Abstract
This document provides an overview of the architecture, features, and functionality of the PowerEdge MX networking infrastructure.

October 2019
## Revisions

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<tr>
<th>Date</th>
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<tr>
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Introduction

Our vision at Dell EMC is to be the essential infrastructure company from the edge, to the core, and to the cloud. Dell EMC Networking ensures modernization for today’s applications and for the emerging cloud-native world. Dell EMC is committed to disrupting the fundamental economics of the market with an open strategy that gives you the freedom of choice for networking operating systems and top-tier merchant silicon. The Dell EMC strategy enables business transformations that maximize the benefits of collaborative software and standards-based hardware, including lowered costs, flexibility, freedom, and security. Dell EMC provides further customer enablement through validated deployment guides which demonstrate these benefits while maintaining a high standard of quality, consistency, and support.

The new Dell EMC PowerEdge MX is a unified, high-performance data center infrastructure, providing the agility, resiliency and efficiency to optimize a wide variety of traditional and new, emerging data center workloads and applications. With its kinetic architecture and agile management, PowerEdge MX dynamically configures compute, storage and fabric, increases team effectiveness, and accelerates operations. Its responsive design and delivers the innovation and longevity customers of all sizes need for their IT and digital business transformations.

As part of the PowerEdge MX platform, the Dell EMC SmartFabric OS10 network operating system includes SmartFabric Services. SmartFabric Services is a network automation and orchestration solution that is fully integrated with the MX Platform.

Figure 1  Dell EMC PowerEdge MX7000 chassis

This document provides an overview of the architecture, features, and functionality of the PowerEdge MX networking infrastructure.
Note: For information on SmartFabric mode, SmartFabric Services (SFS), Full Switch mode, and Scalable Fabric, see Dell EMC PowerEdge MX SmartFabric Configuration and Troubleshooting Guide. This guide also includes the deployment of Dell EMC Networking switches with PowerEdge MX Platform in SmartFabric mode.

1.1 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 entered in the GUI
2 Dell EMC PowerEdge MX7000 hardware overview

This section contains information about the hardware and options available in the Dell EMC PowerEdge MX7000. The section is divided into two parts:

- The front of the MX7000 chassis, containing compute and storage sleds
- The back of the MX7000 chassis, containing networking, storage, and management components

2.1 Dell EMC PowerEdge MX7000 (front)

Figure 2 shows the front view of the Dell EMC PowerEdge MX7000 chassis. The left side of the chassis can have one of three control panel options:

- LED status light panel
- Touch screen LCD panel
- Touch screen LCD panel equipped with Dell EMC PowerEdge iDRAC Quick Sync 2

The bottom of Figure 2 shows six hot-pluggable, redundant, 3,000-watt power supplies. Above the power supplies are eight single width slots that support compute and storage sleds. In the example below, the slots contain:

- Four Dell EMC PowerEdge MX740c sleds in slots one through four
- One Dell EMC PowerEdge MX840c sled in slots five and six
- Two Dell EMC PowerEdge MX5016s sleds in slots seven and eight

![Figure 2 Dell EMC PowerEdge MX7000 – front](image-url)
2.1.1 Dell EMC PowerEdge MX740c

The Dell EMC PowerEdge MX740c is a two-socket, full-height, single-width compute sled offers impressive performance and scalability. It is an ideal for dense virtualization environments and can serve as a foundation for collaborative workloads. The MX7000 chassis supports up to eight MX740c sleds.

PowerEdge MX740c key features include:

- Single-width slot design
- Two CPU sockets
- 24 DIMM slots of DDR4 memory
- Boot options include BOSS-S1 or IDSDM
- Up to six SAS/SATA SSD/HDD and NVMe PCIe SSDs
- Two PCIe mezzanine card slots for connecting to network Fabric A and B
- One PCIe mini-mezzanine card slots for connecting to storage Fabric C
- iDRAC9 with Lifecycle controller
2.1.2  Dell EMC PowerEdge MX840c

The Dell EMC PowerEdge MX840c, a powerful four-socket, full-height, double-width server features dense compute, exceptionally large memory capacity, and a highly expandable storage subsystem. It is the ultimate scale-up server that excels at running a wide range of database applications, substantial virtualization, and software-defined storage environments. The MX7000 chassis supports up to four MX840c sleds.

PowerEdge MX840c key features include:

- Dual-width slot design
- Four CPU sockets
- 48 DIMM slots of DDR4 memory
- Boot options include BOSS-S1 or IDSDM
- Up to eight SAS/SATA SSD/HDD and NVMe PCIe SSDs
- Four PCIe mezzanine card slots for connecting to network Fabric A and B
- Two PCIe mini-mezzanine card slots for connecting to storage Fabric C
- iDRAC9 with Lifecycle controller

![Dell EMC PowerEdge MX840c sled with eight 2.5-inch SAS drives](image)

Figure 4  Dell EMC PowerEdge MX840c sled with eight 2.5-inch SAS drives
2.1.3 Dell EMC PowerEdge MX5016s
The Dell EMC PowerEdge MX5016s sled delivers scale-out, shared storage within the PowerEdge MX architecture. The MX5016s provides customizable 12 Gbps direct-attached SAS storage with up to 16 HDDs/SSDs. Both the MX740c and the MX840c sleds can share drives with the MX5016s using the dedicated PowerEdge MX5000s SAS switch. Internal server drives may be combined with up to seven MX5016s sleds on one chassis for extensive scalability. The MX7000 chassis supports up to seven MX5016s storage sleds.

Figure 5 Dell EMC PowerEdge MX5016s sled with the drive bay extended
2.2 Dell EMC PowerEdge MX7000 (back)

The MX7000 includes three I/O fabrics. Fabric A and B for Ethernet and future I/O module connectivity and Fabric C for SAS or Fibre Channel (FC) connectivity. Each fabric provides two slots for redundancy. Figure 6 shows the back of the PowerEdge MX7000 chassis. From top to bottom the chassis is configured with:

- One Dell EMC Networking MX9116n Fabric Switching Engine (FSE) installed in fabric slot A1
- One Dell EMC Networking MX7116n Fabric Expander Module (FEM) installed in fabric slot A2
- Two Dell EMC Networking MX5108n Ethernet switches installed in fabric slots B1 and B2
- Two Dell EMC Networking MXG610s Fibre Channel switches installed in fabric slots C1 and C2
- Two Dell EMC PowerEdge MX9002m modules installed in management slots MM1 and MM2

![Dell EMC PowerEdge MX7000 - back](image-url)
2.2.1 Dell EMC PowerEdge MX9002m module

The Dell EMC MX9002m module controls overall chassis power, cooling, and hosts the OpenManage Enterprise - Modular (OME-M) console. Two external Ethernet ports are provided to allow management connectivity and to connect additional MX7000 chassis in a single logical chassis. An MX7000 supports two MX9002m modules for redundancy. Figure 7 shows a single MX9002m module and its components.

Figure 7 Dell EMC PowerEdge MX9002m module

The following MX9002m module components are labeled in Figure 7:

1. Handle release
2. Gigabit Ethernet port 1
3. Gigabit Ethernet port 2
4. ID button and health status LED
5. Power status LED
6. Micro-B USB port
2.2.2 Dell EMC Networking MX9116n Fabric Switching Engine

The Dell EMC Networking MX9116n Fabric Switching Engine (FSE) is a scalable, high-performance, low latency 25 Gbps Ethernet switch purpose-built for the PowerEdge MX platform. The MX9116n FSE provides enhanced capabilities and cost-effectiveness for the enterprise, mid-market, Tier 2 cloud, and NFV service providers with demanding compute and storage traffic environments.

Besides 16 internal 25 GbE ports, the MX9116n FSE provides:

- Two 100 GbE QSFP28 ports
- Two 100 GbE QSFP28 unified ports
- Twelve 200 GbE QSFP28-Double Density (DD) ports

The QSFP28 ports can be used for Ethernet connectivity, see Appendix B.5 for more information. The unified ports support SAN connectivity supporting both NPIV Proxy Gateway (NPG) and Direct Attach FC capabilities.

The QSFP28-DD ports provide capacity for additional uplinks, VLTi links, connections to rack servers at 10GbE or 25GbE via breakout cables. Also, the QSFP28-DD ports provide fabric expansion connections for up to nine additional MX7000 chassis using the MX7116n Fabric Expander Module. An MX7000 chassis supports up to four MX9116n FSEs in Fabric A and/or B. See Appendix A.4 for more information.

![Figure 8 Dell EMC Networking MX9116n FSE](image)

The following MX9116n FSE components are labeled in Figure 8:

1. Express service tag
2. Storage USB port
3. Micro-B USB console port
4. Power and indicator LEDs
5. Handle release
6. Two QSFP28 ports
7. Two QSFP28 unified ports
8. 12 QSFP28-DD ports

Table 1 shows the port mapping for internal and external interfaces on the MX9116n FSE. The MX9116n FSE maps dual-port mezzanine cards to odd-numbered ports. The MX7116n FEM, connected to the MX9116n FSE, maps to sequential virtual ports with each port representing a compute sled attached to the MX7116n FEM.

Table 1 Port-mapping example for Fabric A
<table>
<thead>
<tr>
<th>MX7000 slot</th>
<th>MX9116n FSE ports</th>
<th>MX7116n FEM virtual ports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ethernet 1/1/1</td>
<td>Ethernet 1/71/1</td>
</tr>
<tr>
<td>2</td>
<td>Ethernet 1/1/3</td>
<td>Ethernet 1/71/2</td>
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<tr>
<td>3</td>
<td>Ethernet 1/1/5</td>
<td>Ethernet 1/71/3</td>
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<tr>
<td>4</td>
<td>Ethernet 1/1/7</td>
<td>Ethernet 1/71/4</td>
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<td>5</td>
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<td>Ethernet 1/1/13</td>
<td>Ethernet 1/71/7</td>
</tr>
<tr>
<td>8</td>
<td>Ethernet 1/1/15</td>
<td>Ethernet 1/71/8</td>
</tr>
</tbody>
</table>
2.2.3 Dell EMC Networking MX7116n Fabric Expander Module

The Dell EMC Networking MX7116n Fabric Expander Module (FEM) acts as an Ethernet repeater, taking signals from an attached compute sled and repeating them to the associated lane on the external QSFP28-DD connector. The MX7116n FEM provides two QSFP28-DD interfaces, each providing up to eight 25 Gbps connections to the chassis.

There is no operating system or switching ASIC on the MX7116n FEM, so it never requires an upgrade. There is also no management or user interface, making the MX7116n FEM maintenance-free. The MX7000 chassis supports up to four MX7116n FEMs in Fabric A and/or B. See Appendix A.4 for more information.

Figure 9  Dell EMC Networking MX7116n FEM

The following MX7116n FEM components are labeled in Figure 9:

1. Express service tag
2. Supported optic LED
3. Power and indicator LEDs
4. Module insertion/removal latch
5. Two QSFP28-DD fabric expander ports

**Note:** The MX7116n FEM cannot act as a stand-alone switch and must be connected to the MX9116n FSE or other Dell EMC Top of Rack (ToR) Switch to function.

Figure 10 shows how the MX7116n FEM can act as a pass-through module. The breakout of the port is shown to connect to ToR switches on 25 GbE and 100 GbE connections and the internal connection to compute sleds with two ports on Mezzanine card.
Figure 11 shows different uplink options for the MX7116n FEM to act as a pass-through module. The MX7116n FEM should be connected to an upstream switch at 25GbE.

If the MX7116n FEM port connects to QSFP28 ports, a QSFP28-DD to 2xQSFP28 cable is used. For this configuration, the ports must be configured to break out as 4x25GbE on OME-M console. If the MX7116n FEM port connects to SFP28 ports, a QSFP28-DD to 8xSFP28 cable is used. These cables can be DAC, AOC, or optical transceiver plus passive fiber. See the PowerEdge MX I/O Guide for more information on
cable selection.

Figure 11  Topologies for MX7116n FEM as pass-through module
### 2.2.4 Dell EMC Networking MX5108n Ethernet switch

The Dell EMC Networking MX5108n Ethernet switch is targeted at small PowerEdge MX7000 deployments of one or two chassis. While not a scalable switch, it still provides high-performance and low latency with a non-blocking switching architecture. The MX5108n provides line-rate of 25 Gbps Layer 2 and Layer 3 forwarding capacity to all connected servers with no oversubscription.

Besides 8 internal 25 GbE ports, the MX5108n provides:

- One 40 GbE QSFP+ port
- Two 100 GbE QSFP28 ports
- Four 10 GbE RJ45 BASE-T ports

The ports can be used to provide a combination of network uplink, VLT interconnect (VLTi), or FCoE connectivity. The MX5108n supports FCoE FIP Snooping Bridge (FSB) mode but does not support NPG or Direct Attach FC capabilities. The MX7000 chassis supports up to four MX5106n Ethernet switches in Fabric A and/or B. See Appendix A.4 for more information.

---

**Figure 12** Dell EMC Networking MX5108n Ethernet switch

The following MX5108n components are labeled in Figure 12:

1. Express service tag
2. Storage USB port
3. Micro-B USB console port
4. Power and indicator LEDs
5. Module insertion/removal latch
6. One QSFP+ port
7. Two QSFP28 ports
8. Four 10GBASE-T ports

---

**Note:** Compute sleds with quad-port mezzanine cards are not supported.
2.2.5 Dell EMC Networking Pass-through modules

There are two Ethernet Pass-Through Modules (PTM) providing non-switched Ethernet connections to Top of Rack switches. Each PTM provides 16 internal 1, 10, and/or 25 GbE ports. Figure 13 shows the 25 GbE Ethernet PTM. The 25 GbE PTM provides 16 external SFP+ ports that can operate at 1/10/25GbE.

The 10GBASE-T Ethernet PTM, shown in Figure 14, provides 16 external RJ45 BASE-T ports that can operate at 1/10GbE. The MX7000 chassis supports a mix of four PTMs in Fabric A and/or B. See Appendix A.4 for more information.

---

**Figure 13** Dell EMC Networking 25 GbE PTM

The following 25 GbE PTM components are labeled in Figure 13:

1. Express service tag
2. Power and indicator LEDs
3. Module insertion/removal latch
4. 16 SFP28 ports

---

**Figure 14** Dell EMC Networking 10GBASE-T PTM

The following 10GBASE-T PTM components are labeled in Figure 14:

1. Express service tag
2. Power and indicator LEDs
3. Module insertion/removal latch
4. 16 10GBASE-T ports

**Note:** For information about PTM compute sled-mapping, see Appendix A.5.
2.2.6 Dell EMC Networking MXG610s Fibre Channel switch

The Dell EMC Networking MXG610s is a high-performance, Gen 6 Fibre Channel switch. The MXG610s features 32 Gbps and 128 Gbps capable interfaces. Ideal for connectivity to all-flash SAN storage solutions and is designed for maximum flexibility and value with “pay-as-you-grow” scalability using a Port on Demand license model. The MXG610s is compatible with Brocade and Cisco fabric/directory class switches.

Besides 16 internal 32 GFC ports, the MXG610s provides:

- Eight 32 Gbps SFP ports
- Two 4x 32 Gbps QSFP ports

The SFP ports can be used to provide connectivity to external FC arrays while the two QSFP ports, each having four 32 GFC lanes, provides connectivity to an existing storage area network (SAN). The MX7000 chassis supports redundant MXG610s in Fabric C.

![Diagram of Dell EMC Networking MXG610s Fibre Channel switch module](image)

**Figure 15  Dell EMC Networking MXG610s Fibre Channel switch module**

The following MXG610s components are labeled in Figure 15:

1. Express service tag
2. Module insertion/removal latch
3. Micro-B USB console port
4. Power and indicator LEDs
5. Eight 32 GFC SFP ports
6. Two 4x 32 GFC QSFP ports
2.2.7 Dell EMC PowerEdge MX5000s SAS module

The Dell EMC PowerEdge MX5000s SAS module supports four SAS internal connections to all eight PowerEdge MX7000 front-facing slots. The MX5000s uses T10 SAS zoning to provide multiple SAS zones/domains for the compute sleds. Storage management is conducted through the OME-M console.

The MX5000s provides Fabric C SAS connectivity to each compute and one or more MX5016s storage sleds. Compute sleds connect to the MX5000s using either SAS Host Bus Adapters (HBA) or a PERC RAID controller in the mini-mezzanine PCI-e slot.

The MX5000s switches are deployed as redundant pairs to offer multiple SAS paths to the individual SAS disk drives. The MX7000 chassis supports redundant MX5000s in Fabric C.

Note: A PowerEdge MX5000s SAS module and a MXG610s is not supported in the same MX7000 chassis.

![Figure 16: Dell EMC PowerEdge MX5000s SAS module](image)

The following MX5000s components are labeled in Figure 16:

1. Express service tag
2. Module insertion/removal latch
3. Power and indicator LEDs
4. Six SAS ports
2.3 **PowerEdge MX7000 I/O Fabrics**

The PowerEdge MX7000 chassis includes two general-purpose I/O fabrics, Fabric A and B. The vertically aligned compute sleds, in slots one through eight, connect to the horizontally aligned I/O modules (IOMs), in fabric slots A1, A2, B1, and B2. This orthogonal connection method results in a mid-plane free design and allows the adoption of new I/O technologies without the burden of having to upgrade the mid-plane.

The MX740c supports two mezzanine cards, which are installed in slots A1 and A2, and the MX840c supports four mezzanine cards, which are installed in slots A1, A2, B1, and B2. Each mezzanine card provides redundant connections to each fabric, A or B, shown in Figure 17. A mezzanine card connects orthogonally to the pair of IOMs installed in the corresponding fabric slot. For example, port one of mezzanine card A1 connects to fabric slot A1, an MX9116n FSE (not shown). The second port of mezzanine card A1 connects to fabric slot A2, an MX7116n FEM (not shown).

![Figure 17 Dell EMC PowerEdge MX740c mezzanine cards](image)

The MX7000 chassis also provides Fabric C, shown in Figure 18, supporting redundant MXG610s FC switches or MX5000s SAS modules. This fabric uses a midplane connecting the C1 and C2 modules to each compute or storage sled. The MX740c supports one mini-mezzanine card, which is installed in slot C1, and the MX840c supports two mini-mezzanine cards, which are installed in slots C1 and C2.

![Figure 18 Dell EMC PowerEdge MX740c mini-mezzanine card](image)
3 OpenManage Enterprise - Modular Edition console

The PowerEdge MX9002m module hosts the OpenManage Enterprise - Modular (OME-M) console. OME-M is the latest addition to the Dell OpenManage Enterprise suite of tools and provides a centralized management interface for the PowerEdge MX platform. OME-M console features include:

- End-to-end lifecycle management for servers, storage, and networking
- Touch LCD for initial setup, and fielding error conditions
- iDRAC9 intelligent automation and security features
- Manage one or multiple chassis from a single web or REST API leveraging multi-chassis management groups
- OpenManage Mobile for configuration and troubleshooting including wireless server vKVM

3.1 PowerEdge MX7000 initial deployment

Initial PowerMX7000 chassis configuration consists of initial deployment, assigning network settings for OME-M, and completing the Chassis Deployment Wizard.

There are three methods for initial configuration:

- Using the LCD touch screen located on the front-left of the MX7000 chassis
- Setting initial OME-M console IP address through KVM on the front-right side of the MX7000 chassis
- Setting initial OME-M console IP address through the serial port on the MX9002m module

On first logging into the OME-M console, a getting started wizard is displayed. The Chassis Deployment Wizard configures the following:

- Time configuration
- Alert configuration settings
- iDRAC9 Quick deployment settings
- Network IOM access settings
- Firmware updates
- Proxy settings
- MCM group definition

Note: For more information regarding the initial deployment of the MX7000, see the Dell EMC PowerEdge MX SmartFabric Configuration and Troubleshooting Guide.
Scalable Fabric Architecture and features

A Scalable Fabric spans multiple chassis and allows them to behave like a single chassis from a networking perspective. In contrast, an MCM group allows multiple chassis to be managed like a single chassis.

A Scalable Fabric consists of two main components, a pair of MX9116n FSEs in the first two chassis and additional pairs of MX7116n FEMs in the remaining chassis. Each MX7116n FEM connects to the MX9116n FSE corresponding to its fabric and slot. This hardware-enabled architecture applies regardless of whether the switch is running in Full Switch or SmartFabric mode. All IOMs participating in the fabric are configured in either Full Switch or SmartFabric mode.

Ensure that at least one compute sled in the chassis is discoverable and compute sleds are properly seated in the compute slots to discover MX7116n FEMs. MX7116n FEMs will not be recognized without at least one discovered compute sled in the chassis.

**Note:** See the *Dell EMC PowerEdge MX SmartFabric Configuration and Troubleshooting Guide* for more information about Full Switch and SmartFabric modes.

Figure 19 shows up to ten MX7000 chassis in a single Scalable Fabric Architecture. The first two chassis hold the MX9116n FSEs while chassis 3 through 10 house MX7116n FEMs. All connections in the figure are using QSFP28-DD connections.
Table 2 shows the recommended IOM slot placement when creating a Scalable Fabric Architecture.

<table>
<thead>
<tr>
<th>MX7000 chassis</th>
<th>Fabric Slot</th>
<th>IOM Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chassis 1</td>
<td>A1</td>
<td>MX9116n FSE</td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>MX7116n FEM</td>
</tr>
<tr>
<td>Chassis 2</td>
<td>A1</td>
<td>MX7116n FEM</td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>MX9116n FSE</td>
</tr>
<tr>
<td>Chassis 3 through 10</td>
<td>A1</td>
<td>MX7116n FEM</td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>MX7116n FEM</td>
</tr>
</tbody>
</table>

To provide further redundancy and throughput to each compute sled, Fabric B can be used to create an additional Scalable Fabric Architecture. Utilizing Fabric A and B can provide up to four 25 Gbps connections to each MX740c or eight 25 Gbps connections to each MX840c.

Figure 20 Two Scalable Fabrics spanning two PowerEdge MX7000 chassis

The following restrictions and guidelines are in place when building a Scalable Fabric:

- Mixing IOM types in the same Scalable Fabric (for example, MX9116n FSE in fabric slot A1 and MX5108n in fabric slot A2) is not supported.
- All participating MX9116n FSEs and MX7116n FEMs must be in MX7000 chassis that are part of the same MCM group, see Dell EMC OpenManage Enterprise-Modular Edition for PowerEdge MX7000 Chassis.
- When using both Fabric A and B for a Scalable Fabric Architecture, the following restrictions apply:
  - IOM placement for each fabric must be the same in each chassis. For instance, with an MX9116n FSE in fabric slot A1, then the second MX9116n FSE should be in fabric slot B1.
  - For chassis 3 through 10, that only contain MX7116n FEMs, they must connect to the MX9116n FSEs in the same MCM group.

**Note:** For information about the recommended MX9116n FSE port connectivity order, see Appendix A.1.
4.1 Interfaces and port groups

On the MX9116n FSE and MX5108n, server-facing interfaces are internal and are enabled by default. To view the backplane port connections to servers, use the `show inventory media` command.

In the output, a server-facing interface displays `INTERNAL` as its media. A `FIXED` port does not use external transceivers and always displays as Dell EMC Qualified true.

```
OS10# show inventory media
--------------------------------------------------------------------------------
System Inventory Media
--------------------------------------------------------------------------------
Node/Slot/Port  Category    Media                      Serial-Number  Dell EMC-Qualified
--------------------------------------------------------------------------------
1/1/1            FIXED      INTERNAL                      true
1/1/2            FIXED      INTERNAL                      true
1/1/3            FIXED      INTERNAL                      true
1/1/4            FIXED      INTERNAL                      true
1/1/5            FIXED      INTERNAL                      true
1/1/6            FIXED      INTERNAL                      true
1/1/7            FIXED      INTERNAL                      true
1/1/8            FIXED      INTERNAL                      true
1/1/9            FIXED      INTERNAL                      true
1/1/10           FIXED      INTERNAL                      true
1/1/11           FIXED      INTERNAL                      true
1/1/12           FIXED      INTERNAL                      true
1/1/13           FIXED      INTERNAL                      true
1/1/14           FIXED      INTERNAL                      true
1/1/15           FIXED      INTERNAL                      true
1/1/16           FIXED      INTERNAL                      true
1/1/17           QSFP28-DD  QSFP28-DD  200GBASE 2SR4 AOC  TW04829489D0007  true
1/1/18           QSFP28-DD  QSFP28-DD  200GBASE 2SR4 AOC  TW04829489D0007  true
1/1/19           Not Present
1/1/20           Not Present
1/1/21           Not Present
--------------------------------------------------------------------------------
Output Truncated

1/1/37           QSFP28-DD  QSFP28-DD  200GBASE 2SR4 AOC  TW04829489J0021  true
1/1/38           QSFP28-DD  QSFP28-DD  200GBASE 2SR4 AOC  TW04829489J0021  true
1/1/39           QSFP28-DD  QSFP28-DD  200GBASE 2SR4 AOC  TW04829489J0024  true
1/1/40           QSFP28-DD  QSFP28-DD  200GBASE 2SR4 AOC  TW04829489J0024  true
1/1/41           QSFP28     QSFP28     100GBASE CR4 2M    CN0APX0084G1F05  true
1/1/42           QSFP28     QSFP28     100GBASE CR4 2M    CN0APX0084G1F49  true
--------------------------------------------------------------------------------
Output Truncated
```

To view the server-facing interface port status, use the `show interface status` command. Server-facing ports are numbered 1/1/1 up to 1/1/16.
For the MX9116n FSE, servers that have a dual-port NIC connect only to odd-numbered internal Ethernet interfaces; for example, an MX740c in slot one would be 1/1/1, and an MX840c in slots five and six occupies 1/1/9 and 1/1/11.

**Note:** Even-numbered Ethernet ports between 1/1/1-1/1/16 are reserved for quad port NICs.

A port group is a logical port that consists of one or more physical ports and provides a single interface to the user. On MX IOMs, only the MX9116n FSE supports port groups:

- QSFP28-DD – Port groups 1 through 12
- QSFP28 – Port groups 13 and 14
- Unified port groups – Port groups 15 and 16

Figure 21 shows these port groups along the top and the bottom shows the physical ports in each port group. For instance, QSFP28-DD port group 1 have member ports 1/1/17 and 1/1/18, and unified port group 15 has a single member, port 1/1/43.

4.1.1 **QSFP28-DD port groups**

On the MX9116n FSE, QSFP28-DD port groups are 1 through 12 which contain ports 1/1/17 through 1/1/40 and are used to:

- Connect to a MX7116n FEM to extend the Scalable Fabric
- Connect to an Ethernet rack server or storage device
- Connect to another networking device

By default, QSFP28-DD port groups one through nine are in fabric-expander-mode, which is an 8x 25 GbE interface, used only to connect to MX7116n FEMs in additional chassis. The interfaces from the MX7116n FEM appear as standard Ethernet interfaces from the perspective of the MX9116n FSE.

Figure 22 illustrates how the QSFP28-DD cable provides 8x 25 GbE lanes between the MX9116n FSE and a MX7116n FEM.
Note: Compute sleds with dual-port NICs require only MX7116n FEM port 1 to be connected.

In addition to fabric-expander-mode, QSFP28-DD port groups support the following Ethernet breakout configurations:

- 8x 10 GbE – Breakout a QSFP28-DD port into eight 10 GbE interfaces
- 8x 25 GbE – Breakout a QSFP28-DD port into eight 25 GbE interfaces
- 2x 40 GbE – Breakout a QSFP28-DD port into two 40 GbE interfaces
- 2x 100 GbE – Breakout a QSFP28-DD port into two 100 GbE interfaces

By default, QSFP28-DD port groups 10 through 12 are in 2x 100 GbE breakout mode.

Note: Before changing the port breakout configuration from one setting to another, the port must first be set back to the default setting. See the Dell EMC PowerEdge MX SmartFabric Configuration and Troubleshooting Guide for more information about port breakout configuration.

4.1.2 Single-density QSFP28 port groups

On the MX9116n FSE, Single-density QSFP28 port groups are 13 and 14 and contain ports 1/1/41 and 1/1/42 and are used to connect to upstream networking devices. By default, both port groups are set to 1x 100 GbE. Port groups 13 and 14 support the following Ethernet breakout modes:

The MX9116n FSE single-density QSFP28 port groups support the following Ethernet breakout configurations:

- 4x 10 GbE – Breakout a QSFP28 port into four 10 GbE interfaces
- 1x 40 GbE – Set a QSFP28 port to 40 GbE mode
- 4x 25 GbE – Breakout a QSFP28 port into four 25 GbE interfaces
- 2x 50 GbE – Breakout a QSFP28 port into two 50 GbE interfaces
- 1x 100 GbE – Reset the unified port back to the default, 100 GbE mode
When connecting a pair of PowerEdge MX IOMs in Smart Fabric mode to an upstream switch pair, the upstream switch pair must:

- Both upstream switches must be connected using technologies such as Dell EMC VLT or Cisco Nexus vPC.
- The upstream switch ports must be in a port-channel using LACP
- Ensure a compatible Spanning Tree Protocol (STP) is configured, see Appendix A.2.

4.1.3 Unified port groups
In SmartFabric OS10, unified port groups operate as either Ethernet or FC. By default, both unified port groups, 15 and 16, are set to 1x 100 GbE. To activate FC interfaces, the two port groups as FC interfaces, use the command, `mode fc`.

The MX9116n FSE unified port groups support the following Ethernet breakout configurations:

- 4x 10 GbE – Breakout a QSFP29 port into four 10 GbE interfaces
- 1x 40 GbE – Set a QSFP28 port to 40 GbE mode
- 4x 25 GbE – Breakout a QSFP port into four 25 GbE interfaces
- 2x 50 GbE – Breakout a QSFP28 port into two 50 GbE interfaces
- 1x 100 GbE – Reset the unified port back to the default, 100 GbE mode

The MX9116n FSE unified port groups support the following FC breakout configurations:

- 4x 8 Gb – Breakout a unified port group into four 8 GbFC interfaces
- 2x 16 Gb – Breakout a unified port group into two 16 GbFC interfaces
- 4x 16 Gb – Breakout a unified port group into four 16 GbFC interfaces
- 1x 32 Gb – Breakout a unified port group into one 32 GbFC interface
- 2x 32 Gb – Breakout a unified port group into two 32 GbFC interfaces
- 4x 32 Gb – Breakout a unified port group into four 32 GbFC interfaces, rate limited.

4.1.4 Rate limited 32 Gb Fibre Channel
When using 32 Gb FC, the data rate is 28 Gbps due to 64b/66b encoding. Figure 23 shows one of the unified interfaces, port groups 15 and 16. The port group is set to 4x 32 Gb FC mode. However, each of the four lanes is 25 Gbps, not 28 Gbps. When these lanes are mapped from the Network Processing Unit (NPU) to the FC ASIC, for conversion to FC signaling, the 32GFC interfaces are mapped to four 25 Gbps lanes. With each lane operating at 25 Gbps, not 28 Gbps, the result is rate limited 32 Gb FC.
While each 32 Gb FC connection is providing 25 Gbps, the overall FC bandwidth available is 100 Gbps per unified port group, or 200 Gbps for both ports. However, if an application requires the maximum 28 Gbps throughput per port, use the 2x 32 Gb breakout mode. This mode configures the connections between the NPU and the FC ASIC as shown in Figure 24.

In 2x 32 Gb FC breakout mode, the MX9116n FSE binds two 50 Gbps links together to provide 100 Gbps bandwidth per lane to the FC ASIC. This results in the two FC ports operating at 28 Gbps. The overall FC bandwidth available is 56 Gbps per unified port, or 112 Gbps for both. Compared to the 200 Gbps using 4x 32 Gb FC.

**Note:** Rate limited ports are not oversubscribed ports. There is no FC frame drop on these ports and buffer to buffer credit exchanges ensure flow consistency.
4.1.5 Virtual ports

A virtual port is a logical SmartFabric OS10 port that connects to a downstream server and has no physical hardware location on the switch. Virtual ports are created when an MX9116n FSE onboards a MX7116n FEM. The onboarding process consists of discovery and configuration. An attached MX9116n FSE in Full Switch mode automatically discovers the MX7116n FEM when these conditions are met:

- The MX7116n FEM is connected to the MX9116n FSE by attaching a cable between the QSFP28-DD ports on both devices
- The interface for the QSFP28-DD port-group connected to the MX9116n FSE is in 8x 25 GbE FEM mode
- At least one blade server is inserted into the MX7000 chassis containing the MX7116n FEM

To verify that a MX7116n FEM is communicating with the MX9116n FSE, enter the `show discovered-expanders` command.

```
MX9116n-FSE # show discovered-expanders

Service   Model    Type  Chassis      Chassis-slot Port-group Virtual
         tag        service-tag  chassis  slot     Slot-Id
----------------------------------
D10DXC2   MX7116n  1     SKY002Z      A1           1/1/1

FEM
```

**Note:** For more information about virtual ports, see the [Dell EMC SmartFabric OS10 Users Guide](#).
4.2 Embedded Top of Rack switching

Most environments with blade servers also have rack servers. Figure 25 shows the typical design having rack servers connecting to their respective Top of Rack (ToR) switches and blade chassis connecting to a different set of ToR switches. If the storage array was Ethernet-based, it can be connected to the core/spine.

This design is inefficient and expensive. Communication between rack and blade servers must traverse the core, increasing latency, and the storage array consumes expensive core switch ports. This results in increased operations cost from the increased number of managed switches.

Embedded ToR functionality is built into the MX9116n FSE. Configure any QSFP28-DD port to break out into 8x 10 GbE or 8x 25 GbE and connect the appropriate cable and optics. This allows all servers and storage connect directly to the MX9116n FSE and communication between all devices is kept within the switch. This provides a single point of management and network security while reducing cost and improving performance and latency.
Figure 25 shows eight switches in total. Figure 26 shows that using embedded ToR, switch count is reduced to the two MX9116n FSE in the two chassis.
PowerEdge MX IOM operating modes

The Dell EMC Networking MX9116n Fabric Switching Engine (FSE) and MX5108n Ethernet Switch operate in one of two modes:

- **Full Switch mode (Default)** – All switch-specific SmartFabric OS10 capabilities are available
- **SmartFabric mode** – Switches operate as a Layer 2 I/O aggregation fabric and are managed through the Open Manage Enterprise-Modular (OME-M) console

The following SmartFabric OS10 CLI commands have been added specifically for the PowerEdge MX platform:

- `show switch-operating-mode` – displays the current operating mode (SmartFabric or Full Switch) of a supported switch
- `show discovered-expanders` – displays the MX7116n FEMs attached to the MX9116n FSEs
- `show unit-provision` – displays or configures the unit ID and service tag of a MX7116n FEM attached to a MX9116n FSE

**Note:** For more information, see the SmartFabric OS10 User Guide for PowerEdge MX I/O Modules on the [Support for Dell EMC Networking MX9116n - Manuals and documents](https://www.dell.com/support) and [Support for Dell EMC Networking MX5108- Manuals and documents](https://www.dell.com/support) web pages.

Table 3 outlines the differences between the two operating modes and apply to both the MX9116n FSE and the MX5108n switches.

<table>
<thead>
<tr>
<th><strong>Full Switch mode</strong></th>
<th><strong>SmartFabric mode</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration changes are persistent during power cycle events.</td>
<td>Only the configuration changes made using the OS10 commands below are persistent across power cycle events. All other CLI configuration commands are disabled.</td>
</tr>
<tr>
<td>clock</td>
<td>clock</td>
</tr>
<tr>
<td>fc alias</td>
<td>fc alias</td>
</tr>
<tr>
<td>fc zone</td>
<td>fc zone</td>
</tr>
<tr>
<td>fc zoneset</td>
<td>fc zoneset</td>
</tr>
<tr>
<td>hostname</td>
<td>hostname</td>
</tr>
<tr>
<td>host-description</td>
<td>host-description</td>
</tr>
<tr>
<td>interface</td>
<td>interface</td>
</tr>
<tr>
<td>ip nameserver</td>
<td>ip nameserver</td>
</tr>
<tr>
<td>ip ssh server</td>
<td>ip ssh server</td>
</tr>
<tr>
<td>ip telnet server</td>
<td>ip telnet server</td>
</tr>
<tr>
<td>login concurrent-session</td>
<td>login concurrent-session</td>
</tr>
<tr>
<td>login statistics</td>
<td>login statistics</td>
</tr>
<tr>
<td>logging</td>
<td>logging</td>
</tr>
<tr>
<td>management route</td>
<td>management route</td>
</tr>
<tr>
<td>ntp</td>
<td>ntp</td>
</tr>
<tr>
<td>snmp-server</td>
<td>snmp-server</td>
</tr>
<tr>
<td>tacacs-server</td>
<td>tacacs-server</td>
</tr>
<tr>
<td>username</td>
<td>username</td>
</tr>
<tr>
<td>spanning-tree</td>
<td>spanning-tree</td>
</tr>
<tr>
<td>vlan</td>
<td>vlan</td>
</tr>
</tbody>
</table>
### Full Switch mode

In Full Switch mode, all SmartFabric OS10 features and functions supported by the hardware are available to the user. In other words, the switch operates the same way as any other SmartFabric OS10 switch. Configuration is primarily done using the CLI, however, the following items can be configured or managed using the OME-M GUI:

1. Initial switch deployment: Configure hostname, password, SNMP, NTP, and so on
2. Set ports administratively up or down, configure MTU
3. Monitor health, logs, alerts, and events
4. Update the SmartFabric OS10 software
5. View physical topology
6. Switch power management

Full Switch mode is typically used when a desired feature or function is not available when operating in SmartFabric mode. For more information about Dell EMC SmartFabric OS10 operations, see [Dell EMC Networking OS Info Hub](https://www.dell.com/support/home/global/en/).  

### SmartFabric mode

A SmartFabric is a logical entity that consists of a collection of physical resources, such as servers and switches, and logical resources such as networks, templates, and uplinks. The OpenManage Enterprise – Modular (OME-M) console provides a method to manage these resources as a single unit.

For more information about SmartFabric mode, see the [Dell EMC PowerEdge MX SmartFabric Configuration and Troubleshooting Guide](https://www.dell.com/support/home/global/en/).
A   Additional Information

This section contains additional details to clarify the concepts covered in the main body of the document.

A.1   Recommended port order for MX7116n FEM connectivity

While any QSFP28-DD port can be used for any purpose, Table 4 outlines the recommended port order for connecting chassis with MX7116n FEM modules to the MX9116n FSE to optimize tile utilization. Table 4 references IOMs in Fabric A, but the same guidelines apply to IOMs in Fabric B.

**Note:** If using the recommended connection order shown below, you must change the breakout type of port-group 9 to FabricExpander.

<table>
<thead>
<tr>
<th>Chassis</th>
<th>MX9116n FSE port group</th>
<th>Physical Port Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>Port group 1</td>
<td>17 and 18</td>
</tr>
<tr>
<td>3</td>
<td>Port group 7</td>
<td>29 and 30</td>
</tr>
<tr>
<td>4</td>
<td>Port group 2</td>
<td>19 and 20</td>
</tr>
<tr>
<td>5</td>
<td>Port group 8</td>
<td>31 and 32</td>
</tr>
<tr>
<td>6</td>
<td>Port group 3</td>
<td>21 and 22</td>
</tr>
<tr>
<td>7</td>
<td>Port group 9</td>
<td>33 and 34</td>
</tr>
<tr>
<td>8</td>
<td>Port group 4</td>
<td>23 and 24</td>
</tr>
<tr>
<td>9</td>
<td>Port group 10</td>
<td>35 and 36</td>
</tr>
<tr>
<td>10</td>
<td>Port group 6</td>
<td>25 and 26</td>
</tr>
</tbody>
</table>

Figure 27   Recommended MX7000 chassis connection order
A.2 Spanning Tree Protocol recommendations

By default, SmartFabric OS10 uses Rapid per-VLAN Spanning Tree Plus (RPVST+) across all switching platforms including PowerEdge MX networking IOMs. SmartFabric OS10 also supports RSTP.

**Note:** Dell EMC recommends using RSTP instead of RPVST+ when more than 64 VLANs are required in a fabric to avoid performance problems.

Caution should be taken when connecting an RPVST+ to an existing RSTP environment. RPVST+ creates a single topology per VLAN with the default VLAN, typically VLAN 1, for the Common Spanning Tree (CST) with RSTP.

For non-native VLANs, all bridge protocol data unit (BPDU) traffic is tagged and forwarded by the upstream, RSTP-enabled switch with the associated VLAN. These BPDUs use a protocol-specific multicast address.

Any other RPVST+ tree attached to the RSTP tree might process these packets accordingly leading to the potential of unexpected trees.

**Note:** When connecting to an existing environment that is not using RPVST+, Dell EMC recommends changing to the existing spanning tree protocol before connecting a SmartFabric OS10 switch. This ensures same type of Spanning Tree is run on the SmartFabric OS10 MX switches and the upstream switches.

To switch from RPVST+ to RSTP, use the `spanning-tree mode rstp` command:

```
MX9116N-A1(config)# spanning-tree mode rstp
MX9116N-A1(config)# end
```

To validate the STP configuration, use the `show spanning-tree brief` command:

```
MX9116N-A1# show spanning-tree brief
Spanning tree enabled protocol rstp with force-version rstp
Executing IEEE compatible Spanning Tree Protocol
Root ID   Priority 0, Address 4c76.25e8.f2c0
Root Bridge hello time 2, max age 20, forward delay 15
Bridge ID Priority 32768, Address 2004.0f00.cd1e
Configured hello time 2, max age 20, forward delay 15
Flush Interval 200 centi-sec, Flush Invocations 95
Flush Indication threshold 0 (MAC flush optimization is disabled)
```

**Note:** STP is required. Operating a SmartFabric with STP disabled creates network loops and is not supported.
A.3 NIC teaming guidelines

While NIC teaming is not required, it is suggested for redundancy unless a specific implementation recommends against it.

There are two main kinds of NIC teaming:

- **Switch dependent**: Also referred to as LACP, 802.3ad, or Dynamic Link Aggregation, this teaming method uses the LACP protocol to understand the teaming topology. This teaming method provides Active-Active teaming and requires the switch to support LACP teaming.

- **Switch independent**: This method uses the operating system and NIC device drivers on the server to team the NICs. Each NIC vendor may provide slightly different implementations with different pros and cons.

NIC Partitioning (NPAR) can impact how NIC teaming operates. Based on restrictions that are implemented by the NIC vendors related to NIC partitioning, certain configurations preclude certain types of teaming.

The following restrictions are in place for both Full Switch and SmartFabric modes:

- If NPAR is NOT in use, both Switch Dependent (LACP) and Switch Independent teaming methods are supported
- If NPAR IS in use, only Switch Independent teaming methods are supported. Switch Dependent teaming is NOT supported

If Switch Dependent (LACP) teaming is used, the following restrictions are in place:

- The iDRAC shared LAN on motherboard (LOM) feature can only be used if the “Failover” option on the iDRAC is enabled
- If the host OS is Windows, the LACP timer MUST be set to “slow” (also referred to as “normal”)
  1. Microsoft Windows 2012 R2, see Instructions
  2. Microsoft Windows 2016, see Instructions

Refer to the network adapter or operating system documentation for detailed NIC teaming instructions.

**Note**: If using VMware ESXi and LACP, Dell EMC recommends using VMware ESXi 6.7.0 Update 2.

Table 5 shows the options that the MX Platform provides for NIC Teaming.

<table>
<thead>
<tr>
<th>No Teaming</th>
<th>No NIC Bonding/Teaming or Switch Independent Teaming</th>
</tr>
</thead>
<tbody>
<tr>
<td>LACP Teaming</td>
<td>LACP (Also called 802.3ad or Dynamic Link Aggregation)</td>
</tr>
<tr>
<td>Other</td>
<td>Other (Not recommended. Can have performance impact on link management)</td>
</tr>
</tbody>
</table>

**Note**: LACP Fast timer is not currently supported.
A.4 PowerEdge MX IOM slot support matrix

Table 6 shows the recommended PowerEdge MX IOM slot configurations.

<table>
<thead>
<tr>
<th>Slot A1</th>
<th>Slot A2</th>
<th>Slot B1</th>
<th>Slot B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MX9116n</td>
<td>MX9116n</td>
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<tr>
<td>MX5108n</td>
<td>MX5108n</td>
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<tr>
<td>MX7116n</td>
<td>MX7116n</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
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<tr>
<td>MX9116n</td>
<td>MX9116n</td>
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<td>SFP28 PTM</td>
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<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
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<tr>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
</tr>
</tbody>
</table>
Table 7 lists all other supported IOM slot configurations. These configurations are either single IOMs configurations or each chassis contains dual MX9116n FSEs. In either configuration, redundancy is not a requirement.

Table 7 Other supported IOM configurations

<table>
<thead>
<tr>
<th>Slot A1</th>
<th>Slot A2</th>
<th>Slot B1</th>
<th>Slot B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MX9116n</td>
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<td></td>
<td></td>
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<tr>
<td>MX5108n</td>
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<td></td>
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<tr>
<td>MX7116n</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SFP28 PTM</td>
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<td></td>
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</tr>
<tr>
<td>10GBASE-T PTM</td>
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<tr>
<td>MX9116n</td>
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<td>MX7116n</td>
<td>MX7116n</td>
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</tr>
<tr>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MX9116n</td>
<td>MX9116n</td>
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<td>MX5108n</td>
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<tr>
<td>MX7116n</td>
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<td>MX7116n</td>
</tr>
<tr>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
</tr>
<tr>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
</tr>
<tr>
<td>MX9116n</td>
<td>MX9116n</td>
<td>MX5108n</td>
<td>MX5108n</td>
</tr>
<tr>
<td>MX9116n</td>
<td>MX9116n</td>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
</tr>
<tr>
<td>MX9116n</td>
<td>MX9116n</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
</tr>
<tr>
<td>MX9116n</td>
<td>MX7116n</td>
<td>MX5108n</td>
<td>MX5108n</td>
</tr>
<tr>
<td>MX7116n</td>
<td>MX9116n</td>
<td>MX5108n</td>
<td>MX5108n</td>
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<tr>
<td>MX9116n</td>
<td>MX7116n</td>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
</tr>
<tr>
<td>MX7116n</td>
<td>MX9116n</td>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
</tr>
<tr>
<td>MX9116n</td>
<td>MX7116n</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
</tr>
<tr>
<td>MX7116n</td>
<td>MX9116n</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
</tr>
<tr>
<td>MX7116n</td>
<td>MX7116n</td>
<td>MX5108n</td>
<td>MX5108n</td>
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</table>

<table>
<thead>
<tr>
<th>Slot A2</th>
<th>Slot A2</th>
<th>Slot B1</th>
<th>Slot B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MX7116n</td>
<td>MX7116n</td>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
</tr>
<tr>
<td>MX7116n</td>
<td>MX7116n</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
</tr>
<tr>
<td>MX5108n</td>
<td>MX5108n</td>
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<td>MX9116n</td>
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<tr>
<td>MX5108n</td>
<td>MX5108n</td>
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<td>MX5108n</td>
<td>MX5108n</td>
<td>MX9116n</td>
<td>MX9116n</td>
</tr>
<tr>
<td>MX5108n</td>
<td>MX5108n</td>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
</tr>
<tr>
<td>MX5108n</td>
<td>MX5108n</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
</tr>
<tr>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
<td>MX9116n</td>
<td>MX9116n</td>
</tr>
<tr>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
<td>MX7116n</td>
<td>MX7116n</td>
</tr>
<tr>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
<td>MX9116n</td>
<td>MX7116n</td>
</tr>
<tr>
<td>-----------</td>
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<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
<td>MX7116n</td>
<td>MX9116n</td>
</tr>
<tr>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
</tr>
<tr>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
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<td>MX9116n</td>
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<tr>
<td>10GBASE-T PTM</td>
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<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
<td>MX9116n</td>
<td>MX7116n</td>
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<tr>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
<td>MX7116n</td>
<td>MX9116n</td>
</tr>
<tr>
<td>10GBASE-T PTM</td>
<td>10GBASE-T PTM</td>
<td>SFP28 PTM</td>
<td>SFP28 PTM</td>
</tr>
</tbody>
</table>
A.5 Pass-Through Module (PTM) port mapping

Figure 28 shows the port mapping between compute sleds and PTM interfaces. This mapping applies to both 25 Gbps and 10 Gbps PTMs.

Figure 28  Ethernet PTM mezzanine mapping

Note: Ports 9-14 are reserved for future expansion.
B Optics and Cables

This appendix provides a summary of the specified industry standards and the use case regarding the Dell EMC PowerEdge MX7000 chassis. For console management cabling, see Management Networks for Dell EMC Networking.

B.1 Supported optics and cables

The PowerEdge MX7000 supports various optics and cables. Table 8 shows the various cable types that are supported.

Note: Additional information on supported cables and optics can be found in the PowerEdge MX I/O Guide.

<table>
<thead>
<tr>
<th>Cable Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAC (Copper)</td>
<td>• Direct attach copper</td>
</tr>
<tr>
<td></td>
<td>• Copper wires and shielding</td>
</tr>
<tr>
<td></td>
<td>• 2-wires/channel</td>
</tr>
<tr>
<td>AOC (Optical)</td>
<td>Active Optical Cable</td>
</tr>
<tr>
<td>MMF (Optical)</td>
<td>• Multi-Mode Fiber</td>
</tr>
<tr>
<td></td>
<td>• Large core fiber (~50um)</td>
</tr>
<tr>
<td></td>
<td>• 100m (300m to match SMF) reach</td>
</tr>
<tr>
<td></td>
<td>• Transceivers are low cost</td>
</tr>
<tr>
<td></td>
<td>• Fiber 3x cost of SMF</td>
</tr>
<tr>
<td>SMF (Optical)</td>
<td>• Single-Mode Fiber</td>
</tr>
<tr>
<td></td>
<td>• Tiny core fiber (~9um)</td>
</tr>
<tr>
<td></td>
<td>• 2/10Km reach</td>
</tr>
<tr>
<td></td>
<td>• Transceivers are expensive</td>
</tr>
</tbody>
</table>
Table 9 shows the different optical connectors and a brief description of the standard.

Table 9  Optical connectors

<table>
<thead>
<tr>
<th>Connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Form-factor Pluggable (SFP)</td>
<td>SFP</td>
</tr>
<tr>
<td>• SFP = 1Gb</td>
<td>• 1 Channel</td>
</tr>
<tr>
<td>• SFP+= 10Gb</td>
<td>• 2 Fibers or wires</td>
</tr>
<tr>
<td>• SFP28 = 25Gb</td>
<td>• 1-1.5W</td>
</tr>
<tr>
<td></td>
<td>• Duplex LC optical connector</td>
</tr>
<tr>
<td></td>
<td>• MMF or SMF</td>
</tr>
<tr>
<td>Quad Small Form-factor Pluggable (QSFP)</td>
<td>QSFP</td>
</tr>
<tr>
<td>• QSFP+ = 40Gb</td>
<td>• 4 Channels</td>
</tr>
<tr>
<td>• QSFP28 = 100Gb</td>
<td>• 8 Fibers or wires</td>
</tr>
<tr>
<td></td>
<td>• 3.5W-5W</td>
</tr>
<tr>
<td></td>
<td>• MPO12 8 fiber parallel optical connector</td>
</tr>
<tr>
<td>Quad Small Form-factor Pluggable Double – Density (QSFP-DD)</td>
<td>QSFP-DD</td>
</tr>
<tr>
<td>• QSFP28-DD = 2x100Gb</td>
<td>• 8 channels</td>
</tr>
<tr>
<td>• QSFP56-DD = 2x200Gb</td>
<td>• 16 fibers or wires</td>
</tr>
<tr>
<td></td>
<td>• 10W</td>
</tr>
<tr>
<td></td>
<td>• MPO12DD 16 fiber parallel optical connector</td>
</tr>
</tbody>
</table>

Table 10 shows the location within the chassis, where each type of media is relevant.

Table 10  Media associations

<table>
<thead>
<tr>
<th>Media Type</th>
<th>Mx9116n</th>
<th>MX7116n</th>
<th>MX5108n</th>
<th>25GbE PTM</th>
<th>25GbE Switch</th>
<th>100GbE Switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFP+</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>SFP28</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>QSFP+</td>
<td>X</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>QSFP28</td>
<td>X</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>QSFP28-DD</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each type of media has a specific use case regarding the MX7000, with each type of media there are various applications. The following sections outline where in the chassis each type of media is relevant.

**Note:** See the [Dell EMC Networking Transceivers and Cables](#) document for more information about supported optics and cables.
B.2 SFP+/SFP28

As seen in Table 10, SFP+ is a 10GbE transceiver and SFP28 is a 25GbE transceiver both of which can use either fiber or copper media to achieve 10GbE or 25GbE communication in each direction. While the MX5108n has four 10GBASE-T copper interfaces, the focus is on optical connectors.

The SFP+ media type is typically seen in the PowerEdge MX7000 with the use of the 25GbE PTM and using breakout cables form the QSFP+ and QSFP28 ports. The following are supported on the PowerEdge MX7000:

- Direct Attach Copper (DAC)
- LC fiber optic cable with SFP+ transceivers

The use of SFP+/SFP28 as it relates to QSFP+ and QSFP28, is discussed in those sections.

**Note:** If using SFP+ media, the endpoints of the connection need to be set to 10GbE.

---

Figure 29 shows an example of SFP+ cables and transceivers. Also, the SFP+ form factor can be seen referenced in the QSFP+ and QSFP28 sections with the use of breakout cables.
B.3 QSFP+

QSFP+ is a 40Gb standard that uses either fiber or copper media to achieve communication in each direction. This standard has four individual 10Gb lanes which can be used together to achieve 40GbE throughput or separately as four individual 10GbE connections (using breakout connections). One variant of the Dell QSFP+ transceiver is shown in Figure 30.

Figure 30 QSFP+ Transceiver

The QSFP+ media type has several uses in the PowerEdge MX7000. While the MX9116n FSE does not have interfaces that are dedicated to QSFP+, ports 41 through 44 can be broken out to 1x 40GbE that enables QSFP+ media to be used in those ports. The MX5108n has one dedicated QSFP+ port and two QSFP28 ports that can be configured for 1x 40GbE.

Figure 31 shows an example of QSFP+ Coppers. The Direct Attach Copper (DAC) is a copper cable with a QSFP+ transceiver on either end. The Multi-fiber Push On (MPO) cable is a fiber cable that has MPO connectors on either end; these connectors attach to QSFP+ transceivers. The third variant is an Active Optical Cable (AOC) that is similar to the DAC with a fixed fiber optic cable in between the attached QSFP+ transceivers.

Direct Attach Copper (DAC)  Multi-fiber Push On (MPO) Cable  Active Optical Cable (AOC)

Figure 31 QSFP+ cables

The PowerEdge MX7000 also supports the use of QSFP+ to SFP+ breakout cables. This offers the ability to use a QSFP+ port and connect to four SFP+ ports on the terminating end.
Figure 32 shows the DAC and MPO cables, which are two variations of breakout cables. The MPO cable in this example attaches to one QSFP+ transceiver and four SFP+ transceivers.

**Direct Attach Copper (DAC) Breakout**

**Multi-fiber Push On (MPO) Breakout Cable**

Note: The MPO breakout cables use a QSFP+ transceiver on one end and four SFP+ transceivers on the terminating end.

**B.4 QSFP28**

The QSFP28 standard is 100Gb that uses either fiber or copper media to achieve communication in each direction. The QSFP28 transceiver has four individual 25Gb lanes which can be used together to achieve 100GbE throughput or separately as four individual 25GbE connections (using 4 SFP28 modules). One variant of the Dell QSFP28 transceiver is shown in Figure 33.

**Figure 33 QSFP28 transceiver**
There are three variations of cables for QSFP28 connections. The variations are shown in Figure 34.

**Direct Attach Copper (DAC)**

**Multi-fiber Push On (MPO) Cable**

**Active Optical Cable (AOC)**

![QSFP28 cables](image)

**Note:** The QSFP28 form factor can use the same MPO cable as QSFP+. The DAC and AOC cables are different in that the attached transceiver is a QSFP28 transceiver rather than QSFP+.

QSFP28 supports the following breakout configurations:

1. 1x 40GbE with QSFP+ connections, using either a DAC, AOC, or MPO cable and transceiver.
2. 2x 50GbE with a fully populated QSFP28 end and two de-populated QSFP28 ends, each with 2x25GbE lanes. This product is only available as DAC cables.
3. 4x 25GbE with a QSFP28 connection and using four SFP28 connections, using either a DAC, AOC, or MPO breakout cable with associated transceivers.
4. 4x 10GbE with a QSFP28 connection and using four SFP+ connections, using either a DAC, AOC, or MPO breakout cable with associated transceivers.

B.5 **QSFP28-Double Density**

A key technology that enables the Scalable Fabric Architecture is the QSFP28 double-density (DD) connector. The QSFP28-DD form factor expands on the QSFP28 pluggable form factor by doubling the number of available lanes from four to eight, with each lane operating at 25 Gbps, the result is 200 Gbps for each connection.

Figure 35 shows that the QSFP28-DD connector is slightly longer than the QSFP28 connector. This design allows for the second row of pads to carry the additional four 25 Gbps lanes.

**Note:** A 100 GbE QSFP28 optic can be inserted into a QSFP28-DD port resulting in 100 GbE of available bandwidth. The other 100 GbE will not be available.
QSFP28-DD and QSFP28 physical interfaces

QSFP28-DD cables and optics build on the current QSFP28 naming convention. For example, the current 100GbE short range transceiver has the following description:

Q28-100G-SR4: Dell Networking Transceiver, 100GbE QSFP28, SR4, MPO12, MMF

The equivalent QSFP28-DD description is easily identifiable:

Q28DD-200G-2SR4: Dell Networking Transceiver, 2x100GbE QSFP28-DD, 2SR4, MPO12-DD, MMF
Technical resources

Dell EMC Networking Guides

Dell EMC PowerEdge MX SmartFabric Configuration and Troubleshooting Guide

Dell EMC PowerEdge MX IO Guide

Dell EMC PowerEdge MX SmartFabric Deployment Video

Dell EMC OpenManage Enterprise-Modular Edition User's Guide v1.00.01

Dell EMC SmartFabric OS10 User Guide

Manuals and documents for Dell EMC PowerEdge MX7000

Dell EMC PowerEdge MX SmartFabric Deployment with Cisco ACI Video

Manuals and documents for Dell EMC Networking MX9116n

Manuals and documents for Dell EMC Networking MX5108n

Dell EMC OME-M v1.00.01 for PowerEdge MX7000 Chassis User's Guide

Dell EMC Networking Layer 3 Leaf-Spine Deployment and Best Practices with OS10
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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