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# Implementing FCoE in the Linux Operating System

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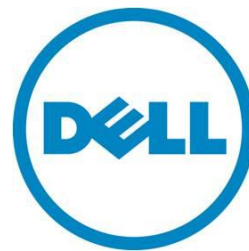
*This white paper explains using Broadcom-based network adapters and Dell Force10 and Cisco Nexus switches.*

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## Executive summary

This document provides instructions on setting up Fibre Channel over Ethernet (FCoE) using a Dell Force10 switch, a Cisco Nexus switch, Broadcom-based network adapters, and servers running supported Linux operating systems. It is intended for intermediate Network and System Administrators with 2-5 years of experience, and assumes a moderate level of network switch administration expertise and Linux system administration expertise.

## Introduction

Fibre Channel over Ethernet (FCoE) encapsulates Fibre Channel frames over IEEE 802.3 Ethernet networks equipped with FCoE compliant hardware, thereby reducing the amount of physical IO connectivity necessary to access Fibre Channel-based storage. However, FCoE can be challenging to implement due to the complexities involved in correctly configuring the various devices on the network, such as the SAN, switches, network interface adapters, and operating systems on the servers. This Dell How-To document is intended to assist you in setting-up FCoE in your environment.

Due to the numerous variances in possible SAN, switch, network interface adapter, and server choices, it is not possible to write exact instructions for every conceivable supported configuration. As such, this document is written toward implementing one specific real-world configuration, as detailed in the Described Configuration section below.

## Described configuration

This example used the following Hardware:

- SAN: EMC Clariion CX700.
- Switches: Dell Force10 MXL 10/40GbE Switch (edge); Cisco Nexus 5020 Switch (distribution); Appropriate core switch for your network of any applicable make and model (core)
- Chassis: Dell M1000e Blade Server Chassis
- Server: Dell PowerEdge M520 Server
- Network Adapter: Broadcom 57810S Dual-Port 10GbE KR Blade Converged Mezzanine Card
- Operating System: Red Hat Enterprise Linux 6.2; SuSE Linux Enterprise Server 11 Service Pack 2

## Prerequisites

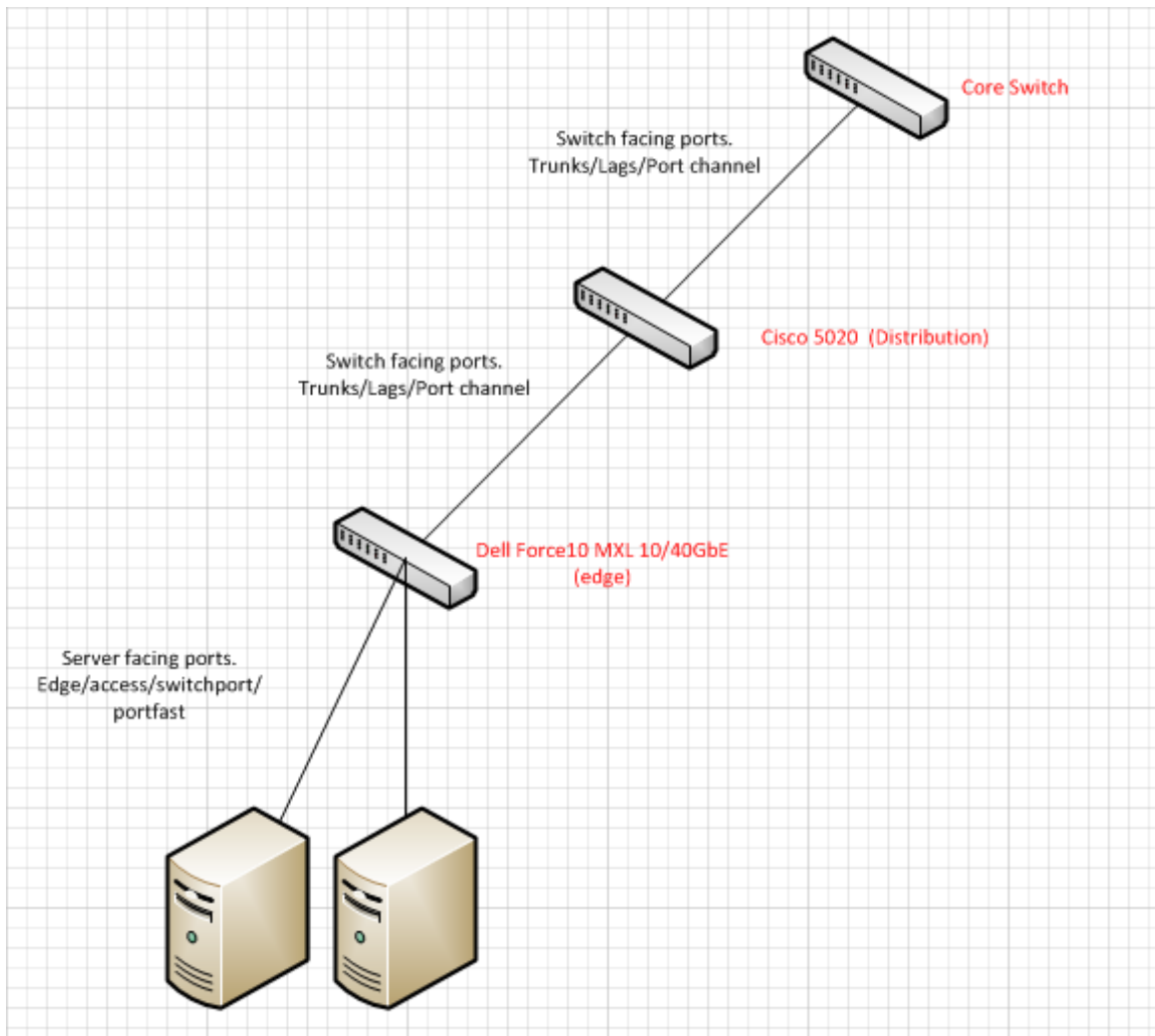
Prior to attempting to configure FCoE for Linux, meet the following prerequisites:

1. The Firmware of the Dell Force10 switch must be up-do-date. Refer to the [Dell Support Website](#) and enter your service tag to download and receive instruction on how to update your Dell Force10 switch to the latest firmware. In this document, Dell Force10 MXL 10/40GbE firmware version 8.3.16.1 was used.
2. The Firmware of the Cisco switch must be up-do-date. Refer to the Cisco Support Website to download and receive instruction on how to update your Cisco switch to the latest firmware. In this document, Cisco Nexus 5020 firmware version 5.1(3)N2(1a) was used.
3. The firmware of the Broadcom network adapter must be up-to-date. Please refer to [Dell Support Website](#) and enter your service tag to download and receive instruction on how to update your Broadcom network adapter to the latest firmware. In this document, Broadcom 57810S Dual-Port 10GbE KR Blade Converged Mezzanine Card firmware version 7.2.14 was used.
4. Install the appropriate Linux Operating System and make sure it is functioning on the Dell PowerEdge server. In addition, the Ethernet interface over which you want FCoE traffic to flow must be configured and online. Verify that you can ping another device on the network using this Ethernet interface before attempting to setup FCoE.
5. The driver for the Broadcom network adapter must be up-do-date. Refer to [Dell Support Website](#) and enter your service tag to download and receive instruction on how to install the latest driver for your Broadcom network adapter. In this document, Broadcom LAN driver for Linux version 17.2.0 was used.
6. You need access to the installation media for your particular Linux operating system.
7. You must set up the appropriate LUNs for use on your Fibre Channel SAN. The SAN is not aware that the FCoE is being used and the LUN will be set up and functioning identically as would any other non-FCoE connected Fibre Channel LUN, regardless of the make and model of the SAN. Configuration of the SAN is outside the scope of this FCoE-centric document. For instructions on setting-up the appropriate LUNs for your particular SAN, refer the documentation for your Fibre Channel SAN.

## Setting up your network infrastructure for FCoE

Perform the following steps to set up your network infrastructure for FCoE. While performing these steps, refer to the network diagram in Figure 1.

Figure 1. Network infrastructure diagram.



1. Set up in NPIV mode and enable the FCoE feature on the Cisco Nexus 5020 *distribution* switch. From the Global Configuration Mode of the *distribution* switch, run the following commands:

```
feature fcoe  
feature lcap  
feature lldp  
feature npiv
```

2. Enable the FCoE feature on the Dell Force10 MXL 10/40GbE *edge* switch by running the following commands from the Global Configuration Mode of the *edge* switch command line:

```
service-class dynamic dot1p
cam-acl l2acl 4 ipv4acl 2 ipv6acl 0 ipv4qos 2 l2qos 1 l2pt 0 ipmacacl 0 vman-qos 0 ecfmac 0
fcoeacl 2 iscsiopacl 2
feature fip-snooping
fip-snooping enable
protocol lldp
  no advertise dcbx-tlv ets-reco
  advertise management-tlv system-description system-name
```

3. Program the server facing ports (internal ports connected to the PowerEdge blade servers) on the *edge* switch by running the following commands from the switch command line:

```
interface TenGigabitEthernet 0/30
  no ip address
  mtu 12000
  portmode hybrid
  switchport
  spanning-tree pvst edge-port
!
protocol lldp
  dcbx port-role auto-downstream
  no shutdown
```

4. Program the switch facing ports (physically accessible ports on the back of the M1000e chassis) on the *edge* switch by running the following commands from the switch command line:

```
interface TenGigabitEthernet 0/49
  description LAG port to Cisco 5020
  no ip address
  mtu 12000
!
port-channel-protocol LACP
port-channel 2 mode active
!
protocol lldp
  no advertise dcbx-tlv ets-reco
  dcbx port-role auto-upstream
  no shutdown
!
***NOTE: If not in a LAG, omit the highlighted in red above***
```

5. Create the default VLAN by giving the `default-vlan XX` command (where XX equals the VLAN number) from the *edge* switch command line as seen below:

```
default-vlan 46
```

6. Create the FCoE VLAN (this is the actual VLAN that allows FCoE traffic on the *edge* switch) from the *edge* switch command line as seen below:

```
int vlan 255
```



7. On the Cisco Nexus 5020 *distribution* switch, make sure that the FCoE VLAN is created and associated to the appropriate Virtual SAN (VSAN) by running the following from the switch command line:

```
interface vlan 255          (creates the VLAN)
FCOE vsan 255              (defines the VLAN as FCoE, and then associates it to VSAN 255)
no shut                    (turns on the VLAN)
```

8. On the *distribution* switch; make sure that the appropriate native VLAN for that interface is set up as seen below:

```
interface Ethernet 1/12
switchport mode trunk
switchport trunk native vlan 46
switchport trunk allowed vlan 46,255  (notice that the appropriate FCoE VLAN is
also allowed, VLAN 255)
```

9. Bind the FCoE-FIP MAC address of the server's network interface adapter. You can get the server's MAC address from the CMC by navigating to **Server -> Setup -> FlexAddress** from the CMC management GUI. Be aware of what port your server is on and what side of the fabric your server is on (for example: Fabric A side 2). You bind this address on the Cisco 5020 *distribution* switch that is running NPIV mode by running the following commands from the switch command line:

```
interface vfc XX          (this creates a Virtual Fibre Channel (FVC) interface; XX is any
                           number id that is available)
bind mac-address a4:ba:db:49:d0:17 (binding FCoE-FIP MAC Address)
no shutdown              (this turns on the interface)
```

10. The last thing to do on the *distribution* switch is to place the newly created VFC into the proper VSAN database while in global configuration mode. To do this, run the following commands from the *distribution* switch command line:

```
VSAN database            (enter VSAN definition/configuration mode)
VSAN 255 interface vfc 50 (VFC 50 being placed into VSAN 255)
```

11. On the Dell Force10 MXL 10/40GbE (*edge*) switch, verify that an FCoE connection was established. To do this, run the following command on the *edge* switch command line while in EXEC mode; see Figure 2 for sample results:

```
show fip-snooping enode
```

Figure 2. Results of show fip-snooping enode command.

```
Chassis37_C1#show fip-snooping enode
-----
Enode MAC          Enode Interface    FCF MAC           ULAN              FC-ID
-----
a4:ba:db:49:d0:17  Te 0/7             00:0d:ec:e0:f0:34 255               0d:0b:05
a4:ba:db:49:d3:7a  Te 0/3             00:0d:ec:e0:f0:34 255               0d:0b:03
a4:ba:db:49:d9:34  Te 0/11            00:0d:ec:e0:f0:34 255               0d:0b:02
Chassis37_C1#
```

- Verify that the Fibre Channel forwarder port is enabled and working correctly on the *edge* switch. Run the following command from the *edge* switch command line while in EXEC mode (see Figure 3 for results):

```
show fip-snooping fcf
```

Figure 3. Results of show fip-snooping fcf command.

```
Chassis37_C1#show fip-snooping fcf
-----
FCF MAC          FCF Interface      ULAN              FC-MAP           FKA_ADU_PERIOD   No. of Enodes
-----
00:0d:ec:e0:f0:34  Po 2               255               0e:fc:00 8000             3
Chassis37_C1#
```

- To verify on the Cisco Nexus 5020 *distribution* switch that your server is successfully connected using FCoE, you can run the following commands in EXEC mode; see Figure 4 for results:

```
show fcoe database (this lists the vfcs and their respective active MAC address)
show lldp neighbors (this shows all external connections to the switch, their device IDs, and their respective incoming ports)
```

Figure 4. Results of FCoE and LLDP query commands.

```

EST-5020_2# show fcoe database
-----
INTERFACE          FCID          PORT NAME          MAC ADDRESS
-----
vfc4                0x0d091e     20:01:84:8f:69:5c:ab:8e 84:8f:69:5c:ab:8e
vfc6                0x0d0904     20:01:84:8f:69:5c:af:4d 84:8f:69:5c:af:4d
vfc7                0x0d0903     20:01:84:8f:69:5c:af:4e 84:8f:69:5c:af:4e
vfc49               0x0d0919     20:00:a4:ba:db:49:dd:91 a4:ba:db:49:dd:91
vfc50               0x0d0918     20:01:a4:ba:db:49:dd:85 a4:ba:db:49:dd:85

Total number of flogi count from FCoE devices = 5.

EST-5020_2# show lldp neighbors
Capability codes:
  (R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
  (W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other
Device ID          Local Intf      Hold-time  Capability  Port ID
0005.333b.fd40    Eth1/1         120        ExT 0/17
0005.338a.c789    Eth1/2         120        ExT 0/17
001e.c9f1.0456    Eth1/3         120        TenGigabitEthernet 0/51
001e.c9f1.0456    Eth1/4         120        TenGigabitEthernet 0/50
001e.c9f1.0456    Eth1/5         120        TenGigabitEthernet 0/49
001e.c9f1.0432    Eth1/6         120        TenGigabitEthernet 0/51
001e.c9f1.0432    Eth1/7         120        TenGigabitEthernet 0/50
001e.c9f1.0432    Eth1/8         120        TenGigabitEthernet 0/49
vunic2            Eth1/18        120        0050.5659.dd90
001e.c9f1.0456    Eth1/19        120        TenGigabitEthernet 0/52
001e.c9f1.0432    Eth1/20        120        TenGigabitEthernet 0/52
a4ba.db49.dd1b    Eth1/21        120        a4ba.db49.dd1b
a4ba.db49.dd83    Eth1/22        120        a4ba.db49.dd83
0080.2412.001f    Eth1/29        120        Te1/0/17
5c26.0ad7.04c3    Eth1/30        120        Te1/0/17
5c26.0aaa.2269    Eth1/32        120        1/0/25
0018.8b98.8f32    Eth2/1         120        1/0/25
0018.8b98.8bc8    Eth2/2         120        1/0/25
0018.8b9d.9888    Eth2/3         120        1/0/25
0018.8b98.99bc    Eth2/4         120        1/0/25
Total entries displayed: 20
EST-5020_2#
    
```

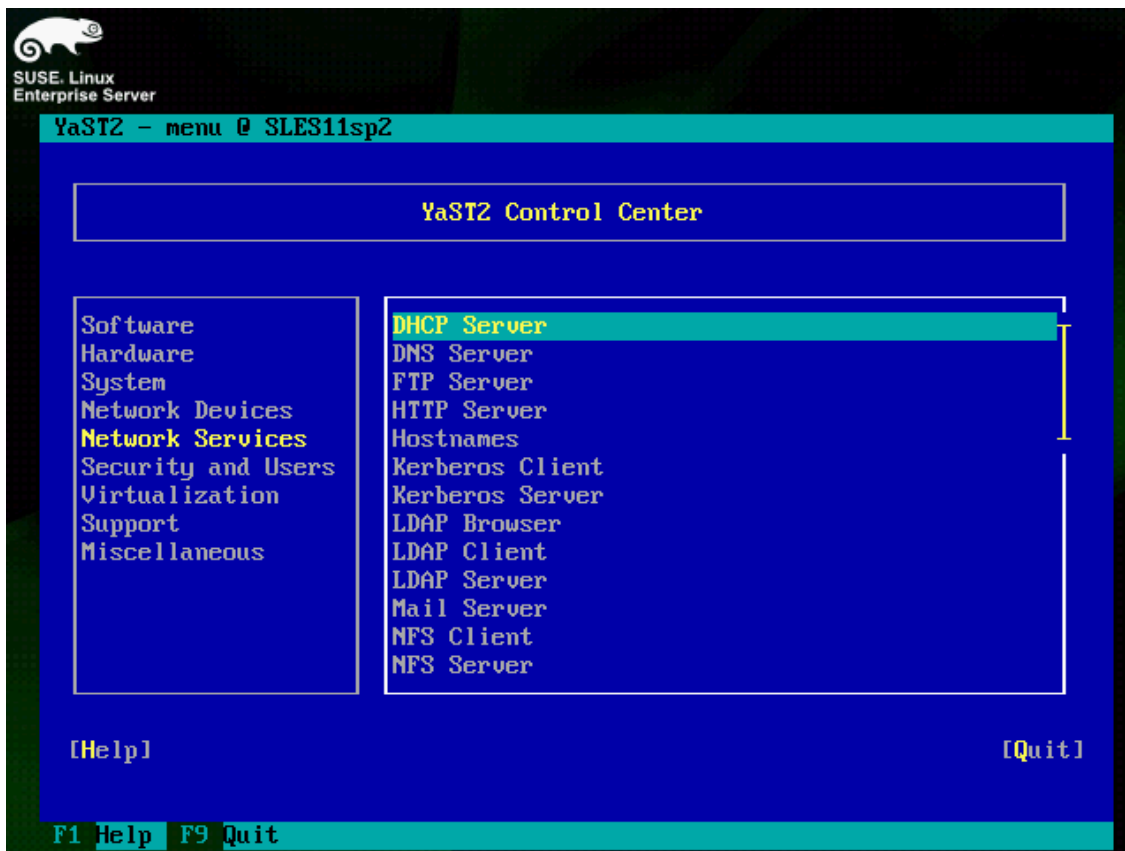
## Setting up FCoE for SLES 11 SP 2

### Installing / verifying FCoE support

If FCoE support has not been installed in SLES 11 SP2, it must be installed. To verify if FCoE support was installed in SLES 11 SP2, perform the following steps:

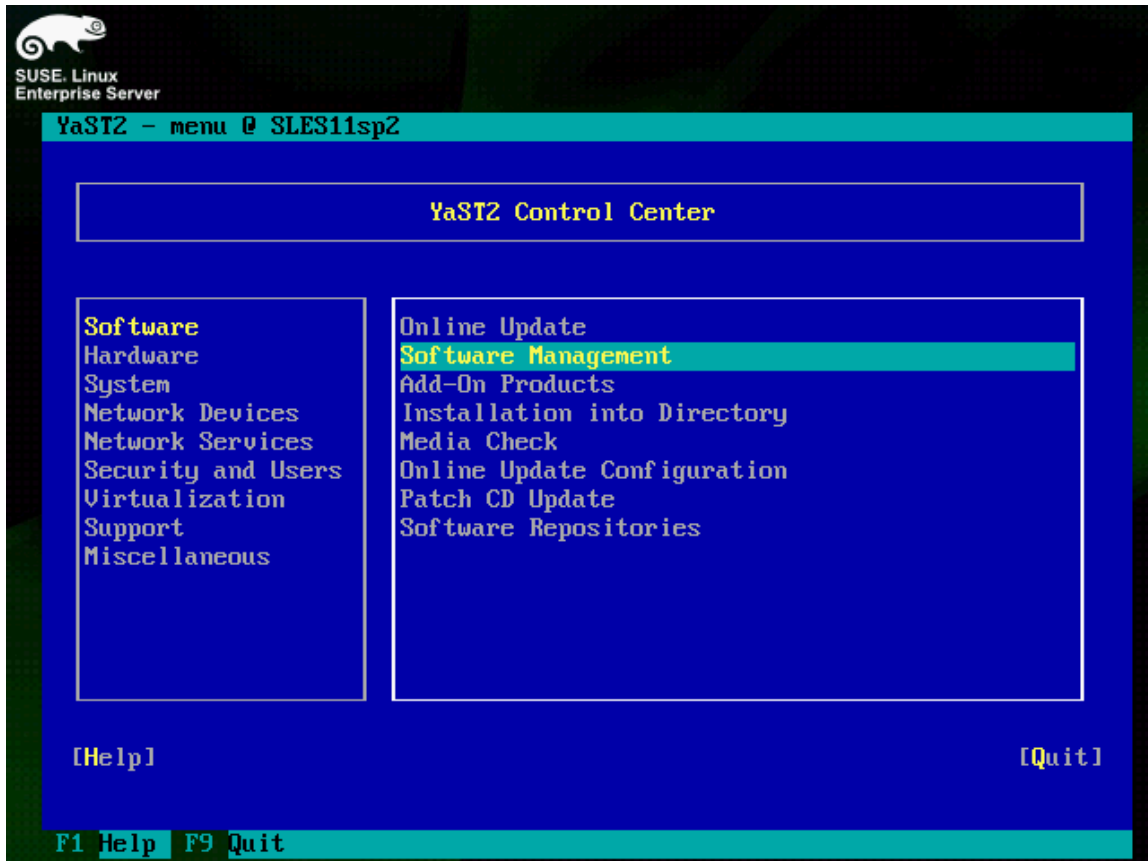
1. Log-in as root, then the start YaST2 Control Center by running the `yast` command. From YaST2, select `Network Services` in the left-side menu, then use the `Tab` key switch to the right-side menu. Use the arrow keys to scroll up and down the list of `Network Services` and look for `FCoE Client Configuration`; if `FCoE Client Configuration` is not listed, as in Figure 5, then FCoE support is not installed in SLES 11 SP2, and must be installed at this time.

Figure 5. FCoE support not installed.



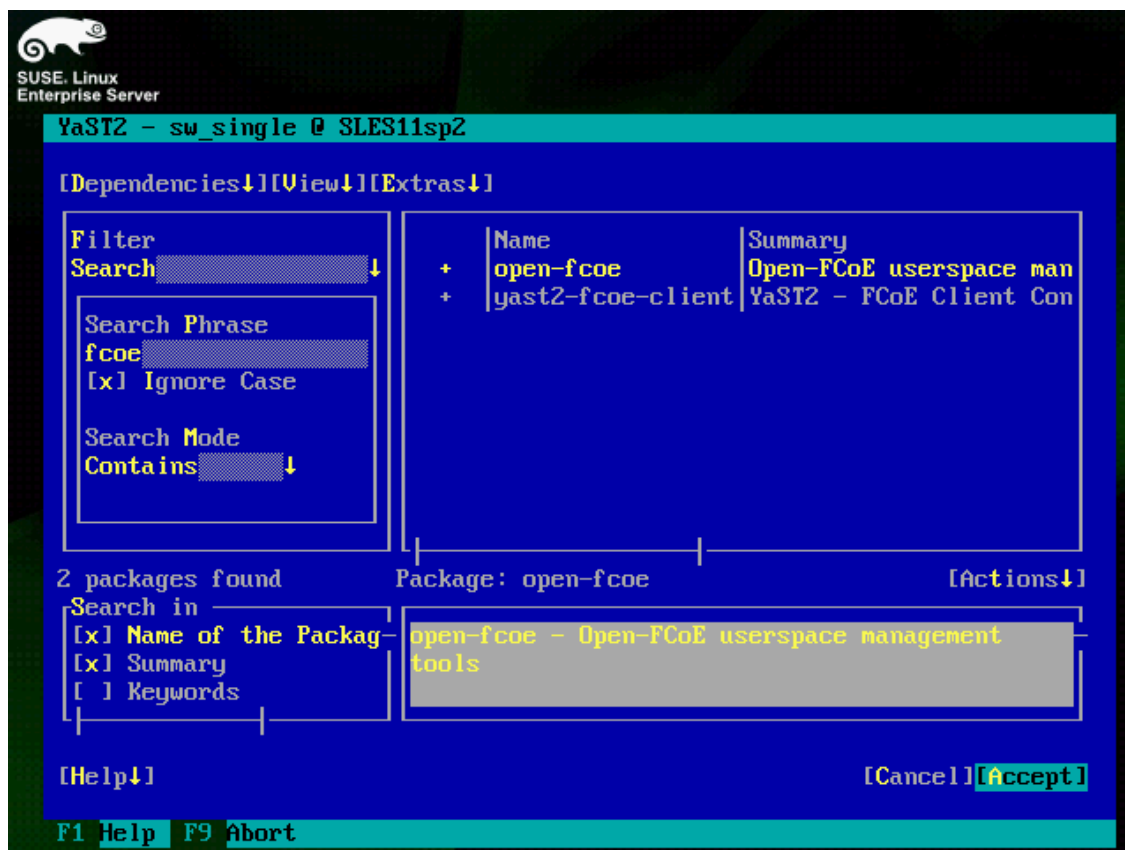
2. To install FCoE and the appropriate support packages, insert Disc 1 of the SLES 11 SP2 installation media into your CD/DVD drive. Next, from YaST2, select `Software` from the left-side menu. Then select `Software Management` in the right-side menu, and press `Enter`, as in Figure 6.

Figure 6. Entering Software Management menu.



3. Type `fcoe` into the `Search Phrase` box, and then press `Enter`. You should be presented with `open-fcoe` and `yast2-fcoe-client` as installable packages. Use the `Tab` key to highlight each of these items, and mark them for installation by using the `Space Bar` to put a `+` in front of each of the packages names. Then select `Accept` to install the packages, as in Figure 7.

Figure 7. Selecting FCoE packages for installation.



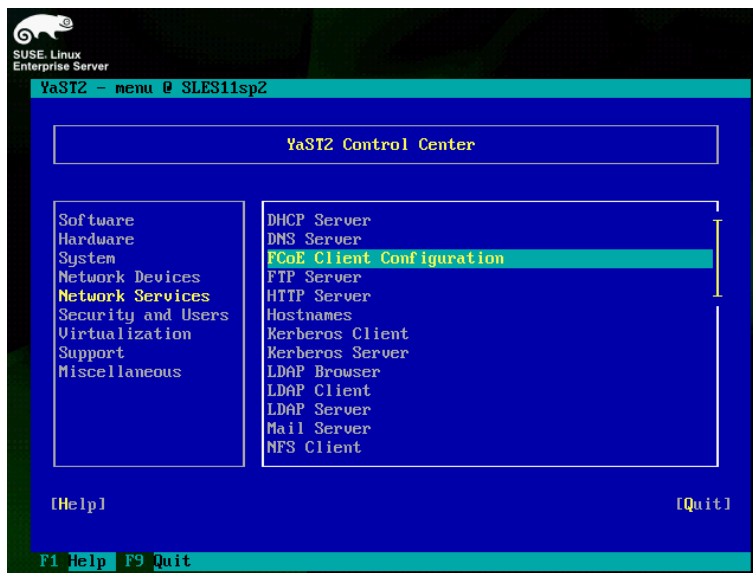
You may be prompted to accept any `Automatic Changes` to resolve dependency issues; if this happens, select `OK` to allow the installation to proceed. After the packages install, you are returned to the YaST2 Control Center. When finished, quit the YaST2 Control Center.

## Configure the FCoE client VLAN

Next, configure the FCoE client VLAN by performing the following steps:

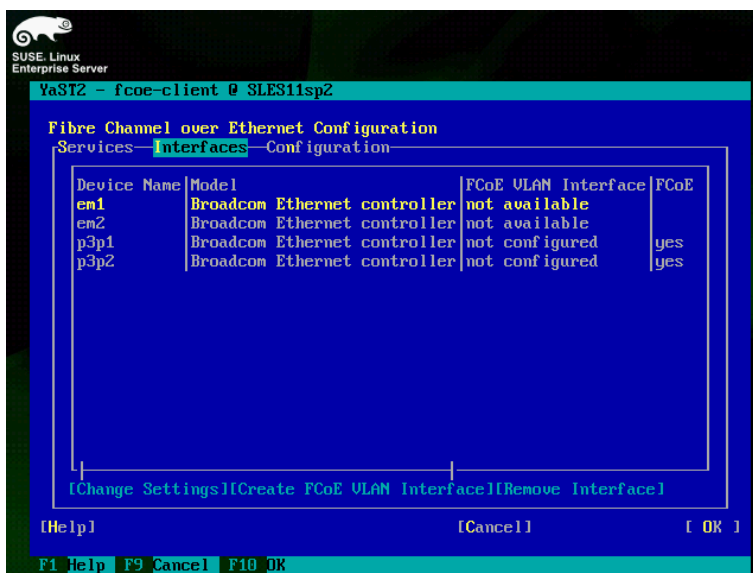
1. Start the YaST2 Control Center using the `yast` command, then select `Network Services`, and then `FCoE Client Configuration`, as in Figure 8.

Figure 8. Network Services menu.



2. You are brought to the Fibre Channel over Ethernet Configuration screen. Use the *Tab* key to select the Interfaces sub-menu, as in Figure 9.

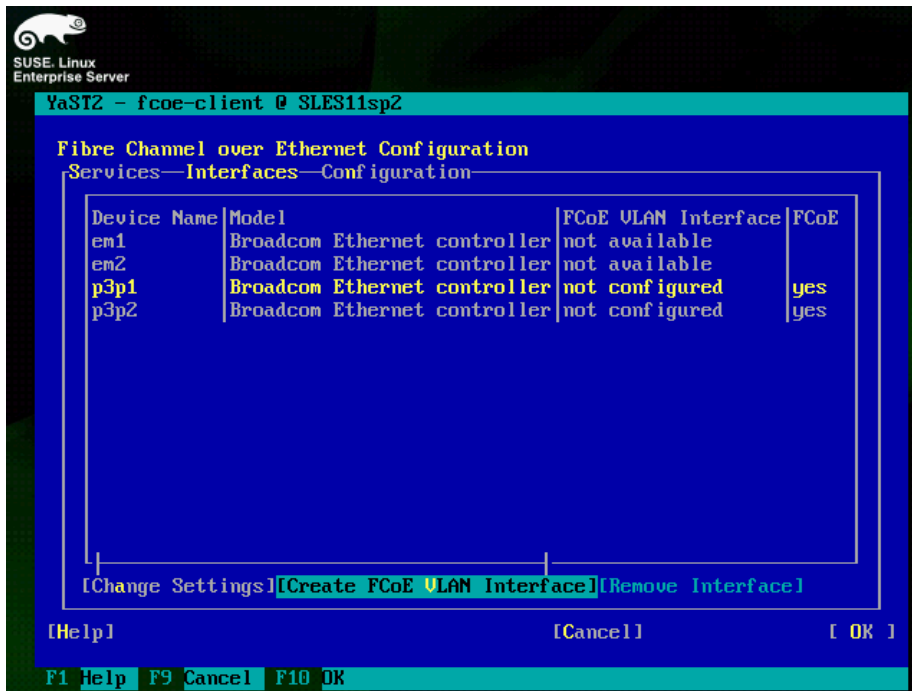
Figure 9. FCoE client configuration screen with interfaces sub menu.



Note that the supported Broadcom network adapters have `yes` listed in the `FCoE` column, while unsupported Broadcom network adapters will not have any listing in the `FCoE` column.

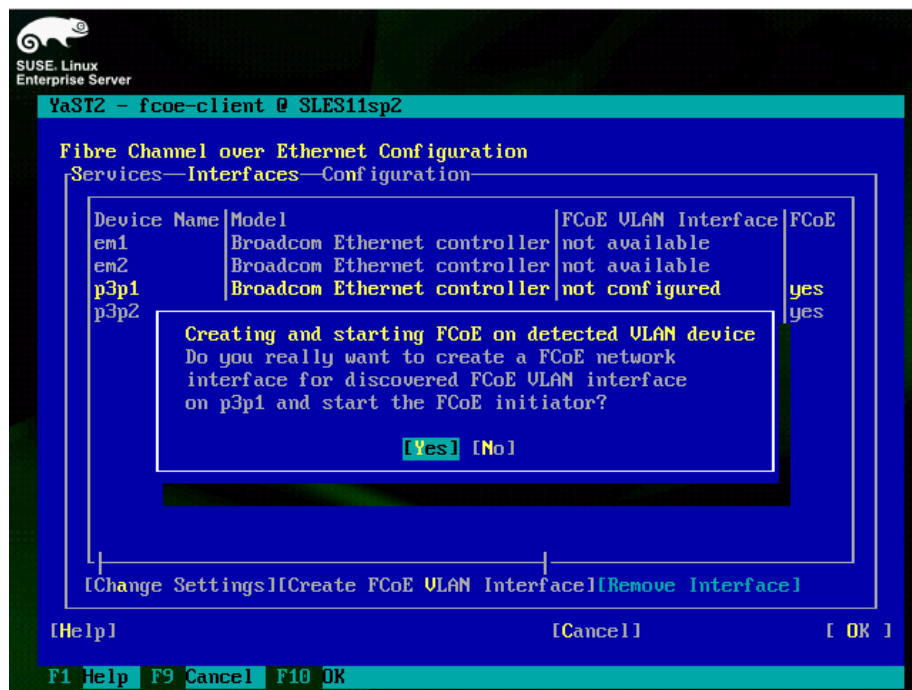
3. Highlight the adapter for which you would like to configure FCoE, and then select `Create FCoE VLAN Interface`, as in Figure 10.

Figure 10. Create FCoE VLAN interface.



4. You are prompted to confirm whether or not you really want to create a new FCoE VLAN interface, as in Figure 11; select **Yes**.

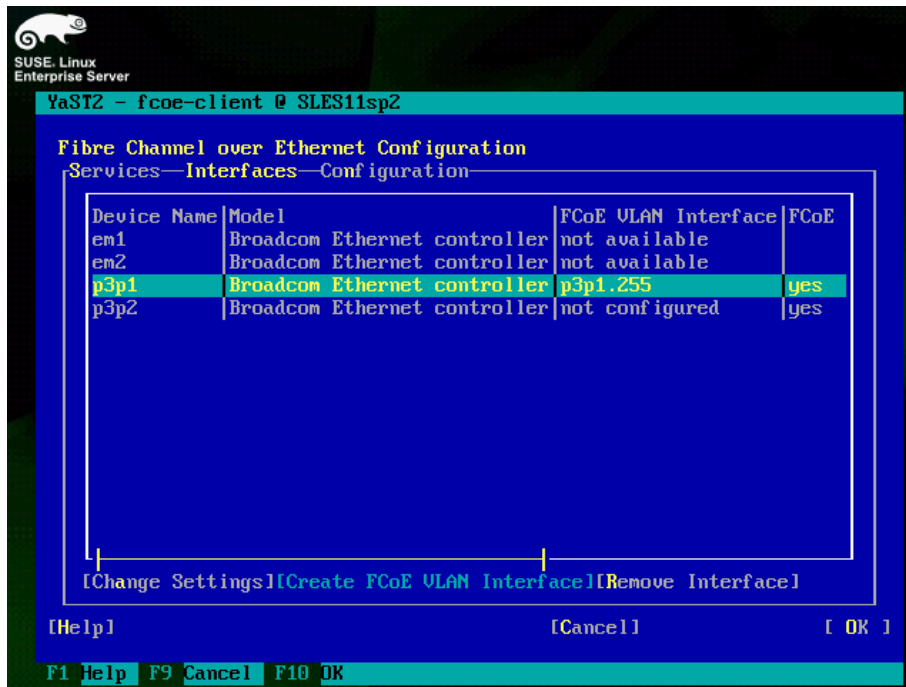
Figure 11. Confirmation of new FCoE VLAN interface.



You then see your FCoE VLAN appear in the FCoE VLAN Interface column, as in Figure 12.

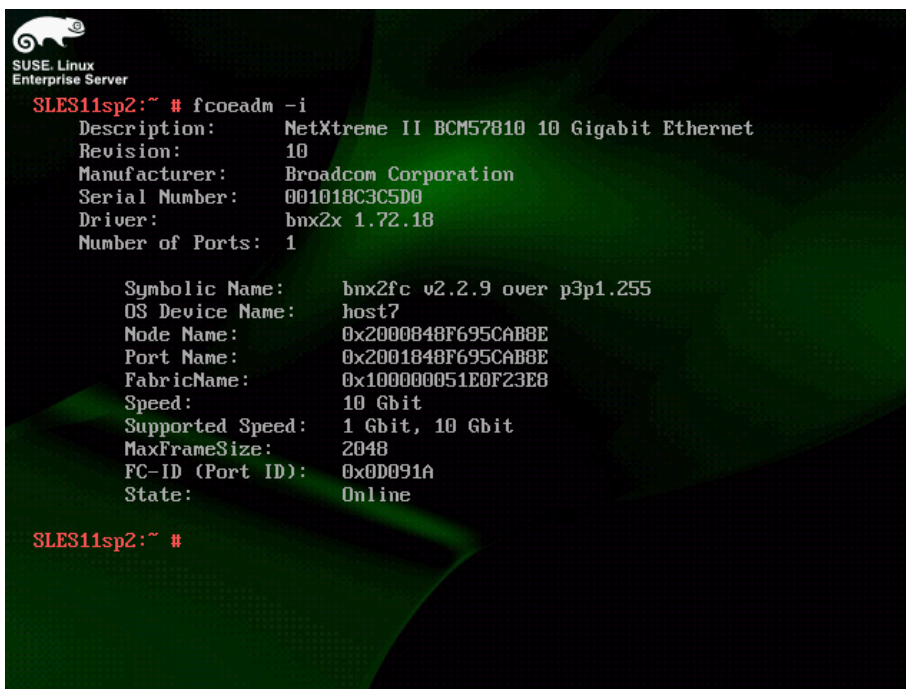


Figure 12. New FCoE VLAN created.



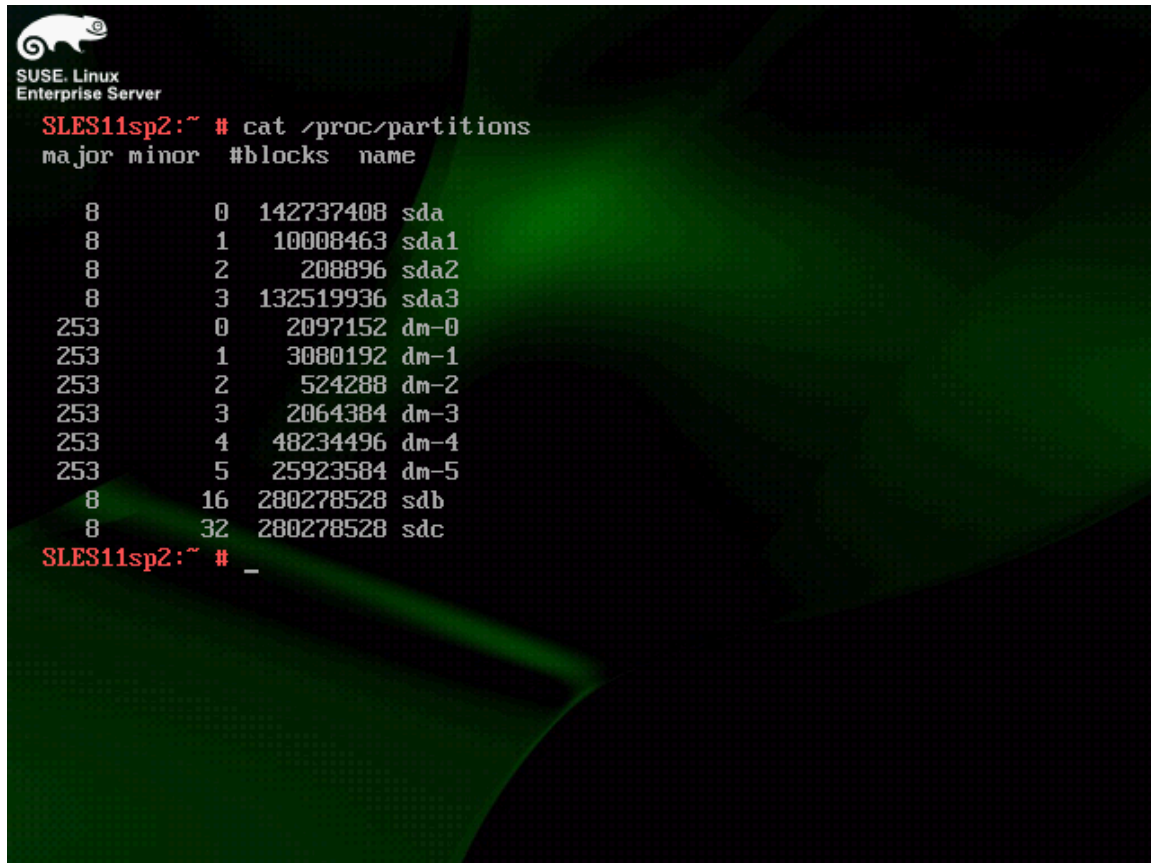
5. Select OK, and then Quit to return to the command prompt. Run the command `fcoeadm -i` to verify that the FCoE VLAN has been successfully brought online, as in Figure 13.

Figure 13. FCoE VLAN is now online.



6. Finally, to determine the device names for your FCoE LUNs, run the `cat /proc/partitions` command, as in Figure 14. In this example, the FCoE LUNs are listed as `/dev/sdb` and `/dev/sdc`.

Figure 14. FCoE LUNs displayed.



```
SUSE Linux Enterprise Server
SLES11sp2:~ # cat /proc/partitions
major minor #blocks name
 8         0 142737408 sda
 8         1 10008463 sda1
 8         2  208896 sda2
 8         3 132519936 sda3
253        0  2097152 dm-0
253        1  3080192 dm-1
253        2   524288 dm-2
253        3  2064384 dm-3
253        4  48234496 dm-4
253        5  25923584 dm-5
 8        16 280278528 sdb
 8        32 280278528 sdc
SLES11sp2:~ # _
```

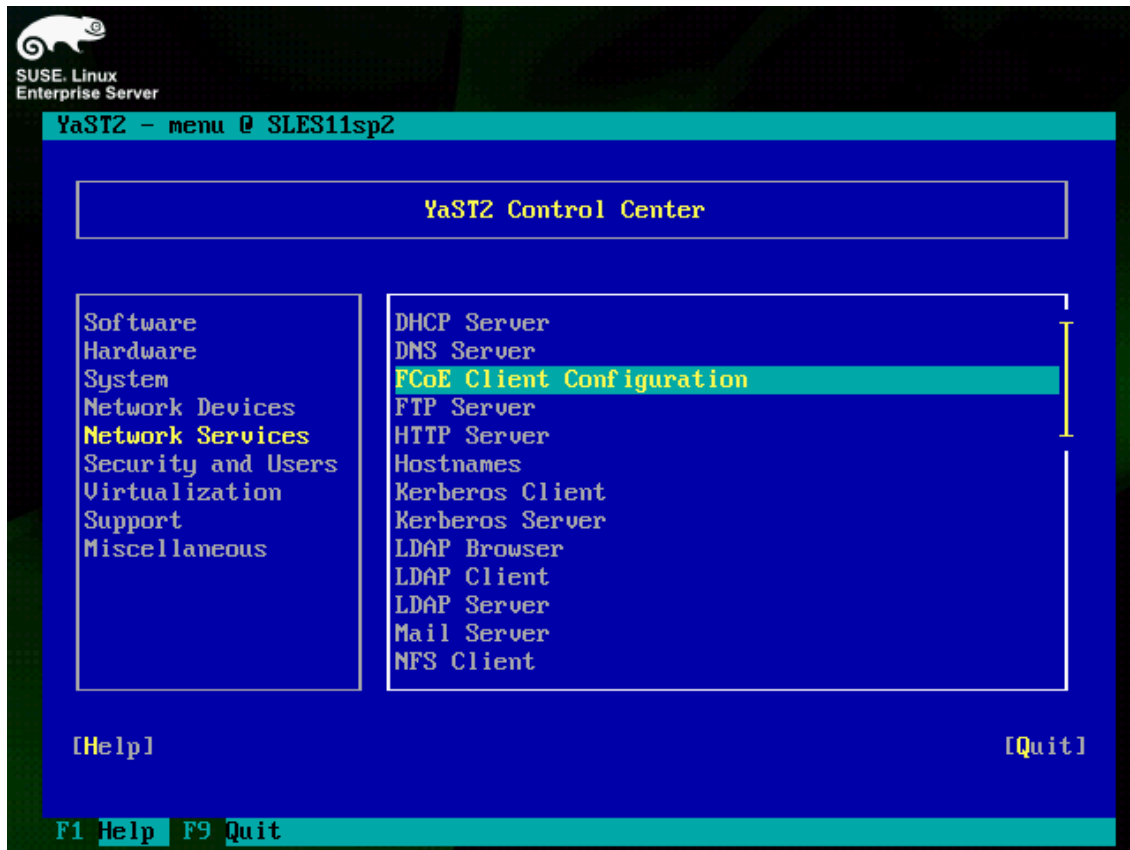
Partition and mount FCoE LUNs as any other hard disk device.

## Configure the FCoE client to start at boot

If you want the FCoE client to start and the FCoE LUNs to automatically be available after every reboot, configure the appropriate services using YaST2 by performing the following steps:

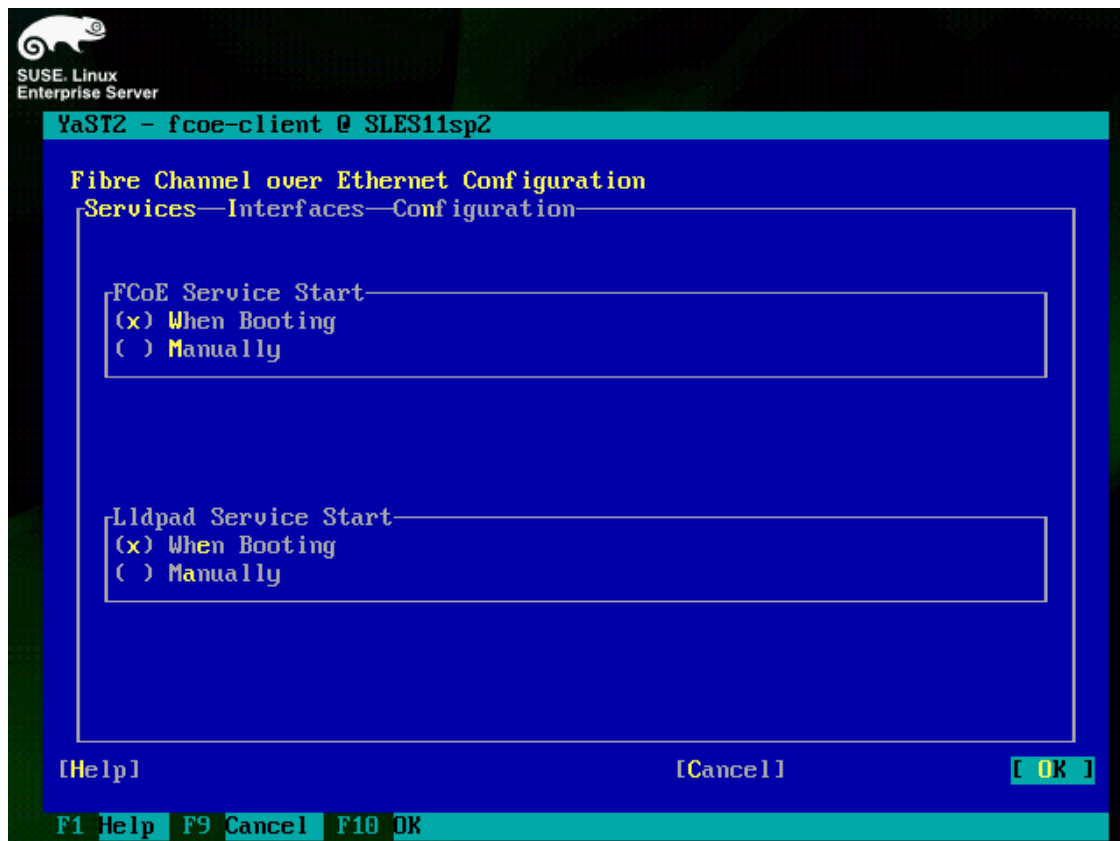
1. Start the YaST2 Control Center using the `yast` command, select `Network Service`, and then `FCoE Client Configuration`, as in Figure 15.

Figure 15. Select the FCoE Client Configuration menu.



2. Configure FCoE to start when the system boots. Select the `Services` menu. Then set both `FCoE Services Start` and `Lldpad Services Start` to `When Booting`, as in Figure 16.

Figure 16. Configure FCoE to start at system boot.



3. Click `OK` and then `Quit` to return to the command prompt. The FCoE client should now start as part of SLES 11 SP2s boot process, and the FCoE LUNs should be available after the system boots.

## Troubleshooting

Various conditions may exist on the network that interferes with FIPS snooping, particularly on congested networks.

If the FCoE client is unable to see the FCoE VLAN after booting, restart the `lldpad` and `fcoe` daemons as a troubleshooting step.

1. To restart the `lldpad` and `fcoe` daemons, run the following commands:

```
rcfcoe stop; rclldpad stop; rclldpad start; rcfcoe start
```

2. Then check the FCoE VLAN status by running `fcoeadm -i`. Figure 17 shows VLAN status details.

Figure 17. Restarting the rcldpad and rcfcoc daemons.

```

SUSE Linux
Enterprise Server

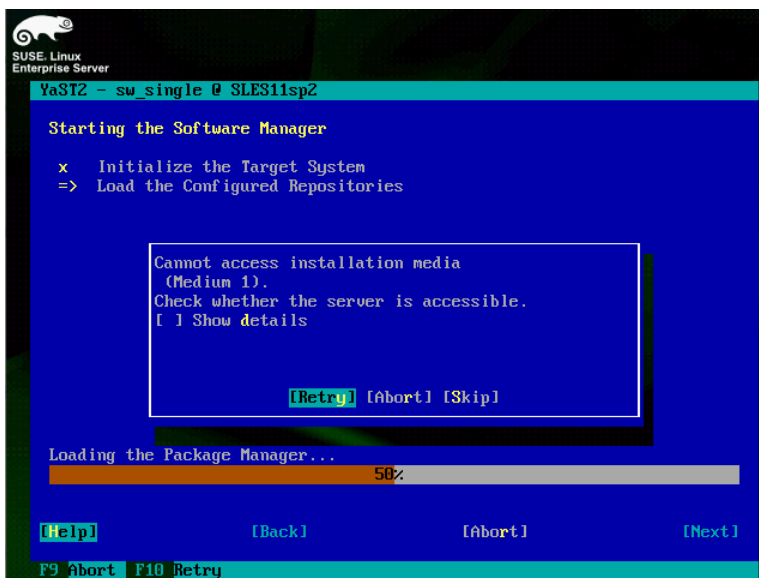
SLES11sp2:~ # rcfcoc stop; rcldpad stop; rcldpad start; rcfcoc start
Stopping FCoE initiator service: done
Shutting down lldpad: done
Starting lldpad: done
Starting FCoE initiator service: done
SLES11sp2:~ # fcoeadm -i
Description: NetXtreme II BCM57810 10 Gigabit Ethernet
Revision: 10
Manufacturer: Broadcom Corporation
Serial Number: 001018C3C5D0
Driver: bnx2x 1.72.18
Number of Ports: 1

Symbolic Name: bnx2fc v2.2.9 over p3p1.255
OS Device Name: host7
Node Name: 0x2000848F695CAB8E
Port Name: 0x2001848F695CAB8E
FabricName: 0x100000051E0F23E8
Speed: 10 Gbit
Supported Speed: 1 Gbit, 10 Gbit
MaxFrameSize: 2048
FC-ID (Port ID): 0x00091D
State: Online

SLES11sp2:~ #
    
```

In some SLES 11 SP2 installations, YaST2 fails to properly detect the SLES 11 SP2 installation media, as in Figure 18.

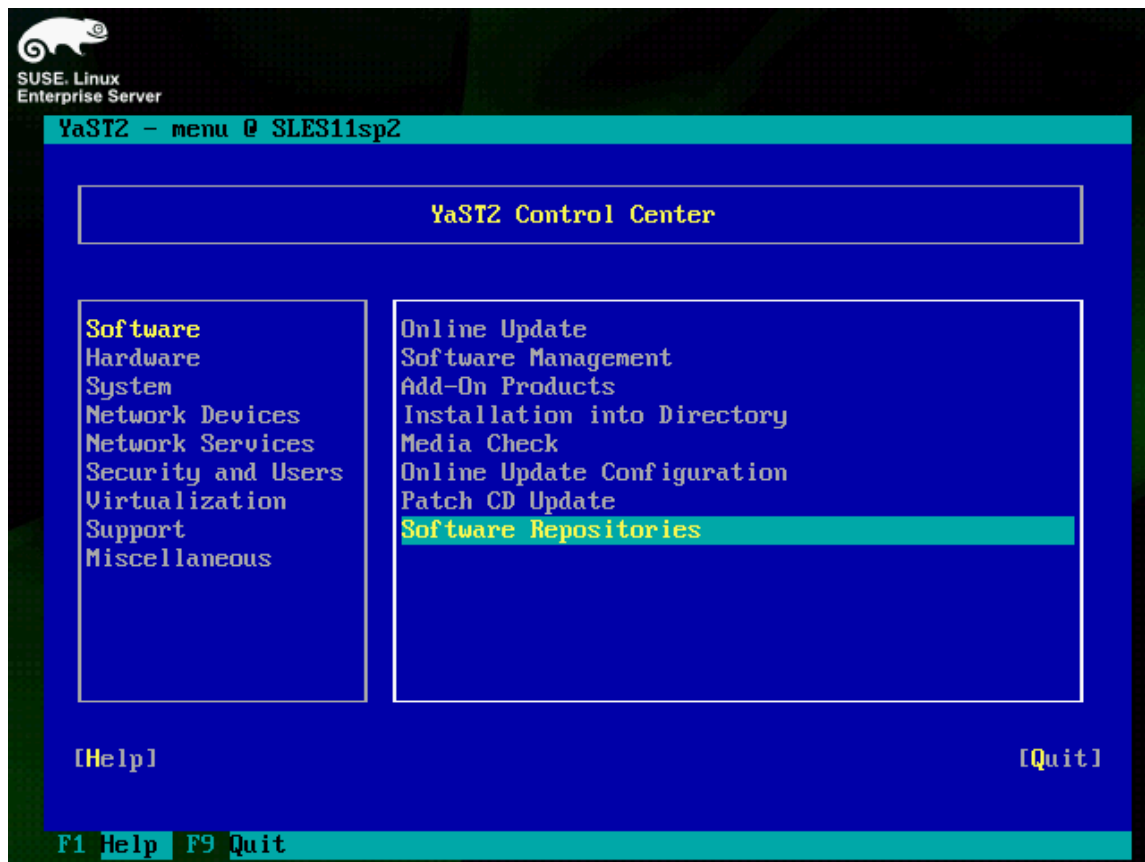
Figure 18. Failure to detect installation media.



The failure to detect installation media is most commonly due to the SLES 11 SP2s configuration files pointing to the incorrect location of the installation media software repository. To correct this issue, perform the following steps:

1. Start YaST2 using the `yast` command, and then select `Software` in the left-side menu, and then select `Software Repositories` on the right side menu, as in Figure 19.

Figure 19. Entering Software Repositories Menu.



2. Delete the existing installation media software repository, and then add the SLES 11 SP2 installation media as a new software repository, as in Figures 20 and 21.

Figure 20. Deleting Old SLES Software Repository.

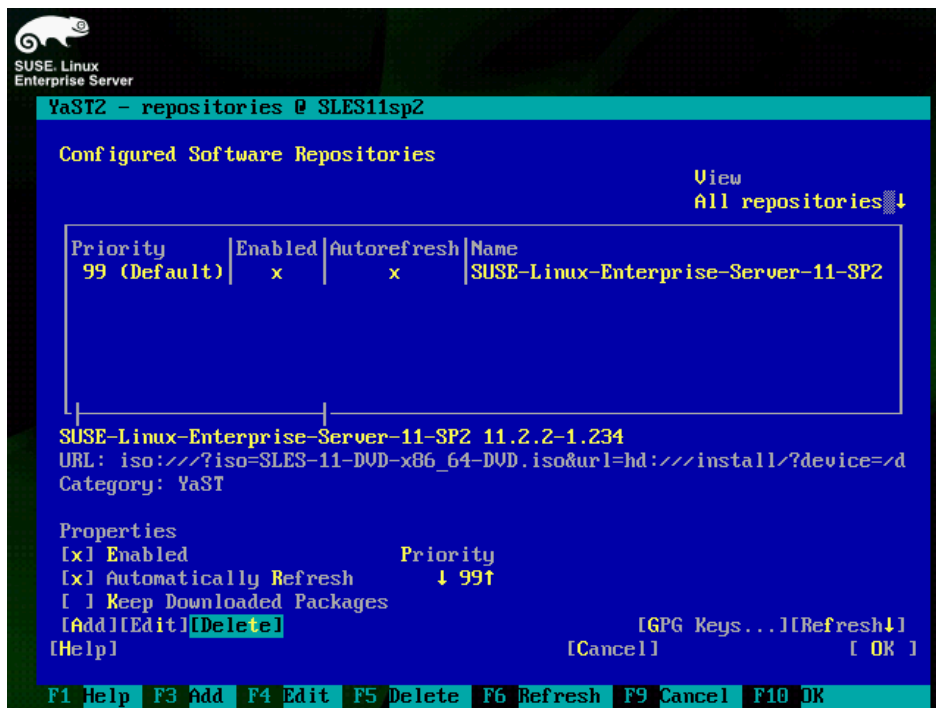
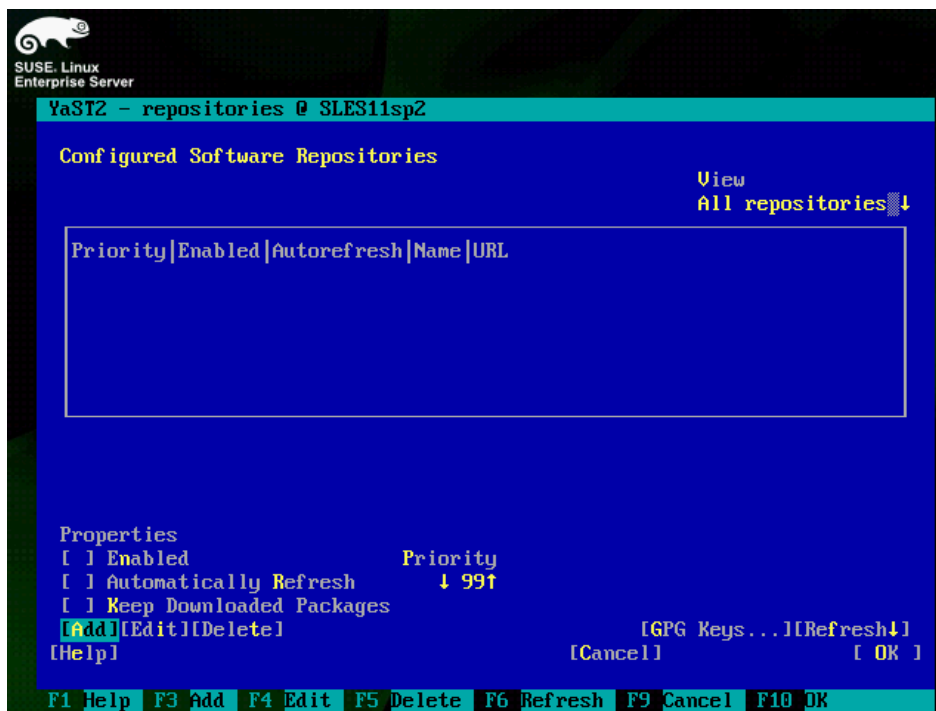


Figure 21. Adding new SLES Install Media Software Repository.



3. Select the appropriate installation media, and then select **Next**, as in Figure 22.
4. Accept the **License Agreement**, select **Next**, and then select **OK**, and you will be returned to the YaST2 Control Center, as in Figure 23.

Figure 22. Selecting the installation media.

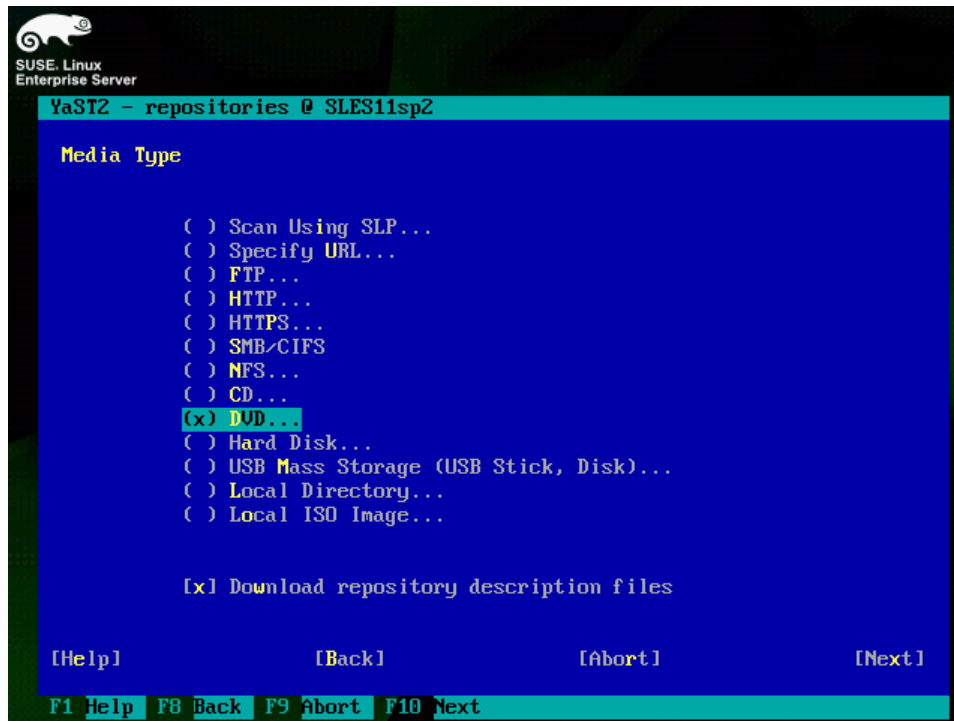
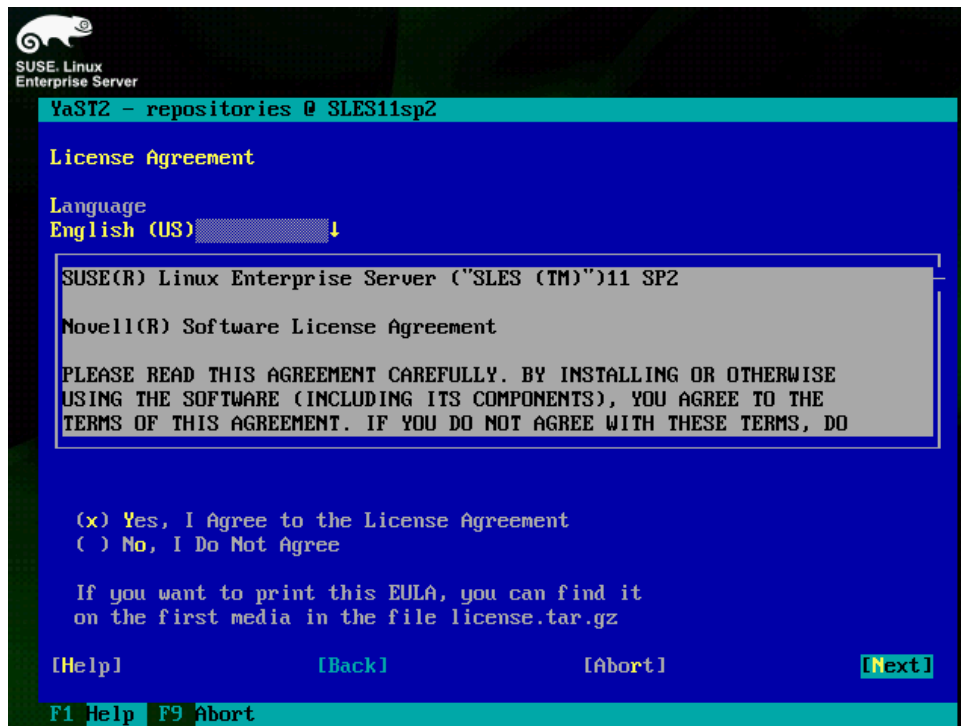


Figure 23. Accepting the License Agreement.





## Setting-up FCoE for RHEL 6.2

### Installing / verifying FCoE support

If FCoE support was not installed in RHEL 6.2, install it. To verify if FCoE support was installed in RHEL 6.2, perform the following steps:

1. Run the following command: `rpm -qa | grep fcoe-utils`. If no information is returned, as in Figure 24, then the `fcoe-utils` package is not installed; it must be installed at this time.

Figure 24. No FCoE support is installed.

```
[root@RHEL62 ~]# rpm -qa | grep fcoe-utils
[root@RHEL62 ~]#
```

2. To install the appropriate FCoE support package (for example: install the `fcoe-utils` package), insert Disc 1 of the Red Hat Enterprise Linux 6.2 installation media into your CD/DVD drive, and then mount the disc to a directory of your choice; in this example, use `/media`, as in Figure 25.

Figure 25. Mounting the installation media.

```
[root@RHEL62 ~]# mount /dev/cdrom /media
mount: block device /dev/sr0 is write-protected, mounting read-only
```

3. Next, change directory to `/media/Packages`, and install the appropriate packages; for example, if you installed your copy of RHEL 6.2 as a Basic Server, you need the following packages: `libhbaapi`; `libconfig`; `lldpad`; `libpciaccess`; `libhbalinux`; `device-mapper-multipath`; `device-mapper-multipath-libs`; `fcoe-utils`. See Figure 26 for details.

Figure 26. Installing FCoE support.

```
[root@RHEL62 ~]# cd /media/Packages/
[root@RHEL62 Packages]# rpm -ihv libhbaapi-2.2-12.el6.x86_64.rpm libconfig-1.3.2-1.1.el6.x86_64.rpm lldpad-0.9.43-12.el6.x86_64.rpm libpciaccess-0.12.1-1.el6.x86_64.rpm libhbalinux-1.0.12-1.el6.x86_64.rpm device-mapper-multipath-0.4.9-46.el6.x86_64.rpm device-mapper-multipath-libs-0.4.9-46.el6.x86_64.rpm fcoe-utils-1.0.20-5.el6.x86_64.rpm
warning: libhbaapi-2.2-12.el6.x86_64.rpm: Header V3 RSA/SHA256 Signature, key ID fd431d51: NOKEY
Preparing...                               ##### [100%]
 1: libhbaapi                               ##### [ 13%]
 2: device-mapper-multipath                 ##### [ 25%]
 3: device-mapper-multipath                 ##### [ 38%]
 4: libpciaccess                            ##### [ 50%]
 5: libhbalinux                             ##### [ 63%]
 6: libconfig                               ##### [ 75%]
 7: lldpad                                  ##### [ 88%]
 8: fcoe-utils                              ##### [100%]
```



Figure 30. Checking the SUPPORTED\_DRIVERS variable.

```

## Type:          yes/no
## Default:       no
# Switch on/off debug messages (script & C code)
DEBUG="no"

## Type:          yes/no
## Default:       yes
# All the messages go to syslog and stderr (script & C code)
USE_SYSLOG="yes"

## Type:          string. Driver names separated by space
## Default:       list of default drivers
# All supported drivers listed here are loaded when service starts
SUPPORTED_DRIVERS="fcoe bnx2fc"

## Type:          integer
## Default:       65
# Wait at most for this amount of seconds to discover all _netdev fstab devices
WAIT_TIMEOUT="65"
~
~
~
~
"config" 19L, 554C

```

- Then, start the `lldpad` and `fcoe` services running the `service lldpad start` and `service fcoe start` commands. Then running the `fcoeadm -i` command to verify that the FCoE VLAN is properly configured, as in Figure 31.

Figure 31. Verifying proper configuration of FCoE VLAN.

```

[root@RHEL62 fcoe]# service lldpad start
Starting lldpad: [ OK ]
[root@RHEL62 fcoe]# service fcoe start
Starting FCoE initiator service: [ OK ]

[root@RHEL62 fcoe]# fcoeadm -i
Description:      NetXtreme II BCM57810 10 Gigabit Ethernet
Revision:        10
Manufacturer:    Broadcom Corporation
Serial Number:   001018C3C5D0
Driver:          bnx2x 1.72.18
Number of Ports: 1

Symbolic Name:   bnx2fc v2.2.9 over p3p1.255-fcoe
OS Device Name:  host9
Node Name:       0x2000848F695CAB8E
Port Name:       0x2001848F695CAB8E
FabricName:      0x100000051E0F23E8
Speed:           10 Gbit
Supported Speed: 1 Gbit, 10 Gbit
MaxFrameSize:   2048
FC-ID (Port ID): 0x0D091E
State:           Online

[root@RHEL62 fcoe]#

```

- Finally, verify LUNs device name by listing all available partitions using the `cat /proc/partitions` command, as in Figure 32.

Figure 32. Verifying LUNs availability.

```
[root@RHEL62 fcoe1]# cat /proc/partitions
major minor #blocks name
 8         0 142737408 sda
 8         1   512000 sda1
 8         2 142224384 sda2
253        0  52428800 dm-0
253        1  8142848  dm-1
 8        16   315392 sdb
 8        17   315391 sdb1
253        2  81649664 dm-2
 8        48 280278528 sdd
 8        64 280278528 sde
[root@RHEL62 fcoe1]# _
```

Partition and mount your FCoE LUNs as any other hard disk device.

## Configure the FCoE client to start at boot

If you want the FCoE client to start and the FCoE LUNs to automatically be available after every reboot, configure the appropriate services using `chkconfig`. To do this, perform the following steps:

1. To enable FCoE at boot time, run the following commands: `chkconfig lldpad on` and `chkconfig fcoe on`, as in Figure 33.

Figure 33. Configuring FCoE to start at system boot.

```
[root@RHEL62 ~]# chkconfig lldpad on
[root@RHEL62 ~]# chkconfig fcoe on
```

2. Verify that the services are set to start at boot by running `chkconfig --list | grep lldpad` and `chkconfig --list | grep fcoe`, as in Figure 34.

Figure 34. Verifying that FCoE services are configured to start at boot time

```
[root@RHEL62 ~]# chkconfig --list | grep lldpad
lldpad      0:off  1:off  2:on   3:on   4:on   5:on   6:off
[root@RHEL62 ~]# chkconfig --list | grep fcoe
fcoe        0:off  1:off  2:on   3:on   4:on   5:on   6:off
[root@RHEL62 ~]#
```

## Troubleshooting

It is possible for other various conditions to exist on the network that can interfere with FIPS snooping, particularly on congested networks. If the FCoE client is unable to see the FCoE VLAN after booting, it is recommend to restart the `lldpad` and `fcoe` daemons as a troubleshooting step.

1. To restart the `lldpad` and `fcoe` daemons, run the following commands:

```
service fcoe stop; service lldpad stop; service lldpad start; service fcoe start
```

Then check the FCoE VLAN status by running `fcoeadm -i`. See Figure 35 for details.

Figure 35. Restarting the lldpad and fcoe daemons.

```
[root@RHEL62 ~]# service fcoe stop; service lldpad stop; service lldpad start; s
ervice fcoe start
Stopping FCoE initiator service:           [ OK ]
Stopping lldpad:                            [ OK ]
Starting lldpad:                            [ OK ]
Starting FCoE initiator service:           [ OK ]

[root@RHEL62 ~]# fcoeadm -i
Description:      NetXtreme II BCM57810 10 Gigabit Ethernet
Revision:        10
Manufacturer:    Broadcom Corporation
Serial Number:   001018C3C5D0
Driver:          bnx2x 1.72.18
Number of Ports: 1

Symbolic Name:   bnx2fc v2.2.9 over p3p1.255-fcoe
OS Device Name:  host7
Node Name:       0x2000848F695CAB8E
Port Name:       0x2001848F695CAB8E
FabricName:      0x100000051E0F23E8
Speed:           10 Gbit
Supported Speed: 1 Gbit, 10 Gbit
MaxFrameSize:   2048
FC-ID (Port ID): 0x0D0D15
State:           Online

[root@RHEL62 ~]#
```

## Conclusion

While it is not possible to cover every conceivable combination of FCoE hardware in a single document, most modern FCoE implementations are likely be fairly similar on the various available FCoE compliant devices. Use this document as a general guide to aid you in configuring FCoE in most situations. If you do use this guide with hardware other than that listed in the Described Configuration section above, verify that it is FCoE compliant and that all appropriate firmware and drivers are updated per vendor specifications prior to attempting to configure FCoE.