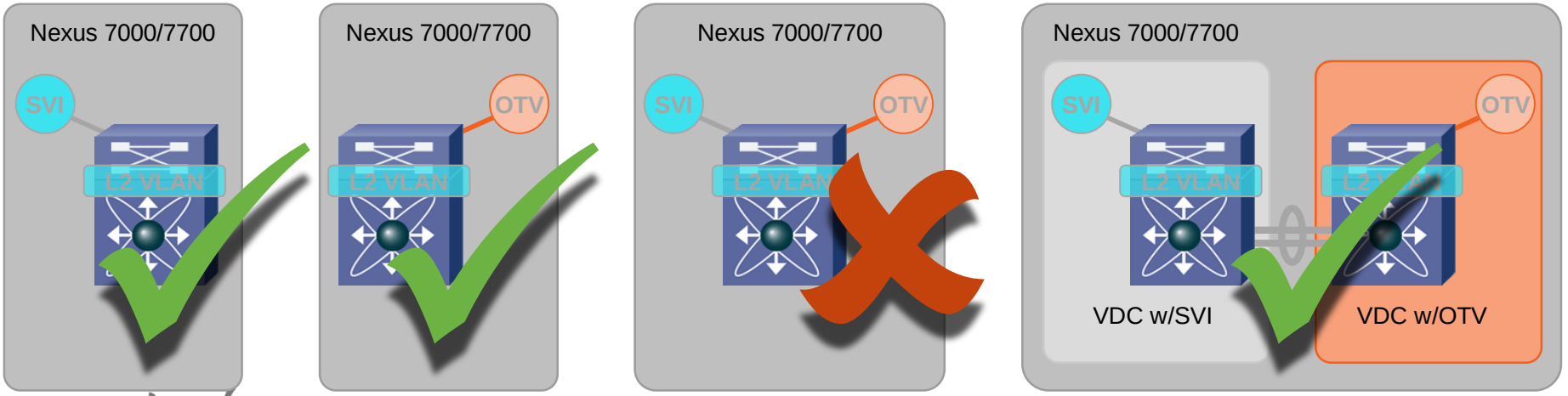
OTV at a Glance

- MAC addresses advertised in routing protocol (control plane learning) between Data Centre sites
- Ethernet traffic between sites encapsulated in IP: “MAC in IP”



OTV VDC Requirement

- Current limitation – SVI (for VLAN termination at L3) and OTV overlay interface (for VLAN extension over OTV) cannot exist in same VDC
- Typical designs move OTV to separate VDC, or separate switch (e.g. Nexus 7702)



Key Takeaways

- Nexus 7000 / Nexus 7700 switching architecture provides **foundation** for flexible and scalable Enterprise network designs
- Nexus 7000 / Nexus 7700 design **building blocks** interwork and complement each other to solve customer challenges
- Nexus 7000 / Nexus 7700 platform continues to **evolve** to support next-generation/emerging technologies and architectures

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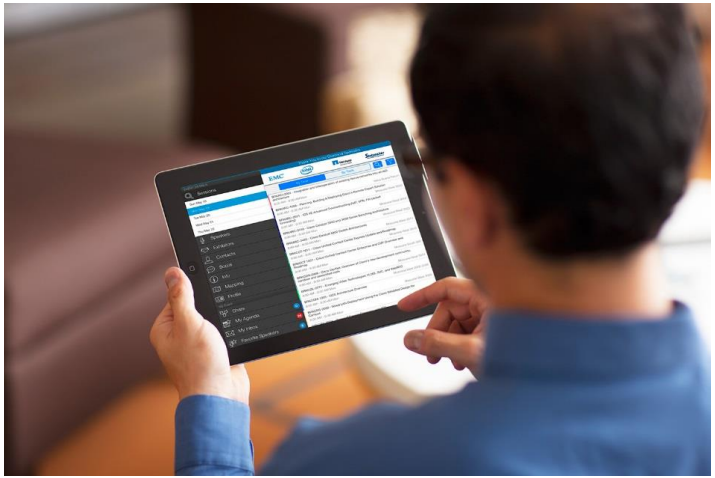

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