Management Networks for Dell EMC Networking

A guide for providing management access to networked devices using console servers, Ethernet out-of-band, and Ethernet in-band

Abstract

Large production networks can span across multiple rooms, buildings, or cities, and contain dozens or hundreds of network switches. Using a management network separate from the production network is often desired to configure and manage these environments. There are three types of management networks that are discussed in this guide, each offering its benefits. Network administrators may use one or more methods to configure, test, and manage their setups.

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1 Introduction

Production networks consist of one or more Ethernet switches that carry production traffic data from end to end. Administrators must be able to access the production switches to manage them. For small networks with switches that are physically accessible in the same room, it is easier for the administrator to access and connect to each switch using the console port. This method is used when the initial configuration is performed and may be used for continued management of the switch. In most instances, however, production networks are too large to configure and manage one switch at a time through the console port. These larger networks contain many switches that are scattered across multiple rooms, buildings, cities, and beyond. In these situations, a management network that is separate from the production network is preferred and offers many benefits.

Management networks allow administrators to configure, manage, and monitor all devices in the network including switches and servers. There are three types of management networks that are widely used with Dell EMC networked devices. This document provides the pros and cons of each management network type and assists you in selecting one or more methods to suit your needs.

1.1 Purpose of this document

Table 1 describes what is and what is not the purpose of this document.

Table 1 Is/is not

This document is:	This document is not:
Used to configure a management network	A guide for managing the production network
Used to connect Dell EMC devices	An interoperability guide for non-Dell devices
For connecting to devices remotely for configuring	A guide for configuring the production network
Provides access to production network devices	For performance analysis, telemetry, or other use

1.2 Typographical conventions

The CLI and GUI examples in this document use the following conventions:

`Monospace Text`	CLI examples
`Underlined Monospace Text`	CLI examples that wrap the page
`Italic Monospace Text`	Variables in CLI examples
`Bold Monospace Text`	Commands entered at the CLI prompt, or to highlight information in CLI output
Bold text	UI elements and information that is entered in the GUI

1.3 Production network example

Figure 1 is an example of a network topology that contains Dell EMC servers, switches, and other devices. This configuration demonstrates a single rack deployment without any management network. The cloud depicts an existing infrastructure, including spine or core switches, typically found in a data center.

Note: Configuration of leaf-spine and other upstream network switches is beyond the scope of this guide.

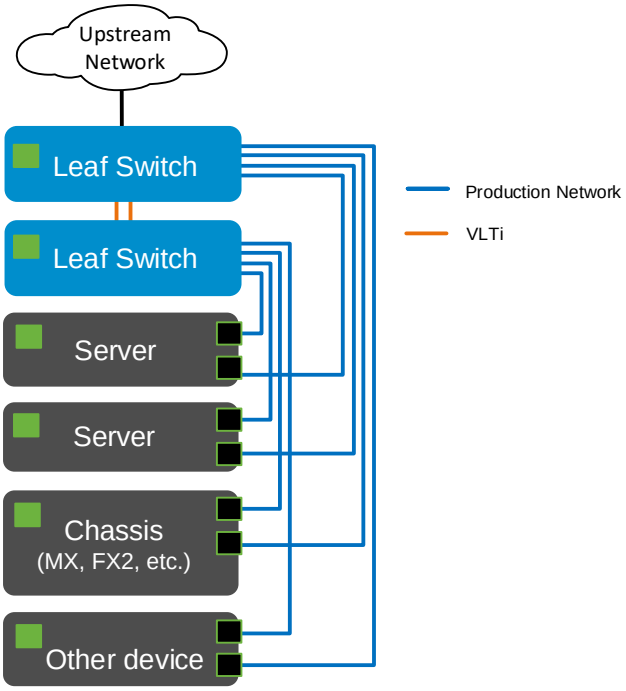


Figure 1 Production network of a single rack without a management network

A management network can be constructed before or after a production network is up and running. This is true for console, OOB, and in-band management. For smaller production networks or for existing networks where only one or two additional devices are being installed, it is easy to configure each new device with a direct console cable from a laptop as the device is being added. This is a practical method for providing short-term access to the equipment.

For long-term access to all equipment on a production network, Dell EMC recommends you implement a management network. The management networks that are described in this guide can be applied to the devices used in the production network. Implementing the management network requires one or more of the following:

- Extra hardware, software, installation, and configuration
- Additional configuration of devices being managed
- Additional cabling

The remainder of this document provides information regarding the various methods for long-term management of the production network.

2 Management network selection

There are three management network methods that are commonly used for deploying and managing switches, servers, and other devices on the network: console, out-of-band Ethernet, and in-band Ethernet. The method that is used is based largely on the existing architecture, preference, budget, or a combination of these factors. If a management network is already in place and working satisfactorily, there is little else to do. The planning or budgeting of a green field network, or the addition to an existing management infrastructure in a brown field network, can prompt questions regarding the method of management to use. This guide helps you decide which method(s) should be used and the process that is required to set up the management network.

The following should be considered when deciding which management network(s) is best for your environment and budget:

- New or existing production network
- Accessibility of the management network when the production network is down
- Ability to connect to management network over IP: SSH, Telnet, HTTPS, HTTPS
- Ability to connect and view logs of production switches while they are booting
- Security
- Budget concerns

Table 2 shows a comparison between the commonly used management networks, each with pros and cons. This information may be used in deciding which management network(s) is best for your environment and budget.

Table 2 Comparison of Management Network Methods

	Console management	**OOB Ethernet management**	**In-band Ethernet management**
Pros	• Ideal for new configurations • Always accessible if power is on • Operates during POST • View logs during boot • Independent network	• Can be accessible when the production network is down • SSH and Telnet support • HTTP and HTTPS support • Allows for ACLs for identity and security	• Uses existing equipment • SSH and Telnet support • HTTP and HTTPS support • Allows for ACLs for identity and security
Cons	• Requires extra equipment for one-to-many management • No SSH or Telnet support • No HTTP or HTTPS support • Slower file transfers/upgrades • Dedicated console cabling, dongle, and driver installation • Embedded USB driver installation	• Requires additional dedicated switches • Requires extra cabling • Dedicated management ports not available on all switches	• May go down along with the production network • Requires use of production network ports • Requires use of production network bandwidth • Dedicated management ports are left unused

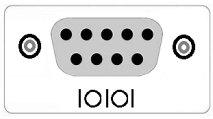
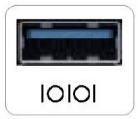
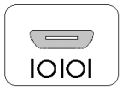
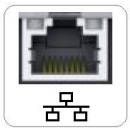
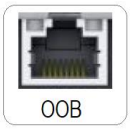
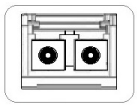
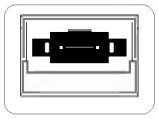
Implementing two or more methods can complement each other and enable network administrators the flexibility of choosing where to deploy each.

2.1 Switch management ports

There are various port types available for connecting switches to a management network. The port that is used depends on the category of management network being used and the port that is available on the managed switch. Table 3 provides examples of ports to look for on the switch.

Note: For additional information regarding the network ports available with your hardware, see the documentation that comes with your hardware.

Table 3 Switch management port connectors

Console Management	OOB Ethernet Management	In-band Ethernet Management
 RJ45 connector  DB9 connector  USB A connector  Micro USB B connector  USB B connector	 RJ45 connector  OOB RJ45 connector	 RJ45 connector  Optical connector*  Optical connector* These connectors for switches are used primarily for production traffic. They can also be used to carry management traffic.

*Optical connectors are embedded in optic transceivers that are used with SFP and QSFP ports. Optionally, a DAC cable can be used in place of these transceivers.

On a switch, the RJ45, DB9, and USB type A console port connectors (showing the “IOIOI” symbol) are RS-232 serial signal connectors. USB type B console ports are USB data ports that connect directly to a workstation USB port.

2.2 Console management

This connection method uses the console port on a device to configure it. Physical access to the device is required when directly connected to a workstation (laptop or desktop) computer. In a data center environment where there are many devices within one or more racks, console ports are typically connected to a console server to aggregate the console connections in the rack.

A single console server usually provides enough ports to manage all of the devices in a rack. There are several third-party manufacturers to choose from that offer console servers. These devices offer an Ethernet NIC port to allow an uplink to an Ethernet network, such as in-band or OOB, as shown in Figure 2. Depending on the console server model, multiple network administrators can use application layer protocols such as SSH, Telnet, HTTP, and others, to log in to the console server and access the console ports of the devices attached.

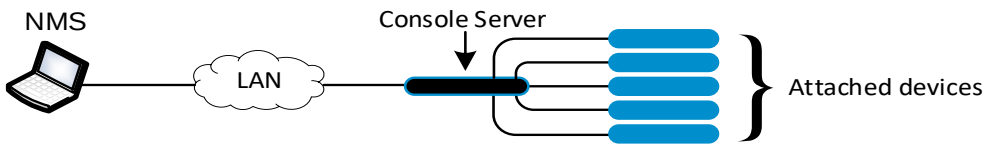


Figure 2 Console server management topology

The application layer protocols are only used on the Ethernet network to connect to the console server. The console server then provides the console port access of the devices being managed.

Chapter 3 discusses how to setup console management for configuring and managing devices.

2.3 OOB Ethernet management

This connection method uses the dedicated Ethernet OOB port on a device to configure and manage it. Two such ports that are commonly used are:

- OOB port on a switch
- iDRAC port on a server

This connection method utilizes a dedicated OOB management switch that provides enough ports to manage all of the devices within a rack. The management switch that is shown in Figure 3 is connected to switches, servers, and other devices for managing.

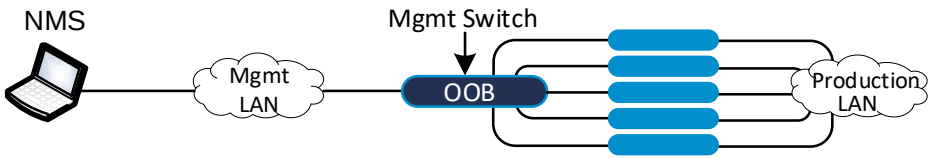


Figure 3 OOB Ethernet management topology

Chapter 4 discusses the setup of Ethernet OOB management for the configuration and management of devices on the production network.

2.4 In-band Ethernet management

The in-band Ethernet method allows production and management data to be shared using the same physical connections. There is little, if any, dedicated infrastructure, including dedicated switches or cabling, involved with this solution.

All Dell EMC switches and servers with Ethernet ports support in-band management. Chassis switches such as the Dell EMC Networking MX9116n and the Dell EMC Networking MX5108n for the Dell EMC PowerEdge MX7000, also support in-band management. In-band management is often attained using a dedicated VLAN used only for management of devices.

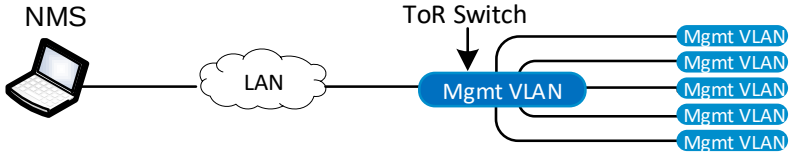


Figure 4 In-band Ethernet management topology

Chapter 5 discusses the setup of Ethernet in-band management for the configuration and management of devices on the production network.

3 Console management

Before discussing console servers, it is important to understand how a single console port is used. Console ports on a switch allow users to access the command line interface (CLI) and to configure the switch. Using a cable and physical access to the switch, users can configure the system right out of the box. A computer with an installed terminal emulator is required.

Ethernet switches generally require VLANs, IP addresses, security, and other settings to properly communicate with the network. The console port may be used to make these initial settings before adding a switch to the existing Ethernet network.

Most switches have a console port as shown in Table 3. A console port cable usually ships in the box with the switch that enables you to connect the switch directly into your workstation for initial configuration. For switches that do not ship with a cable, standard serial cables are typically used.

Note: The documentation that came with your device is the best source to identify the exact cable (and any required adapter) that should be used.

Section 3.1 discusses how to connect to a single switch using its console port. The same information is needed when deploying a console server. Section 3.2 discusses how to set up a console server. Table 4 shows the capabilities of each method.

Table 4 Features of console ports and console servers

Feature	Console port (local access)	Console server (over the network)
Accessible when the managed device has power	✔	✔
Operates during POST	✔	✔
View logs during boot	✔	✔
OOB network	✔	✔
Uses the serial console ports of managed devices	✔	✔
Ideal for out-of-the-box, local configurations	✔	
Accessible without an Ethernet network	✔	
No console server required	✔	
SSH and Telnet may be supported		✔
HTTP and HTTPS may be supported		✔
Provides one-to-many access to managed devices		✔
Ideal for long-term access to managed devices		✔
Remote management of devices		✔

Some switches (with or without a console port) can be preconfigured with an IP address, or have DHCP enabled to allow users to begin configuring the switch with IP, bypassing the initial need for a console port. Check the documentation that came with your device for more information.

Note: A console server is also known as a terminal server, console switch, serial server, and serial concentrator. For consistency, this document only refers to it as a console server.

3.1 Connecting a single switch

Connecting to a single switch can be done by using the switch's console port and connecting it directly to a portable device (such as a laptop). A console server is not used in this case. The console port connector on

most PCs today is USB. See Table 3 to identify the type of console port you are using on the switch. The console port of the switch being configured will be identified with the symbol “IOIOI”. Once you have identified the two connectors being linked, it is easy to determine which console cable to used. PCs without an RS-232 serial port require a “USB to serial” adapter to connect to a switch with only an RS-232 console port.

Note: On a switch, RJ45, DB9, and USB Type A console port connectors (showing the “IOIOI” symbol) are RS-232 serial signal connectors. The USB Type B console ports are USB data ports that connect directly to a PCs USB port.

Use the steps below to connect to a single switch through the console port, and allow the user access to the CLI command prompt.

1. Using a console cable, attach your computer to the console port on the switch as shown in Figure 5.

Figure 5 Connecting to a single device through the console port

2. If the port on the switch is a USB Type B, download and install the associated driver from Table 6.
3. Install a terminal emulator onto your workstation using the documentation that comes with the terminal emulator.

Note: Several terminal emulators are available for Windows, Linux, and other operating systems. PuTTY is one example and can be found at https://www.putty.org.

4. Open the terminal emulator.
5. Using the console port settings in Table 5, configure your terminal emulator to connect to the switch.

Table 5 Console port settings

Dell EMC switch	Console port settings
• S Series Force10: S25, S50, S55, S60, S4810, S4820, S5000, S6000 • Z Series Force10 OS9: Z9000, Z9500 • Chassis Series: m6220, m6348, 8024, m8024-k, MXL, IOA, C9010 • N Series: N1500, N2000, N3000, N4000 • PowerConnect Series: 2700, 2800, 3400, 3500, 5400, 5500, 6200, 7000, 8024, 8100 • X Series: X1000, X4000	• Speed (baud rate) = **9600** • Data bits = **8** • Parity bits = **none** • Stop bits = **1** • Flow control = **none**
• ON Series: N1100-ON, N2100PX-ON, N3100PX-ON, N3000E-ON, S3048-ON, S4048-ON, S4100-ON, S4810-ON, S5000-ON, S5100-ON, S5200-ON, S6000-ON, Z9100-ON, Z9200-ON • Chassis Series: MX7000, FN410S, FN410T, FN2210S	• Speed (baud rate) = **115200** • Data bits = **8** • Parity bits = **none** • Stop bits = **1** • Flow control = **none**

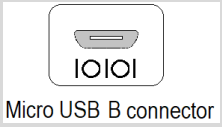
Note: Appendix A provides an example of configuring and using a terminal emulator.

3.1.1 USB Type B connectors

Some switches have multiple serial ports, and often include a standard RS-232 port and a USB Type B console port.

When using a USB Type B console port on a switch, a driver must be installed in the OS of the PC used for the connection. Table 6 shows the required USB Type B drivers for Dell EMC PowerSwitch series switches.

Table 6 USB B drivers for PowerSwitch series switches

This table shows the drivers that are required when using a 

or a 

port.

Switch model	USB B chip	USB B driver
C9010, Z9100, S6100, S6000, S5248BF, S5248LBF, S5212F, S5224F, S5232F, S5248F, S5296F, N16xx, N22xx, N32xx, Z9500	Silicon Labs CP2102	https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers
S4048, S6010, S4048T, S4128/S4128T, S4148/S4148T, S4148E, S4112F/S4112T, S5148F, S5048F, Z9264F	Silicon Labs CP2109	https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers
N1008/N1008P, N1024/N1024P, and N1048/N1048P	FTDI FT230XS	Micro USB port: Windows Update: https://www.ftdichip.com/Drivers/VCP.htm
MX7000 (MSM, MX9116n, MX5108n)	Cypress CY7C6521	Micro USB port: Windows Update https://www.cypress.com/sdc Requires registration
S3048, S3124, S3124F, S3124P, S3148, S3148P, N3132PX, N2128PX, N1524/N1524P, N1548/N1548P N4000, N30xx, N20xx	N/A	RS-232 serial port only

3.2 Using a console server

A console server can be used to simultaneously access the console ports of many switches on the network from one or more locations. This allows network administrators to access devices console ports remotely, without having to be physically next to the devices they are managing. In general, a console server is used for long-term access to many devices in a production network, whereas local access to a console port, using a direct cable from a workstation to the device, is used for short-term access to a single device.

Note: For an example of a console server, see https://www.dell.com/en-us/work/shop/accessories/apd/a7832029.

Figure 6 shows how a console server can attach to and manage all devices with console ports in a rack.

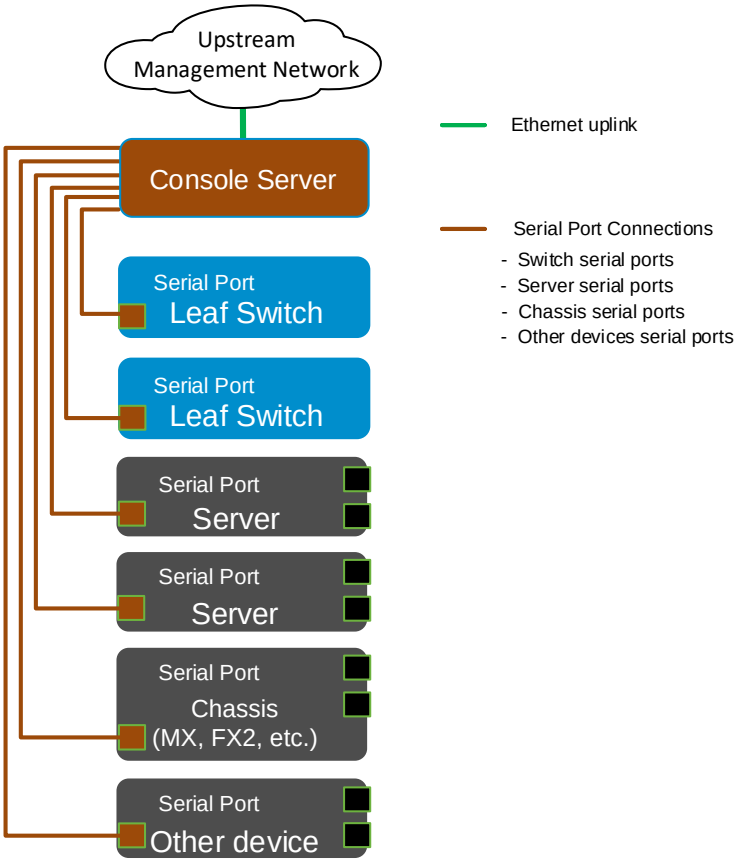


Figure 6 Console port management network in a single rack

Note: SSH/Telnet/HTTP/HTTPS is only used to connect to the console server which provides the user with console port access to the managed devices.

3.2.1 Setting up a console server

Installing and configuring the console server to connect to the Ethernet network, and the switches to be managed, consists of the following basic steps. Consult the documentation provided with the console server for the exact requirements for that device.

Note: Some console servers offer wizards and automatic discovery apps to assist with the steps in this section.

1. Mount the console server into the rack using the instructions.
2. Cable the console server to the Ethernet management network (in-band or OOB).
3. Use cables to connect the console server to each device to be managed.
4. Install the console management software that comes with the console server onto a workstation or NMS (network management system) used to manage the console server.
5. Configure IP information on the console server using the server's documentation.
6. Ping the console server from the management station to confirm that a successful connection is made.
7. If not already done, install a terminal emulator program to a workstation or NMS on the network.
8. Open the terminal emulator from the remote system.

9. Ping the console server from the system where the terminal emulator is installed to confirm that a successful connection is made.

The information that is used in section 3.1 for connecting to a single console port, applies when connecting the console ports to the console server. Consult the documentation that is provided with the console server hardware for additional instructions or troubleshooting.

Note: Appendix A provides an example of configuring and using a terminal emulator.

4 Out-of-band (OOB) management networks

The OOB management network is a separate network that is solely for management traffic. The network uses the dedicated management port on each switch to connect to a management switch dedicated for management traffic. Production traffic initiated by the network end-users does not traverse the OOB management network. An OOB management network is typically desired in most data centers, large enterprises, and backbone networks of service providers, where network management is critical. This topology has the advantage of fast connection speeds of Ethernet over the speeds of serial connections that are shown in the previous topology. The managed devices use IP addresses through static assignment or a DHCP server.

This solution requires the addition of one or more dedicated management switches (as discussed in section 4.1). Using an OOB Ethernet network provides the following benefits:

- Continued access when the production network becomes misconfigured
- Continued access during production network cabling failures
- Accessible through IP protocols such as SSH, HTTPS, Telnet, and HTTP
- Allows for OOB ACLs for identity and security

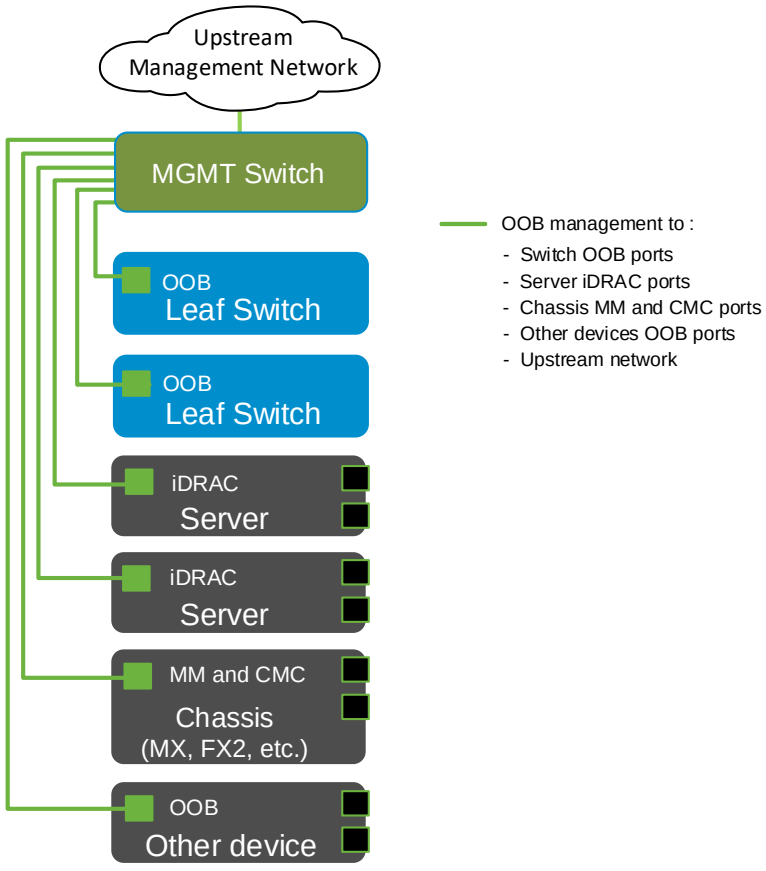


Figure 7 OOB management network of a single rack

4.1 Network management switch

Dedicated network management switches today are usually 1GbE Base-T switches. These switches are less expensive than most other networked equipment they are being used to manage. Many 1GbE Base-T Ethernet switches on the market provide the features needed to make it a viable management switch.

You should select a switch that will provide enough 1GbE ports to connect to all devices you want to manage in the rack. The Dell EMC PowerSwitch S3048-ON and the Dell EMC PowerSwitch N2048 are two examples of switches that are ideal for OOB management of a single rack. Each are 1-RU with forty-eight 1GbE Base-T ports for connecting to downstream managed devices, such as switches and servers. The S3048-ON has four 10GbE SFP+ ports, and the N2048 has two 10GbE SFP+ ports, for connecting to the upstream management cloud. These switches may be used right out of the box to manage a single rack of equipment.

Note: Dell EMC recommends changing the admin password to a complex password during the first login.

4.2 Configuring OOB management on production switches

Note: The steps in this document were validated using specific Dell EMC PowerSwitch series switches and operating systems. The steps may be used for other Dell EMC PowerSwitch series switch models that have the same networking operating system version or later, if the switch has the available port numbers, speeds, and types. Consult your switch's documentation for the specific commands to be used.

The commands for setting the OOB management ports can differ depending on the switch hardware and operating system. For example, the OOB port for the Dell EMC PowerSwitch S4048-ON running OS9 is **`managementethernet 1/1.`** The OOB port for the Dell EMC PowerSwitch S4148-ON running OS10EE is **`mgmt 1/1/1`**. OS9 and OS10EE examples are provided in the following sections.

The commands that are used in the following examples are entered on the production switches that connect their OOB ports to the management switch. OOB interfaces are always untagged.

4.2.1 OS9 configuration

The following commands show how to configure the OOB port on a Dell EMC PowerSwitch series production switch with Dell EMC Networking OS9 installed. Replace the IP address and management route (default gateway) address with the ones for your network.

```
OS9#configure
OS9(conf)#interface managementethernet 1/1
OS9(conf-if-ma-1/1)#ip address 192.168.1.10/24
OS9(conf-if-ma-1/1)#no shutdown
OS9(config)#management route 0.0.0.0/0 192.168.1.1
```

4.2.2 OS10EE configuration

The following commands show how to configure the OOB port on a Dell EMC PowerSwitch series production switch with Dell EMC Networking OS10EE installed. Replace the IP address and management route (default gateway) address with the ones for your network.

```
OS10#configure
OS10(conf)#interface mgmt 1/1/1
OS10(conf-if-ma-1/1/1)#no ip address dhcp
OS10(conf-if-ma-1/1/1)#ip address 192.168.1.10/24
OS10(conf-if-ma-1/1/1)#no ipv6 address autoconfig (optional)
OS10(conf-if-ma-1/1/1)#no ipv6 enable (optional)
OS10(conf-if-ma-1/1/1)#no shutdown
OS10(conf-if-ma-1/1/1)#exit
OS10(config)#management route 0.0.0.0/0 192.168.1.1
```

4.3 Cabling production switches to OOB management

Table 3 on page 8 shows the possible OOB ports available for the Dell EMC PowerSwitch series switches. Notice there are two RJ45 connections with different symbols. Both symbols indicate an OOB port.

Attach a cable from the OOB Ethernet port on the switch to be managed to one of the 48-1GbE ports on the management switch. Test the connection to the management network by pinging between the managed switch and the management station or NMS.

While some Dell EMC PowerSwitch series switches have SSH enabled by default, with Telnet disabled, others have Telnet enabled by default. Check the documentation for the switches you are using to find the default protocols that are enabled and the ID and password credentials for logging in. From the management station or NMS, use the SSH or Telnet application to connect to the managed device.

Note: SSH is inherently more secure than Telnet and is generally preferred in most installations when available.

Note: Dell EMC recommends changing the admin password to a complex password during the first login.

The switches in your rack are now available for managing through the OOB management network. Appendix A provides an example of configuring a terminal emulator to connect to a managed device through SSH and other protocols.

5 In-band management networks

With in-band management, devices are managed through the production network switches, avoiding the need of purchasing a dedicated management switch. This solution requires that you initially configure each managed switch locally through a serial port connection. An in-band management network is typically used when resources are limited. The cost savings can be realized when used in branch offices or smaller deployments. Those businesses still have the option of choosing a hybrid solution, where a dedicated OOB management is only implemented on the most critical part of their production network.

The example topology in Figure 8 shows two Dell EMC 48-port leaf switches configured in a VLT pair to provide redundant paths to the upstream network. The leaf switches that are shown are Dell EMC S4048T-ON switches that connect the servers, and other devices, to each other and to the upstream network.

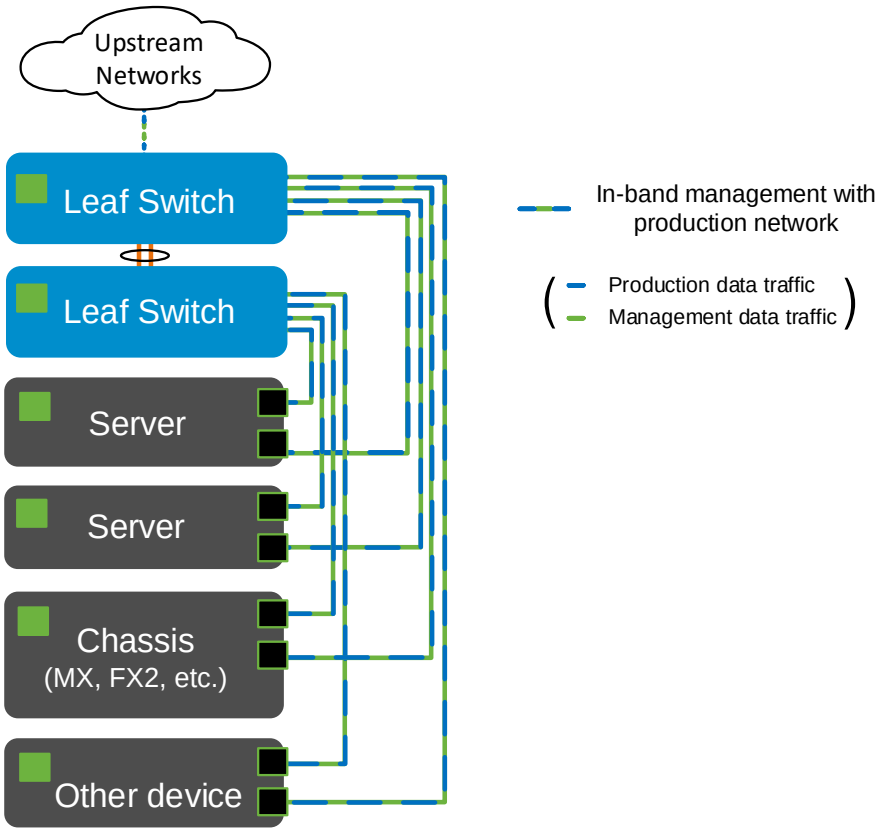


Figure 8 In-band Management network

Note: Configuring routing to the upstream network is beyond the scope of this document.

5.1 Network switch (for production and management)

Selecting the leaf or top-of-rack (ToR) network switches depends on many factors including port speed, media type, cost, and features. Dell EMC offers a full line of data center switches capable of in-band management for the leaf or ToR switch requirements. The S4048T-ON was used in the examples that are provided in this chapter. The S4048T-ON is a 1-RU switch with forty-eight 10GbE Base-T ports for connecting to downstream managed devices. It also has two 40GbE for the VLTi, and four 40GbE for uplinks. The port

count usually provides enough 10GbE ports to connect to all devices in the rack. For this example, rack servers, server chassis, and rack power distribution units (PDUs) were connected.

5.2 Configuring management on production switches

To configure the switch to use the in-band connections (front panel Ethernet ports), an IP address is assigned to a VLAN. By default, all IPs can access the management console of the Dell EMC switch.

The commands for setting up a management VLAN often depend on the switch hardware and operating system. The examples that are provided for the S4048T-ON are running the OS9 or OS10 operating system. Separate VLANs could be configured to manage different types of equipment based on your requirements. In this example, VLAN 10 is used for both switch and server management.

On switches running OS10, Telnet is disabled, and SSH is enabled by default. OS10 has default credentials of admin/admin. The switch is accessible by default using SSH with those credentials. Changing the admin password to something more complex is recommended.

Note: While the steps in this document were validated using the specified Dell EMC PowerSwitch series switches and operating systems, they may be used for other Dell EMC PowerSwitch models using the same networking operating system version or later assuming the switch has the available port numbers, speeds, and types. Consult the documentation included with the switch for the specific commands to use.

5.2.1 OS9 configuration

The commands in this section show how to configure the management VLAN on a Dell EMC PowerSwitch series switch with OS9 installed. For a more secure connection, SSH is enabled and Telnet is disabled.

```
OS9# config
OS9(conf)# ip ssh enable
OS9(conf)# username admin password admin privilege 15
OS9(conf)# no ip telnet enable (optional)
```

Configure the interfaces for the upstream and server connections. In this example port 1/48 is used for upstream and ports 1/1-1/4 are used for server connections. Provide an interface description, use portmode hybrid to allow tagged and un-tagged frames, and configure ports as layer 2 switchport using the switchport command.

```
OS9(conf)#interface tengigabitethernet 1/48
OS9(conf-if-te-1/48)# description upstream network
OS9(conf-if-te-1/48)# portmode hybrid
OS9(conf-if-te-1/48)# switchport
OS9(conf-if-te-1/48)# no shutdown
OS9(conf-if-te-1/48)# exit

OS9(conf)# interface range tengigabitethernet 1/1-1/4
OS9(conf-if-te-1/48)# description server connections
OS9(conf-if-te-1/48)# portmode hybrid
OS9(conf-if-te-1/48)# switchport
OS9(conf-if-te-1/48)# no shutdown
OS9(conf-if-te-1/48)# exit
```

Configure the VLAN for connections to the upstream and server connections port 1/48 is used for upstream and ports 1/1-1/4 are used for server connections in this example. Provide an interface description and apply an IP address. Tag the ports that will be part of the management VLAN

Note: Replace the IP address and VLAN ID shown to match your network.

```
OS9(conf)# interface vlan 10
OS9(conf-if-vl-10)# description Management VLAN
OS9(conf-if-vl-10)# ip address 192.168.1.10/24
OS9(conf-if-vl-10)# no shutdown
OS9(conf-if-vl-10)# tagged tengigabitethernet 1/1-1/4,1/48
```

5.2.2 OS10EE configuration

The commands in this section describe the steps needed to configure the management VLAN port on a Dell EMC PowerSwitch series switch with OS10EE installed. Replace the IP address with an available one for your network.

Configure the management VLAN for upstream and server connections VLAN 10 is used for upstream and server management in this example. Provide interface descriptions. Apply an IP address to the VLAN and add the VLAN to the ports.

```
OS10(config)# interface vlan 10
OS10(config)# description "Management VLAN"
OS10(conf-if-vl-10)# ip address 192.168.1.10/24
OS10(conf-if-vl-10)#exit

Add/apply VLAN to upstream port(s)
OS10(config)# description "upstream network"
OS10(config)# interface ethernet 1/1/48
OS10(conf-if-eth1/1/48)# switchport mode trunk
OS10(conf-if-eth1/1/48)# switchport trunk allowed vlan 10

OS10(config)# description "server connections"
OS10(config)# interface range ethernet 1/1/1-1/1/4
OS10(conf-if-eth1/1/48)# switchport mode trunk
OS10(conf-if-eth1/1/48)# switchport trunk allowed vlan 10
```

Show port configuration:

```
OS10(conf-if-eth1/1/48)# show configuration
 !
 interface ethernet1/1/48
 no shutdown
 switchport mode trunk
 switchport access vlan 1
 switchport trunk allowed vlan 10
```

While some switches have SSH enabled by default (with Telnet disabled), others have Telnet enabled by default. For example, switches running OS10EE have SSH enabled and telnet disabled by default. Check the documentation for the switches you are using to find the default protocols that are enabled and the ID and

password credentials for logging in. From the management station or NMS, use the SSH or Telnet application to connect to the managed device.

Note: Dell EMC recommends changing the admin password to a complex password during the first login.

5.3 Control access to management functions

In an in-band network, it is important to control the access to the management system (CLI). You can control or limit the Telnet or SSH connections to switch management by applying access lists on VTY lines.

To limit access to the switch management, create IPv4 or IPv6 access lists with permit or deny filters. Enter VTY mode using the line vty command in configuration mode and apply the access lists to the VTY line with the {ip | ipv6} access-class access-list-name command.

5.3.1 OS9 configuration

Below is example of a standard ACL that will allow access from the 192.168.1.0 subnet. Provide a description. Set an IP address filter and apply the ACL to VTY lines.

```
OS9(conf)# ip access-list standard ALLOW-NET192
OS9(config-std-nacl)# description Allow 192.168.1 IP addresses
OS9(config-std-nacl)# seq 5 permit 192.168.1.0/24
OS9(config-std-nacl)# seq 20 deny any log
OS9(config-std-nacl)# exit
OS9(conf)# line vty 0 9
OS9(config-line-vty)# access-class ALLOW-NET192 ipv4
```

Note: The above example uses a standard ACL. An extended ACL can be used for configurations requiring more granular filtering.

5.3.2 OS10EE configuration

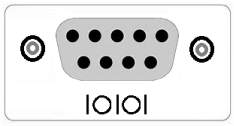
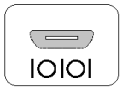
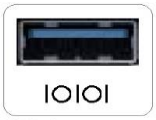
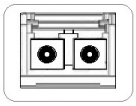
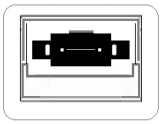
Below is example of an ACL that will allow access from the 192.168.1.0 subnet. Provide a description. Set an IP address filter and apply the ACL to VTY lines.

```
OS10(config)# ip access-list ALLOW-NET192
OS10(config-ipv4-acl)# description “Allow 192.168.1 IP  addresses”
OS10(config-ipv4-acl)# permit ip 192.168.1.0 255.255.255.0 any
OS10(config-ipv4-acl)# deny ip any any
OS10(config-ipv4-acl)# exit
OS10(config)# line vty
OS10(config-line-vty)# ip access-class ALLOW-NET192
```

6 Managing Dell EMC Servers

Connecting servers can be achieved using the same methods as a network switch. Connection options include serial port with console redirection, dedicated iDRAC port connected to OOB Ethernet or in-band Ethernet, and shared LOM iDRAC port connected to the in-band Ethernet network.

Table 7 Management port identification for servers and chassis

Console Management	OOB Ethernet Management	In-band Ethernet Management
 DB9 connector  Micro USB B connector  USB A connector	 RJ45 connector For connecting MX7000 management modules, see the *Dell EMC PowerEdge MX Network Architecture Guide*. For connecting FX2 (FN IOM) management, see the *Dell EMC PowerEdge FX2 FN I/O Module Deployment Guide*.	 RJ45 connector  Optical connector*  Optical connector*

*Optical connectors are embedded in transceivers that are used with SFP and QSFP ports. Optionally, a DAC cable may be used in place of these transceivers.

6.1 Connecting Dell EMC PowerEdge Servers (Serial Port)

As with previous examples in this guide, a terminal emulator application such as PuTTY or Tera Term, can be used to access the console port of a server. Each Dell EMC PowerEdge server or chassis provides one of the serial ports that are listed in Table 7 for console access, enabling the administrator to view and change the BIOS, iDRAC, NIC, and other device settings.

For the example screens below, the RS-232 (9-pin) connector located on the back panel of a Dell EMC PowerEdge server, was used. This port can provide a serial connection for console redirection. The console redirection feature can also be used to access BIOS System Setup, iDRAC, NIC, and other device settings using the serial port.

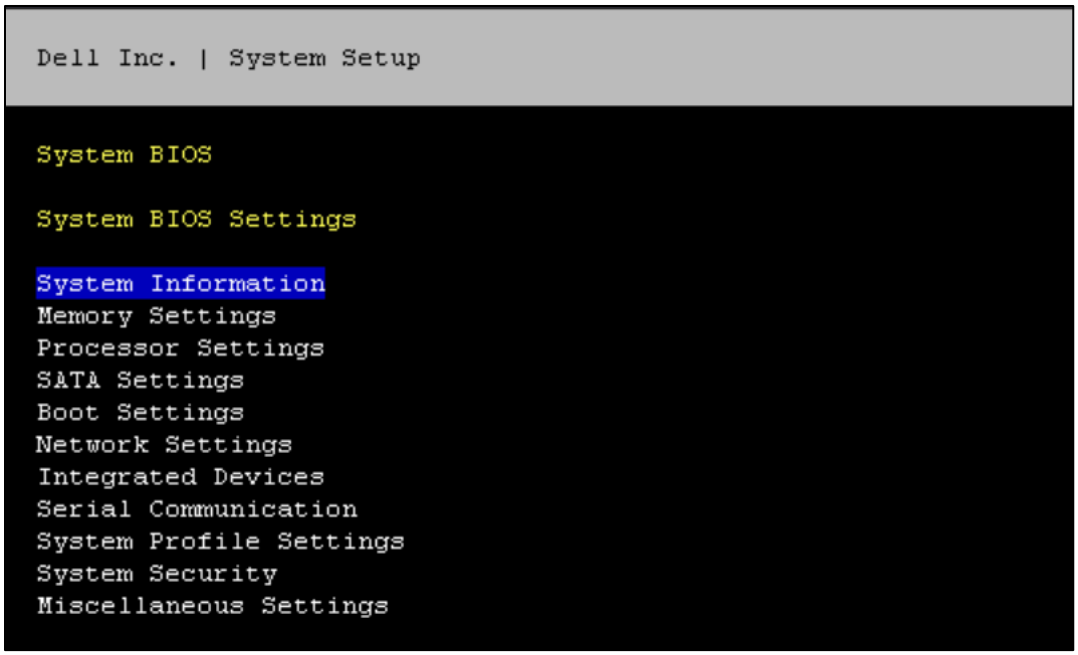


Figure 9 BIOS settings menu from the serial console

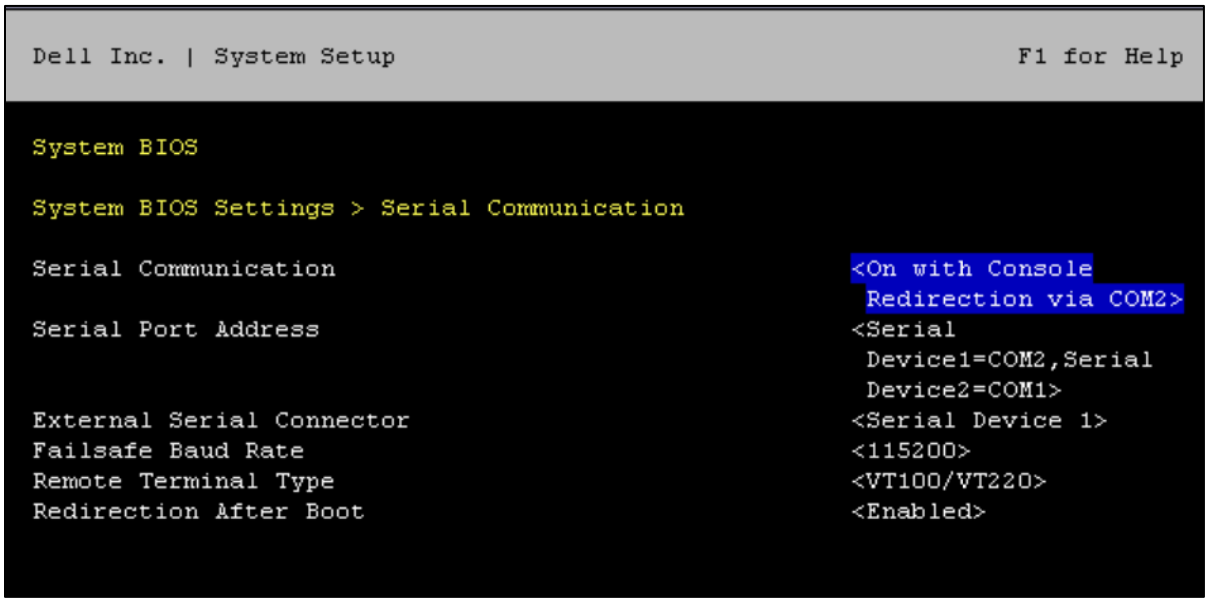


Figure 10 Serial Communication options

The serial communication screen that is shown in Figure 10, is accessed from the BIOS settings. This screen provides console redirection options and allows the administrator to set the port to COM1 or COM2 and select a baud rate.

Refer to the *Installation and Service Manual* for the Dell EMC PowerEdge server you are attaching to for more information on using the serial port.

6.2 Integrated Dell Remote Access Controller (iDRAC)

The integrated Dell Remote Access Controller (iDRAC) is designed to make system administrators more productive and improve the overall availability of Dell EMC PowerEdge server systems. iDRAC alerts administrators about system issues and enables them to perform remote system management. This reduces the need for physical access to the system.

6.2.1 Configuring the iDRAC IP address

Configure the initial network settings based on your network infrastructure to enable the communication to and from iDRAC. There are multiple ways to configure the dedicated iDRAC port IP address. The two most common methods are either using System Setup or, if equipped, the LCD panel.

By default the iDRAC ip is set by DHCP. If no DHCP service is available, the iDRAC will use the default iDRAC IP address 192.168.0.120. The default iDRAC IP can be used to configure the initial network settings, including setting up a static IP for iDRAC.

Other options for setting the IP address:

- **iDRAC Settings Utility** - See the *Dell Integrated Dell Remote Access Controller User's Guide* at www.dell.com/idracmanuals
- **Dell Deployment Toolkit** - See the *Dell Deployment Toolkit User's Guide* at www.dell.com/openmanagemanuals
- **Dell Lifecycle Controller** - See the *Dell Lifecycle Controller User's Guide* at www.dell.com/idracmanuals
- **Server LCD panel –** See LCD panel in Appendix C
- **iDRAC Direct and Quick Sync 2** – See the *Dell Integrated Dell Remote Access Controller User's Guide* at www.dell.com/idracmanuals

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Note: To access iDRAC, ensure that you connect the ethernet cable to the iDRAC dedicated network port. You can also access iDRAC through the shared LOM mode, if you have opted for a system that has the shared LOM mode enabled.

The following screen capture is from System Setup:

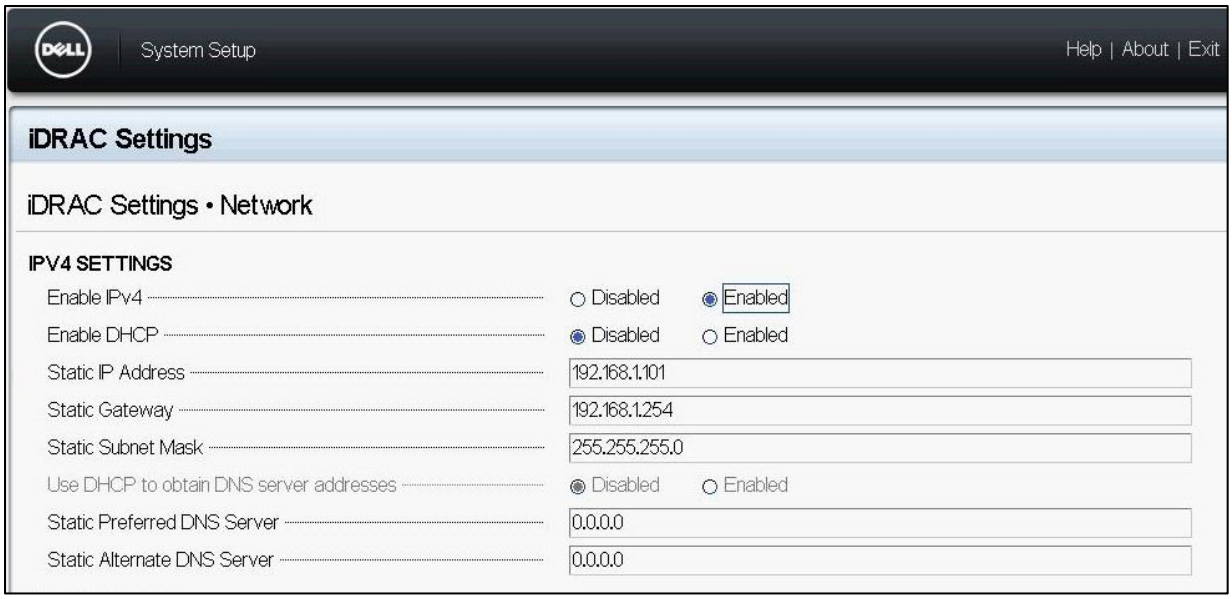

Figure 11 iDRAC IP settings in System Setup

6.3 Connecting to Dell EMC Servers (iDRAC)

There are two connection options to the iDRAC: the dedicated iDRAC port or shared LOM. Some ToR switches may not be of the same media type or speed in this case a media converter could be used to connect to the dedicated iDRAC Ethernet port. For example, an SFP-1000BASET adapter (Dell EMC part number XTY28) or an SFP+-10GBASET adapter (Dell EMC part number PGYJT) could be used on an SFP switch to connect to the BASE T iDRAC port.

6.3.1 Connecting to the dedicated iDRAC port

This connection option uses the server's dedicated iDRAC connection for management, while the production data traffic flows through the NICs on the server. This configuration separates the two flows of traffic. See section 6.4 for license requirements to use the dedicated iDRAC port.

Figure 12 iDRAC NIC settings in System Setup

6.3.2 Connecting to the Shared LOM

This option uses a LOM port that could be shared with the host OS production traffic. Also, LOM ports can be dedicated to server management. For example, with a four-port LOM adapter, LOM ports one and two could be used for production data while three and four could be used for iDRAC, VNC, RDP, or other OS-based management data.

Figure 13 shows a screenshot of the iDRAC settings to use the shared LOM port for iDRAC management.

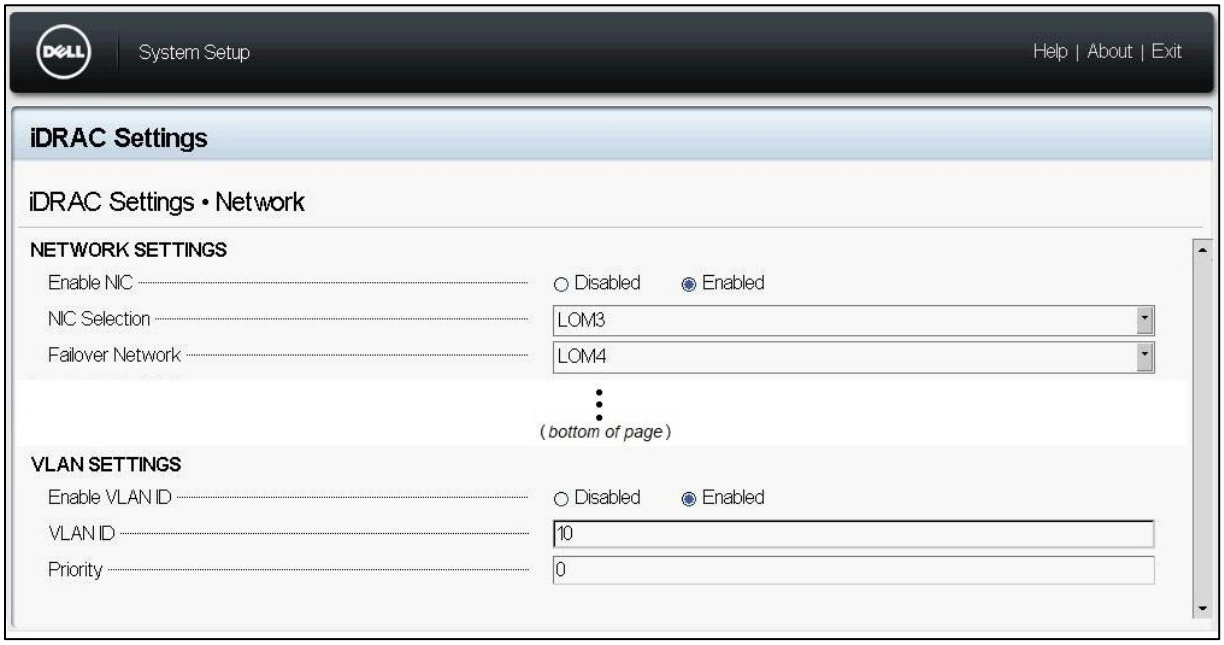

Figure 13 Shared LOM network settings

The iDRAC and OS are configured to use the same Ethernet connection. The advantages of using this method are less cabling and the ability to use a second LOM port as a failover port.

6.4 Licensed features in iDRAC7, iDRAC8, and iDRAC9

The types of connections available depend on the licensed features of the iDRAC. The following table provides a summary of information on iDRAC7, iDRAC8, and iDRAC9 connectivity types:

Table 8 Licensed features in iDRAC7, iDRAC8, and iDRAC9

Connectivity	iDRAC7 Basic	iDRAC7 Express	iDRAC7 Enterprise	iDRAC7 Express for Blades	iDRAC8/9 Basic	iDRAC8/9 Express	iDRAC8/9 Enterprise	iDRAC8/9 Express for Blades
Shared NIC (LOM)	Yes	Yes	Yes	N/A	Yes	Yes	Yes	N/A
Dedicated NIC[1]	No	No	Yes	Yes	Yes	Yes	Yes[2]	Yes

[1] This is the port marked “iDRAC” on the system.

[2] 500 series and lower rack and tower servers require a hardware card to enable this feature; this hardware is offered at additional cost. Features enabled are based on the license purchased.

7 Remote access

Once the communication link is established between a management station and a managed device, there are multiple applications that can be used to open a management session with the device. Each application is based on a CLI, GUI, or SNMP interface. This section provides an explanation and sample screens of the three interfaces.

7.1 Command Line Interface

The Command Line Interface, or CLI, is an application that is operated through an ASCII terminal. The user has greater configuration flexibility by entering the commands directly. The CLI is a basic command-line interpreter with command-line completion, inline syntax help, and prior command recall. The CLI can be accessed from a console terminal connected to a console port or through an SSH/Telnet session. A switch can be configured and maintained by entering commands into the CLI.

The CLI is the choice of most engineers for configuring and maintaining switches. It allows for copying and pasting parts, or all, of a configuration to re-use on other systems. The CLI also provides a basis for scripting and automation. The following is an example taken from Chapter 4 of commands entered at a command line:

```
OS10#configure
OS10(conf)#interface mgmt 1/1/1
OS10(conf-if-ma-1/1/1)#no ip address dhcp
OS10(conf-if-ma-1/1/1)#ip address 192.168.1.10/24
```

Terminal emulators are available for Windows or Linux that run on a PC. Terminal emulators provide a method for entering CLI commands. A terminal emulator example is provided in Appendix A.

7.2 Graphical User Interface

Dell EMC PowerSwitch N-Series switches contain a web-based graphical user interface, or GUI. The GUI allows you to access the switch from an Internet browser using the HTTP or HTTPS protocol.

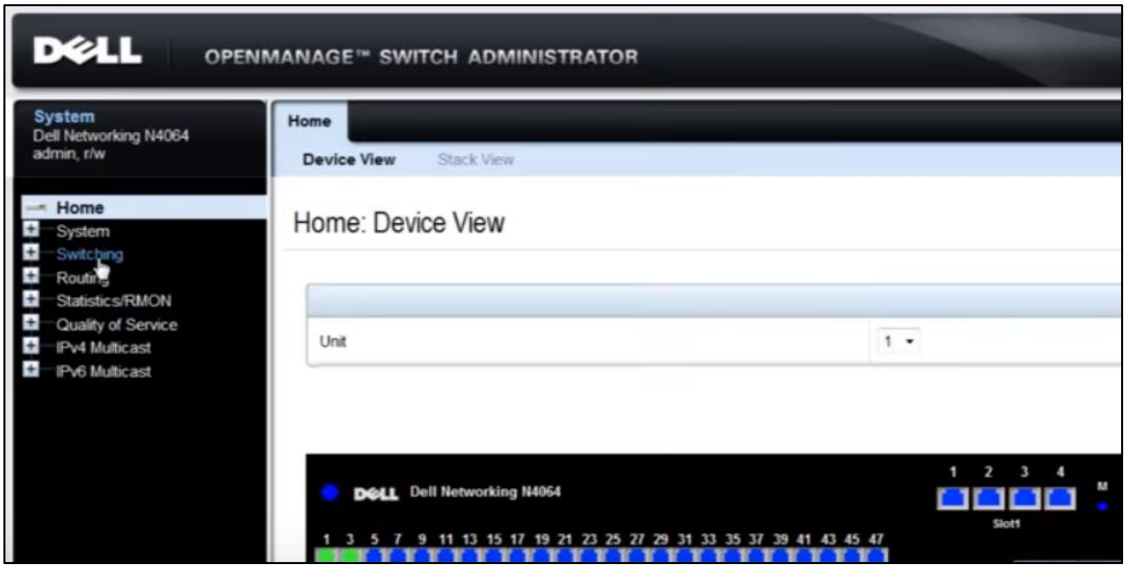

Figure 14 Graphical User Interface

Access to the GUI is obtained by entering the IP address of the managed device into the URL field of the browser. The syntax is **`http(s)://switch_mgmt_ip`**. Figure 14 shows an example of a GUI management screen. This GUI shows a picture of the switch. Green indicates that ports 1 and 2 are up.

The GUI is a quick way to find and implement features available on a switch, without the need or understanding of CLI commands. Once a switch is configured through the GUI, the administrator can view the configuration from the CLI to see what commands were added or changed. This can be used to assist the administrator in learning the CLI commands.

7.3 Simple Network Management Protocol

Simple Network Management Protocol, or SNMP, is an application-layer protocol for configuring and monitoring switches and other devices on the network. Each switch uses a database called a management information base (MIB). The MIB contains hundreds of data points called object identifiers, or OIDs. Some of the OIDs are read-only, such as the System Identifier, while others are read/write by the network administrator. Some OIDs are modified by the switch itself, for example, a temperature OID, while others are modified by the network administrator, such as a port-channel.

Each switch uses a different set of MIBs that are customized for that switch. Dell EMC updates MIB files at the same time their associated firmware files are updated. For this reason, MIBs are available from the same download page on the Dell EMC Support page or are included in the zipped firmware package.

OpenManage Network Manager (OMNM) is a one-to-many management tool based primarily on SNMP. OMNM allows network administrators to work with many switches on the network at one time. CLI and Web GUI interfaces only allow you to manage one switch at a time. Use OMNM to configure, manage, monitor, inventory, backup, and restore several Dell EMC switches at once.

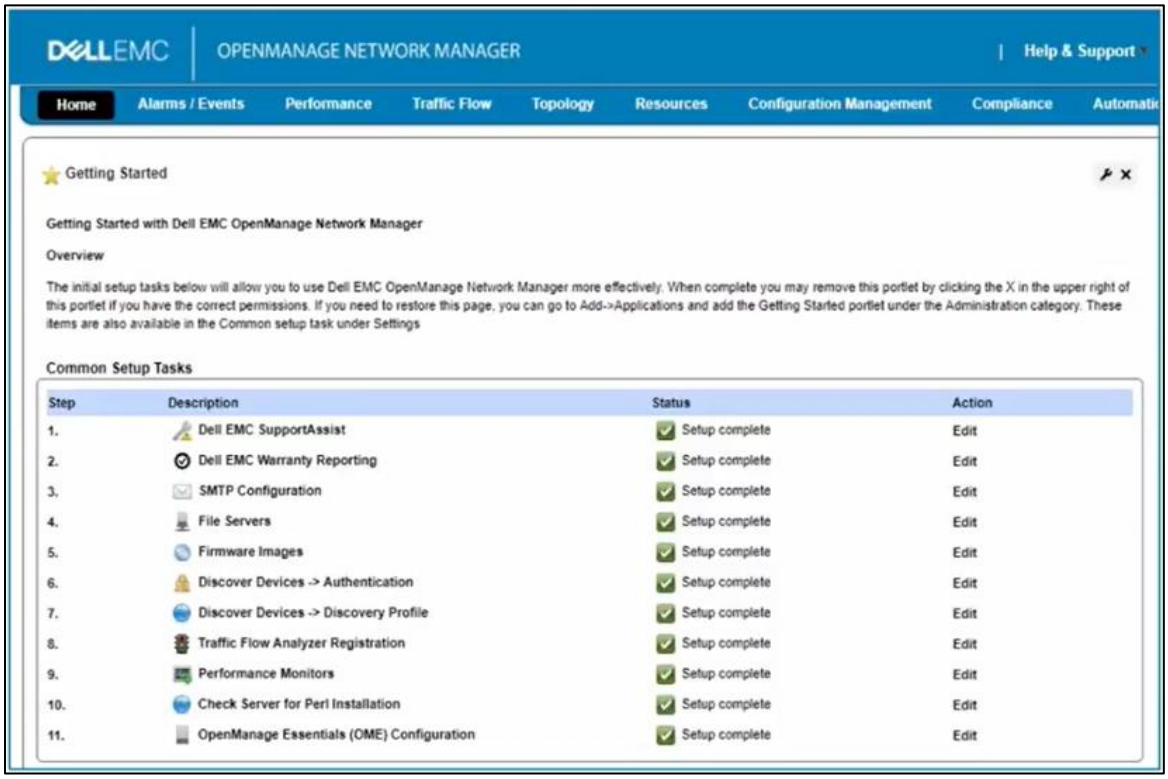

Figure 15 OMNM

For more information on OMNM and to download a free trial, see http://www.dell.com/OMNM.

8 Security considerations

Like a production network, when implementing a management network, Dell EMC recommends that the network administrator take the necessary security measures to ensure the protection and integrity of the data and devices being used. Securing the network infrastructure is a multilayer discipline. The following are security items to consider.

- Physical security involves physical access to the infrastructure. This includes building access controls and access to the network switch and router hardware. Physical security also includes access to patch panels, cabling, and endpoints.
- Network security includes firewalls, network intrusion detection (IDS), and network intrusion prevention (IPS) systems.
- Use of network segmentation (VLANs) and Access Control Lists (ACLs). Use VLANs that group endpoints by common function, for example, accounting, executive, and engineering. ACLs allow or deny access between hosts on different VLANs or networks.
- Authentication, authorization, and accounting (AAA) are services that control entry to the network. Remote Access Dial-In User Service (RADIUS) and Terminal Access Controller Access Control Service Plus (TACACS+) are services that manage AAA.
- Use SSH and disable Telnet.
- Use complex passwords.

There are several switch features that enable network operators to administer security for administrator access to the switch management console and to the web interface, as well as to configure restrictions of network access for network attached devices. It is important to understand each layer of security on your network to guard against all threats to hardware, data integrity, and data security.

See the documentation that comes with your device for more information on available security features and how each is implemented.

A Using a terminal emulator

Terminal emulators are commonly used applications for accessing and managing devices on a network. They are used in conjunction with console ports, console servers, OOB Ethernet, and in-band Ethernet management networks. This section provides examples of connecting to a managed device using a Windows-based terminal emulator.

This appendix provides two basic examples:

- Using a terminal emulator for local access (with a workstation COM port and console cable)
  - > To access the console port on a single device
- Using a terminal emulator for remote access (over Ethernet)
  - > To access console server, Ethernet OOB, and Ethernet in-band devices

A.1 Local access example

This example shows how to use a terminal emulator for connecting to a managed device through a console port. This method uses a workstation and a console cable. The first step is to identify the COM port of your workstation.

A.1.1 Identifying the COM port of your workstation

Skip to the *Terminal emulator settings* section below if you already know the COM port (COM1, COM2, etc.) being used on your workstation.

Since a computer can have multiple serial ports, and each port can be assigned a different COM**x** number, you must first identify the COM port that you will be using. Usually it is COM1 or COM2, but this can vary.

Note: The COM port can be found in the Windows Device Manager or in the computer BIOS. In the BIOS, the COM port being used is found under Serial Port settings. The BIOS only shows COM ports, and not USB ports that are using adapters.

To identify the COM port in Microsoft Windows:

1. Go to the taskbar search box and enter **Device Manager**.
2. Click the **Device Manager** icon to open.
3. Expand the **Ports** listing to identify the active COM port. In this example, COM1 is used as shown in Figure 16 .

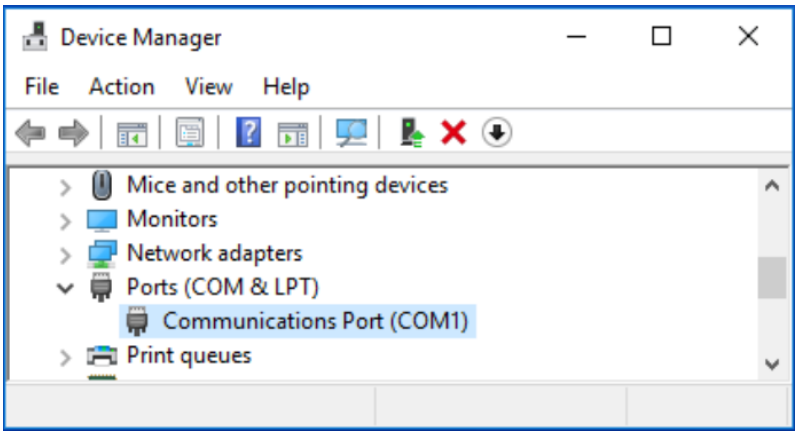

Figure 16 Identifying the serial communications (COM) port

4. If more than one console port is listed, a description is provided to help identify it. For example, if you are using a USB adapter, the description says **Adapter for USB to COM Port** or something similar.
5. If you are unable to positively identify the console port that you have the cable connected to, you can either look in the computer BIOS, or try each (COM1, COM2, etc.), one at a time, in the terminal emulator application using the steps below.

A.1.2 Terminal emulator settings

1. Open the terminal emulator program.
2. Find the settings for **serial**, **serial port**, or similar.

Note: Most terminal emulator programs support Serial, SSH, Telnet, and other services. This section is only concerned with the serial settings.

3. Locate the Port, Port number, Serial port number, or Serial line field.
4. Set the field to match the **COMx** port of your workstation.
5. If connecting to a Dell EMC switch, use Table 5 to locate the settings for the switch.
6. Enter the settings for the following:
   a. Speed (baud rate)
   b. Data bits
   c. Parity bits
   d. Stop bits
   e. Flow control

   For devices not listed in Table 5, see the documentation that came with the device.

7. Open a serial session in the terminal emulator. The CLI appears.

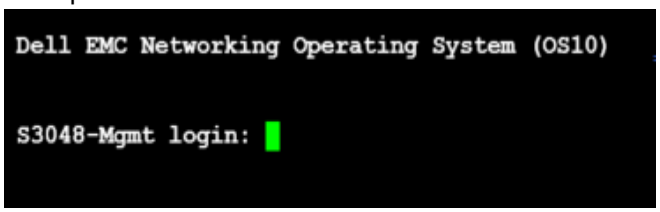

Figure 17 Example login prompt

The look and behavior of the initial prompt that is received depends on the device you are connecting. There are three common behaviors that are associated with an initial connection. One of the following behaviors occurs:

- Password prompt is displayed - You must enter the password to continue. The default ID and password on Dell EMC PowerSwitch series is admin/admin.
- Immediate access - No password is required.
- A setup wizard appears – Use this interview-type program to help with the initial setup.

When connecting to a system with a default password, Dell EMC recommends you change the password for better security. On systems that allow immediate access, Dell EMC recommends that an ID and strong password be created.

While setup wizards can be helpful, users who do not want to use it may bypass it and go directly to the traditional CLI. Read more about the setup process in the User Guide, or Getting Started Guide, of the switch you are connecting to.

You are now ready to enter commands into the CLI to configure the switch.

Note: Dell EMC recommends a strong console password for better security.

A.2 Remote access example

This example discusses how to use a terminal emulator to connect remotely to managed devices through any of the three networks - Console server, Ethernet OOB, and Ethernet in-band, that are discussed in this guide. All three examples use an IP address to access an Ethernet network. For the console server example, the serial COM settings are set using the console server user interface.

Perform the following steps to access a remote device from a terminal emulator. These steps may vary from one terminal emulator application to another. Consult the documentation for your application for more details.

1. Open the terminal emulator from the remote PC on the network.
2. Select the connection protocol (SSH, Telnet, or other) to be used.
3. Enter the hostname or IP address of the switch (or console server) in the appropriate field.
4. If a port number is required (for a console server), add it in the same field as the IP address. Use a colon after the IP address followed by the port number. This number is often used to identify the serial port of the console server.

   For example, an IP address *NNN.NNN.NNN.NNN* and port number *nnnn* will look like "*NNN.NNN.NNN.NNN:nnnn*" which provides the terminal emulator the IP address of the console server, and the serial port that the console server is using to connect to the managed device.

5. If requested, enter the TCP port into the appropriate field.

Note: By default, TCP port numbers are 22 for SSH and 23 for Telnet.

6. Launch the session using the appropriate keyboard or mouse input.

B Connecting to upstream management

Uplink ports on the management switch are used for connecting to the upstream management network. This network can consist of one or more NMS, management stations, and traffic between them and the managed devices. Uplink ports are identified as any Ethernet port that is not the lowest bandwidth on the switch (not including any OOB port). A 10GbE port on a switch which primarily has 1GbE ports is considered an uplink port, and a 100GbE port on a switch which primarily has 10GbE ports is considered an uplink port. Uplink ports are usually the highest bandwidth ports on a switch.

Configuring these uplinks to connect to upstream management is the same whether the management network is in-band or OOB. With OOB management, the OOB port on each managed device is attached to one of the lower bandwidth ports on the OOB management switch. The management switch itself becomes in-band as far as the management network is concerned. Provide an IP address to the management VLAN on any switch, dedicated OOB or not, to allow for routing and troubleshooting.

Optionally, the OOB port on each management switch may be used to allow for a second tier OOB network. The management traffic is routed between the first and second tiers as required.

Note: If using an OOB port, it must be on a different IP subnet than the in-band ports of the same switch.

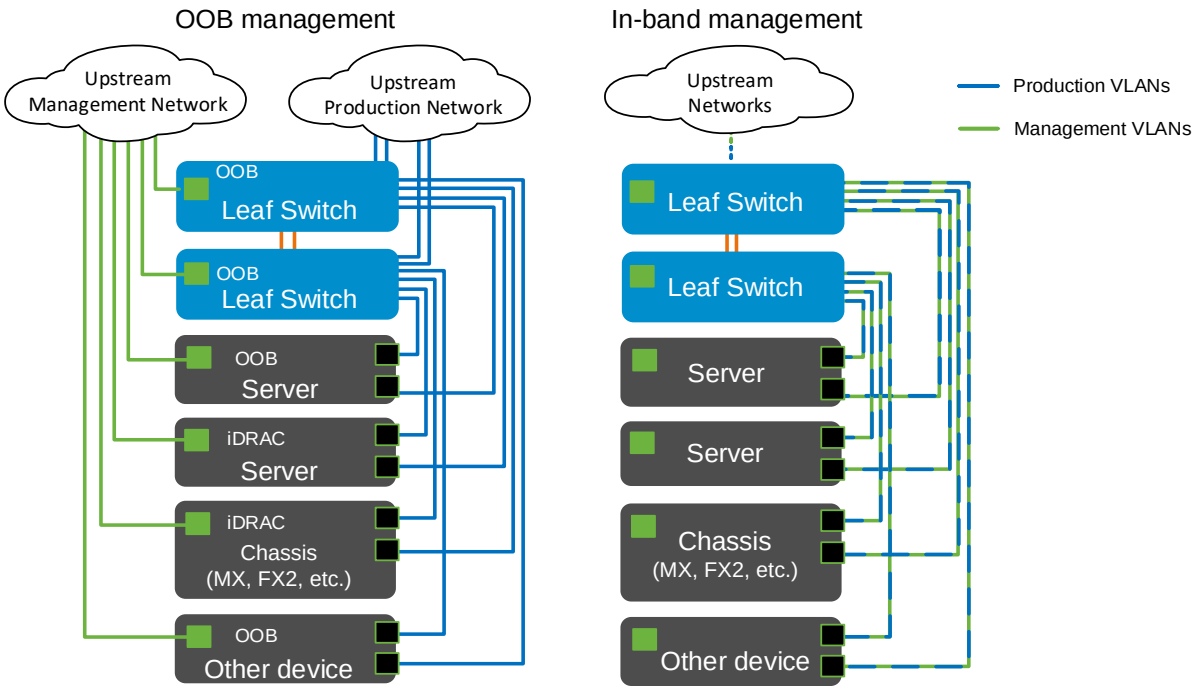

Figure 18 Topologies showing separation of management and production networks

C LCD Panel

If your Dell EMC PowerEdge system is equipped with an LCD panel, it can be used to configure or view the iDRAC IP address of the system. The LCD panel is available only on an optional front bezel.

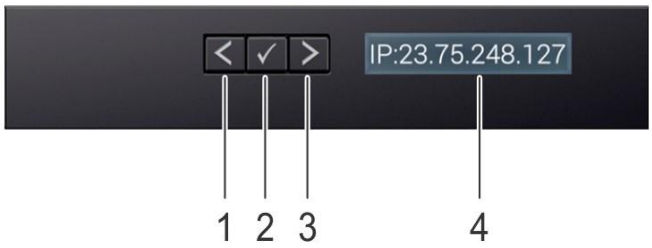

Figure 19 LCD panel showing the iDRAC IP address

Table 9 LCD panel features

Item	Button or display	Description
1	Left	Moves the cursor back in one-step increments.
2	Select	Selects the menu item highlighted by the cursor.
3	Right	Moves the cursor forward in one-step increments. During message scrolling: • Press and hold the right button to increase scrolling speed. • Release the button to stop. **Note:** The display stops scrolling when the button is released. After 45 seconds of inactivity, the display starts scrolling.
4	LCD display	Displays system information, including the iDRAC IP address.

C.1 Home screen view

The Home screen displays user-configurable information about the system. To view the Home screen, press one of the three navigation buttons (Select, Left, or Right). If not on the home screen, you can navigate back to the Home screen by simply pressing and holding the navigation button until the up arrow ↑ is displayed.

C.2 Setup menu

Use the iDRAC option from the setup menu to Select DHCP or Static IP to configure the network mode. If Static IP is selected, the available fields are IP, Subnet (Sub), and Gateway (Gtw). Select Setup DNS to enable DNS and to view domain addresses. Two separate DNS entries are available.

Note: When you select an option from this menu, confirm the option to go to the next action.

C.3 View menu

Use the iDRAC IP option in the View menu to display the IP address. Addresses include DNS (Primary and Secondary), Gateway, IP, and Subnet. Use the MAC option to display the MAC address for iDRAC.

Note: When you select an option from this menu, confirm the option to go to the next action.

See the Dell EMC iDRAC User's Guide for more information on configuring the iDRAC.

D Glossary

The following terms were discussed in this guide.

Access Control List (ACL) – a layer of security used to allow or deny users access to the network.

Command Line Interface (CLI) – a user interface that uses typed commands to configure a device.

Console port - a hardware port that allows direct communication between two devices using a serial cable.

Console Server – a hardware device that allows one-to-many access to console ports of many devices.

Downstream – data traffic or paths going toward end users or end nodes; opposite of upstream.

Ethernet – a system of connecting devices to form a network, while adhering to IEEE 802.3 standards.

HTTP/HTTPS - protocols that are used in transferring data over the Internet.

Integrated Dell Remote Access Card (iDRAC) – allows for management of Dell EMC PowerEdge servers.

In-band – network management method that shares the network infrastructure of the production network.

Management Network – a separate network (physical or virtual) used to manage the production network.

Management Station – a computer that uses one or more apps to configure and monitor network devices.

Network Management System (NMS) – one or more apps that are used to configure and monitor network devices from a single computer or a group of associated computers.

One-to-many – a method that allows the management of many systems from a single device or application.

Out-of-band – a management method that uses a dedicated network infrastructure separate from the production network.

PowerSwitch – Dell EMC manufactured Ethernet switches.

RJ45 - an 8P8C connector found at the end of cables that are commonly used in Ethernet networks.

Serial – a method of network communication where data is transferred one bit at a time.

Simple Network Management Protocol (SNMP) – an application layer protocol for managing networks.

SSH – a secure network protocol commonly used to log in to remote devices for CLI access.

Telnet - a network protocol commonly used to log in to remote devices for CLI access.

Terminal emulator - an application used to log in to remote devices, giving the appearance of a local terminal. Common terminal emulators today include Tera Term and PuTTY.

Upstream – all traffic entering and leaving the higher bandwidth ports of a switch; opposite of downstream.

USB – Universal Serial Bus; an industry standard for particular cables, connectors, and protocols.

User Interface – any software application that allows human interaction with electronic devices.

Virtual TeletYpe (VTY) - a virtual terminal CLI from your workstation to the switch or router.

Web interface – a type of user interface that uses a web browser.

E Components used in the examples

The following table includes the hardware and software that is used to configure the examples in this guide.

Table 10 Components used in this guide

Item	Version
Dell EMC PowerSwitch S4148F-ON	OS10EE v10.4.3.1
Dell EMC PowerSwitch S4048T-ON	OS10EE v10.4.3.1, OS9 v9.14.1.3
Dell EMC PowerSwitch S4048-ON	OS9 v9.14.1.3
Dell EMC PowerSwitch S3048-ON	OS9 v9.14.1.3

F Technical resources

Dell EMC Networking Guides

Dell EMC PowerSwitch S4148F-ON manuals and documentation

Dell EMC PowerSwitch S4048-ON manuals and documentation

Dell EMC PowerSwitch S3048-ON manuals and documentation

Other Dell EMC PowerSwitch Series manuals and documentation

Dell EMC OS10EE User Guide

Dell EMC OS9 User Guide

Dell EMC OS6 User Guide

Dell EMC iDRAC User's Guide

Dell Deployment Toolkit User Guide

OMNM Guides and Documentation

G Fabric Design Center

The Dell EMC Fabric Design Center (FDC) is a cloud-based application that automates the planning, design, and deployment of network fabrics that power Dell EMC compute, storage, and hyper-converged infrastructure solutions. The FDC is ideal for turnkey solutions and automation that is based on validated deployment guides.

FDC allows design customization and flexibility to go beyond validated deployment guides. For additional information, go to the Dell EMC Fabric Design Center.

H Support and feedback

Contacting Technical Support

Support Contact Information	Web: http://www.dell.com/support
	Telephone: USA: 1-800-945-3355

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