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Data Centre Design for the Mid-Size Enterprise

BRKDCT-2218

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Session Objectives

What do we plan to accomplish here?

- Improve understanding of key technological innovations happening in Data Centre networking
- Discuss how these innovations apply to the design of small to midsize Data Centre environments
- Provide a scalable reference model for growing a Data Centre from sub-100 physical ports up to ~800 ports
- Discuss product options to fill the roles in the reference model as requirements grow.

*This session is an **architecture and design** discussion, we will provide pointers to related product and configuration-detail sessions.*

Are you in the right room? Good, let's begin…

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Mid-Market Data Centre Design

One size does not fit all. There is no one answer!

- Gartner
  - Small Business: In the United States, less than $50 million in annual revenue and up to 100 employees; in Europe, less than $10 million in annual revenue and up to 75 employees.
  - Midsize Business: In the United States, between $50 million and $300 million in annual revenue and between 100 and 1,000 employees; in Europe, between $10 million and $150 million in annual revenue and between 75 and 300 employees.
- Wikipedia
  - Small Business In Australia: has to be <15 people.
  - Midsize Business In Australia: has to be <200 people.
- Cisco Categorisation: Customers with 1 to 999 Employees
  - Small = 1 to 99
  - Medium = 100 to 249
  - Mid Market = 250 to 999

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Session Agenda

What to expect in the next 90 minutes

- Data Centre networking requirements
  - Characteristics of network design unique to the Data Centre
- Data Centre networking features and solutions
  - Elements of Cisco feature innovations, and progress in the standards bodies
- Reference Topologies: starting out small and scaling up
  - Entry-level models: sub-100 to 300 server ports
  - Scaled up options: 300 – 500 server ports
  - Full-featured solution: 500 – 800 server ports
- Building blocks to implement needed features
  - Product choices to balance scale and feature requirements with cost

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Hypervisor-Based Server Virtualisation

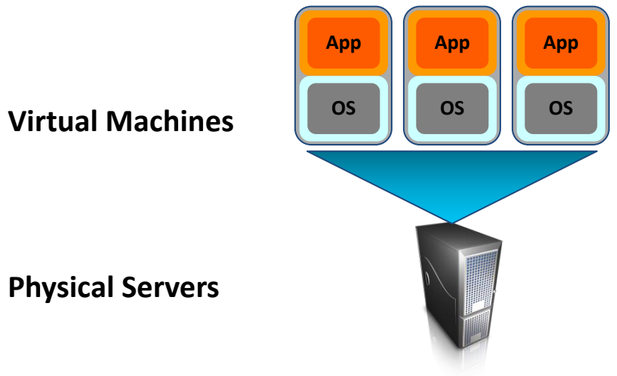
De-coupling applications from physical hardware

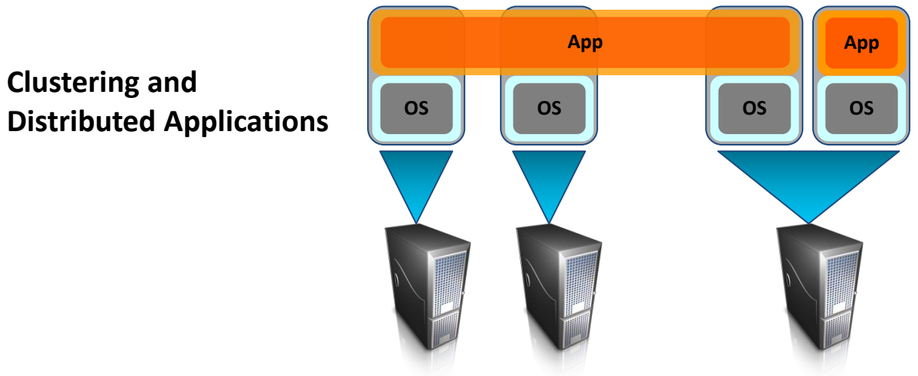
Virtualisation benefits

- Better hardware utilisation and application availability
- Workload Mobility, within or across DC's
- Reduced provisioning time/effort

Increasing demands on the network

- Larger Layer-2 domains
- Focus on shared storage systems
- Software switching redefining the network edge
- L2 extension between physical DC's





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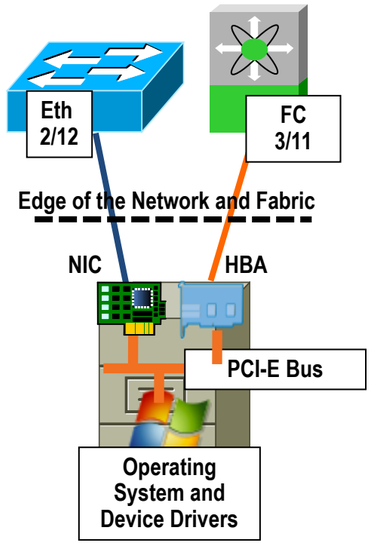
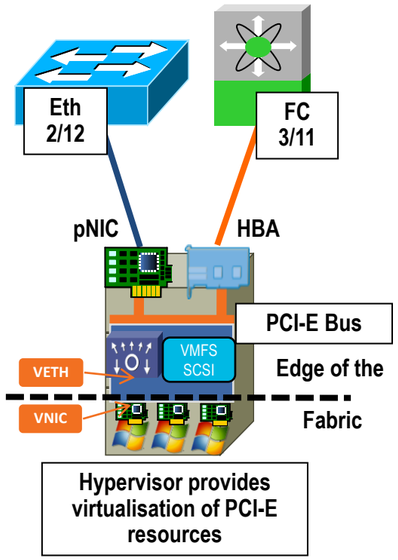
Virtualisation and Software Switching

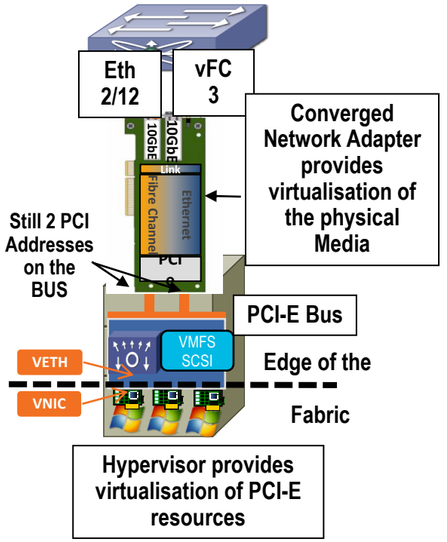
Redefining the “network edge”



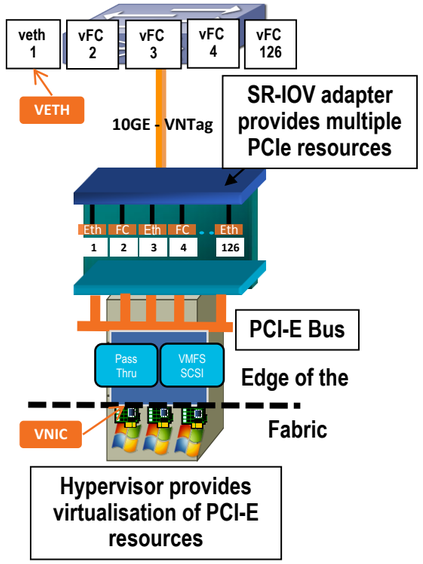
Traditional Model



Add Hypervisor Software Switch



Add CNA for virtual interface density



Move switching function back upstream with FEX-Link

Compute and Fabric Edge are Merging

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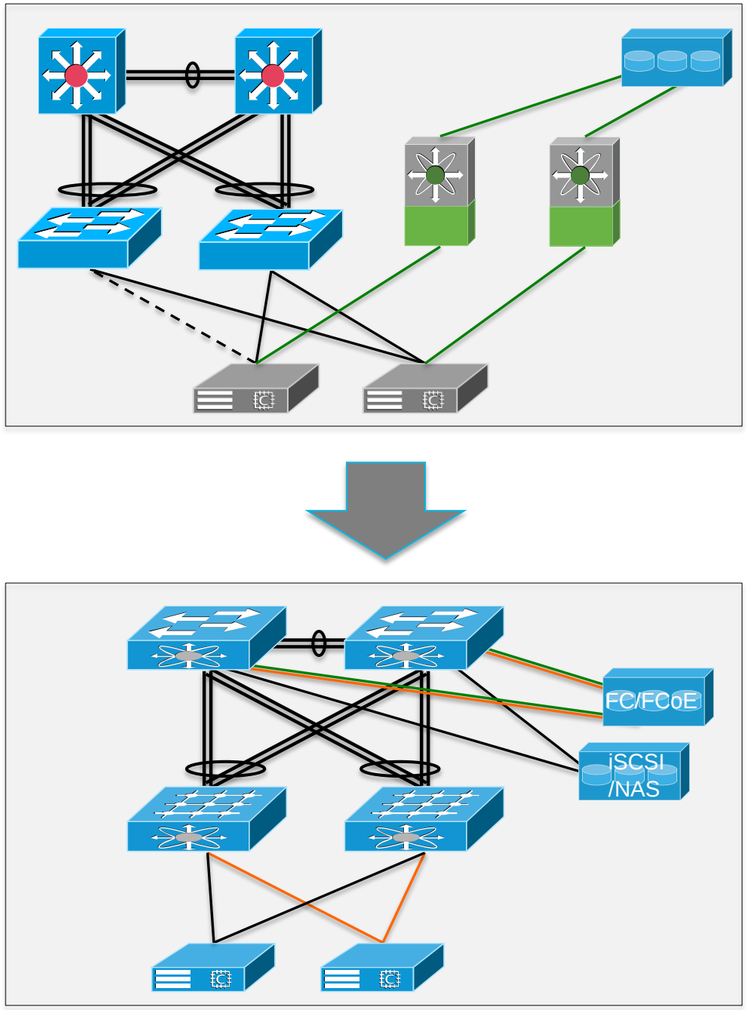
Storage Networking

From separate networks to a converged fabric

- Another wave of network convergence
- Flexibility to support dynamic connectivity requirements
- Block-level protocols:
  - Fibre Channel
  - Fibre Channel over Ethernet (FCoE)
  - iSCSI
- File-based protocols:
  - CIFS
  - NFS



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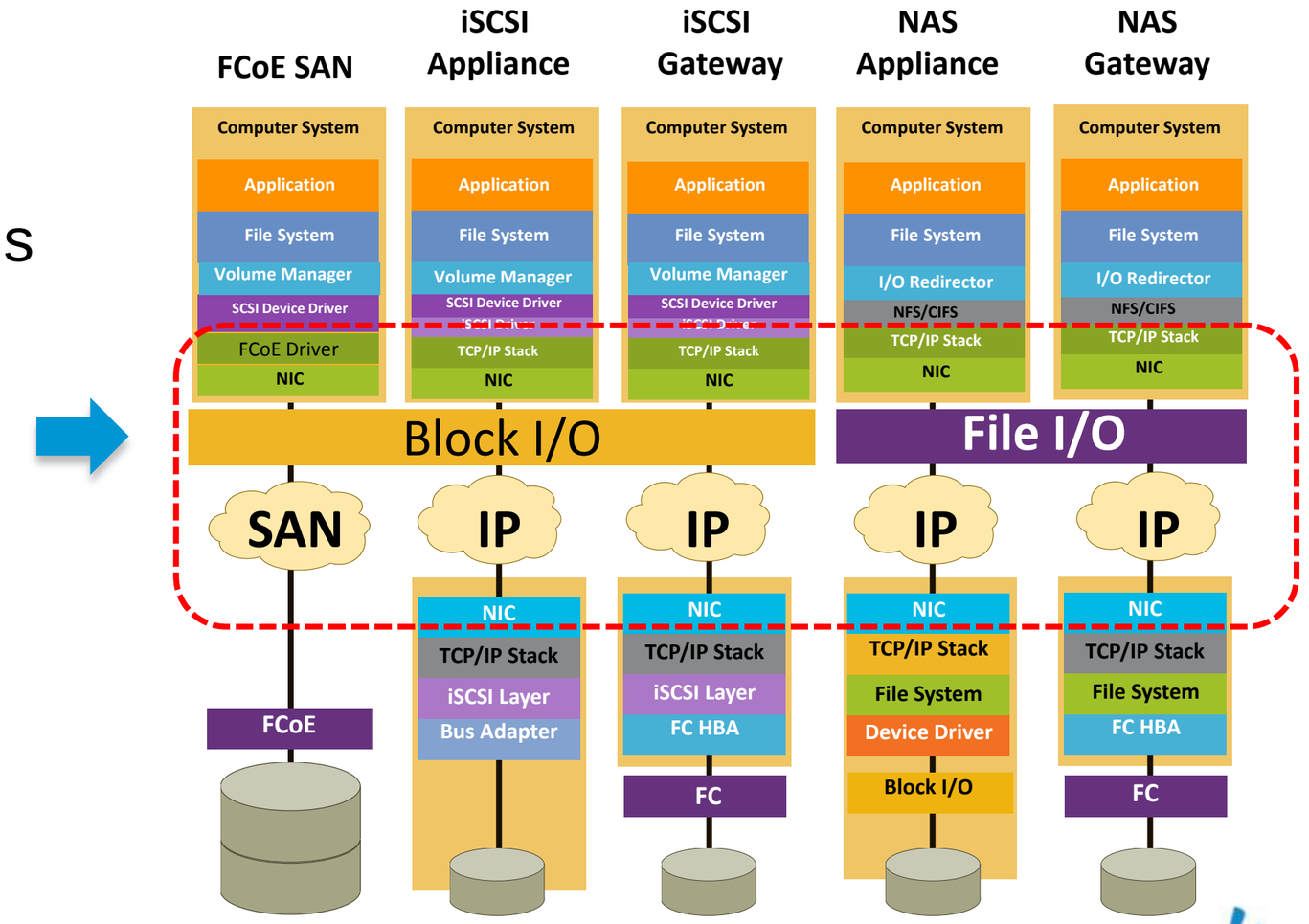
The Goal of a Unified Data Centre Fabric

Keep storage connectivity options open

- Flexibility to support a range of storage systems
- Connectivity for IP/Ethernet and Fibre Channel Endpoints
- ‘Any Server/RU to Any Storage Spindle’



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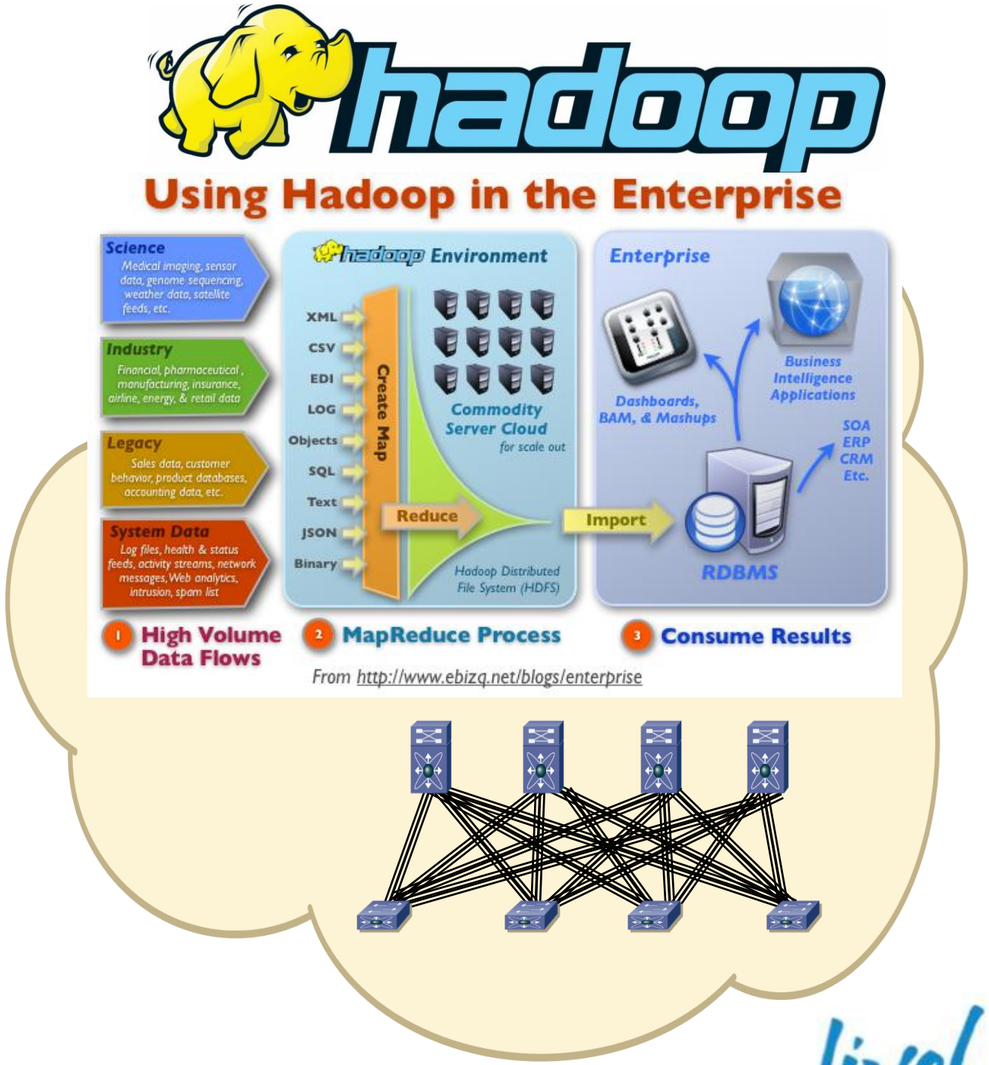
New Application Models

New database models, “Big Data” applications

- Increasing East-West traffic between servers in the data centre
- High performance requirements driving 10 Gbps migration
- Performance demands on buffering and oversubscription:
  - Many-to-one port data patterns
  - Speed mismatches 10/1Gps between nodes (also a common storage issue)
- Demand for low network latency
  - Clustered applications
  - High Frequency Trading



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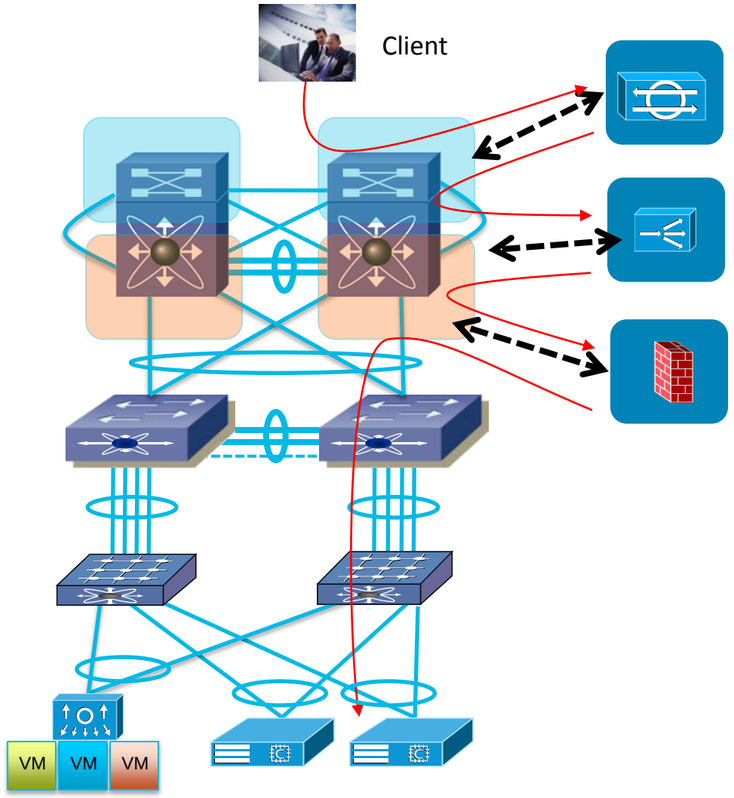
Data Centre Network Services

Integrating service functions into a virtualised fabric

- In the non-virtualised model, services were inserted into the Data Path at network ‘choke points’
- The Logical Topology matched the Physical Topology
- Migration to higher server speeds push the limits of physical service appliances
- Virtualised workloads may require a re-evaluation of where the services are applied and how they are scaled



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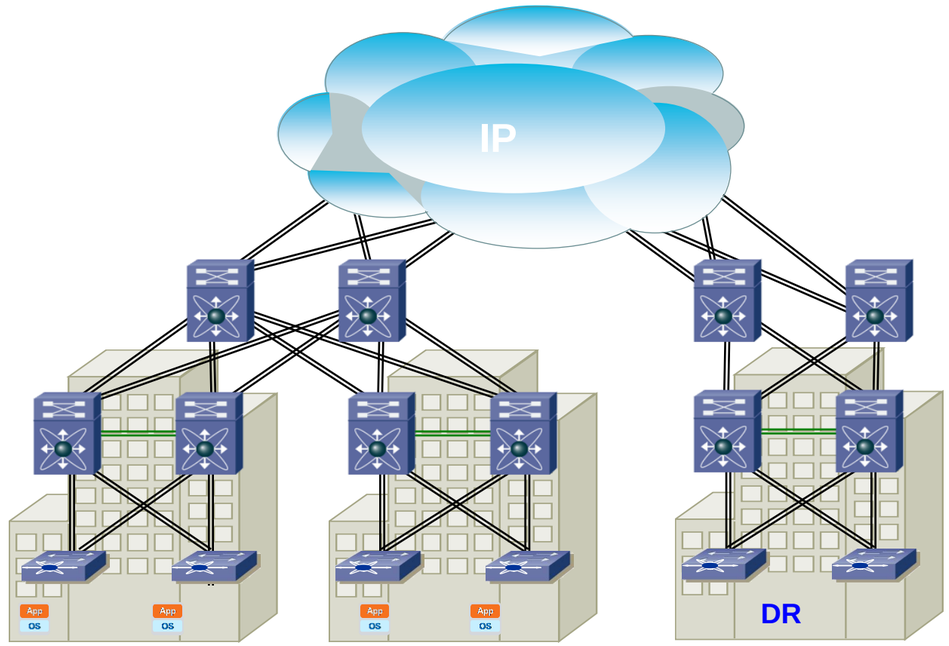
Data Centre Interconnect

Active/Active Workloads and Disaster Recovery

- Virtualisation and workload mobility open up greater flexibility in using multiple locations
- Active/Active workload sharing can be constrained by application latency requirements and storage replication
- Managing Layer-2 extension and Layer-3 address mobility presents many of the same challenges facing larger customers
- Advanced networking features are required to address these needs.



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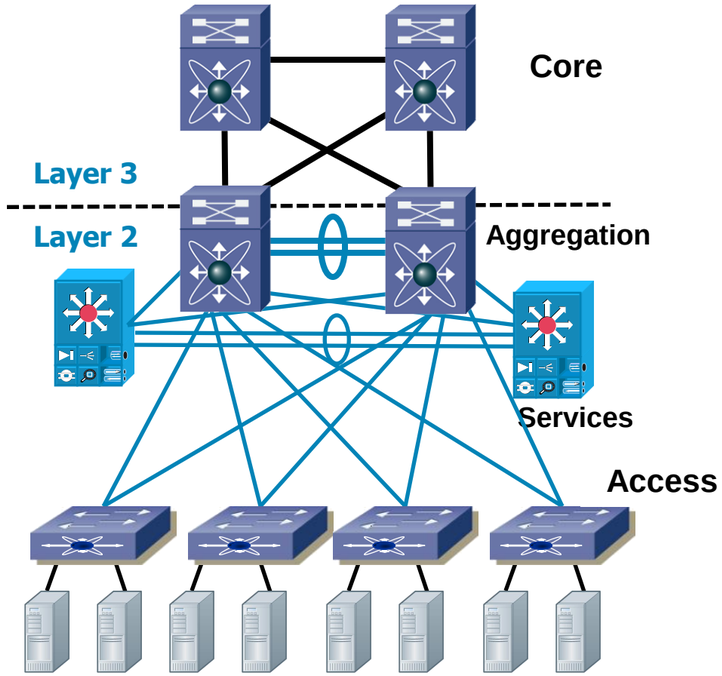
Traditional Data Centre Conceptual Layers

Classic Enterprise Model terminology for reference

- Core: Connection to the “rest of the network” at a main location
- Aggregation: Boundary between Layer-2 and Layer-3 switching; servers IP default gateway lives here.
- Access: Provides physical connections for physical servers (or now logical ports for virtual servers)



Goals for Small and Medium Data Centre Designs:

- Take advantage of current Data Centre feature set while targeting a smaller port count.
- Consolidate conceptual layers into fewer physical devices where possible.
- Consider future needs and design to allow the network to scale as business requirements grow.
- Control costs through platform selection and virtualised switching.

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Session Agenda

Features to address Data Centre challenges

- Data Centre networking requirements
  - Characteristics of network design unique to the Data Centre
- Data Centre networking features and solutions
  - Elements of Cisco feature innovations, and progress in the standards bodies
- Reference Topologies: starting out small and scaling up
  - Entry-level models: sub-100 to 300 server ports
  - Scaled up options 300 – 500 server ports
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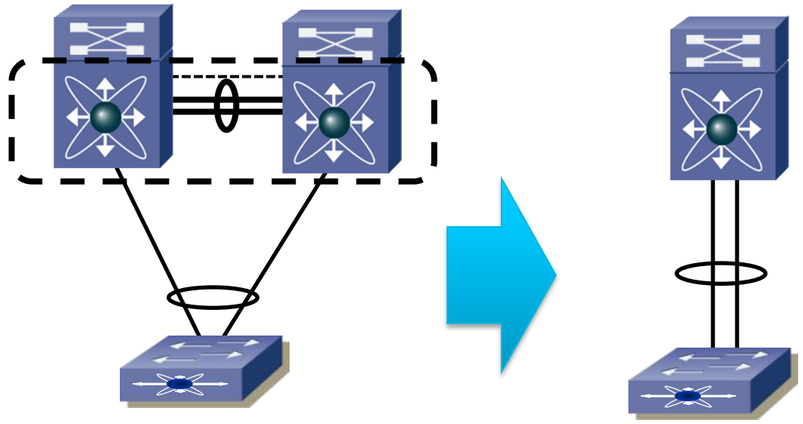
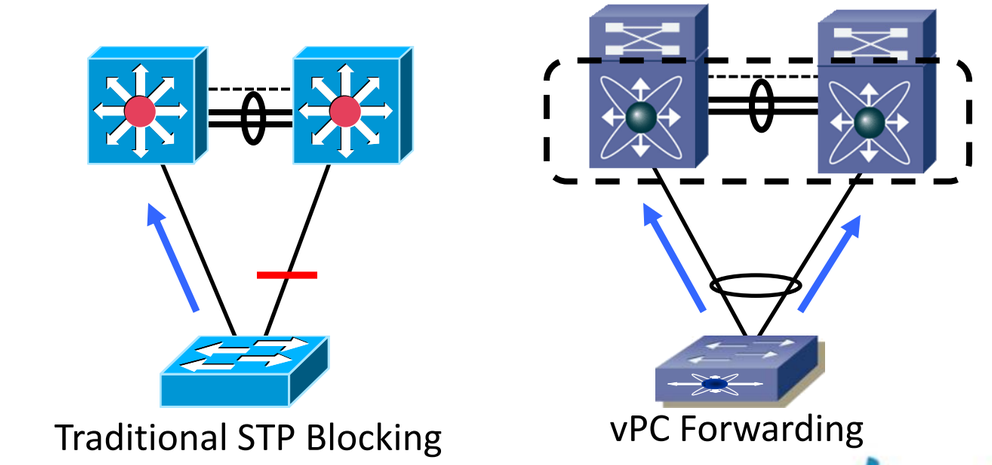
Virtual Port Channel - vPC

Increasing stability and throughput in the Layer-2 domain

- vPC allows a pair of switches to create a port-channel as if they were a single device
- Spanning Tree Protocol (STP) no longer providing the primary loop prevention mechanism
- Eliminates the STP blocked links in traditional topologies, increasing usable bandwidth
- vPC maintains independent control planes and switch management, switches are “vPC peers”





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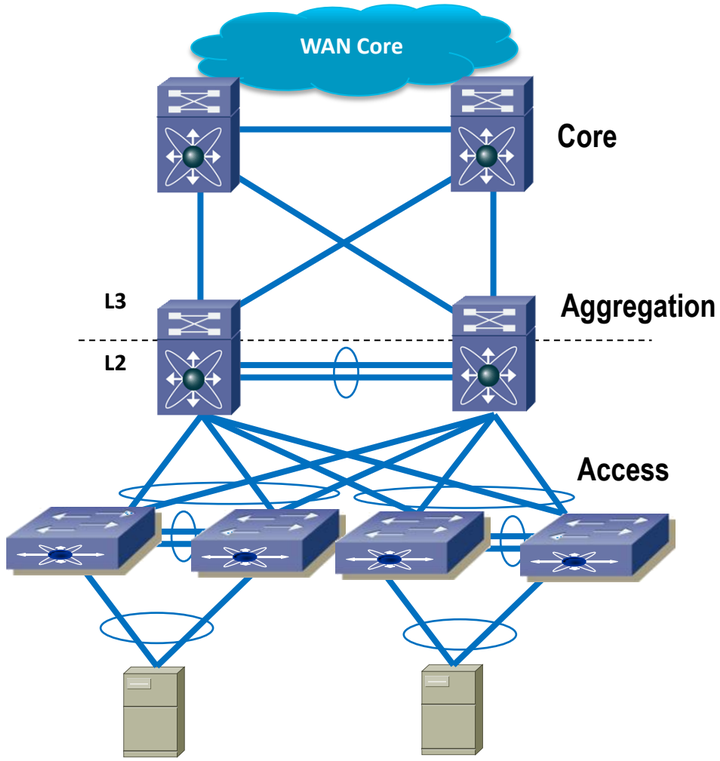
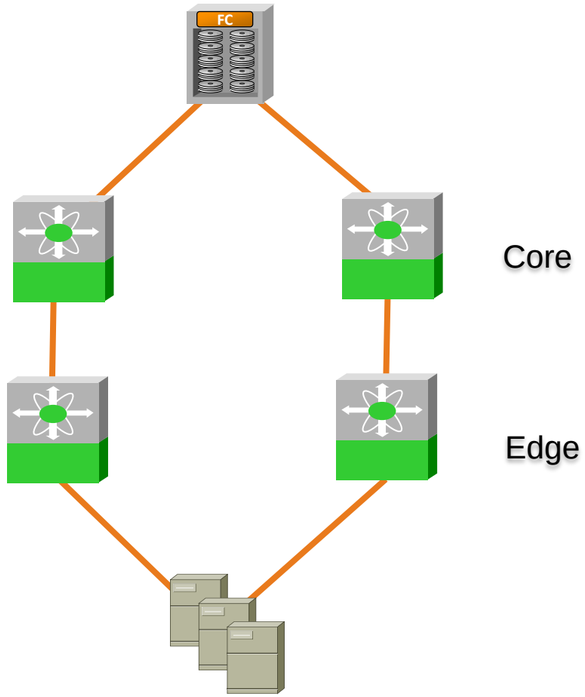
Fibre Channel over Ethernet and vPC

SAN “A” / “B” Support

- LAN and SAN utilise **different** High Availability Models
- SAN is dual fabric, LAN is fully meshed fabric
- vPC enables ‘both’ architectures at the edge (single device models not acceptable to SAN engineers)
- Campus technologies VSS and Stackwise are not SAN-aware





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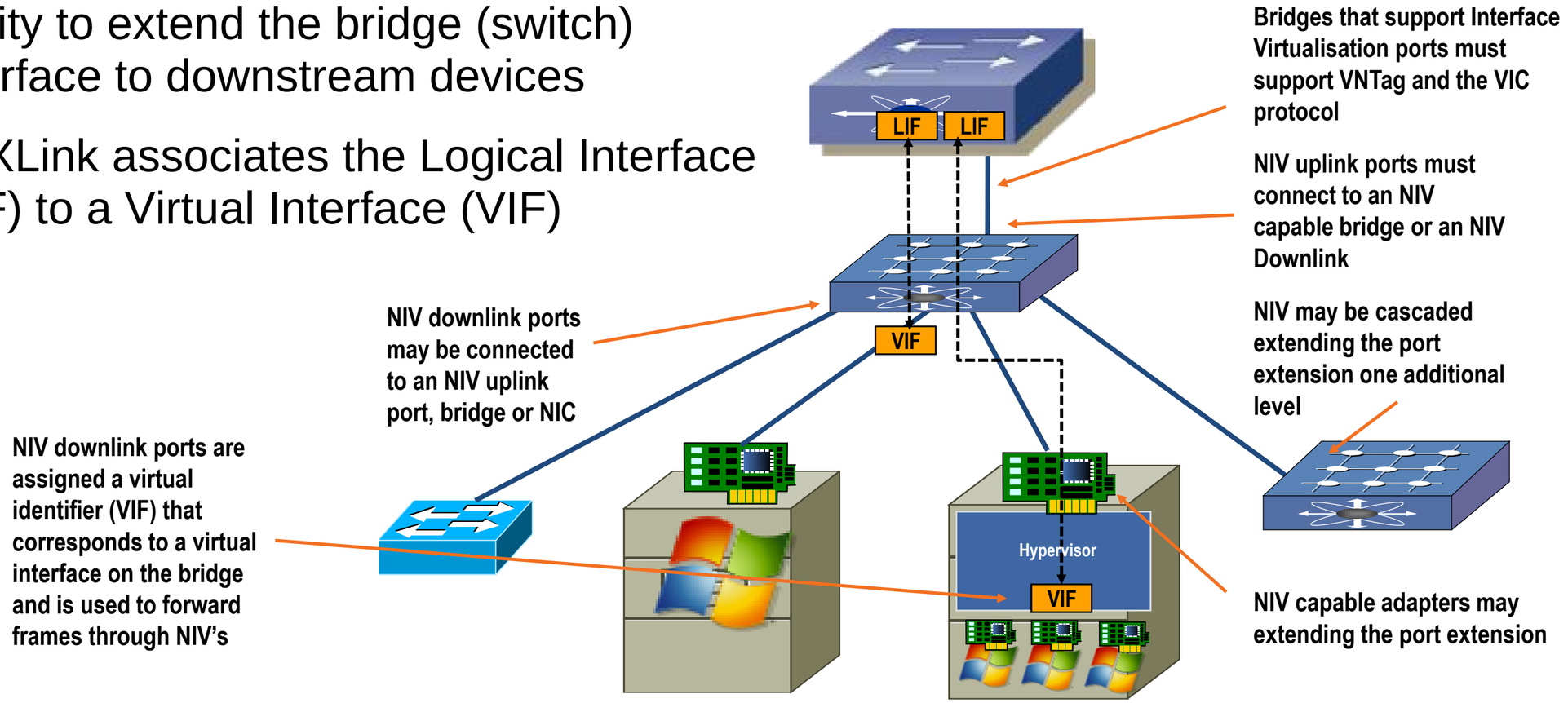
FEX Link Architecture

Cisco Innovation and 802.1BR

- The FEXLink Architecture provides the ability to extend the bridge (switch) interface to downstream devices
- FEXLink associates the Logical Interface (LIF) to a Virtual Interface (VIF)



Note: Not All Designs Supported in the FEXLink Architecture Are Currently Implemented

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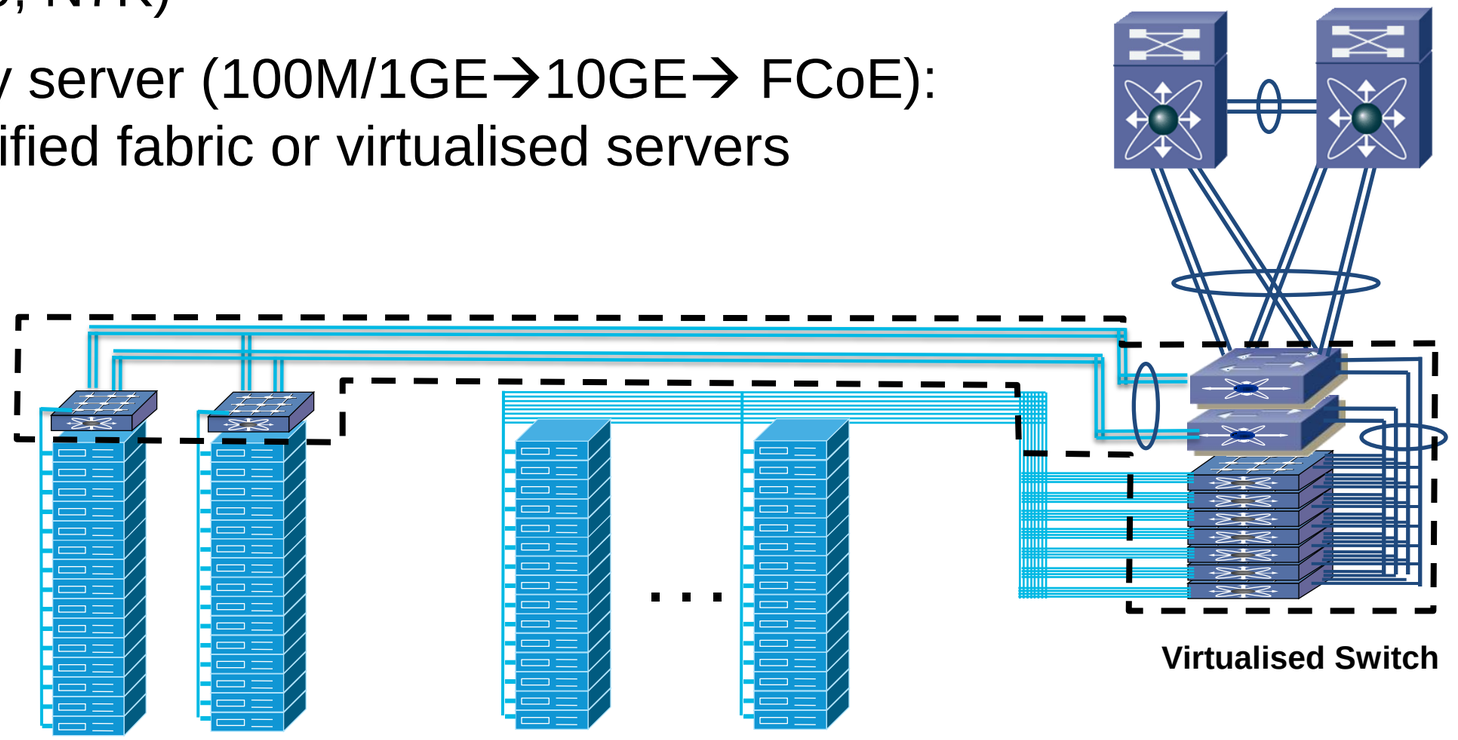
FEX Link: Virtualised Access Switching

Changing the boundaries of the Ethernet switch

- De-coupling of the Layer-1 and Layer-2 topologies
- Line Card Portability (N2K supported with Multiple Parent Switches – N5K, 6100, N7K)
- Unified access for any server (100M/1GE→10GE→ FCoE): Scalable Ethernet, unified fabric or virtualised servers
- Simplified Management Model
- Plug and play provisioning
- Centralised configuration



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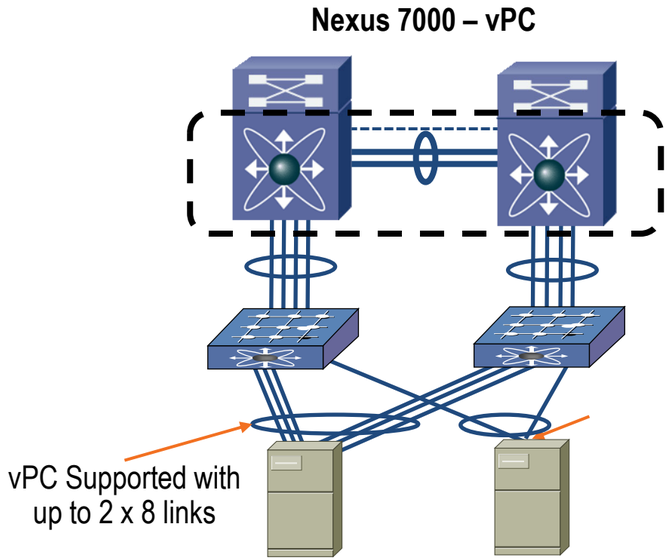
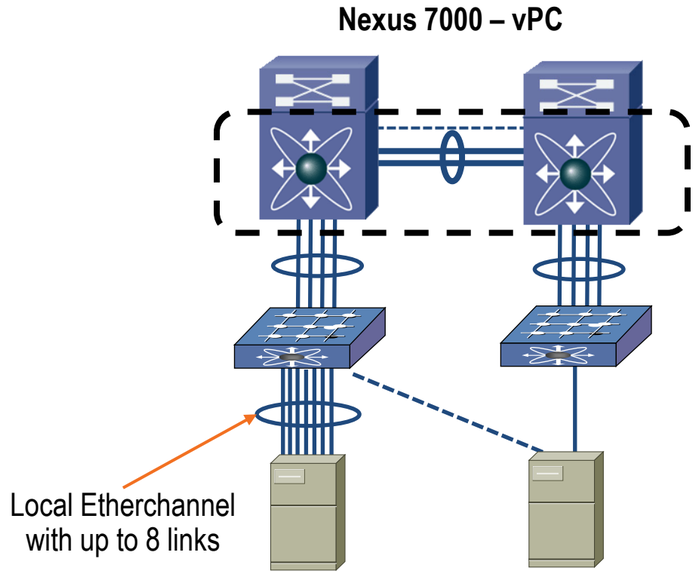
FEX Link and vPC Virtualised Access

Nexus 7000-based vPC topologies



- Redundancy model – Dual Switch (each switch supports redundant supervisors)
- vPC port channel to host interfaces supported in NX-OS 5.2 or greater



- Fabric links supported on N7K-M132XP-12, N7K-M132XP-12L & N7K-F248XP-25
- Nexus 7000 does not require or support dual-homing of FEX

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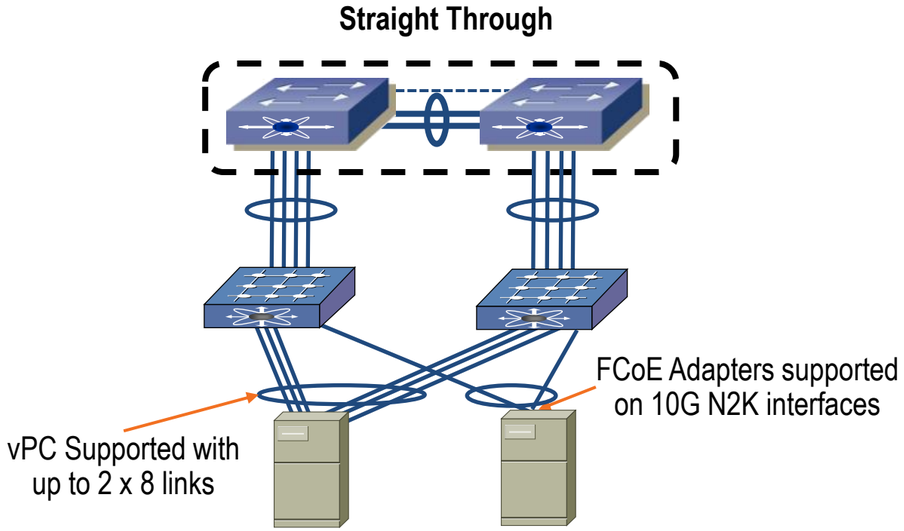
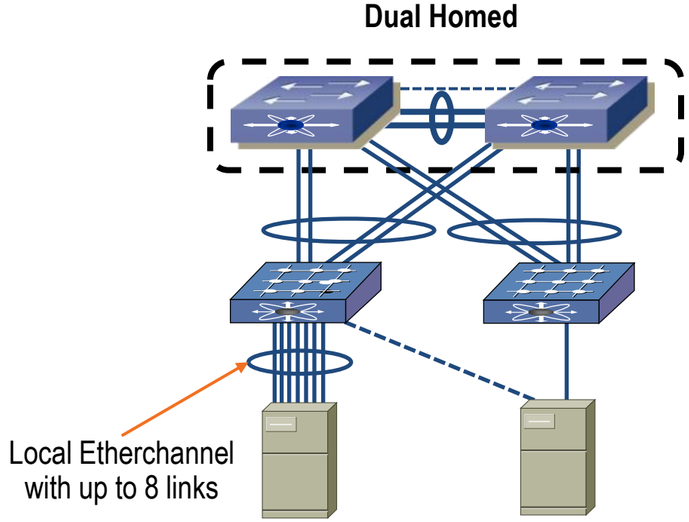
FEX Link and vPC Virtualised Access

Nexus 5000/5500 Topologies prior to 5.1.(3)N1



- Redundancy model – Dual Switch with redundant fabric
- Provides FCoE isolation for Storage topologies (SAN ‘A’ and ‘B’)
- Port Channel and Pinning supported for Fabric Link



- Redundancy model – Single switch with dual ‘supervisor’ for fabric, data control & management planes
- No storage SAN ‘A’ and ‘B’ isolation
- No active/active dual-home was allowed

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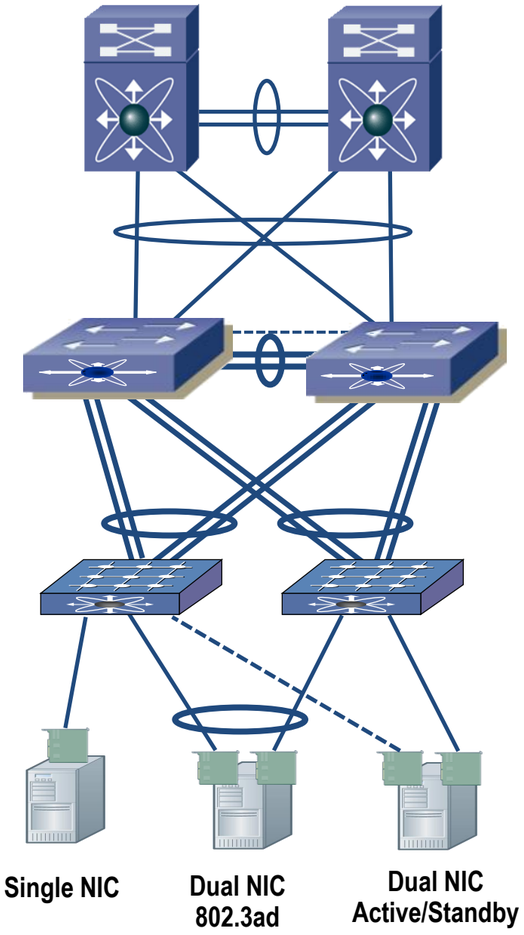
Enhanced Virtual Port Channel (EvPC)

Currently available on Nexus 5500 in NX-OS 5.1(3)N1 and later

- In an Enhanced vPC configuration any and all server NIC teaming configurations will be supported on any port. No ‘orphan ports’ in the design
- All components in the network path are fully redundant.
- Supported FEX parent switch is **Nexus 5500 only**
- Provides flexibility to mix all three server NIC configurations (single NIC, Active/Standby and NIC Port Channel)



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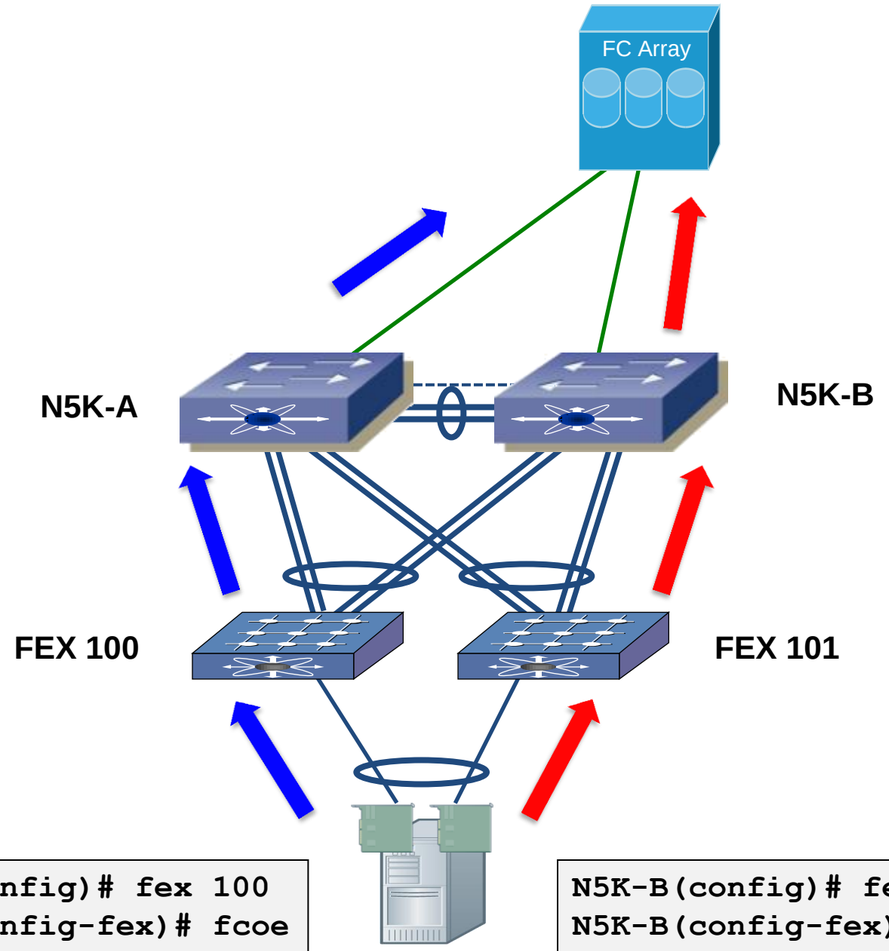
EvPC and FCoE SAN Traffic

Maintaining SAN A / B isolation

- In an Enhanced vPC (EvPC) SAN ‘A/B’ isolation is configured by associating each FEX with either SAN ‘A’ or SAN ‘B’ Nexus 5500
- FCoE & FIP traffic is forwarded only over the links connected to the specific parent switch
- Ethernet is hashed over all FEX fabric links




```
N5K-A(config)# fex 100
N5K-A(config-fex)# fcoe

N5K-A(config)# fex 101
```

```
N5K-B(config)# fex 101
N5K-B(config-fex)# fcoe

N5K-B(config)# fex 100
```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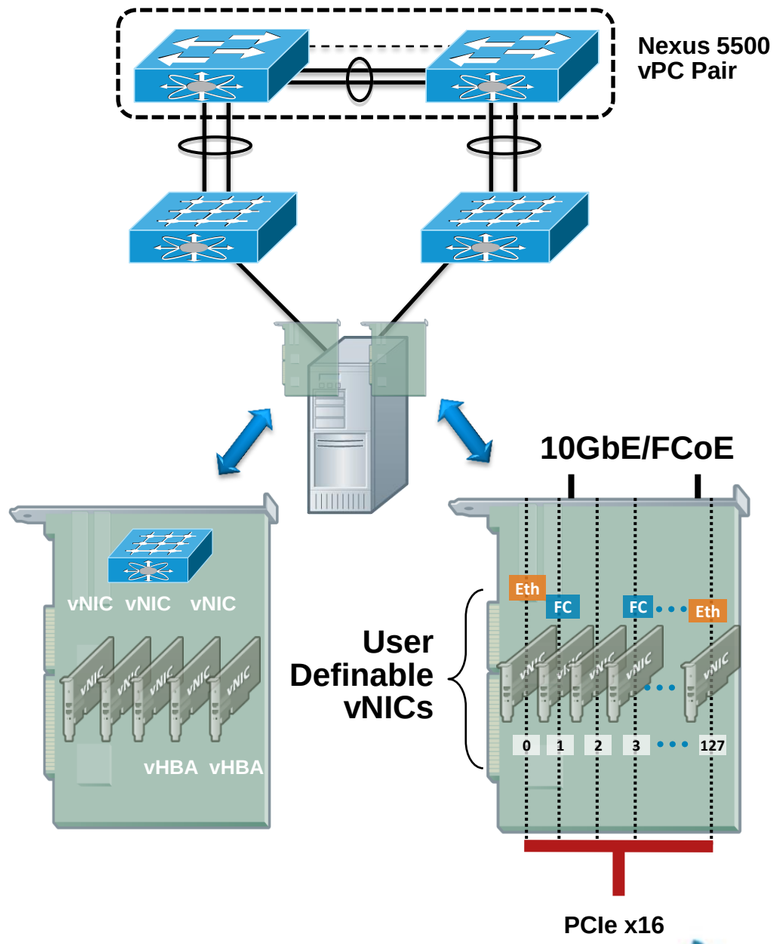
Cisco Adapter-FEX

Fabric Extender implemented in the server NIC

- Adapter-FEX presents standard PCIe virtual NICs (vNICs) to servers
- Adapter-FEX virtual NICs are configured on the server and managed via Nexus 5500
- Forwarding, Queuing, and Policy enforcement for vNIC traffic by Nexus 5500
- Adapter-FEX can be connected to Nexus 2000 Fabric Extender for a cascaded FEX-Link deployment
- Forwarding, Queuing, and Policy enforcement for vNIC traffic still done by Nexus 5500



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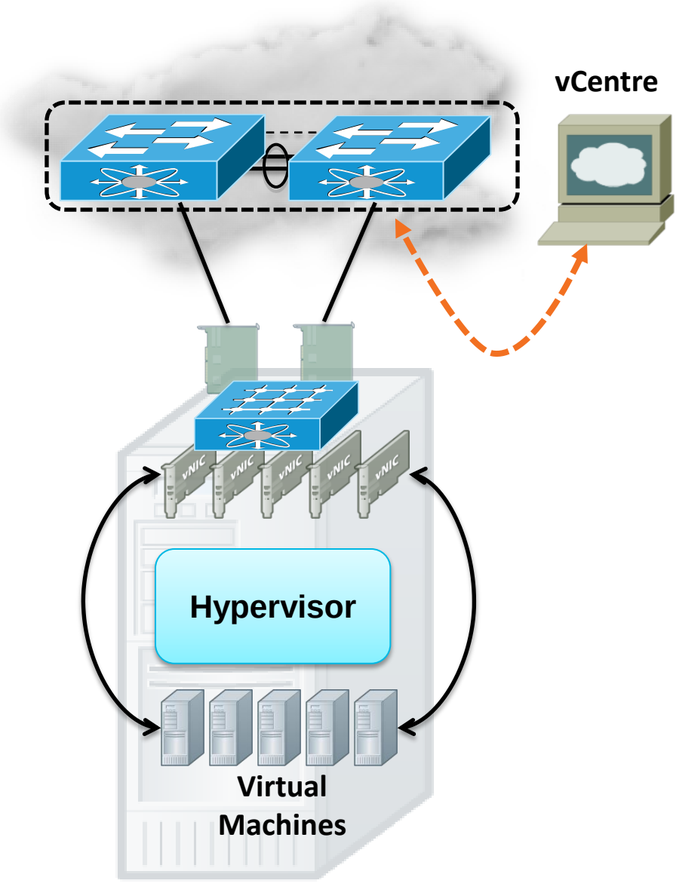
Cisco VM-FEX

Virtual Machine Fabric Extender

- Allows Nexus 5500 pair to register as a DVS in vCentre
- Extends Cisco Adapter FEX technology to the Virtual Machine with vMotion support
- Consolidated management of network, server, and virtual server interfaces
- Offload I/O processing from Server CPU with Cisco Nexus hardware performance
- Technology from the UCS Blade system extended to UCS Rack servers and Nexus 5500



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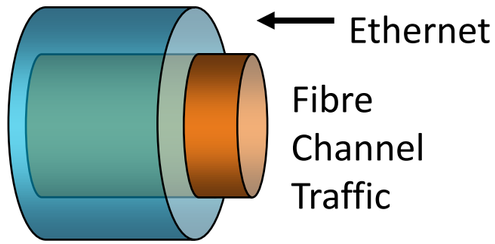
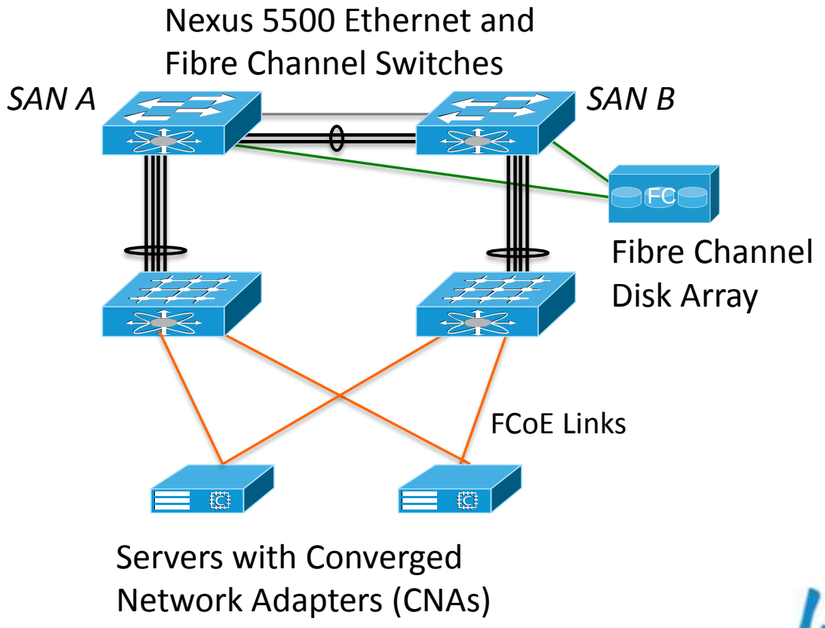
FCoE and Unified Ports

Nexus 5500 flexible definition of port function

- Fibre Channel over Ethernet (FCoE) allows encapsulation and transport of Fibre Channel traffic over a shared Ethernet network
- Traffic may be extended over Multi-Hop FCoE, or directed to an FC SAN
- SAN “A” / “B” isolation is maintained across the network
- Unified Ports may be configured to support either native Fibre Channel or Ethernet





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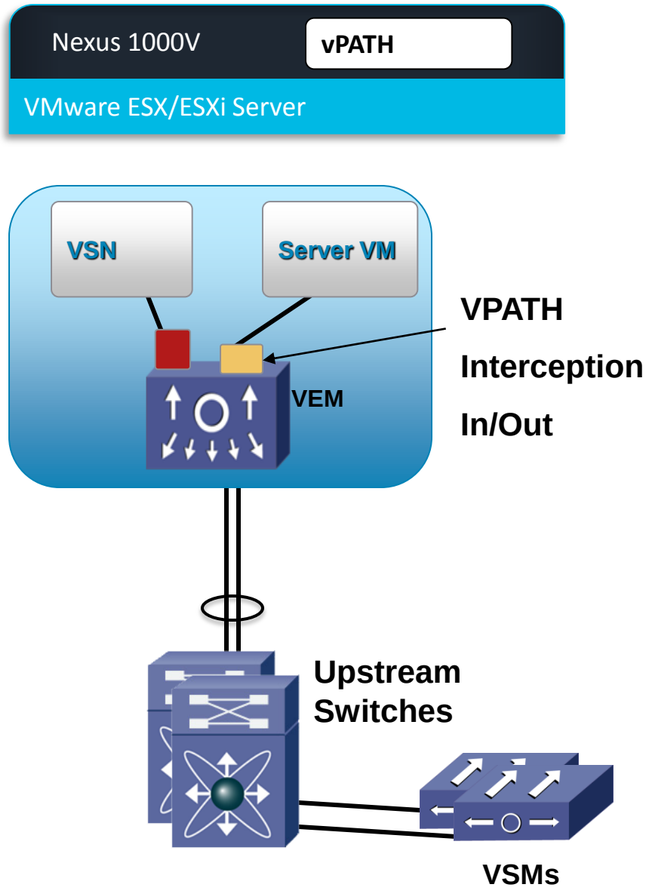
Nexus 1000v and vPATH

Traffic Interception for Data Centre services

- Intelligence built into Virtual Ethernet Module (VEM) of Cisco Nexus 1000V virtual switch (version 1.4 and above.)
- vPATH performs traffic interception and redirection for multiple virtual service nodes:
  - Virtual Security Gateway (VSG)
  - Virtual WAAS (vWAAS)
  - Virtual Network Analysis Module (vNAM)
- vPATH is Multi-tenant Aware.
- Leveraging vPATH can enhance the service performance by moving the processing to hypervisor.



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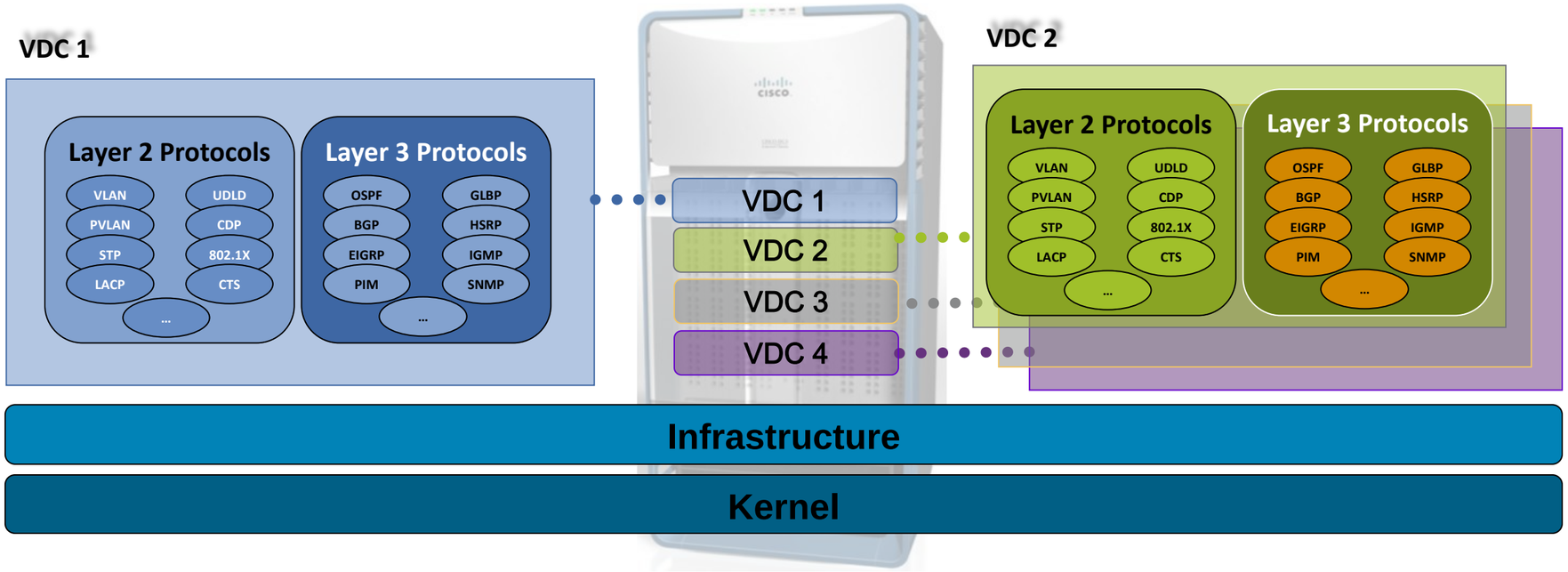
Nexus 7000 Virtualisation with VDCs

Single physical switch acting as multiple virtual devices

- VDC – Virtual Device Context
- Flexible separation/distribution of hardware resources and software components
- Complete data plane and control plane separation

- Complete software fault isolation
- Securely delineated administrative contexts
- Forwarding engine scalability with appropriate interface allocation



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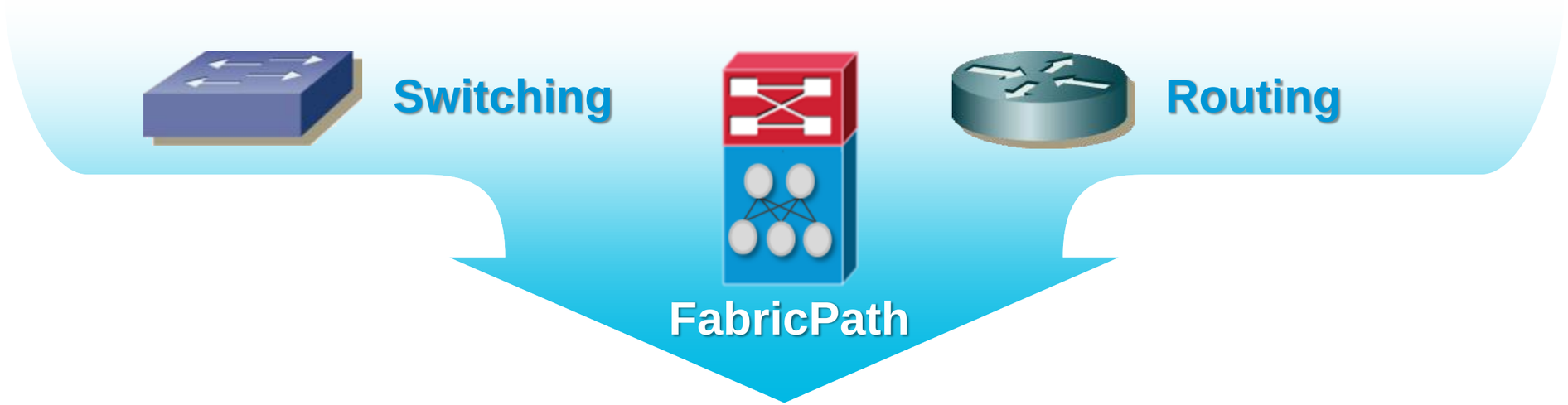
Cisco FabricPath

The best characteristics of both Layer-2, and Layer-3 switching

- **Easy Configuration**
- **Plug & Play**
- **Provisioning Flexibility**

- **Multi-pathing (ECMP)**
- **Fast Convergence**
- **Highly Scalable**



- FabricPath brings Layer 3 routing benefits to flexible Layer 2 bridged Ethernet networks.
- Key features such as vPC+ and multiple topologies make FabricPath a deployable solution; support will be extended to TRILL as it matures.

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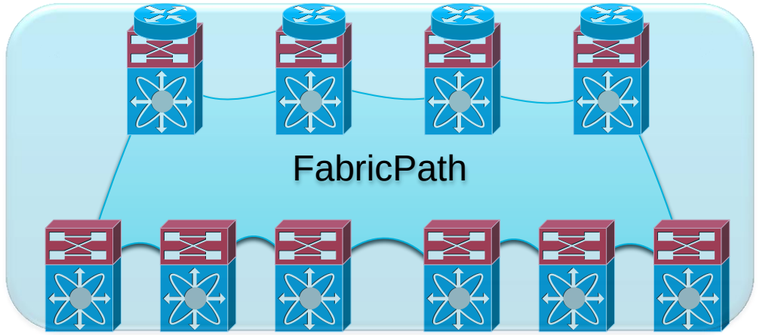
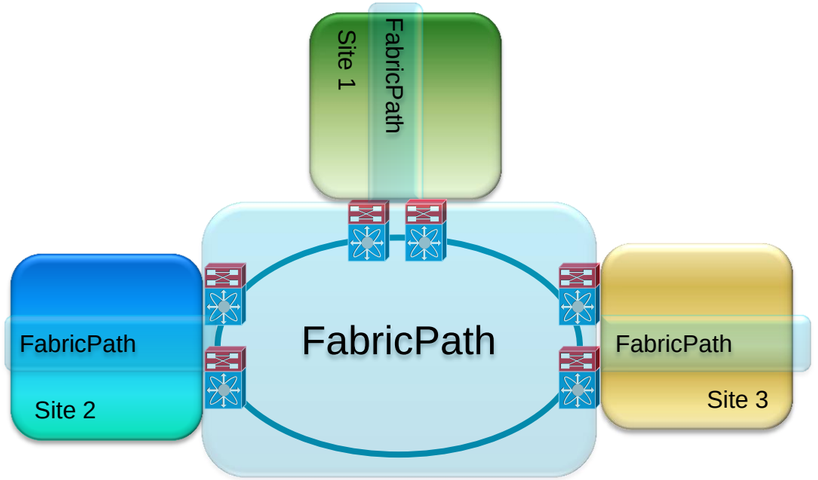
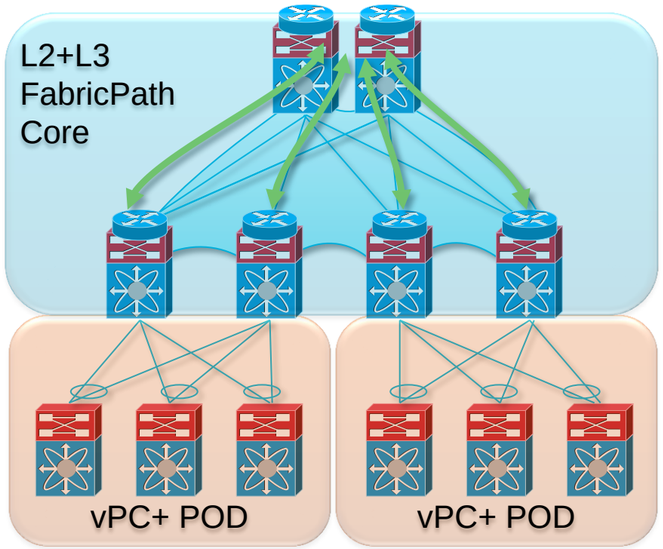
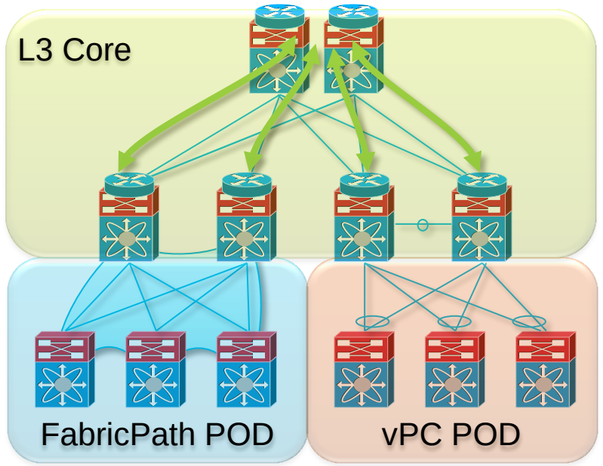
Cisco FabricPath

Flexibility in the Fabric with Layer-2 Routing









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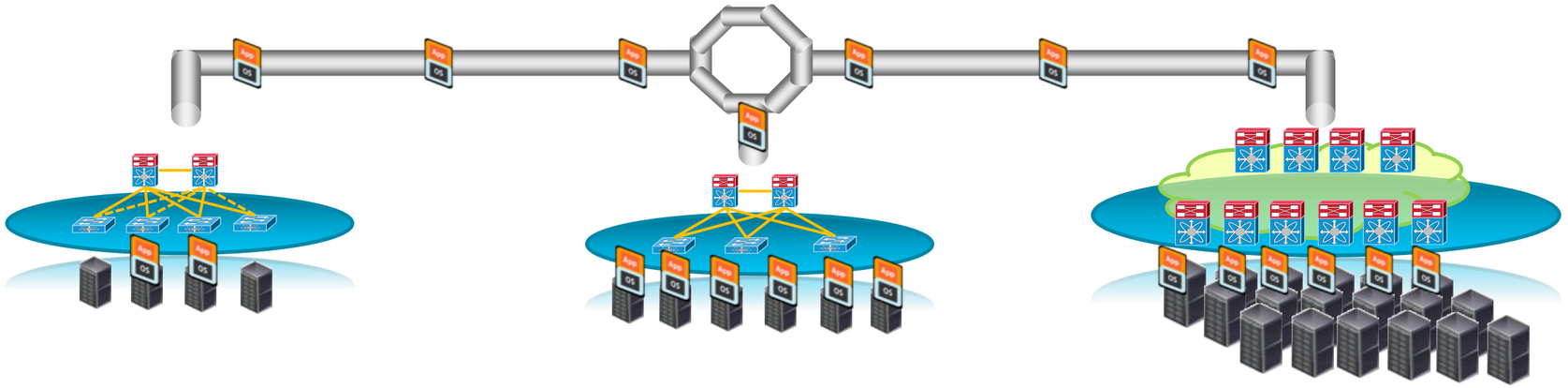
Building the Data Centre Interconnect

Complementary Innovations

- **FabricPath**: Scalable Fabrics for Application Deployment Flexibility
- **OTV** : Layer 2 extensions over Layer 3 for Distributed Clustered Applications
- **LISP**: IP mobility, optimised routing and segmentation within the flexible Fabric



Classical Pod
Spanning Tree Protocol

Scalable Pod
vPC & FEXLink

Highly Scalable Pod
FabricPath

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Session Agenda

Example designs to implement Data Centre features

- Data Centre networking requirements
  - Characteristics of network design unique to the Data Centre
- Data Centre networking features and solutions
  - Elements of Cisco feature innovations, and progress in the standards bodies
- Reference Topologies: starting out small and scaling up
  - Entry-level models: sub-100 to 300 server ports
  - Scaled up options 300 – 500 server ports
  - Full-featured solution, 500 – 800 server ports
- Building blocks to implement needed features
  - Product choices to balance scale and feature requirements with cost

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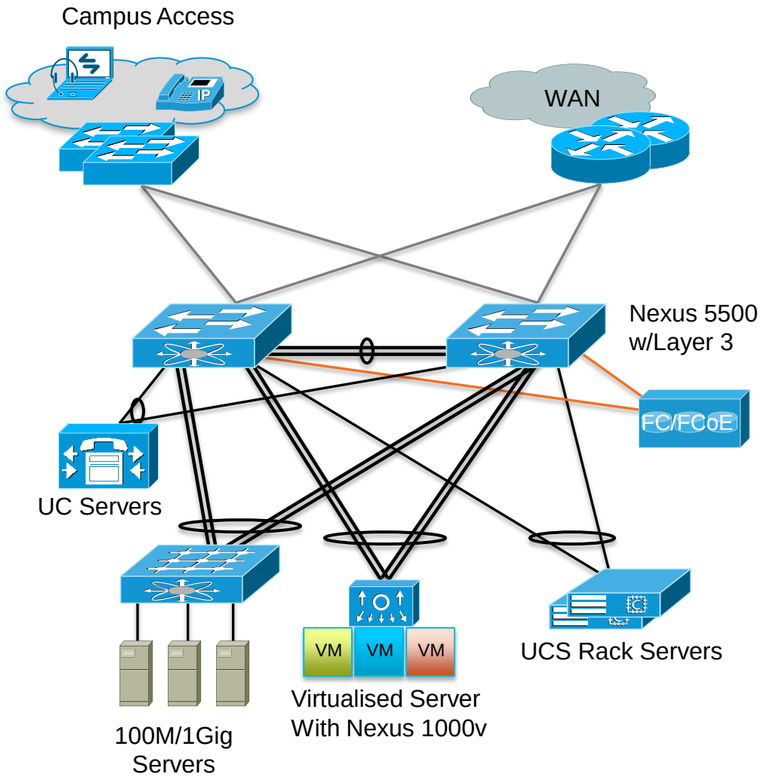
Entry-Level Data Centre Models

Collapsed Core and Virtualised Data Centre Switch sub-100 server ports

- Nexus 5500 virtual chassis combined core and DC pair
- Data Centre specific feature set:
  - FEX (Physical ports, Adapter-FEX, VM-FEX)
  - Virtual Port Channel (vPC)
  - Storage networking with FC, FCoE, Unified Ports, DCB
  - Nexus 1000v with vPATH
  - FabricPath support
  - WAN router required for DCI and other transport services



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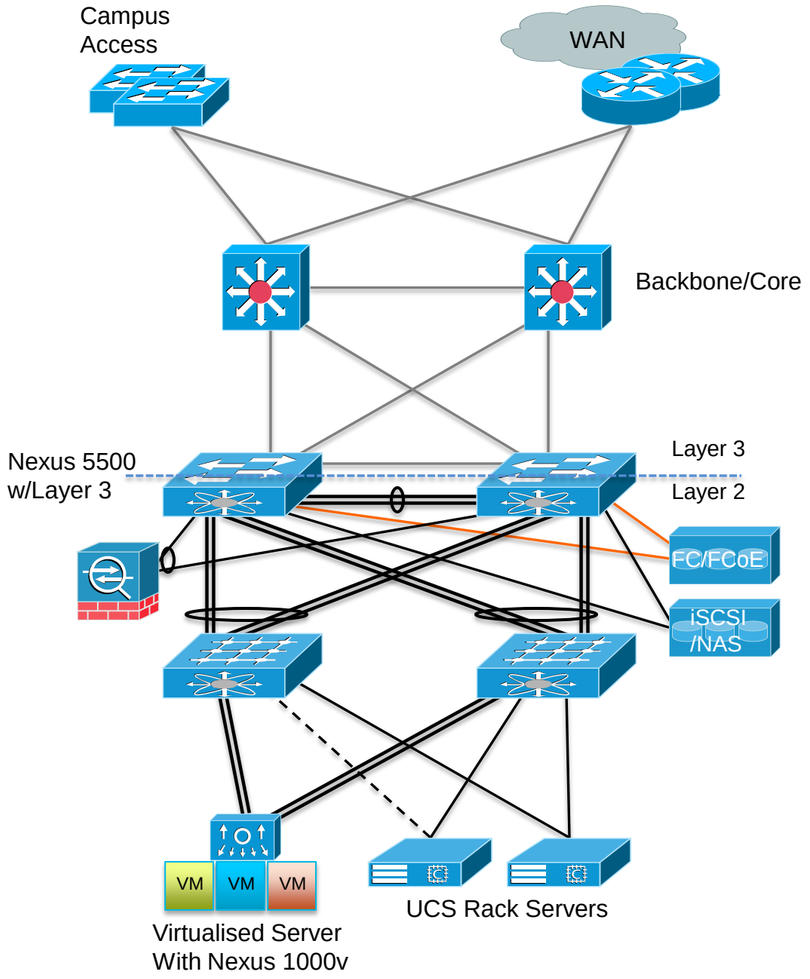
Entry-Level Data Centre Models

Nexus 5500 Layer 3 DC, FEX, and Storage support; 100 to 300 server ports

- Nexus 5500 virtual chassis
  - Scale port count with additional FEX virtual line cards
- Data Centre specific feature set:
  - FEX (Physical ports, Adapter-FEX, VM-FEX)
  - Virtual Port Channel (vPC)
  - Storage networking with FC, FCoE, Unified Ports, DCB
  - Nexus 1000v with vPATH
  - FabricPath support



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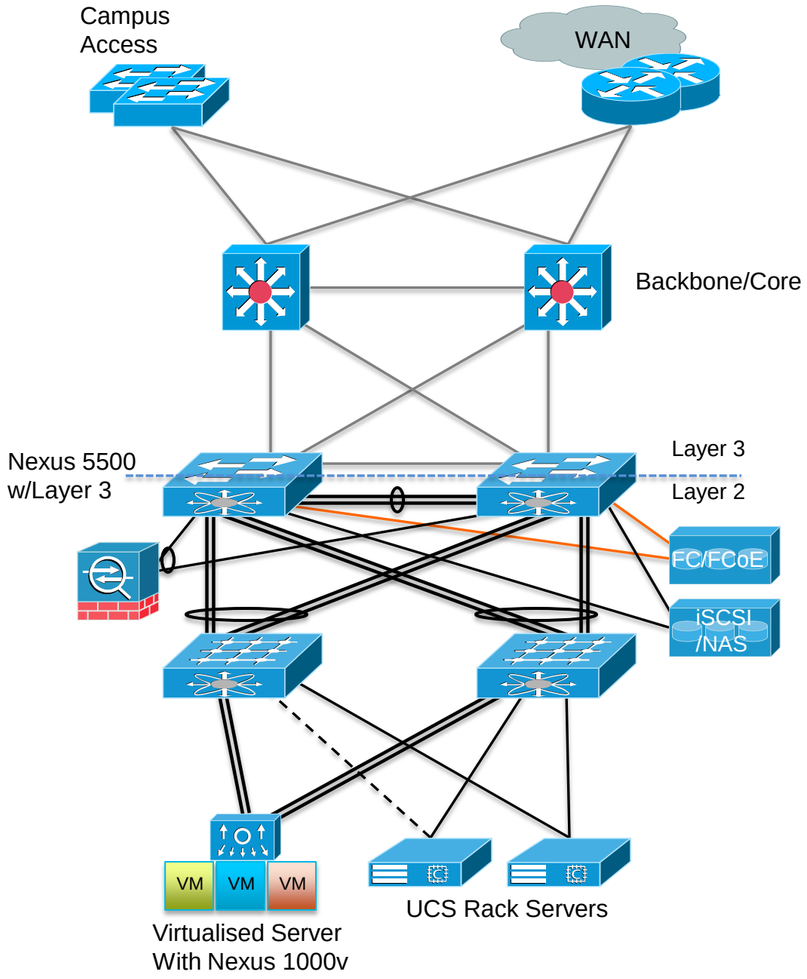
Entry-Level Data Centre Models

Nexus 5500 Layer-3 Configuration Considerations

- Ensure a separate link is configured for Layer-3 peering outside of the vPC links.
- Set COS value with QoS policy to ensure that queuing is correct for traffic passing to and from the L3 module.
- Base Layer-3 license is limited to 256 OSPF routes, or EIGRP Stub-only
  - Enterprise Layer-3 license for greater OSPF scale or full EIGRP
- Turn on vPC enhancements; peer-gateway, arp table sync, auto-recovery
- Leverage vPC+ if multicast PIM-SSM support is required (FabricPath license needed)
- Make sure to use the “bind-vrf” command if design has multicast sources attached to the N5K or N2K



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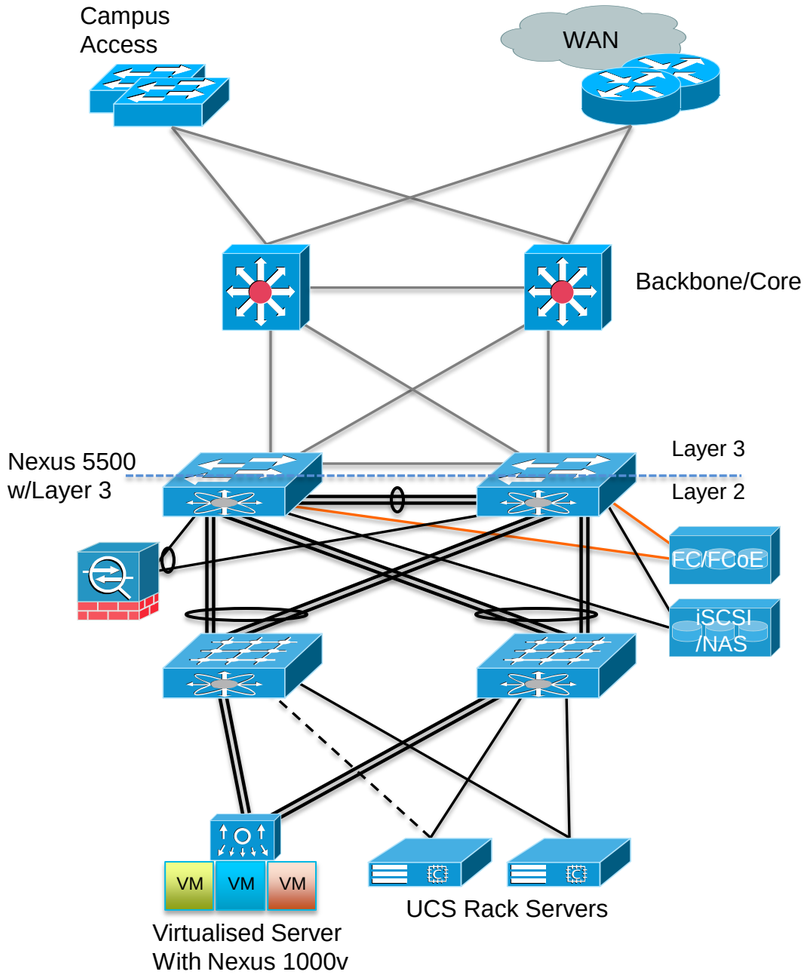
Entry-Level Data Centre Models

Nexus 5500 Layer-3 Scaling Considerations

- Support for up to 16 FEX when Layer-3 enabled in Nexus 5500.
  - 16 total dual-homed FEX.
  - Or 8 single-homed FEX per physical 5500 for a total of 16 active FEX.
- Nexus 5500 Layer-3 module version 1 up to 8000 IPv4 hosts, 4000 Multicast routes.
  - 16000 IPv4 hosts / 8000 Multicast routes on V2 Layer-3 module with updated software.
  - Layer-3 + FEX + vPC designs limited to 1000 multicast groups.
- Operational consideration, In-Service Software Upgrade (ISSU) not supported with Layer-3 on the 5500.



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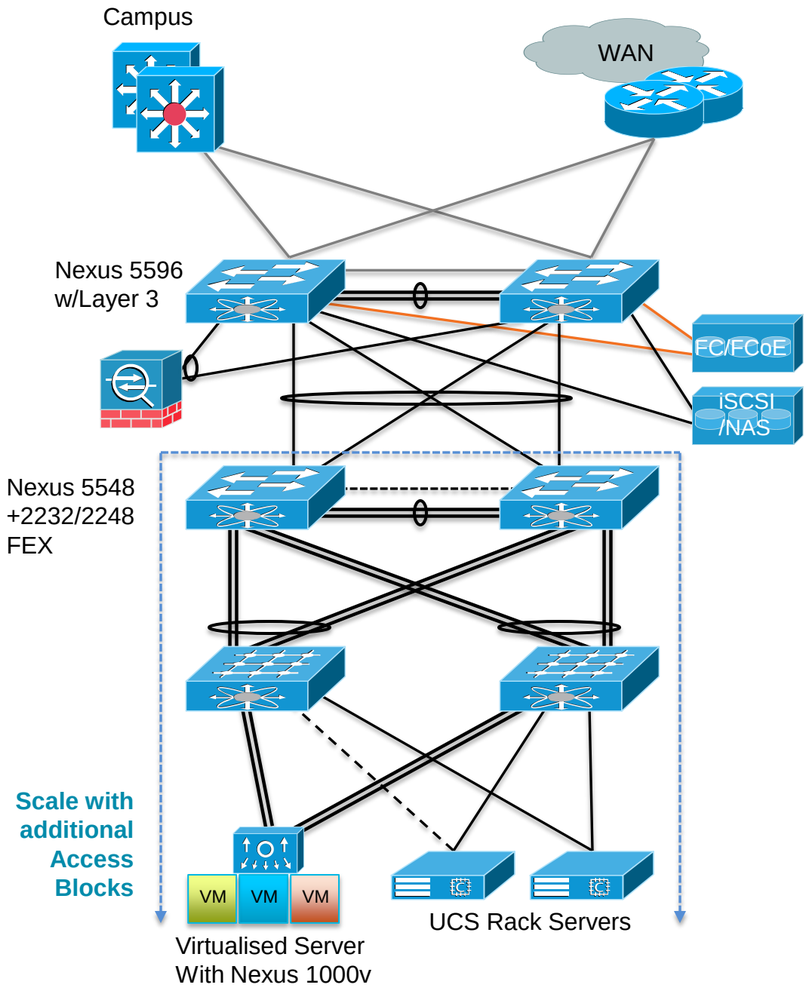
Scaled-up Models, Hierarchical Data Centre

Nexus 5500 Collapsed Core/Aggregation; 300 – 500 server ports

- Nexus 5500 virtual chassis
  - Scale port count with FEX virtual line cards
- Data Centre specific feature set:
  - Virtual Port Channel
  - FEX (Physical ports, Adapter-FEX, VM-FEX)
  - Storage integration FCoE, Unified Ports, DCB
  - Nexus 1000v with vPATH
  - FabricPath support



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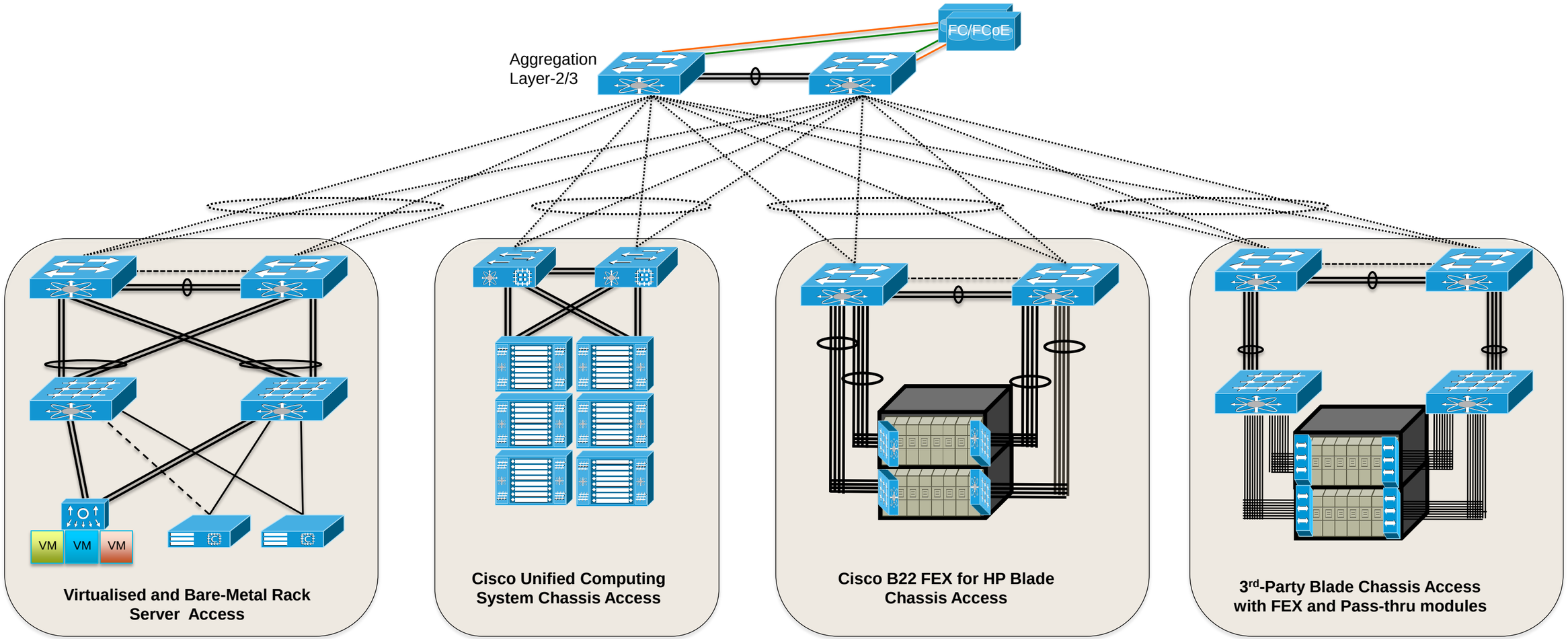
Scaling Designs with Access Block Variants

Mix and match Layer-2 compute connectivity for migration or scale requirements



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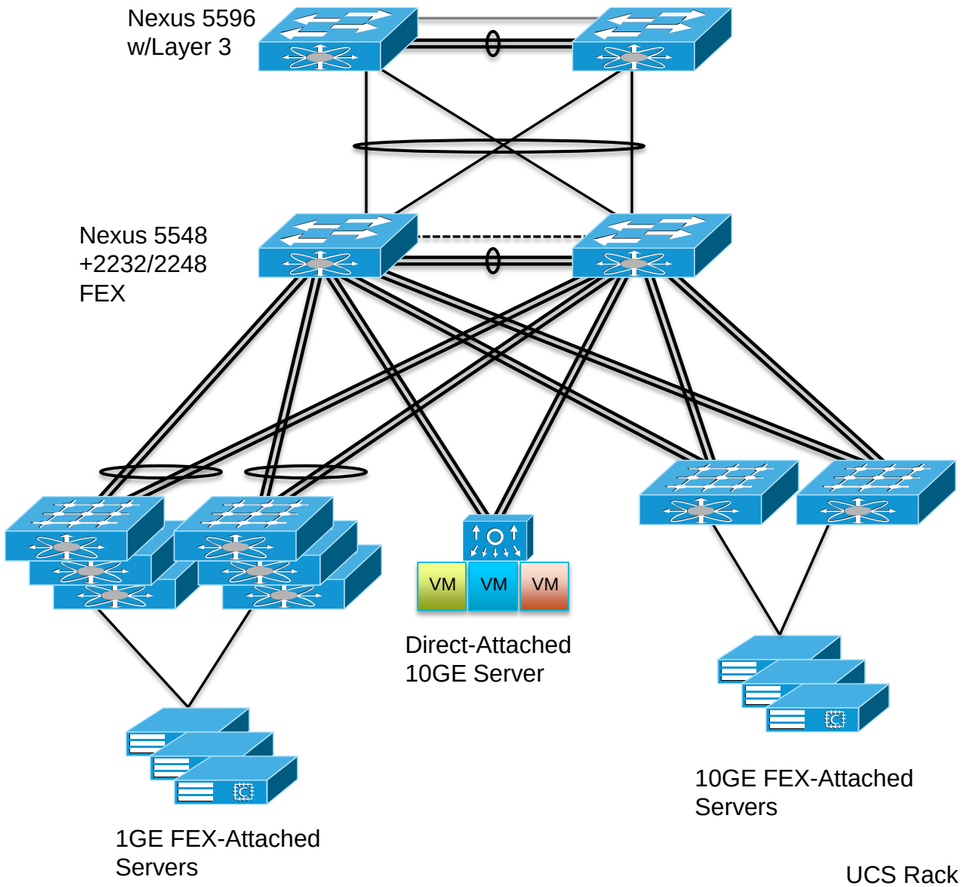
Scaling an Access Block with FEX

Evaluate port density, speed, and oversubscription requirements

- Increase density of 1GE or 10GE ports through additional FEX.
- High-traffic 10GE servers may be attached directly to Nexus 5500 for line-rate switching
- Consider oversubscription:
  - 2232 FEX, 32-port 10GE with 8 10GE uplinks; 4:1 oversubscribed
  - 2248 FEX, 48-port 1GE with 4 10GE uplinks; 1.2:1 oversubscribed
- Consider Nexus 5500 port consumption:
  - 6 2248's x 4 uplinks = 24 ports
  - 2 2232's x 8 uplinks = 16 ports
  - 4 5k-port dual-homed= 8 ports



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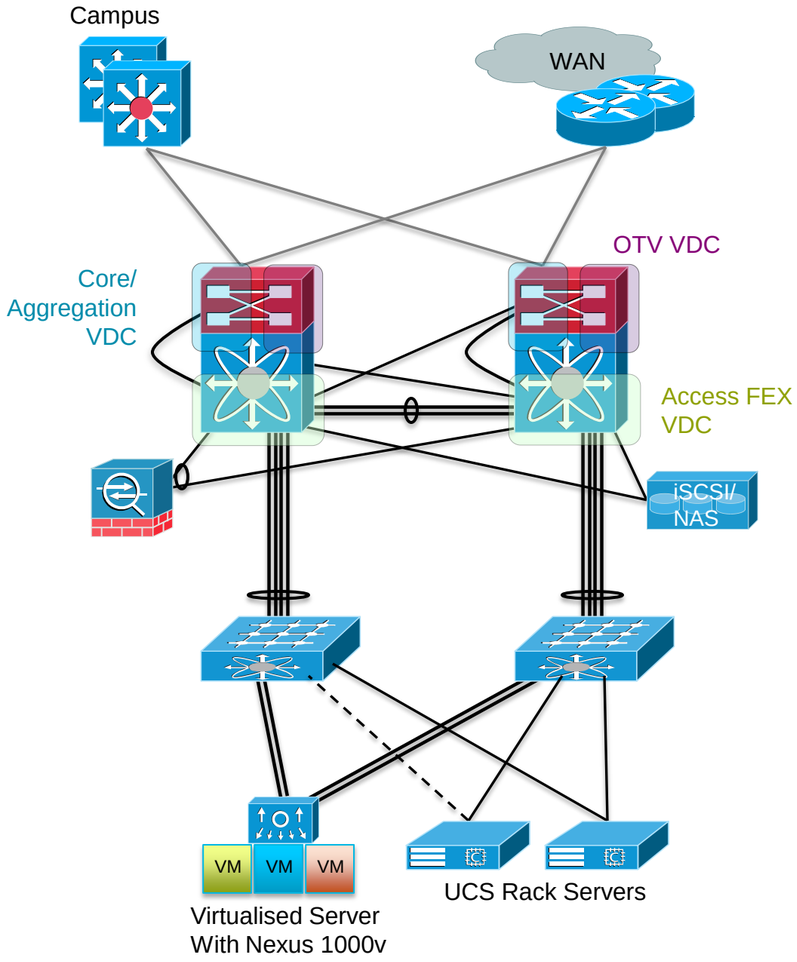
Scaled-up models, VDC - Hierarchical DC

Nexus 7000 VDC-based Core/Aggregation, 300-500 server ports

- Nexus 7000 VDC's
  - Hierarchical logical design with physical device consolidation
  - Design positioned to scale out to the next level
- Data Centre specific feature set:
  - Single-homed Physical FEX
  - OTV, LISP, ISSU, MPLS
  - FabricPath support
  - Nexus 1000v with vPATH

  (Not configured for FC/FCoE, Adapter-FEX)



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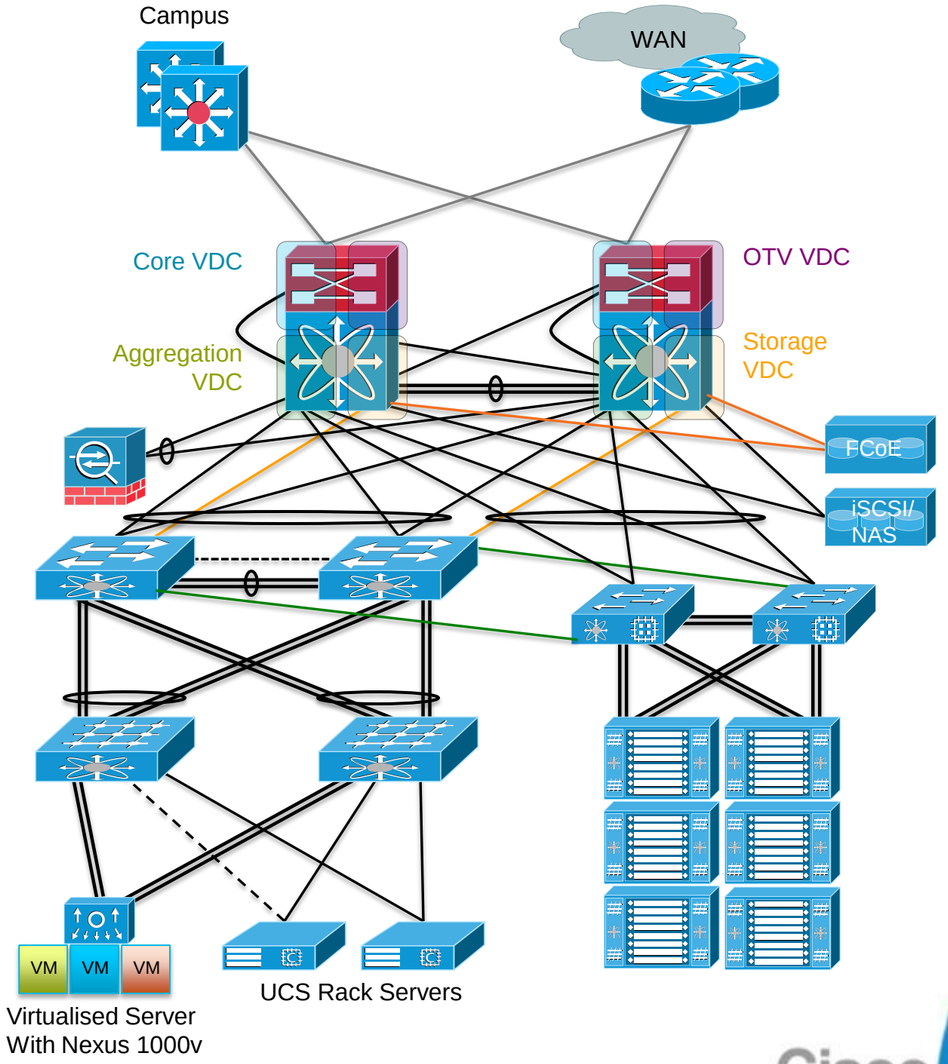
Full-Featured Nexus and UCS Data Centre

Nexus 7000 VDC-based Core/Aggregation, 500-800 server ports

- Nexus 7000 VDC's
- Nexus 5500 Virtual Chassis
- Full Cisco DC feature set:
  - vPC, Enhanced vPC
  - FEX, Adapter-FEX, VM-FEX
  - Storage integration FCoE, Unified Ports, DCB
  - Nexus 7000 OTV, LISP, ISSU, MPLS
  - FabricPath support
  - Nexus 1000v with vPATH
  - UCS FC into Nexus 5500 until direct FCoE is supported



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Session Agenda

Component options for building the Unified Data Centre fabric

- Data Centre networking requirements
  - Characteristics of network design unique to the Data Centre
- Data Centre networking features and solutions
  - Elements of Cisco feature innovations, and progress in the standards bodies
- Reference Topologies: starting out small and scaling up
  - Entry-level models: sub-100 to 300 server ports
  - Scaled up options 300 – 500 server ports
  - Full-featured solution, 500 – 800 server ports
- Building blocks to implement needed features
  - Product choices to balance scale and feature requirements with cost

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Nexus 7000 and 5000 Series Key Features

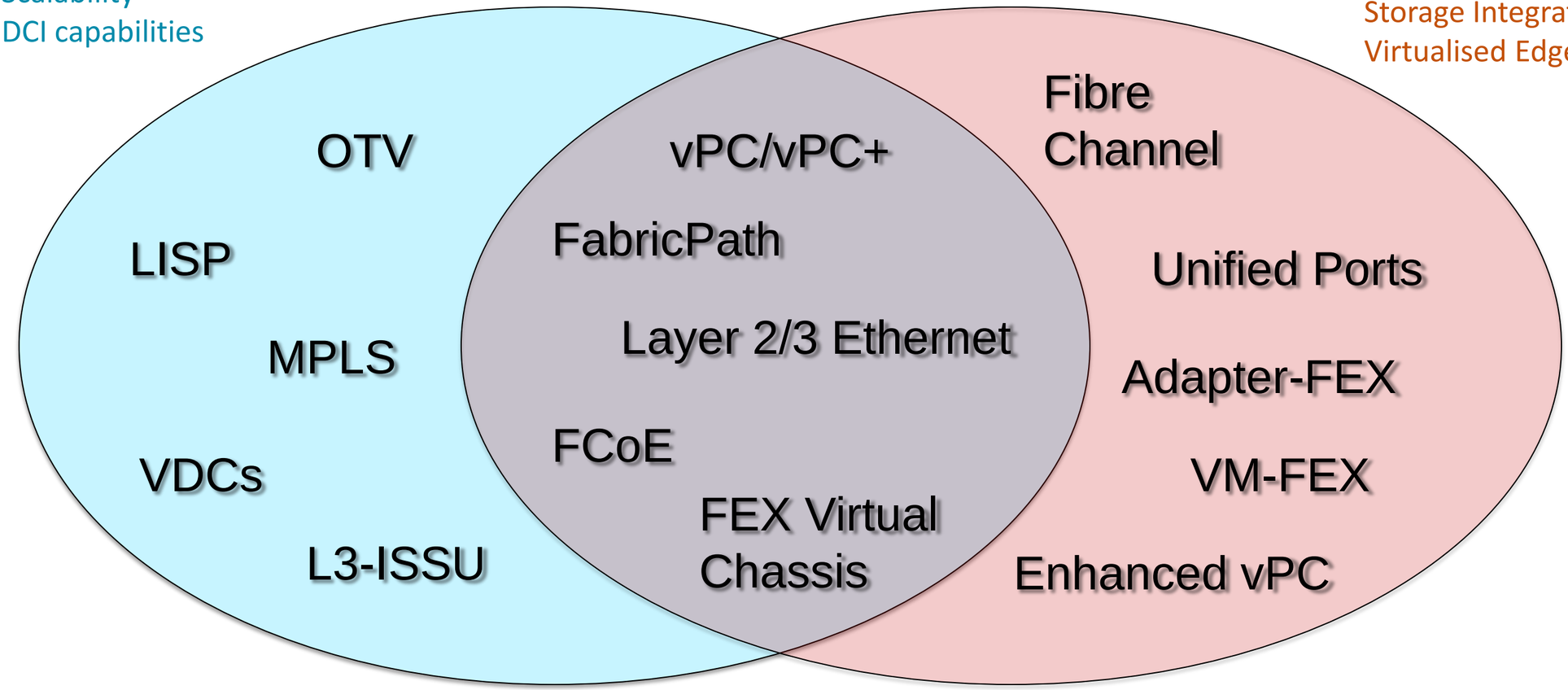
Overlapping capabilities for Data Centre optimisation

Nexus 7000

Core/Aggregation focus
Scalability
DCI capabilities

Nexus 5500

Access/Aggregation focus
Storage Integration
Virtualised Edge Features



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Cisco Nexus Switching Family

Building blocks for today's unified data centre fabric

- **Nexus 7000 Series**: Chassis-based, highly scalable multilayer NX-OS switch
- **Nexus 5500 Series**: Modular 1-2 RU Ethernet, Fibre Channel, and FCoE multilayer NX-OS switch
- **Nexus 3000 Series**: Ultra low-latency, high-performance multilayer NX-OS switch
- **Nexus 2000 Fabric Extenders**: 10Gbps, 1Gbps, 100Mbps virtual line cards for 7000/5000 Series
- **Nexus 1000v**: Virtual machine NX-OS switching for hypervisor environments with service integration

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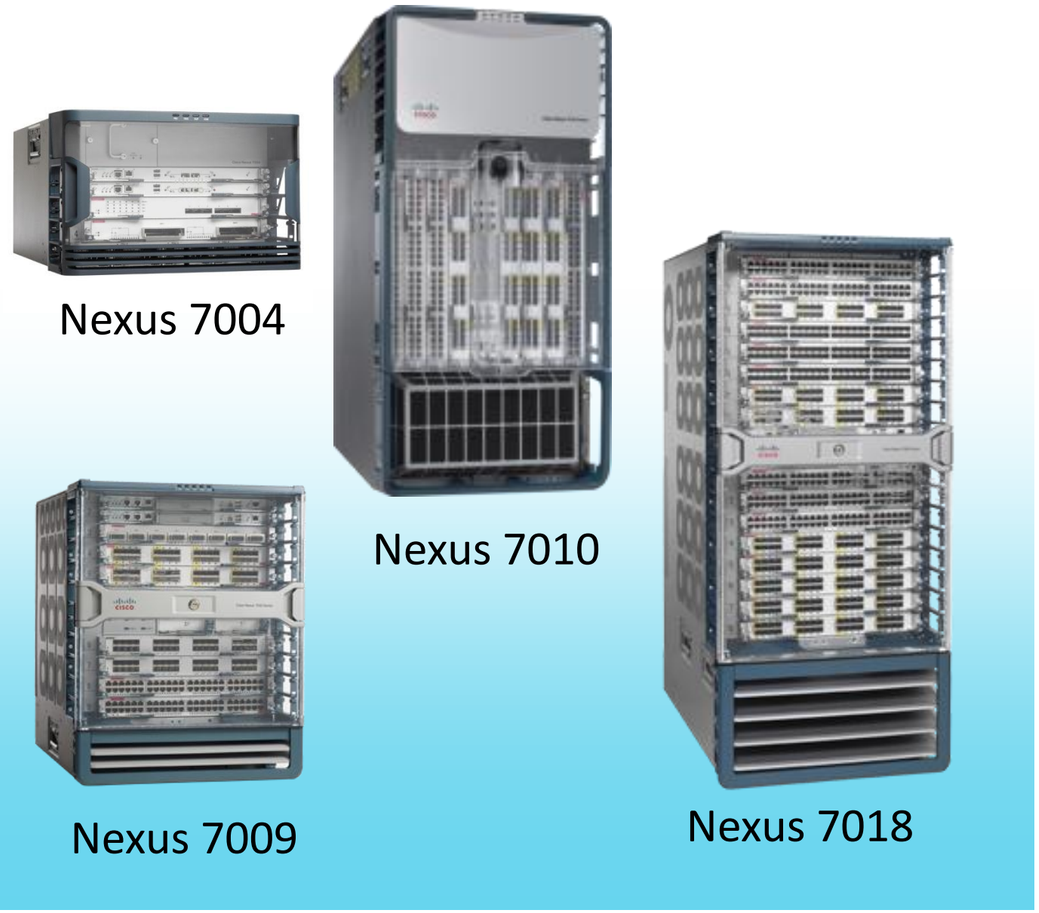
Nexus 7000 Series

Platform Overview

- 4, 9, 10 and 18 slot chassis switch
- 550 Gbps per slot
- 1G, 10G, 40G, and 100G Ethernet
- Hitless Software Upgrades (ISSU)
- Virtual Device Contexts (VDCs)
- Fibre Channel over Ethernet (FCoE)
- FabricPath
- Overlay Transport Virtualisation (OTV)
- Locator/ID Separation Protocol (LISP)
- Multiprotocol Label Switching (MPLS)



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Nexus 7000 Series I/O Module Options

Choices based on performance, feature, and cost requirements

- M1 Series cards provide Layer-2/3 switching and services, large scale routing tables and advanced features
- F1 Series modules provide Layer-2 switching, and can be paired with M1 modules for Layer-3 services
- F2 Series modules (non-enhanced) provide high performance, low latency, high density Layer-2/3 switching.
- M2 Series modules provide full-featured, high-performance 40 and 100 GE

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Nexus 5500 Series

Platform Overview

Nexus 5596T

Nexus 5596UP

- 1 and 2-RU Modular switches
- Lossless Ethernet, Fibre Channel, FCoE switching, IEEE DCB
- 10GBASE-T,100M/1G/10G Ethernet, 1/2/4/8 G Fibre Channel
- Unified Ports (Ethernet/FC)
- FabricPath
- Adapter-FEX
- VM-FEX
- Expandable to Layer-3 Switching

Nexus 5548UP

Nexus 5548UP

Ethernet, Fibre Channel and Layer-3 Expansion Modules

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Cisco Nexus 2000 Series

Line Cards for the Virtualised Access Switch

N2232TM-E

32 Port 1/10GBASE-T Host Interfaces
8 x 10G Uplinks (SFP+)

N2148T

48 Port 1000M Host Interfaces
4 x 10G Uplinks

N2248TP

48 Port 100/1000M Host Interfaces
4 x 10G Uplinks

N2232PP

32 Port 1/10G FCoE Host Interfaces
8 x 10G Uplinks

N2224TP

24 Port 100/1000M Host Interfaces
2 x 10G Uplinks

N2232TM

32 Port 1/10GBASE-T Host Interfaces
8 x 10G Uplinks (Module)

N2248TP-E

48 Port 100/1000M Host Interfaces
4 x 10G Uplinks
32MB Shared Buffer

FET-10G

Cost Effective Fabric Extender Transceiver

B22HP

16 x 1/10G Host Interfaces
8 x 10G Uplinks

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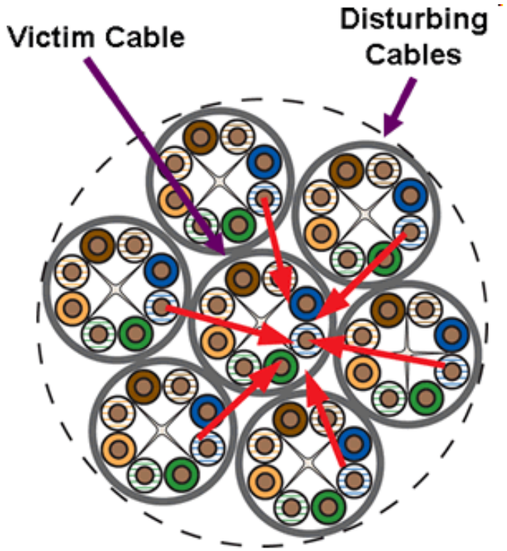
10 Gigabit Ethernet Migration

10GBaseT – Power and EMI Considerations

- Undesired coupling of signal between adjacent cables
- Main electrical parameter limiting the performance of 10G
- Cannot be cancelled
- Re-Training is the major barrier to use of 10GBaseT for block level storage (FCoE)
- Can be prevented or mitigated by:
  - Space (Cat6a solution)
  - Shield (Cat6/Ca6a/Cat7 shielded solutions)



	Technology	Cable	Distance	Power (each side)	Transceiver Latency
2232PP	SFP+ CU Copper	Twinax	1-10m	~0.1 - 1W	~0.25ms
2232TM	10GBASE-T – 65nm	Cat6/6a/7 Cat6/6a/7	100m 30m	~6W ~4-5W	~3ms ~3ms

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Virtualised Adapter Card Choices

For Cisco UCS C-Series and Nexus 5500 switching

Cisco P81E

- vNICs are presented to the host like standard PCIe devices
- In A-FEX mode: supports up to 16 Eth vNIC and 2 FC vHBA
- Adapter Failover feature: in failure scenarios, the vNIC is mapped to the other port transparently to the OS
- In VM-FEX mode: supports up to 96 Virtual Interfaces (vNICs + vHBAs)
- No need to trunk all VLANs to the server interface (improving security and scalability)

Broadcom BCM57712

- 3rd Party adapter supporting VN-TAG
- vNICs are presented to the host like standard PCIe devices
- In A-FEX mode supports up to 8 Virtual Interfaces total
  - Max of 8 vEth
  - Max of 2 vHba
- No adapter failover

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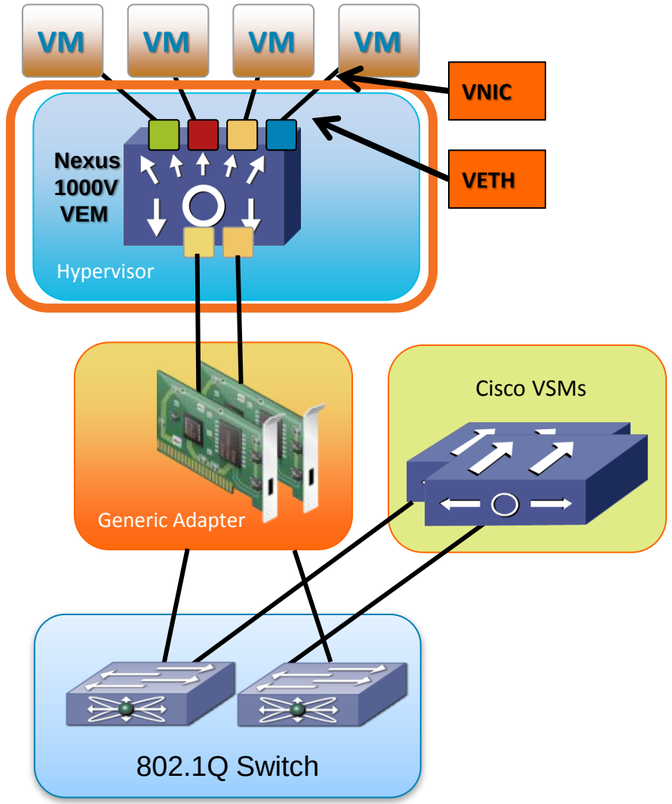
Nexus Switching for Virtualised Servers

Nexus 1000v for VMware environments (Microsoft Hyper-V)

- Embedded Virtual Bridge - Nexus 1000V
  - 802.1q standards based bridge
  - Policy Based port profile applies port security, VLAN, and ACLs, policy maps for QoS treatment for all systems traffic including VM traffic, Console & Vmotion/Vmkernel
  - Includes VXLAN switching capability
- Standard 802.1q based upstream switch
  - Leveraging standard switch to switch links (QoS, trunking, channelling, ..)
  - Policy on upstream switch looks like standard ‘aggregation’ configuration



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Small and Medium Data Centre Design

Summary and key takeaway points

- Data centre design for small to mid-market customers requires solving many of the same challenges larger customers face.
- Data centre specific features from Cisco are available on the Nexus family of switching platforms to address these challenges in varying levels of scale.
- Design elements of the example models covered today allow customers to scale their data centre footprint from entry level through hundreds of server ports.
- Cisco has extended many of the capabilities of the Unified Computing System into the Nexus switching family to allow a single switching fabric to support all variants of compute and storage connectivity needs.

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