



Configuring FCoE Services on Lenovo Networking Switches

**Review the basics of Fibre
Channel over Ethernet**

Configure FCoE on Lenovo switches

**Understand supported FCoE
topologies**

**Understand the benefits of converged
networking including FCoE**

Scott Lorditch



Abstract

This Lenovo Press paper presents an introduction to the use of Fibre Channel over Ethernet (FCoE) on Lenovo Networking switches. One key benefit of deploying FCoE is the network becomes physically easier to manage because a single wiring plant with a single server adapter can provide both SAN and LAN functionality. This paper is intended as a brief reference for network engineers and administrators as an introduction to FCoE and its use on Lenovo products.

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Introduction

This paper presents an introduction to the use of FCoE on Lenovo® Networking switches. It is intended as a brief reference for network engineers and administrators, but not as a substitute for the complete documentation of the switches.

The paper covers the following:

- ▶ FCoE Concepts Introduction/Review
- ▶ FCoE Configuration on Lenovo Switches
- ▶ Supported Connectivity options
- ▶ Notes on configuration of the Emulex adapters
- ▶ FCoE Configuration example
- ▶ Troubleshooting, constraints, and issues with FCoE

FCoE concepts review

Fibre Channel over Ethernet (FCoE) is a technology to integrate LAN (Ethernet) networks and SAN (Fibre Channel) networks into a single converged physical network. FCoE is a data-center technology. One key benefit of deploying FCoE is the network becomes physically easier to manage because a single wiring plant with a single server adapter can provide both SAN and LAN functionality.

Figure 1 shows how storage and IP traffic flow over the same network when FCoE is used.

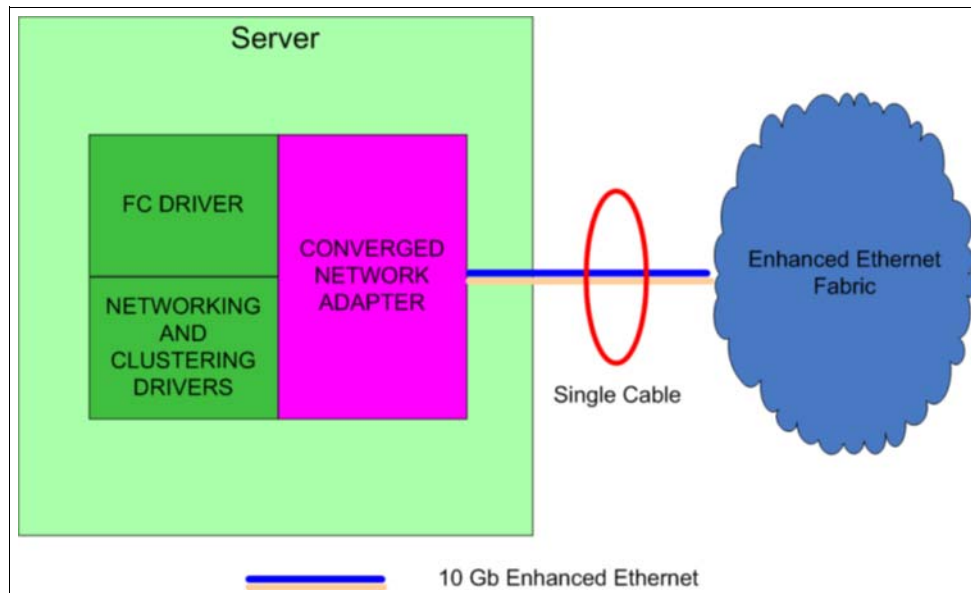


Figure 1 FCoE big picture

From a functional standpoint, FCoE encapsulates FC frames inside Ethernet frames as shown in Figure 2 on page 4.

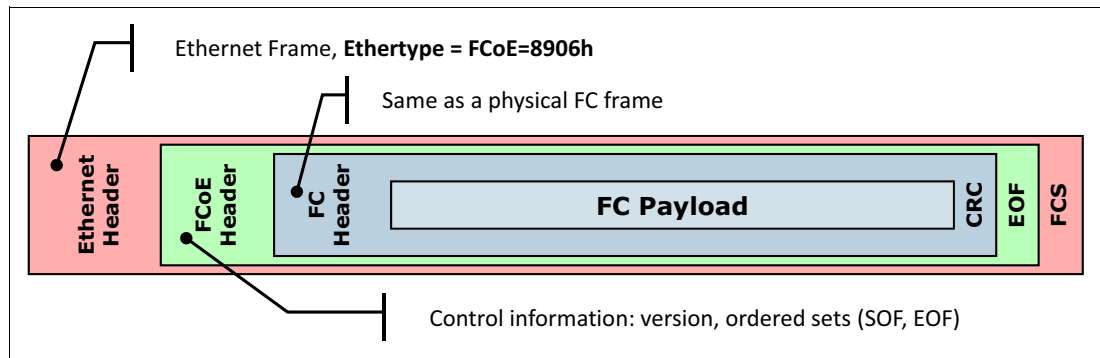


Figure 2 Encapsulation

In most instances a gateway known as an FCF (Fibre Channel Forwarder) is deployed to allow the integration of existing FC storage and SAN environments. Note that FCoE is not a Layer 3 routable protocol, which makes it different from other converged storage protocols such as iFCP, FCIP and iSCSI.

Historically the following key differences between LAN and SAN networks made their convergence problematic:

- ▶ SAN networks do not tolerate packets arriving out of sequence.
- ▶ SAN networks do not have a retransmission mechanism similar to TCP and therefore cannot tolerate dropped packets.

Standards have been developed known as Converged Enhanced Ethernet (CEE) and by other names including “lossless Ethernet” which allow these issues to be handled. Two key standards incorporated within CEE are priority flow control (PFC) and Enhanced Transmission Selection (ETS).

Priority Flow Control

Priority Flow Control (PFC) takes the concept of a pause frame, used in the existing flow control standard, and instead of pausing an entire link it allows only a specific priority of packets (priority queue 3 is used by FCoE) to be paused. This serves to either slow down FCoE traffic so it doesn’t exceed the capacity of the receiver or slow down other traffic to allow FCoE traffic to flow.

The PFC concept is shown in Figure 3.

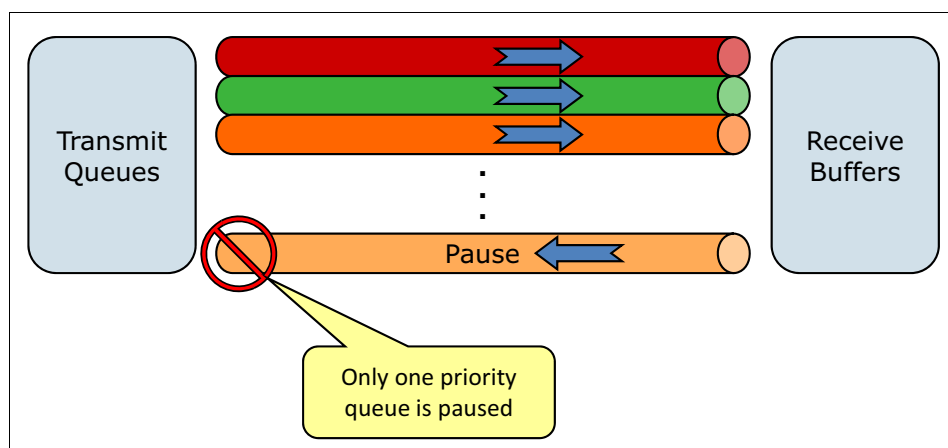


Figure 3 Priority Flow Control

Enhanced Transmission Selection

Enhanced Transmission Selection (ETS) is a prioritization scheme which allows different categories of traffic to be guaranteed a configurable percentage of the bandwidth of a link. This serves to ensure sufficient bandwidth is available for FCoE traffic.

With ETS in use each category of traffic can have a minimum amount of bandwidth dedicated to it. This is shown in Figure 4 on page 5.

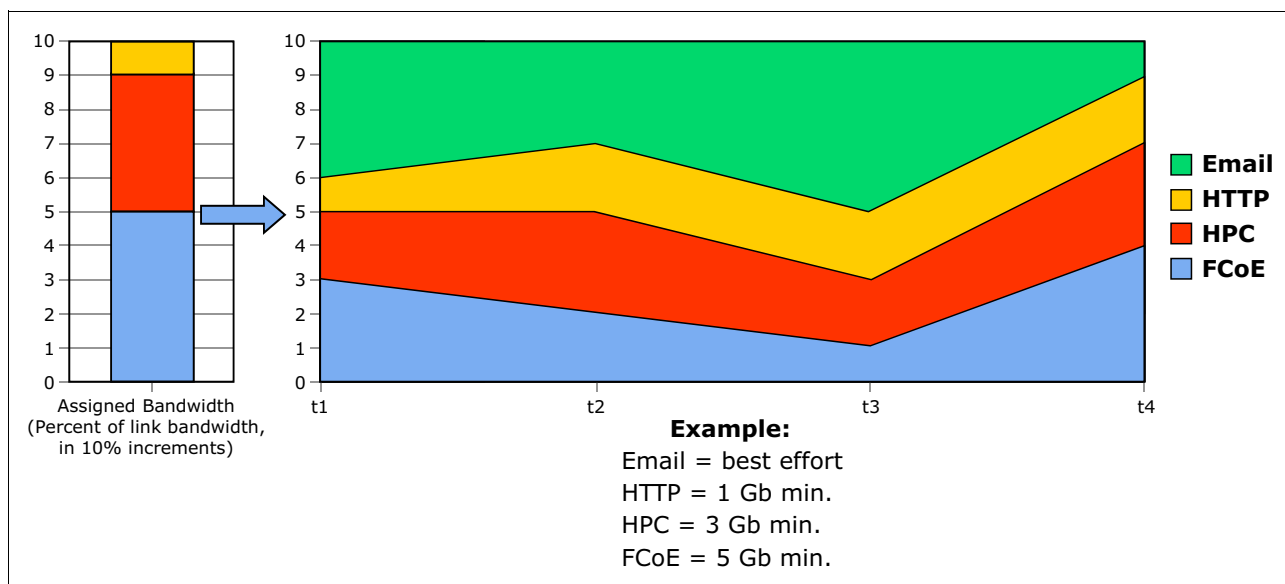


Figure 4 Enhanced Transmission Selection

Current Lenovo Networking products support FCoE in two different ways:

- ▶ A number of Lenovo Networking Ethernet switches at 10Gb and higher can act as FCoE "transit" switches. These switches do not have FC ports and do not include the FCF function. Instead, they sit between a server with a converged network adapter and an upstream switch which does have these functions. These transit switches are sufficiently aware of FCoE to implement the CEE standards for FCoE traffic and the FCoE Initialization Protocol (FIP Snooping) which is necessary to establish an FCoE session.

The following RackSwitch™ offerings provide this support: G8124E, G8264, G8272, G8296, G8316, G8332; in addition the Flex System™ EN4093 and the two interconnects SI4091 and SI4093.

- ▶ Lenovo also offers converged switches, which have ports that are software configurable to be FC ports or Ethernet ports and which can function as FCFs. These switches also include the “transit” function noted earlier. Switches in this category include the RackSwitch G8264CS and Flex System CN4093. In addition to providing full FC switching functionality, they can also act in NPV mode (N-Port Virtualization, also known as transparent mode) as a tributary to an existing SAN switch.

FCF function: MAC and WWN

One of the key functions of a FCF gateway is to deal with the different addressing schemes used by Ethernet and Fibre Channel. Ethernet uses 48-bit MAC addresses, while FC uses 64-bit World Wide Names. Both are typically provided in the hardware and designed to ensure uniqueness. There are also ways to override the burned-in addresses for both MACs and WWNs.

FCFs maintain a table to correlate the MAC and WWN addresses for specific devices participating in FCoE sessions; this enables the FCF to encapsulate FC traffic in Ethernet packets with the appropriate source and destination addresses. The MAC addresses used by converged devices can also be generated by the FC network (“FPMA – Fabric Provided MAC Address”) which simplifies this function. The use of FPMA addressing is not required. An alternative is SPMA (Server Provided MAC Addresses). Currently all Lenovo Networking products and the Emulex adapters in them support and use FPMA.

As shown in Figure 5, FPMA addresses are constructed from the FC_MAP (identifying the fabric) and FC_ID (identifying the specific node, and assigned dynamically).

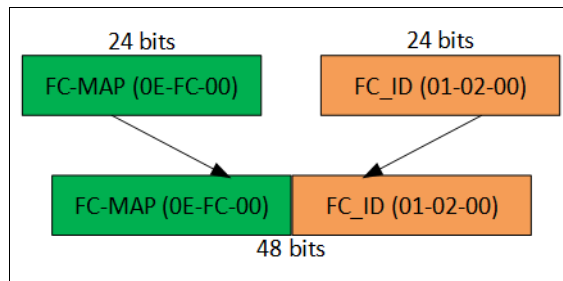


Figure 5 FPMA addresses

In Figure 5, the FC-MAP is configured on the FCF and must match the value used throughout the fabric to which the FCF is connected. The FC-ID is assigned by the fabric and is unique for each N_Port – i.e. for each server or converged adapter.

Just as there are multiple port types defined in the various standards for Fibre Channel, FCoE adds additional, virtualized port types.

Key FC port types:

- ▶ N_port – a port on an end node such as a server or storage farm (“node port”)
- ▶ F_port – a port on an FC switch, typically cabled to a single E_port (“fabric port”)
- ▶ E_port – a port on an FC switch which is cabled to another FC switch (“expansion port”)

Key FCoE port types

- ▶ VE_Port – an Ethernet port used to carry FCoE traffic from one switch to another
- ▶ VN_Port – an Ethernet port on an end node; on a server this would be the FCoE function on a converged adapter.
- ▶ VF_Port – the FCoE function of an Ethernet port on a converged switch which has FCF functionality.

The “V” in the FCoE port types identifies them as virtual, because they typically do not correspond one-to-one with a physical port – such as the VN_Port which does not take up the full functionality of a CNA (Converged Network Adapter) in the way that an N_Port corresponds to an HBA (Host Bus Adapter for Fibre Channel storage).

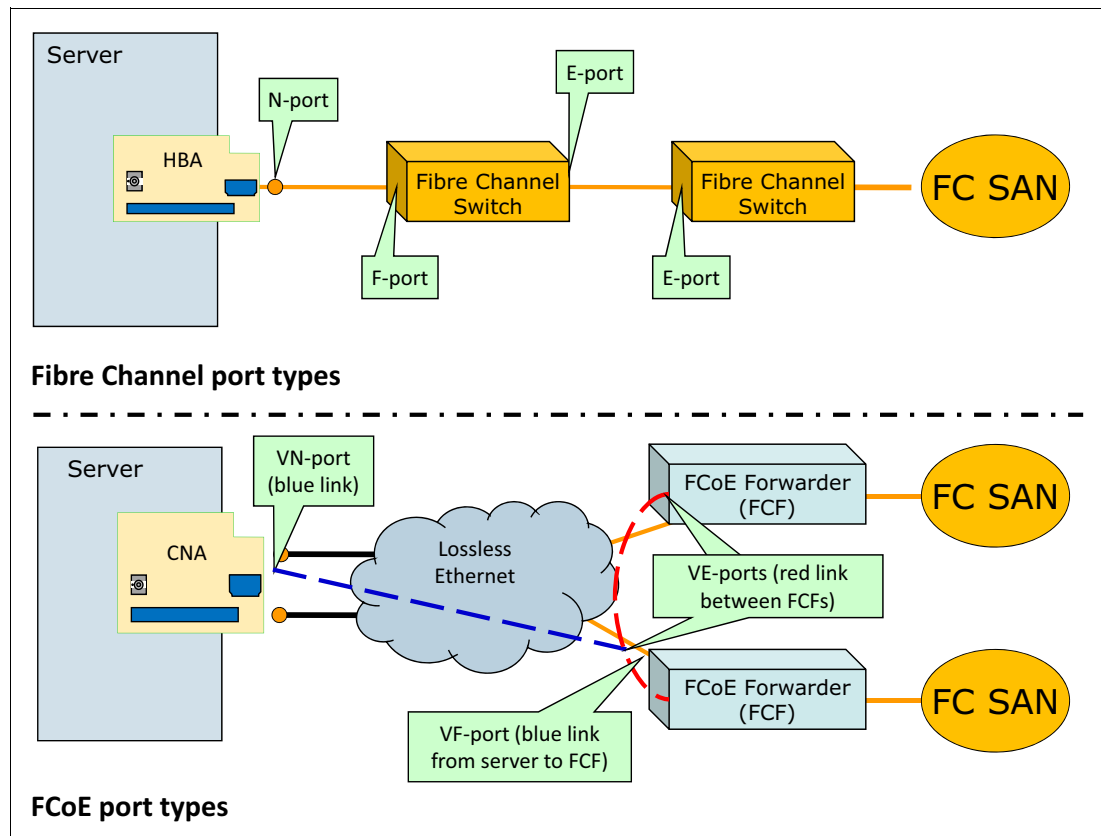


Figure 6 Port types

What is *the* key benefit of FCoE? The simplest answer is that it requires fewer adapters, fewer switches, fewer cables and a single wiring plant rather than distinct wiring for LAN and SAN networks. This typically results in lower overall capital expenses. Operating expenses may also be reduced because a single team may be able to support the overall environment.

Figure 7 on page 8 how FCoE enables to physically distinct networks to be combined into one.

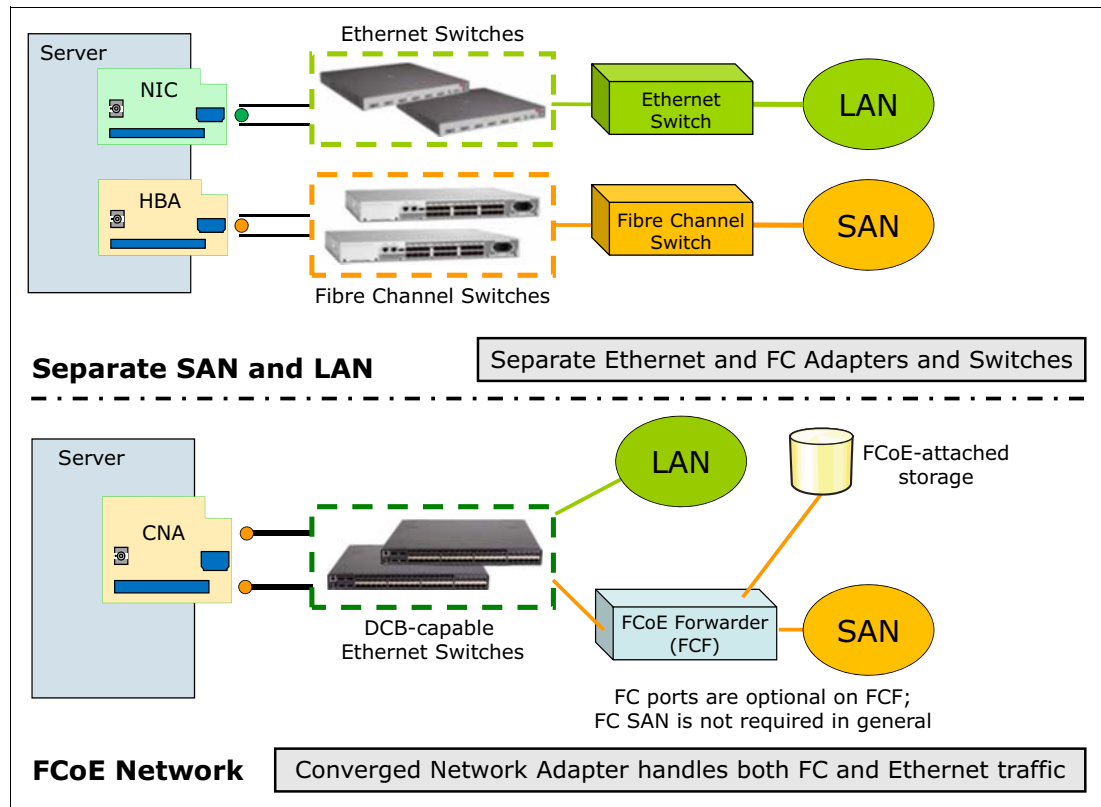


Figure 7 FCoE network consolidation

There are other companies in the industry that offer products incorporating FCoE technology. For instance the Cisco UCS platform requires the use of FCoE and requires the use of a Fabric Interconnect (6xxx series) as the FCF. These devices act as concentrators for multiple UCS chassis and are intended to connect to existing Cisco SAN switching hardware. The Cisco UCS platform does not offer the option of configuring servers or chassis with native Fibre Channel adapters nor native FC switching modules and so provides fewer choices to the customer.

FCoE Configuration

In this section, we show configuration of FCoE transit switches, which are Ethernet end-to-end, and switches which implement the "FCF" gateway functionality and connect to Fibre Channel networks.

FCoE Transit with Non-converged switches

The configuration of an FCoE transit switch is relatively simple. The needed features must be enabled and one or more FCoE VLANs must be configured.

The Lenovo Networking switches that fall into this category include the

- ▶ RackSwitch G8124E
- ▶ RackSwitch G8264
- ▶ RackSwitch G8272
- ▶ RackSwitch G8296

- ▶ RackSwitch G8316
- ▶ RackSwitch G8332
- ▶ Flex System Fabric EN4093R 10Gb Scalable Switch
- ▶ Flex System Fabric SI4093 System Interconnect Module
- ▶ Flex System Fabric SI4093 System Interconnect Module

The basic commands required to enable the needed FCoE transit features on these switches are:

```
cee enable
fcoe fips enable
```

The **cee enable** command turns on Converged Enhanced Ethernet support for the lossless Ethernet standards, including PFC (Priority Flow Control), and ETS (Enhanced Transmission Selection). Note that this support can be used for purposes other than for FCoE, such as for iSCSI.

The **fcoe fips enable** command turns on FIP snooping, which makes the switch aware of FCoE and FIP (FCoE Initialization Protocol).

Beyond this, the FCoE VLANs must be created and ports which connect to servers as well as to the FCFs must be members of one of these VLANs. The default FCoE VLAN is 1002, but use of this VLAN is not required. Ports which are members of FCoE VLANs should always transmit the FCoE traffic with 802.1q tags, which means that all of these ports must be configured as trunk ports, and a different VLAN (such as VLAN 1) should be the native VLAN for these ports.

Also worth noting, both the server-facing and FCF-facing ports should have the same native VLAN. This is required because the FIP VLAN discovery process uses untagged packets and for this process to work it is necessary for these untagged packets to flow between the adapter on the server and the FCF(s).

The VLANs chosen for FCoE are chosen as part of the configuration on the switches where the FCF function is implemented and transit switches must enable those VLANs on both server-facing and FCF-facing ports.

Converged switches - NPV mode

The converged switches available from Lenovo include:

- ▶ Lenovo RackSwitch G8264CS
- ▶ Lenovo Flex System Fabric CN4093 10Gb Converged Scalable Switch

Additional commands beyond those required for FCoE transit configuration (as described in “FCoE Transit with Non-converged switches” on page 8) are used to configure one of the converged switches in transparent (NPV) mode. This mode means that the switch acts as though it were part of an upstream SAN switch, and much of the configuration – such as zoning – resides on that upstream switch.

To enable NPV (N_Port Virtualization) mode, in addition to enabling FCoE and configuring VLANs as described in “FCoE Transit with Non-converged switches” on page 8, the following commands are used:

- ▶ Some of the Omni ports need to be set to operate as FC ports. This is done in pairs, with the odd-numbered port being the lower number of the pair, as follows:


```
system port 59-60 type FC
```

Multiple pairs or ranges can be specified in this command with commas and dashes (eg 59-60,63-64).

- FCoE VLAN(s) must be set to be in NPV mode, and the uplink ports need to be specified. This is done with the commands below (with example parameters):

```
vlan 1012
npv enable
npv traffic-map external-interface 59,60
```

As in the case of a transit switch, ports which will carry FCoE traffic will need to be configured as trunk ports and members of an FCoE VLAN. At least one pair of ports must be set in FC mode, whether or not they are used or even have transceivers installed. This provisioning step is necessary to enable the FC hardware engine inside the switch.

It is possible to have multiple NPV VLANs configured but any one port – including both FC/Omni ports and server-facing Ethernet ports can only be members of a single FCoE VLAN.

Configuration of parameters which are needed to support full SAN switching is not performed on transparent-mode switches such as Lenovo switches when operated in NPV mode. These parameters are specified on the upstream SAN switch.

Converged switches - FCF mode

For full-functioning SAN switching with full FCF functionality, the configuration is somewhat different. In addition, there are some constraints on the use of this mode:

- Lenovo switches do not currently support E_Port or VE_Port connectivity except to another Lenovo switch. This means they do not support participation as a full member of a fabric which consists of SAN switches from another manufacturer. The Lenovo Networking switch should be in NPV mode for such a network. There are several reasons for this operating mode. The key reason is the major SAN switch vendors each have developed and utilize significant proprietary capabilities beyond those specified in the standards, making it extremely difficult to develop and test interoperability for each of these functions and vendors.
- Lenovo Networking equipment does support full FCF mode for FC connectivity directly to storage such as the IBM Storwize V7000.
- Only one full-FCF VLAN can be supported at a time on a given switch. Lenovo switches can still support a “SAN-A/SAN-B” design by using different VLANs on each of a pair of switches such as two CN4093 in a Flex chassis.

The base commands to configure FCF mode – which still requires the basic transit FCoE are as follows (using example parameters):

```
vlan 1012
fcf enable
```

In addition, in full function mode, the Lenovo switch is responsible for zoning. It is possible to set the switch to allow all connections without detailed zoning configuration using a single command:

```
zone default-zone permit
```

This may suffice for a single chassis where all servers need to access storage such as an IBM Storwize V7000. It is also possible to implement granular zoning where zones and zonesets are configured and all of the World-Wide Names are specified. A brief example of

this configuration is shown in Example 1. Zoning is a security feature in Fibre Channel and FCoE networks which defines sets of devices (zones) which are allowed to send and receive traffic only from other devices in the same set (zone). A zoneset is a collection of zones which are used together. Only one zoneset can be active on a switch at any given point in time.

Example 1 Sample zone configuration

```
CN4093(config)# zone name Zone1
CN4093(config-zone)# member pwwn 20:34:00:80:e5:23:b1:55
CN4093(config-zone)# member pwwn 20:34:00:80:e5:27:f4:56
CN4093(config-zone)# member pwwn 20:34:00:80:e5:28:31:13
CN4093(config-zone)# member pwwn 20:34:00:80:e5:28:31:14
CN4093(config-zone)# exit
CN4093(config)# zone name Zone2
CN4093(config-zone)# member pwwn 20:34:00:80:e5:28:43:57
CN4093(config-zone)# member pwwn 20:34:00:80:e5:18:b3:58
CN4093(config-zone)# member pwwn 20:34:00:80:e5:28:31:13
CN4093(config-zone)# exit
CN4093(config)# zoneset name City1
CN4093(config-zoneset)# member Zone1
CN4093(config-zoneset)# member Zone2
CN4093(config-zoneset)# exit
CN4093(config)# zoneset activate name City1
```

Scalability limitations in NPV mode

There are limits to the number of clients that can be supported by a single FCoE VLAN on the Lenovo Networking converged switches. These limits exist due to processing limitations associated with the keep-alive packets which are sent (by default – FKA_ADV_PERIOD) every 8 seconds by each FC port which is a member of an active FCoE VLAN. These keep-alive packets are processed by the Emulex CNAs in connected servers and the CNAs respond with VLAN Request and Discovery Solicitation packets. Managing these responses puts a processing load on the switches which scales linearly with the number of connected servers. As a result, there are published limitations on the number of servers that a single FCoE VLAN on one switch can support:

- ▶ 1 VLAN comprising of 12 FC Uplink Ports can scale up to 70 servers
- ▶ 2 VLANs comprising of 6 FC Uplink Ports each can scale up to 120 servers
- ▶ 4 VLANs comprising of 3 FC Uplink Ports each can scale up to 160 servers

Servers in the same Flex Chassis or connected to the same Top-of-Rack switches do not need to be on the same FCoE VLAN even if their other VLAN memberships are the same. Note that the use of additional uplink ports is intended to add bandwidth capacity between the NPV switch and the core SAN switching fabric.

Supported connectivity

Tested official support for attached devices is as listed in Table 1 on page 12:

Table 1 Mode support

Attached device type	NPV mode	FCF mode
FC storage	No, attach to core switch	Yes
FCoE storage (with Ethernet)	Yes	Yes
Other FC devices (tape, etc.)	No, attach to core switch	Yes

Emulex adapter configuration notes

The storage functionality must be explicitly enabled on the Emulex converged network adapter card. This requires a license key which may need to be installed if acquired separately from the adapter itself or when a hardware replacement is shipped to replace a failed adapter. The OS – including hypervisors – will see a dual-port Fibre Channel HBA when this feature is licensed and enabled. An HBA driver from Emulex will be loaded when this is discovered during boot.

To enable storage functionality, press F1 during boot to enter the UEFI settings panel. From System Settings, select Networking, then the Emulex adapter you need to enable. You will be presented with Figure 8

Emulex refers to this as the card's *personality*. The available options are NIC (no storage functions), iSCSI and FCoE.

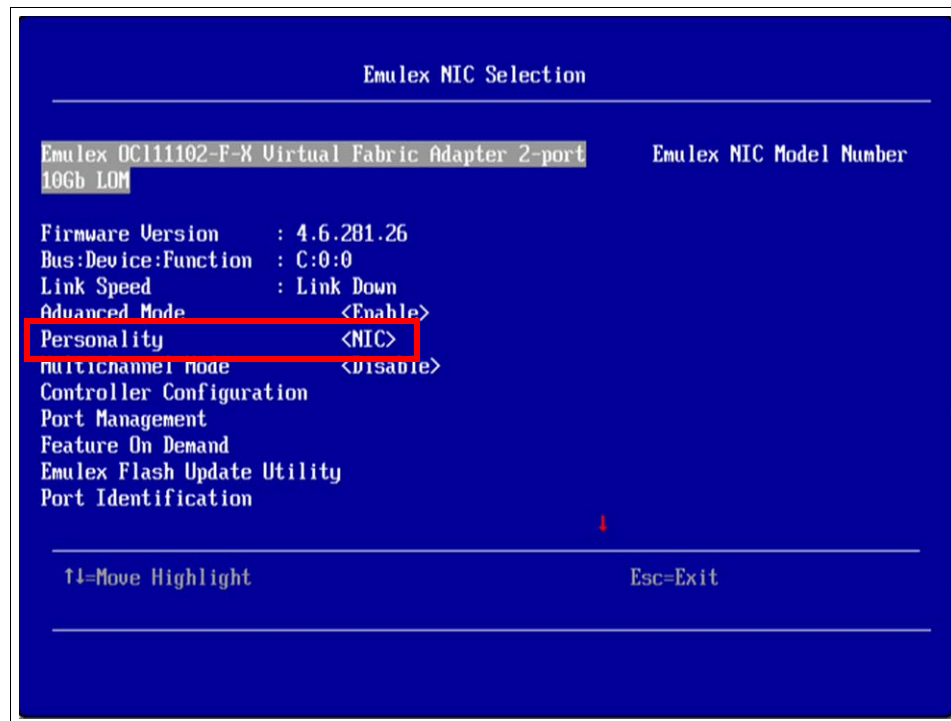


Figure 8 UEFI settings for Emulex FCoE adapters

FCoE switch configuration example

Multiple FCoE VLANs can be active at the same time, and they can be a mix of NPV and FCF modes. However, a given server-facing port should only be a member of one FCoE VLAN at a time if there are multiple active VLANs, and the “dynamic VLAN” support should be disabled to ensure that the host node finds the intended FCoE resources.

It is also possible for the HBAs on a given server to be attached to different VLANs. This can be done while still enabling multipathing if there is a four-port CNA installed in the server. For example, a server with four converged ports could have two ports to provide redundancy on each of two FCoE VLANs.

When multiple Fibre Channel (FC) ports are available to reach the same destination, traffic is balanced over those ports per connection, round-robin style. Other balancing modes which are commonly used on Ethernet are not available with Fibre Channel.

For FCoE to function properly, both the server-facing (internal) and FCF-facing (external) ports must be set in trunk mode so that they can be members of both a native VLAN and an FCoE VLAN.

In Example 2, all of the server ports will have their native VLAN be VLAN 1 so FCF discovery can function properly:

Example 2 Commands to enable FCF

```
CN4093(config)#cee enable
CN4093(config)#fcoe fips enable
CN4093(config)#system port EXT11-EXT14 type fc
CN4093(config)#vlan 1002
CN4093(config-vlan)#enable
CN4093(config-vlan)#member INTA1-INTA7,EXT11-EXT12
CN4093(config-vlan)#npv enable
CN4093(config-vlan)#npv traffic-map external-interface EXT11-EXT12
CN4093(config)#vlan 1003
CN4093(config-vlan)#member INTA8-INTA14,EXT13-EXT14
CN4093(config-vlan)#fcf enable
```

The fcf VLAN will also require zoning configuration. It is possible to use the default command to permit all connections (completely permissive zoning) or explicit zoning can be done as shown in the example below. Zoning configurations are typically of greater length than shown in the example because they will have many more members and multiple zones within a zoneset. (Only one zoneset can be active at a given time but more than one can be part of the switch configuration).

Zoning constraints are as listed in Table 2.

Table 2 Zoning constraints

Parameter	Value
Maximum zonesets:	4
Maximum zones per zoneset:	64
Maximum members per zone:	20
Total maximum zones:	200

Parameter	Value
Total maximum members:	1000

A sample zoning configuration is shown below:

Example 3 Zoning configuration

```
CN4093(config)#zone name lab
CN4093(config-zone)#member pwnn 20:34:00:80:e5:23:f4:55
CN4093(config-zone)#member pwnn 20:34:00:80:e5:23:f4:5e
```

```
CN4093(config-zone)#show zone
zone name lab
pwnn 20:34:00:80:e5:23:f4:55
pwnn 20:34:00:80:e5:23:f4:5e
```

```
CN4093(config-zone)#zoneset name NSJ
CN4093(config-zoneset)#member lab
```

```
CN4093(config-zoneset)#show zoneset
zoneset name NSJ
zone name lab
pwnn 20:34:00:80:e5:23:f4:55
pwnn 20:34:00:80:e5:23:f4:5e
```

```
CN4093(config-zoneset)#zoneset activate name NSJ
CN4093(config)#show zoneset active
```

```
Active Zoneset NSJ has 1 zones
zoneset name NSJ
zone name lab
pwnn 20:34:00:80:e5:23:f4:55
pwnn 20:34:00:80:e5:23:f4:5e
Default-Zone Deny
```

Troubleshooting and known issues

This section will present some basic troubleshooting commands and outline some known issues around FCoE configuration.

FCF Location

The following command shows all the FCF instances of which the switch is aware.

```
show fcoe fips fcf
```

These can be local to the switch where the command is issued or they may be on a transit switch which has upstream connectivity to FCF(s). It is possible that FCF instances belonging to more than one VLAN will appear in the output from this command.

Example 4 Output of the show fcoe fips fcf command

```
CN4093(config-vlan)#show fcoe fips fcf
```

Total number of FCFs detected: 6

FCF MAC	Port	Vlan
-----	-----	-----
6c:ae:8b:90:15:02	EXT11	1002
6c:ae:8b:90:15:03	EXT12	1002
6c:ae:8b:90:15:04	EXT13	1002
6c:ae:8b:90:15:05	EXT14	1002
6c:ae:8b:90:15:06	EXT15	1002
6c:ae:8b:90:15:07	EXT16	1002

If no FCFs are shown in this command, then no FCoE sessions can be established, and there are several possible causes:

- ▶ The necessary VLANs aren't configured, aren't enabled, or don't have all of the needed members.
- ▶ There are no FCFs reachable from the switch; they may need to be configured and/or enabled on another device.
- ▶ The intention is to have this switch (converged switches only) provide FCF function, but it is not enabled on any VLANs.
- ▶ FIP snooping is not enabled on the switch and therefore it won't see the FCFs. There are options to enable and disable snooping on individual ports, but they are rarely needed and rarely used.

FCoE Session Status

The following commands serve to allow you to correlate the different ways that a node in an FCoE network may be identified: WWNs, FCIDs, and MAC addresses:

```
show flogi database
show fcoe database
```

Other commands such as MAC address commands and identify specific servers, etc. Notice that the MAC addresses shown in the FCoE database display are the FPMA (fabric provided) addresses, and not the hardware addresses of the adapters.

The output of the two commands above is shown in Example 5. It shows sessions and identifies the ports where there is an active session, includes FPMA addresses of the servers. It also shows which servers are connected to which FCF when there is more than one.

If there are no sessions showing, there are numerous possible causes which may reside in the server, the switch, the FCF or the storage farm itself.

Example 5 Output of the commands

```
CN4093(config-vlan)#show fcoe database
```

VLAN	FCID	WWN	MAC	Port
-----	-----	-----	-----	-----
1002	e90061	10:00:5c:f3:fc:6e:32:f9	0e:fc:00:e9:00:64	INTA6
1002	e90021	10:00:5c:f3:fc:6e:2f:b9	0e:fc:00:e9:00:41	INTA5

Total number of entries = 2

```
CN4093(config-vlan)#show flogi database
```

Port	FCID	Port-WWN	Node-WWN
INTA5	010101	20:34:00:80:e5:23:f4:55	20:04:00:80:e5:23:f4:55
INTA6	010100	20:34:00:80:e5:23:f4:5e	20:04:00:80:e5:23:f4:5e
Total number of entries = 2			

FC port status displays

The FC switching module which is embedded in both the RackSwitch G8264CS and Flex System CN4093 can be queried and can provide information on the status of the FC ports (Omni ports) in the switches using the `show interface fc` commands listed in Example 6.

Example 6 show interface commands

```
CN4093#show interface fc port 53
```

```
Port Number: EXT11
```

```
-----
AdminState           Online
ConfigType           NP
EPortIsolationReason NotApplicable
LinkSpeed             8000
LinkState             Active
LoginStatus           LoggedIn
OperationalState      Online
RunningType           NP
```

```
CN4093#show interface fc information
```

Alias	Port	Admin State	Oper State	Login Status	Config Type	Running Type	Link Status	Link Speed
-----	----	-----	-----	-----	-----	-----	-----	-----
EXT11	53	Online	Online	LoggedIn	NP	NP	Active	8000
EXT12	54	Online	Online	LoggedIn	NP	NP	Active	8000
...								
UNK	63	Online	Offline	NotLoggedIn	Eth	Eth	Inactive	10000
UNK	64	Online	Offline	NotLoggedIn	Eth	Eth	Inactive	10000

From the output of the commands, it is possible to determine the speed and link status of the Omni ports as well as the FC/FCoE node type – such as the NP nodes shown which are NPV uplink ports.

Summary and Resources

This document is intended as an introduction to FCoE and to its use on Lenovo products. While the use of FCoE is not required in the Lenovo Flex chassis or using rack-mounted Lenovo servers, it is an available option in both of those configurations.

These documents are relevant for more information on the topic.

- *Storage and Network Convergence Using FCoE and iSCSI*

<http://lenovopress.com/sg247986>

- ▶ Lenovo Press Product Guide on the Lenovo RackSwitch G8264CS
<http://lenovopress.com/tips1273>
- ▶ Lenovo Flex System Fabric CN4093 10Gb Converged Scalable Switch
<http://lenovopress.com/tips0910>
- ▶ Flex System Information Center, where you can get the product publications for the Flex System CN4093: Installation Guide, Application Guide, and Command Reference
<http://pic.dhe.ibm.com/infocenter/flexsys/information/index.jsp>
- ▶ RackSwitch G8264CS product publications, which are available at this website:
<http://ibm.com/support/entry/portal/Documentation>

About the author

Scott Lorditch is a Consulting System Engineer for Lenovo. He performs network architecture assessments, and develops designs and proposals for solutions involving Lenovo Networking products. He also developed several training and lab sessions for technical and sales personnel. Scott joined IBM as part of the acquisition of Blade Network Technologies, where he was one of the first employees, and joined Lenovo as part of the System X acquisition from IBM. Earlier, Scott spent almost 20 years working on networking in various industries, working as a senior network architect, a product manager for managed hosting services, and manager of electronic securities transfer projects. Scott holds a BS degree in Operations Research with a specialization in computer science from Cornell University.

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