



Fibre Channel Over Ethernet (FCoE)

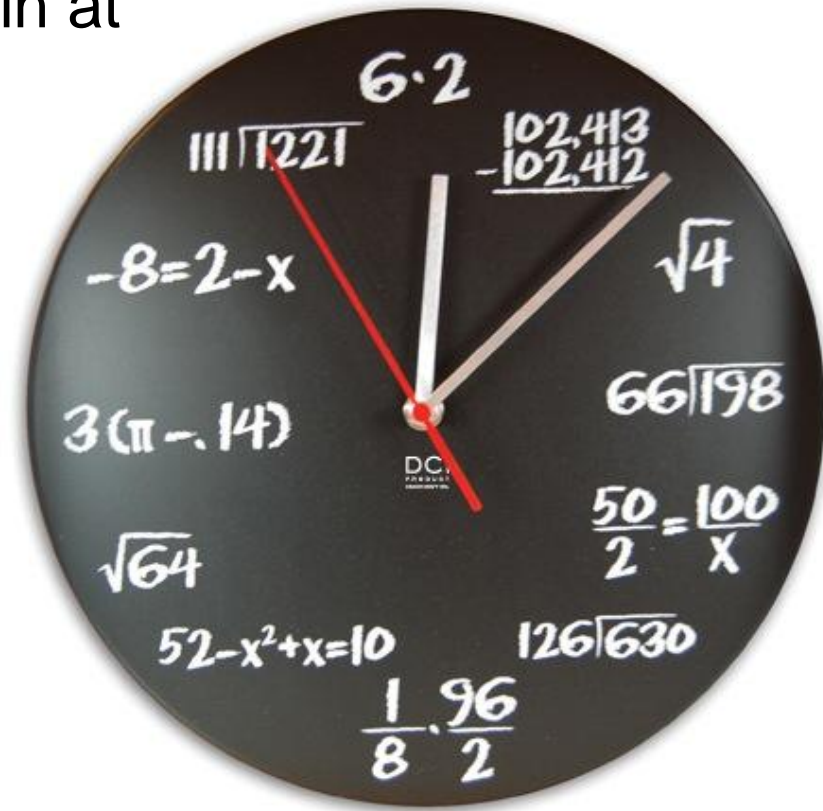
Ozden Karakok



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The Live Ask the Expert Event Will Begin at
10:00 am Eastern Time

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Cisco Support Community - Ask the Expert

- Today's featured expert is Ozden Karakok
- Ask her questions now about FCoE



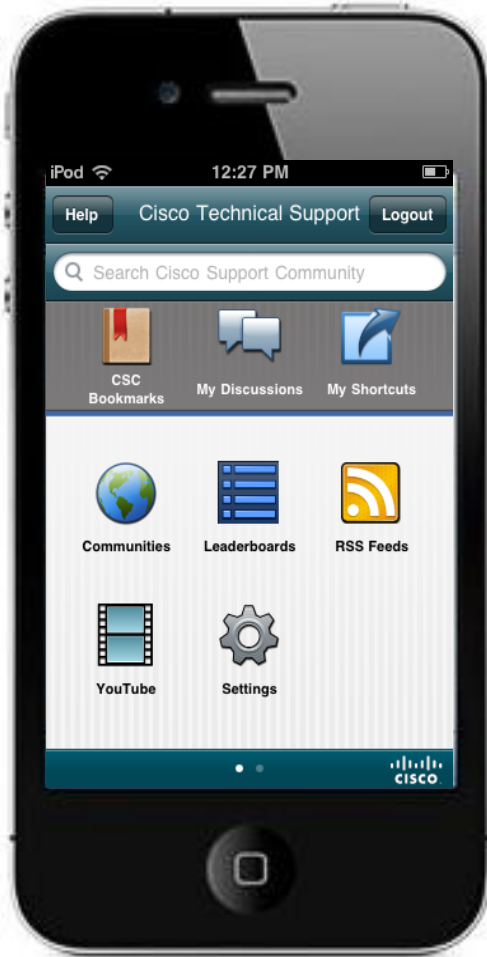
Ozden Karakok

Data Center Technical Lead, Cisco

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Polling Question 1

How open are you adopting new protocols and technology architectures used by your organization in Data Centers?

- a) Very open to change
- b) Moderately open
- c) Neutral
- d) Hesitant
- e) Don't know

Poll Response

How open are you to adopting new protocols and technology architectures used by your organization in Data Centers?

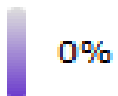
Very open to change



Moderately open



Neutral

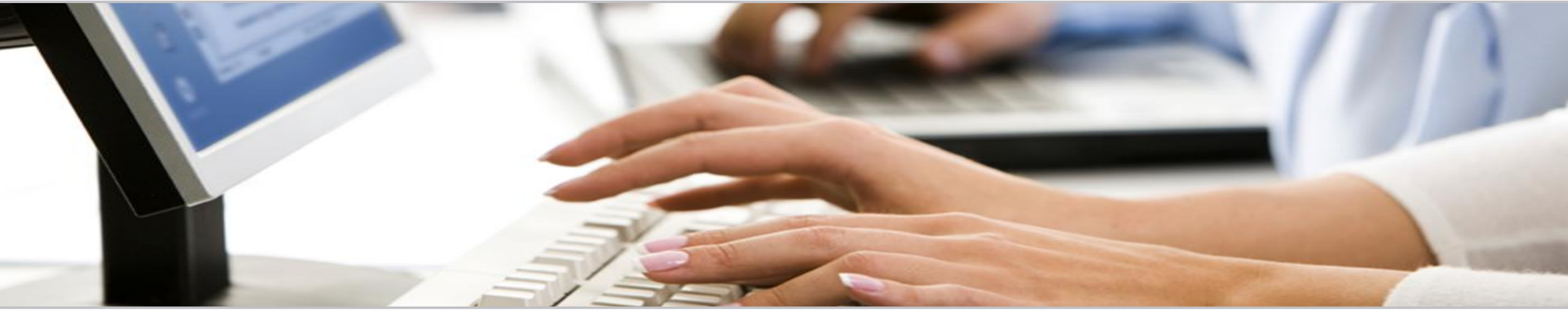


Hesitant



Don't know





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Agenda

- Why are we here?
- Background Information
 - What is FCoE all about and Why?
 - FCoE Building Blocks and Terminology
 - DCB Standard
 - FCoE Protocol Information
- Design Requirements
 - Single Hop Designs
 - Multi-Hop Designs
- Conclusion

Why are we here?

Session Objectives

- Understand the design requirements of a Unified Network
- Understand the Fibre Channel over Ethernet Technologies
- Be able to design single-hop and multi-hop Unified Networks which meet the demands of both SAN and LAN networks

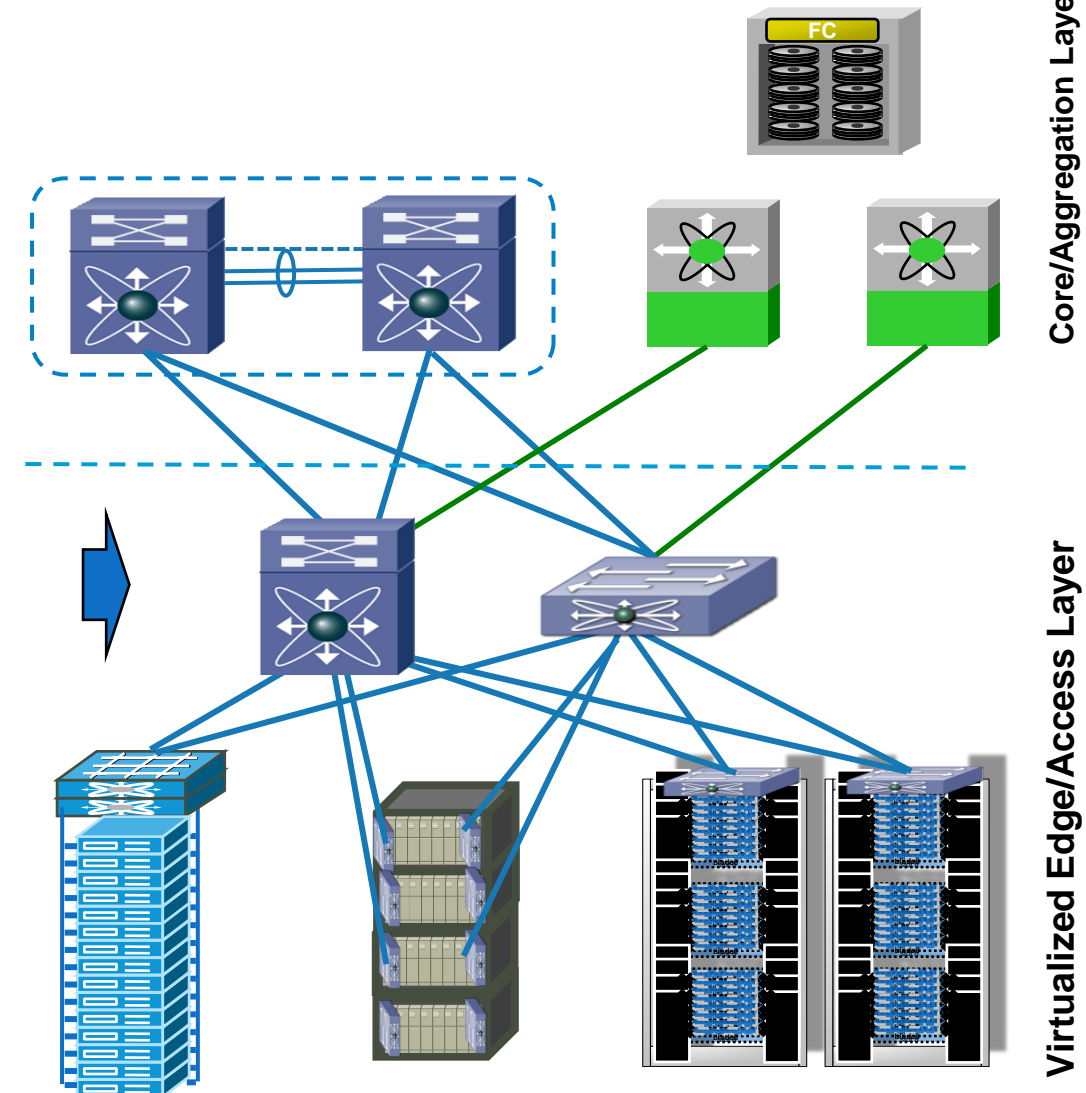
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The Evolving Data Centre Access

The Consolidated Nexus Edge Layer

- The Access Layer is becoming more than just a port aggregator
- Edge of the growing Layer 2 topology
 - Scaling of STP Edge Ports
 - Virtual embedded switches
 - vPC and loop free designs
 - Layer 2 Multi-Pathing (future)
- Foundational element for Unified I/O 'and' Unified Wire
 - DCB and Multi-Hop FCoE Support

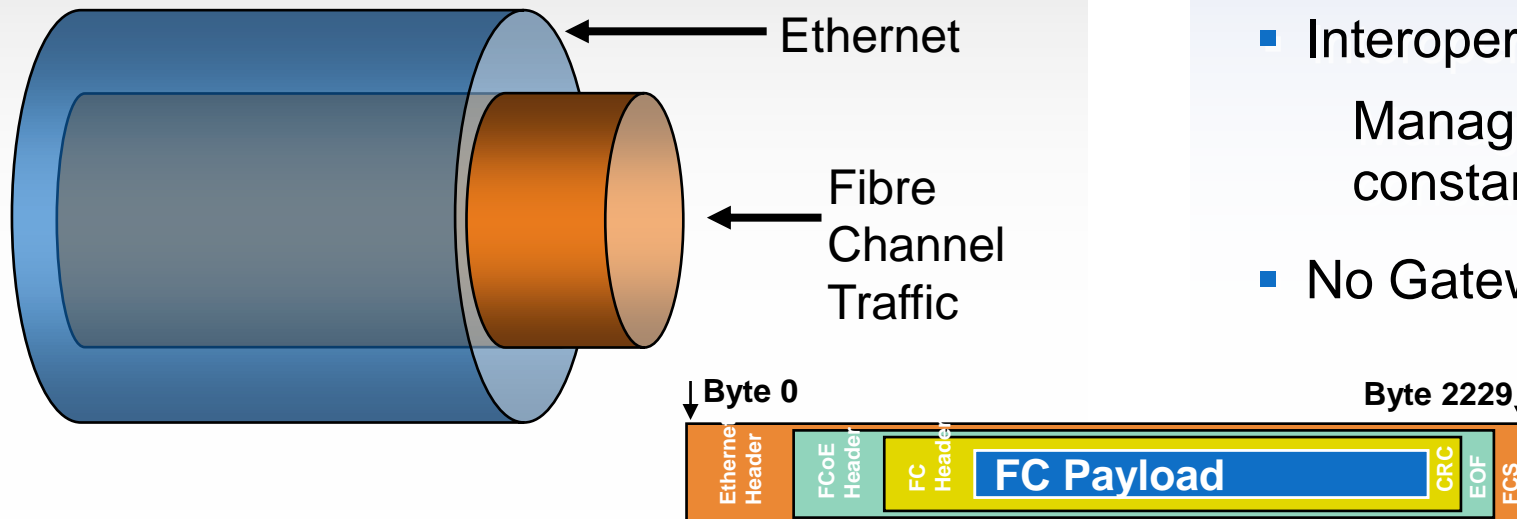


Unified Fabric

Fibre Channel over Ethernet (FCoE)

FCoE

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

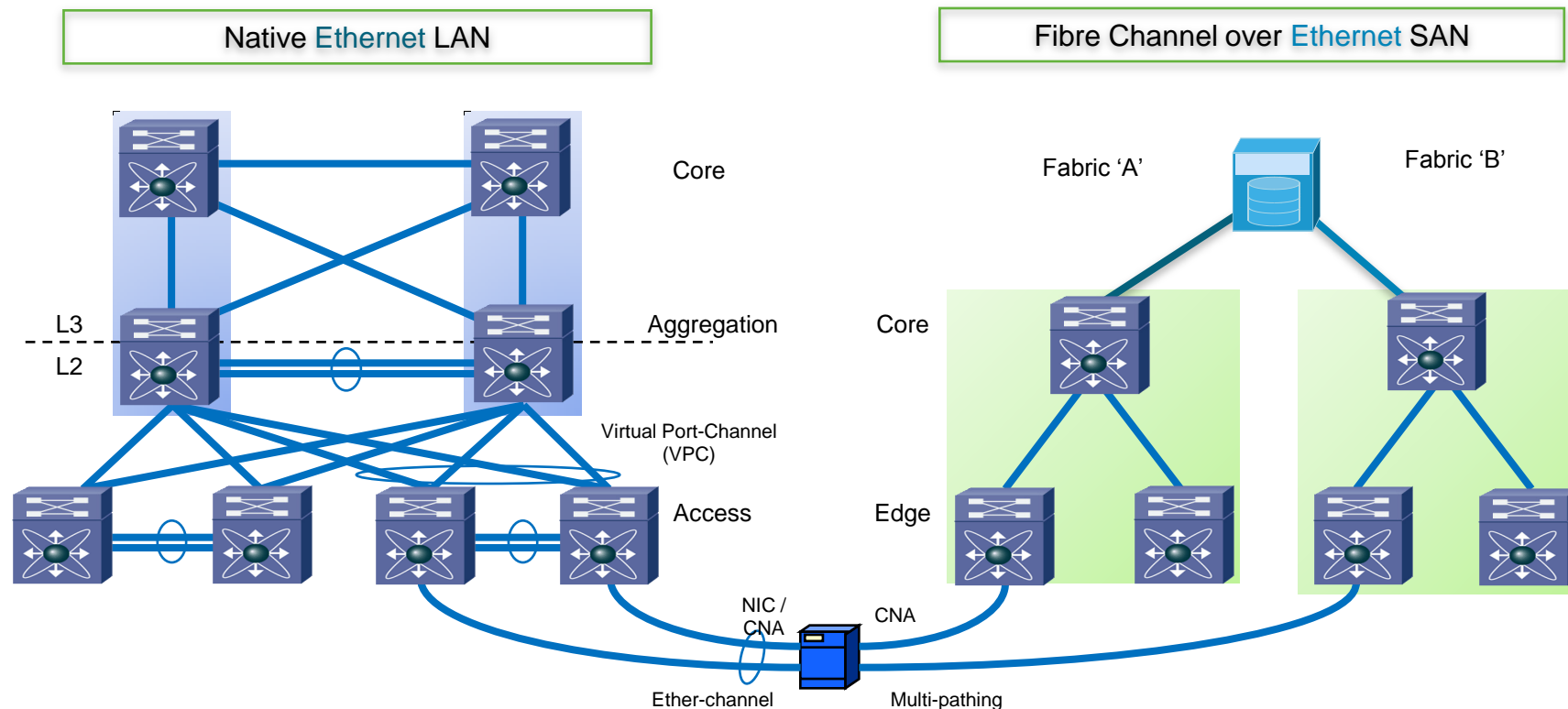


Benefits

- 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 of SAN's remains constant
- No Gateway

Unified Technology

- LAN and SAN networks share the same Unified I/O building blocks: switches and cabling
- Maintains operations, management and troubleshooting
- Takes advantage of the Ethernet Roadmap (10G→40G→100G)



Why FCoE?

- FCoE integrates with today's Fibre Channel SANs
- FCoE enables "Consolidation"
 - Enables LAN and SAN traffic to share wires/devices/adapters for access layer TCO benefits
- FCoE is based on Ethernet
 - Leverages Ethernet technology, investment, market presence, scaling capability
- FCoE invites more user choice
 - Aligns vendors from storage + network markets (e.g. volume NIC suppliers)
 - Benefit is more choice, better assurance of technology supply, price
- FCoE enables FC to become more accessible
 - FCoE going on motherboards = less cost and complexity vs. FC HBAs
 - O/S vendors will adopt with native FCoE stacks – less cost and complexity
- Because vendors can build better products with FCoE

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FCoE Building Blocks

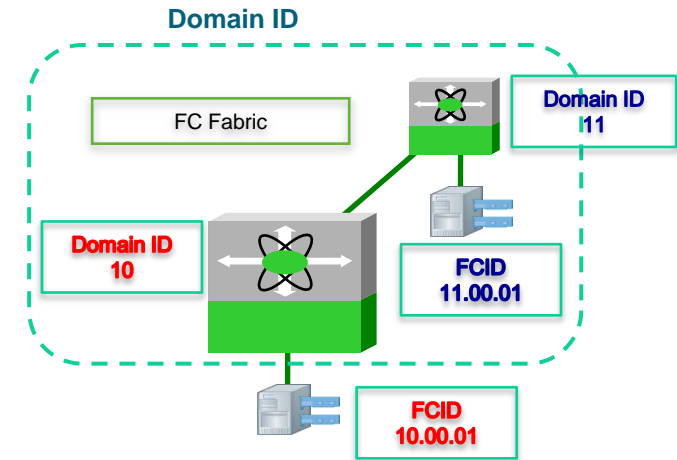
The Acronyms Defined

- **FCF** : Fibre Channel Forwarder (Nexus 5000, Nexus 7000, MDS)
- **FPMA** : A unique MAC address that is assigned by an **FCF** to a single **Enode**
- **Enode**: a Fiber Channel end node that is able to transmit FCoE frames using one or more **Enode** MACs.
- **FCoE Pass-Through** : a DCB device capable of passing FCoE frames to an FCF (i.e. FIP-Snooping)
 - **FIP Snooping Bridge**
- **Single hop FCoE** : running FCoE between the host and the first hop access level switch
- **Multi-hop FCoE** : the extension of FCoE beyond a single hop into the Aggregation and Core layers of the Data Centre Network

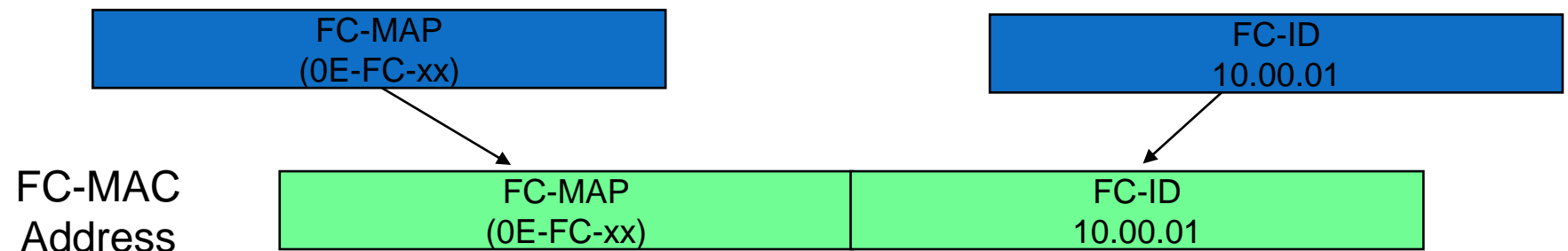
Enode MAC Address

Fibre Channel over Ethernet Addressing Scheme

- Enode FCoE MAC assigned for each FCID
- Enode FCoE MAC composed of a FC-MAP and FCID
 - FC-MAP is the upper 24 bits of the Enode's FCoE MAC
 - FCID is the lower 24 bits of the Enode's MAC
- FCoE forwarding decisions still made based on FSPF and the FCID within the Enode MAC



Fibre Channel FCID Addressing



Show fcoe

```

N5K2-60# show fcoe
FCF details for interface san-port-channel 200
  FCF-MAC is 00:0d:ec:a4:3b:87
  FC-MAP is 0e:fc:00
  FCF Priority is 128
  FKA Advertisement period for FCF is 8 seconds
N5K2-60# show fcoe database
  
```

INTERFACE	FCID	PORT NAME	MAC ADDRESS
vfc1	0x240101	21:00:00:c0:dd:0a:b8:df	00:c0:dd:0a:b8:df
vfc201	0x240100	21:00:00:c0:dd:12:04:f2	00:c0:dd:12:04:f2

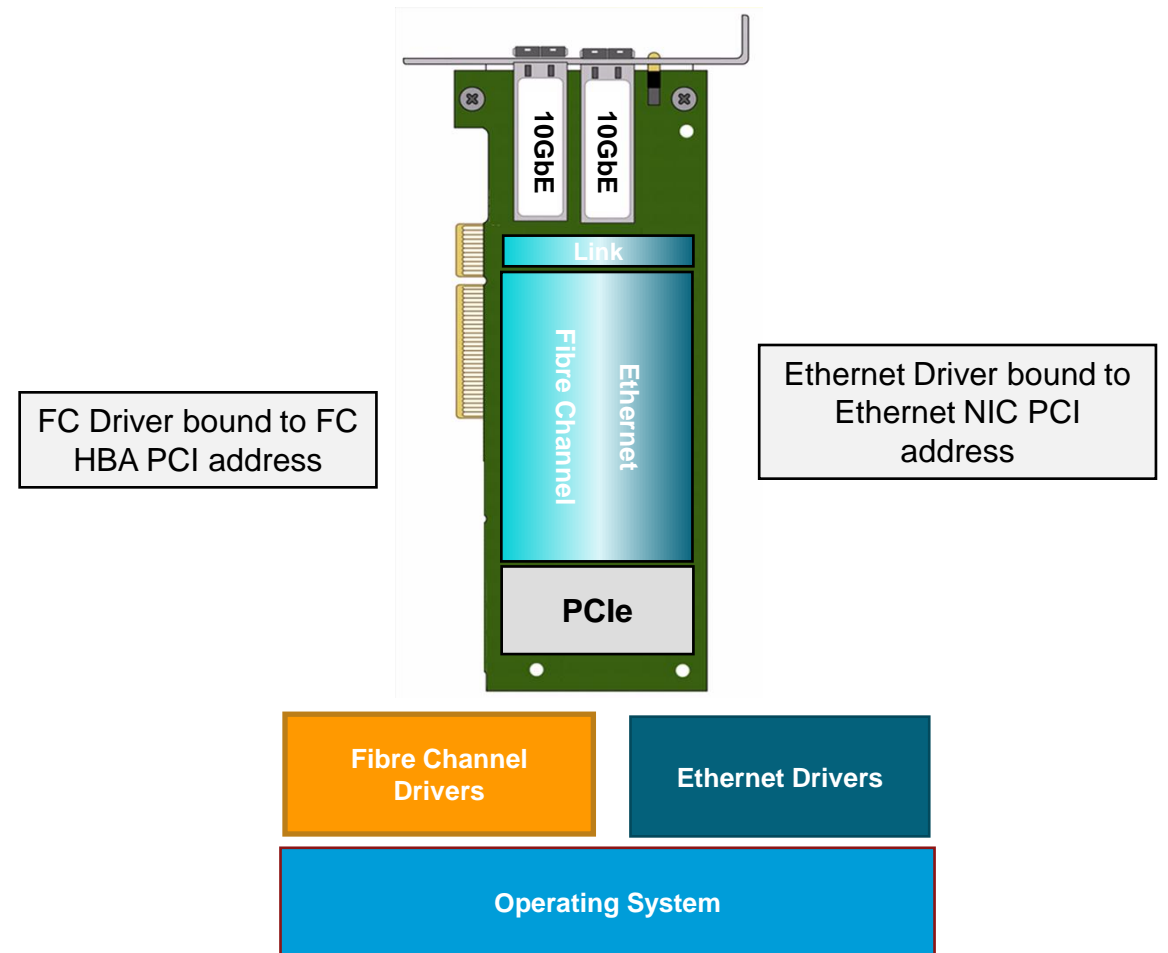
Qlogic SanSurfer output

The screenshot shows the Qlogic SanSurfer configuration page. The 'FCoE' tab is selected, and the 'Parameters' sub-tab is active. The 'ENode MAC Address' field is highlighted with a blue box and contains the value '00:C0:DD:12:04:F2', which corresponds to the MAC address for vfc201 in the terminal output above. The 'VN Port MAC Address' field is also highlighted with a blue box and contains two values: '0E:FC:00' and '24:01:00'. The '24:01:00' value corresponds to the FCID '0x240100' for vfc201. Other fields like 'Hostname', 'NBA Model', and 'HBA Port' are also visible.

FCoE Building Blocks

Converged Network Adapter

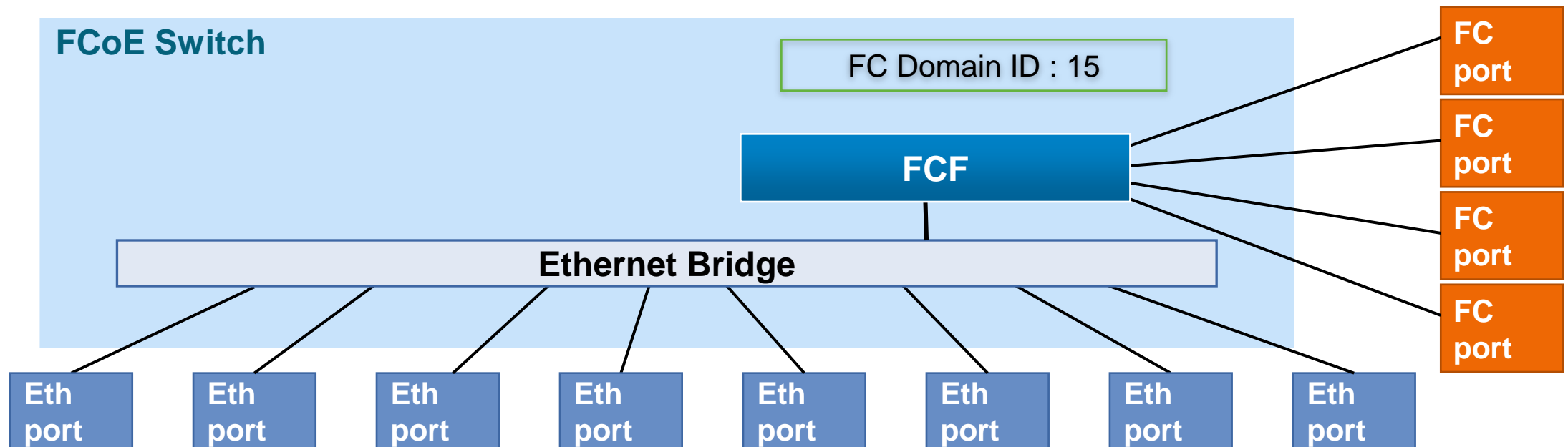
- Replaces multiple adapters per server, consolidating both Ethernet and FC on a single interface
- Appears to the operation system as individual interfaces (NICs and HBAs)
- First Generation CNAs from support **PFC** and **CIN-DCBX**
- Second Generation CNAs support **PFC**, **CEE-DCBX** as well as **FIP**
 - Single chip implementation
 - Half Height/Length
 - Half power consumption



FCoE Building Blocks

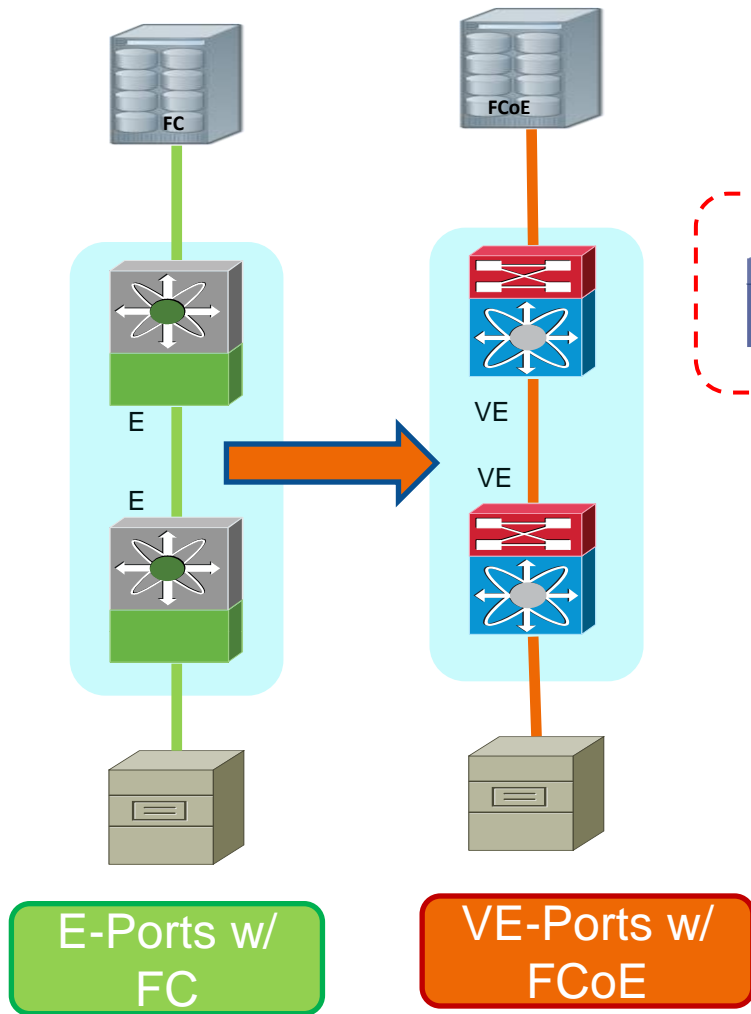
Fibre Channel Forwarder

- FCF (Fibre Channel Forwarder) is the Fibre Channel switching element inside an FCoE switch
 - Fibre Channel logins (FLOGIs) happens at the **FCF**
 - Consumes a **Domain ID**
- FCoE encap/decap happens within the **FCF**
 - Forwarding based on FC information

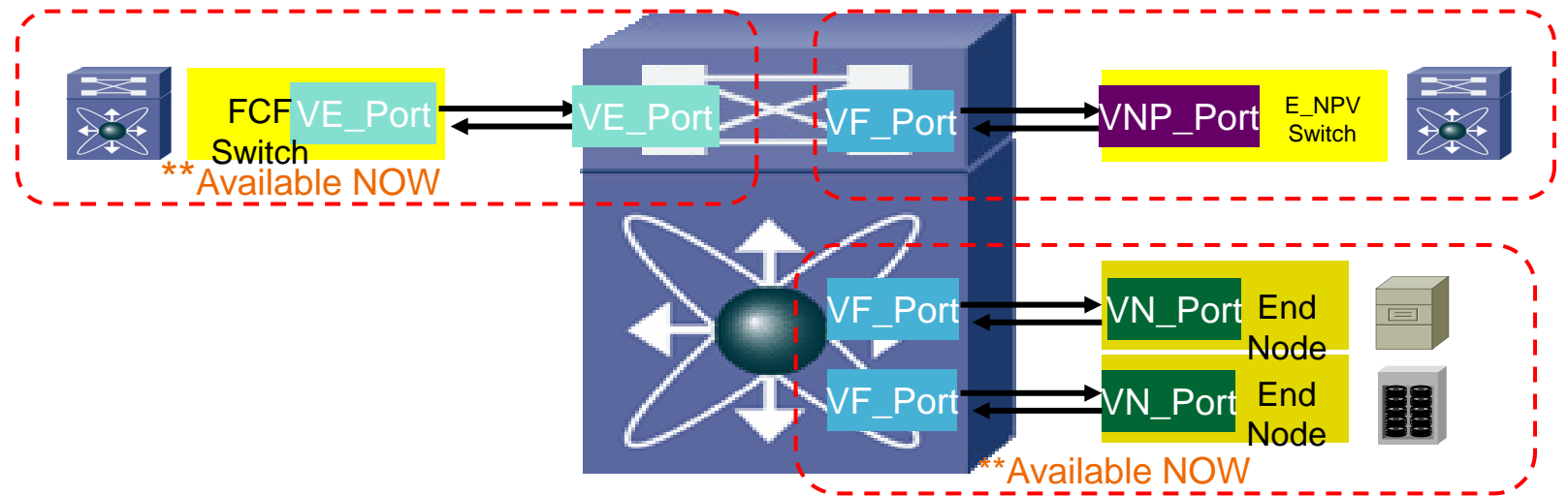


FCoE Building Blocks

FCoE Port Types



FibreChannel over Ethernet Switch



FCoE Switch : FCF

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Standards for I/O Consolidation

- Developed by IEEE 802.1 Data Center Bridging Task Group (DCB)
- All technically stable
- FC-BB-5 standards published by ANSI in May 2010 ->



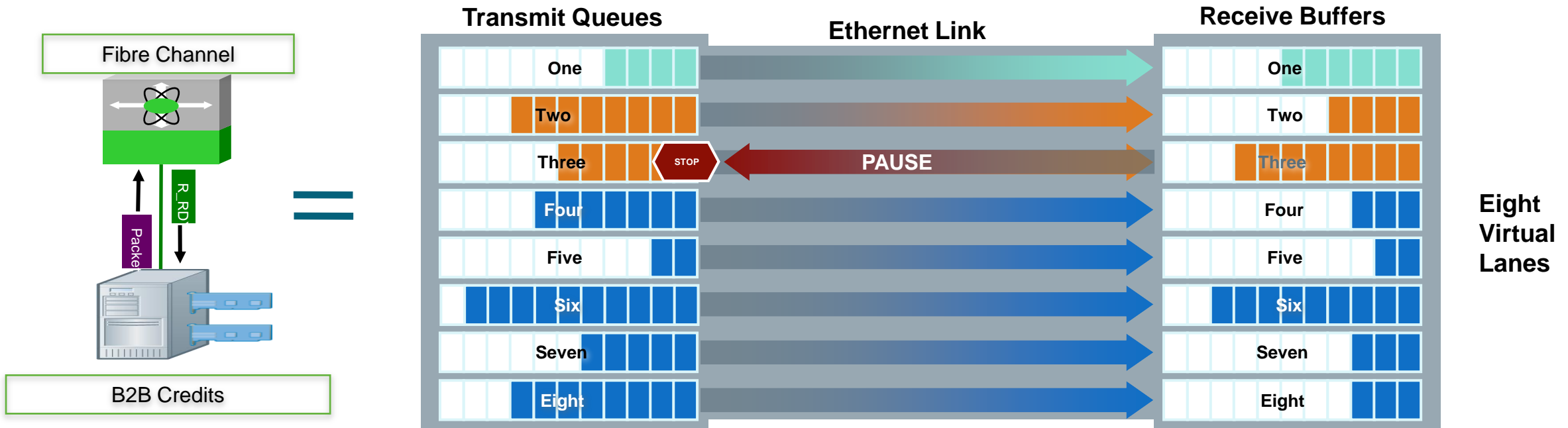
Standard / Feature	Status of the Standard
IEEE 802.1Qbb Priority-based Flow Control (PFC)	Passed Sponsor Ballot, awaiting publication
IEEE 802.3bd Frame Format for PFC	Passed Sponsor Ballot, awaiting publication
IEEE 802.1Qaz Enhanced Transmission Selection (ETS) and Data Center Bridging eXchange (DCBX)	Completed in July 2010 - Entering Sponsor Ballot
IEEE 802.1Qau Congestion Notification	Done!
IEEE 802.1Qbh Port Extender	In its first task group ballot

CEE (Converged Enhanced Ethernet) is an informal group of companies that submitted initial inputs to the DCB WGs.

Priority Flow Control

FCoE Flow Control Mechanism

- Enables lossless Ethernet using PAUSE based on a CoS as defined in 802.1p
- When link is congested, CoS assigned to “no-drop” will be PAUSED
- Other traffic assigned to other CoS values will continue to transmit and rely on upper layer protocols for retransmission
- Not only for FCoE traffic



Priority Flow Control

Operations Configuration – Switch Level

- Once **feature fcoe** is configured, 2 classes are made **by default**

```
policy-map type qos default-in-policy
  class type qos class-fcoe
    set qos-group 1
  class type qos class-default
    set qos-group 0
```

- class-fcoe** is configured to be **no-drop** with an MTU of 2158

```
class type network-qos class-fcoe
  pause no-drop
  mtu 2158
```

- Best Practice** - use the default COS value of **3** for **FCoE/no-drop** traffic
- Can be changed through QOS class-map configuration

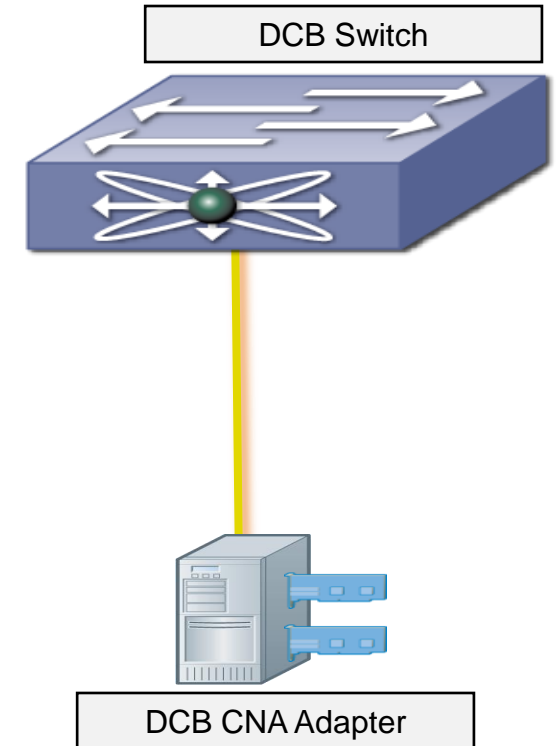
```
N5K# show class-map
```

```
Type qos class-maps
```

```
=====
```

```
class-map type qos match-any class-fcoe
  match cos 3
```

```
class-map type qos match-any class-default
  match any
```




Priority Flow Control

Changing PFC Settings

- Create classification rules first by defining and applying **policy-map type qos**

```
N5010-2(config)# class-map type qos class-lossless
N5010-2(config-cmap-qos)# match cos 4
N5010-2(config-cmap-qos)# policy-map type qos policy-lossless
N5010-2(config-pmap-qos)# class type qos class-lossless
N5010-2(config-pmap-c-qos)# set qos-group 4
N5010-2(config-pmap-uf)# system qos
N5010-2(config-sys-qos)# service-policy type qos input policy-lossless
```

DCBX protocol to negotiate PFC
for priority 4



- Define and apply **policy-map type network-qos**

```
N5010-2(config-pmap-qos)# class type network-qos policy-lossless
N5010-2(config-cmap-uf)# match qos-group 4
N5010-2(config-cmap-uf)# policy-map type network-qos policy-lossless
N5010-2(config-pmap-uf)# class type network-qos class-lossless
N5010-2(config-pmap-uf-c)# pause no-drop
N5010-2(config-pmap-uf)# system qos
N5010-2(config-sys-qos)# service-policy type network-qos policy-lossless
```

Priority Flow Control

Verifying Configurations

```
N5K1# show interface priority-flow-control
```

```
=====
Port                Mode Oper (VL bmap)  RxPPP  TxPPP
=====
Ethernet1/1        Auto On   (8)      0      0
Ethernet1/2        Auto On   (8)      0      0
Ethernet1/3        Auto On   (8)      0      0
Ethernet1/4        Auto Off          0      0
Ethernet1/5        Auto Off          0      0
Ethernet1/6        Auto Off          0      0
Ethernet1/7        Auto On   (8)      0      0
Ethernet1/8        Auto Off          0      0
```

show interface priority-flow-control

Shows ports where PFC is configured, the COS value associated with PFC as well as the PAUSE packets received and sent on that port

Checking the PFC settings on an interface

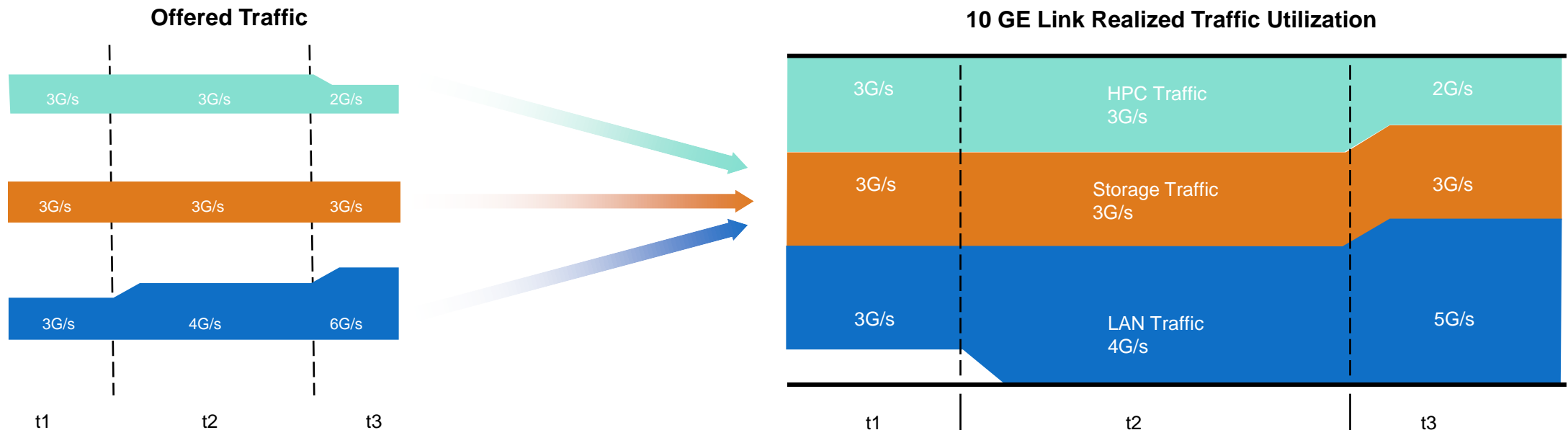
VL bmap = COS set for PFC

VL bmap	Binary	COS
1	00000001	0
2	00000010	1
4	00000100	2
8	00001000	3
16	00010000	4
32	00100000	5
64	01000000	6
128	10000000	7

Enhanced Transmission Selection

Bandwidth Management

- Prevents a single traffic class of “hogging” all the bandwidth and starving other classes
- When a given load doesn’t fully utilize its allocated bandwidth, it is available to other classes
- Helps accommodate for classes of a “bursty” nature



Enhanced Transmission Selection

Bandwidth Management

- Once **feature fcoe** is configured, 2 classes are made **by default**
- By default, each class is given **50%** of the available bandwidth

```
N5K1# show queuing interface ethernet 1/13
```

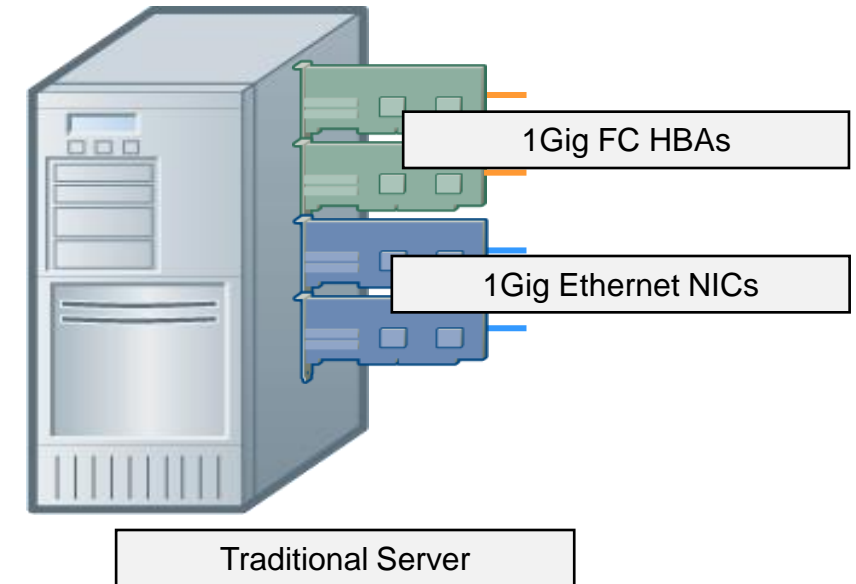
```
Ethernet1/13 queuing information:
```

```
TX Queuing
```

```
qos-group sched-type oper-bandwidth
```

```
0 WRR 50
```

```
1 WRR 50
```



A typical server has equal BW per traffic type

- Can be changed through QoS settings when higher demands for certain traffic exist (i.e. HPC traffic, more Ethernet NICs)

Enhanced Transmission Selection

Changing ETS Bandwidth Configurations

- Create classification rules first by defining and applying **policy-map type qos**
- Define and apply **policy-map type queuing** to configure strict priority and bandwidth sharing

```
N5010-2(config)# class-map type queuing class-voice
N5010-2(config-cmap-que)# match qos-group 2
N5010-2(config-cmap-que)# class-map type queuing class-high
N5010-2(config-cmap-que)# match qos-group 3
N5010-2(config-cmap-que)# class-map type queuing class-low
N5010-2(config-cmap-que)# match qos-group 4
N5010-2(config-cmap-que)# exit
N5010-2(config)# policy-map type queuing policy-BW
N5010-2(config-pmap-que)# class type queuing class-voice
N5010-2(config-pmap-c-que)# priority
N5010-2(config-pmap-c-que)# class type queuing class-high
N5010-2(config-pmap-c-que)# bandwidth percent 50
N5010-2(config-pmap-c-que)# class type queuing class-low
N5010-2(config-pmap-c-que)# bandwidth percent 20
N5010-2(config-pmap-c-que)# class type queuing class-fcoe
N5010-2(config-pmap-c-que)# bandwidth percent 30
N5010-2(config-pmap-c-que)# class type queuing class-default
N5010-2(config-pmap-c-que)# bandwidth percent 0
N5010-2(config-pmap-c-que)# system qos
N5010-2(config-sys-qos)# service-policy type queuing output policy-BW
N5010-2(config-sys-qos)#
```

← FCoE Traffic given 30% of the 10GE link

Data Center Bridging eXchange

Control Protocol – the “handshake”

- Negotiates Ethernet capability's – PFC, ETS, CoS values between peer devices
- Simplifies management of DCB nodes
 - Allows for configuration and distribution of parameters from one node to another
- Responsible for Logical Link Up/Down signaling of Ethernet and Fibre Channel
- Uses Link Layer Discovery Protocol (LLDP) defined by 802.1AB to exchange and discover DCB capabilities
- DCBX negotiation failures result in:
 - per-priority-pause not enabled on CoS values
 - vfc not coming up – when DCBX is being used in FCoE environment



Polling Question 2

What are your plans related to adoption of the FCoE technologies?

- a) Currently using
- b) In Initial deployment or active planning of deployment
- c) Researching or considering
- d) Aware of the protocol
- e) Not aware of the protocol

Poll Response

What are your plans related to adoption of the FCoE technologies?

Currently using



In initial deployment or active planning of deployment



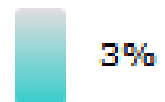
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Understanding FCoE

Fibre Channel is to FCoE...

as



is to



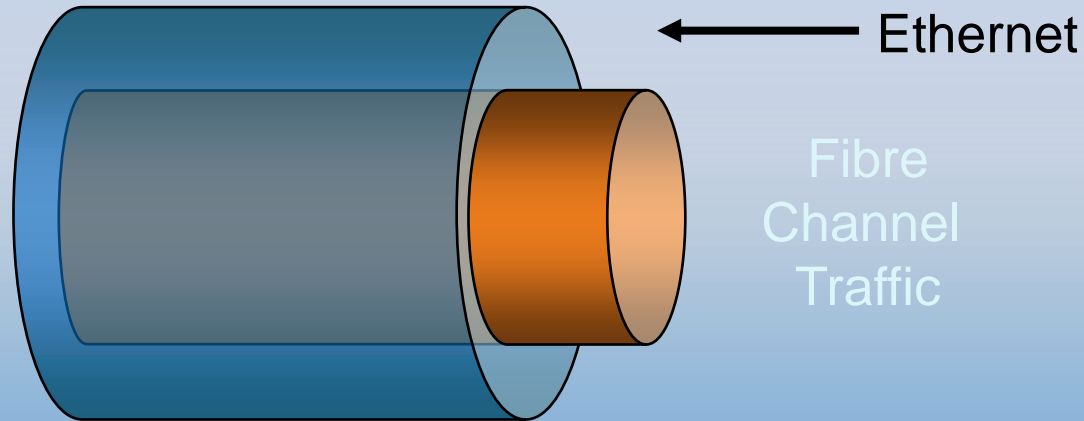
Fiber Channel over Ethernet

FC-BB-5 Protocol



FCoE

Mapping of FC Frames over Ethernet



- ➔ Completely based on the FC model
- ➔ Same host-to-switch and switch-to-switch behavior as FC
- ➔ WWNs, FC-IDs, hard/soft zoning, DNS, RSCN

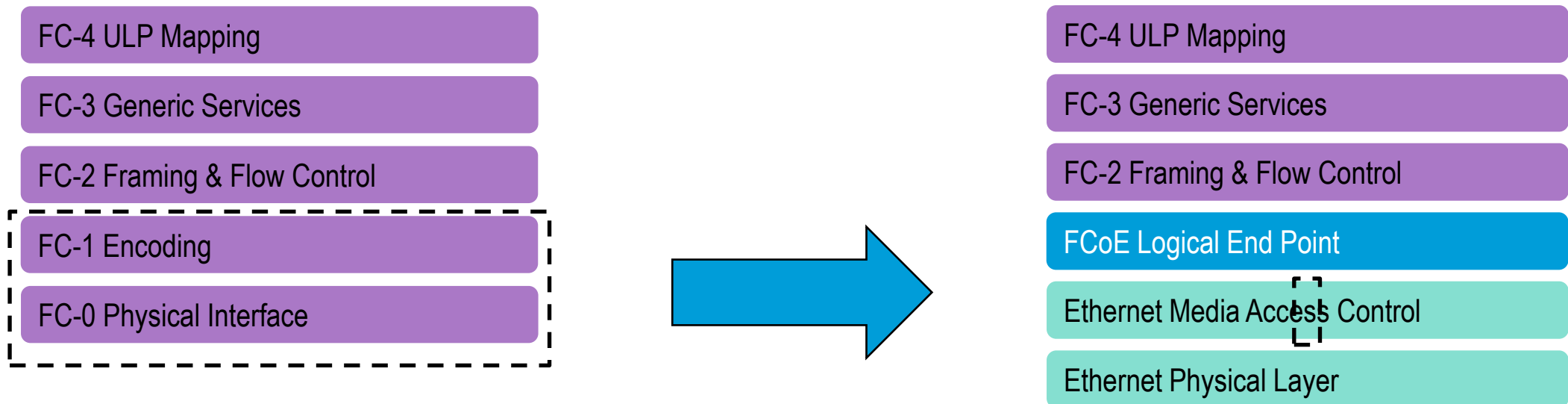
FCoE is Fibre Channel

Cisco	Dell	EMC ²	EMULEX
HP	IBM	Microsoft	NetApp
Intel	QLOGIC	Redhat	VMWARE

Fiber Channel over Ethernet

Protocol Mapping

- From a Fibre Channel standpoint it's
FC connectivity over a new type of cable called... Ethernet
- From an Ethernet standpoints it's
Yet another ULP (Upper Layer Protocol) to be transported



Fiber Channel over Ethernet

Data and Control plane

FCoE is really two different protocols:

FCoE itself

- Is the data plane protocol
- It is used to carry most of the FC frames and all the SCSI traffic
- Uses Fabric Assigned MAC address (dynamic)

FIP (FCoE Initialization Protocol)

- It is the control plane protocol
- It is used to discover the FC entities connected to an Ethernet cloud
- It is also used to login to and logout from the FC fabric

Both Protocols Have...

- Two different Ethertypes FIP 0x8914 , FCOE 0x8906
- Two different frame formats
- Both are defined in FC-BB-5

Fiber Channel over Ethernet Protocol

FCoE Initialization Protocol (FIP)

- Step 1: FCoE VLAN Discovery

FIP sends out a multicast to ALL_FCF_MAC address looking for the FCoE VLAN

FIP frames use the native VLAN

- Step 2: FCF Discovery

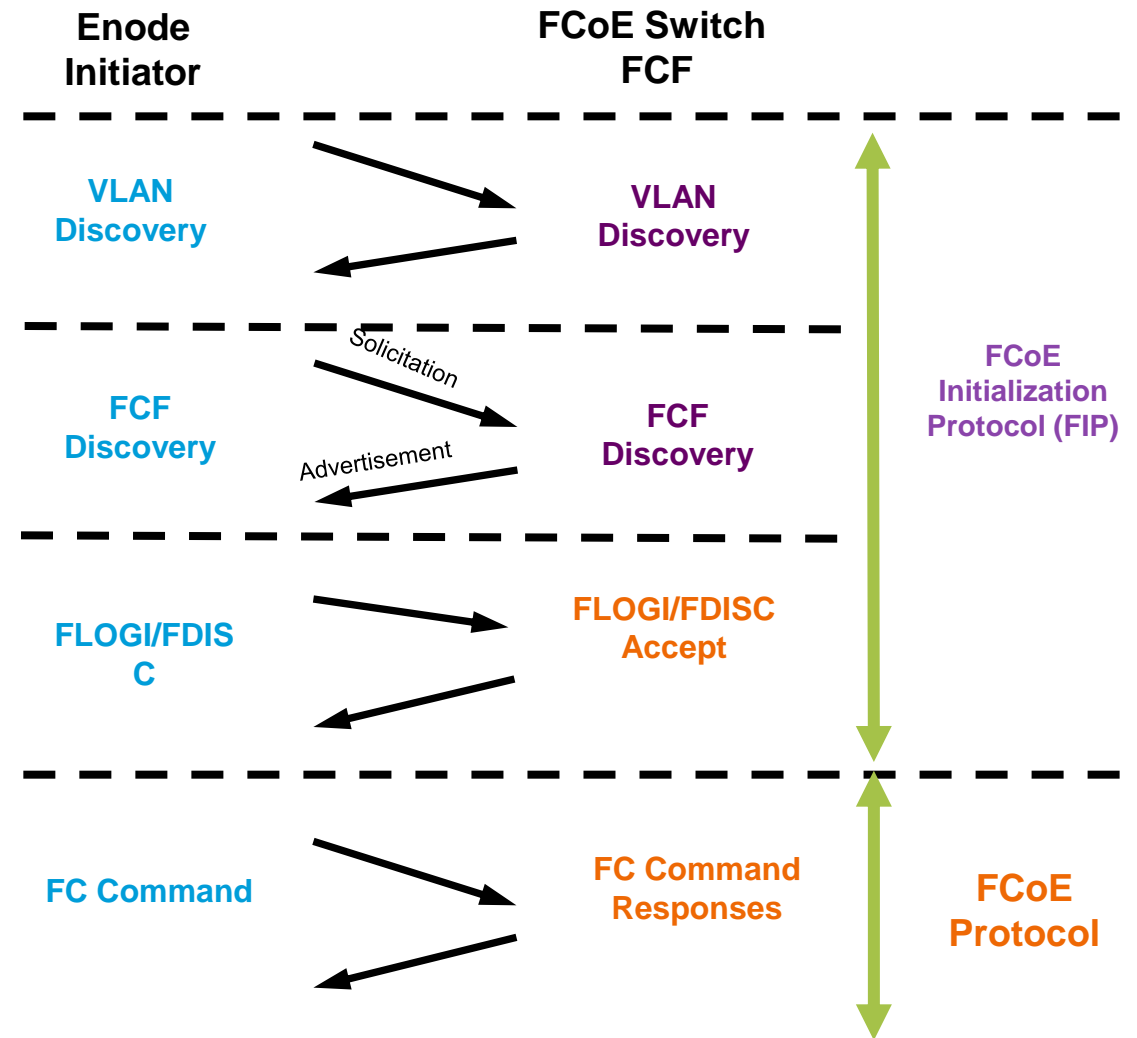
FIP sends out a multicast to the ALL_FCF_MAC address on the FCoE VLAN to find the FCFs answering for that FCoE VLAN

FCF's responds back with their MAC address

- Step 3: Fabric Login

FIP sends a FLOGI request to the FCF_MAC found in Step 2

Establishes a virtual link between host and FCF

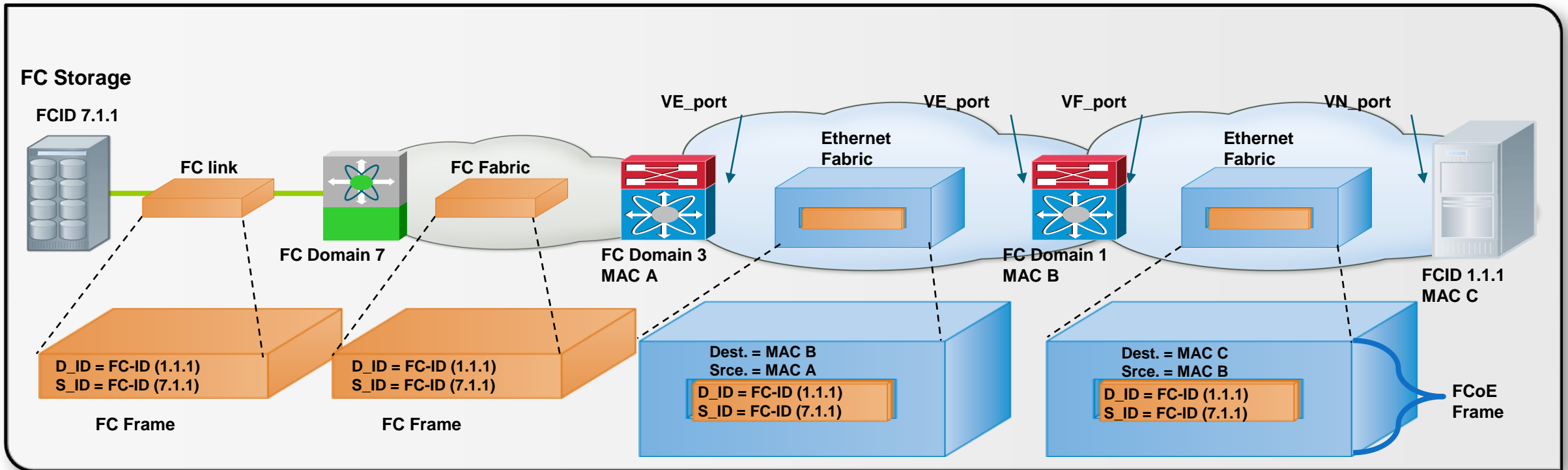


** FIP does not carry any Fibre Channel frames

FCoE Addressing and Forwarding

FCF

- Intermediate switches in the Ethernet cloud
 - All are Fibre Channel Aware
- FCoE frames have:
 - MAC addresses (hop-by-hop)
 - FC addresses (end-to-end)



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The Design Requirements

Ethernet vs Fibre Channel

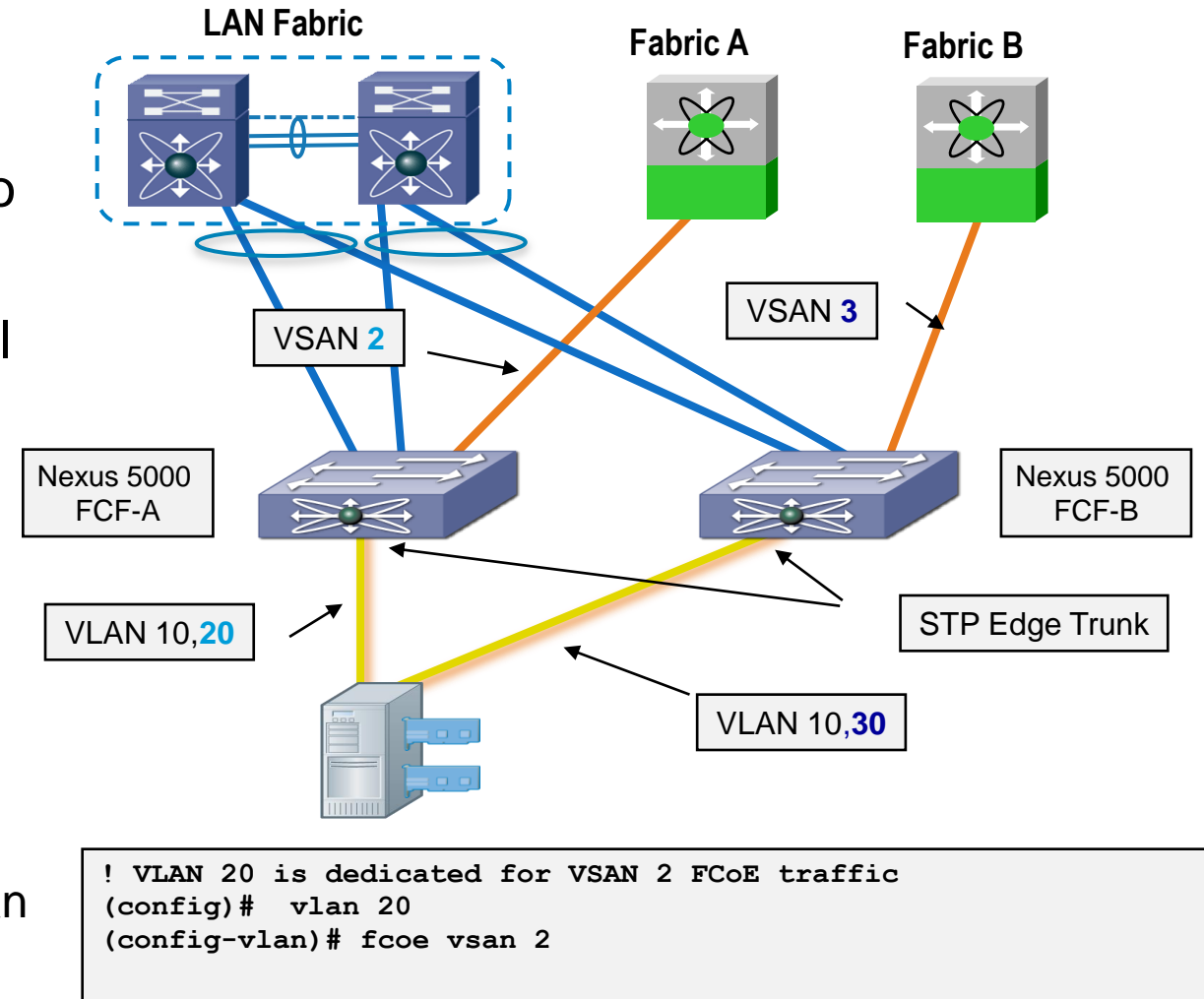
- Ethernet is non-deterministic.
 - Flow control is destination-based
 - Relies on TCP drop-retransmission / sliding window
- Fibre-Channel is deterministic.
 - Flow control is source-based (B2B credits)
 - Services are fabric integrated (no loop concept)



Single Hop Design

The FCoE VLAN

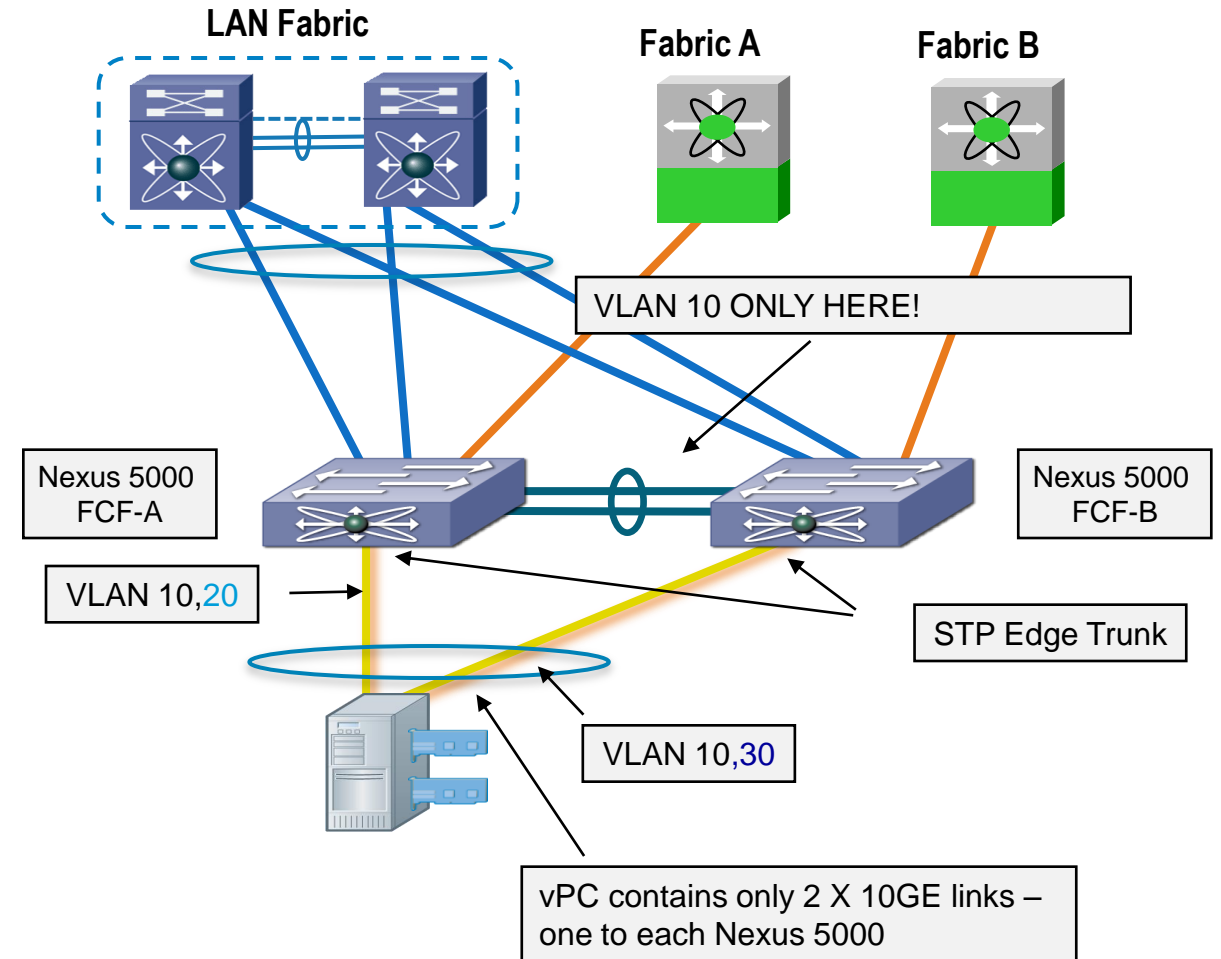
- A VLAN is dedicated for every VSAN in the fabric
- FIP discovers the FCoE VLAN and signals it to the hosts
- Trunking is **not** required on the host driver – all FCoE frames are tagged by the **CNA**
- FCoE VLANs must **not** be configured on Ethernet links that are **not** designate for FCoE
- Maintains isolated edge switches for SAN 'A' and 'B' and separate LAN switches for NIC 1 and NIC 2 (standard NIC teaming)
- In order to maintain the integrity of FC forwarding over FCoE, FCoE VLANs are treated differently than LAN VLANs
 - No flooding, MAC learning, broadcasts, etc.



Single Hop Design

Unified Wires and MCEC

- vPC enabled topologies with FCoE must follow specific design and forwarding rules
- With the NX-OS 4.1(3) releases a 'vfc' interface can only be associated with a vPC which has a single [**one (1)**] CNA port attached to each edge switch
- While the port-channel is the same on N5K-1 and N5K-2, **the FCoE VLANs are different**
- vPC configuration works with Gen-2 FIP enabled CNAs **ONLY**
- FCoE VLANs are '**not**' carried on the vPC peer-link
- FCoE and FIP ethertypes are '**not**' forwarded over the vPC peer link



Direct Attach vPC Topology

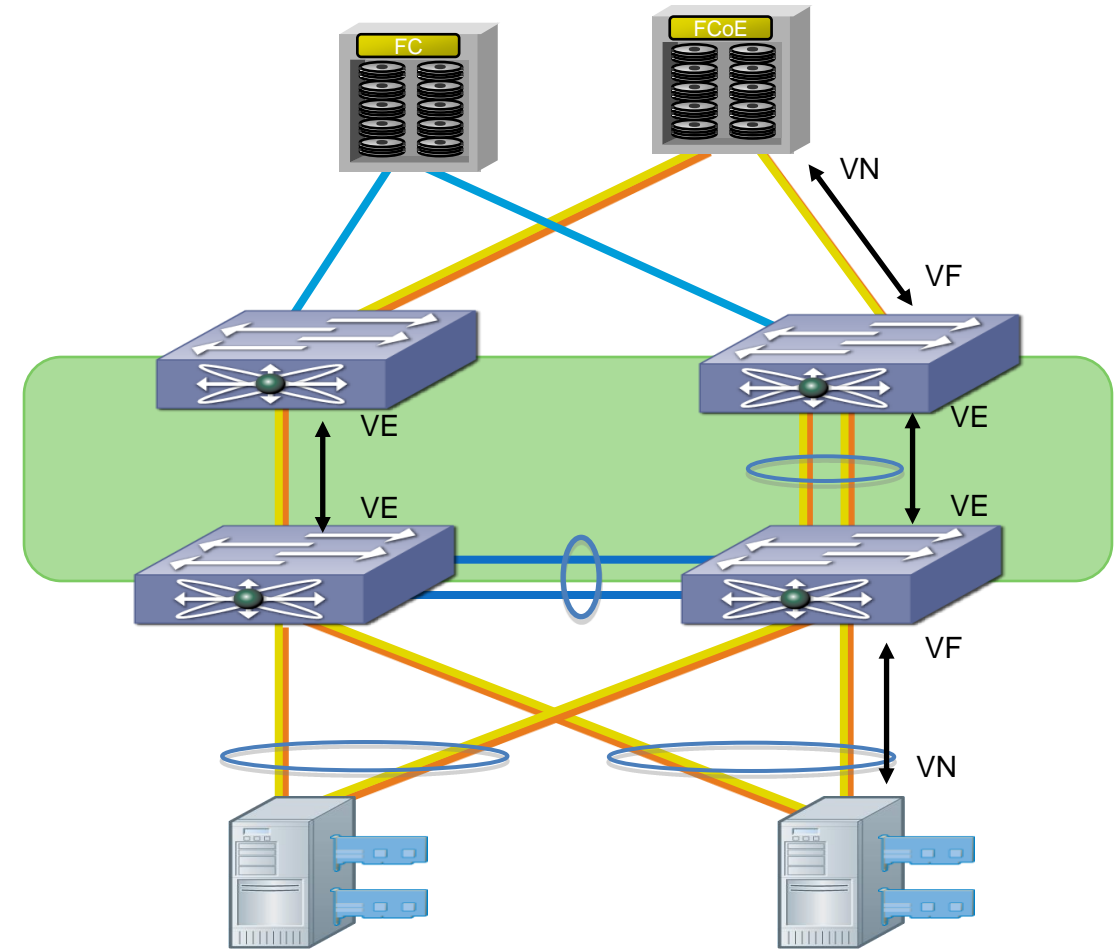
FCoE Multi-Tier Fabric Design

Using VE_Ports

Supported Topologies

- With NX-OS 5.0(2)N2, VE_Ports are supported on/between the Nexus 5000 and Nexus 5500 Series Switches
- VE_Ports run between switches acting as Fibre Channel Forwarders (FCFs)
- VE_Ports are bound to the underlying 10G infrastructure
 - VE_Ports can be bound to a single 10GE port
 - VE_Ports can be bound to a port-channel interface consisting of multiple 10GE links

Supported distance for FCoE in NX-OS 5.0(2)N2 is up to 3Km by tuning 'no-drop' class buffer size and thresholds (on both N5020 and N5548)



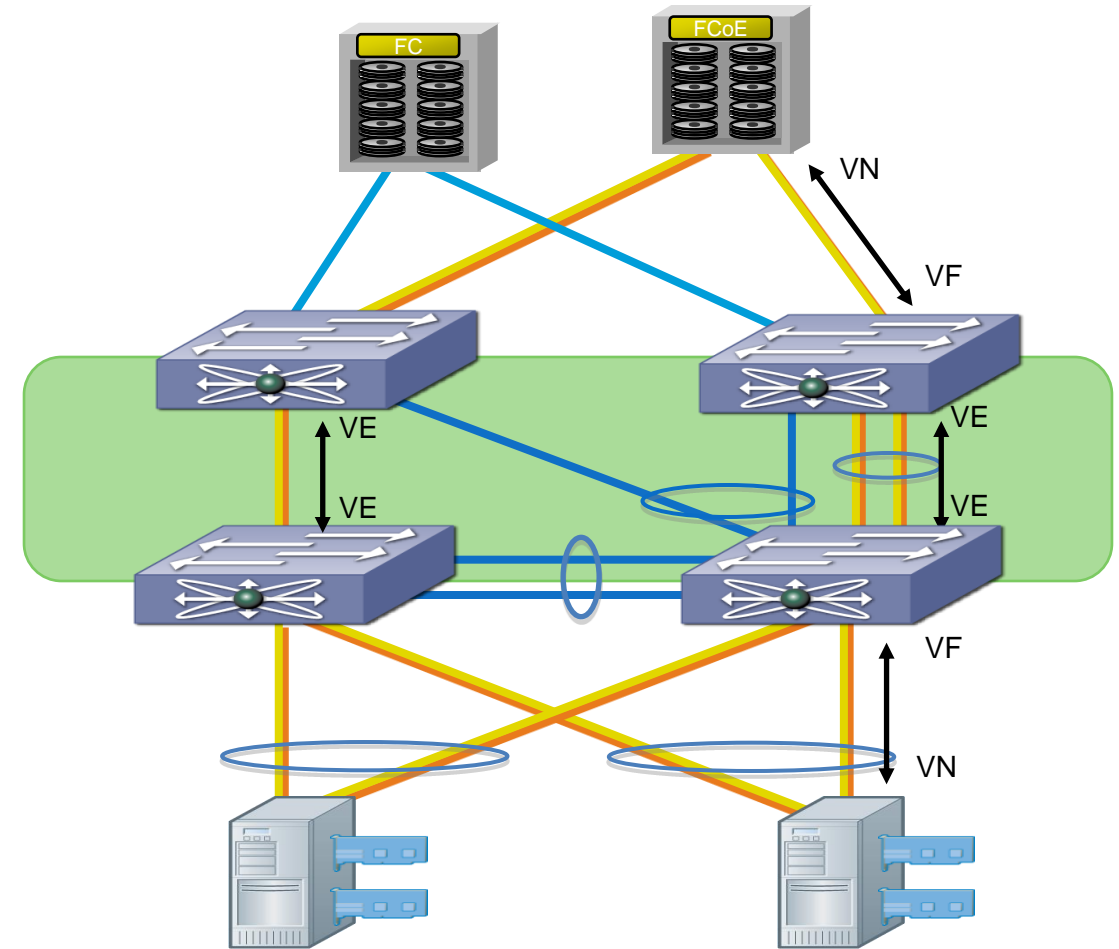
All above switches are Nexus 5X00 Series acting as an FCF

FCoE Multi-Tier Fabric Design

VE_Ports in vPC Topologies

Supported Topologies

- Just like earlier releases in NX-OS 5.0(2)N2 release, FCoE is NOT supported over virtual Port-Channels (vPC). This includes VE_Ports.
- In topologies that use vPCs for Ethernet traffic, separate dedicate links are required to carry FCoE traffic:
 - Ethernet VLANs would be carried on the vPC
 - FCoE only VLANs would be carried on the VE_Ports
- FCoE VLANs must NOT be configured on the inter-switch vPC interfaces



All above switches are Nexus 5X00 Series acting as an FCF

So Remember...

- All “Unified” options are important and have different places within the Data Center Network
- FCoE offers a more flexible and cheaper deployment option over Fibre Channel
- FCoE IS Fibre Channel
- Multi-hop FCoE extends the FCoE fabric beyond the access
- Cisco offers end-to-end FCoE solution with Nexus platform

Polling Question 3

What is your primary motivation for interest in FCoE?

- a) SAN/LAN network convergence
- b) Management/operations cost reduction
- c) Benefits related to server virtualization deployments
- d) Reduction of data center cabling
- e) Simplified server side networking
- f) Ease of migration from pure fibre channel environment

Poll Response

What is your primary motivation for interest in FCoE?

SAN/LAN network convergence



Management/operations cost reduction



Benefits related to server virtualization deployments



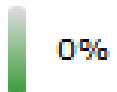
Reduction of data center cabling



Simplified server side networking



Ease of migration from pure fibre channel environment





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Q&A

We Appreciate Your Feedback!

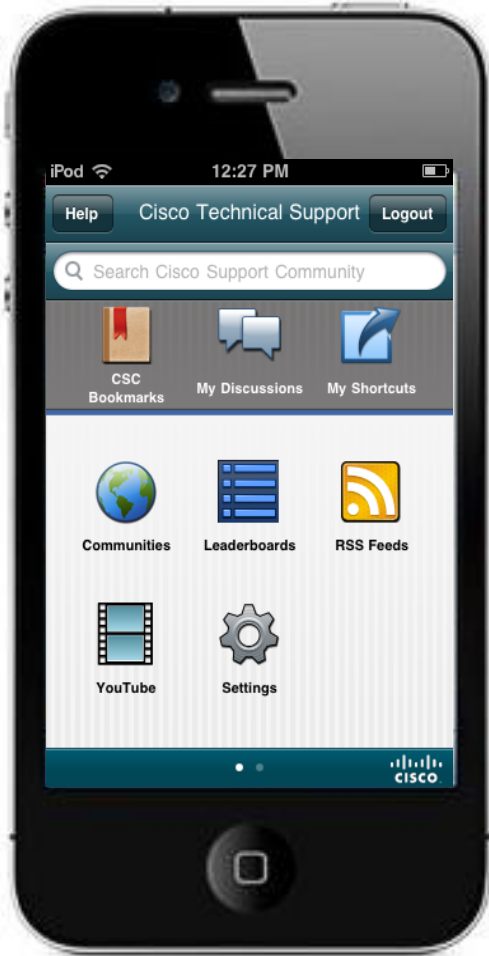
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Some Useful FCoE Links

Unified Fabric

<http://www.cisco.com/en/US/netsol/ns945/index.html>

Fibre Channel over Ethernet (FCoE)

<http://www.cisco.com/go/fcoe>

IEEE 802.1 Data Center Bridging – White Papers

<http://www.cisco.com/en/US/netsol/ns783/index.html>

<http://www.fcoe.com> & FC-BB-5 Standard <http://www.fcoe.com/09-056v5.pdf>

“I/O Consolidation in the Data Center” by Silvano Gai, Claudio DeSanti

<http://www.ciscopress.com/bookstore/product.asp?isbn=158705888X>

Nexus 5000 Troubleshooting Guide

http://www.cisco.com/en/US/partner/docs/switches/datacenter/nexus5000/sw/troubleshooting/guide/N5K_Troubleshooting_Guide.html

Post Questions on Our Forum Here:

<https://supportforums.cisco.com/community/netpro/network-infrastructure/routing>



Thank You for Your Time

Please Take a Moment to Complete the Evaluation





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