DC 3.0

Next Generation Data Center Design
Data Center 3.0 Evolution

Consolidation  Virtualization  Automation  Utility  Market

Inter-Cloud
Private Clouds
Unified Computing
Unified Fabric
Data Center Networking
Data Center Systems Portfolio

- Nexus and Catalyst Switching Systems
  - Catalyst Family
  - Nexus Family

- DC Interconnect Systems
  - DC Edge Routing
  - WAN Optimization
  - Optical Family

- DC Services Systems
  - ASA and ACE Families

- DC Storage Systems
  - MDS 9000 Family

- Unified Computing System
  - UCS Family
Data Center Server Access
Network Equipment Distribution

End of Row and Middle of Row

End of Row
- Traditionally used
- Copper from server to access switches
- Poses challenges on highly dense server farms
  - Distance from farthest rack to access point
  - Row length may not lend itself well to switch port density

Common Characteristics
- Typically used for modular access
- Cabling is done at DC build-out
- Model evolving from EoR to MoR
  - Lower cabling distances (lower cost)
  - Allows denser access (better flexibility)
- 6-12 multi-RU servers per Rack
- 4-6 Kw per server rack, 10Kw-20Kw per network rack
- Subnets and VLANs: one or many per switch. Subnets tend to be medium and large

Middle of Row
- Use is starting to increase given EoR challenges
- Copper from servers to access switches
- Fiber may be used to aggregate ToR
- It addresses aggregation requirements for ToR access environments
**Network Equipment Distribution**

*Top of Rack*

**ToR**
- Used in conjunction with dense access racks (1U servers)
- Typically one access switch per rack
  - Some customers are considering two + cluster
- Typically:
  - ~10-15 server per rack (enterprises)
  - ~15-30 server per rack (SP)
- Use of either side of rack is gaining traction
- Cabling:
  - Within rack: Copper for server to access switch
  - Outside rack (uplink):
    - Copper (GE): needs a MoR model for fiber aggregation
    - Fiber (GE or 10GE): is more flexible and also requires aggregation model (MoR)
- **Subnets and VLANs:**
  - one or many subnets per access switch
  - Subnets tend to be small
Density and Scalability Implications
Top of Rack ./ Middle Of Row

With ~1,000 Servers/
9 Slot Access Switches=
8 Access Switches (250 ports) to manage

1RU Access

With ~1,000 Servers/
25 Cabinets =
50 Access Switches (40 ports) to manage

Modular Access

Lower STP Proc
More I/O Cables
Fewer uplinks
Higher STP Proc
Fewer I/O Cables
More uplinks
Herausforderungen bei Server Anschluss im RZ

Wie sind die Schnittstellen und Prozesse zwischen den einzelnen Funktionen?
Nexus Data Center Product Portfolio

- Nexus 1000
- Nexus 2000
- Nexus 5010
- Nexus 5020
- Nexus 5018
- Nexus 7010
- Nexus 7018

- 520G
- 1Tb/s
- 7.5Tb/s
- 15Tb/s

- Server
- Access
- Aggregation/Core

NX-OS
Nexus 7000
Network Implications

Fabric Convergence
One network for storage, Ethernet, IP, and HPC traffic

Virtualization
Server, Switch, Network

Move the Decimal Point
1G->10G->40G/100G Multi-terabit switch fabrics

Operational Continuity
Modular OS; In Service Software Upgrade, Integrated Diagnostics

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Cisco Nexus 7000 Series Data Center Class Switches

- Zero service disruption infrastructure
- Graceful systems operations
- Integrated lights-out management
- Fully Distributed Data Workflow

- Lossless fabric architecture
- 15+ Terabit scalability: Dense 40GbE/100GbE ready
- Unified fabric ready

- Virtualized control and data plane
- Cisco® TrustSec roles-based security
- Efficient physical and power design
Virtual Port-Channel - vPC

- Allow a single device to use a port channel across two upstream switches
- Eliminate STP blocked ports
- Uses all available uplink bandwidth
- Dual-homed server operate in active-active mode
- Provide fast convergence upon link/device failure
- Reduce CAPEX and OPEX
- Available in NX-OS 4.1 with current and future hardware
N7k Virtual Device Contexts (VDCs)

Network Virtualization

- Network Consolidation:
  - Multiple logical nets/single physical net
  - Maintain clear delineation between nets
    - Independent Topologies
    - Clear Management Boundaries
    - Fault Containment
- Service Velocity:
  - In-line tests
  - Rapid deployment and rollback
    - e.g. Enable Utility Computing
- Device Consolidation:
  - Logical Appliances
  - Multi-switch emulation
  - Power, Cooling & Real-Estate efficiencies
NX-OS High Availability

- Hardware provides redundancy at every component level:
  - Supervisors
  - Fabrics
  - Power
  - Fans

- Software offers multi-layered, multi-faceted resiliency:
  - Stateful process restarts
  - Graceful restart for routing protocols
  - Stateful supervisor engine switchovers
  - True in-service software upgrades

- Hardware and software combine to deliver data-center class high availability – zero service disruption
Unified Fabric
Nexus 5000
Data Center Ethernet (DCE™): What & Why

- Data Center Ethernet is a Cisco “toolbox” of Ethernet Enhancements
- Standards based
- Supported by Eco-system partners
- Benefits
  - Enables the Unified Fabric to accommodate LAN, Storage and clustering application
    - Lossless transport
    - Congestion management
    - Enables larger L2 domains
# Data Center Ethernet

<table>
<thead>
<tr>
<th>Feature / Standard</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority Flow Control (PFC) IEEE 802.1Qbb</td>
<td>Enable multiple traffic types to share a common Ethernet link without interfering with each other</td>
</tr>
<tr>
<td>Bandwidth Management IEEE 802.1Qaz</td>
<td>Enable consistent management of QoS at the network level by providing consistent scheduling Aka Enhanced Transmission Selection (ETS)</td>
</tr>
<tr>
<td>Congestion Management IEEE 802.1Qau</td>
<td>End-to-end congestion management for L2 network</td>
</tr>
<tr>
<td>Data Center Bridging Exchange Protocol (DCBX)</td>
<td>Management protocol for enhanced Ethernet capabilities</td>
</tr>
<tr>
<td>L2 Multipath for Unicast and Multicast</td>
<td>Increase bandwidth, multiple active paths. No spanning tree</td>
</tr>
</tbody>
</table>
Data Center Ethernet: PFC & Bandwidth Management

**Priority Flow Control**

- Enables lossless Fabrics for each class of service
- PAUSE sent per virtual lane when buffers limit exceeded

**COS based Bandwidth Management**

- Enables Intelligent sharing of bandwidth between traffic classes
- 802.1Qaz Enhanced Transmission

![Diagram showing the interaction between transmit queues, ethernet link, and receive buffers with Priority Flow Control and COS based Bandwidth Management.](image-url)
### Evolution of Ethernet Physical Media

**Role of Transport in Enabling 10GE Technology**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Cable</th>
<th>Distance</th>
<th>Power (each side)</th>
<th>Transceiver Latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFP+ CU Copper</td>
<td>Twinax</td>
<td>10m</td>
<td>~0.1W</td>
<td>~0.25μs</td>
</tr>
<tr>
<td>SFP+ USR ultra short reach</td>
<td>MM OM2 MM OM3</td>
<td>10m 100m</td>
<td>1W</td>
<td>~0.1μs</td>
</tr>
<tr>
<td>SFP+ SR short reach</td>
<td>MM OM1 MM OM3</td>
<td>33m 300m</td>
<td>1W</td>
<td>~0.1μs</td>
</tr>
<tr>
<td>10GBASE-T</td>
<td>Cat6 Cat6a/7</td>
<td>55m 100m 30m</td>
<td>~8W ~8W ~4W</td>
<td>2.5μs 2.5μs 1.5μs</td>
</tr>
</tbody>
</table>

**10GE Copper Solution**
- Low cost
- Low power and latency
- Up to 10 meters (in-rack and adjacent rack cabling)

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Mid 1980's

- 10Mb
- UTP Cat 3

- SFP+ to SFP+
- SFP+ Cu

- X2 SFP+ to SFP+ SFP+ to SFP+
FC over Ethernet (FCoE)

- Mapping of FC Frames over Ethernet
- Enables FC to Run on a Lossless Ethernet Network

**Benefits**

- Fewer Cables
  - Both block I/O & Ethernet traffic co-exist on same cable
- Fewer adapters needed
- Overall less power
- Interoperates with existing SAN’s
  - Management SAN’s remains constant
- No Gateway
I/O Consolidation

**Today**

- Parallel LAN/SAN Infrastructure
- Inefficient use of Network Infrastructure
- 5+ connections per server – higher adapter and cabling costs
- Adds downstream port costs; cap-ex and op-ex
- Each connection adds additional points of failure in the fabric
- Longer lead time for server provisioning
- Multiple fault domains – complex diagnostics
- Management complexity

**I/O Consolidation with FCoE**

- Enhanced Ethernet and FCoE
- Ethernet
- FC

Nexus 5000

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FCoE: Storage Targets

- Direct attached FCoE Storage
- Unified FCoE network environment
- Maintains architecture of SAN separation for high availability
Unified “SAN” Fabric

The Nexus 5000 Unified Fabric carries all SAN Traffic

- **FCoE**
- **iSCSI**
- **NAS**

- 10GE with DCE provides consolidated fabric
- PFC insures lossless connectivity for All storage application
- CoS based Enhanced Transmission provides Bandwidth Management
Case for a Unified Data Center Fabric

Complexity, Cost, Power

Universal I/O Ubiquitous Connectivity
Nexus 5000: I/O Consolidation

16 Servers | Enet | FC | Total
---|---|---|---
Adapters | 20+ | 20 | 40*
Switches | 2 | 2 | 4
Cables | 40 | 40 | 80
Mgmt Pts | 2 | 2 | 4

Nearly twice the Cables

- Half the Cables
- Half the Adapters
- Power & Cooling Savings
- Consistent Management

16 Servers | Enet | FC | Total
---|---|---|---
Adapters | 20 | 0 | 20
Switches | 2 | 0 | 2
Cables | 40 | 0 | 40
Mgmt Pts | 2 | 0 | 2

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Adapter Strategy

10GE

Wide Industry Acceptance
2x10GE NIC

Intelligent NIC®
Price-Performance Leader

Available Today

FCoE

Minimal Disruption Using
Existing Driver Stacks

“Free” SAN Access for
Any Ethernet Equipped Host

Available June 2008

FCoE s/w stack
PFC & DCBX
Menlo: I/O Consolidation Network Adapter

- Off the shelf NIC and HBA ASICs from: Qlogic, Emulex
  - Dual 10GE/FCoE ports
- Support for native drivers and utilities
  - Customer certified stacks
- Replaces multiple adapters per server
- Consolidates 10GE and FC on a single interface
- Minimum disruption in existing customer environments
- Supports PFC & DCBX
- Linux (SLES & Redhat) and Windows versions

Menlo ASIC
Cisco/Nuova designed multiplexer and FCoE offload protocol engine
Standard Fibre Channel Connectivity

FCoE is transparent to FC
- Ethernet is a transport
- FCoE is just another ether-type

Nexus 5K is also an FC switch
- FC domain, zoning, services...

Connects to existing Fabrics
- Retain existing FC investment
- Same management model

Nexus 5K emulates Server ports
- N-port Virtualization
- NPIV

The Nexus 5000 is fully compatible with Existing Fibre Channel Fabrics
Nexus 5000 Data Center Server Switches

- **Data Center Server Switches**
  - 56 port, 2 RU (40 fixed)
  - 28 port, 1 RU (20 fixed)

- **Expansion Modules**
  - 4xFC + 4x10GE
  - 6X10GE
  - 8xFC (future)

- **Ports Types**
  - SFP+ (optical and copper)
  - SFP (optical - Fibre Channel)
  - 10GbaseT (future)

- **Multi-protocol (LAN, SAN, Cluster)**
  - Ethernet
    - 10GE
  - Cisco Data Center Ethernet
  - FCoE
  - Fiber Channel
    - 1/2/4G FC

- **10GE & FCoE adapters (partners)**
  - Emulex, Qlogic, Intel, Netxen

*Max Port Densities*
Up to 52x10GE Line Rate
Up to 16x1/2/4G FC + 40x10GE

*FC ports are SFP*
Comprehensive Management Tools

- Management Suite for Nuova Switch
  - CLI structured like Cisco IOS® CLI
  - Cisco Fabric Manager (Fibre Channel)
  - Cisco DCNM
- Roles Based Access Control
- Standard, Open Interfaces
  - SNMP, CIM XML (SMI-S)
Common SAN/LAN Architecture

Administrative Boundaries

Network Admin
Login: Net_admin
Password: abc1234

SAN Admin
Login: SAN_admin
Password: xyz6789

Ethernet
FC
Common SAN/LAN Architecture

Administrative Boundaries via RBAC

LAN

SAN A

SAN B

Network Admin
Login: Net_admin
Password: abc1234

SAN Admin
Login: SAN_admin
Password: xyz6789

NX5000

CNA

DataCenter Ethernet with FCoE

Ethernet

FC
Nexus 2148
**Nexus 5000 Data Center Access Switch Portfolio**

### Q2CY08
- **Nexus 5020**
  - 56-Port 2RU Switch

### Q3CY08
- **Nexus 5010**
  - 28-Port 1RU Switch

### Q1CY09
- **Nexus 2148T**
  - 1GE FEX (1RU)
  - 48x1GE + 4x10GE ports

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**Nexus 5000 unified fabric switch**
- High density 10 Gig Ethernet Switch
- Low latency HPC
- Unified Fabric
- Optimized virtualized services

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**Simplifies Data Center architecture & operations**
- Significantly increases port density for N5000 solutions
- Cost-effective 1GE and 10GE connectivity
- Integrated management domain with N5000
- Combines benefits of ToR and EoR architectures
Nexus 5000 Fabric EXtender (FEX)

The Nexus 5000 Fabric Extender (FEX) acts as a remote line card (module) for the Nexus 5000, retaining all centralized management and configuration on the Nexus 5000, transforming it to a Virtualized Chassis.
Fabric Extender overview

- 48 x 1 GigabitEthernet Interfaces
- 4 x 10 GigabitEthernet Interfaces
- Beacon & Status LEDs
- Redundant, Hot-Swappable Power Supplies
- Hot-Swappable Fan Tray
ToR FEX Deployment with Nexus 5020
Fabric Extender Management model

- Fabric Extender is NOT an independent manageable entity
- From a management perspective, FEX is modeled as a Nexus 5000 line-card
- Nexus 5000 and FEX communicate via in-band connectivity
- Out-of-band method for debugging and disaster recovery only to be used by Cisco field personnel through dongle connector
- No configuration is stored on the FEX
Nexus 1000v
Cisco Virtual Network Link – VN-Link

Virtualizing the Network Domain

Policy-Based VM Connectivity

Mobility of Network & Security Properties

Non-Disruptive Operational Model

Two Complementary Models to Address Evolving Customer Requirements

Cisco Nexus 1000V

(Software Based)

Nexus 5000 with VN-Link

(Hardware Based)
Cisco Nexus 1000V
Industry First 3rd Party Virtual Distributed Switch

- Nexus 1000V provides enhanced VM switching for VMW ESX environments

- Features VN-Link capabilities:
  - Policy-based VM connectivity
  - Mobility of network and security properties
  - Non-disruptive operational model

- Ensures visibility and continued connectivity during VMotion

Enabling Acceleration of Server Virtualization Benefits
Cisco Nexus 1000V Architecture

- **Virtual Supervisor Module (VSM)**
  - Virtual or Physical appliance running Cisco OS (supports HA)
  - Performs management, monitoring, & configuration
  - Tight integration with VMware Virtual Center

- **Virtual Ethernet Module (VEM)**
  - Enables advanced networking capability on the hypervisor
  - Provides each VM with dedicated "switch port"
  - Collection of VEMs = 1 Distributed Switch

Cisco Nexus 1000V Enables:
- Policy Based VM Connectivity
- Mobility of Network & Security Properties
- Non-Disruptive Operational Model

Diagram showing servers, VMs, and VEM connections.
Cisco Nexus 1000V
Faster VM Deployment

Cisco VN-Link—Virtual Network Link

- **Policy-Based VM Connectivity**
- **Mobility of Network & Security Properties**
- **Non-Disruptive Operational Model**

Defined Policies
- WEB Apps
- HR
- DB
- Compliance

VM Connection Policy
- Defined in the network
- Applied in Virtual Center
- Linked to VM UUID

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Cisco Nexus 1000V
Richer Network Services

VN-Link: Virtualizing the Network Domain

Policy-Based VM Connectivity
Mobility of Network & Security Properties
Non-Disruptive Operational Model

VMs Need to Move
- VMotion
- DRS
- SW Upgrade/Patch
- Hardware Failure

VN-Link Property Mobility
- VMotion for the network
- Ensures VM security
- Maintains connection state

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Cisco Nexus 1000V
Increase Operational Efficiency

VN-Link: Virtualizing the Network Domain

Policy-Based VM Connectivity

Mobility of Network & Security Properties

Non-Disruptive Operational Model

Server

VM #1
VM #2
VM #3
VM #4

Cisco Nexus 1000V

VMW ESX

VM #5
VM #6
VM #7
VM #8

Server

Server Benefits
- Maintains existing VM mgmt
- Reduces deployment time
- Improves scalability
- Reduces operational workload
- Enables VM-level visibility

Network Benefits
- Unifies network mgmt and ops
- Improves operational security
- Enhances VM network features
- Ensures policy persistence
- Enables VM-level visibility