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MX Series 5G Universal Routing Platform Interface Module Reference

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The information in this document is current as of the date on the title page.

YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. Junos OS has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

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DPC, SPC, MPC, MIC, and PIC Descriptions

About This Guide

Use this guide as a reference for the interface modules (also known as line cards) supported by MX Series 5G Universal Routing Platforms, including Dense Port Concentrators (DPCs), Flexible Port Concentrators (FPCs), Physical Interface Cards (PICs), Services Processing Card (SPC), Modular Port Concentrators (MPCs) and Modular Interface Cards (MICs).

RELATED DOCUMENTATION

- Junos OS Documentation

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PART

Overview

CHAPTER 1

Interface Module Overview

IN THIS CHAPTER

MX Series Interface Module Overview

Juniper Networks MX Series 5G Universal Routing Platforms process incoming and outgoing packets on several different types of interface modules (also known as line cards). The configuration syntax for each type of line card is the same: *type-fpc/pic/port*.:

Table 1:

Interface Module	Description
Dense Port Concentrators (DPCs)	Provide multiple physical interfaces and Packet Forwarding Engines on a single board that installs into a slot within the MX240, MX480, and MX960 routers. These topics have more information about DPCs: • "MX Series DPC Overview" on page 8 • "DPCs Supported on MX240, MX480, and MX960 Routers" on page 9

Table 1: ***(Continued)***

Interface Module	Description
Flexible Port Concentrators (FPCs) and Physical Interface Cards (PICs)	FPCs provide packet forwarding services, PICs install in FPCs and provide physical interfaces for the router, FPCs are installed in a slot in an MX240, MX480, and MX960 router. These topics have more information about FPCs and PICs: • "MX Series FPC and PIC Overview" on page 60 • "High Availability Features" on page 61 • "FPCs Supported by MX240, MX480, and MX960 Routers" on page 61 • "PICs Supported by MX240, MX480, and MX960 Routers" on page 62

Table 1: ***(Continued)***

Interface Module	Description
Trio Modular Port Concentrators (MPCs) and Modular Interface Cards (MICs)	MPCs provide packet forwarding services, and MICs install into MPCs to provide the physical interfaces. You can install up to two MICs of different media types in the same MPC as long as the MPC supports those MICs. The maximum number of supported MPCs varies per router and hardware configuration. MPCs are inserted into a slot in an MX240, MX480, MX960, MX2008, MX2010, and MX2020 router. MPCs for MX5, MX10, MX40, MX80, and MX104 routers install directly into the router chassis. There are also fixed-configuration MPCs, with built-in network ports or services functionality, that do not accept MICs. These topics have more information about MPCs and MICs: • "MX Series MPC Overview" on page 15 • "MX Series MIC Overview" on page 29 • "MPCs Supported by MX Series Routers" on page 16 • "MICs Supported by MX Series Routers" on page 30 • "MIC/MPC Compatibility" on page 46 • "Protocols and Applications Supported on MPCs for MX Series Routers" on page 472 • "Protocols and Applications Supported by the MPC3E on MX Series Routers" on page 515 • "Protocols and Applications Supported on the MPC4E for MX Series Routers" on page 530 • "Protocols and Applications Supported by the MPC5E for MX Series Routers" on page 545 • "Protocols and Applications Supported by the MPC6E for MX2000 Routers" on page 557

Table 1: *(Continued)*

Interface Module	Description
	• "Protocols and Applications Supported by the MPC7E for MX Series Routers" on page 568 • "Protocols and Applications Supported by the MPC8E and MPC9E on the MX2010 and MX2020 Routers" on page 582 • "Protocols and Applications Supported by the MS-MIC and MS-MPC" on page 594 • "Protocols and Applications Supported by the MX10003 MPC (Multi-Rate) on the MX10003 Router" on page 597
Switch Control Boards (MX-SCBs, MX-SCBEs, MX-SCBE2s, and SCB3s)	Control power to MPCs, monitor and control system functions such as fan speed and the system front panel, and manage clocking, resets, and boots. Depending on the MX chassis and the level of redundancy, the number of SCBs can vary. The MX240 and MX480 require two SCBs for 1+1 redundancy, whereas the MX960 requires three SCBs for 2+1 redundancy. There are four generations of SCBs for MX Series 5G Universal Routing Platforms: SCB-MX, SCBE-MX, SCBE2-MX, and SCBE3-MX. These topics have more information about SCBs: • *MX-Series Switch Control Board (SCB) Description* • *SCBE3-MX Description* • *SCBE2-MX Description* • *SCBE-MX Description* • *SCB-MX Description*

Table 1: ***(Continued)***

Interface Module	Description
Switch Fabric Boards (SFBs)	Provide increased fabric bandwidth per slot. The MX2000 line of routers can support eight SFBs and eight Enhanced SFBs (SFB2) but not both at the same time. SFBs are supported on MX2010 and MX2020 routers. These topics have more information about SFBs: • *MX2000 Switch Fabric Board (SFB) Overview* • *MX2000-SFB2-S Enhanced Switch Fabric Board Description*
Routing Engines (REs) and Control Boards with Routing Engines (CB-REs)	Provide the software processes that run Junos OS. The Routing Engine maintains the routing tables, manages the routing protocols used on the router, controls the router interfaces, controls some chassis components, and provides the interface for system management and user access to the router. Each CB-RE is a combined Routing Engine and Switch Control Board in one unit. These topics have more information about REs and CB-REs for MX routers: • *MX2000 Host Subsystem CB-RE Description* • *MX960 Routing Engine Description* • *MX480 Routing Engine Description* • *MX240 Routing Engine Description* • *MX5, MX10, MX40, and MX80 Routing Engine Description* • *RE-S-X6-64G Routing Engine Description* • *RE-MX2000-1800x4 CB-RE Description* • *REMX2K-X8-64G and REMX2K-X8-64G-LT CB-RE Description* • *Routing Engine Specifications*

Table 1: ***(Continued)***

Interface Module	Description
MX-ADC	A special line card adapter (ADC) for line cards that were designed to work with the MX-SCB and MX-SCBE line cards (MPC1E, MPC2E, and MPC3E). MX-ADCs can only be used with MX2010 and MX2020 routers. The ADC is a hardware casing that fits into a line card slot. The MPCs attach to the ADCs which in turn attach to the backplane. See *MX2000 Adapter Card (ADC) Description* for more information about MX-ADCs.

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CHAPTER 2

DPCs Supported on MX Series Routers

IN THIS CHAPTER

MX Series DPC Overview

A Dense Port Concentrator (DPC) provides multiple physical interfaces and Packet Forwarding Engines (PFEs) on a single board that installs into a slot within the MX240, MX480, and MX960 routers. The DPCs are optimized for Ethernet density and can support up to 40 Gigabit Ethernet or four 10-Gigabit Ethernet ports.

The DPC assembly combines packet forwarding and Ethernet interfaces on a single board, with four 10-Gbps Packet Forwarding Engines. Each Packet Forwarding Engine consists of one chip for Layer 3 processing and one Layer 2 network processor. The DPCs interface with the power supplies and Switch Control Boards (SCBs).

NOTE: In the Junos OS CLI, you use the FPC syntax to configure or display information about DPCs, and you use the PIC syntax to configure or display information about Packet Forwarding Engines on the DPCs.

DPCs install vertically in the MX960 router chassis and horizontally in the MX480 and MX240 router chassis. The maximum number of supported DPCs varies per router:

- MX960 router—up to 12 DPCs
- MX480 router—up to 6 DPCs
- MX240 router—up to 3 DPCs

When a slot is not occupied by a DPC, you must insert a blank DPC to fill the empty slot and ensure proper cooling of the system. For complete information about installing and handling DPCs, see the hardware guide for your router.

RELATED DOCUMENTATION

DPCs Supported on MX240, MX480, and MX960 Routers

DPCs Supported on MX240, MX480, and MX960 Routers

NOTE: These DPCs have all been announced as End of Life (EOL). The End of Support (EOS) milestone dates for each model are published at https://www.juniper.net/support/eol/mseries_hw.html.

Table 2 on page 9 lists the DPCs supported by the MX240, MX480, and MX960 routers.

Table 2: DPCs Supported in MX240, MX480, and MX960 Routers

DPC Name	DPC Model Number	Ports	Maximum Throughput per DPC
Gigabit Ethernet			
"Gigabit Ethernet DPC with SFP" on page 76	DPC-R-40GE-SFP EOL (see PSN-TSB14931)	40	40 Gbps
"Gigabit Ethernet Enhanced DPC with SFP" on page 79	DPCE-R-40GE-SFP EOL (see PSN-TSB16810)	40	40 Gbps

Table 2: DPCs Supported in MX240, MX480, and MX960 Routers *(Continued)*

DPC Name	DPC Model Number	Ports	Maximum Throughput per DPC
"Gigabit Ethernet Enhanced Ethernet Services DPC with SFP" on page 82	DPCE-X-40GE-SFP EOL (see PSN-TSB16810)	40	40 Gbps
"Gigabit Ethernet Enhanced Queuing Ethernet Services DPC with SFP" on page 85	DPCE-X-Q-40GE-SFP EOL (see PSN-TSB16059)	40	40 Gbps
"Gigabit Ethernet Enhanced Queuing IP Services DPCs with SFP" on page 88	DPCE-R-Q-20GE-SFP EOL (see PSN-TSB16059)	20	20 Gbps
"Gigabit Ethernet Enhanced Queuing IP Services DPCs with SFP" on page 88	DPCE-R-Q-40GE-SFP EOL (see PSN-TSB15618)	40	40 Gbps
"10-Gigabit Ethernet DPC with XFP" on page 92	DPC-R-4XGE-XFP EOL (see PSN-TSB14931)	4	40 Gbps
10-Gigabit Ethernet			
"10-Gigabit Ethernet Enhanced DPCs with XFP" on page 95	DPCE-R-2XGE-XFP EOL (see PSN-TSB15618)	2	20 Gbps

Table 2: DPCs Supported in MX240, MX480, and MX960 Routers *(Continued)*

DPC Name	DPC Model Number	Ports	Maximum Throughput per DPC
"10-Gigabit Ethernet Enhanced DPCs with XFP" on page 95	DPCE-R-4XGE-XFP EOL (see PSN-TSB16810)	4	40 Gbps
"10-Gigabit Ethernet Enhanced Ethernet Services DPC with XFP" on page 98	DPCE-X-4XGE-XFP EOL (see PSN-TSB16810)	4	40 Gbps
"10-Gigabit Ethernet Enhanced Queuing Ethernet Services DPC with XFP" on page 101	DPCE-X-Q-4XGE-XFP EOL (see PSN-TSB16059)	4	40 Gbps
"10-Gigabit Ethernet Enhanced Queuing IP Services DPC with XFP" on page 104	DPCE-R-Q-4XGE-XFP EOL (see PSN-TSB15618)	4	40 Gbps
Multi-Rate Ethernet			
"Multi-Rate Ethernet Enhanced DPC with SFP and XFP" on page 106	DPCE-R-20GE-2XGE EOL (see PSN-TSB15618)	22	40 Gbps
"Multi-Rate Ethernet Enhanced Ethernet Services DPC with SFP and XFP" on page 110	DPCE-X-20GE-2XGE EOL (see PSN-TSB15618)	22	40 Gbps

Table 2: DPCs Supported in MX240, MX480, and MX960 Routers *(Continued)*

DPC Name	DPC Model Number	Ports	Maximum Throughput per DPC
"Multi-Rate Ethernet Enhanced Queuing IP Services DPC with SFP and XFP" on page 113	DPCE-R-Q-20GE-2XGE EOL (see PSN-TSB16810)	22	40 Gbps
Tri-Rate Ethernet			
"Tri-Rate Enhanced DPC" on page 119	DPCE-R-40GE-TX EOL (see PSN-TSB16059)	40	40 Gbps
"Tri-Rate Enhanced Ethernet Services DPC" on page 122	DPCE-X-40GE-TX EOL (see PSN – TSB15619)	40	40 Gbps
Services			
"Multiservices DPC" on page 116	MS-DPC EOL (see PSN– TSB16812)	2 (Not supported)	–

RELATED DOCUMENTATION

- Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R) | **427**
- Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X) | **436**
- Protocols and Applications Supported by Enhanced Queuing IP Services DPCs (DPCE-R-Q) | **444**
- Protocols and Applications Supported by Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) | **453**
- Protocols and Applications Supported by the Multiservices DPC (MS-DPC) | **459**

CHAPTER 3

SPC Supported on MX Series Routers

IN THIS CHAPTER

MX-SPC3 Services Card Overview and Support on MX240, MX480, and MX960 Routers

The MX-SPC3 Services Card is a Services Processing Card (SPC) that provides additional processing power to run Next Gen Services. The MX-SPC3 contains two Services Processing Units (SPUs) with 128 GB of memory per SPU. Line cards such as DPCs, MPCs, and MICs, intelligently distribute all traffic traversing the router to the SPUs to have services processing applied to it.
Next Gen Services provide the best of both routing and security features on MX Series routers MX240, MX480, and MX960. All Next Gen Services are provided by the MX-SPC3 Services Card. Next Gen Services provide capabilities for manipulating traffic before it's delivered to its destination.

NOTE: The only services card that supports Next Gen Services is the MX-SPC3.

Table 3 on page 13 shows the SPC and its first supported Junos OS release on MX240, MX480, and MX960, routers.

Table 3: MX-SPC3 Supported by MX240, MX480, and MX960 Routers

SPC Name	SPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers
MX-SPC3 Services Card	JNP-SPC3	19.3R2

The MX-SPC3 services card is compatible end-to-end with the MX Series Switch Fabrics, Routing Engines and MPC line cards for MX240, MX480, and MX960 routers. See Table 23 on page 131.

NOTE: Routing Engines use the following naming conventions:

- *BB*: Routing Engines suffixed with *BB* refer to the Base Bundle (BB) Routing Engine. You can only order it with a Chassis Bundle suffixed with *BB*.
- *R*: Routing Engines suffixed with *R* refer to a Redundant (R) Routing Engine. You can only order it with the Chassis Bundle and can't order it separately.
- *S*: Routing Engines suffixed with *S* refer to a standalone Routing Engine that you can order without the Chassis. You can either use it as a spare or when upgrading a non-redundant system to make it redundant.

CHAPTER 4

MPCs Supported on MX Series Routers

IN THIS CHAPTER

MX Series MPC Overview

Modular Port Concentrators (MPCs) provide packet forwarding services. The MPCs are inserted into a slot in an MX240, MX480, MX960, MX2008, MX2010, MX2020, and MX10003 router. MPCs for MX5, MX10, MX40, MX80, and MX104 routers install directly into the router chassis. Modular Interface Cards (MICs) provide the physical interfaces and install into the MPCs. You can install up to two MICs of different media types in the same MPC as long as the MPC supports those MICs.

A specialized fixed configuration MPC provides higher port density over MICs and combines packet forwarding and Ethernet interfaces onto a single line card. The fixed configuration MPC is inserted into a slot in a router and contains no slots for MICs.

MICs receive incoming packets from the network and transmit outgoing packets to the network. During this process, each MIC performs framing and high-speed signaling for its media type. Before transmitting outgoing data packets through the MIC interfaces, the MPCs encapsulate the packets received. Each MPC is equipped with up to four Junos Trio chipsets, which perform control functions tailored to the MPC's media type.

You'll need to install a high-capacity fan tray to use an MPC. When a slot is not occupied by an MPC, you must insert a blank MPC to fill the empty slot and ensure proper cooling of the system. For complete information about installing and handling MPCs, see the hardware guide for your router.

The maximum number of supported MPCs varies per router and hardware configuration:

- MX2020 router—Up to 20 MPCs (For power requirements, see *Calculating AC Power Requirements for MX2020 Routers* and Calculating DC Power Requirements for MX2020 Routers).
- MX2010 router—Up to 10 MPCs (For power requirements, see *Calculating AC Power Requirements for MX2010 Routers* and *Calculating DC Power Requirements for MX2010 Routers*.)

- The MX2008 router supports up to 10 MPCs. For power requirements, see Calculating AC Power Requirements for MX2008 Routers and Calculating DC Power Requirements for MX2008 Routers.
- MX960 router—Up to 12 MPCs (For power requirements, see *Calculating Power Requirements for MX960 Routers*.)
- MX480 router—Up to six MPCs (For power requirements, see *Calculating Power Requirements for MX480 Routers*.)
- MX240 router—Up to three MPCs (For power requirements, see *Calculating Power Requirements for MX240 Routers*.)

RELATED DOCUMENTATION

MPCs Supported by MX Series Routers | **16**

Protocols and Applications Supported on MPCs for MX Series Routers | **472**

Protocols and Applications Supported by the MPC3E on MX Series Routers | **515**

Protocols and Applications Supported on the MPC4E for MX Series Routers | **530**

Protocols and Applications Supported by the MPC5E for MX Series Routers | **545**

Protocols and Applications Supported by the MPC6E for MX2000 Routers | **557**

Protocols and Applications Supported by the MX2K-MPC11E | **641**

MX Series MIC Overview | **29**

MICs Supported by MX Series Routers | **30**

MPCs Supported by MX Series Routers

MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers on page 17 lists the MPCs and their first supported Junos OS release on MX240, MX480, MX960, MX10003, MX10004, and MX10016, MX2008, MX2010, and MX2020 routers.

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX2008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
Fixed Configuration MPCs									
"MPC-3D-16XGE-SFPP" on page 136	MPC-3D-16XGE-SFP	10.0R2	–		–		15.1F7	12.3	12.3
"Multiservices MPC" on page 139	MS-MPC	13.2R4	–		–		15.1F7	15.1	15.1
"32x10GE MPC4E" on page 177	MPC4E-3D-32XGE-SFPP	12.3R2	–		–		15.1F7	12.3R2	12.3R2
"2x100GE + 8x10GE MPC4E" on page 179	MPC4E-3D-2CGE-8XGE	12.3R2	–		–		15.1F7	12.3R2	12.3R2

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX20008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
"6x40GE + 24x10GE MPC5E" on page 182	MPC5E-40G10G	13.3R2	–		–		15.1F7	13.3R2	13.3R2
"6x40GE + 24x10GE MPC5EQ" on page 187	MPC5EQ-40G10G	13.3R2	–		–		15.1F7	13.3R2	13.3R2
"2x100GE + 4x10GE MPC5E" on page 190	MPC5E-100G10G	13.3R3	–		–		15.1F7	13.3R3	13.3R3
"2x100GE + 4x10GE MPC5EQ" on page 193	MPC5EQ-100G10G	13.3R3	–		–		15.1F7	13.3R3	13.3R3

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX2008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
MPC7E-MRATE	MPC7E-MRATE	• 15.1F4 with Junos Continuity • 16.1R1 and later	–		–		15.1F7	• 15.1F4 with Junos Continuity • 16.1R1 and later	• 15.1F4 with Junos Continuity • 16.1R1 and later
MPC7E-10G	MPC7E-10G	• 15.1F5 with Junos Continuity • 16.1R1 and later	–		–		15.1F7	• 15.1F5 with Junos Continuity • 16.1R1 and later	• 15.1F5 with Junos Continuity • 16.1R1 and later

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX2008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
"MPC10E-10C-MRATE" on page 210	MPC10E-10C-MRATE	19.2R1	–		–		–	–	–
"MPC10E-15C-MRATE" on page 215	MPC10E-15C-MRATE	19.1R1	–		–		–	–	–

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX20008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
"MX2K-MPC11E Modular Port Concentrator" on page 221	MX2K-MPC11E							• 19.3R2 and later 19.3 releases • 20.1R1 **NOTE:** The MX2K-MPC11EMP	• 19.3R2 and later 19.3 releases • 20.1R1 **NOTE:** The MX2K-MPC11EMP
		-	-		-		-		

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX20008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
								C is not supported in any 19.4 releases.	C is not supported in any 19.4 releases.
"MPC1" on page 142	MX-MPC1-3D	10.2	**MPCs**				15.1F7	12.3	12.3

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX20008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
"MPC1E" on page 144	MX-MPC1E-3D	11.2R4	–		–		15.1F7	12.3	12.3
"MPC1Q" on page 146	MX-MPC1-3D-Q	10.2	–		–		15.1F7	12.3	12.3
"MPC1EQ" on page 148	MX-MPC1E-3D-Q	11.2R4	–		–		15.1F7	12.3	12.3
"MPC2" on page 150	MX-MPC2-3D	10.1	–		–		15.1F7	12.3	12.3
"MPC2E" on page 152	MX-MPC2E-3D	11.2R4	–		–		15.1F7	12.3	12.3
"MPC2Q" on page 154	MX-MPC2-3D-Q	10.1	–				15.1F7	12.3	12.3
"MPC2EQ" on page 156	MX-MPC2E-3D-Q	11.2R4	–		–		15.1F7	12.3	12.3

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX2008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
"MPC2 EQ" on page 158	MX-MPC2-3D-EQ	10.1	–		–		15.1F7	12.3	12.3
"MPC2E EQ" on page 160	MX-MPC2E-3D-EQ	11.2R4	–		–		15.1F7	12.3	12.3
"MPC2E P" on page 162	MX-MPC2E-3D-P	12.2	–		–		15.1F7	12.3	12.3
MPC2E NG	MX-MPC2E-3D-NG	14.1R4, 14.2R3 and Junos Continuity 15.1	–		–		15.1F7	14.1R4, 14.2R3 and Junos Continuity 15.1	14.1R4, 14.2R3 and Junos Continuity 15.1
MPC2E NG Q	MX-MPC2E-3D-NG-Q	14.1R4, 14.2R3 and Junos Continuity 15.1	–		–		15.1F7	14.1R4, 14.2R3 and Junos Continuity 15.1	14.1R4, 14.2R3 and Junos Continuity 15.1

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX20008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
"MPC3E" on page 169	MX-MPC3E-3D	12.1	–		–		15.1F7	12.3	12.3
MPC3E-3D-NG	MX-MPC3E-3D-NG	14.1R4, 14.2R3 and Junos Continuity 15.1	–		–		15.1F7	14.1R4, 14.2R3 and Junos Continuity 15.1	14.1R4, 14.2R3 and Junos Continuity 15.1
MPC3E-3D-NG-Q	MX-MPC3E-3D-NG-Q	14.1R4, 14.2R3 and Junos Continuity 15.1	–		–		15.1F7	14.1R4, 14.2R3 and Junos Continuity 15.1	14.1R4, 14.2R3 and Junos Continuity 15.1
"MPC6E" on page 196	MX2K-MPC6E	–	–		–		15.1F7	13.3R2	13.3R2

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX2008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
MPC8E	MX2K-MPC8E	–	–		–		15.1F7	• 15.1F5 with Junos Continuity • 16.1R1 and later	• 15.1F5 with Junos Continuity • 16.1R1 and later
MPC9E	MX2K-MPC9E	–	–		–		15.1F7	• 15.1F5 with Junos Continuity • 16.1R1 and later	• 15.1F5 with Junos Continuity • 16.1R1 and later

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX2008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
MX10003 MPC (Multi-Rate)	MX10003-LC2103	–	17.3R1		–		–	–	–
MX10003 MPC (Multi-Rate)	MX10003-LC2103-V2	–	21.3R1				–	–	–
MX10K-LC2101	JNP10K-LC2101	-	-	22.3R1	18.2R1	19.2R1	-	-	-
MX10K-LC480	JNP10K-LC480	-	-	22.3R1	21.2R1	21.2R1	-	-	-
MX10K-LC9600	JNP10K-LC9600	-	-	22.3R1	21.4R1	-	-	-	-
MX10K-LC4800	JNP10K-LC4800	-	-	24.2R1	24.2R1	-	-	-	-
MX10K-LC4802	JNP10K-LC4802			25.2R1	25.2R1				
Services Processing Cards (SPCs)									

Table 4: MPCs Supported by MX240, MX480, MX960, MX10003, MX10004, MX10016, MX2008, MX2010, and MX2020 Routers *(Continued)*

MPC Name	MPC Model Number	First Junos OS Release on MX240, MX480, and MX960 Routers	First Junos OS Release on MX10003 Routers	First Junos OS Release on MX10004 Routers	First Junos OS Release on MX10008 Routers	First Junos OS Release on MX10016 Routers	First Junos OS Release on MX20008 Routers	First Junos OS Release on MX2010 Routers	First Junos OS Release on MX2020 Routers
MX-SPC3 Services Card	JNP-SPC3	19.3R2	-	-	-	-	-	-	-

RELATED DOCUMENTATION

- MX Series MPC Overview | **15**
- MX Series MPC Overview | **15**
- MX Series MIC Overview | **29**
- *MICs Supported by MX Series Routers*
- *MIC/MPC Compatibility*
- Pathfinder: Hardware Supported by Junos Continuity Software

CHAPTER 5

MICs Supported on MX Series Routers

IN THIS CHAPTER

MX Series MIC Overview

MICs provide the physical connections to various network media types. MICs allow different physical interfaces to be supported on a single line card. You can install MICs of different media types on the same router as long as the router supports those MICs.

MICs receive incoming packets from the network and transmit outgoing packets to the network. During this process, each MIC performs framing and high-speed signaling for its media type. MICs install into Modular Port Concentrators (MPCs) which provide packet forwarding services. Before transmitting outgoing data packets through the MIC interfaces, the Modular Port Concentrator (MPCs) encapsulate the packets received. Each MPC is equipped with up to four Junos Trio chipsets, which perform control functions tailored to the MPC's media type.

MICs and MPCs function similarly to PICs and FPCs. MICs are hot-removable and hot-insertable. You can install up to two MICs of different media types in the same MPC as long as the MPC supports those MICs. Depending on the MX router chassis, the MICs install vertically or horizontally into MPCs, or directly into the MX router chassis as follows:

- Vertically into MPCs—MX960, MX2008, MX2010, and MX2020 routers
- Horizontally into MPCs—MX10003, MX480, and MX240 routers
- Directly into the router chassis—MX5, MX10, MX40, MX80, and MX104 routers

NOTE: The MX80 router is available as a modular (MX80) or fixed (MX80-48T) chassis. Both chassis have a fixed Modular Interface Card (MIC) that has 3 10-Gigabit Ethernet

ports. The fixed MX80 router has an additional 48 10/100/1000Base-T RJ45 ports. The modular chassis has two dedicated slots for MICs.

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MICs Supported by MX Series Routers

The following tables list the first supported Junos OS release for the MX Series.

- Table 5 on page 30 lists the first supported Junos OS release for MICs on MX240, MX480, MX960, and MX2008 routers.
- Table 6 on page 35 lists the first supported Junos OS release for MICs on MX2010 and MX2020 routers.
- Table 7 on page 39 list the first supported Junos OS release for MICs on MX5, MX10, and MX40 routers.
- Table 8 on page 42 lists the first supported Junos OS release for MICs on MX80 and MX104 routers.
- Table 9 on page 45 lists the first supported Junos OS release for MICs on MX10003 router.

Table 5: MICs Supported by MX240, MX480, MX960, and MX2008 Routers

MIC Name	MIC Model Number	Ports	MX240, MX480, and MX960 Routers	MX2008 Routers
ATM				
"ATM MIC with SFP" on page 256	MIC-3D-8OC3-2OC12-ATM	8	12.1	15.1F7

Table 5: MICs Supported by MX240, MX480, MX960, and MX2008 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX240, MX480, and MX960 Routers	MX2008 Routers
DS3/E3				
"DS3/E3 MIC" on page 261	MIC-3D-8DS3-E3, MIC-3D-8CHDS3-E3-B	8	11.4	15.1F7
Circuit Emulation				
"Channelized E1/T1 Circuit Emulation MIC" on page 342	MIC-3D-16CHE1-T1-CE	16	12.3	15.1F7
Gigabit Ethernet				
"Gigabit Ethernet MIC with SFP" on page 267	MIC-3D-20GE-SFP	20	10.1	15.1F7
"Gigabit Ethernet MIC with SFP (E)" on page 272	MIC-3D-20GE-SFP-E	20	13.3	15.1F7
"Gigabit Ethernet MIC with 256b-AES MACsec" on page 280	MIC-MACSEC-20GE	20	18.3	—
10-Gigabit Ethernet				
"10-Gigabit Ethernet MICs with XFP" on page 284	MIC-3D-2XGE-XFP	2	10.2	15.1F7

Table 5: MICs Supported by MX240, MX480, MX960, and MX2008 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX240, MX480, and MX960 Routers	MX2008 Routers
"10-Gigabit Ethernet MICs with XFP" on page 284	MIC-3D-4XGE-XFP	4	10.1	15.1F7
"1-Gigabit/10-Gigabit Ethernet MIC with SFP+ (10 Ports)" on page 289	MIC-3D-10GE-SFP-E	10	24.2	—
"10-Gigabit Ethernet MIC with SFP+ (10 Ports)" on page 294	MIC3-3D-10XGE-SFPP	10	12.3	15.1F7
"10-Gigabit Ethernet MIC with SFP+ (24 Ports)" on page 297	MIC6-10G	24	—	15.1F7
"10-Gigabit Ethernet OTN MIC with SFP+ (24 Ports)" on page 299	MIC6-10G-OTN	24	—	15.1F7
40-Gigabit Ethernet				
"40-Gigabit Ethernet MIC with QSFP+" on page 301	MIC3-3D-2X40GE-QSFPP	2	12.2	15.1F7
100-Gigabit Ethernet				
"100-Gigabit Ethernet MIC with CFP" on page 303	MIC3-3D-1X100GE-CFP	1	12.1	15.1F7

Table 5: MICs Supported by MX240, MX480, MX960, and MX2008 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX240, MX480, and MX960 Routers	MX2008 Routers
"100-Gigabit Ethernet MIC with CXP" on page 306	MIC3-3D-1X100GE-CXP	1	12.2	15.1F7
"100-Gigabit Ethernet MIC with CXP (4 Ports)" on page 308	MIC6-100G-CXP	4	—	15.1F7
"100-Gigabit Ethernet MIC with CFP2" on page 310	MIC6-100G-CFP2	2	—	15.1F7
100-Gigabit DWDM OTN				
"100-Gigabit DWDM OTN MIC with CFP2-ACO" on page 312	MIC3-100G-DWDM	1	15.1F5 15.1F6 17.1R1	15.1F7
Multi-Rate				
"SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364	MIC-3D-4OC3OC12-1OC48	4	11.2	15.1F7
"SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364	MIC-3D-8OC3OC12-4OC48	8	11.2	15.1F7

Table 5: MICs Supported by MX240, MX480, MX960, and MX2008 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX240, MX480, and MX960 Routers	MX2008 Routers
"Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324	MIC-3D-4CHOC3-2CHOC12	4	11.4	15.1F7
"Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324	MIC-3D-8CHOC3-4CHOC12	8	11.4	15.1F7
"Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP" on page 333	MIC-3D-4COC3-1COC12-CE	4	12.2	15.1F7
MIC MRATE (12-Port Multi-Rate MIC with QSFP+)	MIC-MRATE	12	—	15.1F7
"Multi-Rate Ethernet MIC" on page 369 (12-Port Multi-Rate MACsec MIC with QSFP+)	MIC-MACSEC-MRATE	12	—	17.4
Tri-Rate				
"Tri-Rate MIC" on page 353	MIC-3D-40GE-TX	40	10.2	15.1F7
Services				

Table 5: MICs Supported by MX240, MX480, MX960, and MX2008 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX240, MX480, and MX960 Routers	MX2008 Routers
"Multiservices MIC" on page 361	MS-MIC-16G	0	13.2	15.1F7
SONET/SDH				
"SONET/SDH OC192/STM64 MIC with XFP" on page 379	MIC-3D-1OC192-XFP	1	12.2	15.1F7

Table 6: MICs Supported by MX2010 and MX2020 Routers

MIC Name	MIC Model Number	Ports	MX2010 Routers	MX2020 Routers
ATM				
"ATM MIC with SFP" on page 256	MIC-3D-8OC3-2OC12-ATM	8	12.3	12.3
DS3/E3				
"DS3/E3 MIC" on page 261	MIC-3D-8DS3-E3, MIC-3D-8CHDS3-E3-B	8	12.3	12.3
Circuit Emulation				
"Channelized E1/T1 Circuit Emulation MIC" on page 342	MIC-3D-16CHE1-T1-CE	16	—	—
Gigabit Ethernet				

Table 6: MICs Supported by MX2010 and MX2020 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX2010 Routers	MX2020 Routers
"Gigabit Ethernet MIC with SFP" on page 267	MIC-3D-20GE-SFP	20	12.3	12.3
"Gigabit Ethernet MIC with SFP (E)" on page 272	MIC-3D-20GE-SFP-E	20	13.3	13.3
10-Gigabit Ethernet				
"10-Gigabit Ethernet MICs with XFP" on page 284	MIC-3D-2XGE-XFP	2	12.3	12.3
"10-Gigabit Ethernet MICs with XFP" on page 284	MIC-3D-4XGE-XFP	4	12.3	12.3
"1-Gigabit/10-Gigabit Ethernet MIC with SFP+ (10 Ports)" on page 289	MIC-3D-10GE-SFP-E	10	24.2	24.2
"10-Gigabit Ethernet MIC with SFP+ (10 Ports)" on page 294	MIC3-3D-10XGE-SFPP	10	12.3	12.3
"10-Gigabit Ethernet MIC with SFP+ (24 Ports)" on page 297	MIC6-10G	24	13.3R2	13.3R2
"10-Gigabit Ethernet OTN MIC with SFP+ (24 Ports)" on page 299	MIC6-10G-OTN	24	13.3R3	13.3R3
40-Gigabit Ethernet				
"40-Gigabit Ethernet MIC with QSFP+" on page 301	MIC3-3D-2X40GE-QSFPP	2	12.3	12.3

Table 6: MICs Supported by MX2010 and MX2020 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX2010 Routers	MX2020 Routers
100-Gigabit Ethernet				
"100-Gigabit Ethernet MIC with CFP" on page 303	MIC3-3D-1X100 GE-CFP	1	12.3	12.3
"100-Gigabit Ethernet MIC with CXP" on page 306	MIC3-3D-1X100 GE-CXP	1	12.3	12.3
"100-Gigabit Ethernet MIC with CXP (4 Ports)" on page 308	MIC6-100G-CXP	4	13.3R2	13.3R2
"100-Gigabit Ethernet MIC with CFP2" on page 310	MIC6-100G-CFP2	2	13.3R3	13.3R3
100-Gigabit DWDM OTN				
"100-Gigabit DWDM OTN MIC with CFP2-ACO" on page 312	MIC3-100G-DWDM	1	15.1F515.1F617.1R1	15.1F515.1F617.1R1
Multi-Rate				
"SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364	MIC-3D-4OC3OC12-1OC48	4	12.3	12.3
"SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364	MIC-3D-8OC3OC12-4OC48	8	12.3	12.3

Table 6: MICs Supported by MX2010 and MX2020 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX2010 Routers	MX2020 Routers
"Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324	MIC-3D-4CHOC3-2CHOC12	4	12.3	12.3
"Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324	MIC-3D-8CHOC3-4CHOC12	8	12.3	12.3
"Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP" on page 333	MIC-3D-4COC3-1COC12-CE	4	12.3	12.3
MIC MRATE (12-Port Multi-Rate MIC with QSFP+)	MIC-MRATE	12	15.1F5 with Junos Continuity 16.1R1 and later	15.1F5 with Junos Continuity 16.1R1 and later
"Multi-Rate Ethernet MIC" on page 369 (12-Port Multi-Rate MACsec MIC with QSFP+)	MIC-MACSEC-MRATE	12	17.4	17.4
Tri-Rate				
"Tri-Rate MIC" on page 353	MIC-3D-40GE-TX	40	12.3	12.3
Services				
"Multiservices MIC" on page 361	MS-MIC-16G	0	13.2	13.2
SONET/SDH				

Table 6: MICs Supported by MX2010 and MX2020 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX2010 Routers	MX2020 Routers
"SONET/SDH OC192/ STM64 MIC with XFP" on page 379	MIC-3D-1OC192-XFP	1	12.3	12.3

Table 7: MICs Supported by MX5, MX10, and MX40 Routers

MIC Name	MIC Model Number	Ports	MX5	MX10	MX40
ATM					
"ATM MIC with SFP" on page 256	MIC-3D-8OC3-2OC12-ATM	8	12.1	12.1	12.1
DS3/E3					
"DS3/E3 MIC" on page 261	MIC-3D-8DS3-E3, MIC-3D-8CHDS3-E3-B	8	11.4	11.4	11.4
Circuit Emulation					
"Channelized E1/T1 Circuit Emulation MIC" on page 342	MIC-3D-16CHE1-T1-CE	16	13.2R2	13.2R2	13.2R2
"Channelized E1/T1 Circuit Emulation MIC (H)" on page 347	MIC-3D-16CHE1-T1-CE-H	16	—	—	—

Table 7: MICs Supported by MX5, MX10, and MX40 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX5	MX10	MX40
Gigabit Ethernet					
"Gigabit Ethernet MIC with SFP" on page 267	MIC-3D-20GE-SFP	20	11.2R4	11.2R4	11.2R4
"Gigabit Ethernet MIC with SFP (E)" on page 272	MIC-3D-20GE-SFP-E	20	13.2R2	13.2R2	13.2R2
"Gigabit Ethernet MIC with SFP (EH)" on page 277	MIC-3D-20GE-SFP-EH	20	—	—	—
10-Gigabit Ethernet					
"10-Gigabit Ethernet MICs with XFP" on page 284	MIC-3D-2XGE-XFP	2	11.2R4	11.2R4	11.2R4
Multi-Rate					
"SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364	MIC-3D-4OC3 OC12-1OC48	4	11.2R4	11.2R4	11.2R4

Table 7: MICs Supported by MX5, MX10, and MX40 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX5	MX10	MX40
"SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364	MIC-3D-8OC3 OC12-4OC48	8	11.2R4	11.2R4	11.2R4
"Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324	MIC-3D-4CHO C3-2CHOC12	4	11.4	11.4	11.4
"Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324	MIC-3D-8CHO C3-4CHOC12	8	11.4	11.4	11.4
"Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP" on page 333	MIC-3D-4COC3 -1COC12-CE	4	12.2	12.2	12.2
"Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP (H)" on page 338	MIC-4COC3-1C OC12-CE-H	—	—	—	—

Table 7: MICs Supported by MX5, MX10, and MX40 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX5	MX10	MX40
Tri-Rate					
"Tri-Rate MIC" on page 353	MIC-3D-40GE-TX	40	—	11.2R4	11.2R4
Services					
"Multiservices MIC" on page 361	MS-MIC-16G	0	13.2 Rear slot only.	13.2 Rear slot only.	13.2 Rear slot only.
"SONET/SDH OC192/STM64 MIC with XFP" on page 379	MIC-3D-1OC192-XFP	1	12.2	12.2	12.2

Table 8: MICs Supported by MX80 and MX104 Routers

MIC Name	MIC Model Number	Ports	MX80	MX104
ATM				
"ATM MIC with SFP" on page 256	MIC-3D-8OC3-2OC12-ATM	8	12.1	13.3
DS3/E3				
"DS3/E3 MIC" on page 261	MIC-3D-8DS3-E3, MIC-3D-8CHDS3-E3-B	8	11.4	13.3
Circuit Emulation				

Table 8: MICs Supported by MX80 and MX104 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX80	MX104
"Channelized E1/T1 Circuit Emulation MIC" on page 342	MIC-3D-16CHE1-T1-CE	16	13.2R2	13.2R2
"Channelized E1/T1 Circuit Emulation MIC (H)" on page 347	MIC-3D-16CHE1-T1-CE-H	16	—	13.2R2
Gigabit Ethernet				
"Gigabit Ethernet MIC with SFP" on page 267	MIC-3D-20GE-SFP	20	10.2	13.2R2
"Gigabit Ethernet MIC with SFP (E)" on page 272	MIC-3D-20GE-SFP-E	20	13.2R2	13.2R2
"Gigabit Ethernet MIC with SFP (EH)" on page 277	MIC-3D-20GE-SFP-EH	20	—	13.2R2
"Gigabit Ethernet MIC with 256b-AES MACsec" on page 280	MIC-MACSEC-20GE	20	18.3	18.3
"10-Gigabit Ethernet MICs with XFP" on page 284	MIC-3D-2XGE-XFP	2	10.2	13.2R2
Multi-Rate				

Table 8: MICs Supported by MX80 and MX104 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX80	MX104
"SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364	MIC-3D-4OC3OC12-1OC48	4	11.2	13.3
"SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364	MIC-3D-8OC3OC12-4OC48	8	11.2	13.3
"Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324	MIC-3D-4CHOC3-2CHOC12	4	11.4	13.3
"Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324	MIC-3D-8CHOC3-4CHOC12	8	11.4	13.3
"Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP" on page 333	MIC-3D-4COC3-1COC12-CE	4	12.2	13.2R2
"Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP (H)" on page 338	MIC-4COC3-1COC12-CE-H	—	—	13.2R2
Tri-Rate				

Table 8: MICs Supported by MX80 and MX104 Routers *(Continued)*

MIC Name	MIC Model Number	Ports	MX80	MX104
"Tri-Rate MIC" on page 353	MIC-3D-40GE-TX	40	10.2	13.2R2
Services				
"Multiservices MIC" on page 361	MS-MIC-16G	0	13.2 Rear slot only. Supported on the modular MX80 and fixed MX80-48T	13.3R2 **NOTE**: Starting From Junos OS 13.3R3, 14.1R2, and 14.2R1, MX104 supports only two Multiservices MICs.
SONET/SDH				
"SONET/SDH OC192/STM64 MIC with XFP" on page 379	MIC-3D-1OC192-XFP	1	12.2	13.3

Table 9: MICs Supported by MX10003 Router

MIC Name	MIC Model Number	Ports	MX10003
Multi-Rate			
MIC MRATE (12-Port Multi-Rate MIC with QSFP+)	JNP-MIC1	12	17.3
"Multi-Rate Ethernet MIC" on page 369 (12-Port Multi-Rate MACsec MIC with QSFP+)	JNP-MIC1-MACSEC	12	17.3R2

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MIC/MPC Compatibility

The following tables provide a compatibility matrix for the MICs currently supported by MPC1, MPC2, MPC3, MPC6, MPC8, and MPC9 on MX240, MX480, MX960, MX2008, MX2010, MX2020, and MX10003 routers. Each table lists the first Junos OS release in which the MPC supports the MIC. For example, Junos OS Release 10.2 is the first release in which the MX-MPC1-3D supports the Gigabit Ethernet MIC with SFP. An en dash indicates that the MIC is not supported.

Table 10: MIC/MPC1 Compatibility

MIC Name	MPC1	MPC1E	MPC1 Q	MPC1E Q
MIC-3D-8OC3-2OC12-ATM ("ATM MIC with SFP" on page 256)	–	–	12.1	12.1R4
MIC-3D-20GE-SFP ("Gigabit Ethernet MIC with SFP" on page 267)	10.2	11.2R4	10.2	11.2R4
MIC-3D-20GE-SFP-E ("Gigabit Ethernet MIC with SFP (E)" on page 272)	13.2R2	13.2R2	13.2R2	13.2R2
MIC-3D-2XGE-XFP ("10-Gigabit Ethernet MICs with XFP" on page 284)	10.2	11.2R4	10.2	11.2R4

Table 10: MIC/MPC1 Compatibility *(Continued)*

MIC Name	MPC1	MPC1E	MPC1 Q	MPC1E Q
MIC-3D-4XGE-XFP ("10-Gigabit Ethernet MICs with XFP" on page 284)	—	—	—	—
MIC-3D-40GE-TX ("Tri-Rate MIC" on page 353)	10.2	11.2R4	10.2	11.2R4
MIC-3D-4OC3OC12-1OC48, MIC-3D-8OC3OC12-4OC48 ("SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364)	11.2	11.2R4	11.2	11.2R4
MIC-3D-4COC3-1COC12-CE ("Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP" on page 333)	—	—	12.2	12.2
MIC-3D-1OC192-XFP ("SONET/SDH OC192/STM64 MIC with XFP" on page 379)	12.2	12.2	12.2	12.2

Table 10: MIC/MPC1 Compatibility *(Continued)*

MIC Name	MPC1	MPC1E	MPC1 Q	MPC1E Q
MIC-3D-4CHOC3-2CHOC12, MIC-3D-8CHOC3-4CHOC12 MIC-4COC3-2COC12-G, MIC-8COC3-4COC12-G ("Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324)	—	—	11.4	11.4
MIC-3D-16CHE1-T1-CE ("Channelized E1/T1 Circuit Emulation MIC" on page 342)	13.2 **NOTE**: Support for Non-Channelized MIC only.	13.2 **NOTE**: Support for Non-Channelized MIC only.	12.3	12.3
MIC-3D-8DS3-E3, MIC-3D-8CHDS3-E3-B ("DS3/E3 MIC" on page 261) **NOTE**: You cannot run Channelized DS3 (MIC-3D-8CHDS3-E3) on non-Q MPCs. Channelized DS3 is supported only on Q and EQ-based MPCs.	11.4	11.4	11.4	11.4

Table 10: MIC/MPC1 Compatibility *(Continued)*

MIC Name	MPC1	MPC1E	MPC1 Q	MPC1E Q
MIC-MACSEC-20GE "Gigabit Ethernet MIC with 256b-AES MACsec" on page 280	18.3R1	18.3R1	18.3R1	18.3R1
MS-MIC-16G ("Multiservices MIC" on page 361)	13.2	13.2	13.2	13.2

Table 11: MIC/MPC2 Compatibility

MIC Name	MPC2	MPC2E	MPC2E -3D-NG	MPC2 Q	MPC2E Q	MPC2 EQ	MPC2E EQ	MPC2E P	MPC2E -3D-NG-Q
MIC-3D-8OC3-2OC12-ATM ("ATM MIC with SFP" on page 256)	—	—	14.1R4, 14.2R3 with Junos Continuity 15.1	12.1	12.1R4	12.1	12.1R4	—	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-20GE-SFP ("Gigabit Ethernet MIC with SFP" on page 267)	10.1	11.2R4	14.1R4, 14.2R3 with Junos Continuity 15.1	10.1	11.2R4	10.1	11.2R4	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1

Table 11: MIC/MPC2 Compatibility *(Continued)*

MIC Name	MPC2	MPC2E	MPC2E-3D-NG	MPC2Q	MPC2EQ	MPC2EQ	MPC2EEQ	MPC2EP	MPC2E-3D-NG-Q
MIC-3D-20GE-SFP-E ("Gigabit Ethernet MIC with SFP (E)" on page 272)	13.2R2	13.2R2	14.1R4, 14.2R3 with Junos Continuity 15.1	13.2R2	13.2R2	13.2R2	13.2R2	13.2R2	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-2XGE-XFP ("10-Gigabit Ethernet MIC with XFP" on page 284)	10.2	11.2R4	14.1R4, 14.2R3 with Junos Continuity 15.1	10.2	11.2R4	10.2	11.2R4	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-10GE-SFP-E "1-Gigabit/10-Gigabit Ethernet MIC with SFP+ (10 Ports)" on page 289	—	—	24.2	—	—	—	—	—	24.2
MIC-3D-4XGE-XFP ("10-Gigabit Ethernet MICs with XFP" on page 284)	10.1	11.2R4	14.1R4, 14.2R3 with Junos Continuity 15.1	10.1	11.2R4	10.1	11.2R4	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1

Table 11: MIC/MPC2 Compatibility *(Continued)*

MIC Name	MPC2	MPC2E	MPC2E-3D-NG	MPC2Q	MPC2EQ	MPC2EQ	MPC2EEQ	MPC2EP	MPC2E-3D-NG-Q
MIC-3D-40GE-TX ("Tri-Rate MIC" on page 353)	10.2	11.2R4	14.1R4, 14.2R3 with Junos Continuity 15.1	10.2	11.2R4	10.2	11.2R4	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-4OC3OC12-1OC48, MIC-3D-8OC3OC12-4OC48 ("SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364)	11.4	11.4	14.1R4, 14.2R3 with Junos Continuity 15.1	11.4	11.4	11.4	11.4	—	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-4COC3-1COC12-CE ("Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP" on page 333)	—	—	—	12.2	12.2	12.2	12.2	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1

Table 11: MIC/MPC2 Compatibility *(Continued)*

MIC Name	MPC2	MPC2E	MPC2E-3D-NG	MPC2Q	MPC2EQ	MPC2EQ	MPC2EEQ	MPC2EP	MPC2E-3D-NG-Q
MIC-3D-1OC192-XFP ("SONET/SDH OC192/STM64 MIC with XFP" on page 379)	12.2	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1	12.2	12.2	12.2	12.2	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-4CHOC3-2CHOC12, MIC-3D-8CHOC3-4CHOC12 MIC-4COC3-2COC12-G, MIC-8COC3-4COC12-G ("Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324)	—	—	15.1 with flexible queuing option	11.4	11.4	11.4	11.4	—	15.1 14.1R4, 14.2R3 with Junos Continuity
MIC-3D-16CHE1-T1-CE ("Channelized E1/T1 Circuit Emulation MIC" on page 342)	13.2 **NOTE**: Support for Non-Channelized MIC only.		15.1 with flexible queuing option	12.3	12.3	12.3	12.3	—	14.1R4, 14.2R3 with Junos Continuity 15.1

Table 11: MIC/MPC2 Compatibility *(Continued)*

MIC Name	MPC2	MPC2E	MPC2E-3D-NG	MPC2Q	MPC2EQ	MPC2EQ	MPC2EEQ	MPC2EP	MPC2E-3D-NG-Q
MIC-3D-8DS3-E3, MIC-3D-8CHDS3-E3-B ("DS3/E3 MIC" on page 261) **NOTE**: You cannot run Channelized DS3 (MIC-3D-8CHDS3-E3) on non-Q MPCs. Channelized DS3 is supported only on Q and EQ-based MPCs.	11.4	11.4	14.1R4, 14.2R3 with Junos Continuity 15.1	11.4	11.4	11.4	11.4	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1
MS-MIC-16G ("Multiservices MIC" on page 361) **NOTE**: Only one MS-MIC-16G can be installed into any MPC.	13.2	13.2	14.1R4, 14.2R3 with Junos Continuity 15.1	13.2	13.2	13.2	13.2	13.2	14.1R4, 14.2R3 with Junos Continuity 15.1

Table 11: MIC/MPC2 Compatibility *(Continued)*

MIC Name	MPC2	MPC2E	MPC2E -3D-NG	MPC2 Q	MPC2E Q	MPC2 EQ	MPC2E EQ	MPC2E P	MPC2E -3D-NG-Q
MIC-MACSEC-20 GE "Gigabit Ethernet MIC with 256b-AES MACsec" on page 280	18.3R1	18.3R1	18.3R1	18.3R1	18.3R1	18.3R1	18.3R1	18.3R1	18.3R1

Table 12: MIC/MPC3 Compatibility

MIC Name	MPC3E	MPC3E-3D-NG	MPC3E-3D-NG-Q
MIC-3D-8OC3-2OC12-ATM ("ATM MIC with SFP" on page 256)	—	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-20GE-SFP ("Gigabit Ethernet MIC with SFP" on page 267)	12.1	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-20GE-SFP-E ("Gigabit Ethernet MIC with SFP (E)" on page 272)	13.2R2	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC3-3D-1X100GE-CFP ("100-Gigabit Ethernet MIC with CFP" on page 303)	12.1	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1

Table 12: MIC/MPC3 Compatibility *(Continued)*

MIC Name	MPC3E	MPC3E-3D-NG	MPC3E-3D-NG-Q
MIC-3D-2XGE-XFP ("10-Gigabit Ethernet MICs with XFP" on page 284)	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-4XGE-XFP ("10-Gigabit Ethernet MICs with XFP" on page 284)	—	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-10GE-SFP-E "1-Gigabit/10-Gigabit Ethernet MIC with SFP+ (10 Ports)" on page 289	—	24.2	24.2
MIC3-3D-10XGE-SFPP ("10-Gigabit Ethernet MIC with SFP + (10 Ports)" on page 294)	12.3	14.1R4, 14.2 R3 and Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC3-3D-2X40GE-QSFPP ("40-Gigabit Ethernet MIC with QSFP+" on page 301)	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC3-3D-1X100GE-CXP ("100-Gigabit Ethernet MIC with CXP" on page 306)	12.2	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC3-100G-DWDM ("100-Gigabit DWDM OTN MIC with CFP2-ACO" on page 312)	15.1F515.1F617.1R1	15.1F515.1F617.1R1	15.1F515.1F617.1R1

Table 12: MIC/MPC3 Compatibility *(Continued)*

MIC Name	MPC3E	MPC3E-3D-NG	MPC3E-3D-NG-Q
MIC-3D-4OC3OC12-1OC48 MIC-3D-8OC3OC12-4OC48 ("SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364)	13.3	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-1OC192-XFP ("SONET/SDH OC192/STM64 MIC with XFP" on page 379)	13.3	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-4COC3-1COC12-CE ("Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP" on page 333)	—	—	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-16CHE1-T1-CE ("Channelized E1/T1 Circuit Emulation MIC" on page 342)	—	15.1 with flexible queuing option	15.1
MS-MIC-16G ("Multiservices MIC" on page 361) **NOTE**: On MPC3E, the installation of the Multiservices MIC (MS-MIC-16G) with MIC3-3D-2X40GE-QSFPP, MIC3-3D-10XGE-SFPP, or MIC3-3D-1X100GE-CFP does not meet the NEBS criteria. **NOTE**: Only one MS-MIC-16G can be installed into any MPC.	13.2R2	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1

Table 12: MIC/MPC3 Compatibility *(Continued)*

MIC Name	MPC3E	MPC3E-3D-NG	MPC3E-3D-NG-Q
MIC-3D-40GE-TX "Tri-Rate MIC" on page 353	—	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-4OC3OC12-1OC48, MIC-3D-8OC3OC12-4OC48 "SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 364	12.1	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-4CHOC3-2CHOC12, MIC-3D-8CHOC3-4CHOC12 MIC-4COC3-2COC12-G, MIC-8COC3-4COC12-G "Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP" on page 324	—	15.1 with flexible queuing option	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-3D-8DS3-E3, MIC-3D-8CHDS3-E3-B "DS3/E3 MIC" on page 261 **NOTE**: You cannot run Channelized DS3 (MIC-3D-8CHDS3-E3) on non-Q MPCs. Channelized DS3 is supported only on Q and EQ-based MPCs.	12.1	14.1R4, 14.2R3 with Junos Continuity 15.1	14.1R4, 14.2R3 with Junos Continuity 15.1
MIC-MACSEC-20GE "Gigabit Ethernet MIC with 256b-AES MACsec" on page 280	18.3R1	18.3R1	18.3R1

Table 13: MIC/MPC6 Compatibility

MIC Name	MPC6E
MIC6-10G "10-Gigabit Ethernet MIC with SFP+ (24 Ports)" on page 297	13.3R2
MIC6-10G-OTN "10-Gigabit Ethernet OTN MIC with SFP+ (24 Ports)" on page 299	13.3R3
MIC6-100G-CXP "100-Gigabit Ethernet MIC with CXP (4 Ports)" on page 308	13.3R2
MIC6-100G-CFP2 "100-Gigabit Ethernet MIC with CFP2" on page 310	13.3R3

Table 14: MIC/MPC8 Compatibility

MIC Name	MPC8E
MIC-MRATE *MIC MRATE*	15.1F5 with Junos Continuity 16.1R1
MIC-MACSEC-MRATE "Multi-Rate Ethernet MIC" on page 369	17.4

Table 15: MIC/MPC9 Compatibility

MIC Name	MPC9E
MIC-MRATE *MIC MRATE*	15.1F5 with Junos Continuity 16.1R1

Table 15: MIC/MPC9 Compatibility *(Continued)*

MIC Name	MPC9E
MIC-MACSEC-MRATE "Multi-Rate Ethernet MIC" on page 369	17.4

Table 16: MIC/MPC10003 Compatibility

MIC Name	MPC10003
JNP-MIC1 "Multi-Rate Ethernet MIC" on page 369	17.3
JNP-MIC1-MACSEC "Multi-Rate Ethernet MIC" on page 369	17.3R2

CHAPTER 6

FPCs and PICs Supported on MX Series Routers

IN THIS CHAPTER

MX Series FPC and PIC Overview

Flexible PIC Concentrators (FPCs) and Physical Interface Cards (PICs) function similarly to MICs and MPCs. PICs provide physical interfaces for the router and install into FPCs which provide packet forwarding services. Each FPC supports up to two Physical Interface Cards (PICs). You can install PICs of different media types on the same router as long as the router supports those PICs.

PICs receive incoming packets from the network and transmit outgoing packets to the network. During this process, each PIC performs framing and high-speed signaling for its media type. Before transmitting outgoing data packets, the PICs encapsulate the packets received. Each PIC is equipped with a media-specific ASIC that performs control functions tailored to the PIC's media type.

An FPC occupies two Dense Port Concentrator (DPC) slots on an MX Series router. FPCs install vertically in the MX960 router chassis, and horizontally in the MX480 and MX240 router chassis. The maximum number of supported FPCs varies per router:

- MX960 router—6 FPCs
- MX480 router—3 FPCs
- MX240 router—1 FPC

MX240, MX480, and MX960 routers support 2 PICs per FPC. The maximum number of supported PICs varies per router:

- MX960 router—12 PICs
- MX480 router—6 PICs

- MX240 router—2 PICs

Blank PICs resemble other PICs but do not provide any physical connection or activity. When a slot is not occupied by a PIC, you must insert a blank PIC to fill the empty slot and ensure proper cooling of the system.

RELATED DOCUMENTATION

High Availability Features | 61

FPCs Supported by MX240, MX480, and MX960 Routers

PICs Supported by MX240, MX480, and MX960 Routers

High Availability Features

High availability features include Routing Engine redundancy, graceful Routing Engine switchover (GRES), nonstop bridging, nonstop active routing, graceful restart for routing protocols, Virtual Router Redundancy Protocol (VRRP), and unified in-service software upgrade (ISSU). Some high availability features are not supported by all platforms and all PICs. For more information, see the *Unified ISSU System Requirements* in the Junos OS High Availability User Guide.

RELATED DOCUMENTATION

MX Series FPC and PIC Overview | 60

FPCs Supported by MX240, MX480, and MX960 Routers | 61

PICs Supported by MX240, MX480, and MX960 Routers | 62

FPCs Supported by MX240, MX480, and MX960 Routers

An FPC occupies two slots when installed in an MX240, MX480, or MX960 router. The maximum number of supported FPCs varies per router:

- MX960 router—6 FPCs
- MX480 router—3 FPCs
- MX240 router—1 FPC

Table 17 on page 62 lists FPCs supported by MX240, MX480, and MX960 routers.

Table 17: FPCs Supported by MX240, MX480, and MX960 Routers

FPC Type	FPC Name	FPC Model Number	Maximum Number of PICs Supported	Maximum Throughput per FPC (Full-duplex)	First Junos OS Release
3	FPC3	MX-FPC3	2	20 Gbps	9.4
2	FPC2	MX-FPC2	2	10 Gbps	9.5

RELATED DOCUMENTATION

MX Series FPC and PIC Overview | 60

PICs Supported by MX240, MX480, and MX960 Routers

High Availability Features | 61

PICs Supported by MX240, MX480, and MX960 Routers

Table 18 on page 62 lists the PICs supported by MX240, MX480, and MX960 routers.

Table 18: PICs Supported by MX240, MX480, and MX960 Routers

PIC Name	PIC Model Number	Ports	Type	First Junos OS Release
Channelized IQ PICs				
"Channelized OC12/STM4 Enhanced IQ (IQE) PIC with SFP" on page 386	PB-4CHOC12-STM4-IQE-SFP	4	2	9.5
"Channelized OC48/STM16 Enhanced IQ (IQE) PIC with SFP" on page 387	PB-1CHOC48-STM16-IQE	1	2	9.5

Table 18: PICs Supported by MX240, MX480, and MX960 Routers *(Continued)*

PIC Name	PIC Model Number	Ports	Type	First Junos OS Release
SONET/SDH PICs				
"SONET/SDH OC3/STM1 (Multi-Rate) PIC with SFP" on page 394	PB-4OC3-1OC12-SON2-SFP	4	2	9.5
"SONET/SDH OC12/STM4 (Multi-Rate) PIC with SFP" on page 399	PB-4OC3-4OC12-SON-SFP	4	2	9.5
"SONET/SDH OC48/STM16 Enhanced IQ (IQE) PIC with SFP" on page 403	PC-4OC48-STM16-IQE-SFP	4	3	10.4R2
"SONET/SDH OC48/STM16 (Multi-Rate) PIC with SFP" on page 409	PB-1OC48-SON-B-SFP	1	2	9.5
"SONET/SDH OC48/STM16 PIC with SFP" on page 413	PC-4OC48-SON-SFP	4	3	9.4
"SONET/SDH OC192c/STM64 PIC" on page 417	PC-1OC192-SON-VSR	1	3	9.4
"SONET/SDH OC192c/STM64 PIC with XFP" on page 422	PC-1OC192-SON-XFP	1	3	9.4

RELATED DOCUMENTATION

MX Series FPC and PIC Overview | **60**

FPCs Supported by MX240, MX480, and MX960 Routers

High Availability Features | **61**

CHAPTER 7

Network Interface Specifications

IN THIS CHAPTER

Determining Transceiver Support and Specifications

You can find information about the pluggable transceivers supported on your Juniper Networks device by using the Hardware Compatibility Tool. In addition to transceiver and connector type, the optical and cable characteristics—where applicable—are documented for each transceiver. The Hardware Compatibility Tool allows you to search by product, displaying all the transceivers supported on that device, or category, displaying all the transceivers by interface speed or type. The Hardware Compatibility Tool is located at https://apps.juniper.net/hct/.

Some transceivers support additional monitoring using the operational mode CLI command `show interfaces diagnostics optics`. Use the Hardware Compatibility Tool to determine if your transceiver supports monitoring. See the Junos OS documentation for your device for a description of the monitoring fields.

CAUTION: The Juniper Networks Technical Assistance Center (JTAC) provides complete support for Juniper-supplied optical modules and cables. However, JTAC does not provide support for third-party optical modules and cables that are not qualified or supplied by Juniper Networks. If you face a problem running a Juniper device that uses third-party optical modules or cables, JTAC may help you diagnose host-related issues if the observed issue is not, in the opinion of JTAC, related to the use of the third-party optical modules or cables. Your JTAC engineer will likely request that you check the third-party optical module or cable and, if required, replace it with an equivalent Juniper-qualified component.

Use of third-party optical modules with high-power consumption (for example, coherent ZR or ZR+) can potentially cause thermal damage to or reduce the lifespan of the host

equipment. Any damage to the host equipment due to the use of third-party optical modules or cables is the users' responsibility. Juniper Networks will accept no liability for any damage caused due to such use.

RELATED DOCUMENTATION

- show interfaces diagnostics optics (Gigabit Ethernet, 10-Gigabit Ethernet, 40-Gigabit Ethernet, 100-Gigabit Ethernet, and Virtual Chassis Port)
- show interfaces diagnostics optics (SONET)
- show interfaces diagnostics optics
- show interfaces diagnostics optics
- show interfaces diagnostics optics

Cable and Connector Specifications for MX and PTX Series Devices

IN THIS SECTION

The transceivers that are supported on MX Series and PTX Series devices use fiber-optic cables and connectors. The type of connector and the type of fiber depends on the transceiver type.

You can determine the type of cable and connector required for your specific transceiver by using the Hardware Compatibility Tool.

CAUTION: To maintain agency approvals, use only a properly constructed, shielded cable.

NOTE: The terms multifiber push-on (MPO) and multifiber termination push-on (MTP) describe the same connector type. The rest of this topic uses MPO to mean MPO or MTP.

12-Fiber MPO Connectors

There are two types of cables used with 12-fiber MPO connectors on Juniper Networks devices—patch cables with MPO connectors on both ends, and breakout cables with an MPO connector on one end and four LC duplex connectors on the opposite end. Depending on the application, the cables might use single-mode fiber (SMF) or multimode fiber (MMF). Juniper Networks sells cables that meet the supported transceiver requirements, but it is not required to purchase cables from Juniper Networks.

Ensure that you order cables with the correct polarity. Vendors refer to these crossover cables as *key up to key up*, *latch up to latch up*, *Type B*, or *Method B*. If you are using patch panels between two transceivers, ensure that the proper polarity is maintained through the cable plant.

Also, ensure that the fiber end in the connector is finished correctly. Physical contact (PC) refers to fiber that has been polished flat. Angled physical contact (APC) refers to fiber that has been polished at an angle. Ultra physical contact (UPC) refers to fiber that has been polished flat, to a finer finish. The required fiber end is listed with the connector type in the Hardware Compatibility Tool.

12-Fiber Ribbon Patch Cables with MPO Connectors

You can use 12-fiber ribbon patch cables with socket MPO connectors to connect two transceivers of the same type—for example, 40GBASE-SR4-to-40GBASESR4 or 100GBASE-SR4-to-100GBASE-SR4. You can also connect 4x10GBASE-LR or 4x10GBASE-SR transceivers by using patch cables—for example, 4x10GBASE-LR-to-4x10GBASE-LR or 4x10GBASE-SR-to-4x10GBASE-SR—instead of breaking the signal out into four separate signals.

Table 19 on page 66 describes the signals on each fiber. Table 20 on page 67 shows the pin-to-pin connections for proper polarity.

Table 19: Cable Signals for 12-Fiber Ribbon Patch Cables

Fiber	Signal
1	Tx0 (Transmit)
2	Tx1 (Transmit)

Table 19: Cable Signals for 12-Fiber Ribbon Patch Cables *(Continued)*

Fiber	Signal
3	Tx2 (Transmit)
4	Tx3 (Transmit)
5	Unused
6	Unused
7	Unused
8	Unused
9	Rx3 (Receive)
10	Rx2 (Receive)
11	Rx1 (Receive)
12	Rx0 (Receive)

Table 20: Cable Pinouts for 12-Fiber Ribbon Patch Cables

MPO Pin	MPO Pin
1	12
2	11
3	10

Table 20: Cable Pinouts for 12-Fiber Ribbon Patch Cables *(Continued)*

MPO Pin	MPO Pin
4	9
5	8
6	7
7	6
8	5
9	4
10	3
11	2
12	1

12-Fiber Ribbon Breakout Cables with MPO-to-LC Duplex Connectors

You can use 12-ribbon breakout cables with MPO-to-LC duplex connectors to connect a QSFP+ transceiver to four separate SFP+ transceivers—for example, 4x10GBASE-LR-to-10GBASE-LR or 4x10GBASE-SR-to-10GBASE-SR SFP+ transceivers. The breakout cable is constructed out of a 12-fiber ribbon fiber-optic cable. The ribbon cable splits from a single cable with a socket MPO connector on one end, into four cable pairs with four LC duplex connectors on the opposite end.

Figure 1 on page 69 shows an example of a typical 12-ribbon breakout cable with MPO-to-LC duplex connectors (depending on the manufacture, your cable may look different).

Figure 1: 12-Ribbon Breakout Cable

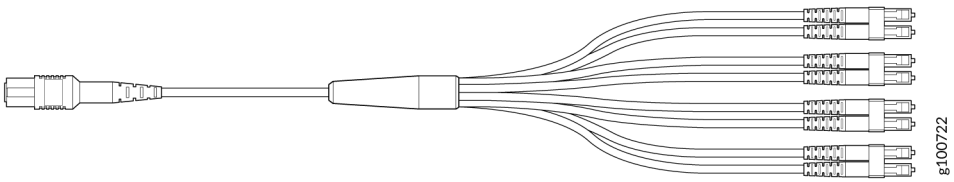


Table 21 on page 69 describes the way the fibers are connected between the MPO and LC duplex connectors. The cable signals are the same as those described in Table 19 on page 66.

Table 21: Cable Pinouts for 12-Fiber Ribbon Breakout Cables

MPO Connector Pin	LC Duplex Connector Pin
1	Tx on LC Duplex 1
2	Tx on LC Duplex 2
3	Tx on LC Duplex 3
4	Tx on LC Duplex 4
5	Unused
6	Unused
7	Unused
8	Unused
9	Rx on LC Duplex 4
10	Rx on LC Duplex 3
11	Rx on LC Duplex 2

Table 21: Cable Pinouts for 12-Fiber Ribbon Breakout Cables *(Continued)*

MPO Connector Pin	LC Duplex Connector Pin
12	Rx on LC Duplex 1

12-Ribbon Patch and Breakout Cables Available from Juniper Networks

Juniper Networks sells 12-ribbon patch and breakout cables with MPO connectors that meet the requirements described above. It is not required to purchase cables from Juniper Networks. Table 22 on page 70 describes the available cables.

Table 22: 12-Ribbon Patch and Breakout Cables Available from Juniper Networks

Cable Type	Connector Type	Fiber Type	Cable Length	Juniper Model Number
12-ribbon patch	Socket MPO/PC to socket MPO/PC, key up to key up	MMF (OM3)	1 m	MTP12-FF-M1M
			3 m	MTP12-FF-M3M
			5 m	MTP12-FF-M5M
			10 m	MTP12-FF-M10M
	Socket MPO/APC to socket MPO/APC, key up to key up	SMF	1 m	MTP12-FF-S1M
			3 m	MTP12-FF-S3M
			5 m	MTP12-FF-S5M
			10 m	MTP12-FF-S10M
12-ribbon breakout	Socket MPO/PC, key up, to four LC/UPC duplex	MMF (OM3)	1 m	MTP-4LC-M1M

Table 22: 12-Ribbon Patch and Breakout Cables Available from Juniper Networks *(Continued)*

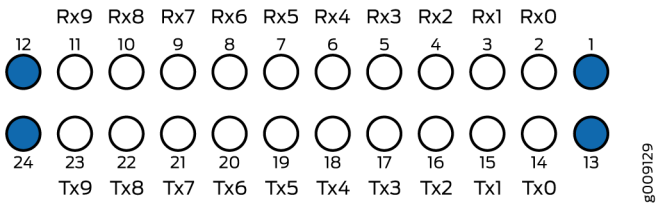
Cable Type	Connector Type	Fiber Type	Cable Length	Juniper Model Number
			3 m	MTP-4LC-M3M
			5 m	MTP-4LC-M5M
			10 m	MTP-4LC-M10M
	Socket MPO/APC, key up, to four LC/UPC duplex	SMF	1 m	MTP-4LC-S1M
			3 m	MTP-4LC-S3M
			5 m	MTP-4LC-S5M
			10 m	MTP-4LC-S10M

24-Fiber MPO Connectors

You can use patch cables with 24-fiber MPO connectors to connect two supported transceivers of the same type—for example, 100GBASE-SR10-to-100GBASE-SR10.

Figure 2 on page 71 shows the 24-fiber MPO optical lane assignments.

Figure 2: 24-Fiber MPO Optical Lane Assignments



NOTE: Ensure that you order cables with the correct polarity. Vendors refer to these crossover cables as *key up to key up*, *latch up to latch up*, *Type B*, or *Method B*. If you are using patch panels between two transceivers, ensure that the proper polarity is maintained through the cable plant.

The MPO optical connector for the CFP2-100G-SR10-D3 is defined in *Section 5.6 of the CFP2 Hardware Specification and Section 88.10.3 of IEEE STD 802.3-2012*. These specifications include the following requirements:

- Recommended Option A in IEEE STD 802.3-2012.
- The transceiver receptacle is a plug. A patch cable with a socket connector is required to mate with the module.
- Ferrule finish shall be flat polished interface that is compliant with IEC 61754-7.
- Alignment key is key up.

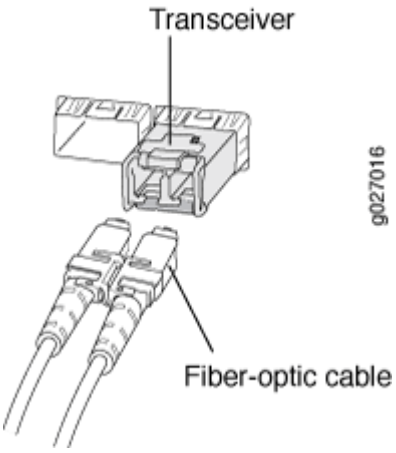
The optical interface must meet the requirement FT-1435-CORE in *Generic Requirements for Multi-Fiber Optical Connectors*. The module must pass the wiggle test defined by IEC 62150-3.

LC Duplex Connectors

You can use patch cables with LC duplex connectors to connect two supported transceivers of the same type—for example, 40GBASE-LR4-to-40GBASE-LR4 or 100GBASE-LR4-to100GBASE-LR4. The patch cable is one fiber pair with two LC duplex connectors at opposite ends. LC duplex connectors are also used with 12-fiber ribbon breakout cables, as described in "12-Fiber Ribbon Breakout Cables with MPO-to-LC Duplex Connectors" on page 68.

Figure 3 on page 73 shows an LC duplex connector being installed in a transceiver.

Figure 3: LC Duplex Connector



2

PART

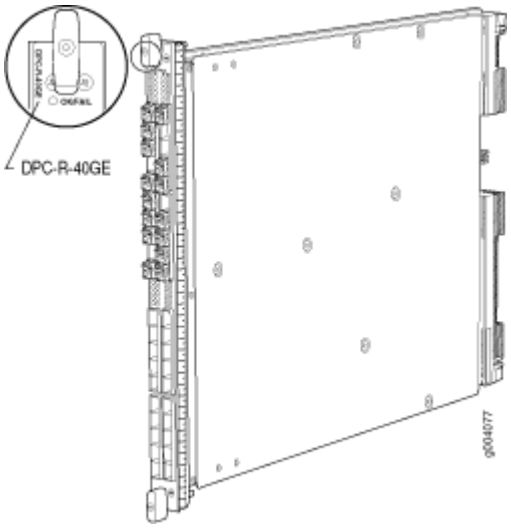
DPC, SPC, MPC, MIC, and PIC Descriptions

CHAPTER 8

MX Series DPC Descriptions

IN THIS CHAPTER

Gigabit Ethernet DPC with SFP



Software release	• Junos OS Release 8.2 and later • End-of-life (see notification PSN-2009-06-400)
Description	• 40 Gigabit Ethernet ports • Power requirement: 6.98 A @ 48 V (335 W) • Weight: 13.1 lb (5.9 kg) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: DPC-R-40GE-SFP • Name in the CLI: `DPC 40x 1GE R`
Hardware features	• High-performance throughput on each port at speeds up to 1 Gbps • Autonegotiation between Gigabit Ethernet circuit partners • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes

Software features	• Optical diagnostics and related alarms • See "Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R)" on page 427 for information about the protocols and applications that this DPC supports.
Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: 0 (bottom left row of 10 ports), 1 (bottom right row of 10 ports), 2 (top left row of 10 ports), or 3 (top right row of 10 ports) • port: 0 through 9 For example, ge-1/3/0 is the interface for port 0 in the top right row of 10 ports on a DPC installed in slot 1.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router. **NOTE**: Do not install Gigabit Ethernet SFPs in the SONET/SDH port. The port will not recognize the SFP.

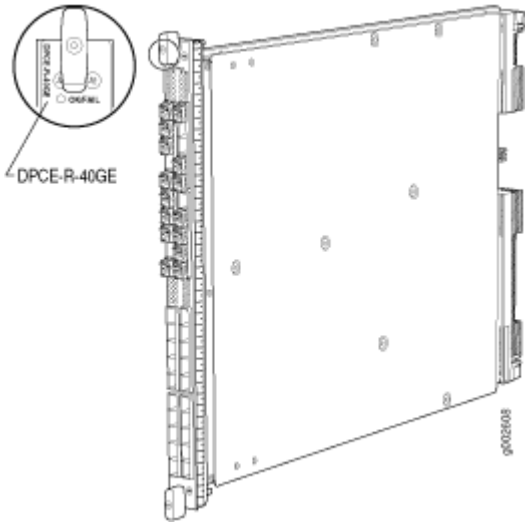
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. Link LED, one green per port: • Off—No link. • On steadily—Link is active. The Link LEDs are labeled in groups of five: • **0/0** for **0/0** through **0/4** • **0/5** for **0/5** through **0/9** • **1/0** for **1/0** through **1/4** • **1/5** for **1/5** through **1/9** • **2/0** for **2/0** through **2/4** • **2/5** for **2/5** through **2/9** • **3/0** for **3/0** through **3/4** • **3/5** for **3/5** through **3/9**

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

Gigabit Ethernet Enhanced DPC with SFP



Software release	• Junos OS Release 8.4 and later
Description	• 40 Gigabit Ethernet ports • Power requirement: 6.98 A @ 48 V (335 W) • Weight: 13.1 lb (5.9 kg) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: DPCE-R-40GE-SFP • Name in the CLI: DPCE 40x 1GE R
Hardware features	• High-performance throughput on each port at speeds up to 1 Gbps • Autonegotiation between Gigabit Ethernet circuit partners • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes • Enhanced ASICs for increased performance and scalability of Layer 2 features

Software features	• Optical diagnostics and related alarms • See "Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R)" on page 427 for information about the protocols and applications that this DPC supports.
Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: 0 (bottom left row of 10 ports), 1 (bottom right row of 10 ports), 2 (top left row of 10 ports), or 3 (top right row of 10 ports) when installed horizontally • port: 0 through 9 For example, ge-1/3/0 is the interface for port 0 in the top right row of 10 ports on a DPC installed in slot 1. For information on the interface numbering, see the *DPC Port and Interface Numbering* topic for the respective MX router.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router. **NOTE**: Do not install Gigabit Ethernet SFPs in the SONET/SDH port. The port will not recognize the SFP.

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. Link LED, one green per port: • Off—No link. • On steadily—Link is active. The Link LEDs are labeled in groups of five: • **0/0** for **0/0** through **0/4** • **0/5** for **0/5** through **0/9** • **1/0** for **1/0** through **1/4** • **1/5** for **1/5** through **1/9** • **2/0** for **2/0** through **2/4** • **2/5** for **2/5** through **2/9** • **3/0** for **3/0** through **3/4** • **3/5** for **3/5** through **3/9**

RELATED DOCUMENTATION

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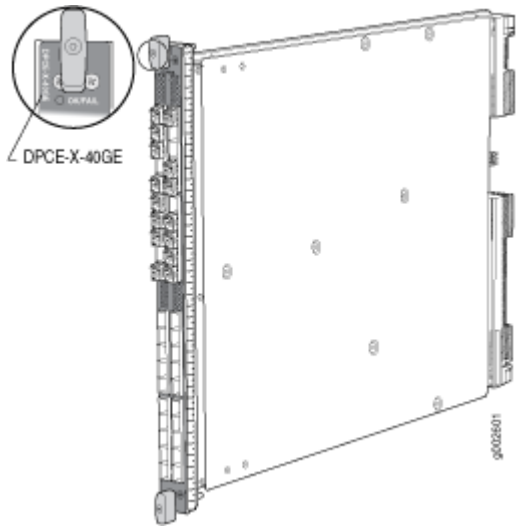
DPCs Supported on MX240, MX480, and MX960 Routers | 9

Gigabit Ethernet Enhanced Ethernet Services DPC with SFP



Software release	• Junos OS Release 8.4 and later
Description	• 40 Gigabit Ethernet ports • Power requirement: 6.98 A @ 48 V (335 W) • Weight: 13.1 lb (5.9 kg) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: DPCE-X-40GE-SFP • Name in the CLI: DPCE 40x 1GE X
Hardware features	• High-performance throughput on each port at speeds up to 1 Gbps • Autonegotiation between Gigabit Ethernet circuit partners • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes • Enhanced ASICs for increased performance and scalability of Layer 2 features

Software features	• Optical diagnostics and related alarms • See "Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X)" on page 436 for information about the protocols and applications that this DPC supports. **NOTE**: The routing table is limited to 32,000 IP routes. This limitation applies to any manner in which the routes are learned, such as OSPF, RIP, and so on. The DPC supports BGP for L2 VPNs only.
Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: 0 (bottom left row of 10 ports), 1 (bottom right row of 10 ports), 2 (top left row of 10 ports), or 3 (top right row of 10 ports) • port: 0 through 9 For example, ge-1/3/0 is the interface for port 0 in the top right row of 10 ports on a DPC installed in slot 1.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router. **NOTE**: Do not install Gigabit Ethernet SFPs in the SONET/SDH port. The port will not recognize the SFP.

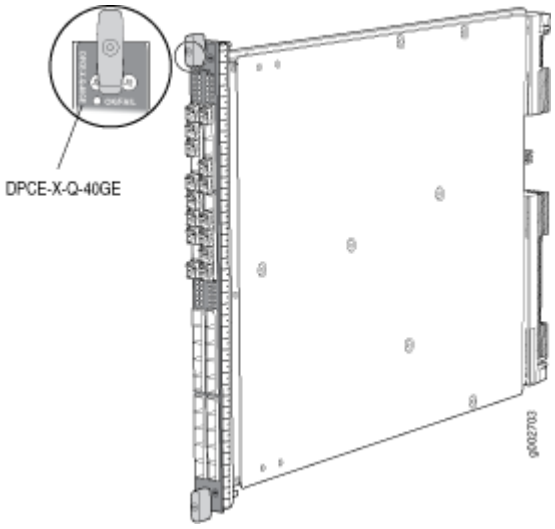
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. Link LED, one green per port: • Off—No link. • On steadily—Link is active. The Link LEDs are labeled in groups of five: • **0/0** for **0/0** through **0/4** • **0/5** for **0/5** through **0/9** • **1/0** for **1/0** through **1/4** • **1/5** for **1/5** through **1/9** • **2/0** for **2/0** through **2/4** • **2/5** for **2/5** through **2/9** • **3/0** for **3/0** through **3/4** • **3/5** for **3/5** through **3/9**

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

Gigabit Ethernet Enhanced Queuing Ethernet Services DPC with SFP



Software release	• Junos OS Release 8.5 and later
Description	• 40 Gigabit Ethernet ports • Power requirement: 7.6 A @ 48 V (365 W) • Weight: 13.1 lb (5.9 kg) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: DPCE-X-Q-40GE-SFP • Name in the CLI: DPCE 40x 1GE X EQ
Hardware features	• High-performance throughput on each port at speeds up to 1 Gbps • Autonegotiation between Gigabit Ethernet circuit partners • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes • Enhanced ASICs for increased performance and scalability of Layer 2 features

Software features	• Optical diagnostics and related alarms • See "Protocols and Applications Supported by Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q)" on page 453 for information about the protocols and applications that this DPC supports. **NOTE**: The routing table is limited to 32,000 IP routes. This limitation applies to any manner in which the routes are learned, such as OSPF, RIP, and so on. The DPC supports BGP for L2 VPNs only.
Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: 0 (bottom left row of 10 ports), 1 (bottom right row of 10 ports), 2 (top left row of 10 ports), or 3 (top right row of 10 ports) • port: 0 through 9 For example, ge-1/3/0 is the interface for port 0 in the top right row of 10 ports on a DPC installed in slot 1.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router. **NOTE**: Do not install Gigabit Ethernet SFPs in the SONET/SDH port. The port will not recognize the SFP.

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. Link LED, one green per port: • Off—No link. • On steadily—Link is active. The Link LEDs are labeled in groups of five: • **0/0** for **0/0** through **0/4** • **0/5** for **0/5** through **0/9** • **1/0** for **1/0** through **1/4** • **1/5** for **1/5** through **1/9** • **2/0** for **2/0** through **2/4** • **2/5** for **2/5** through **2/9** • **3/0** for **3/0** through **3/4** • **3/5** for **3/5** through **3/9**

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

Gigabit Ethernet Enhanced Queuing IP Services DPCs with SFP

Figure 4: 20-Port Gigabit Ethernet Enhanced Queuing IP Services DPC with SFP

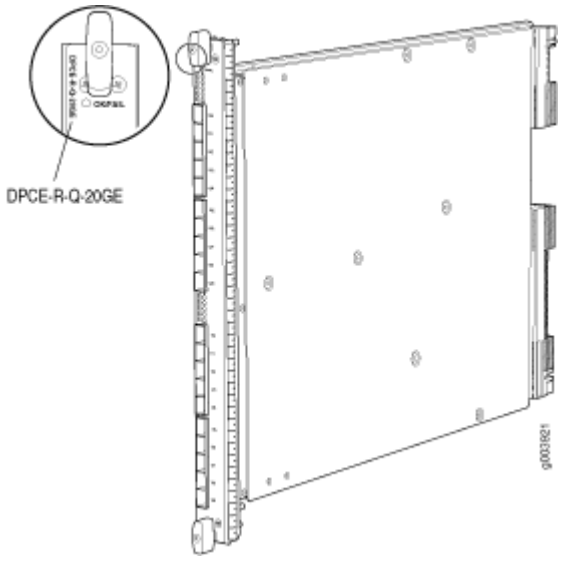
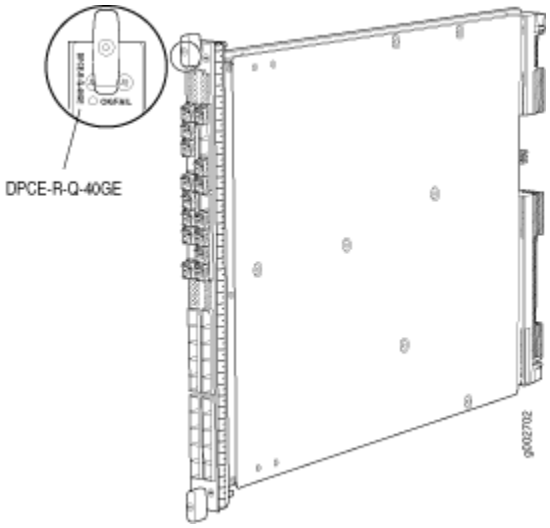


Figure 5: 40-Port Gigabit Ethernet Enhanced Queuing IP Services DPC with SFP



Software release	• 20-port: Junos OS Release 9.1 and later • 40-port: Junos OS Release 8.5 and later End-of-life (see notification PSN-2011-07-314)

Description	20-port: • 20 Gigabit Ethernet ports • Power requirement: 4.2 A @ 48 V (200 W) • Weight: 13 lb (5.9 kg) • Model number: DPCE-R-Q-20GE-SFP • Name in the CLI: DPCE 20x 1GE R EQ 40-port: • 40 Gigabit Ethernet ports • Power requirement: 7.6 A @ 48 V (365 W) • Weight: 13.1 lb (5.9 kg) • Model number: DPCE-R-Q-40GE-SFP • Name in the CLI: DPCE 40x 1GE R EQ
Hardware features	• High-performance throughput on each port at speeds up to 1 Gbps • Autonegotiation between Gigabit Ethernet circuit partners • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes • Enhanced ASICs for increased performance and scalability of Layer 2 features
Software features	• Optical diagnostics and related alarms • See "Protocols and Applications Supported by Enhanced Queuing IP Services DPCs (DPCE-R-Q)" on page 444 for information about the protocols and applications that this DPC supports.

Interfaces	Syntax: ge-*fpc/pic/port* where:
	• fpc: Slot in the router where the DPC is installed
	• pic:
	  • 20-port: 0 (left row of 10 ports), or 1 (right row of 10 ports)
	  • 40-port: 0 (bottom left row of 10 ports), 1 (bottom right row of 10 ports), 2 (top left row of 10 ports), or 3 (top right row of 10 ports)
	• port: 0 through 9
	For example, ge-1/1/0 is the interface for port 0 in the (top for 40-port) right row of 10 ports on a DPC installed in slot 1.

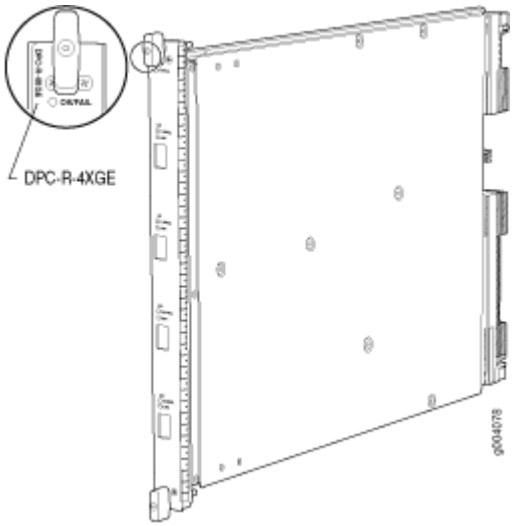
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router. **NOTE**: Do not install Gigabit Ethernet SFPs in the SONET/SDH port. The port will not recognize the SFP.

LEDs	**OK/FAIL** LED, one bicolor:
	• Steady green—DPC is functioning normally.
	• Blinking green—DPC is transitioning online or offline.
	• Red—DPC has failed.
	Link LED, one green per port:
	• Off—No link.
	• On steadily—Link is active.
	The Link LEDs are labeled in groups of five:
	• 20-port:
	  • **0/0** for **0/0** through **0/4**
	  • **0/5** for **0/5** through **0/9**
	  • **1/0** for **1/0** through **1/4**
	  • **1/5** for **1/5** through **1/9**
	• 40-port:
	  • **0/0** for **0/0** through **0/4**
	  • **0/5** for **0/5** through **0/9**
	  • **1/0** for **1/0** through **1/4**
	  • **1/5** for **1/5** through **1/9**
	  • **2/0** for **2/0** through **2/4**
	  • **2/5** for **2/5** through **2/9**
	  • **3/0** for **3/0** through **3/4**
	  • **3/5** for **3/5** through **3/9**

RELATED DOCUMENTATION

MX Series DPC Overview | 8

10-Gigabit Ethernet DPC with XFP



Software release	• Junos OS Release 8.2 and later • End-of-life (see notification PSN-2009-06-400)
Description	• Four 10-Gigabit Ethernet ports • Power requirement: 6.46 A @ 48 V (310 W) • Weight: 13.1 lb (5.9 kg) • Model number: DPC-R-4XGE-XFP • Name in the CLI: DPC 4x 10GE R

Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • WAN-PHY mode at 9.953 Gbps • LAN-PHY mode at 10.3125 Gbps • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes
Software features	• Configurable WAN-PHY mode options • See "Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R)" on page 427 for information about the protocols and applications that this DPC supports.
Interfaces	Syntax: xe-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: 0 through 3 • port: 0 For example, xe-1/3/0 is the interface for the last port on a DPC installed in slot 1.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router.

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **TUNNEL** LED, one green per port: • Off—Normal operating mode. • On steadily—Port configured in tunnel mode. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is active. The **TUNNEL** and **LINK** LEDs are labeled top to bottom **0/0** through **3/0**.

RELATED DOCUMENTATION

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DPCs Supported on MX240, MX480, and MX960 Routers | 9

10-Gigabit Ethernet Enhanced DPCs with XFP

Figure 6: 2-Port 10-Gigabit Ethernet Enhanced DPC with XFP

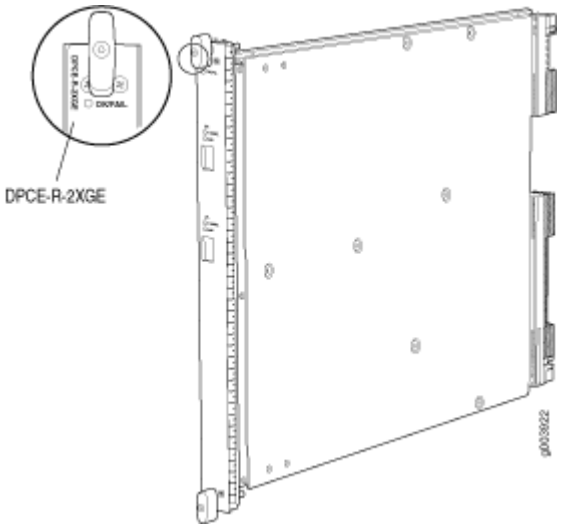
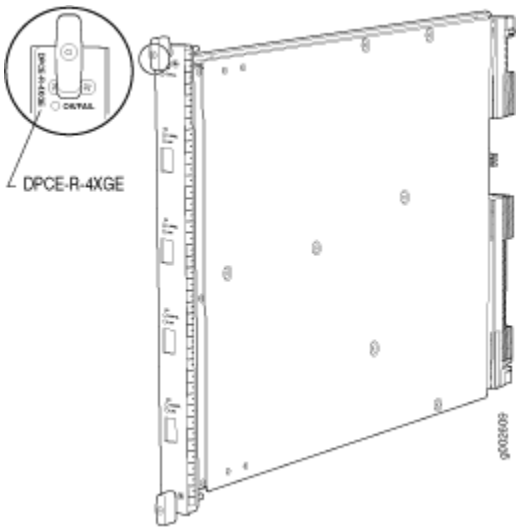


Figure 7: 4-Port 10-Gigabit Ethernet Enhanced DPC with XFP



Software release	• 2-port: Junos OS Release 9.1 and later End-of-life (see notification PSN-2011-02-314) • 4-port: Junos OS Release 8.4 and later

Description	2-port: • Two 10-Gigabit Ethernet ports • Power requirement: 3.65 A @ 48 V (175 W) • Weight: 12 lb (5.4 kg) • Model number: DPCE-R-2XGE-XFP • Name in the CLI: DPCE 2x 10GE R 4-port: • Four 10-Gigabit Ethernet ports • Power requirement: 6.46 A @ 48 V (310 W) • Weight: 13.1 lb (5.9 kg) • Model number: DPCE-R-4XGE-XFP • Name in the CLI: DPCE 4x 10GE R
Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • WAN-PHY mode at 9.953 Gbps • LAN-PHY mode at 10.3125 Gbps • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes • Enhanced ASICs for increased performance and scalability of Layer 2 features
Software features	• Configurable WAN-PHY mode options • See "Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R)" on page 427 for information about the protocols and applications that these DPCs support.

Interfaces	Syntax: xe-*fpc/pic/port* where:
	• fpc: Slot in the router where the DPC is installed
	• pic:
	  • 2-port: 0 or 1
	  • 4-port: 0 through 3
	• port: 0
	For example, xe-1/0/0 is the interface for the first port on a DPC installed in slot 1.

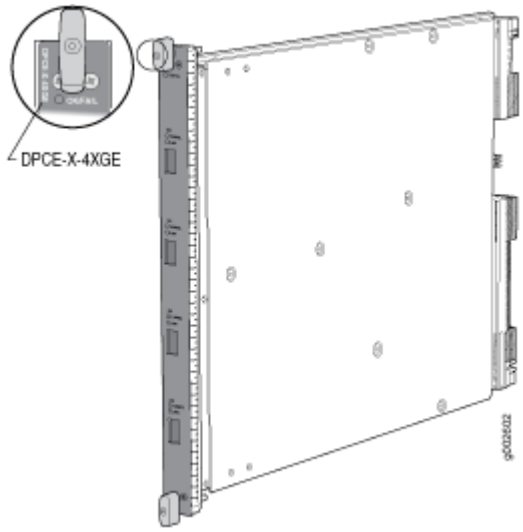
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **TUNNEL** LED, one green per port: • Off—Normal operating mode. • On steadily—Port configured in tunnel mode. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is active. The **TUNNEL** and **LINK** LEDs are labeled top to bottom: • 2-port: **0/0** through **1/0** • 4-port: **0/0** through **3/0**

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

10-Gigabit Ethernet Enhanced Ethernet Services DPC with XFP



Software release	• Junos OS Release 8.4 and later
Description	• Four 10-Gigabit Ethernet ports • Power requirement: 6.46 A @ 48 V (310 W) • Weight: 13.1 lb (5.9 kg) • Model number: DPCE-X-4XGE-XFP • Name in the CLI: DPCE 4x 10GE X

Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • WAN-PHY mode at 9.953 Gbps • LAN-PHY mode at 10.3125 Gbps • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes • Enhanced ASICs for increased performance and scalability of Layer 2 features
Software features	• Configurable WAN-PHY mode options • See "Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X)" on page 436 for information about the protocols and applications that this DPC supports. **NOTE**: The routing table is limited to 32,000 IP routes. This limitation applies to any manner in which the routes are learned, such as OSPF, RIP, and so on. The DPC supports BGP for L2 VPNs only.
Interfaces	Syntax: xe-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: 0 through 3 • port: 0 For example, xe-1/0/0 is the interface for the first port on a DPC installed in slot 1.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router.

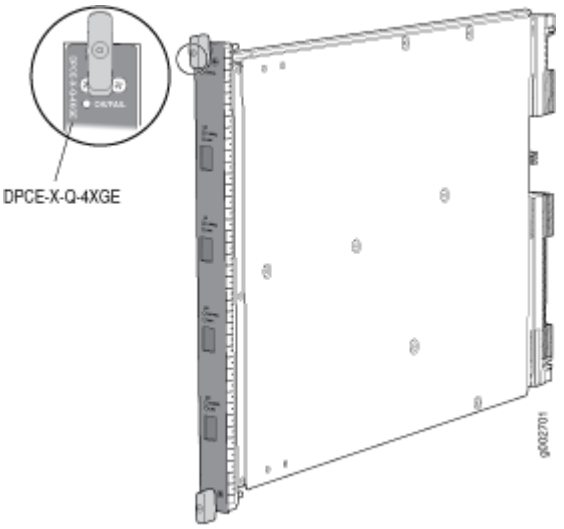
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **TUNNEL** LED, one green per port: • Off—Normal operating mode. • On steadily—Port configured in tunnel mode. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is active. The **TUNNEL** and **LINK** LEDs are labeled top to bottom **0/0** through **3/0**.

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

10-Gigabit Ethernet Enhanced Queuing Ethernet Services DPC with XFP



Software release	• Junos OS Release 8.5 and later
Description	• Four 10-Gigabit Ethernet ports • Power requirement: 6.87 A @ 48 V (330 W) • Weight: 13.1 lb (5.9 kg) • Model number: DPCE-X-Q-4XGE-XFP • Name in the CLI: DPCE 4x 10GE X EQ
Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • WAN-PHY mode at 9.953 Gbps • LAN-PHY mode at 10.3125 Gbps • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes • Enhanced ASICs for increased performance and scalability of Layer 2 features

Software features	• Configurable WAN-PHY mode options • See "Protocols and Applications Supported by Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q)" on page 453 for information about the protocols and applications that this DPC supports. **NOTE**: The routing table is limited to 32,000 IP routes. This limitation applies to any manner in which the routes are learned, such as OSPF, RIP, and so on. The DPC supports BGP for L2 VPNs only.
Interfaces	Syntax: xe-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: 0 through 3 • port: 0 For example, xe-1/0/0 is the interface for the first port on a DPC installed in slot 1.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router.

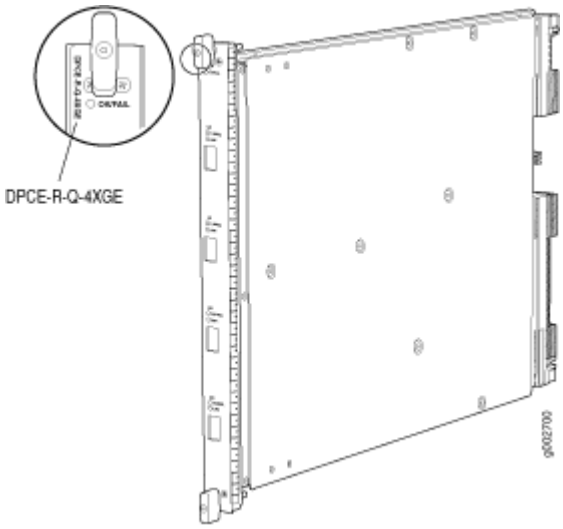
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **TUNNEL** LED, one green per port: • Off—Normal operating mode. • On steadily—Port configured in tunnel mode. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is active. The **TUNNEL** and **LINK** LEDs are labeled top to bottom **0/0** through **3/0**.

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

10-Gigabit Ethernet Enhanced Queuing IP Services DPC with XFP



Software release	• Junos OS Release 8.5 and later • End-of-life (see notification PSN-2011-07-314)
Description	• Four 10-Gigabit Ethernet ports • Power requirement: 6.87 A @ 48 V (330 W) • Weight: 13.1 lb (5.9 kg) • Model number: DPCE-R-Q-4XGE-XFP • Name in the CLI: DPCE 4x 10GE R EQ
Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • WAN-PHY mode at 9.953 Gbps • LAN-PHY mode at 10.3125 Gbps • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes • Enhanced ASICs for increased performance and scalability of Layer 2 features

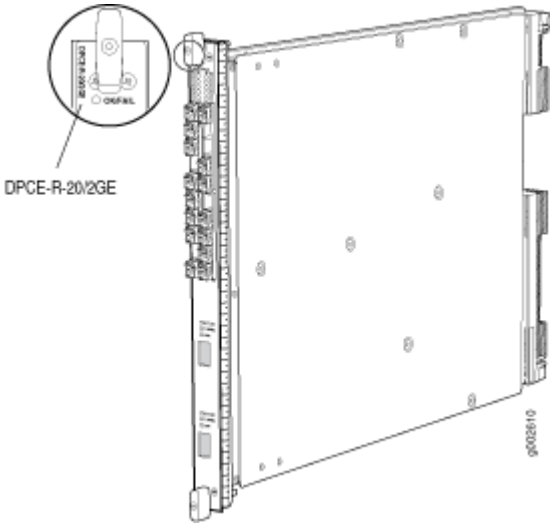
Software features	• Configurable WAN-PHY mode options • See "Protocols and Applications Supported by Enhanced Queuing IP Services DPCs (DPCE-R-Q)" on page 444 for information about the protocols and applications that this DPC supports.
Interfaces	Syntax: xe-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: 0 through 3 • port: 0 For example, xe-1/0/0 is the interface for the first port on a DPC installed in slot 1.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **TUNNEL** LED, one green per port: • Off—Normal operating mode. • On steadily—Port configured in tunnel mode. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is active. The **TUNNEL** and **LINK** LEDs are labeled top to bottom **0/0** through **3/0**.

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

Multi-Rate Ethernet Enhanced DPC with SFP and XFP



Software release	• Junos OS Release 9.2 and later
Description	• 20 Gigabit Ethernet ports • 2 10-Gigabit Ethernet ports • Power requirement: 6.94 A @ 48 V (333 W) • Weight: 13.1 lb (5.9 kg) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: DPCE-R-20GE-2XGE • Name in the CLI: DPCE 20x 1GE + 2x 10GE R

Hardware features	• SFP ports:
	  • High-performance throughput on each port at speeds up to 1 Gbps
	• XFP ports:
	  • High-performance throughput on each port at speeds up to 10 Gbps
	  • WAN-PHY mode at 9.953 Gbps
	  • LAN-PHY mode at 10.3125 Gbps
	• Autonegotiation between Gigabit Ethernet circuit partners
	• Full-duplex mode
	• Maximum transmission units (MTUs) of up to 9192 bytes
	• Enhanced ASICs for increased performance and scalability of Layer 2 features

Software features	• Configurable WAN-PHY mode options • Optical diagnostics and related alarms • See "Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R)" on page 427 for information about the protocols and applications that this DPC supports.

Interfaces	Syntax: *mediatype-fpc/pic/port* where:
	• mediatype: ge or xe
	• fpc: Slot in the router where the DPC is installed
	• pic:
	  • ge: 0 or 1
	  • xe: 2 or 3
	• port:
	  • ge: 0 through 9
	  • xe: 0
	For example, xe-1/3/0 is the interface for the port labeled **PORT 3/0** on a DPC installed in slot 1.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router.

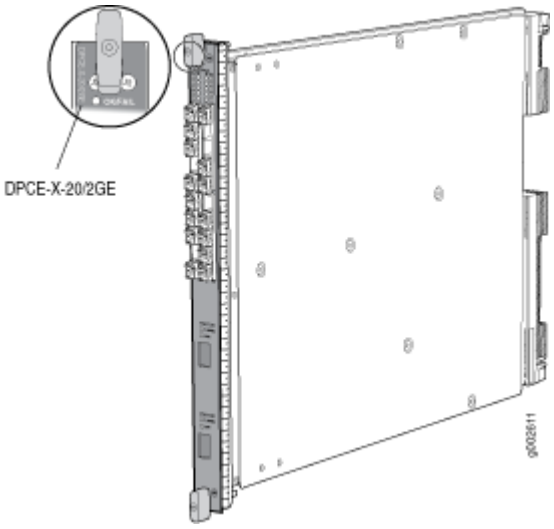
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is active. **TUNNEL** LED, one green per XFP port: • Off—Normal operating mode. • On steadily—Port configured in tunnel mode. The SFP Link LEDs are labeled in groups of five: • **0/0** for **0/0** through **0/4** • **0/5** for **0/5** through **0/9** • **1/0** for **1/0** through **1/4** • **1/5** for **1/5** through **1/9** The XFP ports are labeled top to bottom **2/0** and **3/0**.

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

Multi-Rate Ethernet Enhanced Ethernet Services DPC with SFP and XFP



Software release	• Junos OS Release 9.2 and later • End-of-life (see notification PSN-2011-07-314)
Description	• 20 Gigabit Ethernet ports • 2 10-Gigabit Ethernet ports • Power requirement: 6.94 A @ 48 V (333 W) • Weight: 13.1 lb (5.9 kg) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: DPCE-X-20GE-2XGE • Name in the CLI: DPCE 20x 1GE + 2x 10GE X

Hardware features	• SFP ports:
	  • High-performance throughput on each port at speeds up to 1 Gbps
	• XFP ports:
	  • High-performance throughput on each port at speeds up to 10 Gbps
	  • WAN-PHY mode at 9.953 Gbps
	  • LAN-PHY mode at 10.3125 Gbps
	• Full-duplex mode
	• Maximum transmission units (MTUs) of up to 9192 bytes
	• Enhanced ASICs for increased performance and scalability of Layer 2 features

Software features	• Configurable WAN-PHY mode options • Optical diagnostics and related alarms • See "Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X)" on page 436 for information about the protocols and applications that this DPC supports.

Interfaces	Syntax: *mediatype-fpc/pic/port* where:
	• mediatype: ge or xe
	• fpc: Slot in the router where the DPC is installed
	• pic:
	  • ge: 0 or 1
	  • xe: 2 or 3
	• port:
	  • ge: 0 through 9
	  • xe: 0
	For example, xe-1/3/0 is the interface for the port labeled **PORT 3/0** on a DPC installed in slot 1.

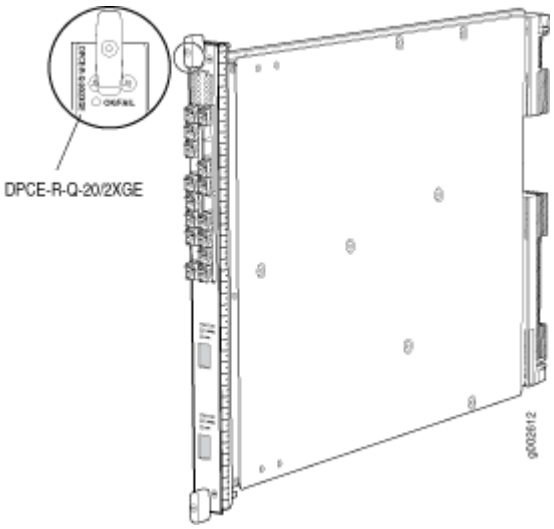
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is active. **TUNNEL** LED, one green per XFP port: • Off—Normal operating mode. • On steadily—Port configured in tunnel mode. The SFP Link LEDs are labeled in groups of five: • **0/0** for **0/0** through **0/4** • **0/5** for **0/5** through **0/9** • **1/0** for **1/0** through **1/4** • **1/5** for **1/5** through **1/9** The XFP ports are labeled top to bottom **2/0** and **3/0**.

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

Multi-Rate Ethernet Enhanced Queuing IP Services DPC with SFP and XFP



Software release	• Junos OS Release 9.3 and later
Description	• 20 Gigabit Ethernet ports • 2 10-Gigabit Ethernet ports • Power requirement: 6.98 A @ 48 V (335 W) • Weight: 13.1 lb (5.9 kg) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: DPCE-R-Q-20GE-2XGE • Name in the CLI: DPCE 20x 1GE + 2x 10GE R EQ

Hardware features	• SFP ports:
	  • High-performance throughput on each port at speeds up to 1 Gbps
	• XFP ports:
	  • High-performance throughput on each port at speeds up to 10 Gbps
	  • WAN-PHY mode at 9.953 Gbps
	  • LAN-PHY mode at 10.3125 Gbps
	• Full-duplex mode
	• Maximum transmission units (MTUs) of up to 9192 bytes
	• Enhanced ASICs for increased performance and scalability of Layer 2 features

Software features	• Configurable WAN-PHY mode options • Optical diagnostics and related alarms • See "Protocols and Applications Supported by Enhanced Queuing IP Services DPCs (DPCE-R-Q)" on page 444 for information about the protocols and applications that this DPC supports.

Interfaces	Syntax: *mediatype-fpc/pic/port* where:
	• mediatype: ge or xe
	• fpc: Slot in the router where the DPC is installed
	• pic:
	  • ge: 0 or 1
	  • xe: 2 or 3
	• port:
	  • ge: 0 through 9
	  • xe: 0
	For example, xe-1/3/0 is the interface for the port labeled **PORT 3/0** on a DPC installed in slot 1.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. You can install any transceiver supported by the DPC. For information about installing and removing transceivers, see the hardware guide for your router.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is active. **TUNNEL** LED, one green per XFP port: • Off—Normal operating mode. • On steadily—Port configured in tunnel mode. The SFP Link LEDs are labeled in groups of five: • **0/0** for **0/0** through **0/4** • **0/5** for **0/5** through **0/9** • **1/0** for **1/0** through **1/4** • **1/5** for **1/5** through **1/9** The XFP ports are labeled top to bottom **2/0** and **3/0**.

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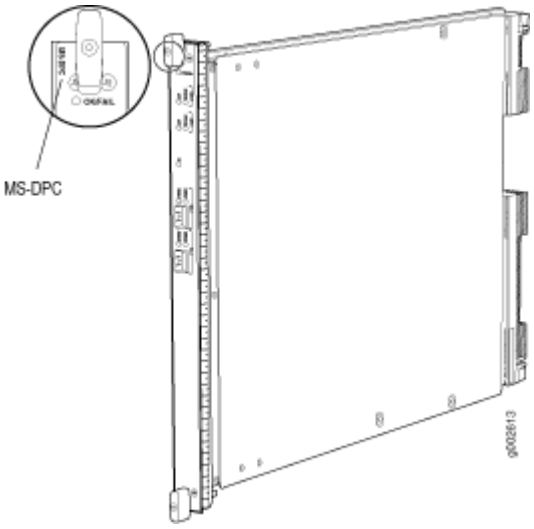
DPCs Supported on MX240, MX480, and MX960 Routers | 9

Multiservices DPC



Software release	• Junos OS Release 9.3 and later

Description	• Power requirement: 5.52 A @ 48 V (265 W)
	• Weight: 14.7 lb (6.7 kg)
	• Supports tunnel services. This feature is included with the DPC and does not require an individual license.
	• Individual licenses must be purchased for additional services.
	• Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network
	• The maximum number of supported MS-DPCs is as follows:
	  • MX240 router: 2
	  • MX480 router: 4
	  • MX960 router: 8
	• Model number: MS-DPC

Hardware features	• Active monitoring on up to 10 million flows • Maximum transmission units (MTUs) of up to 9192 bytes • Two Multiservices Processing Units (MSPUs) per DPC, which include two 1.1Ghz multicore CPUs, each with 4GB of memory for processing integrated services
Software features	• Support for up to 12,000 service sets • See "Protocols and Applications Supported by the Multiservices DPC (MS-DPC)" on page 459 for information about the protocols and applications that this DPC supports.
Interfaces	Syntax: *mediatype-fpc/pic/port* where: • mediatype: gr, pc, pd, etc • fpc: Slot in the router where the MPC is installed • pic: 0 or 1 • port: 0 **NOTE**: Port number reflects the internal interface and is not a physical port.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. • SFPs are not supported.

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **STATUS** LED, one tricolor per MSPU: • Off—MSPU is offline. If both MSPUs are offline it is safe to remove the DPC from the chassis. • Green—MSPU is operating normally. • Yellow—MSPU is initializing. • Red—MSPU has an error or failure. Application (**APP**) LED, one tricolor per MSPU: • Off—Service is not running on the MSPU. • Green—Service is running on the MSPU under acceptable load. • Yellow—Service on the MSPU is overloaded.

RELATED DOCUMENTATION

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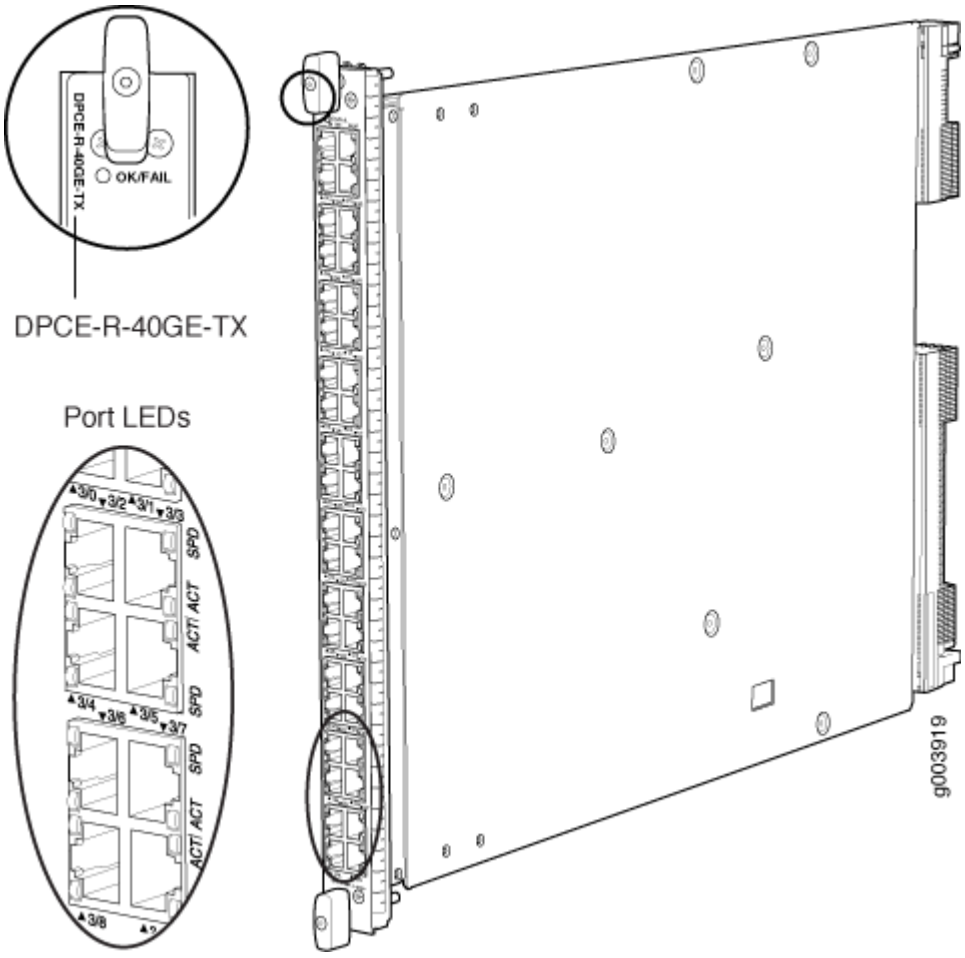
DPCs Supported on MX240, MX480, and MX960 Routers | 9

Tri-Rate Enhanced DPC



Software release	• Junos OS Release 9.1 and later
Description	• 40 autonegotiating 10BASE-T, 100BASE-TX, or 1000BASE-T Megabit Ethernet ports • Power requirement: 6.67 A @ 48 V (320 W) • Weight: 14.5 lb (6.6 kg) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: DPCE-R-40GE-TX • Name in the CLI: DPCE 40x 1GE R TX

Hardware features	• High-performance throughput on each port at speeds of 10 Mbps, 100 Mbps, or 1000 Mbps
	• Autonegotiation between Gigabit Ethernet circuit partners
	• Full-duplex mode
	• Maximum transmission units (MTUs) of up to 9192 bytes
	• Enhanced ASICs for increased performance and scalability of Layer 2 features
	• There are four sets of 10 ports labeled:
	  • 0/0 through 0/9
	  • 1/0 through 1/9
	  • 2/0 through 2/9
	  • 3/0 through 3/9

Software features	• See "Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R)" on page 427 for information about the protocols and applications that this DPC supports.
Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: Grouping of 10-ports, numbered 0 through 3 • port: 0 through 9 For example, ge-1/3/0 is the interface for port 0 (labeled **3/0**) in the right-most grouping of ports on a DPC installed in slot 1.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device.
	
	The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
	
	• Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector
	
	• Pinout:
	
	  • Junos OS Release 9.1: MDI
	
	  • Junos OS Release 9.2 and later: MDI, MDI crossover
	
	• Maximum distance: 328 ft/100 m
	
	CAUTION: Do not use RJ-45 cables with strain-relief boots exceeding 1.5 mm from the bottom of the connector. Cable boots that exceed this measurement can damage the port.

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **ACT** LED, one green per port: • Off—No active traffic. • Blinking—Link is active. **SPD** LED, one bicolor: • Green—DPC is functioning in 1000BASE-T mode. • Yellow—DPC is functioning in 10BASE-T or 100BASE-TX mode. • Off—No link. The **ACT** and **SPD** LEDs are located on either side of the ports labeled horizontally and top to bottom **0/0** through **3/9**.

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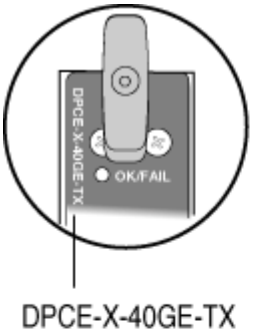
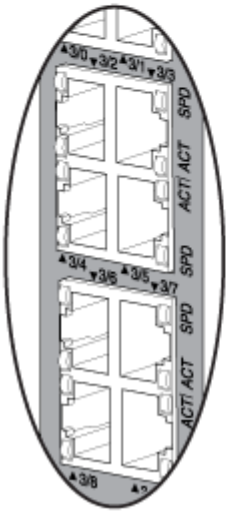
DPCs Supported on MX240, MX480, and MX960 Routers | 9

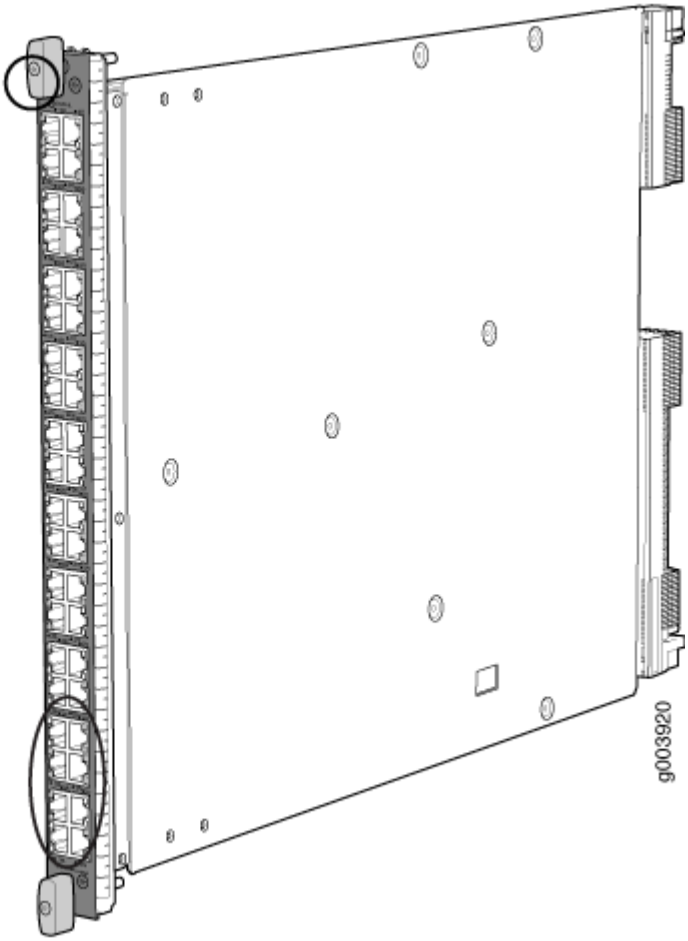
Tri-Rate Enhanced Ethernet Services DPC



DPCE-X-40GE-TX

Port LEDs





Software release	• Junos OS Release 9.1 and later • EOL (see PSN-2009-06-400)

Description	• 40 autonegotiating 10BASE-T, 100.BASE-TX, or 1000BASE-T Megabit Ethernet ports • Power requirement: 6.67 A @ 48 V (320 W) • Weight: 14.5 lb (6.6 kg) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: DPCE-X-40GE-TX • Name in the CLI:
Hardware features	• High-performance throughput on each port at speeds of 10 Mbps, 100 Mbps, or 1000 Mbps • Autonegotiation between Gigabit Ethernet circuit partners • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes • Enhanced ASICs for increased performance and scalability of Layer 2 features
Software features	• See "Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X)" on page 436 for information about the protocols and applications that this DPC supports.
Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the DPC is installed • pic: Grouping of 10-ports, numbered 0 through 3 • port: 0 through 9 For example, ge-1/3/0 is the interface for port 0 (labeled **3/0**) in the right-most grouping of ports on a DPC installed in slot 1.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device.
	
	The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
	
	• Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector
	
	• Pinout:
	
	  • Junos OS Release 9.1: MDI
	
	  • Junos OS Release 9.2 and later: MDI, MDI crossover
	
	• Maximum distance: 328 ft/100 m
	
	CAUTION: Do not use RJ-45 cables with strain-relief boots exceeding 1.5 mm from the bottom of the connector. Cable boots that exceed this measurement can damage the port.

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—DPC is functioning normally. • Blinking green—DPC is transitioning online or offline. • Red—DPC has failed. **ACT** LED, one green per port: • Off—No active traffic. • Blinking—Link is active. **SPD** LED, one bicolor: • Green—DPC is functioning in 1000BASE-T mode. • Yellow—DPC is functioning in 10BASE-T or 100BASE-TX mode. • Off—No link. The **ACT** and **SPD** LEDs are located on either side of the ports labeled horizontally and top to bottom **0/0** through **3/9**.

RELATED DOCUMENTATION

MX Series DPC Overview | 8

DPCs Supported on MX240, MX480, and MX960 Routers | 9

CHAPTER 9

MX Series SPC Description

IN THIS CHAPTER

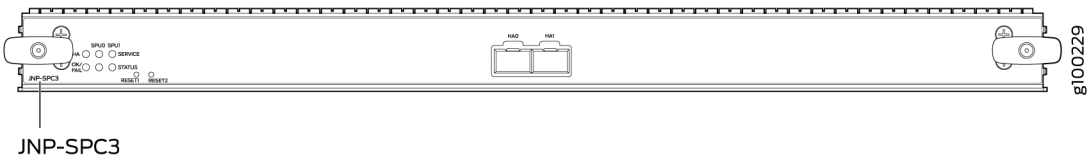
MX-SPC3 Services Card

The MX-SPC3 (Model number: JNP-SPC3) is a Services Processing Card (SPC) that provides additional processing power to run Next Gen Services. Next Gen Services provide capabilities for manipulating traffic before it's delivered to its destination. The MX-SPC3 Services Card is supported on MX240, MX480, and MX960 routers.

It contains two Services Processing Units (SPUs) with 128 GB of memory per SPU. Line cards such as DPCs, MICs, and MPCs intelligently distribute all traffic traversing the router to the SPUs to have services processing applied to it (see Figure 8 on page 126).

You can install the MX-SPC3 in any of the slots that are not reserved for Switch Control Board (SCB). If a slot is not occupied by a card, you must install a blank panel to shield the empty slot and to allow cooling air to circulate properly through the device.

Figure 8: MX-SPC3 Services Card



Software release	• Junos OS Release 19.3R2 and later

Description	Services Processing Card (SPC) with two SPUs of 256 GB memory. • Model number: JNP-SPC3 • Power requirement: 650 W maximum • Weight: Approximately 18 lb (8.3 kg)

Hardware features	• Two 10–Gigabit Ethernet small form-factor pluggable plus (SFP+) chassis cluster control ports for connecting multiple devices into a redundant chassis cluster.
	• Fabric interfaces
	• One Gigabit Ethernet switch that provides control connectivity to the Routing Engine.
	• Two interfaces from the SCBs that enable the boards to be powered on and controlled.
	• Physical SPC connectors
	• Midplane connectors and power circuitry
	• Each SPU includes:
	  • Two 2.3-GHz CPUs
	  • One Crypto Engine
	  • 128 GB memory
	• Two 128 GB solid state-drives (SSDs).
	• LEDs on the faceplate that indicate the SPC and SPU status.

Supported Slots	• MX240–Any slot, except the bottom slot **0** () which is reserved for SCB/RE. • MX480–Any slot, except the bottom slots **0** () or **1** () which are reserved for SCB/RE. • MX960–Any slot, except slot **11** () , and slots **0** () or **1** () which are reserved for SCB/RE.

Compatibility	The MX-SPC3 services card is compatible end-to-end with the MX Series Switch Fabrics, Routing Engines and MPC line cards. See Table 23 on page 131.

LEDs

OK/FAIL LED, one bicolor:

- Steady green–The SPC is operating normally.
- Red–The SPC has failed and is not operating normally.
- Off–The SPC is powered down.

STATUS LED, one tricolor for each SPU **SPU 0** and **SPU 1**:

- Off–The SPU is offline.
- Blinking Amber–The SPU is initializing.
- Green–The SPU initialization is done and it is operating normally.
- Red–The SPU has encountered an error or a failure.

SERVICE LED, one tricolor for each SPU **SPU 0** and **SPU 1**:

- Off–The SPU is offline.
- Blinking Red–The SPU initialization is done.
- Blinking Amber–Service is initializing on the SPU.
- Green–Service is running on the SPU under acceptable load.
- Solid Red–Service encountered an error or a failure.

HA LED, one tricolor:

- Green–Clustering is operating normally. All cluster members and monitored links are available, and no error conditions are detected.
- Red–A critical alarm is present on clustering. A cluster member is missing or unreachable, or the other node is no longer part of a cluster because it has been disabled by the dual membership and detection recovery process in reaction to a control-link or fabric-link failure.
- Amber–All cluster members are present, but an error condition has compromised the performance and resiliency of the cluster. The reduced bandwidth could cause packets to be dropped or could result in reduced resiliency because a single point of failure might exist. The error condition might be caused by:
  - The loss of chassis cluster links which causes an interface monitoring failure.

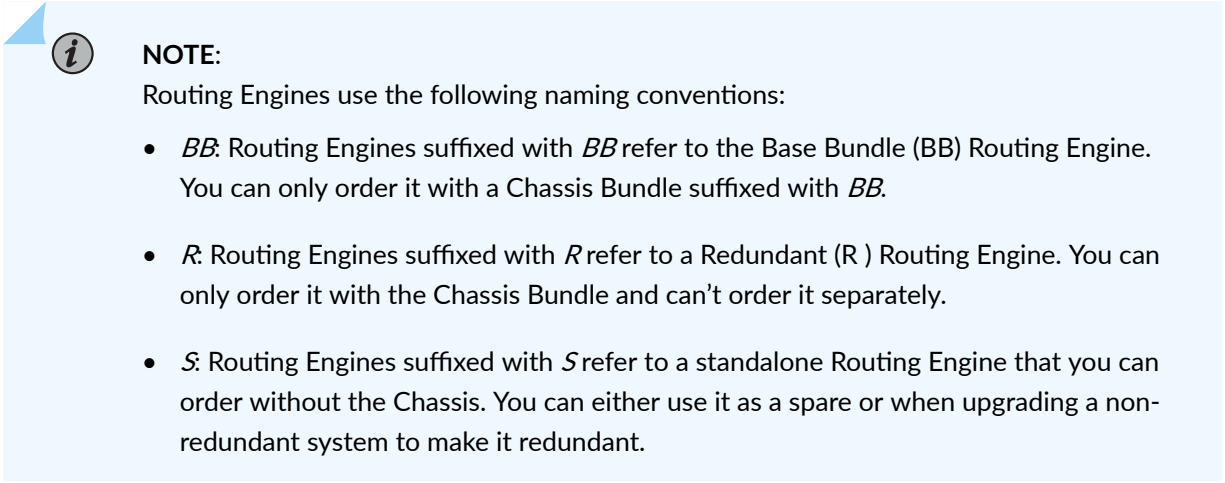
- An error in an SPU or NPU.
- Failure of the spu-monitoring or cold-sync-monitoring processes.
- A chassis cluster IP monitoring failure.

- Off–The node is not configured for clustering or it has been disabled by the dual membership and detection recovery process in reaction to a control link or fabric link failure.

LINK/ACT LED, one for each of the two ports **CHASSIS CLUSTER CONTROL 0** and **CHASSIS CLUSTER CONTROL 1**:

- Green–Chassis cluster control port link is active.
- Off–No link.

The MX-SPC3 services card is compatible end-to-end with the MX Series Switch Fabrics, Routing Engines and MPC line cards on MX240, MX480, and MX960 routers. See Table 23 on page 131.



NOTE:
Routing Engines use the following naming conventions:

- *BB*: Routing Engines suffixed with *BB* refer to the Base Bundle (BB) Routing Engine. You can only order it with a Chassis Bundle suffixed with *BB*.
- *R*: Routing Engines suffixed with *R* refer to a Redundant (R) Routing Engine. You can only order it with the Chassis Bundle and can't order it separately.
- *S*: Routing Engines suffixed with *S* refer to a standalone Routing Engine that you can order without the Chassis. You can either use it as a spare or when upgrading a non-redundant system to make it redundant.

Table 23: MX-SPC3 Services Card Compatibility with MX Series Switch Fabrics, Routing Engines and MPC Line Cards

Switch Fabric	Route Engine	MPC Line Cards
SCBE	RE-S-1800X4-16G-BB RE-S-1800X4-16G-UPG-BB RE-S-1800X4-16G-S RE-S-1800X4-16G-R RE-S-1800X4-32G-BB RE-S-1800X4-32G-UB RE-S-1800X4-32G-S RE-S-1800X4-32G-R	MPC2E-3D MPC2-3D-NG MPC3E and MPC3E-3D-NG MPC4E-3D MPC-3D-16XGE
SCBE2	RE-S-1800X4-16G-BB RE-S-1800X4-16G-UPG-BB RE-S-1800X4-16G-S RE-S-1800X4-16G-R RE-S-1800X4-32G-BB RE-S-1800X4-32G-UB RE-S-1800X4-32G-S RE-S-1800X4-32G-R RE-S-X6-64G-UB RE-S-X6-64G-S RE-S-X6-64G-R RE-S-X6-64G-BB RE-S-X6-128G-S-S RE-S-X6-128G-S-R RE-S-X6-128G-S-BB	MPC2E-3D MPC2-3D-NG MPC3E and MPC3E-3D-NG MPC4E-3D MPC5E and MPC5EQ MPC7E and MPC7EQ MPC-3D-16XGE

Table 23: MX-SPC3 Services Card Compatibility with MX Series Switch Fabrics, Routing Engines and MPC Line Cards *(Continued)*

Switch Fabric	Route Engine	MPC Line Cards
SCBE3	RE-S-1800X4-16G-BB RE-S-1800X4-16G-UPG-BB RE-S-1800X4-16G-S RE-S-1800X4-16G-R RE-S-1800X4-32G-BB RE-S-1800X4-32G-UB RE-S-1800X4-32G-S RE-S-1800X4-32G-R RE-S-X6-64G-BB RE-S-X6-64G-UB RE-S-X6-64G-S RE-S-X6-64G-R RE-S-X6-128G-S-BB RE-S-X6-128G-S-S RE-S-X6-128G-S-R	MPC2-3D-NG MPC4E-3D MPC5E and MPC5EQ MPC7E and MPC7EQ MPC-3D-16XGE MPC10E-10C MPC10E-15C

Table 24 on page 132 provides a summary of Next Gen Services supported by MX-SPC3.

Table 24: Next Gen Services Supported by MX-SPC3 Services Card

Feature Category / Feature		First Supported Junos OS Release
Carrier Grade NAT	Basic-NAT44	19.3R2
	Basic-NAT66	19.3R2
	Dynamic-NAT44	19.3R2

Table 24: Next Gen Services Supported by MX-SPC3 Services Card *(Continued)*

Feature Category / Feature		First Supported Junos OS Release
	Static Destination NAT	19.3R2
	Basic-NAT-PT	19.3R2
	NAPT-PT	19.3R2
	NAPT44	19.3R2
	NAPT66	19.3R2
	Port Block Allocation	19.3R2
	Deterministic-nat44 and nat64	19.3R2
	End Point Independent Mapping (EIM)/End Point	19.3R2
	Independent Filtering (EIF)	19.3R2
	Persistent NAT – Application Pool Pairing (APP)	19.3R2
	Twice-NAT44 – Basic, Dynamic and NAPT	19.3R2
	NAT64	19.3R2
	XLAT-464	19.3R2
	NPTv6	19.3R2

Table 24: Next Gen Services Supported by MX-SPC3 Services Card *(Continued)*

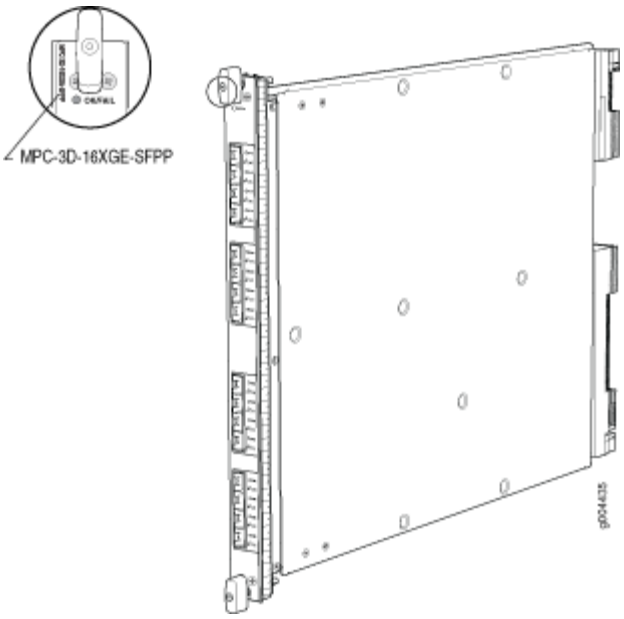
Feature Category / Feature		First Supported Junos OS Release
	Port Control Protocol (PCP) – v1 and v2	20.1R1
	DS-Lite	20.2R1
	NAT46	20.2R1
Stateful Firewall Services		19.3R2
Intrusion Detection Services (IDS)		19.3R2
Traffic Load Balancer		19.3R2
DNS Request Filtering		19.3R2
Aggregated Multiservices Interfaces		19.3R2
Inter-chassis High Availability	CGNAT, Stateful Firewall, and IDS Flows	19.3R2
URL Filtering		20.1R1
HTTP Content Manager (HCM)		20.2R1
IPsec		21.1R1

CHAPTER 10

MX Series MPC Descriptions

IN THIS CHAPTER

MPC-3D-16XGE-SFPP



Software release

- MX240, MX480, and MX960 routers : Junos OS Release 10.0R2 and later
- MX2010 and MX2020 router: Junos OS Release 12.3 and later

Description	• Fixed configuration MPC with sixteen 10-Gigabit Ethernet ports
	• Power requirement: 9.17 A @ 48 V (440 W)
	• Weight: 18.35 lb (8.3 kg)
	• Model numbers:
	  • MPC-3D-16XGE-SFPP
	  • MPC-3D-16XGE-SFPP-R-B
	• Name in the CLI:
	  • `MPC 3D 16x10GE`
	  • `MPC 3D 16x10GE EM`

Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • Four fully programmable Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services • One Junos Trio chipset per set of four ports • LAN-PHY mode at 10.3125 Gbps **NOTE**: The 16x10GE 3D MPC does not support WAN-PHY mode.
Software features	• Optical diagnostics and related alarms • See "Protocols and Applications Supported on MPCs for MX Series Routers" on page 472 for information about the protocols and applications that this MPC supports.
Interfaces	Syntax: xe-*fpc/pic/port* where: • fpc: Slot in the router where the MPC is installed • pic: Grouping of 4 ports, numbered 0 through 3 • port: 0 through 3 For example, xe-1/3/3 is the interface for the last port (labeled **3/3**) on an MPC installed in slot 1.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: The 16x10GE 3D MPC does not support WAN-PHY mode. **NOTE**: SFPP-10G-CT50-ZR is not NEBS compliant when plugged into the MPC-3D-16XGE-SFPP. If the ambient air temperature exceeds 55°C (131°F), Junos OS disables the transmitter, which takes the optical transceiver offline.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed. Enable/disable LED, one bicolor per port: • Green—Port is enabled. • Yellow—Port is not functioning normally. • Off—Port is disabled. The enable/disable LEDs are labeled in groups of four: • **0/0** through **0/3** • **1/0** through **1/3** • **2/0** through **2/3** • **3/0** through **3/3**

RELATED DOCUMENTATION

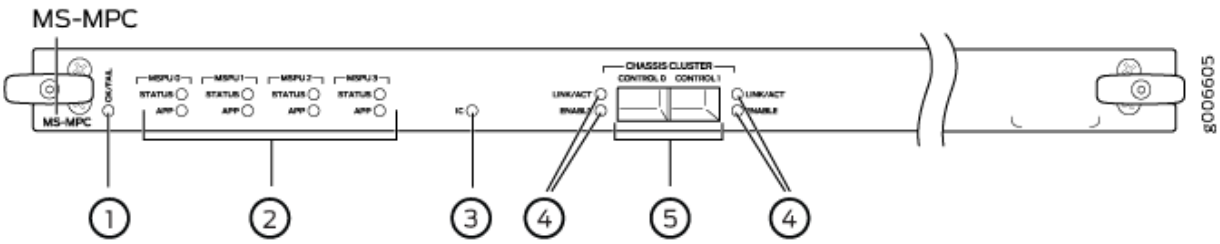
MX Series MPC Overview | **15**

MPCs Supported by MX Series Routers | **16**

Media MTU Sizes by Interface Type

Multiservices MPC

Figure 9: Multiservices MPC



1– OK/Fail LED	4– Link/Act and Enable LEDs
2– MSPU Status and APP LEDs	5– Control 0 and Control 1 ports
3– IC LED	

Software release	• Junos OS Release 13.2R4 and later For information on which MPCs are supported on MX Series routers, see "MPCs Supported by MX Series Routers" on page 16.
Description	• Power requirement: 12.2 Amps @ 48 V (585 W) • Weight: 14 lbs. • Model number: MS-MPC • Name in the CLI: `MS-MPC`
Hardware features	• One Junos Trio chipset for increased scaling for bandwidth, subscribers, and services. • Enhanced memory with 128 GB of memory (32 GB per NPU) and processing capabilities. • NPU CPU Clock Cycle of 1.2GHz. • Four NPUs per MPC. • Works with SCBs and SCBEs. • Interoperable with MS-DPCs. Both MS-MPCs and MS-DPCs can co-exist in the same chassis.

Software features	• Active flow monitoring and export of flow monitoring version 9 records based on RFC 3954 • IP Security (IPsec) encryption • Network Address Translation (NAT) for IP addresses • Port Address Translation (PAT) for port numbers • Traffic sampling • Stateful firewall with packet inspection—detects SYN attacks, ICMP and UDP floods, and ping-of-death attacks • Network Attack Protection (NAP) • Support for up to 6000 service sets • Support for MTUs up to 9192 bytes. • Multiple services can be supported. See Junos OS Services Interfaces Library for Routing Devices for more information. • See "Protocols and Applications Supported by the MS-MIC and MS-MPC" on page 594 for information about the protocols and applications that this MIC supports.

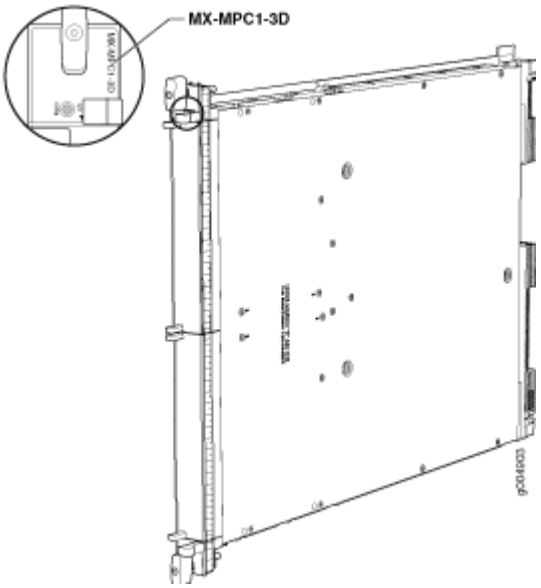
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed. IC LED—Reserved for future use. **STATUS** LED, one tricolor per MSPU: • Off—MSPU is offline. If both MSPUs are offline it is safe to remove the DPC from the chassis. • Green—MSPU is operating normally. • Yellow—MSPU is initializing. • Red—MSPU has an error or failure. Application (**APP**) LED, one tricolor per MSPU: • Off—Service is not running on the MSPU. • Green—Service is running on the MSPU under acceptable load. • Yellow—Service on the MSPU is reconfiguring. • Red—Service on the MSPU has failed. Activity (**LINK/ACT**) LED, one per control port: • Off—No link. • Green—Chassis cluster control port link is active. **ENABLE** LED, one per control port: • Off—Chassis cluster control port is disabled. • Green—Chassis cluster control port is enabled.

RELATED DOCUMENTATION

MX Series MPC Overview | **15**

Multiservices MIC and Multiservices MPC (MS-MIC and MS-MPC) Overview

MPC1



Software release	• MX240, MX480, and MX960 routers: Junos OS Release 10.2 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.
Description	• Power requirement: 3.4 A @ 48 V (165 W) • Weight: 13.8 lb (6.3 kg) • Model number: MX-MPC1-3D • Name in the CLI: `MPC Type 1 3D`

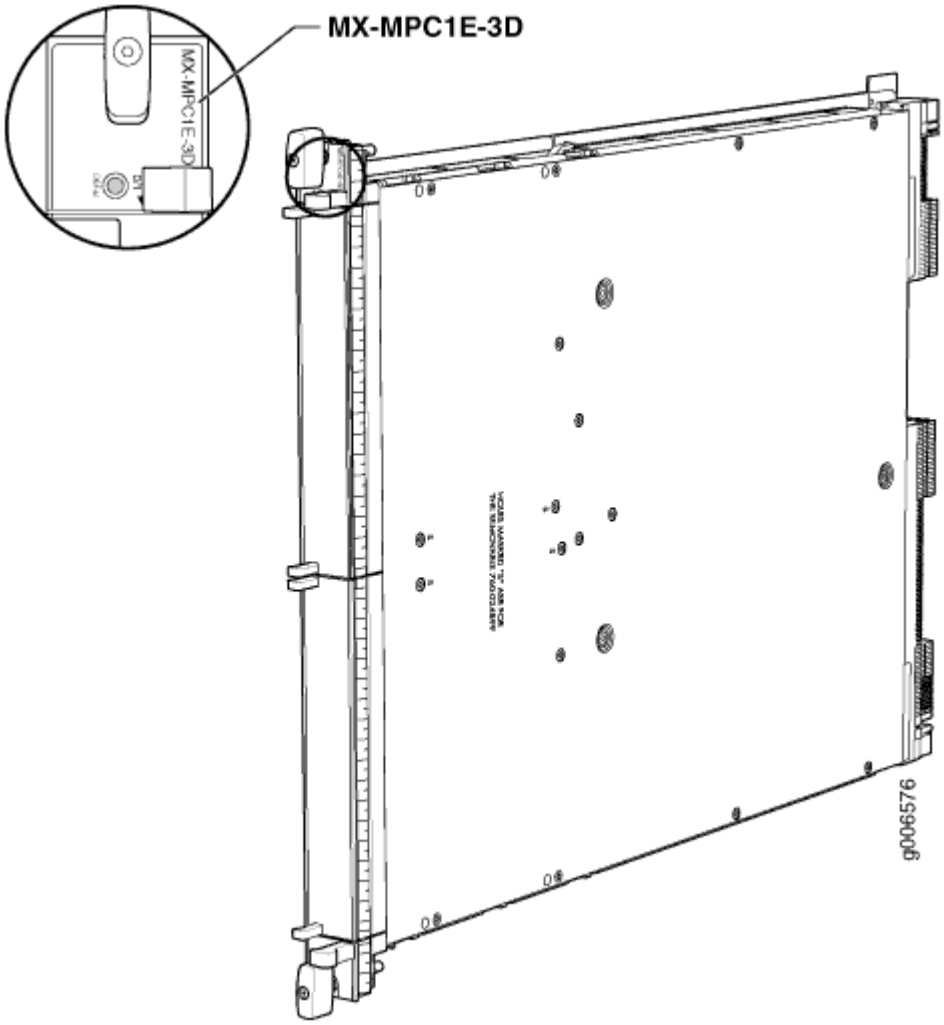
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • One Junos Trio chipset for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps
Software features	• See "Protocols and Applications Supported on MPCs for MX Series Routers" on page 472 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

MX Series MPC Overview | **15**

MPCs Supported by MX Series Routers | **16**

MPC1E



Software release	• MX240, MX480, and MX960 routers: Junos OS Release 11.2R4 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.

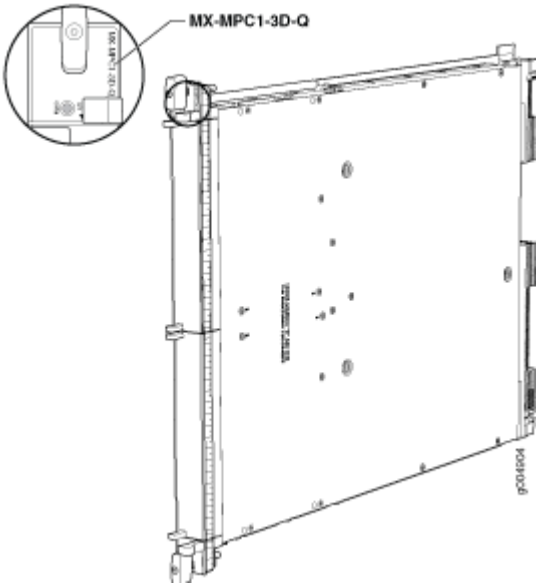
Description	• Power requirement: 3.4 A @ 48 V (165 W) • Weight: 13.8 lb (6.3 kg) • Model number: MX-MPC1E-3D • Name in the CLI: `MPCE Type 1 3D`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • One Junos Trio chipset for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps
Software features	• See "Protocols and Applications Supported on the MPC1E for MX Series Routers" on page 491 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

MX Series MPC Overview | 15

MPCs Supported by MX Series Routers | 16

MPC1 Q



Software release	• MX240, MX480, and MX960 routers: Junos OS Release 10.2 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.
Description	• Power requirement: 3.65 A @ 48 V (175 W) • Weight: 13.8 lb (6.3 kg) • Model number: MX-MPC1-3D-Q • Name in the CLI: `MPC Type 1 3D Q`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • One Junos Trio chipset for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps

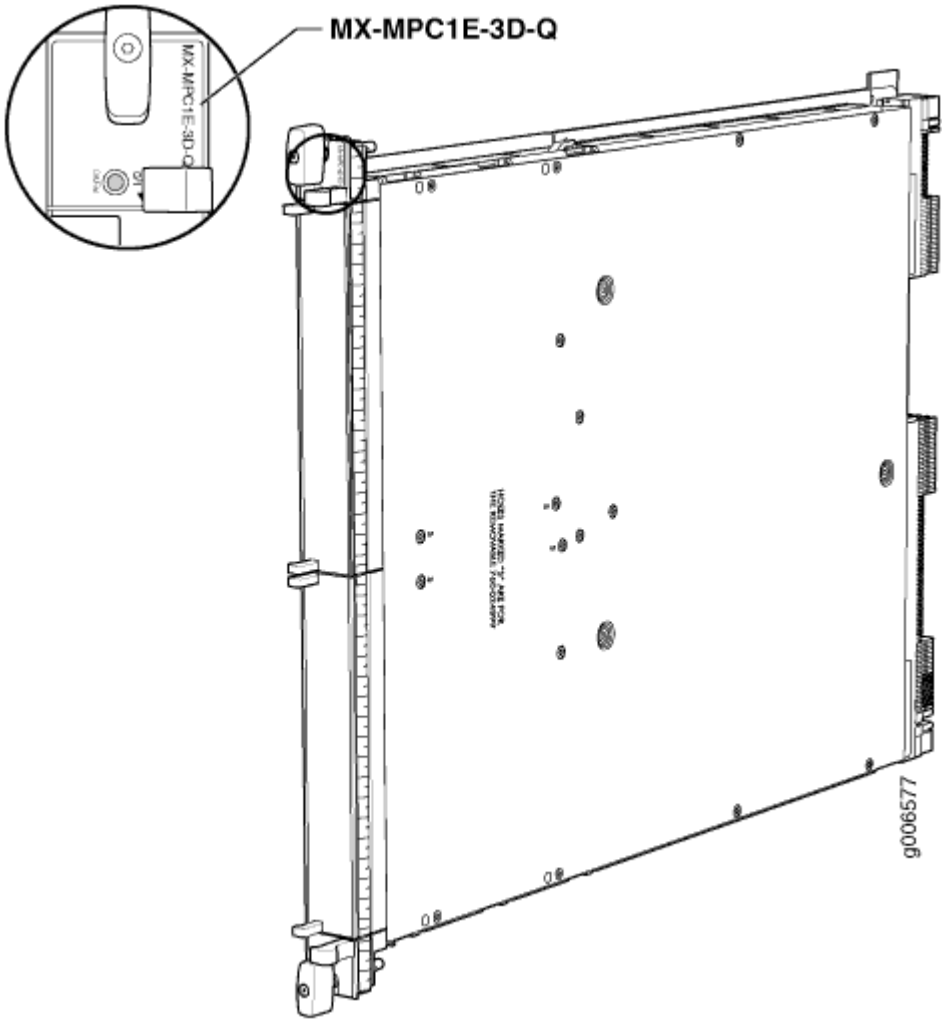
Software features	• See "Protocols and Applications Supported on MPCs for MX Series Routers" on page 472 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

MX Series MPC Overview | **15**

MPCs Supported by MX Series Routers | **16**

MPC1E Q



Software release	• MX240, MX480, and MX960 routers: Junos OS Release 11.2R4 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.

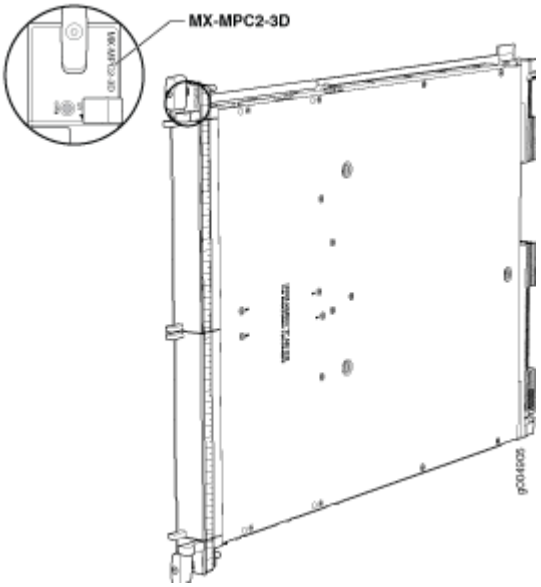
Description	• Power requirement: 3.65 A @ 48 V (175 W) • Weight: 13.8 lb (6.3 kg) • Model number: MX-MPC1E-3D-Q • Name in the CLI: `MPCE Type 1 3D Q`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • One Junos Trio chipset for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps
Software features	• See "Protocols and Applications Supported on the MPC1E for MX Series Routers" on page 491 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

MX Series MPC Overview | 15

MPCs Supported by MX Series Routers | 16

MPC2



Software release	• MX240, MX480, and MX960 routers : Junos OS Release 10.1 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.
Description	• Power requirement: 5.7 A @ 48 V (274 W) • Weight: 14 lb (6.4 kg) • Model number: MX-MPC2-3D • Name in the CLI: `MPC Type 2 3D`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • Two Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps

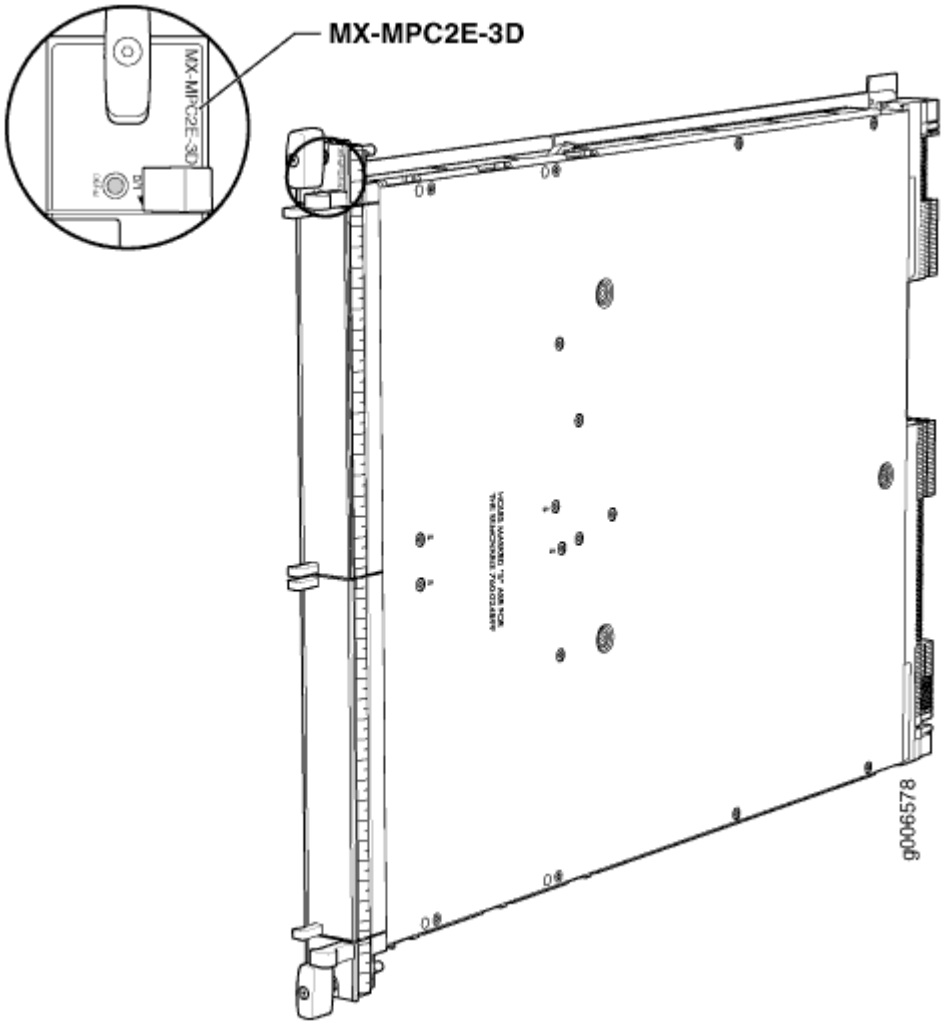
Software features	• See "Protocols and Applications Supported on MPCs for MX Series Routers" on page 472 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

MX Series MPC Overview | **15**

MPCs Supported by MX Series Routers | **16**

MPC2E



Software release	• MX240, MX480, and MX960 routers : Junos OS Release 11.2R4 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.

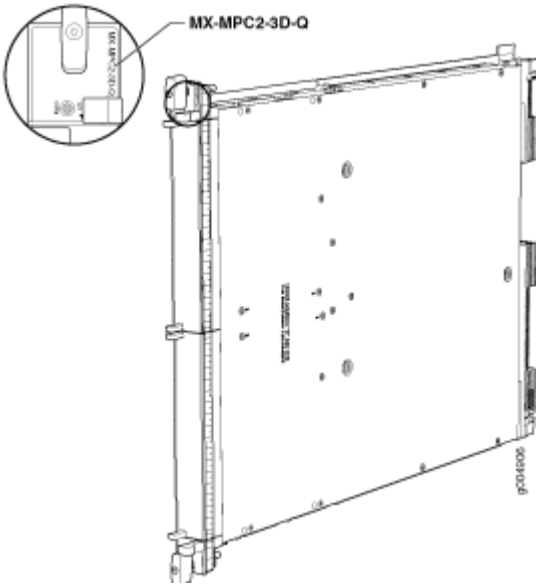
Description	• Power requirement: 5.7 A @ 48 V (274 W) • Weight: 14 lb (6.4 kg) • Model number: MX-MPC2E-3D • Name in the CLI: `MPCE Type 2 3D`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • Two Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps
Software features	• See "Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E" on page 501 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

MX Series MPC Overview | 15

MPCs Supported by MX Series Routers | 16

MPC2 Q



Software release	• MX240, MX480, and MX960 routers : Junos OS Release 10.1 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.
Description	• Power requirement: 6.13 A @ 48 V (294 W) • Weight: 14 lb (6.4 kg) • Model number: MX-MPC2-3D-Q • Name in the CLI: `MPC Type 2 3D Q`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • Two Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps

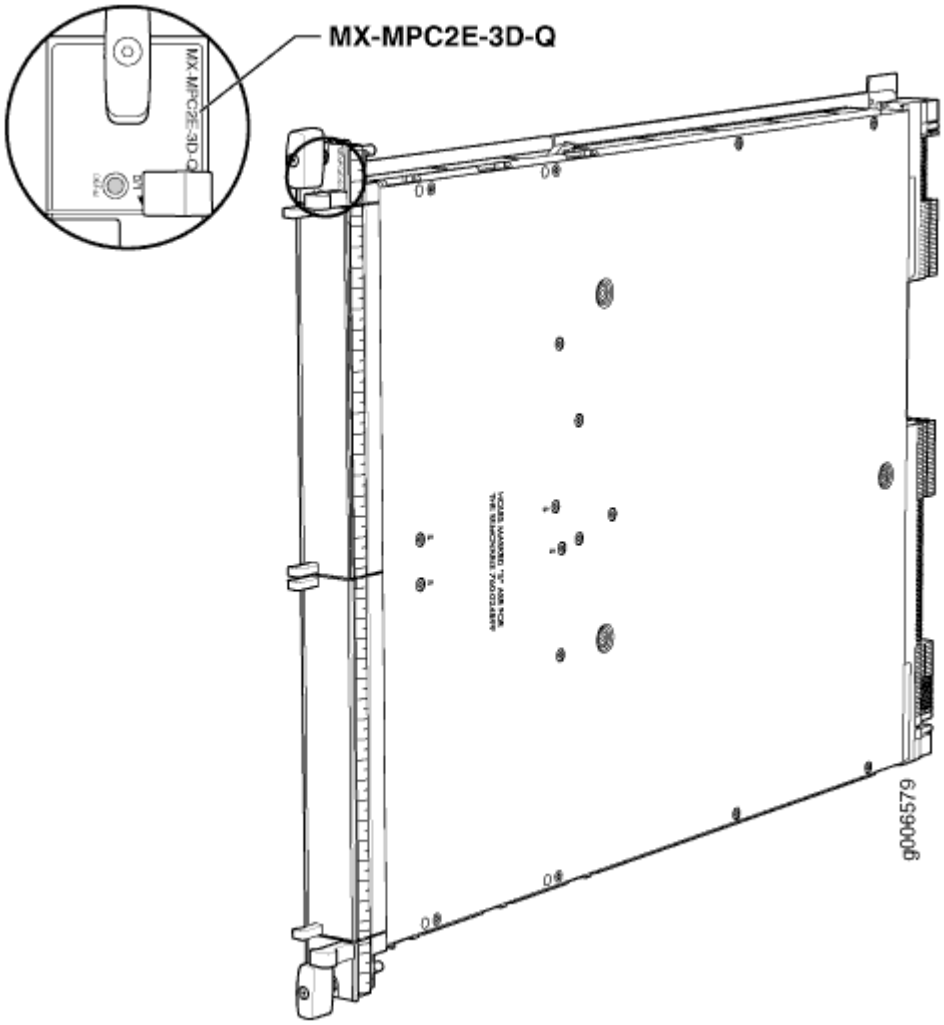
Software features	• See "Protocols and Applications Supported on MPCs for MX Series Routers" on page 472 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

MX Series MPC Overview | **15**

MPCs Supported by MX Series Routers | **16**

MPC2E Q



Software release	• MX240, MX480, and MX960 routers : Junos OS Release 11.2R4 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.

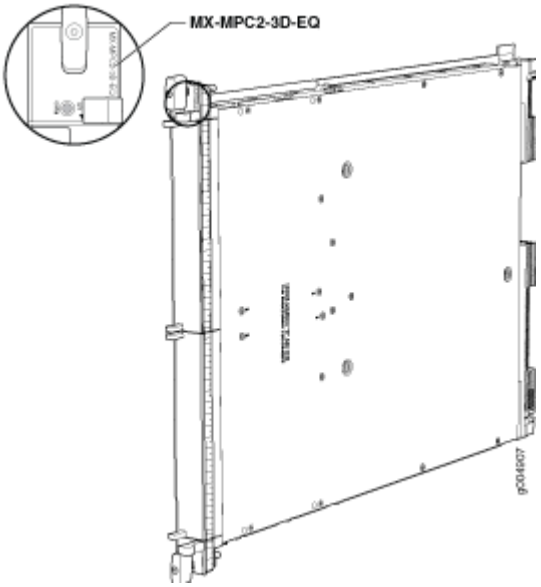
Description	• Power requirement: 6.13 A @ 48 V (294 W) • Weight: 14 lb (6.4 kg) • Model number: MX-MPC2E-3D-Q • Name in the CLI: `MPCE Type 2 3D Q`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • Two Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps
Software features	• See "Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E" on page 501 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

MX Series MPC Overview | 15

MPCs Supported by MX Series Routers | 16

MPC2 EQ



Software release	• MX240, MX480, and MX960 routers : Junos OS Release 10.1 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.
Description	• Power requirement: 6.13 A @ 48 V (294 W) • Weight: 14 lb (6.4 kg) • Model number: MX-MPC2-3D-EQ • Name in the CLI: `MPC Type 2 3D EQ`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • Two Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps

Software features	• See "Protocols and Applications Supported on MPCs for MX Series Routers" on page 472 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

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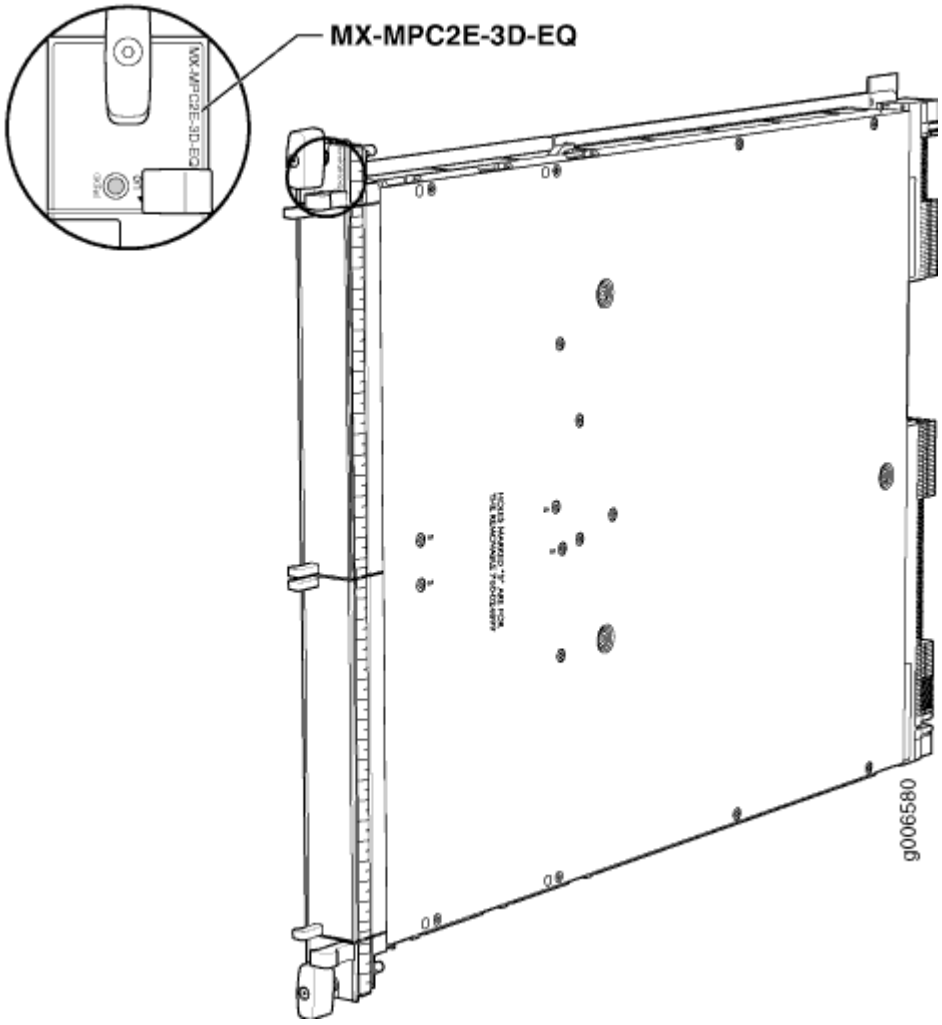
MPCs Supported by MX Series Routers | **16**

MPC2E EQ



Software release	• MX240, MX480, and MX960 routers : Junos OS Release 11.2R4 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.

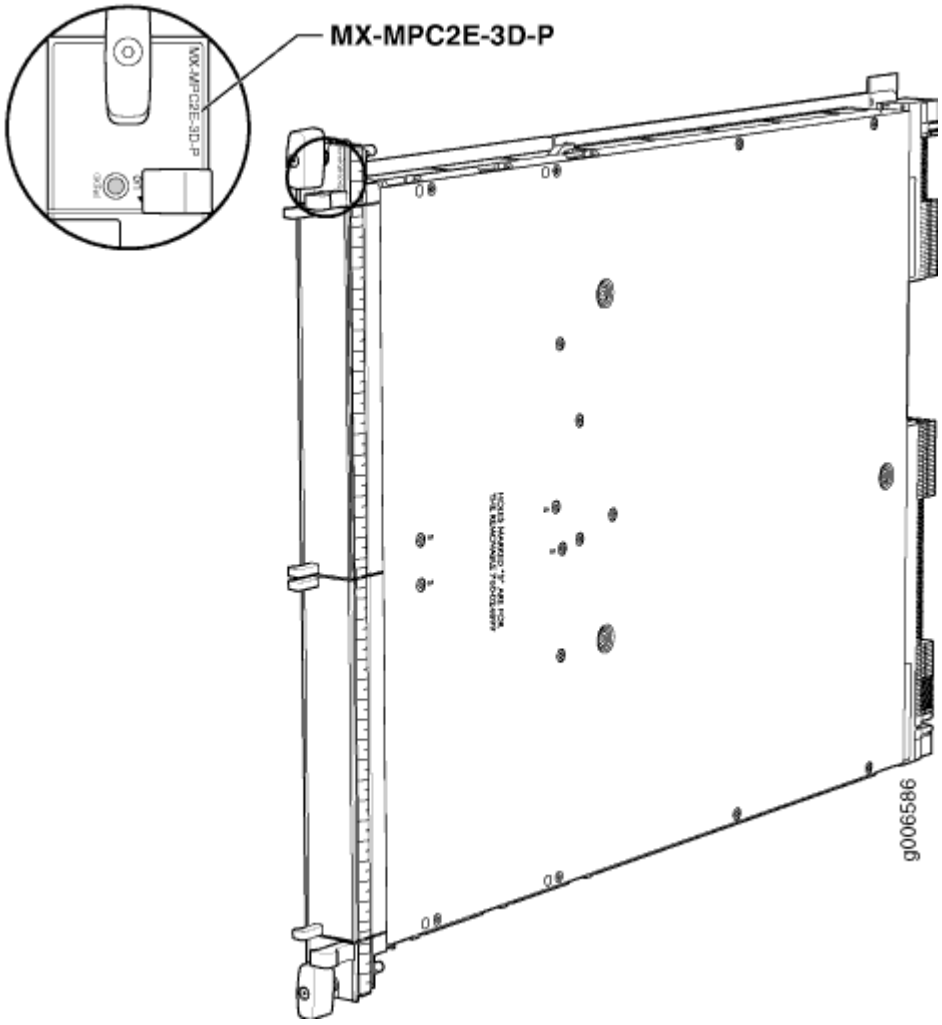
Description	• Power requirement: 6.13 A @ 48 V (294 W) • Weight: 14 lb (6.4 kg) • Model number: MX-MPC2E-3D-EQ • Name in the CLI: `MPCE Type 2 3D EQ`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • Two Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps
Software features	• See "Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E" on page 501 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

MX Series MPC Overview | **15**

MPCs Supported by MX Series Routers | **16**

MPC2E P



Software release

- MX240, MX480, and MX960 routers : Junos OS Release 12.2 and later
- MX2010 and MX2020 router: Junos OS Release 12.3 and later

For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.

Description	• Power requirement: 6.13 A @ 48 V (294 W) • Weight: 14 lb (6.4 kg) • Model number: MX-MPC2E-3D-P • Name in the CLI: `MPCE Type 2 3D P`
Hardware features	• Two slots for MICs labeled **PIC 0/1** and **PIC 2/3** • Two Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps
Software features	• See "Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E" on page 501 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

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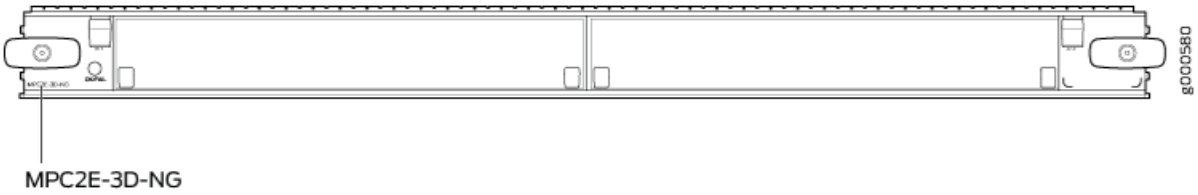
MPCs Supported by MX Series Routers | 16

MPC2E NG



Software release	• Refer to the JTAC Knowledgebase article https://kb.juniper.net/KB21476 for recommended software releases. • Refer to MIC/MPC Compatibility for information about which MICs are supported on this MPC.
Description	• 80 Gbps capacity without hierarchical quality of service (HQoS) • Requires high-capacity fan trays and high-capacity filter trays • Weight: 15.96 lb (7.26 kg) • Model numbers: MPC2E-3D-NG • Name in the CLI: `MPC2E NG PQ & Flex Q` • Add-on license provides limited additional flexible queuing. **NOTE**: MPC2E-3D-NG is not compatible with SCB, you must use either SCBE-MX or SCBE2-MX for the switch fabric interface.

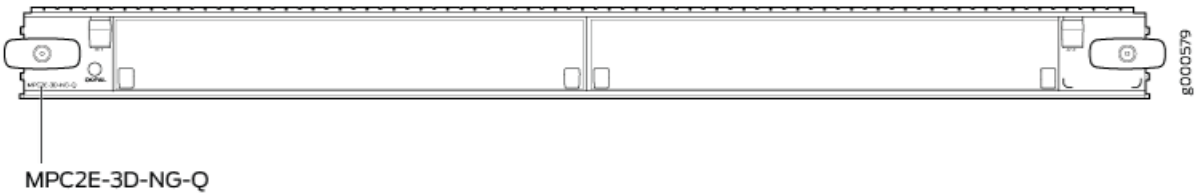
Hardware features	• Line-rate throughput of up to 80 Gbps • Supports WAN-PHY mode at 9.95 Gbps and LAN-PHY mode at 10.31 Gbps • Two slots for MICs • Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services. **NOTE**: MPC2E-3D-NG is not compatible with SCB, you must use either SCBE-MX or SCBE2-MX for the switch fabric interface. **NOTE**: MPC2E-3D-NG does not support MIC3-3D-10XGE-SFPP, MIC3-3D-1X100GE-CFP, MIC3-3D-1X100GE-CXP, and MIC3-3D-2X40GE-QSFPP. **NOTE**: The non-HQOS MPC3E NG and MPC2E NG MPCs support MIC-3D-8CHOC3-4CHOC12 and MIC-3D-4CHOC3-2CHOC12 only with a limited queuing license.
Software features	• Chained composite next hops • Layer 3 VPN localization • Detection of Layer 2 loops • Entropy label support in mixed mode • SNMP and CLI support for Routing Engine memory monitoring • Mixed-mode LAG support on core interfaces • Dynamic power management for MICs • Support for flexible-queuing • See Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E for information about the protocols and applications that this MPC supports.

Power requirement	Maximum with highest-power MICs at 55° C: 9.88 A @ 48 V (474 W) At different temperatures: • 55° C: 474 W • 40° C: 417 W • 25° C: 400 W
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

- MX Series MPC Overview
- MPCs Supported by MX Series Routers
- Junos Continuity Software

MPC2E NG Q



Software release	• Refer to the JTAC Knowledgebase article https://kb.juniper.net/KB21476 for recommended software releases. • Refer to MIC/MPC Compatibility for information about which MICs are supported on this MPC.

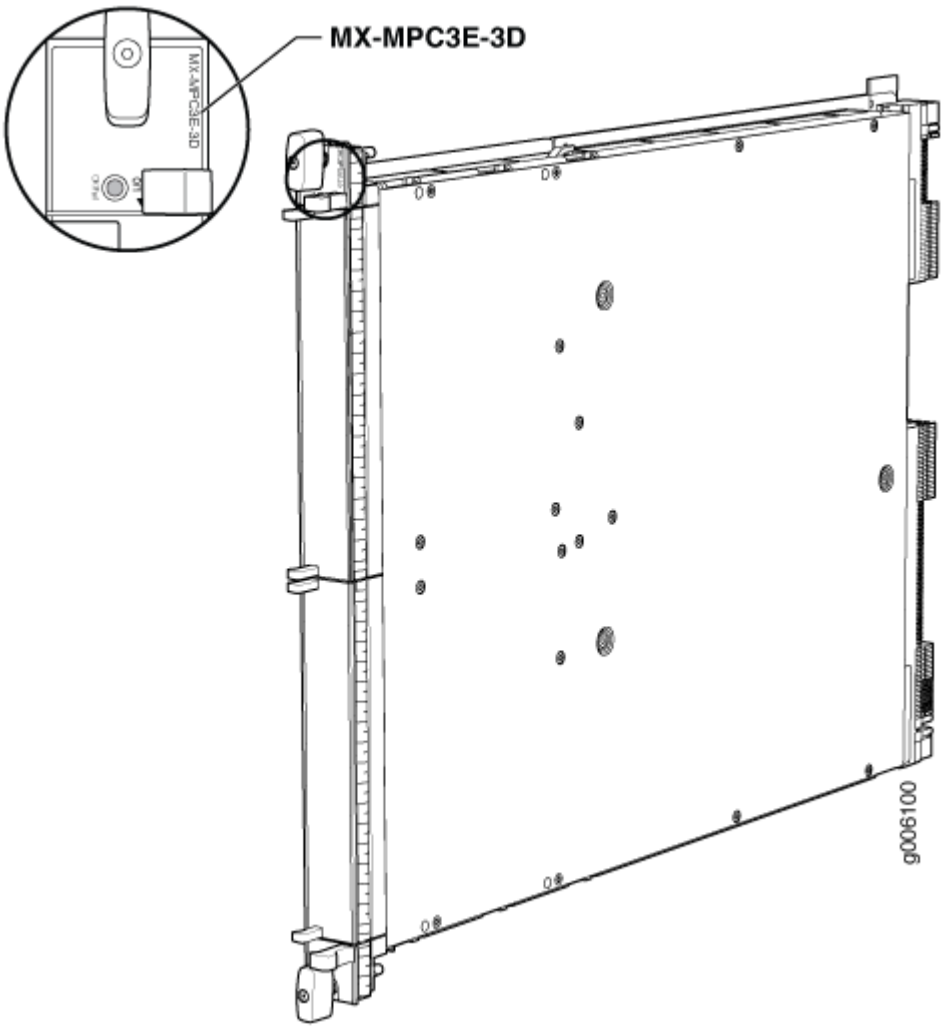
Description	• 80 Gbps capacity with hierarchical quality of service (HQoS) • Requires high-capacity fan trays and high capacity filter trays • Weight: 15.96 lb (7.26 kg) • Model number: MPC2E-3D-NG-Q • Name in the CLI: `MPC2E NG HQoS` **NOTE**: MPC2E-3D-NG-Q is not compatible with SCB, you must use either SCBE-MX or SCBE2-MX for the switch fabric interface.
Hardware features	• Line-rate throughput of up to 80 Gbps • Supports up to 512,000 queues per slot • Supports WAN-PHY mode at 9.95 Gbps and LAN-PHY mode at 10.31 Gbps • Two slots for MICs • Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services. **NOTE**: The MPC2E-3D-NG-Q has only one lookup chip (LU). **NOTE**: MPC2E-3D-NG-Q does not support MIC3-3D-10XGE-SFPP, MIC3-3D-1X100GE-CFP, MIC3-3D-1X100GE-CXP, and MIC3-3D-2X40GE-QSFPP.

Software features	• Chained composite next hops • Layer 3 VPN localization • Detection of Layer 2 loops • Entropy label support in mixed mode • SNMP and CLI support for Routing Engine memory monitoring • BFD support for inline MLPPP/MLFR • Mixed Mode LAG support on core interfaces • Dynamic power management for MICs • See Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E for information about the protocols and applications that this MPC supports.
Power requirement	Maximum with highest-power MICs at 55° C: 11.02 A @ 48 V (529 W) At different temperatures: • 55° C: 529 W • 40° C: 460 W • 25° C: 438 W
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

- MX Series MPC Overview
- MPCs Supported by MX Series Routers
- Junos Continuity Software

MPC3E



Software release	• MX240, MX480, and MX960 routers : Junos OS Release 12.1 and later • MX2010 and MX2020 router: Junos OS Release 12.3 and later For information on which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.

Description	• Power requirement: 10.83 A @ 48 V (440 W; plus 40 W for each of the two MICs) • Requires high-capacity fan trays • Weight: 14.94 lb (6.78 kg) • Model number: MX-MPC3E-3D • Name in the CLI: `MPCE Type 3 3D`
Hardware features	• Two slots for MICs • Chipset for increased scaling for bandwidth, subscribers, and services • Supports maximum transmission unit (MTU) size of 9,192 bytes for host bound packets. For Junos OS 16.1R1 and later releases, the MTU size supported is 9,500 bytes. **NOTE**: To support fabric redundancy, the MPC3E requires the Enhanced MX Switch Control Board (SCBE).
Software features	• See "Protocols and Applications Supported by the MPC3E on MX Series Routers" on page 515 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

RELATED DOCUMENTATION

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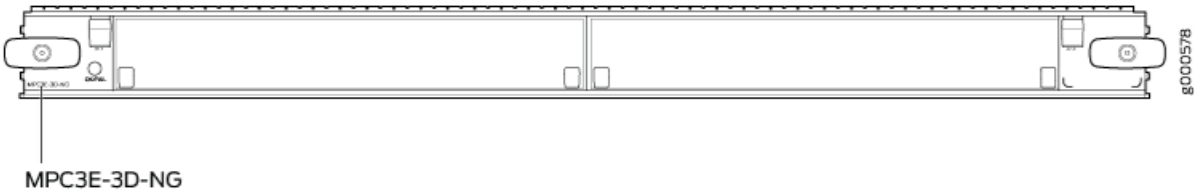
MPCs Supported by MX Series Routers | 16

MPC3E-3D-NG

IN THIS SECTION



Software release	• Junos OS releases 14.1R4, 14.2R3 and Junos Continuity, Junos OS release 15.1 and later. • Refer to MIC/MPC Compatibility for information about which MICs are supported on this MPC. • Refer to the JTAC Knowledgebase article https://kb.juniper.net/KB21476 for recommended software releases.
Description	• 130 Gbps capacity without hierarchical quality of service (HQoS) • Requires high-capacity fan trays and high-capacity filter trays • Weight: 15.96 lb (7.26 kg) • Model number: MPC3E-3D-NG • Name in the CLI: `MPC3E NG PQ & Flex Q` • Add-on license provides limited additional flexible queuing.

Hardware features	• Line-rate throughput of up to 130 Gbps • Supports WAN-PHY mode at 9.95 Gbps and LAN-PHY mode at 10.31 Gbps • Early Junos releases support a maximum transmission unit (MTU) size of 9,192 bytes for host-bound packets. In later releases, the supported MTU size is 9,500 bytes. • Two slots for MICs • Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services **NOTE**: The non-HQOS MPC3E NG and MPC2E NG MPCs support MIC-3D-8CHOC3-4CHOC12 and MIC-3D-4CHOC3-2CHOC12 only with a limited queuing license.
Software features	• Chained composite next hops • Layer 3 VPN localization • Detection of Layer 2 loops • Entropy label support in mixed mode • SNMP and CLI support for Routing Engine memory monitoring • Mixed Mode LAG support on core interfaces • Dynamic power management for MICs • Support for flexible-queuing • See Protocols and Applications Supported by the MPC3E on MX Series Routers for information about the protocols and applications that this MPC supports.
Power requirement	Maximum with highest-power MICs at 55° C: 11.13 A @ 48 V (534 W) At different temperatures: • 55° C: 534 W • 40° C: 485 W • 25° C: 461 W

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

Platform Specific Behavior

Use the below table to review platform-specific behavior for your platforms.

Table 25: Platform-Specific Behavior

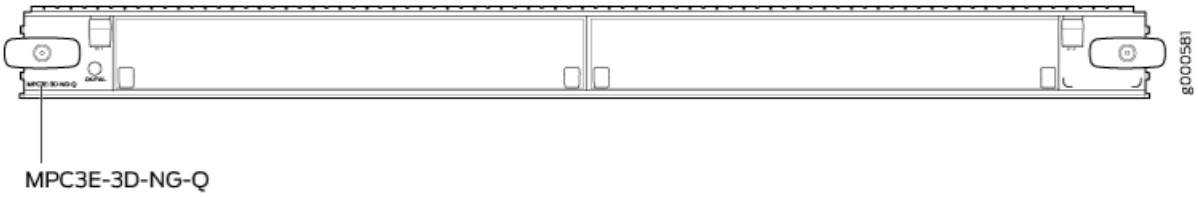
Platform	Behavior
MX240, MX480, and MX960	The MPC3E-3D-NG requires high-capacity power supplies, high-capacity fan trays, and enhanced switch control boards (SCBE, SCBE2, or SCBE3) on MX240, MX480, and MX960 routers.
MX960	On the MX960 router, all the MPC slots work in a chassis temperature of up to 40°C (104°F), at an altitude of up to 6000 feet. However, when the chassis temperature exceeds 40°C (104°F), • the slot 11 does not work with MPC3E-3D-NG, MPC3E-3D-NG-Q, MPC4E, and MPC5E. • the slot 0 does not work with MPC4E and MPC5E.

RELATED DOCUMENTATION

- MX Series MPC Overview
- MPCs Supported by MX Series Routers
- Junos Continuity Software

MPC3E-3D-NG-Q

IN THIS SECTION



Software release	• Refer to MIC/MPC Compatibility for information about which MICs are supported on this MPC. • Refer to the JTAC Knowledgebase article https://kb.juniper.net/KB21476 for recommended software releases.
Description	• 130 Gbps capacity with hierarchical quality of service (HQoS) • Requires high-capacity fan trays and high-capacity filter trays • Weight: 15.96 lb (7.26 kg) • Model number: MPC3E-3D-NG-Q • Name in the CLI: `MPC3E NG HQoS` **NOTE**: MPC3E-3D-NG-Q is not compatible with SCB, you must use either SCBE-MX or SCBE2-MX for the switch fabric interface.

Hardware features	• Line-rate throughput of up to 130 Gbps • Supports up to 512,000 queues per slot • Supports WAN-PHY mode at 9.95 Gbps and LAN-PHY mode at 10.31 Gbps • Early Junos releases support a maximum transmission unit (MTU) size of 9,192 bytes for host-bound packets. In later releases, the supported MTU size is 9,500 bytes. • Two slots for MICs • Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services
Software features	• Chained composite next hops • Layer 3 VPN localization • Detection of Layer 2 loops • Entropy label support in mixed mode • SNMP and CLI support for Routing Engine memory monitoring • BFD support for inline MLPPP/MLFR • Mixed Mode LAG support on core interfaces • Dynamic power management for MICs • See Protocols and Applications Supported by the MPC3E on MX Series Routers for information about the protocols and applications that this MPC supports.
Power requirement	Maximum with highest-power MICs at 55° C: 12.15 A @ 48 V (583 W) At different temperatures: • 55° C: 583 W • 40° C: 532 W • 25° C: 503 W

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed.

Platform Specific Behavior

Use the below table to review platform-specific behavior for your platforms.

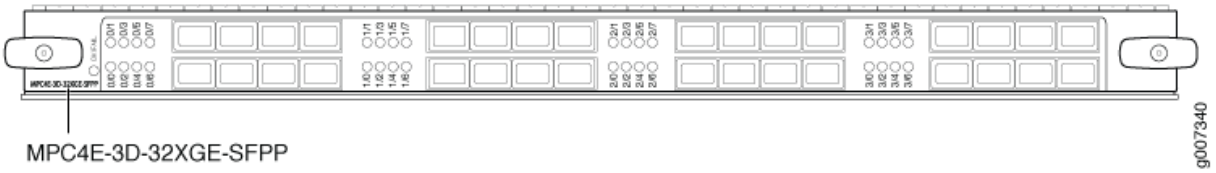
Table 26: Platform-Specific Behavior

Platform	Behavior
MX960	On the MX960 router, all the MPC slots work in a chassis temperature of up to 40°C (104°F), at an altitude of up to 6000 feet. However, when the chassis temperature exceeds 40°C (104°F), • the slot 11 does not work with MPC3E-3D-NG, MPC3E-3D-NG-Q, MPC4E, and MPC5E. • the slot 0 does not work with MPC4E and MPC5E.

RELATED DOCUMENTATION

- MX Series MPC Overview
- MPCs Supported by MX Series Routers
- Junos Continuity Software

32x10GE MPC4E



Software release	• Junos OS Release 12.3R2 and later
Description	• Fixed configuration MPC with thirty-two 10-Gigabit Ethernet ports • Power requirement: 12.7 A @ 48 V (610 W) • Weight: 19.4 lb (8.8 kg) • Model number: MPC4E-3D-32XGE-SFPP
Hardware features	• Line-rate throughput of up to 260 Gbps • WAN-PHY mode at 10 Gbps on a per-port basis • Supports maximum transmission unit (MTU) size of 9,192 bytes for host bound packets. For Junos OS 16.1R1 and later releases, the MTU size supported is 9,500 bytes. • Supported on MX2020, MX2010, MX960, MX480, and MX240 routers with both normal-capacity and high-capacity power supplies and fan trays. **NOTE**: By default on MX480 routers, only 5 out of the 6 line-card slots can be populated with MPC4Es. By default on MX960 routers, only 10 out of the 11 line-card slots can be populated with MPC4Es. This is a power restriction of default operating mode which supports operation at 55°C ambient temperature. You can insert other line-cards in the remaining slots as long as the power budget is not exceeded. However, if ambient-temperature is configured to 25°C or 40°C, all the 6 slots of an MX480 can be populated with MPC4E, and all the 11 slots of an MX960 can be populated with MPC4E. For more information about power requirements, see *Power Requirements for an MX480 Router*, and *Power Requirements for an MX960 Router*.

Software features	• Optical diagnostics and related alarms • Up to 260 Gbps of full-duplex traffic • Intelligent oversubscription services • Configurable LAN-PHY and WAN-PHY mode options per port • Local loopback • Configurable to interoperate with routers that use the 100-Gigabit Ethernet PIC (Type 4 PIC on Type 4 FPC) • See "Protocols and Applications Supported on the MPC4E for MX Series Routers" on page 530 for information about the protocols and applications that this MPC supports.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: SFPP-10GE-ZR has a commercial temperature rating and is not NEBS compliant when plugged into the 32x10GE MPC4E with SFP+. If the ambient air temperature exceeds 50°C (122°F), Junos OS disables the transmitter, which takes the optical transceiver offline. **NOTE**: SFPP-10G-DT-ZRC2 is not NEBS compliant when plugged into the MPC4E-3D-32XGE-SFPP MPC. If the ambient air temperature exceeds 50°C (122°F), Junos OS disables the transmitter, which takes the optical transceiver offline. **NOTE**: On the MX960 router, all the MPC slots work in a chassis temperature of up to 40°C (104°F), at an altitude of up to 6000 feet. However, when the chassis temperature exceeds 40°C (104°F), • the slot 11 does not work with MPC3E-3D-NG, MPC3E-3D-NG-Q, MPC4E, and MPC5E. • the slot 0 does not work with MPC4E and MPC5E.

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed. Enable/disable LED, one bicolor per port: • Green—Port is enabled. • Red—Port has failed. • Off—Port is disabled. The enable/disable LEDs are arranged in four groups: • **0/0** through **0/7** • **1/0** through **1/7** • **2/0** through **2/7** • **3/0** through **3/7**

RELATED DOCUMENTATION

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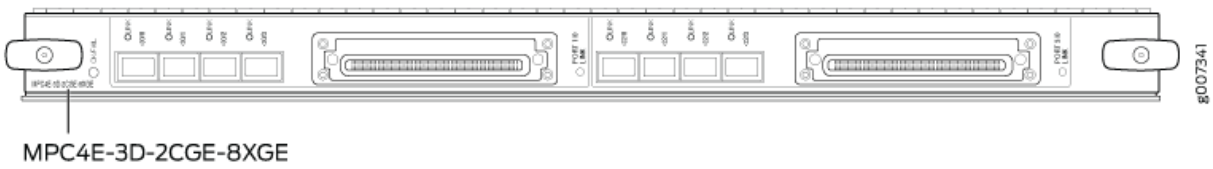
MPCs Supported by MX Series Routers | **16**

Configuring MPC4E (MPC4E-3D-2CGE-8XGE) to Interoperate with 100-Gigabit Ethernet PICs on Type 4 FPC Using SA Multicast Mode

2x100GE + 8x10GE MPC4E



MPC4E-3D-2CGE-8XGE

Software release	• Junos OS Release 12.3R2 and later
Description	• Fixed configuration MPC with two 100-Gigabit Ethernet ports and eight 10-Gigabit Ethernet ports • Power requirement: 12.7 A @ 48 V (610 W) • Weight: 19.4 lb (8.8 kg) • Model number: MPC4E-3D-2CGE-8XGE • Dimensions: Height = 1.25 in. (3.2 cm), Width = 17 in. (43.2 cm), Depth = 22 in. (55.9 cm)

Hardware features	• Line-rate throughput of up to 260 Gbps
	• WAN-PHY mode at 10 Gbps on a per-port basis
	• Supported only on the MX960, MX480, and MX240 routers with high-capacity power supplies and high-capacity fan trays.
	• Supports maximum transmission unit (MTU) size of 9,192 bytes for host bound packets. For Junos OS 16.1R1 and later releases, the MTU size supported is 9,500 bytes.
	• The ports are labeled as:
	  • 10-Gigabit Ethernet ports: **0/0** through **0/3**
	  • 100-Gigabit Ethernet ports: **PORT 1/0**
	  • 10-Gigabit Ethernet ports: **2/0** through **2/3**
	  • 100-Gigabit Ethernet ports: **PORT 3/0**
	NOTE: By default on MX480 routers, only 5 out of the 6 line-card slots can be populated with MPC4Es. By default on MX960 routers, only 10 out of the 11 line-card slots can be populated with MPC4Es. This is a power restriction of default operating mode which supports operation at 55°C ambient temperature. You can insert other line-cards in the remaining slots as long as the power budget is not exceeded. However, if ambient-temperature is configured to 25°C or 40°C, all the 6 slots of an MX480 can be populated with MPC4E, and all the 11 slots of an MX960 can be populated with MPC4E. For more information about power requirements, see *Power Requirements for an MX480 Router*, and *Power Requirements for an MX960 Router*.

Software features	• Optical diagnostics and related alarms • Configurable LAN-PHY and WAN-PHY mode options per 10-Gigabit Ethernet port • Up to 260 Gbps of full-duplex traffic • Intelligent oversubscription services • Local loopback • Configurable to interoperate with routers that use the 100-Gigabit Ethernet PIC (Type 4 PIC on Type 4 FPC) • See "Protocols and Applications Supported on the MPC4E for MX Series Routers" on page 530 for information about the protocols and applications that this MPC supports.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: SFPP-10GE-ZR has a commercial temperature rating and is not NEBS compliant when plugged into the 2x100GE + 8x10GE MPC4E. If the ambient air temperature exceeds 50°C (122°F), Junos OS disables the transmitter, which takes the optical transceiver offline. **NOTE**: SFPP-10G-DT-ZRC2 is not NEBS compliant when plugged into the MPC4E-3D-2CGE-8XGE MPC. If the ambient air temperature exceeds 50°C (122°F), Junos OS disables the transmitter, which takes the optical transceiver offline. **NOTE**: CFP-100GBASE-LR4 and CFP-100GBASE-ZR are not NEBS compliant when plugged into the 2x100GE + 8x10GE MPC4E. If the ambient air temperature exceeds 50°C (122°F), the software disables the transmitter, which takes the optical transceiver offline. **NOTE**: On the MX960 router, all the MPC slots work in a chassis temperature of up to 40°C (104°F), at an altitude of up to 6000 feet. However, when the chassis temperature exceeds 40°C (104°F), • the slot 11 does not work with MPC3E-3D-NG, MPC3E-3D-NG-Q, MPC4E, and MPC5E. • the slot 0 does not work with MPC4E and MPC5E.

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed. **LINK** LED, one tricolor per port: • Green—Port is enabled. • Red—Port has failed. • Yellow—Port is disabled by configuration. • Off—Port is disabled.

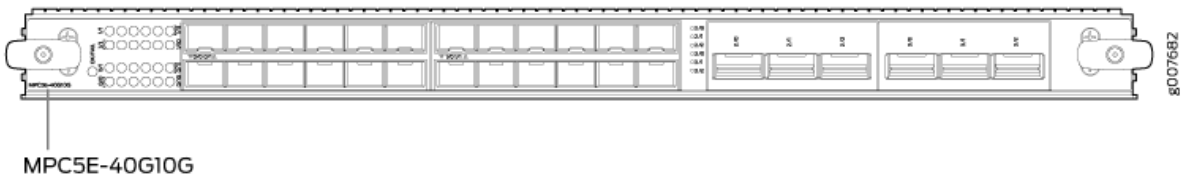
RELATED DOCUMENTATION

MX Series MPC Overview | **15**

MPCs Supported by MX Series Routers | **16**

Configuring MPC4E (MPC4E-3D-2CGE-8XGE) to Interoperate with 100-Gigabit Ethernet PICs on Type 4 FPC Using SA Multicast Mode

6x40GE + 24x10GE MPC5E



Software release	• Junos OS Release 13.3R2 and later

Description	• Fixed-port MPC with six 40-Gigabit Ethernet ports and twenty-four 10-Gigabit Ethernet ports • Weight: 21 lb (9.52 kg) • Model number: MPC5E-40G10G • Name in the CLI: `MPC5E 3D 24XGE+6XLGE`

Hardware features

- Line-rate throughput of up to 240 Gbps
- Supports one of the following port combinations:
  - Six 40-Gigabit Ethernet ports
  - Twenty-four 10-Gigabit Ethernet ports
  - Three 40-Gigabit Ethernet ports and twelve 10-Gigabit Ethernet ports
- Supports up to 32,000 queues per-slot
- LAN-PHY mode at 10.3125 Gbps on a per-port basis
- WAN-PHY mode at 9.95328 Gbps on a per-port basis
- Supports maximum transmission unit (MTU) size of 9,192 bytes for host bound packets. For Junos OS 16.1R1 and later releases, the MTU size supported is 9,500 bytes.
- The ports are labeled as:
  - 10-Gigabit Ethernet ports:

    0/0 through **0/11**

    1/0 through **1/11**
  - 40-Gigabit Ethernet ports:

    2/0 through **2/2**

    3/0 through **3/2**
- The MPC5E supports the enhanced Switch Control Board (MX-SCBE) and MX-SCBE2 on MX240, MX480, and MX960 routers. The MPC5E does not support the legacy SCB (MX-SCB). The MPC5E supports the Switch Fabric Board (SFB) on MX2010 and MX2020 routers.
- MPC5E does not interoperate with the existing DPCs, except the Multiservices DPC (MS-DPC).

NOTE:
On the MX960 router, all the MPC slots work in a chassis temperature of up to 40°C (104°F), at an altitude of up to 6000 feet. However, when the chassis temperature exceeds 40°C (104°F),

	• the slot 11 does not work with MPC3E-3D-NG, MPC3E-3D-NG-Q, MPC4E, and MPC5E. • the slot 0 does not work with MPC4E and MPC5E.
Software features	• Optical diagnostics and related alarms • Support for optical transport network (OTN) on 10-Gigabit Ethernet ports • Two packet-forwarding engines, PFE0 and PFE1. PFE0 hosts PIC0 and PIC2. PFE1 hosts PIC1 and PIC3. • Configurable LAN-PHY and WAN-PHY mode options per 10-Gigabit Ethernet port • See "Protocols and Applications Supported by the MPC5E for MX Series Routers" on page 545 for information about the protocols and applications that this MPC supports. **NOTE**: On MX240, MX480, and MX960 routers, MPC5E powers on only if the `network-services` mode on the router is configured to either **enhanced-ip** or **enhanced-ethernet**. On MX2010 and MX2020 routers, only **enhanced-ip** is supported. **NOTE**: A maximum of two PICs can be powered on at any one time (PIC0 or PIC2, and PIC1 or PIC3). The other PICs must be powered off.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: QSFPP-40GE-LX4 is not NEBS compliant on the MX960 router in FPC slot 0 or FPC slot 11.

Power requirements	• Typical: 9.68 A @ 48 V (460 W) • At different temperatures with default configuration: 55° C: 558 W 40° C: 496 W 25° C: 469 W • At different temperatures when `flexible-queueing-mode` CLI knob is configured under `set chassis fpc 1 flexible-queuing-mode`: 55° C: 607 W 40° C: 541 W 25° C: 511 W
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed. 10-Gigabit Ethernet **LINK** LED, one green per port: • Green—Link is up. • Off—Link is down or disabled. 40-Gigabit Ethernet **LINK** LED, one bicolor per port: • Green—Link is up. • Yellow—Link is disabled. • Off—Link is down.

RELATED DOCUMENTATION

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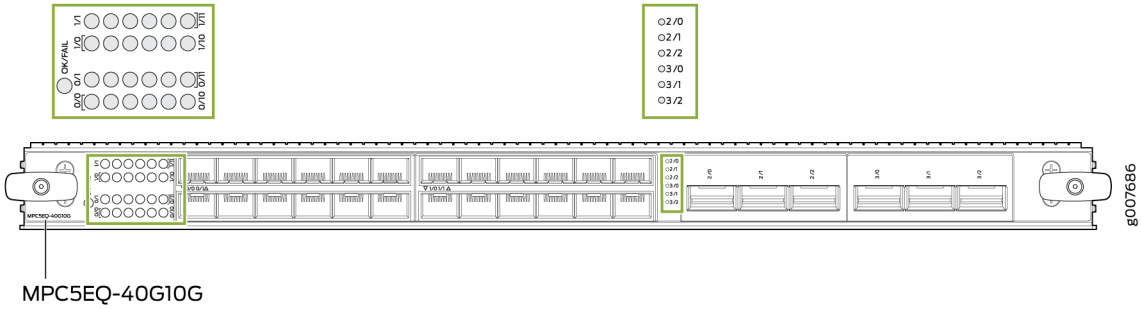
MPCs Supported by MX Series Routers | **16**

10-Gigabit Ethernet OTN Options Configuration Overview

6x40GE + 24x10GE MPC5EQ



Software release	• Junos OS Release 13.3R2 and later
Description	• Fixed-configuration MPC with six 40-Gigabit Ethernet ports and twenty-four 10-Gigabit Ethernet ports • Weight: 21 lb (9.52 kg) • Model number: MPC5EQ-40G10G • Name in the CLI: `MPC5E 3D Q 24XGE+6XLGE`

Hardware features

- Line-rate throughput of up to 240 Gbps
- Supports one of the following port combinations:
  - Six 40-Gigabit Ethernet ports
  - Twenty-four 10-Gigabit Ethernet ports
  - Three 40-Gigabit Ethernet ports and twelve 10-Gigabit Ethernet ports
- Supports up to 1 million queues per-slot
- LAN-PHY mode at 10.3125 Gbps on a per-port basis
- WAN-PHY mode at 9.95328 Gbps on a per-port basis
- Supports maximum transmission unit (MTU) size of 9,192 bytes for host bound packets. For Junos OS 16.1R1 and later releases, the MTU size supported is 9,500 bytes.
- The ports are labeled as:
  - 10-Gigabit Ethernet ports:

    0/0 through **0/11**

    1/0 through **1/11**
  - 40-Gigabit Ethernet ports:

    2/0 through **2/2**

    3/0 through **3/2**
- The MPC5E supports the enhanced Switch Control Board (MX-SCBE) and MX-SCBE2 on MX240, MX480, and MX960 routers. The MPC5E does not support the legacy SCB (MX-SCB). The MPC5E supports the Switch Fabric Board (SFB) on MX2010 and MX2020 routers.
- MPC5E does not interoperate with the existing DPCs, except the Multiservices DPC (MS-DPC).

  NOTE:
  On the MX960 router, all the MPC slots work in a chassis temperature of up to 40°C (104°F), at an altitude of up to 6000 feet. However, when the chassis temperature exceeds 40°C (104°F),

	• the slot 11 does not work with MPC3E-3D-NG, MPC3E-3D-NG-Q, MPC4E, and MPC5E. • the slot 0 does not work with MPC4E and MPC5E.
Software features	• Supports hierarchical QoS (HQoS) • Optical diagnostics and related alarms • Support for optical transport network (OTN) on 10-Gigabit Ethernet ports • Configurable LAN-PHY and WAN-PHY mode options per 10-Gigabit Ethernet port • Intelligent oversubscription services • See "Protocols and Applications Supported by the MPC5E for MX Series Routers" on page 545 for information about the protocols and applications that this MPC supports. **NOTE**: On MX240, MX480, and MX960 routers, MPC5E powers on only if the `network-services` mode on the router is configured to either **enhanced-ip** or **enhanced-ethernet**. On MX2010 and MX2020 routers, only **enhanced-ip** is supported.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: QSFPP-40GE-LX4 is not NEBS compliant on the MX960 router in FPC slot 0 or FPC slot 11.
Power requirements	• Typical: 9.68 A @ 48 V (460 W) • At different temperatures: 55° C: 607 W 40° C: 541 W 25° C: 511 W

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed. 10-Gigabit Ethernet **LINK** LED, one green per port: • Green—Link is up. • Off—Link is down or disabled. 40-Gigabit Ethernet **LINK** LED, one bicolor per port: • Green—Link is up. • Yellow—Link is disabled. • Off—Link is down.

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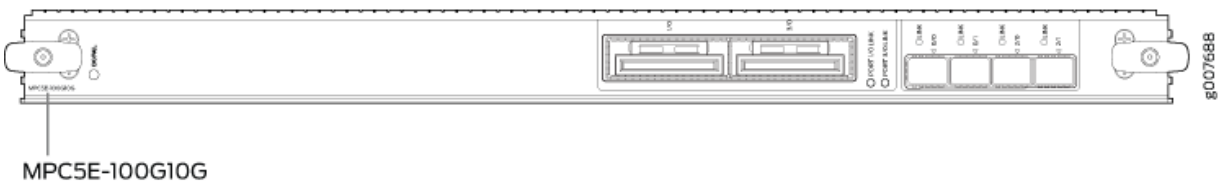
MPCs Supported by MX Series Routers | **16**

10-Gigabit Ethernet OTN Options Configuration Overview

2x100GE + 4x10GE MPC5E



Software release	• Junos OS Release 13.3R3 and later

Description	• Fixed-configuration MPC with two 100-Gigabit Ethernet ports and four 10-Gigabit Ethernet ports • Weight: 21 lb (9.52 kg) • Model number: MPC5E-100G10G • Name in the CLI: `MPC5E 3D 2CGE+4XGE`

Hardware features	• Line-rate throughput of up to 240 Gbps
	• Supports up to 32,000 queues per-slot
	• LAN-PHY mode at 10.3125 Gbps on a per-port basis
	• WAN-PHY mode at 9.95328 Gbps on a per-port basis
	• Supports maximum transmission unit (MTU) size of 9,192 bytes for host bound packets. For Junos OS 16. and later releases, the MTU size supported is 9,500 bytes.
	• The ports are labeled as:
	  • 10-Gigabit Ethernet ports: **0/0**, **0/1**, **2/0**, and **2/1**
	  • 100-Gigabit Ethernet ports: **1/0** and **3/0**
	• The MPC5E supports the enhanced Switch Control Board (MX-SCBE) and MX-SCBE2 on MX240, MX480 MX960 routers. The MPC5E does not support the legacy SCB (MX-SCB). The MPC5E supports the Switch Fabric Board (SFB) on MX2010 and MX2020 routers.
	• MPC5E does not interoperate with the existing DPCs, except the Multiservices DPC (MS-DPC).
	NOTE:
	On the MX960 router, all the MPC slots work in a chassis temperature of up to 40°C (104°F), at an altitude to 6000 feet. However, when the chassis temperature exceeds 40°C (104°F),
	  • the slot 11 does not work with MPC3E-3D-NG, MPC3E-3D-NG-Q, MPC4E, and MPC5E.
	  • the slot 0 does not work with MPC4E and MPC5E.

Software features	• Configurable LAN-PHY and WAN-PHY mode options per 10-Gigabit Ethernet port • Optical diagnostics and related alarms • Intelligent oversubscription services • See "Protocols and Applications Supported by the MPC5E for MX Series Routers" on page 545 for inform about the protocols and applications that this MPC supports. **NOTE**: On MX240, MX480, and MX960 routers, MPC5E powers on only if the `network-services` mode on t router is configured to either **enhanced-ip** or **enhanced-ethernet**. On MX2010 and MX2020 routers, only **enhanced-ip** is supported.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers sup on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: • CFP2-100G-ER4-D is not NEBS compliant on the MX960 router in FPC slot **0** or FPC slot **11**. • CFP2-DCO-T-WDM-1 is not NEBS compliant on the MX960 router or the MX2020 router in FPC slot FPC slot 11. Slots **0** and **11** can only work with an ambient temperature of up to 40° C.
Power requirements	• Typical: 10.52 A @ 48 V (505 W) • At different temperatures: 55° C: 607 W 40° C: 541 W 25° C: 511 W

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed. 10-Gigabit Ethernet **LINK** LED, one bicolor per port: • Green—Link is up. • Yellow—Link is disabled. • Off—Link is down or disabled. 100-Gigabit Ethernet **LINK** LED, one bicolor per port: • Green—Link is up. • Yellow—Link is disabled. • Off—Link is down.

RELATED DOCUMENTATION

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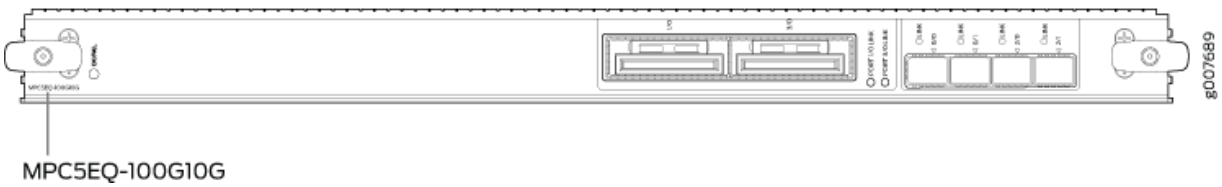
MPCs Supported by MX Series Routers

10-Gigabit Ethernet OTN Options Configuration Overview

100-Gigabit Ethernet OTN Options Configuration Overview

2x100GE + 4x10GE MPC5EQ



Software release	• Junos OS Release 13.3R3 and later
Description	• Fixed-configuration MPC with two 100-Gigabit Ethernet ports and four 10-Gigabit Ethernet ports • Weight: 21 lb (9.52 kg) • Model number: MPC5EQ-100G10G • Name in the CLI: `MPC5E 3D Q 2CGE+4XGE`

Hardware features	• Line rate throughput of up to 240 Gbps
	• Supports up to 1 million queues per-slot
	• LAN-PHY mode at 10.3125 Gbps on a per-port basis
	• WAN-PHY mode at 9.95328 Gbps on a per-port basis
	• Supports maximum transmission unit (MTU) size of 9,192 bytes for host bound packets. For Junos OS 16.1R1 and later releases, the MTU size supported is 9,500 bytes.
	• The ports are labeled as:
	  • 10-Gigabit Ethernet ports: **0/0**, **0/1**, **2/0**, and **2/1**
	  • 100-Gigabit Ethernet ports: **1/0** and **3/0**
	• The MPC5E supports the enhanced Switch Control Board (MX-SCBE) and MX-SCBE2 on MX240, MX480 and MX960 routers. The MPC5E does not support the legacy SCB (MX-SCB). The MPC5E supports the Switch Fabric Board (SFB) on MX2010 and MX2020 routers.
	• MPC5E does not interoperate with the existing DPCs, except the Multiservices DPC (MS-DPC).
	NOTE:
	On the MX960 router, all the MPC slots work in a chassis temperature of up to 40°C (104°F), at an altitude up to 6000 feet. However, when the chassis temperature exceeds 40°C (104°F),
	  • the slot 11 does not work with MPC3E-3D-NG, MPC3E-3D-NG-Q, MPC4E, and MPC5E.
	  • the slot 0 does not work with MPC4E and MPC5E.

Software features	• Supports hierarchical QoS (HQoS) • Configurable LAN-PHY and WAN-PHY mode options per 10-Gigabit Ethernet port • Optical diagnostics and related alarms • Intelligent oversubscription services • See "Protocols and Applications Supported by the MPC5E for MX Series Routers" on page 545 for information about the protocols and applications that this MPC supports. **NOTE**: On MX240, MX480, and MX960 routers, MPC5E powers on only if the `network-services` mode on t router is configured to either **enhanced-ip** or **enhanced-ethernet**. On MX2010 and MX2020 routers, only **enhanced-ip** is supported.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: • CFP2-100G-ER4-D is not NEBS compliant on the MX960 router in FPC slot **0** or FPC slot **11**. • CFP2-DCO-T-WDM-1 is not NEBS compliant on the MX960 router or the MX2020 router in FPC slot FPC slot 11. Slots **0** and **11** can only work with an ambient temperature of up to 40° C.
Power requirements	• Typical: 10.52 A @ 48 V (505 W) • At different temperatures: 55° C: 607 W 40° C: 541 W 25° C: 511 W

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed. 10-Gigabit Ethernet **LINK** LED, one bicolor per port: • Green—Link is up. • Yellow—Link is disabled. • Off—Link is down or disabled. 100-Gigabit Ethernet **LINK** LED, one bicolor per port: • Green—Link is up. • Yellow—Link is disabled. • Off—Link is down.

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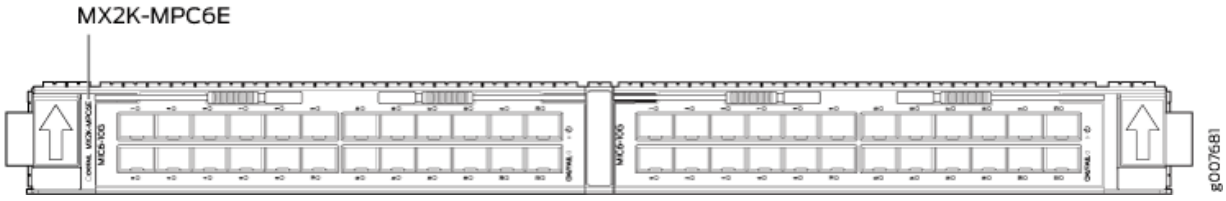
MPCs Supported by MX Series Routers

10-Gigabit Ethernet OTN Options Configuration Overview

100-Gigabit Ethernet OTN Options Configuration Overview

MPC6E



Software release	• Junos OS Release 13.3R2 and later For information about which MICs are supported on this MPC, "MIC/MPC Compatibility" on page 46.
Description	• Two slots for MICs • Weight: 27.4 lb (12.43 kg) (net weight without blank panels) • Model number: MX2K-MPC6E • Name in the CLI: `MPC6E 3D`
Hardware features	• Two slots for MICs • Line-rate throughput of up to 480 Gbps • Field-removable septum, to accommodate future full-height MICs • Supports maximum transmission unit (MTU) size of 9,192 bytes for host bound packets. For Junos OS 16.1R1 and later releases, the MTU size supported is 9,500 bytes.
Maximum Power Requirements	Power requirement: 20.9 A @ 52 V (880 W; plus 104 W for each MIC) MX2K-MPC6E: • Typical: 648 W • 880 W at 55° C • 834 W at 40° C • 824 W at 25° C

Software features	• Optical diagnostics and related alarms • Configurable LAN-PHY and WAN-PHY mode options per 10-Gigabit Ethernet port • Two Packet Forwarding Engines for each MIC slot • Intelligent oversubscription services • See "Protocols and Applications Supported by the MPC6E for MX2000 Routers" on page 557 for information about the protocols and applications that this MPC supports.
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Blinking green—MPC is transitioning online or offline. • Red—MPC has failed. **LINK** LED, one bicolor per port: • Green—Link is up. • Yellow—Link is disabled. • Off—Link is down.

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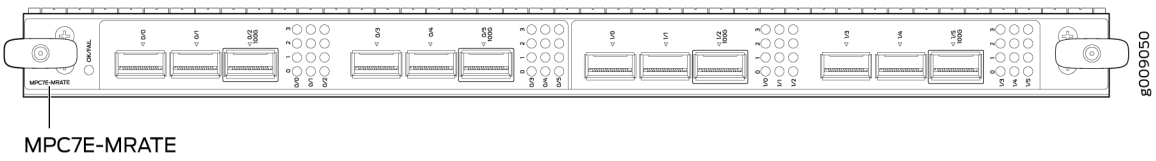
MPCs Supported by MX Series Routers | 16

MPC7E-MRATE

IN THIS SECTION

• Platform Specific Behavior | 201



MPC7E-MRATE

Description

- Fixed-configuration MPC with 10-Gbps, 40-Gbps, and 100-Gbps port speeds
- Weight: 15.7 lb (7.12 kg)
- Model number: MPC7E-MRATE
- Name in the CLI: `MPC7E-MRATE`

Hardware features

- Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services
- Twelve Gigabit Ethernet ports that can be configured as 40-Gigabit Ethernet port or as four 10-Gigabit Ethernet ports using a breakout cable. The ports support quad small-form factor pluggable plus (QSFP +) transceivers. The 40Gbps or 100Gbps ports configured to run at 10Gbps speed are shown in the CLI as follows:

```
show interfaces terse
Interface               Admin Link Proto    Local                 Remote
xe-10/0/0:0             up    down
xe-10/0/0:1             up    down
xe-10/0/0:2             up    down
xe-10/0/0:3             up    down
```

- Four out of the twelve ports can be configured as 100-Gigabit Ethernet ports. Port numbers **0/2**, **0/5**, **1/2** and **1/5** are the four 100-Gigabit Ethernet ports.
- You can configure different combination of port speeds as long as the aggregate capacity per group of six ports labeled **0/0** through **0/5** does not exceed 240 Gbps. Similarly, aggregate capacity per group of the other six ports labeled **1/0** through **1/5** should not exceed 240 Gbps.
- The ports are labeled as (with the MPC orientation as shown in the above figure):
  - 10-Gigabit Ethernet or 40-Gigabit Ethernet ports:

    0/0, **0/1**, **0/2 100G**, **0/3**, **0/4**, **0/5 100G**, **1/0**, **1/1**, **1/2 100G**, **1/3**, **1/4**, and **1/5 100G**

  - 100-Gigabit Ethernet ports:

    0/2 100G, **0/5 100G**, **1/2 100G** and **1/5 100G**

  NOTE: Only ports marked **100G** support 100-Gigabit Ethernet speed using QSFP28 transceivers.
- Supports maximum transmission units (MTUs) from 256 bytes through 16,000 bytes for transit traffic, and from 256 bytes through 9,500 bytes for host bound packets.

Software features

- Supports rate selectability at the port level.
- By default, the ports are configured as 10-Gigabit Ethernet ports.
- Optical diagnostics and related alarms
- See Protocols and Applications Supported by the MPC7E for MX Series Routers for information about the protocols and applications that the MPC7E supports.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
Power requirements	• At different temperatures: 55° C: 545 W 40° C: 465 W 25° C: 440 W
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Yellow—MPC has failed. **LINK** LED, one green per port (4 per QSFP+ cage): • Steady green—Link is up. • Off—Link is down or disabled.

Platform Specific Behavior

Use the below table to review platform-specific behavior for your platforms.

Table 27: Platform-Specific Behavior

Platform	Behavior
MX960	On MX960 routers, you can operate the MPC7E MRATE line card in any MPC slot at an ambient temperature of up to 40° C and at any altitude. All the MPC slots can be occupied by an MPC7E MRATE line card at temperatures of up to 55° C and at sea level. At an ambient temperature of above 55° C, and at sea level, slot 11 cannot host MPC7E MRATE line cards.

Table 27: Platform-Specific Behavior *(Continued)*

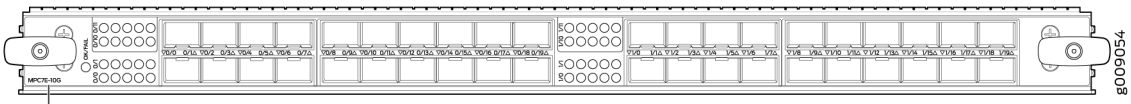
Platform	Behavior
MX240, MX480, MX960	• MPC7E powers on only if the `network-services` mode on the router is configured as either **enhanced-ip** or **enhanced-ethernet**. • Requires high-capacity power supplies, high-capacity fan trays, and SCBE2 or SCBE3 switch control boards. • Supports a line-rate throughput of up to 480 Gbps.
MX2000	• Supports a line-rate throughput of up to 400 Gbps on MX2000 routers with SFB, and up to 430 Gbps on MX2000 routers with SFB2. • Requires an adapter card to be housed in MX2000 routers.

RELATED DOCUMENTATION

- MPCs Supported by MX Series Routers
- Junos Continuity Software User Guide (Junos OS Release 14.1R4 and Later Releases)

MPC7E-10G

IN THIS SECTION



MPC7E-10G

Description	• Fixed-configuration MPC with forty 10-Gbps ports • Weight: 17 lb (7.7 kg) • Model number: MPC7E-10G • Name in the CLI: `MPC7E 3D 40XGE`

Hardware features	• Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services.
	• Forty 10-Gigabit Ethernet ports. The ports support SFP+ transceivers. Each port supports 10 Gbps or 1 Gbps speed.
	• Supports maximum transmission units (MTUs) from 256 bytes through 16,000 bytes for transit traffic, and from 256 bytes through 9,500 bytes for host bound packets.
	• The ports are labeled as (with the MPC orientation as shown in the figure):
	  • **0/0** through **0/9**
	  • **0/10** through **0/19**
	  • **1/0** through **1/9**
	  • **1/10** through **1/19**

Software features	• Supports MACsec using the following encryption algorithms: gcm-aes-128, gcm-aes-xpn-128, gcm-aes-256, and gcm-aes-xpn-256. MACsec is supported at 10 Gbps and 1 Gbps speeds. • SupportsHyper mode to speed up packet processing. • Supports Flexible queuing using an add-on license to support 32,000 queues per line card, including queues on both ingress and egress interfaces. You can use an additional license to support up to 512,000 queues. • Optical diagnostics and related alarms • See Protocols and Applications Supported by the MPC7E for MX Series Routers for information about the protocols and applications that MPC7Es support.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. • 10GBASE-ZR (model number: SFPP-10G-ZR-OTN-XT) **NOTE**: MPC7E-10G does not support OTN rates. • 10GBASE-ZR (model number: SFPP-10G-DT-ZRC2) **NOTE**: Supports 40° C ambient temperature operation at any altitude, and 55° C ambient temperature operation at sea level.
Power requirements	• Typical: 405 W • At different temperatures: 55° C: 500 W 40° C: 465 W 25° C: 430 W

LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Yellow—MPC has failed. Link LED, one green per port: • Steady green—Link is up. • Off—Link is down or disabled.

Platform Specific Behavior

Use the below table to review platform-specific behavior for your platforms.

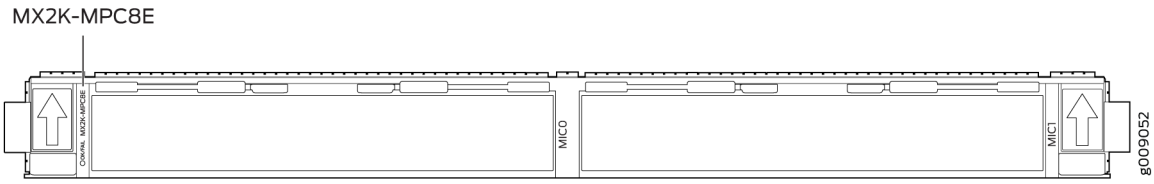
Table 28: Platform-Specific Behavior

Platform	Behavior
MX960	All the MPC slots can be occupied by MPC7E-10G at an ambient temperature of up to 40° C and at any altitude. All the MPC slots can be occupied by MPC7E-10G at temperatures of up to 55° C and at sea level. At an ambient temperature of above 55° C, and at an altitude above sea level, slot **11** cannot host MPC7E-10G.
MX240, MX480, MX960	• MPC7E powers on only if the `network-services` mode on the router is configured as either **enhanced-ip** or **enhanced-ethernet**. • Requires high-capacity power supplies, high-capacity fan trays, and SCBE2 or SCBE3 switch control boards. • Supports a line-rate throughput of up to 400 Gbps.
MX2000	• Supports a line-rate throughput of up to 400 Gbps. • Requires an adapter card to be housed in MX2000 routers.

RELATED DOCUMENTATION

- MX Series MPC Overview
- MPCs Supported by MX Series Routers
- Junos Continuity Software User Guide (Junos OS Release 14.1R4 and Later Releases)

MPC8E



Description

- Weight: 31.4 lb (14.24 kg) (net weight without blank panels)
- Model number: MX2K-MPC8E
- Name in the CLI: `MPC8E 3D`

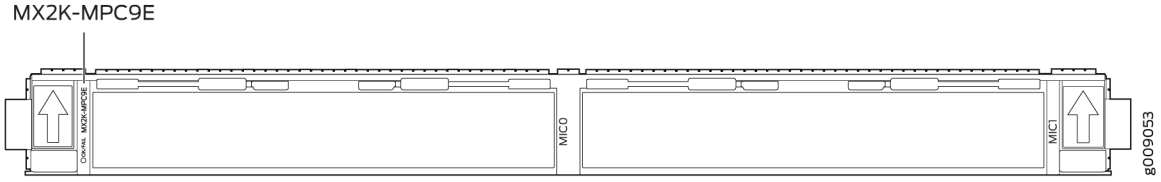
Hardware features	• Supports a line-rate throughput of up to 960 Gbps on the MX2000 routers. • Supports a line-rate throughput of up to 1600 Gbps (1.6 Tbps) on the MX2000 routers with software upgrade. **NOTE**: You can upgrade MPC8E to provide an increased bandwidth of 1600 Gbps (1.6 Tbps) by using an add-on license. After you perform the upgrade, MPC8E provides a bandwidth of 1.6 Tbps, which is equivalent to the bandwidth of "MPC9E" on page 208. However, the MPC continues to be identified as MPC8E. • Four Packet Forwarding Engines, each providing a maximum bandwidth of 240 Gbps in normal mode and 400 Gbps in 1.6Tbps upgraded mode. A license is required to operate in 1.6 Tbps upgraded mode. • Supports two MICs. For information about which MICs are supported on this MPC, see MIC/MPC Compatibility. • Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services. • Supports the Switch Fabric Boards SFB and SFB2. When MPC8E is used with SFB, the line-rate throughput is limited to 800 Gbps. • Supports maximum transmission units (MTUs) from 256 bytes through 16,000 bytes for transit traffic, and from 256 bytes through 9,500 bytes for host bound packets.
Software features	• Dynamic power management for effective utilization of available power. • Inline flow monitoring for higher scalability and performance. • Flexible queuing using an add-on license to support 32,000 queues per line card, including queues on both ingress and egress interfaces. You can use an additional license to support up to 512,000 queues per slot or 1,000,000 queues per slot. • Hyper mode to speed up packet processing. • Optical diagnostics and related alarms. For more information about features supported on MPC8E, see Protocols and Applications Supported by the MPC8E and MPC9E on the MX2010 and MX2020 Routers.

Power requirements (without MICs)	Normal mode with line-rate throughput of 960 Gbps: • Typical: 688 W • At different temperatures: 55° C: 805 W 40° C: 720 W 25° C: 690 W Upgrade mode with line-rate throughput of 1.6 Tbps: • Typical: 838 W • At different temperatures: 55° C: 1018 W 40° C: 870 W 25° C: 840 W
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Yellow—MPC has failed.

RELATED DOCUMENTATION

- MPCs Supported by MX Series Routers
- Junos Continuity Software User Guide (Junos OS Release 14.1R4 and Later Releases)

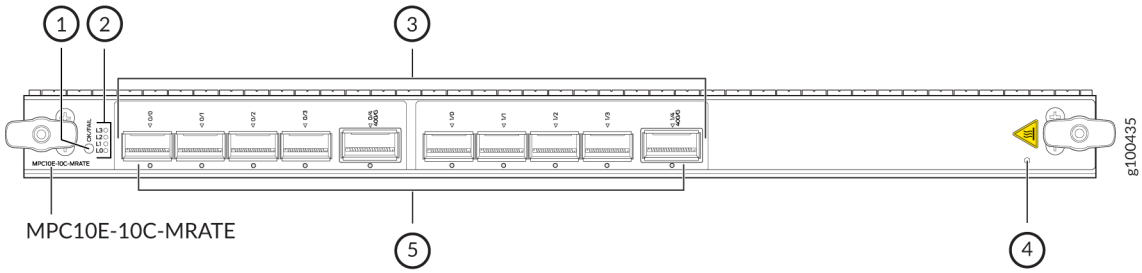
MPC9E



Description	• Weight: 31.4 lb (14.24 kg) (net weight without blank panels) • Model number: MX2K-MPC9E • Name in the CLI: `MPC9E 3D`
Hardware features	• Line-rate throughput of up to 1600 Gbps (1.6 Tbps) on MX2000 routers. • Four Packet Forwarding Engines, each providing a maximum bandwidth of 400 Gbps. • Supports two MICs. For information about which MICs are supported on this MPC, see MIC/MPC Compatibility. • Junos Trio chipsets for increased scaling for bandwidth, subscribers, and services • Supports the Switch Fabric Boards SFB and SFB2. When MPC9E is used with SFB, the line-rate throughput is limited to 800 Gbps. • Supports maximum transmission units (MTUs) from 256 bytes through 16,000 bytes for transit traffic, and from 256 bytes through 9,500 bytes for host bound packets.
Software features	• Understanding How Dynamic Power Management Enables Better Utilization of Power for effective utilization of available power. • *Inline Active Flow Monitoring* for higher scalability and performance. • *Flexible Queuing Mode* using an add-on license to support 32,000 queues per line card, including queues on both ingress and egress interfaces. You can use an additional license to support up to 512,000 queues per slot or 1,000,000 queues per slot. • *Hyper Mode* to speed up packet processing. • Optical diagnostics and related alarms. For more information about features supported on MPC9E, see Protocols and Applications Supported by the MPC8E and MPC9E on the MX2010 and MX2020 Routers.

Power requirements (without MICs)	• Typical: 838 W • At different temperatures: 55° C: 1018 W 40° C: 870 W 25° C: 840 W
LEDs	**OK/FAIL** LED, one bicolor: • Steady green—MPC is functioning normally. • Yellow—MPC has failed.

MPC10E-10C-MRATE



1– OK/FAIL LED	4– Physical Presence button
2– Lane LEDs	5– Port LEDs
3– Network ports	

Software release	Junos OS Release 19.2R1 and later **NOTE**: It is not possible to purchase a license that enables you to upgrade from the MPC10E-10C-MRATE MPC10E-15C-MRATE.

Description	• Weight: 19.75 lb (9.0 kg) • Model number: MPC10E-10C-MRATE • Name in the CLI: `MPC10E 3D MRATE-10xQSFPP`

Hardware features

- Fixed-configuration MPC with 10-Gbps, 25-Gbps, 40-Gbps, 100-Gbps, and 400-Gbps port speeds.
- Line-rate throughput of up to 1.0 Tbps on MX240, MX480, and MX960 5G Universal Routing Platforms w installed with an enhanced midplane.

  NOTE: In the CLI, when you run the `show chassis hardware` command, the midplane description will say `Enhanced <platform> Backplane`.

- Line-rate throughput of up to 800 Gbps on MX240, MX480, and MX960 5G Universal Routing Platforms installed with a standard midplane.

  NOTE: In the CLI when you run the `show chassis hardware` command, the midplane description will say `<platform> Backplane`. When the MPC10E-10C-MRATE is installed with the standard midplane, to achie maximum line-rate performance, the MPC's fabric redundancy mode must be configured in increased bandwidth mode.

- Contains the following port types:
  - QSFP28 ports—Port numbers 0/0 through 0/3, and 1/0 through 1/3 (10-Gbps, 40-Gbps, and 100-Gb speeds supported).
  - QSFP56-DD ports—Port numbers 0/4, and 1/4 (10-Gbps, 40-Gbps, 100-Gbps, and 400-Gbps port sp supported).
- The Processor Mezzanine Board (PMB) consists of a 1.6-GHz Intel Broadwell 8-core CPU, 100-GB SATA S and two 16-GB ECC DDR4 DRAM modules.
- Two Packet Forwarding Engines, each providing a maximum bandwidth of 500 Gbps.
- Juniper Trio 5 silicon for increased scaling, bandwidth, subscribers, and services.
- Supports maximum transmission units (MTUs) from 256 bytes through 16,000 bytes for transit traffic, and 256 bytes through 9500 bytes for host-bound packets.
- To achieve maximum line-rate performance, the MPC's fabric redundancy mode must be configured in inc bandwidth mode.
- To achieve maximum performance, the following number of SCBE3-MX Switch Control Boards (SCBs) mu installed in the system:
  - MX960—3 SCBE3-MX
  - MX240 and MX480—2 SCBE3-MX
- Requires high-capacity power supplies and high-capacity fan trays used in MX Series routers.
- On MX960 routers, the MPC10E-10C-MRATE is not supported in the line-card slots numbered 0, 1, and

NOTE: When operating the MPC10E-10C-MRATE in ambient temperatures above the maximum normal operating temperature of 104° F (40° C), you may see a decrease in performance. This situation is normal, the card is operating as designed. If a decrease in performance does occur, a yellow alarm appears on the s The decrease in performance is not a permanent situation. This may occur during NEBS operating environr conditions.

Software features	• Media Access Control Security is supported. See *Understanding Media Access Control Security (MACsec)* MACsec is supported on 10-Gbps, 25-Gbps, 40-Gbps, and 100-Gbps port speeds. • Security Support: • *Secure boot* (see Secure Boot For more information about features supported on MPC10E, see "Protocols and Applications Supported by th MPC10E" on page 623.
Power requirements	The power numbers are measured using the following configuration: • IPv4 forwarding with 200-bytes packet size. • Line-rate traffic on all ports for 1.0 Tbps aggregate bandwidth. • All 10 ports are configured for 100-Gigabit Ethernet, with QSFP28 LR4 transceivers installed on all ports. At different temperatures: • 131° F (55° C): 620 W **NOTE**: To operate the MPC10E-10C-MRATE in ambient temperatures of 104° F (40° C) to 131° F (55° the MPC10E-10C-MRATE must be running on Junos OS Release 19.4R1 or later. • 104° F (40° C): 590 W • 77° F (25° C): 545 W

LEDs	**OK/FAIL** LED, one bicolor: • Green—MPC is functioning normally. • Red—MPC has failed. Port LED: • Off—Port link is down with loss of signal. • Green—Port link is up with no alarms or failures. • Amber—Port link is down with alarms. Or the port has been administratively disabled through the CLI. • Red—A transceiver on the port is experiencing a fault. Lane LED: There are four Lane LEDs, which are shared by the network ports. The lane LEDs work with the Junos OS sof to determine which port the Lane LEDs are displaying the status for. The Lane LEDs are used for the following configurations: • When a network port is configured for 4 x 10-Gigabit Ethernet channelized interfaces with a breakout cab • When a network port is configured for 4 x 25-Gigabit Ethernet channelized interfaces with a breakout cab See *MPC and MIC Lane LED Scheme Overview* for more details.

Cables and connectors

You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported your Juniper Networks device.

The list of supported transceivers for the MX Series is located at MX Series Supported Transceivers.

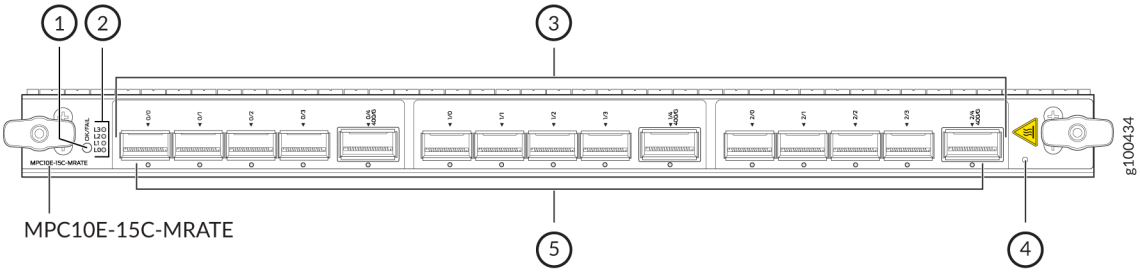
Starting in Junos OS Release 19.3R1, the MPC10E-10C-MRATE supports 25-Gbps port speeds when the net port is configured for 4 x 25-Gigabit Ethernet channelized interfaces with a breakout cable. This configuration only supported up to an ambient temperature of 104° F (40° C).

When operating the MPC10E-10C-MRATE in ambient temperatures above 104° F (40° C), only the QSFP-10 CWDM4-ET transceiver is supported.

The QDD-400G-LR8 transceiver is supported at certain ambient temperature and altitude combinations. The following table lists the supported combinations.

Altitude (Feet Above Sea Level)	Maximum Ambient Temperature
6000	36° C (96.8° F)
5000	37° C (98.6° F)
4000	38° C (100.4° F)
3000	39° C (102.2° F)
2000 and below	40° C (104° F)

MPC10E-15C-MRATE



1– OK/FAIL LED

4– Physical Presence button

2– Lane LEDs	5– Port LEDs
3– Network ports	

Software release	Junos OS Release 19.1R1 and later **NOTE**: It is not possible to purchase a license that enables you to upgrade from the MPC10E-10C-MRATE MPC10E-15C-MRATE.
Description	• Weight: 20.4 lb (9.25 Kg) • Model number: MPC10E-15C-MRATE • Name in the CLI: `MPC10E 3D MRATE-15xQSFPP`

Hardware features

- Fixed-configuration MPC with 10-Gbps, 25-Gbps, 40-Gbps, 100-Gbps, and 400-Gbps port speeds.
- Line-rate throughput of up to 1.5 Tbps on MX240, MX480, and MX960 5G Universal Routing Platforms v installed with an enhanced midplane. If you are running Junos OS Release 19.1R1, you must have an enha midplane installed.

  NOTE: In the CLI, when you run the `show chassis hardware` command, the midplane description will say `Enhanced <platform> Backplane`.

- Line-rate throughput of up to 800 Gbps on MX240, MX480, and MX960 5G Universal Routing Platforms installed with a standard midplane. Support for the standard midplane starts in Junos OS Release 19.2R1.

  NOTE: In the CLI, when you run the `show chassis hardware` command, the midplane description will say `<platform> Backplane`.

- Contains the following port types:
  - QSFP28 ports—Port numbers 0/0 through 0/3, 1/0 through 1/3, and 2/0 through 2/3 (10-Gbps, 40-G and 100-Gbps port speeds supported).
  - QSFP56-DD ports—Port numbers 0/4, 1/4, and 2/4 (10-Gbps, 40-Gbps, 100-Gbps, and 400-Gbps po speeds supported).
- The Processor Mezzanine Board (PMB) consists of a 1.6-GHz Intel Broadwell 8-core CPU, 100-GB SATA S and two 16-GB ECC DDR4 DRAM modules.
- Three Packet Forwarding Engines, each providing a maximum bandwidth of 500 Gbps.
- Juniper Trio 5 silicon for increased scaling for bandwidth, subscribers, and services.
- Supports maximum transmission units (MTUs) from 256 bytes through 16,000 bytes for transit traffic, and 256 bytes through 9500 bytes for host-bound packets.
- To achieve maximum line-rate performance, the MPC's fabric redundancy mode must be configured in inc bandwidth mode.
- To achieve maximum performance, the following number of SCBE3-MX switch control boards must be ins in the system:
  - MX960—3 SCBE3-MX
  - MX240 and MX480—2 SCBE3-MX
- Requires high-capacity power supplies and high-capacity fan trays used in MX Series routers.
- On MX960 routers, the MPC10E-15C-MRATE is not supported in the line-card slots numbered 0, 1, and

- On MX480 routers, there is a limit to the number of MPC10E-15C-MRATEs that can be installed. The MX power supplies do not produce enough power for a chassis that is fully loaded with MPC10E-15C-MRAT cards. Table 29 on page 218 lists the maximum number of MPC10E-15C-MRATEs that can be installed in MX480.

Table 29: Number of MPC10E-15C-MRATE Supported in an MX480

Chassis Power Supply	Temperature	Maximum Number of MPC10E-15C-MRAT
MX480 with high-capacity AC power supplies in the high-line (220V) power configuration	77° F (25° C)	4
MX480 with high-capacity AC power supplies in the low-line (120V) power configuration	77° F (25° C)	3
MX480 with high-capacity AC power supplies in the high-line (220V) power configuration	104° F (40° C)	4
MX480 with high-capacity AC power supplies in the low-line (120V) power configuration	104° F (40° C)	3
MX480 with high-capacity DC power supplies	77° F (25° C)	5
MX480 with high-capacity DC power supplies	104° F (40° C)	4[2]

1. In determining the maximum number of MPC10E-15C-MRATEs supported in an MX480, the assumption is that two SCBE3-MX switch co boards and two RE-S-X6 routing engines are installed in the MX480.

2. At 104° F (40° C), if only one routing engine is installed, five MPC10E-15C-MRATEs can be installed.

Software features	• Media Access Control Security is supported. See *Understanding Media Access Control Security (MACsec)* MACsec is supported on 10-Gbps, 25-Gbps, 40-Gbps, and 100-Gbps port speeds. • Security Support: • *Secure boot* (see *Secure Boot*) For more information about features supported on MPC10E, see "Protocols and Applications Supported by t MPC10E" on page 623.
Power requirements	The power numbers are measured using the following configuration: • IPv4 forwarding with 200-bytes packet size. • Line-rate traffic on all ports for 1.5 Tbps aggregate bandwidth. • All 15 ports are configured for 100-Gigabit Ethernet, with QSFP28 LR4 transceivers installed on all ports. At different temperatures: • 104° F (40° C): 785 W • 77° F (25° C): 720 W

LEDs	**OK/FAIL** LED, one bicolor: • Green—MPC is functioning normally. • Red—MPC has failed. Port LED: • Off—Port link is down with loss of signal. • Green—Port link is up with no alarms or failures. • Amber—Port link is down with alarms. Or the port has been administratively disabled through the CLI. • Red—A transceiver on the port is experiencing a fault. Lane LED: There are four Lane LEDs, which are shared by the network ports. The lane LEDs work with the Junos OS sof to determine which port the Lane LEDs are displaying the status for. The Lane LEDs are used for the following configurations: • When a network port is configured for 4 x 10-Gigabit Ethernet channelized interfaces with a breakout cal • When a network port is configured for 4 x 25-Gigabit Ethernet channelized interfaces with a breakout cal See *MPC and MIC Lane LED Scheme Overview* for more details.

Cables and connectors

You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported your Juniper Networks device.

The list of supported transceivers for the MX Series is located at MX Series Supported Transceivers.

Starting in Junos OS Release 19.3R1, the MPC10E-15C-MRATE supports 25-Gbps port speeds when the net port is configured for 4 x 25-Gigabit Ethernet channelized interfaces with a breakout cable.

The QDD-400G-LR8 transceiver is supported at certain ambient temperature and altitude combinations. The following table lists the supported combinations.

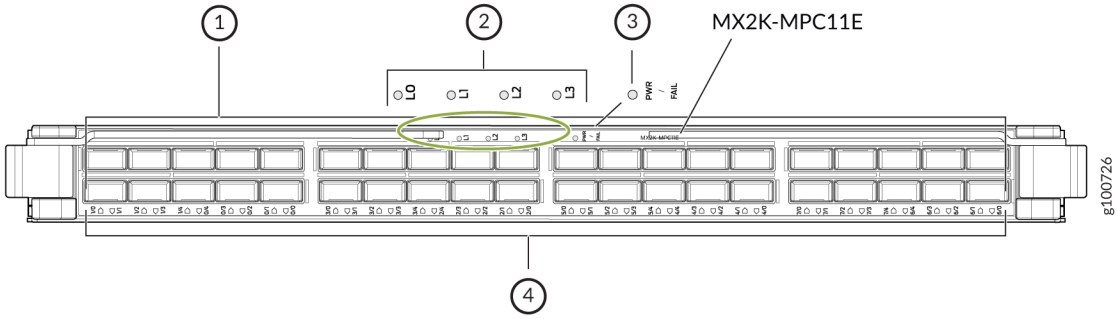
Altitude (Feet Above Sea Level)	Maximum Ambient Temperature
6000	36° C (96.8° F)
5000	37° C (98.6° F)
4000	38° C (100.4° F)
3000	39° C (102.2° F)
2000 and below	40° C (104° F)

MX2K-MPC11E Modular Port Concentrator

IN THIS SECTION

The MX2K-MPC11E is a fixed-configuration Module Port Concentrator (MPC) which delivers bandwidth up to 4-Tbps per MPC slot for MX2020 and MX2010 routers. See Figure 10 on page 222.

Figure 10: MX2K-MPC11E Modular Port Concentrator



1– Port Panel	3– PWR/FAIL LED
2– Lane LEDs	4– QSFP Port Link/Traffic Port LEDs

Software release	• Junos OS Release 19.3R2 and later 19.3 releases • Junos OS Release 20.1R1 and later releases **NOTE**: The MX2K-MPC11E is not supported in any Junos OS 19.4 releases.
Physical Description	• Weight: 36.2 lb (16.4 kg) • Model number: MX2K-MPC11E • Name in CLI: `MPC11E 3D MRATE-40xQSFPP` • Number of ports: 40

Prerequisites	• Requires at least one MX2000-SFB3 switch fabric board.
	  • Requires one of the following routing engines:
	  • RE-MX2000-1800X4
	  • REMX2K-1800-32G
	  • REMX2K-X8-128G
	  • REMX2K-X8-64G

Hardware features	• WAN Interface: 4-Tbps bandwidth per MX2K-MPC11E. • High Scale and Density: For MX2020 routers, provides 80-Tbps of system capacity and support for up to 800 100GbE interfaces or 160 400GbE interfaces. For MX2010 routers, provides 40-Tbps of system capa and support for up to 400 100GbE or 80 400GbE interfaces. • 400-Gbps with multi-rate QSFP56-DD interfaces • MACsec-ready for secure connectivity up to 100-Gbps port speeds • Channelization: Supports 4x10-Gbps and 25-Gbps via port channelization using breakout cables • Multi-rate 4x10-GbE, 40-GbE, and 100-GbE, 4x100-GbE, and 400-GbE ports • Seamless deployment: works with your existing power and cooling infrastructure • Supports maximum transmission units (MTUs) from 256 bytes through 16,000 bytes for transit traffic, and from 256 bytes through 9500 bytes for host-bound packets.
Software features	For more information about the software features supported on the MX2K-MPC11E, see Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers.
Power requirements	The power numbers are measured using the following configuration: • Line-rate traffic on all ports for 4-Tbps aggregate bandwidth • All 40 ports configured for 100-Gbps with QSFP28 transceivers installed in all ports The default ambient temperature for MX2000 routers is set to 104° F (40° C). You can set the ambient temperature to 77° F (25° C) or 131°F (55° C) using a CLI configuration command. Maximum power: 1980 W at 104° F (40° C) + 6000 ft. (1829 m) **NOTE**: When operating the MX2K-MPC11E in ambient temperatures above the maximum normal operati temperature of 104° F (40 C) you may see a decrease in performance. This situation is normal, and the car operating as designed. If a decrease in performance does occur, a yellow alarm appears on the system. The decrease in performance is not a permanent situation. This may occur during NEBS operating environment conditions.

LEDs	**PWR/FAIL** LED: • Steady green—MPC is functioning normally • Slow blinking green—MPC is initializing • Fast blinking green—MPC is being identified by software • Red—MPC has failed QSFP Port Link/Traffic Port LED: • Off—Port link is down with loss of signal • Green—Port link is up with no alarms or failures • Amber—Port link is down with alarms, or the port has been administratively disabled through the CLI • Red—A transceiver on the port is experiencing a fault Lane LEDs (**L0, L1, L2, L3**): When Port 0 is channelized for 4x10-Gbps, the link status for the device connected to the channelized port is indicated by one of four lane LEDs on the MX2K-MPC11E port panel. Like the QSFP Port Link/Traffic Port LE each individual lane LED has four states: off, green, amber, and red. See Configuring Rate Selectability on the MX2K-MPC11E to Enable Different Port Speeds and MPC and MIC Lane LED Scheme Overview for more de **NOTE**: For the 40GbE and 100GbE modes, the lane LEDs are not applicable.
Supported Transceivers	**TIP**: Use the Hardware Compatibility Tool to find information about the pluggable transceivers supported o MX2K-MPC11E.
Upgrades	Programmable components in the MX2K-MPC11E, including complex programmable logic devices (CPLD), ar field-upgradable.

MPC Interoperability	The MX2K-MPC11E is interoperable with these MPCs: • MX2K-MPC11E • MPC6E • MPC8E • MPC9E • MS-MPC Starting in Junos OS Release 22.2R1 MX2K-MPC11E is interoperable with these MPCs: • MPC7E • MPC5E • MPC2E-NG (with ethernet MICs only) • MPC3E-NG (with ethernet MICs only)
Switch Fabric Board Interoperability	The MX2K-MPC11E supports only MX2000-SFB3 switch fabric boards. It does not support legacy switch fab boards (SFB or SFB2).
Supported Routing Engines	The MX2K-MPC11E supports these routing engines: • RE-MX2000-1800X4 • REMX2K-1800-32G • REMX2K-X8-128G • REMX2K-X8-64G

Supported Power Supply Modules	The MX2K-MPC11E supports these power supply modules: • MX2000-PSM-AC • MX2000-PSM-DC • MX2K-PSM-HV **NOTE**: With the existing power supplies, an MX2020 can support a maximum of 14 MX2K-MPC11Es (sev the top MPC slots and seven in the bottom MPC slots) while maintaining PSM redundancy in each zone. Tl MX2010 with existing power supplies can support a maximum of six MX2K-MPC11Es and maintain PSM redundancy.

MX2K-MPC11E Port Panel

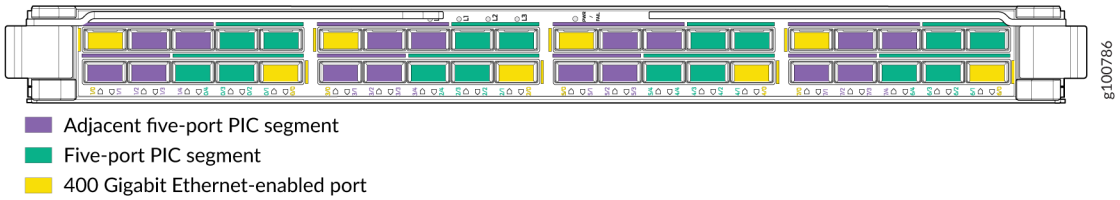
The MX2K-MPC11E port panel has 40 rate-selectable (multi-rate) ports that support quad small form-factor pluggable plus (QSFP28) transceivers. The MX2K-MPC11E has eight built-in PICs, **PIC0** to **PIC7**. Each PIC has five physical ports which constitute a logical PIC in the software. The default port speed is 100-Gbps for all ports. You can channelize Port 0 using Junos OS CLI configuration commands to create multiple independent 4x10 Gbps interfaces, and then use breakout cables to connect to other servers, storage devices, and routers. Table 30 on page 227 lists the optical transceivers that support channelization. For instructions on how to channelize ports, see Configuring Rate Selectability on the MX2K-MPC11E to Enable Different Port Speeds.

NOTE: When you configure different data rates for Port 0 in a PIC, the total throughput for the PIC can't exceed 500 Gbps.

You'll notice that the ports have colored lines above them. The colors help you to easily identify the ports that are associated with the same PIC/PFE. As shown in Figure 11 on page 227, here's what the colors mean:

- Purple—Indicates an adjacent five-port PIC segment. Each port group has an adjacent five-port PIC segment.
- Green—Indicates a five-port PIC segment.
- Yellow—Indicates the 400-Gbps-capable ports on each PIC.

Figure 11: Port Numbering for the MX2K-MPC11E



The purple and green lines in a port group denote the five ports associated with a PIC. For example, starting with the port groups on the left side of the port panel, the five ports with a purple line above them all connect to PIC 1. The five ports with a green line above them all connect to PIC 0. The numbers and arrows below the bottom ports tell you the PIC/port number. The up arrow means that the PIC/port number is for the top port. The down arrow means that the PIC/port number is for the bottom port. The port numbering is not contiguous.

QSFP Transceivers and Port Speeds

You can plug 100-GbE optics into any of the 40 ports.

Table 30 on page 227 summarizes the Packet Forwarding Engine mapping and the supported port speeds.

Table 30: Rate Selectability for the MX2K-MPC11E

PIC	Port Number	Port Speed Supported	Optics Supported
PIC 0 (or PFE 0)	0	40-Gbps 4x10-Gbps 100-Gbps 4x100-Gbps 400-Gbps	• 4x10 GbE support using QSFPP-4x10GE breakout optics • 1x40GbE support using QSFPP optics • 1x100GE support using QSFP28 optics For the latest list of transceivers supported by MX2K-MPC11E, see this HCT page. **NOTE**: By default, all the active ports operate in 100-Gbps mode.
	1-4	100-Gbps	

Table 30: Rate Selectability for the MX2K-MPC11E *(Continued)*

PIC	Port Number	Port Speed Supported	Optics Supported
PIC 1 (or PFE 1)	0	40-Gbps 4x10-Gbps 100-Gbps 4x100-Gbps 400-Gbps	
	1-4	100-Gbps	
PIC 2 (or PFE 2)	0	40-Gbps 4x10-Gbps 100-Gbps 4x100-Gbps 400-Gbps	
	1-4	100-Gbps	
PIC 3 (or PFE 3)	0	40-Gbps 4x10-Gbps 100-Gbps 4x100-Gbps 400-Gbps	
	1-4	100-Gbps	

Table 30: Rate Selectability for the MX2K-MPC11E *(Continued)*

PIC	Port Number	Port Speed Supported	Optics Supported
PIC 4 (or PFE 4)	0	40-Gbps 4x10-Gbps 100-Gbps 4x100-Gbps 400-Gbps	
	1-4	100-Gbps	
PIC 5 (or PFE 5)	0	40-Gbps 4x10-Gbps 100-Gbps 4x100-Gbps 400-Gbps	
	1-4	100-Gbps	
PIC 6 (or PFE 6)	0	40-Gbps 4x10-Gbps 100-Gbps 4x100-Gbps 400-Gbps	
	1-4	100-Gbps	

Table 30: Rate Selectability for the MX2K-MPC11E *(Continued)*

PIC	Port Number	Port Speed Supported	Optics Supported
PIC 7 (or PFE 7)	0	40-Gbps 4x10-Gbps 100-Gbps 4x100-Gbps 400-Gbps	
	1-4	100-Gbps	

Maximum MX2K-MPC11E Support Per Chassis

The number of MX2K-MPC11E line cards that the MX2020 and MX2010 router chassis can support varies, depending upon the ambient temperature of the chassis and the PSM redundancy. Table 31 on page 230 shows the number of MX2K-MPC11E line cards that are supported on the MX2020 router with fully populated, existing PDMs and PSMs (in redundant and non-redundant modes) at 40° C (104° F) + 6000 ft. (1829 m).

The following table is for a maximum power of 80A with 40V DC:

Table 31: MX2K-MPC11E Line Card Maximums Per PSM Redundancy (MX2000-PSM-AC-80A / MX2000-PSM-DC-80A), Temperature, and Elevation for MX2020 Routers

	With PSM Redundancy	Without PSM Redundancy	Temperature and Elevation
Upper Zone	7	8	40° C (104° F) + 6000 ft. (1829 m)
Lower Zone	7	8	40° C (104° F) + 6000 ft. (1829 m)
Total	14	16	40° C (104° F) + 6000 ft. (1829 m)

The following table is for a maximum power of 60A with 40V DC:

Table 32: MX2K-MPC11E Line Card Maximums Per PSM Redundancy (MX2000-PSM-AC-60A/ MX2000-PSM-DC-60A), Temperature, and Elevation for MX2020 Routers

	With PSM Redundancy	Without PSM Redundancy	Temperature and Elevation
Upper Zone	5	6	40° C (104° F) + 6000 ft. (1829 m)
Lower Zone	5	6	40° C (104° F) + 6000 ft. (1829 m)
Total	10	12	40° C (104° F) + 6000 ft. (1829 m)

Table 33 on page 231 shows the number of MX2K-MPC11E line cards that are supported on the MX2010 router with fully populated, existing PDMs and PSMs (in redundant and non-redundant modes) at 40° C (104° F) + 6000 ft. (1829 m).

The following table is for a maximum power of 80A with 40V DC:

Table 33: MX2K-MPC11E Line Card Maximums Per PSM Redundancy (MX2000-PSM-AC80A/ MX2000-PSM-DC-80A), Temperature, and Elevation for MX2010 Routers

MX2010 Line Card Type	Maximum Supported With PSM Redundancy	Maximum Supported Without PSM Redundancy	Temperature and Elevation
MX2K-MPC11E	6	7	40° C (104° F) + 6000 ft. (1829 m)

The following table is for a maximum power of 60A with 40V DC:

Table 34: MX2K-MPC11E Line Card Maximums Per PSM Redundancy (MX2000-PSM-AC-60A/ MX2000-PSM-DC-60A), Temperature, and Elevation for MX2010 Routers

MX2010 Line Card Type	Maximum Supported With PSM Redundancy	Maximum Supported Without PSM Redundancy	Temperature and Elevation
MX2K-MPC11E	5	6	40° C (104° F) + 6000 ft. (1829 m)

When the universal (HVAC/HVDC) PSMs (MX2K-PSM-HV) and PDMs (MX2K-PDM-HV) are used, the MX2010 and MX2020 support the MPC11E in all slots, with or without PSM redundancy. See Table 35 on page 232 and Table 36 on page 232.

Table 35: MX2K-MPC11E Line Card Maximums Per PSM Redundancy (MX2K-PSM-HV), Temperature, and Elevation for MX2020 Routers

	With PSM Redundancy	Without PSM Redundancy	Temperature and Elevation
Upper Zone	10	10	40° C (104° F) + 6000 ft. (1829 m)
Lower Zone	10	10	40° C (104° F) + 6000 ft. (1829 m)
Total	20	20	40° C (104° F) + 6000 ft. (1829 m)

Table 36: MX2K-MPC11E Line Card Maximums Per PSM Redundancy (MX2K-PSM-HV), Temperature, and Elevation for MX2010 Routers

MX2010 Line Card Type	Maximum Supported With PSM Redundancy	Maximum Supported Without PSM Redundancy	Temperature and Elevation
MX2K-MPC11E	10	10	40° C (104° F) + 6000 ft. (1829 m)

RELATED DOCUMENTATION

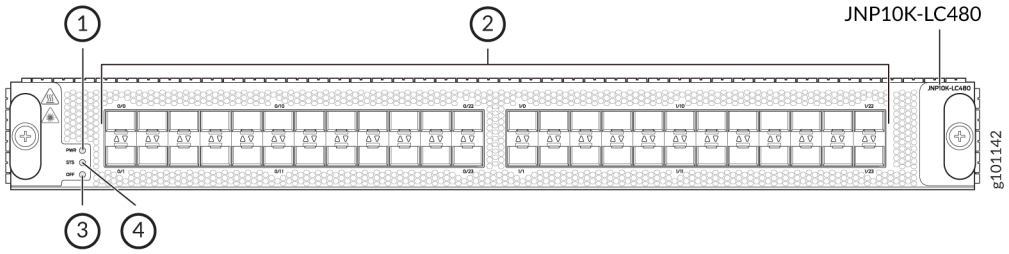
Protocols and Applications Supported by the MX2K-MPC11E | **641**

MX2000-SFB3 Switch Fabric Board Description

Removing and Installing MX10008 MPC Components

MX10K-LC480

The MX10K-LC480 (Model number: JNP10K-LC480) is a fixed-configuration line card with 48 SFP/SFP+ ports. Each port supports a speed of 10 Gbps or 1 Gbps, providing the line card a maximum bandwidth of 480 Gbps. The MX10K-LC480 has two Packet Forwarding Engines, each providing a maximum bandwidth of 240 Gbps. The line card plugs in to the MX10004, MX10008, and MX10016 routers horizontally at the front of the chassis.



1– Power (**PWR**) LED.	3– Offline/online (**OFF**) button.
2– Port LEDs.	4– Status (**STS**) LED.

Software release	• Junos OS Release 21.2R1 and later when installed in MX10008 and MX10016. • Junos OS Release 22.3R1 and later when installed in MX10004.
Description	• Model number: JNP10K-LC480 • Name in the CLI: `JNP10K-LC480` • Weight: 21.6 lb (9.8 kg) • Dimensions: Height = 1.89 in. (48.01 mm), width = 17.2 in (436.88 mm), depth = 19.05 in. (484 mm) (excluding FRU ejector)

Hardware features	• Fixed-configuration line card with 10-Gbps and 1-Gbps port speeds
	• Line-rate throughput of up to 480 Gbps
	• Two Packet Forwarding Engines, each providing a maximum bandwidth of 240 Gbps
	• EA chipset for increased scaling for bandwidth, subscribers, and services
	• Supports the Switch Fabric Boards JNP10004-SF2, JNP10008-SF, JNP10008-SF2 and JNP10016-SF
	• Interoperates with the JNP10K-LC2101 and JNP10K-LC9600 line cards
	• Operates with the following Routing and Control Boards: JNP10K-RE1, JNP10K-RE1-128, and JNP10K-RE1-LT; JNP10K-RE3, JNP10K-RE3-LT, JNP10K-RE3-256, and JNP10K-RE3LT256
	• Operates with the following power supplies and fan trays:
	  • JNK10K-PWR-AC or JNK10K-PWR-DC with the JNP10004-FAN2, JNP10008-FAN, or JNP10016-FAN.
	  • JNP10K-PWR-AC3 or JNP10K-PWR-DC3 or JNP10K-PWR-AC3H with JNP10004-FAN3,
	In both of the above configurations, the MX10K-LC480 line card adheres to the complete NEBS compliance (NEBS GR63-CORE, GR1089-CORE, and SR3580 compliance).
	• Meets the full NEBS requirement on the MX10004, MX10008, and MX10016 routers
	• Supports a maximum transmission unit (MTU) ranging from 256 bytes through 16,000 bytes for transit traffic and for host-bound packets

Software features	• Default port configuration of 10 Gigabit Ethernet (GbE) • Supports optics diagnostics and related alarms

Power requirements	• Power consumption at different temperatures when all ports are configured in 10-Gbps speed: 25° C: 420 W (without MACSec), 430 W (with MACSec) 40° C: 430 W (without MACSec), 450 W (with MACSec) 55° C: 450 W (without MACSec), 480 W (with MACSec) • Power consumption at different temperatures when all ports are configured in 1-Gbps speed: 25° C: 360 W (without MACSec), 370 W (with MACSec) 40° C: 370 W (without MACSec), 390 W (with MACSec) 55° C: 390 W (without MACSec), 420 W (with MACSec)
LEDs	**PWR** LED • Steady green—Line-card power is ok. • Steady red—Line-card power-on has failed. • Off—Line card is not receiving power. **STS** LED • Steady green (blinking green when the beacon or the port location is on)—Line card is online. • Blinking green—The line card is booting. • Steady red (blinking red when the beacon or the port location is on)—Line card is faulty or an alarm has been raised. • Off—Line card is disabled or offline. Port LED • Off—Port does not have a transceiver module. • Steady green (blinking green when the beacon or the port location is on)—Port link is up with no alarms or failures. • Steady amber (blinking amber when the beacon or the port location is on)—Port link is down because the port is disabled through the CLI or the port encountered errors such as loss of signal, local fault, or remote fault.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers that your Juniper Networks device supports. See the list of supported transceivers for the MX Series at MX Series Supported Transceivers.

MX10K-LC480 supports 1-Gbps Copper SFP modules in all the ports. You must use shielded RJ45 cables with 1-Gbps copper SFP modules.

You must install the MX10K-LC480 line card in the MX10008 and MX10016 routers along with the front panel with filter to meet the EMI Class-A emission standards.

The following applies to a router (MX10008 or MX10016) installed with the front panel:

- We recommend that you use only 16 ports per line card with copper SFP modules - the last 8 ports on the MIC0 (0/16 through 0/23) and the first 8 ports on the MIC1 (1/0 through 1/7).
- The MX10008 router supports a maximum of 128 copper SFP modules of 1 Gbps capacity.
- The MX10016 router supports a maximum of 192 copper SFP modules of 1 Gbps capacity.

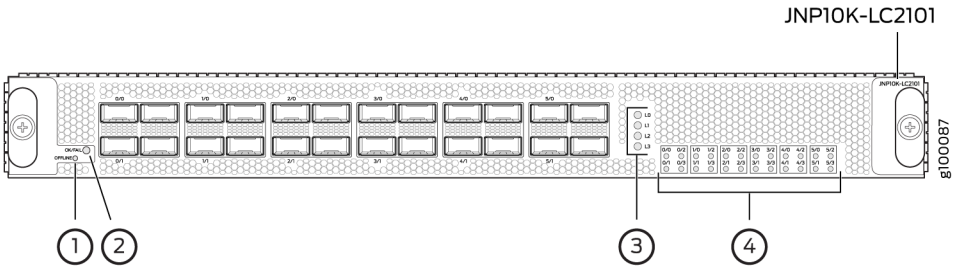
NOTE: The 1-Gbps copper SFP modules on the MX10K-LC480 line card do not support Precision Time Protocol (PTP) or Synchronous Ethernet functionality.

RELATED DOCUMENTATION

Protocols and Applications Supported by MX10K-LC480

MX10K-LC2101

The MX10K-LC2101 line card is a fixed configuration MPC. It does not contain separate slots for Modular Interface Cards (MICs). The MX10004 routers support four and the MX10008 routers support eight MX10K-LC2101 MPCs. The line card provides a maximum bandwidth of 2.4Tbps and has six Packet Forwarding Engines, each providing a maximum bandwidth of up to 400 Gbps. The line card plugs in to the MX10004, MX10008, and MX10016 routers horizontally at the front of the chassis.



1– **OFFLINE** button	3– Lane LEDs
2– **OK/FAIL** LED	4– Port LEDs

Software release	• Junos OS Release 18.2R1 and later when installed in MX10008 and Mx10016. • Junos OS Release 22.3R1 and later when installed in MX10004.
Description	• Weight: 31.57 lb (14.32 kg) • Model number: JNP10K-LC2101 • Name in the CLI: `JNP10K-LC2101` • Dimensions: Height = 1.89 in. (48.01 mm), Width = 17.2 in (436.88 mm), Depth = 19.05 in. (484 mm) (Exc FRU ejector)

Hardware features

- Fixed-configuration MPC with 10-Gbps, 40-Gbps, and 100-Gbps port speeds.
- All the ports are Multi-Rate ports. Each port is capable of supporting either 100 Gbps or 40 Gbps or 10 G (4x10-Gbps with breakout cable).
- Line-rate throughput of up to 2.4 Tbps.
- Six Packet Forwarding Engines, each providing a maximum bandwidth of 400 Gbps.
- EA chipsets for increased scaling for bandwidth, subscribers, and services.
- Supports the Switch Fabric Boards, JNP10004-SF2, JNP10008-SF, JNP10008-SF2, and JNP10016-SF.
- Supports maximum transmission units (MTUs) from 256 bytes through 16,000 bytes for transit traffic, and 256 bytes through 9,500 bytes for host-bound packets.
- Operates with the following Routing and Control Boards: JNP10K-RE1, JNP10K-RE1-128, and JNP10K-R JNP10K-RE3, JNP10K-RE3-LT, JNP10K-RE3-256, and JNP10K-RE3LT256
- Operates only with the following power supplies and fans/fan trays:
  - JNP10K-PWR-AC2
  - JNP10K-PWR-DC2
  - JNP10K-PWR-AC3
  - JNP10K-PWR-AC3H
  - JNP10K-PWR-DC3
  - JNP10008-FAN2 or JNP10008-FAN3 (in the MX10008)
  - JNP10008-FTC2 or JNP10008-FTC3 (in the MX10008)
  - JNP10004-FAN2 or JNP10004-FAN3 (in the MX10004)
  - JNP10004-FTC2 or JNP10004-FTC3 (in the MX10004)

  NOTE: A combination of the MX10K-LC2101 with the JNP10K-PWR-AC2 or JNP10K-PWR-DC2 pow supplies and the JNP10008-FAN3/FTC3 (in the MX10008) or JNP10004-FAN3/FTC3 (in the MX1000 not supported.

Software features	• Supports rate selectability at the port level. • By default, the ports are configured as 10-Gigabit Ethernet ports. • Optical diagnostics and related alarms.
Power requirements	Line-rate throughput of 2.4 Tbps: • Power consumption at different temperatures: 25° C: 1335 W 40° C: 1425 W
LEDs	**OK/FAIL** LED: • Steady green—MPC is functioning normally. • Yellow—MPC has failed. Port LED—**Link** • Off—Port is not enabled. • Green—Port link is up with no alarms or failures. • Red—Port link is down with alarms. **NOTE**: When a QSFP+ port is configured for the 10-Gigabit mode with a breakout cable, the link status for 10-Gigabit port is indicated with the addition of four LEDs provided on the line card. The lane LEDs for the corresponding port indicates the port status. Like the port status LED, each individual lane LED supports four states as: OFF, AMBER, GREEN, RED. See M and MIC Lane LED Scheme Overview for more details. For the 40-Gigabit mode the lane number LED is not applicable. The port LED indicates the port status, irresp of whichever lane number LED is ON.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers sup on your Juniper Networks device. The list of supported transceivers for the MX Series is located at MX Series Supported Transceivers.

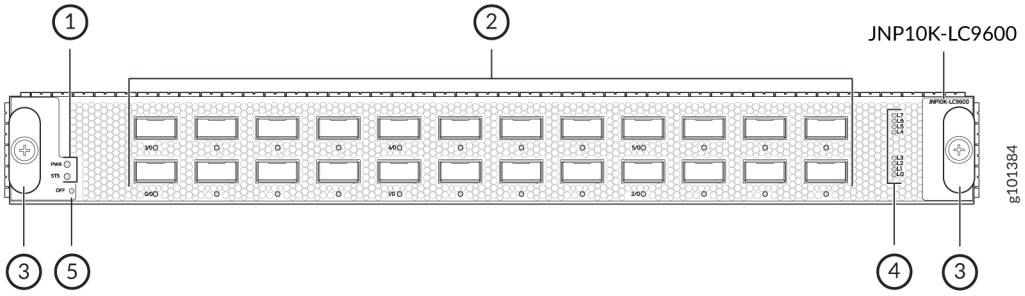
RELATED DOCUMENTATION

- Protocols and Applications Supported by the JNP10K-LC2101

MX10K-LC9600

The MX10K-LC9600 (Model number: JNP10K-LC9600) is a fixed-configuration 24-port line card that provides a line-rate throughput of 9.6 Tbps. The line card has twenty-four QSFP ports, each capable of supporting a maximum speed of 400 Gbps.

Figure 12: MX10K-LC9600



1– Power (**PWR**) and Status (**STS**) LEDs	4– Lane LEDs
2– QSFP Ports	5– Offline (**OFF**) button
3– Ejector Handles	

The MX10K-LC9600 line card combines Packet Forwarding Engines based on custom ASICs by Juniper Networks. The line card has six forwarding ASICs, each hosting two Packet Forwarding Engines. The line card has 12 Packet Forwarding Engines, each providing a maximum bandwidth of 800 Gbps.

You can channelize the ports using breakout cables to speeds of 400 Gbps, 200 Gbps, 100 Gbps, 50 Gbps, 40 Gbps, 25 Gbps, or 10 Gbps.

The 9.6-Tbps line card is designed to operate only with the following components:

- JNP10004-SF2 and JNP10008-SF2 switch fabric
- JNP10K-PWR-AC3, JNP10K-PWR-AC2, JNP10K-PWR-DC3, JNP10K-PWR-AC3H, or JNP10K-PWR-DC2 power supplies
- JNP10008-FAN3 or JNP10008-FAN2 fan tray
- JNP10008-FTC3 or JNP10008-FTC2 fan tray controller

- JNP10004-FAN3 or JNP10004-FAN2 fan tray
- JNP10004-FTC3 or JNP10004-FTC2 fan tray

NOTE: The fabric connectors on the MX10K-LC9600 line card are sensitive to debris accumulation. The connectors interface with the connectors on the JNP10004-SF2 SFB and the JNP10008-SF2 SFB. The connectors must be kept clean and free of dust and other particles to ensure a high-quality connection between the MX10K-LC9600 line card and the JNP10004-SF2 SFB and the JNP10008-SF2 SFB.

The MX10K-LC9600 line card runs the Juniper Networks Junos OS software on Juniper Networks JNP10K-LC9600 hardware. The MX10K-LC9600 plugs in to the MX10004 and MX10008 routers horizontally at the front of the chassis.

The fabric interface connectors on the MX10K-LC9600 line card have a preinstalled protective plastic dust cover. This cover keeps the connectors clean and free of dust and other particles. Remove the dust cover before you install the line card in the router. Save the plastic cover for future use to re-install when you remove the line card from the router.

The WAN ports on the MX10K-LC9600 line card also have preinstalled protective plastic dust covers. These covers keep the ports clean and free of dust and other particles. Keep these covers installed in any port that is not occupied by an optic module.

Software release	• Junos OS Release 21.4R1 and later when installed in MX10008. • Junos OS Release 22.3R1 and later when installed in MX10004.
Description	• Model number: JNP10K-LC9600 • Name in the CLI: `JNP10K-LC9600` • Weight: 27 lb (12.24 kg) • Dimensions: Height = 1.89 in. (48.01 mm), width = 17.2 in (436.88 mm), depth = 19.05 in. (484 mm) (excluding FRU ejector)

Hardware features

- Is a fixed-configuration line card with 400-Gbps, 200-Gbps, 100-Gbps, 50-Gbps, 40-Gbps, 25-Gbps, or 10-Gbps port speeds.
- Offers line-rate throughput of up to 9.6 Tbps.
- Includes twelve Packet Forwarding Engines, each allows for a maximum bandwidth of 800 Gbps.
- Is compatible with the JNP10004-SF2 and JNP10008-SF2 switch fabric boards.
- Interoperates with the MX10K-LC2101 and MX10K-LC480 line cards.
- Operates with the JNP10K-RE1, JNP10K-RE1-LT, and JNP10K-RE1-128; JNP10K-RE3, JNP10K-RE3-LT, JNP10K-RE3-256, and JNP10K-RE3LT256 Routing and Control Boards.
- Operates only with the following power supplies and fan trays:
  - JNP10K-PWR-AC3
  - JNP10K-PWR-AC2
  - JNP10K-PWR-DC3
  - JNP10K-PWR-DC2
  - JNP10K-PWR-AC3H
  - JNP10008-FAN3
  - JNP10008-FTC3
  - JNP10008-FAN2
  - JNP10008-FTC2
  - JNP10004-FAN3
  - JNP10004-FTC3
  - JNP10004-FAN2
  - JNP10004-FTC2
- Supports a maximum transmission unit (MTU) of 16,000 bytes for transit traffic and host-bound packets.

Software features	• Supports rate selectability at the port level. • By default, the ports are configured as 400-Gigabit Ethernet ports. • Supports acoustic reduction through a low-power mode EM policy profile when only 100-Gigabit Ethernet ports are used. • Supports optical diagnostics and related alarms.
Power requirements	Power consumption at different temperatures when all ports are configured in 400-Gbps speed: • 25° C: 1655 W • 40° C: 1770 W

LEDs	**PWR** LED • Steady green—Line-card power is ok. • Steady red—Line-card power-on has failed. • Off—Line card is not receiving power. **STS** LED • Steady green (blinking green when the beacon or the port location is on)—Line card is online. • Blinking green—The line card is booting. • Steady red (blinking red when the beacon or the port location is on)—Line card is faulty or an alarm has been raised. • Off—Line card is disabled or offline. Port LED • Off—Port does not have a transceiver module. • Steady green (blinking green when the beacon or the port location is on)—Port link is up with no alarms or failures. • Steady amber (blinking amber when the beacon or the port location is on)—Port link is down because the port is disabled through the CLI, or the port encountered errors such as loss of signal, local fault, or remote fault. Lane LEDs • The lane LEDs for the corresponding port indicate the port status. • Like the port status LED, each individual lane LED supports four states as: OFF, AMBER, GREEN, and RED.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers that your Juniper Networks device supports. See the list of supported transceivers for the MX Series at MX Series Supported Transceivers.

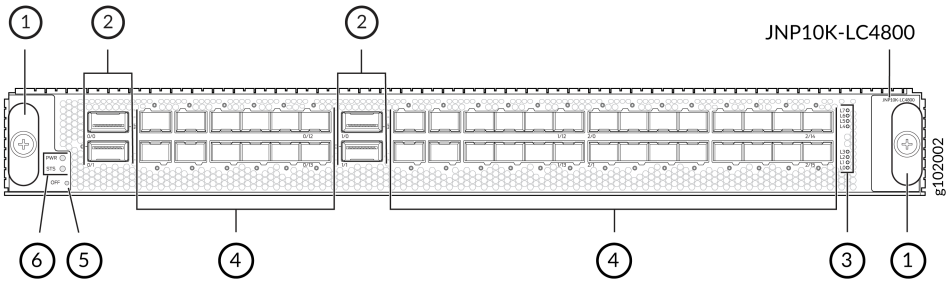
RELATED DOCUMENTATION

- Protocols and Applications Supported by MX10K-LC9600

MX10K-LC4800

The MX10K-LC4800 line card (model number: JNP10K-LC4800) is a fixed-configuration 44-port line card that provides a line-rate throughput of 4.8 Tbps. This line card supports 100-Gigabit Ethernet (100GbE) and 400GbE deployments.

Figure 13: MX10K-LC4800 Line Card



1– Ejectors	4– SFP56-DD ports
2– QSFP56-DD ports	5– **OFF** (offline) button
3– Lane LEDs	6– **PWR** and **STS** LEDs

The MX10K-LC4800 line card plugs into the MX10004 and MX10008 routers horizontally at the front of the chassis. The line card runs the Junos operating system (Junos OS).

Software release	Junos OS Release 24.2R1 and later when installed in MX10004 or MX10008 routers.
Description	• Model number: JNP10K-LC4800 • Name in the CLI: `JNP10K-LC4800` • Weight: 40 lb (18.14 kg) • Dimensions: Height = 1.89 in. (48.01 mm), width = 17.2 in (436.88 mm), depth = 19.05 in. (484 mm) (excluding the ejectors)

Hardware features

- Is a fixed-configuration line card with 44 ports (40 SFP56-DD ports and 4 QSFP56-DD ports).
- Supports channelization of the ports, using breakout cables, as follows:
  - Each SFP56-DD port supports the following speeds: 1 Gbps, 10 Gbps, 25 Gbps, 50 Gbps, and 100 Gbps.
  - Each QSFP56-DD port supports the following speeds: 4x10 Gbps, 4x25 Gbps, 40 Gbps, 100 Gbps, 2x100 Gbps, 4x100 Gbps, and 400 Gbps.

    NOTE: The MX10K-LC4800 line card does not support mixed breakout port speeds within a single port cage. For example, you cannot configure 4x25 Gbps and 4x10 Gbps speeds simultaneously within a single port cage.

    NOTE: When you configure a QSFP56-DD port as a 400 Gbps port, the adjacent two SFP56-DD ports (horizontally placed) get disabled.
- Offers a line-rate throughput of up to 4.8 Tbps. However, all the ports on the line card operate at a speed of 100 Gbps by default, providing a maximum per-slot bandwidth of 4.4 Tbps.
- Has three forwarding ASICs, each hosting two Packet Forwarding Engines. Each Packet Forwarding Engine supports a maximum bandwidth of 800 Gbps.
- Supports up to 32-GB Double Data Rate 4 (DDR4) memory (16 GB x 2 VLP DDR4 RDIMM PMB).
- Is compatible with the JNP10004-SF2 (in the MX10004) and JNP10008-SF2 (in the MX10008) Switch Fabric Boards (SFBs).
- Interoperates with the MX10K-LC9600, MX10K-LC2101, and MX10K-LC480 line cards.
- Operates with the JNP10K-RE1, JNP10K-RE1-LT, and JNP10K-RE1-128; JNP10K-RE3, JNP10K-RE3-LT, JNP10K-RE3-256, and JNP10K-RE3LT256 Routing and Control Boards (RCBs).
- Operates only with the following power supply units (PSUs) and fan trays:
  - JNP10K-PWR-AC2
  - JNP10K-PWR-DC2
  - JNP10K-PWR-AC3

	• JNP10K-PWR-DC3 • JNP10K-PWR-AC3H • JNP10008-FAN2 or JNP10008-FAN3 (in the MX10008) • JNP10008-FTC2 or JNP10008-FTC3 (in the MX10008) • JNP10004-FAN2 or JNP10004-FAN3 (in the MX10004) • JNP10004-FTC2 or JNP10004-FTC3 (in the MX10004) • Supports a maximum transmission unit (MTU) of 16,000 bytes for transit traffic and host-bound packets. **NOTE**: If you configure an SFP56-DD port as a 1-Gbps port, the port supports an MTU of 3800 bytes. • Adheres to the complete NEBS compliance (NEBS GR63-CORE, GR1089-CORE, and SR3580 compliance).
Software features	• Supports rate selectability at the port level • By default, the ports are configured as 100-Gigabit Ethernet ports • Supports optical diagnostics and related alarms • Has three logical PICs, each serviced by a dedicated forwarding ASIC • Enhanced MACsec support on all the optical ports
Power requirements	Power consumption at different temperatures when all the ports are configured to operate at 100-Gbps speed: • 25°C: 966 W • 40°C: 1005 W • 55°C: 1030 W

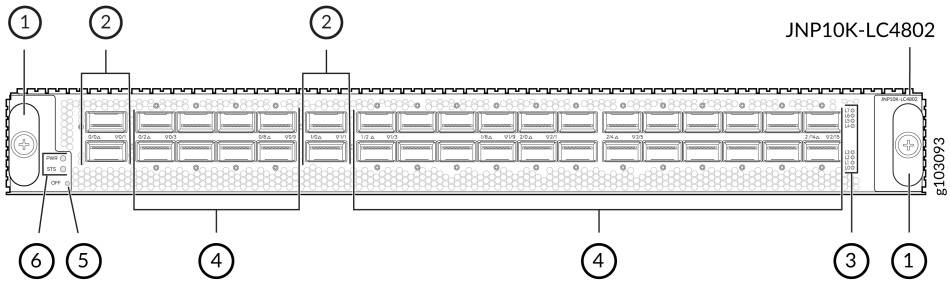
LEDs	**PWR** LED • Steady green—Line card is receiving power. • Steady red—Line card has failed to power on. • Off—Line card is not receiving power. **STS** LED • Steady green (when the beacon or the port location is on)—Line card is online. • Blinking green—The line card is booting. • Steady red (when the beacon or the port location is on)—Line card is faulty or an alarm has been raised. • Off—Line card is disabled or offline. Port LED (next to each port) • Off—Port does not have a transceiver module. • Steady green (when the beacon or the port location is on)—Port link is up with no alarms or failures. • Steady amber (when the beacon or the port location is on)—Port link is down because the port is disabled through the CLI, or the port encountered errors such as loss of signal, local fault, or remote fault. Lane LEDs • The lane LEDs for the corresponding ports indicate the port status. • Similar to the port status LED, each individual lane LED supports four states: OFF, AMBER, GREEN, and RED.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers that your Juniper Networks device supports. The following 400G-ZR optics are only supported up to 40°C. For more information, see Hardware Compatibility Tool. • JCO400-QDD-ZR • JCO400-QDD-ZR-M • QDD-400G-ZR • QDD-400G-ZR-M • QDD-400G-ZR-M-HP

MX10K-LC4802

The MX10K-LC4802 line card (model number: JNP10K-LC4802) is a fixed-configuration 36-port line card that provides a line-rate throughput of 4.8 Tbps. This line card supports 100-Gigabit Ethernet (100 GbE) and 400 GbE deployments.

Figure 14: MX10K-LC4802 Line Card



1– Ejectors	4– QSFP28 ports
2– QSFP56-DD ports	5– **OFF** (offline) button
3– Lane LEDs	6– **PWR** and **STS** LEDs

The MX10K-LC4802 line card plugs into the MX10004 and MX10008 routers horizontally in the front of the chassis. The line card runs the Junos operating system (Junos OS).

Software release	Junos OS Release 25.2R1 and later when installed in MX10004 or MX10008 routers.
Description	• Model number: JNP10K-LC4802 • Name in the CLI: `JNP10K-LC4802` • Weight: 40 lb (18.14 kg) • Dimensions: Height = 1.89 in. (48.01 mm), width = 17.2 in (436.88 mm), depth = 19.05 in. (484 mm) (excluding the ejectors)

Hardware features

- Is a fixed-configuration line card with 36 ports (32 QSFP28 ports and four QSFP56-DD ports).
- Supports channelization of the ports, using breakout cables, as follows:
  - Each QSFP28 port supports the following speeds: 1 Gbps, 4x10 Gbps, 4x25 Gbps, 40 Gbps, and 100 Gbps.

    NOTE: 1 Gbps and 10 Gbps speeds through pluggable SFP QSA adaptor.
  - Each QSFP56-DD port supports the following speeds: 4x10 Gbps, 4x25 Gbps, 40 Gbps, 100 Gbps, 2x100 Gbps, 4x100 Gbps, and 400 Gbps.

    NOTE: The MX10K-LC4802 line card does not support mixed breakout port speeds within a single port cage. For example, you cannot configure 4x25 Gbps and 4x10 Gbps speeds simultaneously within a single port cage.
  - Port configurations supported in 40G, 4x10G, and 4x25G modes:
    - 40G PIC-Mode—Ports supported on:
      - PIC-0 and PIC-1: Ports 0, 1, 2, 3, 6, and 7
      - PIC-2: Ports 0, 1, 4, 5, 8, 9, 12, and 13.

      NOTE: Physical interface (IFDs) are created for these ports.
    - 40G, 4x10G, and 4x25G port profile—Port pairs supported on:
      - PIC-0 and PIC-1: Port pairs (2 and 4), (3 and 5), (6 and 8), and (7 and 9).
      - PIC-2: Port pairs (0 and 2), (1 and 3), (4 and 6), (5 and 7), (8 and 10), (9 and 11), (12 and 14), and (13 and 15).

      NOTE: You can configure only single port at a time from each port pair. Also, if you configure any port as 100G port the other port in the pair cannot be configured as 40G/4x10G/4x25G port.
- Offers a line-rate throughput of up to 4.8 Tbps. However, when all the 32 QSFP28 ports operate at a speed of 100 Gbps and the 4 QSFP56-DD ports operate at 400 Gbps by default, providing a maximum bandwidth of 4.8 Tbps.
- Has three forwarding ASICs, each hosting two Packet Forwarding Engines. Each Packet Forwarding Engine supports a maximum bandwidth of 800 Gbps.
- Supports up to 64-GB Double Data Rate 4 (DDR4) memory.

	• Is compatible with the JNP10004-SF2 (in the MX10004) and JNP10008-SF2 (in the MX10008) Switch Fabric Boards (SFBs).
	
	All SFBs slots must be installed to achieve full line rate performance.
	
	• Interoperates with the MX10K-LC2101, MX10K-LC480, MX10K-LC9600, and MX10K-LC4800 line cards.
	
	• Operates with the JNP10K-RE1, JNP10K-RE1-LT, and JNP10K-RE1-128; JNP10K-RE3, JNP10K-RE3-LT, JNP10K-RE3-256, and JNP10K-RE3LT256 Routing and Control Boards (RCBs).
	
	• Operates only with the following power supply units (PSUs) and fan trays:
	
	  • JNP10K-PWR-AC2
	
	  • JNP10K-PWR-DC2
	
	  • JNP10K-PWR-AC3
	
	  • JNP10K-PWR-AC3H
	
	  • JNP10K-PWR-DC3
	
	  • JNP10008-FAN2 or JNP10008-FAN3 (in the MX10008)
	
	  • JNP10008-FTC2 or JNP10008-FTC3 (in the MX10008)
	
	  • JNP10004-FAN2 or JNP10004-FAN3 (in the MX10004)
	
	  • JNP10004-FTC2 or JNP10004-FTC3 (in the MX10004)
	
	• Supports a maximum transmission unit (MTU) of 16,000 bytes for transit traffic and host-bound packets.
	
	NOTE: If you configure an QSFP28 port as a 1-Gbps port, the port supports an MTU of 3800 bytes.
	
	• Adheres to the complete NEBS compliance (NEBS GR63-CORE, GR1089-CORE, and SR3580 compliance).

Software features	• Supports rate selectability at the port level • By default, the ports are configured as 100-Gigabit Ethernet ports • Supports optical diagnostics and related alarms • Has three logical PICs, each serviced by a dedicated forwarding ASIC

Power requirements	Power requirement of the LC4802 is approximately 1215 W including optics. Power consumption at different temperatures when all the ports are configured to operate at 100-Gbps speed: • 25°C: 1082 W • 40°C: 1099 W • 55°C: 1133 W
LEDs	**PWR** LED • Steady green—Line card is receiving power. • Steady red—Line card has failed to power on. • Off—Line card is not receiving power. **STS** LED • Steady green (when the beacon or the port location is on)—Line card is online. • Blinking green—The line card is booting. • Steady red (when the beacon or the port location is on)—Line card is faulty or an alarm has been raised. • Off—Line card is disabled or offline. Port LED (next to each port) • Off—Port does not have a transceiver module. • Steady green (when the beacon or the port location is on)—Port link is up with no alarms or failures. • Steady amber (when the beacon or the port location is on)—Port link is down because the port is disabled through the CLI, or the port encountered errors such as loss of signal, local fault, or remote fault. Lane LEDs • The lane LEDs for the corresponding ports indicate the port status. • Similar to the port status LED, each individual lane LED supports four states: OFF, AMBER, GREEN, and RED.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers that your Juniper Networks device supports. The following 400G-ZR optics are only supported up to 40°C. For more information, see Hardware Compatibility Tool. • JCO400-QDD-ZR • JCO400-QDD-ZR-M • QDD-400G-ZR • QDD-400G-ZR-M • QDD-400G-ZR-M-HP

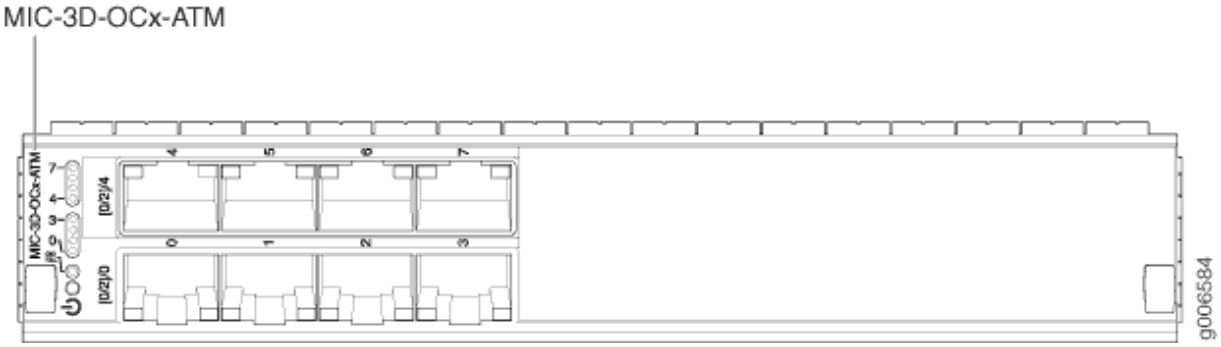
CHAPTER 11

MX Series MIC Descriptions

IN THIS CHAPTER

ATM MIC with SFP

Figure 15: 8-Port ATM MIC with SFP



Software release	• Junos 12.1 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• Rate-selectable using one of the following rates:
	  • 8-port OC3
	  • 2-port OC12
	• Power requirement: 0.73 A @ 48 V (35 W)
	• Weight: 1.2 lb (0.54 kg)
	• Model number: MIC-3D-8OC3-2OC12-ATM
	• Name in the CLI: `3D 8OC3 2OC12 ATM`

Hardware features	• High-performance parsing of SONET/SDH frames • Packet segmentation and reassembly (SAR) management and output port queuing • Packet buffering, Layer 2 parsing • Line rate throughput for each port

Software features

- Circuit cross-connect (CCC) for leveraging ATM access networks
- User-configurable virtual circuit (VC) and virtual path (VP) support
- Support for idle cell or unassigned cell transmission
- OAM fault management processes alarm indication signal (AIS), remote defect indication (RDI) cells, and loop cells
- Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP
- Local and remote loopback
- Simple Network Management Protocol (SNMP):
  - Management Information Base (MIB) 2 (RFC 1213)
  - ATM MIB (RFC 1695)
  - SONET MIB
  - PWE3 MIB (RFC 5603)
  - PW-ATM-MIB (RFC 5605)
  - PW-FRAME-MIB (RFC 5601)
  - MIB for CoS
- Unspecified bit rate (UBR), non-real-time variable bit rate (VBR), and constant bit rate (CBR) traffic shaping
- Per-VC or per-VP traffic shaping
- Support for F4 OAM cells (AIS, RDI, Loopback, and Continuity Check)
- Support for F5 OAM cells (AIS, RDI, Loopback, and Continuity Check)
- Support for 16 bit VCI range
- Encapsulations:
  - atm-ccc-cell-relay (Junos 12.1 and later)
  - atm-ccc-vc-mux (Junos 12.1 and later)

	• atm-snap (Junos 12.2 and later) • atm-vc-mux (Junos 12.2 and later) • atm-tcc-snap (Junos 13.3 and later) • atm-tcc-vc-mux (Junos 13.3 and later) • vlan-vci-ccc (Junos 16.1 and later) • ether-over-atm-llc • ppp-over-ether-over-atm-llc • atm-ppp-vc-mux **NOTE**: Inline MLPPP is not supported on this MIC.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. Link LED, one green per port: • Off—No link. • On steadily—Link is up. • Blinking—Online with alarms for remote failures • Blinking rapidly—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- Alarm indication signal—line (AIS-L)
- Alarm indication signal—path (AIS-P)
- Bit error rate—signal degrade (BERR-SD)
- Bit error rate—signal fail (BERR-SF)
- Loss of cell delineation (LOC)
- Loss of frame (LOF)
- Loss of pointer (LOP-P)
- Loss of signal (LOS)
- Payload mismatch (PLM-P)
- Payload unequipped (unequipped STS at path level) (UNEQ-P)
- Remote defect indication—line (RDI-L)
- Remote defect indication—path (RDI-P)
- Error detection:
  - Bit interleaved parity errors B1, B2, B3
  - Errored seconds (ES-S, ES-L, ES-P)
  - Far-end bit errors, remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
  - Far-end bit errors, remote error indication—path (REI-P), far-end path coding violations (CV-PFE)
  - Far-end errored seconds (ES-LFE, ES-PFE)
  - Far-end severely errored seconds (SES-LFE, SES-PFE)
  - Far-end unavailable seconds (UAS-LFE, UAS-PFE)
  - Severely errored framing (SEF)
  - Severely errored framing seconds (SEFS-S)

- Severely errored seconds (SES-S, SES-L, SES-P)
- Unavailable seconds (UAS-L, UAS-P)

NOTE: MIC-3D-8OC3-2OC12-ATM Revision 8 and Revision 22 are supported only by the following Junos OS releases:

- Junos OS Release 12.3—12.3R9 and later
- Junos OS Release 13.3—13.3R6 and later
- Junos OS Release 14.1—14.1R4 and later
- Junos OS Release 14.2—14.2R3 and later
- Junos OS Release 15.1 and later

You must upgrade to a supported Junos OS release to use MIC-3D-8OC3-2OC12-ATM Revision 8 and Revision 22 and later.

RELATED DOCUMENTATION

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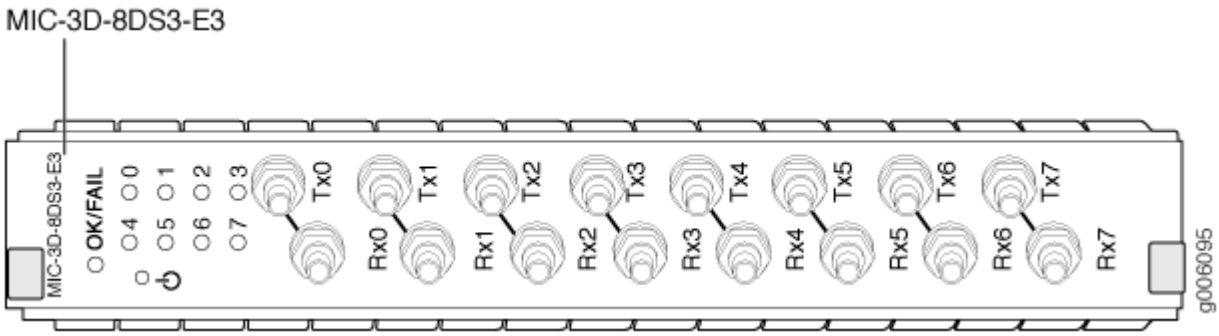
DS3/E3 MIC

Figure 16: DS3/E3 MIC



Software release	• Junos OS Release 11.4 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• Eight E3 or DS3 ports
	• DS3/E3 MIC ports can be configured as one of the following:
	  • 8 clear-channel DS3 ports
	  • 8 channelized DS3 ports
	  • 8 clear-channel E3 ports
	
	  NOTE: You can upgrade the DS3/E3 MIC with the S-MIC-3D-8CHDS3 software license (purchased separately) to support DS3 channelization. Channelized DS3/E3 MIC is supported only on queuing MPCs. On the MX80 router, you also need an S-MX80-Q software license.
	• DS3 or E3 is configurable on a per-port granularity
	• DS3 channelization for the 8-port Channelized DS3/E3 MIC:
	  • 8 DS3 channels
	  • 224 DS1 channels
	  • 2038 DS0 channels
	• Power requirement: 4.0 A @ 9 V (36W)
	• Weight: 4.4 lb (2 kg)
	• Model numbers:
	  • DS3/E3 MIC: MIC-3D-8DS3-E3
	  • Channelized DS3/E3 MIC: MIC-3D-8CHDS3-E3-B

Hardware features	• Ports are numbered 0 through 7, Tx0 through Tx7 and Rx0 through Rx7

Software features

- Maximum transmission units (MTUs) of up to 9192 bytes
- Framing: M13, C-bit parity, framed clear channel
- Subrate and scrambling:

  NOTE: Only DS3 interfaces support subrate and scrambling.

  - Digital Link/Quick Eagle
  - Kentrox
  - Larscom
  - ADTRAN
  - Verilink
- Internal and look clocking
- DS3 far-end alarm and control (FEAC) channel
- Full bit error rate test (BERT) for DS0, DS1, and DS3
- Encapsulations:
  - MPLS fast reroute
  - MPLS CCC (circuit cross-connection)
  - MPLS TCC (translational cross-connection)
  - Cisco High-Level Data Link Control (cHDLC)
  - Cisco HDLC CCC
  - Cisco HDLC TCC
  - Point-to-Point Protocol (PPP)
  - PPP for CCC
  - PPP for TCC
  - Flexible Frame Relay
  - Frame Relay

- Frame Relay for CCC
- Frame Relay for TCC
- PPP over Frame Relay

  NOTE: Ethernet over Frame Relay is not supported.

- Encapsulations available only for Channelized DS3/E3 MIC (Junos OS Release 12.1 and later):
  - Multilink Point-to-Point Protocol (MLPPP)
  - Multiclass MLPPP
  - Multilink Frame Relay (MLFR) end-to-end (FRF.15)
  - Multilink Frame Relay (MLFR) UNI NNI (FRF.16, also referred to as MFR)
  - Compressed Real-Time Transport Protocol (CRTP)

    NOTE: When you configure multilink services on a MIC in an MX Series router, ensure that a Multiservices DPC is present in the same router.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. • Coaxial: Custom 10-ft (3-m) mini-SMB to BNC cable (model number: CBL-DS3-E3-M-S), set of 8 cables (bundled RX and TX)

LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally • Red—MIC has failed Link LED, one green per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	DS3 alarms: • Alarm indication signal (AIS) • Loss of frame (LOF) • Loss of signal seconds (LOS) • Phase lock loop (PLL) DS3 error detection: • C-bit code violations (CCV) • C-bit errored seconds (CES) • C-bit severely errored seconds (CSES) • CRC errors • Excessive zeros (EXZ) • Far-end block error (FEBE) • Far-end receive failure (FERF) • Line errored seconds (LES) • Parity bit (P-bit) code violations (PCV) • Parity bit (P-bit) errored seconds (PES) • Parity bit (P-bit) severely errored framing seconds (PSES) • Severely errored framing seconds (SEFS) • Unavailable seconds (UAS)

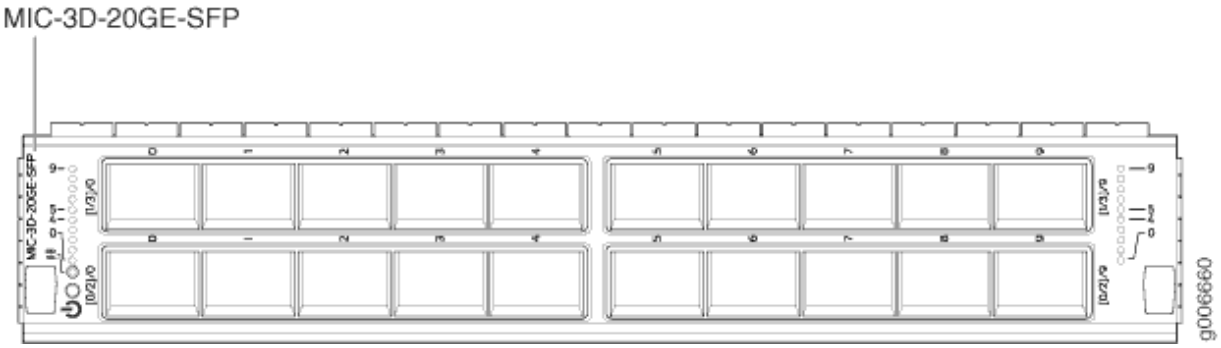
RELATED DOCUMENTATION

MX Series MIC Overview | 29

Gigabit Ethernet MIC with SFP

IN THIS SECTION

Figure 17: 20-Port Gigabit Ethernet MIC with SFP



Software release	• Junos 10.1 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• 20 Gigabit Ethernet ports • Power requirement: 0.77 A @ 48 V (37 W) • Weight: 1.2 lb (0.54 kg) • Model number: MIC-3D-20GE-SFP • Name in the CLI: `3D 20GE SFP`

Hardware features	• High-performance throughput on each port at speeds up to 1 Gbps • Autonegotiation between Gigabit Ethernet circuit partners • Up to 20-Gbps of full-duplex traffic • Maximum transmission units (MTUs) of up to 9192 bytes
Software features	• Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID)
Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the MPC is installed • pic: The logical PIC number on the MIC, numbered 0, 1, 2, and 3. • port: 0 through 9 For example, ge-3/3/0 is the interface for port 0 in PIC 3 on the MPC installed in slot 3. Figure 18 on page 270, Figure 19 on page 271, and Figure 20 on page 272 show examples of the port numbering for the Gigabit Ethernet MIC with SFP installed in an MX960, MX480, and MX240, respectively.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. Link LED, one green per port: • Off—No link. • On steadily—Link is up.

Port Numbering

Figure 18 on page 270, Figure 19 on page 271, and Figure 20 on page 272 show examples of the port numbering for the Gigabit Ethernet MIC with SFP on the MX960, MX480, and MX240, respectively.

Figure 18: Port Numbering for the Gigabit Ethernet MIC with SFP (MX960)

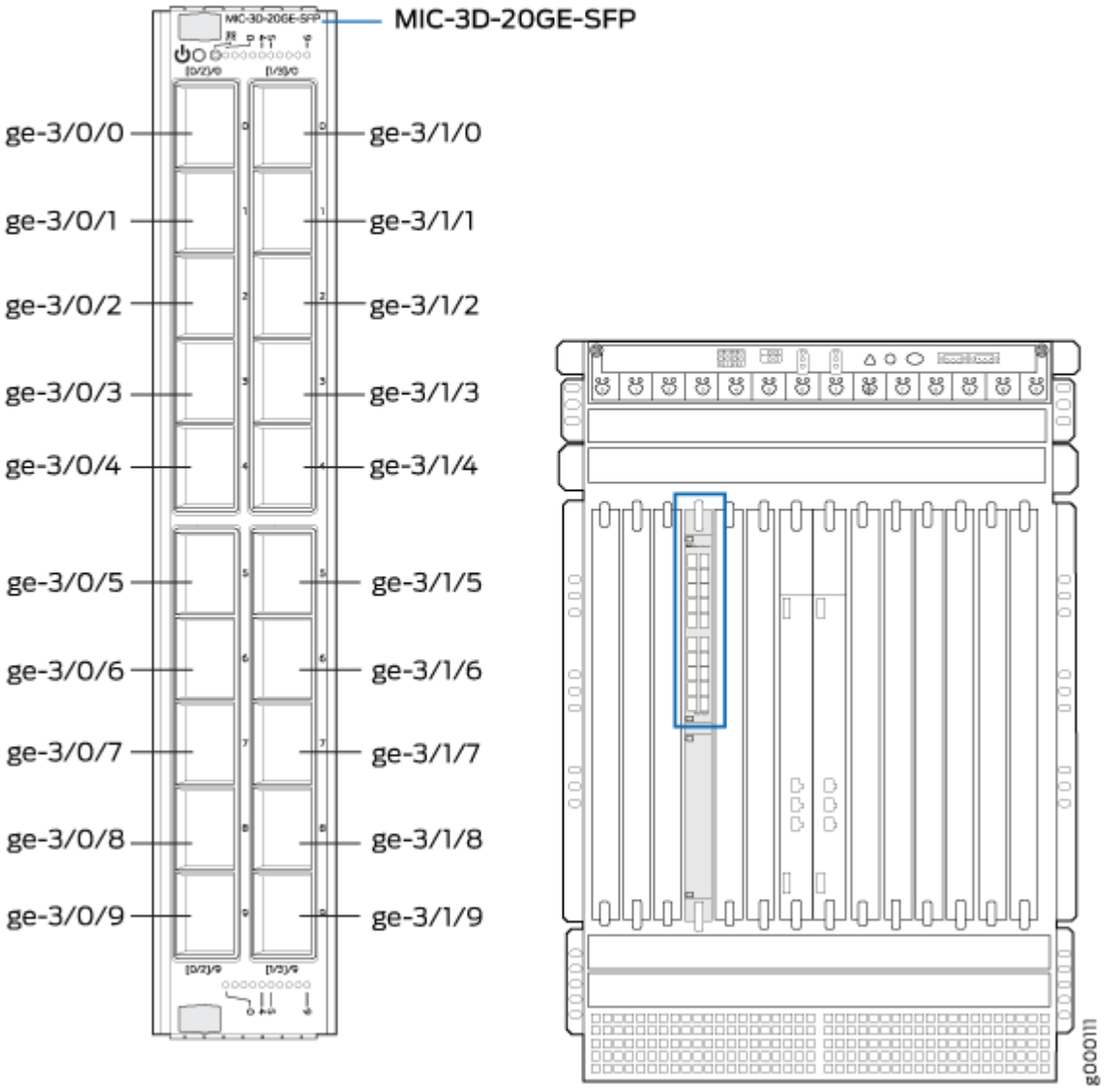


Figure 19: Port Numbering for the Gigabit Ethernet MIC with SFP (MX480)

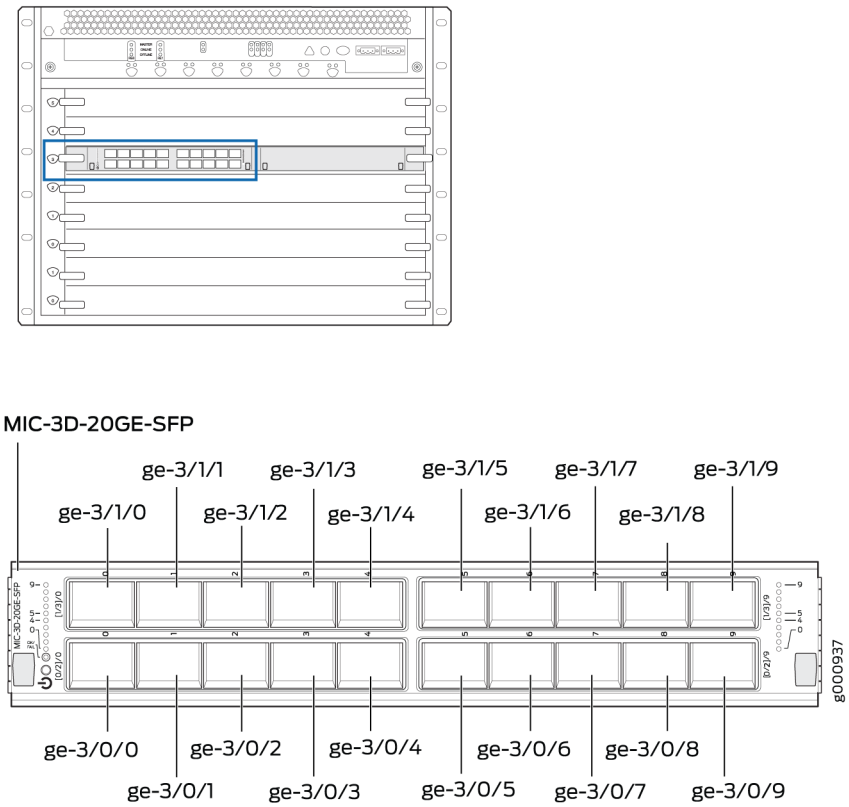
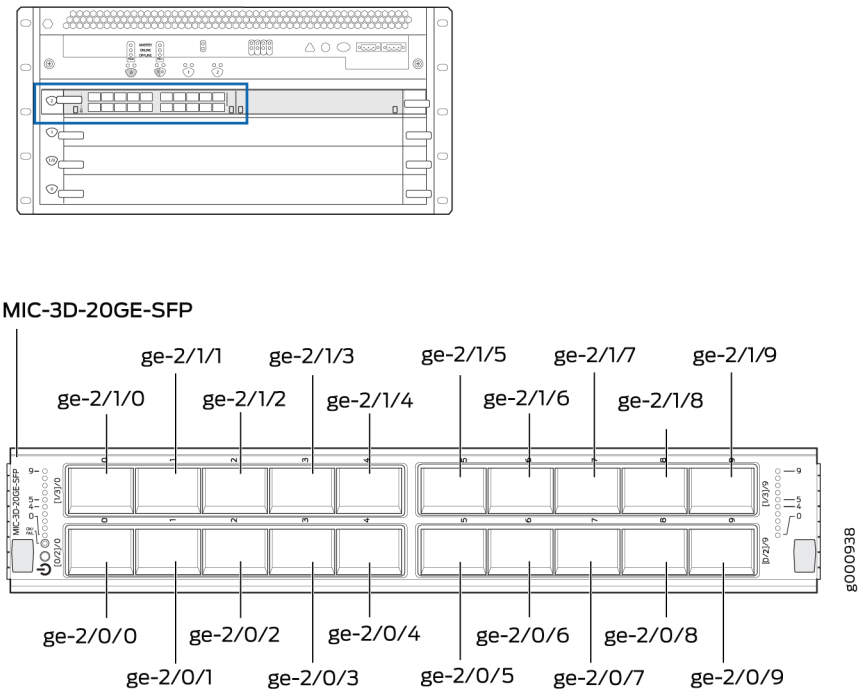


Figure 20: Port Numbering for Gigabit Ethernet MIC with SFP (MX240)

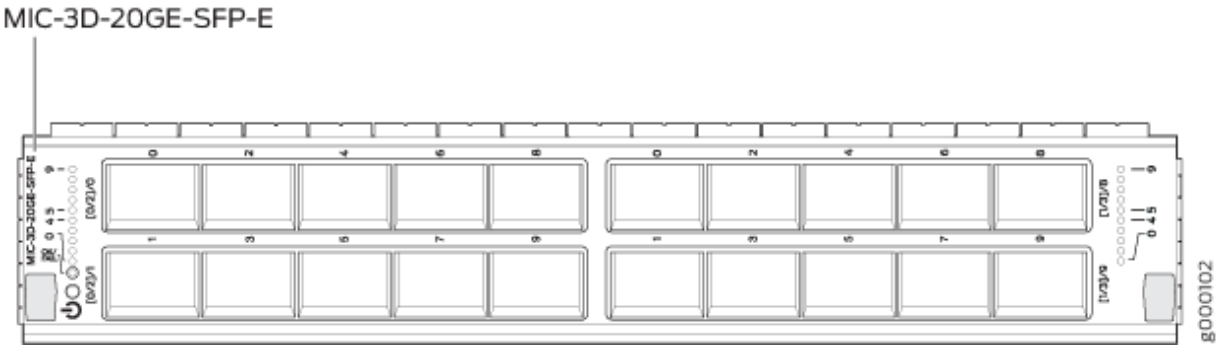


RELATED DOCUMENTATION

MX Series MIC Overview | 29

Gigabit Ethernet MIC with SFP (E)

Figure 21: 20-Port Gigabit Ethernet MIC with SFP (E)



Software release	• Junos 13.2R2 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• 20 Gigabit Ethernet ports • Power requirement: 0.77 A @ 48 V (37 W) • Weight: 1.2 lb (0.54 kg) • Model number: MIC-3D-20GE-SFP-E • Name in the CLI: `3D 20x 1GE(LAN)-E,SFP`
Hardware features	• High-performance throughput on each port at speeds up to 1 Gbps • Auto-negotiation between Gigabit Ethernet circuit partners • Up to 20-Gbps of full-duplex traffic • Maximum transmission units (MTUs) of up to 9192 bytes • Environmentally hardened for 32° F (0° C) to 131° F (55° C) operating temperatures • SEC PHY • Timing PHY

Software features	• Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID) • Precision Time Protocol (PTP) or IEEE 1588v2 • Media Access Control Security (MACsec)
Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the MPC is installed. The MPCs are represented in the CLI as `FPC0` through `FPC19`. • pic: The logical PIC number on the MIC, numbered 0 or 1. Figure 22 on page 275, Figure 23 on page 276, and Figure 24 on page 277 illustrate the port numbering for the Gigabit Ethernet MIC with SFP (E) installed in the MX960, MX480, and MX240, respectively. • port: 0 through 9. For example, ge-3/1/0 is the interface for port 0 in PIC 1 on the MPC installed in slot 3. Figure 22 on page 275, Figure 23 on page 276, and Figure 24 on page 277 illustrate the port numbering for the MIC-3D-20GE-SFP-E installed in an MX960, MX480, and MX280, respectively.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. Link LED, one green per port: • Off—No link. • On steadily—Link is up.

Figure 22: Port Numbering for the MIC-3D-20GE-SFP-E (MX960)

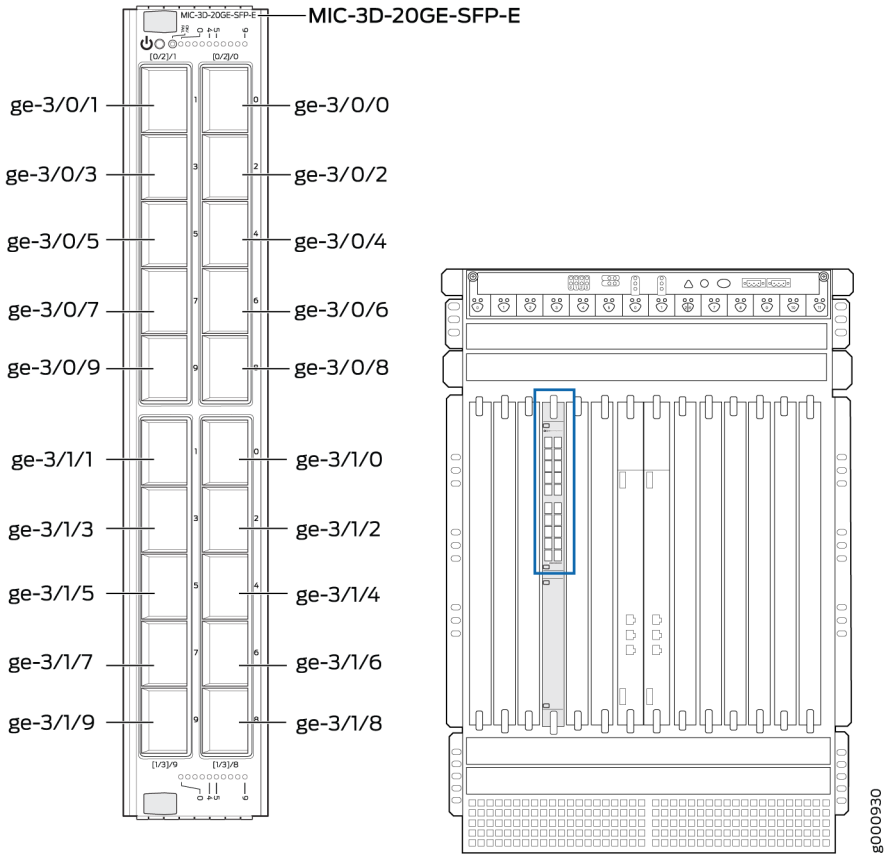
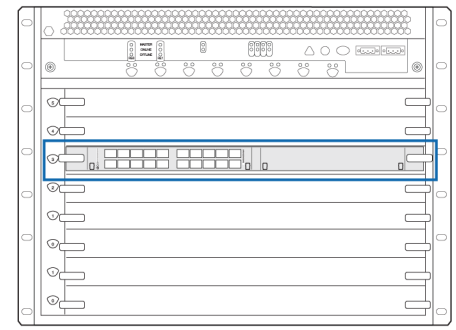


Figure 23: Port Numbering for the MIC-3D-20GE-SFP-E (MX480)



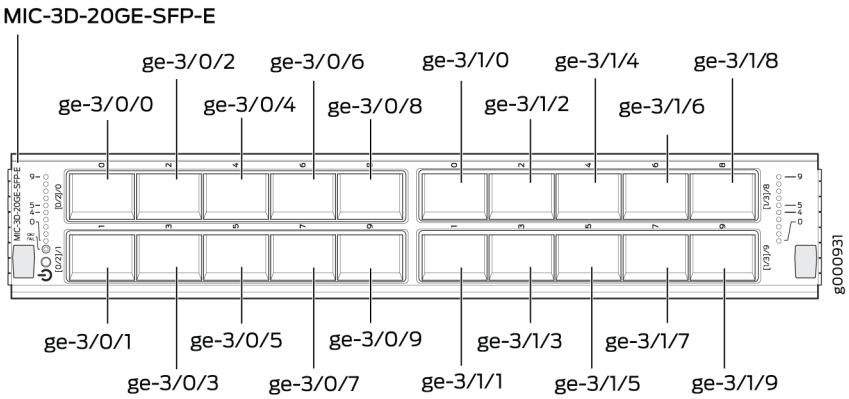
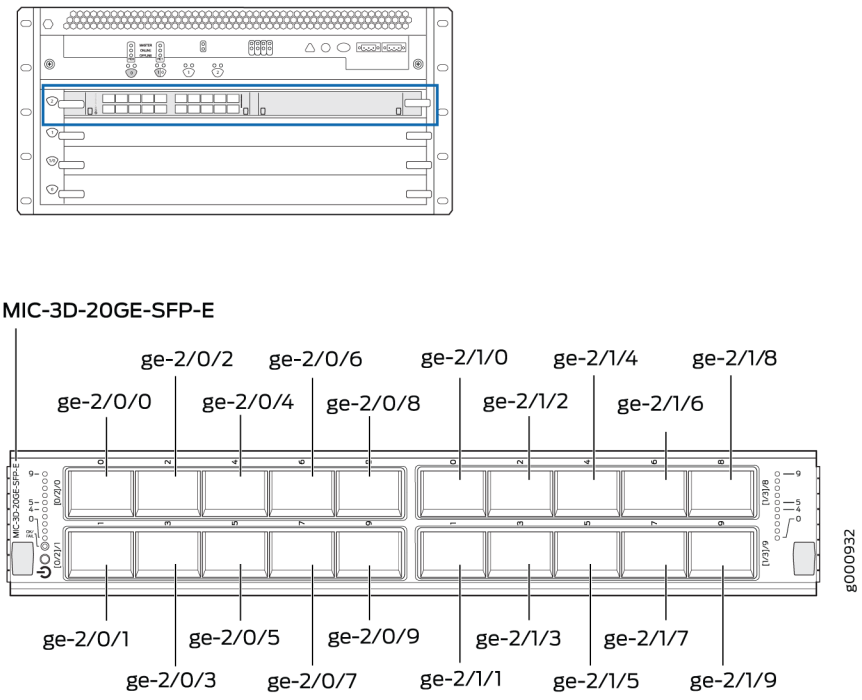


Figure 24: Port Numbering for the MIC-3D-20GE-SFP-E (MX240)

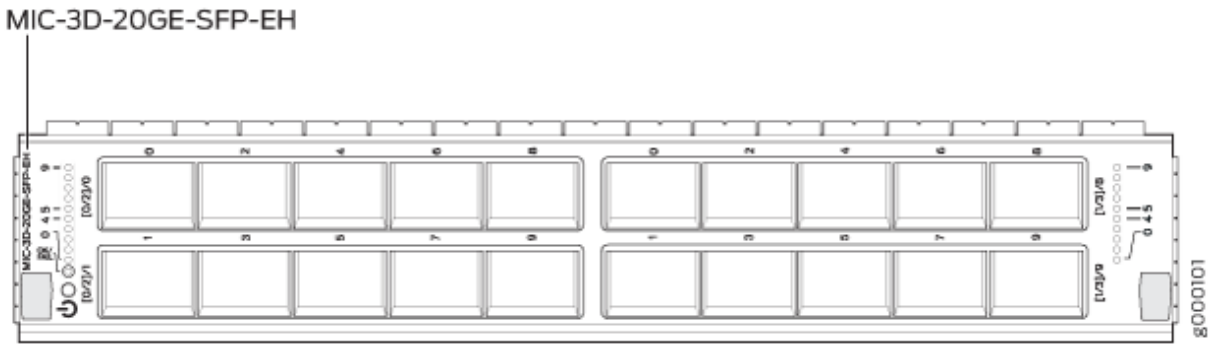


RELATED DOCUMENTATION

MX Series MIC Overview | 29

Gigabit Ethernet MIC with SFP (EH)

Figure 25: 20-Port Gigabit Ethernet MIC with SFP (EH)



Software release	• Junos 13.2R2 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• 20 Gigabit Ethernet ports • Power requirement: 0.77 A @ 48 V (37 W) • Weight: 1.2 lb (0.54 kg) • Model number: MIC-3D-20GE-SFP-EH • Name in the CLI: `3D 20x 1GE(LAN)-EH,SFP`
Hardware features	• High-performance throughput on each port at speeds up to 1 Gbps • Autonegotiation between Gigabit Ethernet circuit partners • Up to 20-Gbps of full-duplex traffic • Maximum transmission units (MTUs) of up to 9192 bytes • Environmentally hardened for –40° F (–40° C) to 149° F (65° C) operating temperatures • SEC PHY • Timing PHY

Software features	• Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID) • Precision Time Protocol (PTP) or IEEE 1588v2 • Media Access Control Security (MACsec)
Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the MPC is installed • pic: 0 (left grouping of 10 ports) or 1 (right grouping of 10 ports) when installed in MIC slot 0; 2 (left grouping of 10 ports) or 3 (right grouping of 10 ports) when installed in MIC slot 1 • port: 0 through 9 For example, ge-1/3/0 is the interface for port 0 in the right grouping of ports on the MIC installed in MIC slot 1 on an MPC installed in slot 1.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

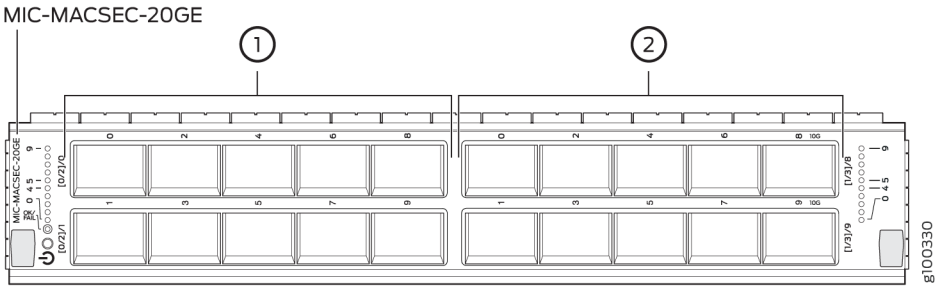
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. Link LED, one green per port: • Off—No link. • On steadily—Link is up.

RELATED DOCUMENTATION

MX Series MIC Overview | 29

Gigabit Ethernet MIC with 256b-AES MACsec

Figure 26: 20-Port Gigabit Ethernet MIC with MACsec



1– PIC0 ports

2– PIC1 ports (Ports 8 and 9 are 10-Gbps ports)

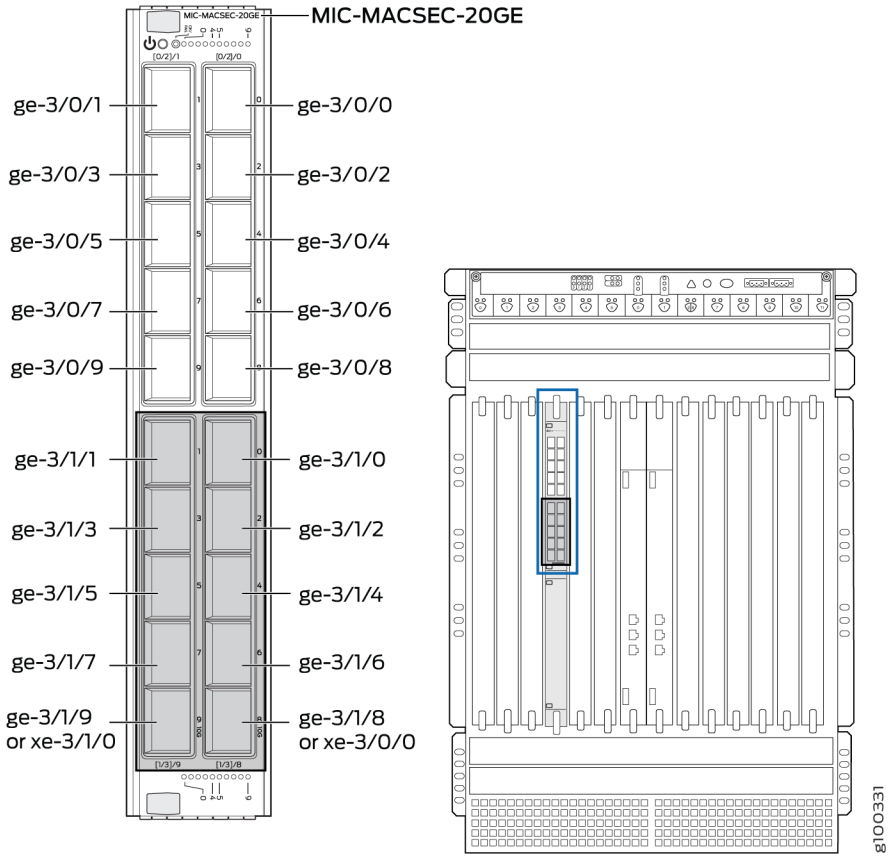
Software release	• Junos 18.3R1 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• 20 Gigabit Ethernet ports • Typical power requirement: 1A @ 48V (48 W) Maximum power requirement: 1.25A @ 48V (60 W) • Weight: 1.7 lb (0.77 kg) • Model number: MIC-MACSEC-20GE • Name in the CLI (MIC): `2x10GE SFPP/20x10GE SFP MACSEC` Name in the CLI (PIC): `1x10GE SFPP/10x1 GE SFP MACSEC` **NOTE**: FPCs in the MX240, MX480, MX960 routers and the FEB in the MX80 and MX104 routers undergo an automatic bounce or a reboot when the port speed alternates between 1-Gbps and 10-Gbps.
Hardware features	• 20 SFP ports supporting 20 SFP optics modules operating in 1-Gbps mode or two SFP+ ports supporting 2 SFP+ optics modules operating in 10-Gbps mode. **NOTE**: The MIC can operate either in 2x10-Gbps mode or in 20x1-Gbps mode. Mixed mode (1x10G + 10x1G) is not supported. • Up to 20-Gbps of full-duplex traffic • Maximum transmission units (MTUs) of up to 9192 bytes • SEC PHY

Software features	• Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID) • Media Access Control Security (MACsec) **NOTE**: Auto-negotiation is not supported on PHY8490 ports when the MIC is operating in the 20x1-Gbps mode. To establish connection, you must disable auto-negotiation on both the router and the peer device (using the `edit interfaces` *`interface-name`* `gigether-option no-auto-negotiation` statement).
xInterfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the MPC is installed. The MPCs are represented in the CLI as `FPC0` through `FPC9`. • pic: The logical pics in MIC0 are 0 and 1, while in MIC1, they are 2 and 3. Figure 27 on page 283, illustrates the port numbering for the Gigabit Ethernet MIC with MACsec installed in the MX960. • port: 0 through 9. For example, ge-3/1/0 is the interface for port 0 in PIC 1 on the MPC installed in slot 3. Figure 27 on page 283, illustrate the port numbering for the MIC-MACSEC-20GE installed in an MX960. **NOTE**: When the MIC is operating in the 10-Gbps mode, all the other 1-Gbps ports are disabled.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. Green Status LED, one per port: • Off—Not enabled. • On steadily—Port is online with no alarms or failures.

Figure 27: Port Numbering for the MIC-MACSEC-20GE



NOTE: In the 10-Gbps mode, the last two ports of the MIC which are marked as **10G** (**[1 / 3] / 8** and **[1 / 3] / 9**) can be used as 10-Gbps ports.

NOTE: When the MIC is operating in the 10-Gbps mode, all the other 1-Gbps ports are disabled.

NOTE: Tri-rate copper SFPs are not supported on the dual-rate 1G/10G (PHY8490) ports (marked **[1 / 3] / 8** and **[1 / 3] / 9**) on the MIC.

RELATED DOCUMENTATION

MX Series MIC Overview | 29

10-Gigabit Ethernet MICs with XFP

Figure 28: 2-Port 10-Gigabit Ethernet MIC with XFP

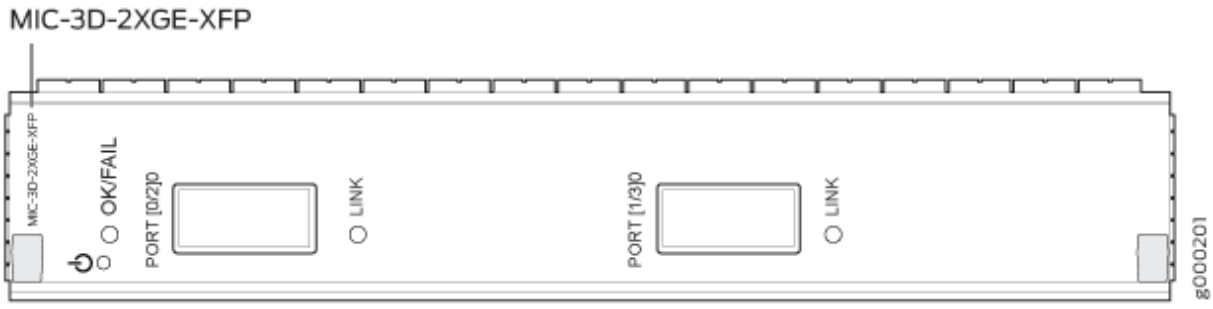
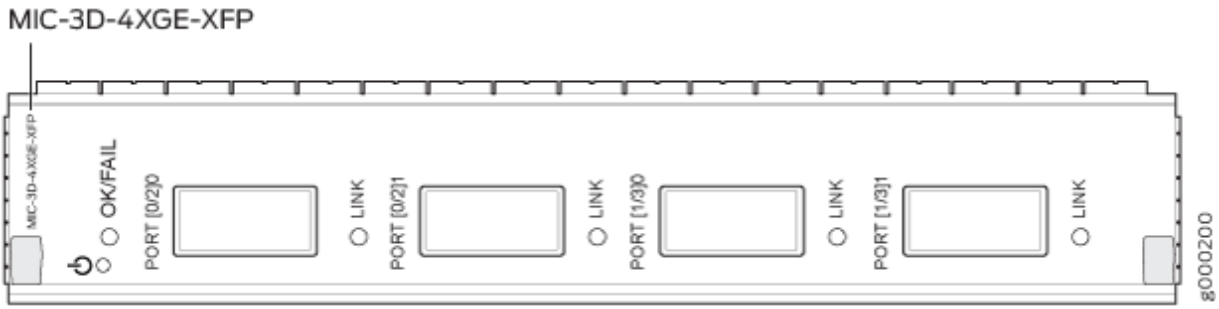


Figure 29: 4-Port 10-Gigabit Ethernet MIC with XFP



Software release	• 2-port: Junos 10.2 and later • 4-port: Junos 10.1 and later For information on which MPCs support these MICs, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• Two or four 10-Gigabit Ethernet ports
	• Power requirement:
	  • 2-port: 0.6 A @ 48 V (29 W)
	  • 4-port: 0.56 A @ 48 V (27 W)
	• Weight:
	  • 2-port: 1 lb (0.45 kg)
	  • 4-port: 1.1 lb (0.5 kg)
	• Model number:
	  • 2-port: MIC-3D-2XGE-XFP
	  • 4-port: MIC-3D-4XGE-XFP
	• Name in the CLI:
	  • 2-port: `3D 2X10GE XFP`
	  • 4:-port `3D 4X10GE XFP`

Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.953 Gbps • Maximum transmission units (MTUs) of up to 9192 bytes
Software features	• Configurable LAN-PHY and WAN-PHY mode options • Synchronous Ethernet support • Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID)

Interfaces	Syntax: xe-*fpc/pic/port* where:
	• fpc: Slot in the router where the MPC is installed
	• pic:
	  • 2-port: 0 or 1 when installed in MIC slot 0; 2 or 3 when installed in MIC slot 1
	  • 4-port: 0 or 1 when installed in MIC slot 0; 2 or 3 when installed in MIC slot 1
	• port:
	  • 2-port: 0
	  • 4-port: 0 or 1
	For example, xe-1/3/0 is the interface for port 0 on the MIC installed in MIC slot 1 on an MPC installed in slot 1.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is up with or without activity. The ports are labeled (see Figure 30 on page 288 and Figure 31 on page 288). • 2-port: **[0/2]0**, **[1/3]0** • 4-port: **[0/2]0**, **[0/2]1**, **[1/3]0**, and **[1/3]1**

Figure 30: Port Numbering for 2-Port 10-Gigabit Ethernet MIC with XFP

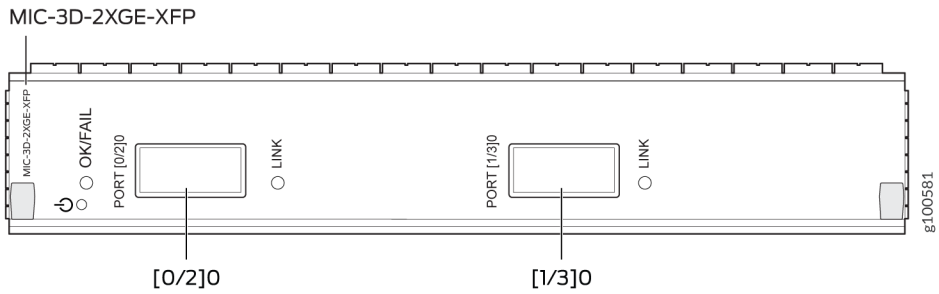
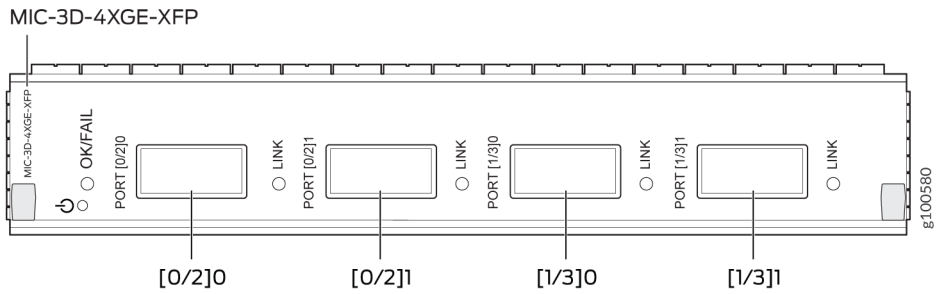


Figure 31: Port Numbering for 4-Port 10-Gigabit Ethernet MIC with XFP

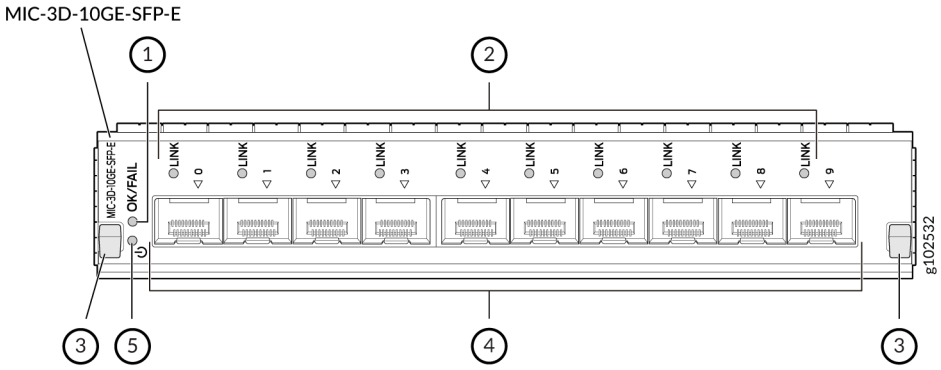


RELATED DOCUMENTATION

MX Series MIC Overview | 29

1-Gigabit/10-Gigabit Ethernet MIC with SFP+ (10 Ports)

Figure 32: 1-Gigabit/10-Gigabit Ethernet MIC with SFP+ (10 Ports)



1– MIC LED	4– Ports
2– Link LEDs	5– MIC Power Button
3– Ejector Levers	

You can switch the Modular Interface Card (MIC) on or off by pressing the MIC power button using a pin.

Table 37: Specifications of 1-Gigabit/10-Gigabit Ethernet MIC with SFP+ (10 Ports)

Software release	• Junos OS Release 24.2R1 and later

Description	• Transceiver: Ten 1GbE/10GbE small form-factor pluggable plus (SFP+) ports that support Media Access Control Security (MACsec) **NOTE**: Do not install 1GbE small form-factor pluggable (SFP) and 10GbE small form-factor pluggable plus (SFP+) transceivers in the MIC at the same time. • Power requirement: 3.75 A @ 12 V (45 W) • Weight: 1.1 lb (0.50 kg) • Model number: MIC-3D-10GE-SFP-E • Name in the CLI: `10x 10GE SFPP / 10x 1GE SFP MACsec` • Modular Port Concentrators (MPCs) that support the MIC: MPC2E-3D-NG, MPC2E-3D-NG-Q, MPC3E-3D-NG, and MPC3E-3D-NG-Q • Routers that support the MIC: MX240, MX480, MX960, MX2010, and MX2020
Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • Hot-removable and hot-insertable field-replaceable unit (FRU)—You can remove and replace the MIC without powering off the MPC or router or disrupting the MPC or router functions. • Maximum transmission units (MTUs) of up to 9500 bytes • Support for SFP/SFP+ optical transceivers

Software features	• Configurable LAN-PHY mode option at 10.3125 Gbps per port • Flexible Ethernet encapsulation • IEEE 802.1Q virtual LANs (VLANs) • MAC accounting and policing—Dynamic local address learning of source MAC addresses • MACsec • Multiple Tag Protocol Identifiers (TPIDs) • Optical diagnostics and related alarms • Precision Time Protocol (PTP): G.8275.1 profile and G.8275.1 profile over LAG • PTP: IEEE1588 default profile in IPv4 unicast mode • Remote monitoring (RMON) EtherStats • Synchronous Ethernet • Virtual Router Redundancy Protocol (VRRP)
Environmental tolerances	• Normal operation ensured in the temperature range of 32° F through 104° F (0° C through 40° C) • Nonoperating storage temperature in the shipping container in the range of –40° F through 158° F (–40° C through 70° C) • Short-term operation ensured in the relative humidity range of 5% through 90% RH noncondensing

Cables and connectors

TIP: You can use the Hardware Compatibility Tool to find information about the optical transceivers supported on your Juniper Networks device.

NOTE:

- **Commercial temperature rated optical transceivers**—The operating temperature range for commercial temperature rated optical transceivers is from 32° F through 158° F (0° C through 70° C). The MIC-3D-10GE-SFP-E MIC supports optical transceivers that require less than 1.5 W power at ambient temperatures of up to 115° F (46° C). The MIC supports optical transceivers that require more than 1.5 W power at ambient temperatures of up to 104° F (40° C).

- **Industrial temperature rated and extended temperature rated optical transceivers**—The operating temperature range for industrial temperature rated optical transceivers is from –40° F through 185° F (–40° C through 85° C).

  The operating temperature range for extended temperature rated optical transceivers is greater than that for the commercial temperature rated optical transceivers and lower than that for the industrial temperature rated optical transceivers. For example, the operating temperature ranges from 14° F through 167° F (–10° C through 75° C) or –4° F through 185° F (–20° C through 85° C). The industrial temperature rated and extended temperature rated optical transceivers are denoted with suffixes -ET or -XT.

  The MIC-3D-10GE-SFP-E MIC supports industrial temperature rated optical transceivers that require more than 1.7 W power at ambient temperatures of up to 115° F (46° C).

  The MIC-3D-10GE-SFP-E MIC supports industrial temperature rated and extended temperature rated optical transceivers that require less than 1.7 W power at ambient temperatures of up to:

  - 142° F (61° C) on MX240 and MX480 routers
  - 142° F (61° C) in MX960 routers, except when the MIC is installed in a Dense Port Concentrator (DPC) in slot 11
  - 115° F (46° C) on MX2010 and MX2020 routers

- **High-power industrial and extended temperature rated optical transceivers**—The MIC-3D-10GE-SFP-E MIC supports the following high-power industrial and extended temperature rated optical transceivers at ambient temperatures of up to 115° F (46° C):

  - SFPP-10GE-ZR-IT

- SFPP-10GE-ZR-OTN-XT
- SFPP-10GE-ER-IT
- SFPP-10GE-DWDM-IT

LEDs	MIC status LED • Green, on steadily—The MIC is powered on and functioning normally. • Amber—The MIC is powering on. **LINK** LED, one per port: • Green—The port is up; the link is active. • Amber—The port is detecting alarms; the link is not active. • Off—The port is disabled.

The MIC has one logical PIC. When the MIC is installed in slot 0 of an MPC, the PIC number is 0; when the MIC is installed in slot 1 of an MPC, the PIC number is 2. For example, when the MIC is installed in slot 1 of an MPC installed in slot 3 of a router, the interfaces are numbered xe-3/2/0 through xe-3/2/9.

RELATED DOCUMENTATION

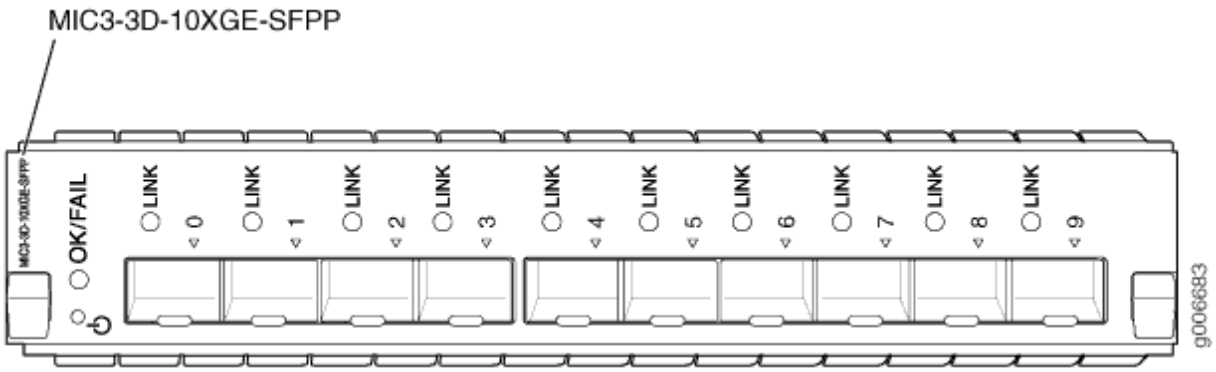
MX Series MIC Overview | 29

MICs Supported by MX Series Routers | 30

MIC/MPC Compatibility | 46

10-Gigabit Ethernet MIC with SFP+ (10 Ports)

Figure 33: 10-Gigabit Ethernet MIC with SFP+



Software release	• Junos 12.3 and later
Description	• Ten 10-Gigabit Ethernet ports • Power requirement: 0.62 A @ 48 V (29.8 W) • Weight: 1.54 lb (0.70 kg) • Model number: MIC3-3D-10XGE-SFPP • Name in the CLI: `3D 10xGE SFPP`
Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • Supports 10 SFP+ pluggable optic ports • Voltage Sequencer for local voltage sequence control and monitoring • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.95328 Gbps • Maximum transmission units (MTUs) of up to 9192 bytes

Software features	• Configurable LAN-PHY and WAN-PHY mode options per port • Synchronous Ethernet support • Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID)
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: SFPP-10GE-ZR has a commercial temperature rating and is not NEBS compliant when plugged into the 10-Gigabit Ethernet MIC with SFP+. If the ambient air temperature exceeds 40 degrees C, the software disables the transmitter, which takes the optical transceiver offline. **NOTE**: SFPP-10G-DT-ZRC2 is not NEBS compliant when plugged into the MIC3-3D-10XGE-SFPP MIC. If the ambient air temperature exceeds 40 degrees C, Junos OS disables the transmitter, which takes the optical transceiver offline.

LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. **LINK** LED, one per SFP+ port: • Off—No link. • Green—Link is up. • Yellow—Link is disabled. The ports are labeled: • **Port [0]** to **Port [9]**

NOTE: The MIC3-3D-10XGE-SFPP MIC has one logical PIC. When the MIC is installed in slot 0 of an MPC the PIC number is 0, and when the MIC is installed in slot 1 of an MPC the PIC number is 2. For example, when the MIC is installed in slot 3 of the MX960 router, in slot 1 of the MPC, the interfaces are numbered xe-3/2/0 through xe-3/2/9.

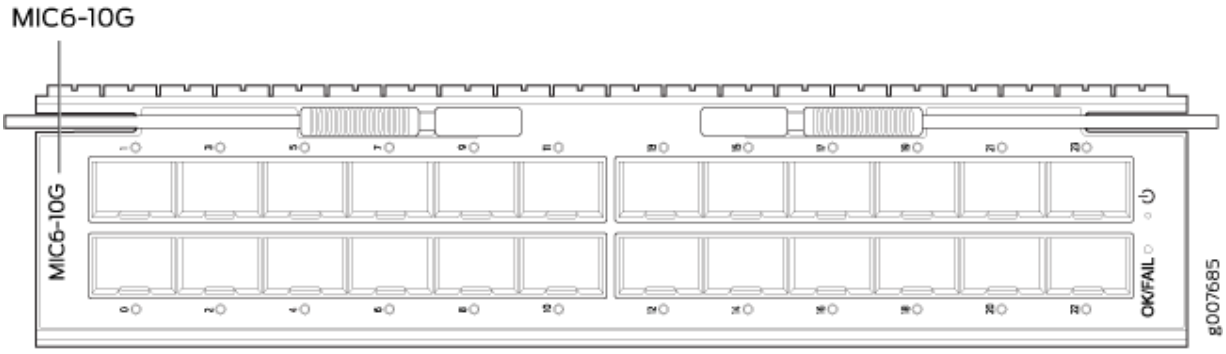
RELATED DOCUMENTATION

MX Series MIC Overview | 29

MICs Supported by MX Series Routers | 30

MIC/MPC Compatibility | 46

10-Gigabit Ethernet MIC with SFP+ (24 Ports)



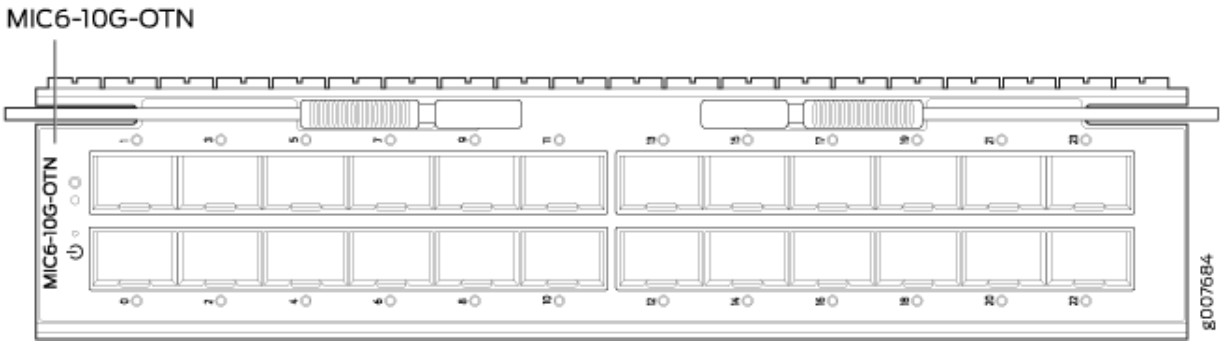
Software release	• Junos 13.3R2 and later For information about which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information about which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• Twenty-four 10-Gigabit Ethernet ports • Power requirement: 7.1 A @ 10.4 V (74 W) • Weight: 3.2 lb (1.45 kg) • Model number: MIC6-10G • Name in the CLI: `24x10GE SFPP`
Hardware features	• Supports 24 SFP+ pluggable optic ports • High-performance throughput on each port at speeds up to 10 Gbps • LAN-PHY mode at 10.3125 Gbps • WAN-PHY mode at 9.95328 Gbps • Supports LOS-squelch, enabling Synchronous Ethernet fast-clock-failover on a port down event • Maximum transmission units (MTUs) of up to 9192 bytes

Software features	• Configurable LAN-PHY and WAN-PHY mode options per port • Compliant to ITU-T specifications • Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • IEEE 802.1ad support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • In-service software upgrade (Unified ISSU)
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Yellow—MIC is coming online. • Red—MIC has failed. **LINK** LED, one bicolor per SFP+ port: • Off—No link. • Green—Link is up. • Yellow—Link is disabled. The ports are labeled: • Port **[0]** to Port **[23]**

RELATED DOCUMENTATION

MX Series MIC Overview | 29

10-Gigabit Ethernet OTN MIC with SFP+ (24 Ports)



Software release	• Junos 13.3R3 and later For information about which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information about which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• Twenty-four 10-Gigabit optical transport network (OTN) ports for transport of 10-Gigabit Ethernet (10GBASE-R) traffic • Power requirement: 1.5 A @ 52 V (84 W) • Weight: 3.4 lb (1.54 kg) • Model number: MIC6-10G-OTN • Name in the CLI: `24x10GE OTN`

Hardware features	• High-performance throughput on each port at speeds up to 10 Gbps • LAN-OTU2e mode (G.Sup43, 7.1) at 11.09 Gbps • WAN-OTU2 mode (G.Sup43, 6.1) at 10.70 Gbps • Supports LOS-squelch, enabling Synchronous Ethernet fast-clock-failover on a port-down event • Provides IEEE 1588 time-stamping at physical interface for improved accuracy • Maximum transmission units (MTUs) of up to 9192 bytes
Software features	• OTN support for 10-Gigabit Ethernet interface • Compliant with ITU-T specifications • Transparent transport of 10-Gigabit Ethernet signals with optical channel transport unit 2 (OTU2/OTU2e) framing • Optical diagnostics and related alarms • Configurable LAN-PHY, WAN-PHY, or OTN mode options per port • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q VLAN support • IEEE 802.1ad support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • In-service software upgrade (Unified ISSU)
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

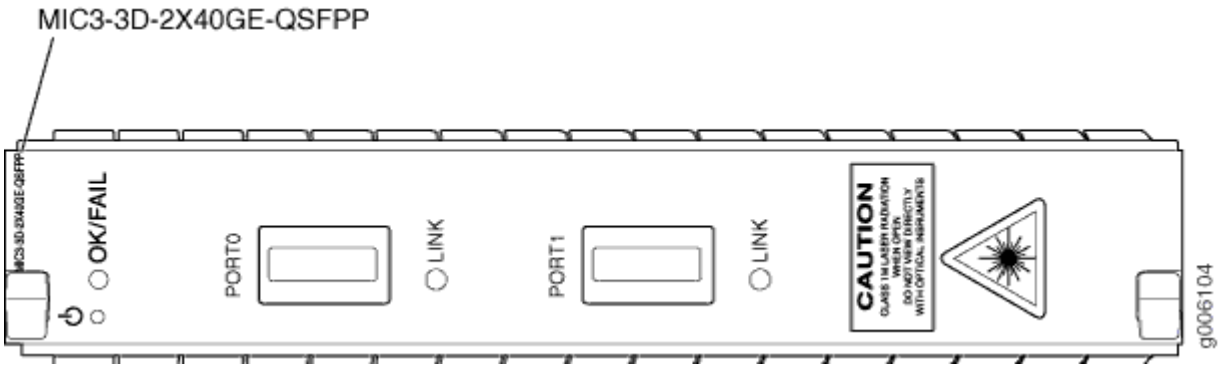
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Yellow—MIC is coming online. • Red—MIC has failed. **LINK** LED, one bicolor per port: • Off—No link. • Green—Link is up. • Yellow—Link is disabled. The ports are labeled: • Port **[0]** through Port **[23]**

RELATED DOCUMENTATION

MX Series MIC Overview | 29

40-Gigabit Ethernet MIC with QSFP+

Figure 34: 40-Gigabit Ethernet MIC with QSFP+



Software release	• 12.2 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• Two 40-Gigabit Ethernet ports • Power requirement: 0.38 A @ 48 V (18 W) • Weight: 1.19 lb (0.54 kg) • Model number: MIC3-3D-2X40GE-QSFPP
Hardware features	• High-performance throughput on each port at speeds up to 40 Gbps • Up to 40-Gbps of full-duplex traffic • Maximum transmission units (MTUs) of up to 9192 bytes
Software features	• Synchronous Ethernet support • Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID)
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

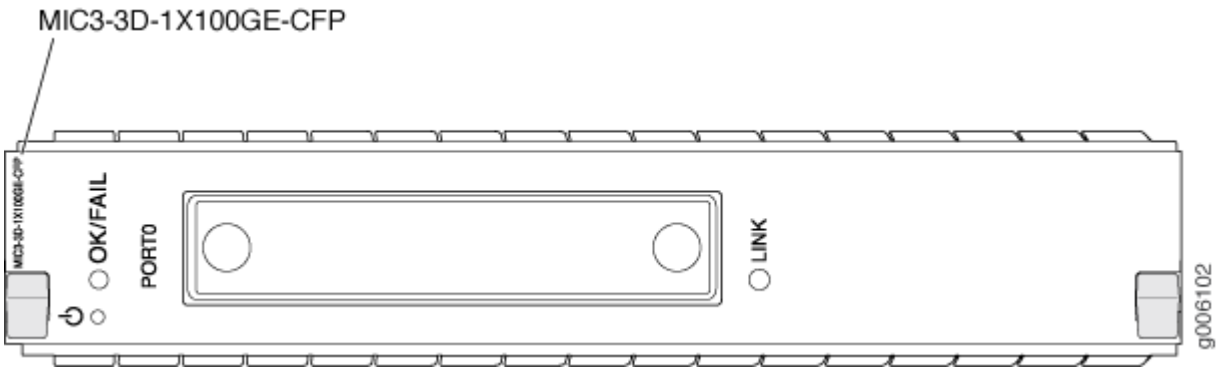
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is up with or without activity. • Yellow—Link is disabled. The ports are labeled: • PORT [0] - PORT [1]

RELATED DOCUMENTATION

MX Series MIC Overview | 29

100-Gigabit Ethernet MIC with CFP

Figure 35: 1-Port 100 Gigabit Ethernet MIC with CFP



Software release	• 12.1 and later For information about which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information about which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• One 100-Gigabit Ethernet port • Power requirement: 0.83 A @ 48 V (40 W) • Weight: 1.94 lb (0.88 kg) • Model number: MIC3-3D-1X100GE-CFP • Name in the CLI: `1X100GE CFP`
Hardware features	• High-performance throughput on each port at speeds up to 100 Gbps • Up to 100-Gbps of full-duplex traffic • Maximum transmission units (MTUs) of up to 9192 bytes • The port is labeled **PORT0**
Software features	• Synchronous Ethernet support • Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID)

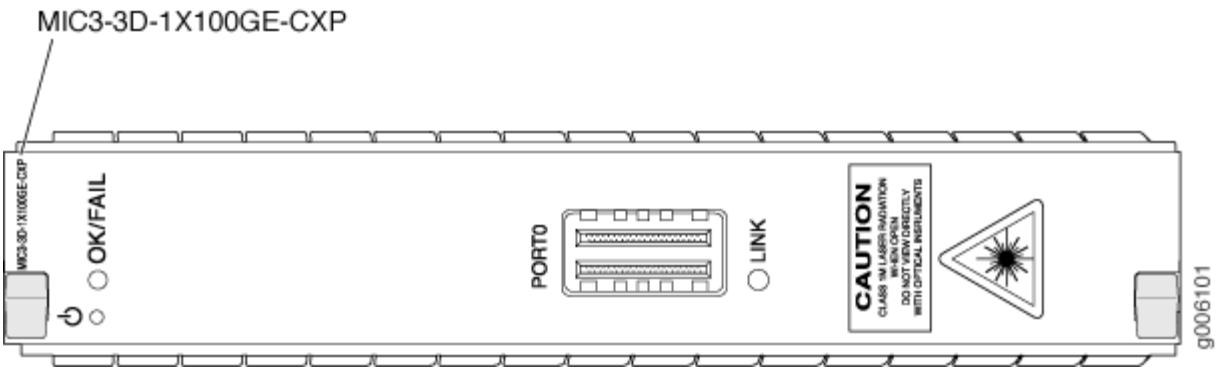
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: The CFP-100GBASE-ER4 transceiver is NEBS-compliant in the 100-Gigabit Ethernet MIC with CFP, but only when the other MIC slot in the MPC3E is empty. If another MIC is present and the ambient temperature exceeds 40 degrees C, the software converts CFP-100GBASE-ER4 to low power mode, which takes the transceiver offline. • Fiber-optic 100-Gigabit C form-factor Plugabble **NOTE**: The CFP-100GBASE-ZR transceiver is NEBS compliant in the 100-Gigabit Ethernet MIC with CFP, but only when the other MIC slot in the MPC3E is empty. If another MIC is present and the ambient air temperature exceeds 40 degrees C, the software disables the transmitter, which takes the optical transceiver offline. The other MIC slot must be filled with a blank panel.
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is up. • Yellow—Link is disabled.

RELATED DOCUMENTATION

MX Series MIC Overview | 29

100-Gigabit Ethernet MIC with CXP

Figure 36: 100-Gigabit Ethernet MIC with CXP



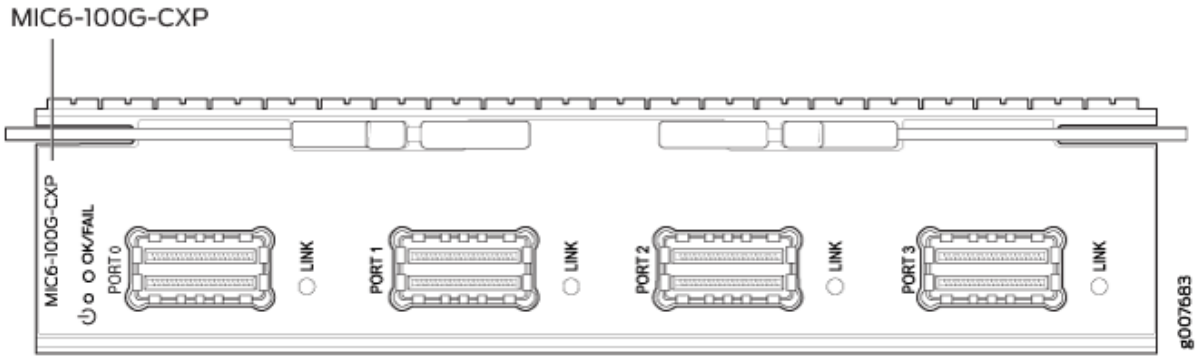
Software release	• 12.2 and later For information about which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information about which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• One 100-gigabit Ethernet port • Power requirement: 0.42 A @ 48 V (20 W) • Weight: 1.03 lb (0.47 kg) • Model number: MIC3-3D-1X100GE-CXP • Name in the CLI: `3D 1x100GE CXP`
Hardware features	• High-performance throughput on each port at speeds up to 100 Gbps • Up to 100-Gbps of full-duplex traffic • Maximum transmission units (MTUs) of up to 9192 bytes • The port is labeled **PORT0**

Software features	• Synchronous Ethernet support • Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID)
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. **LINK** LED, one green per port: • Off—No link. • On steadily—Link is up with or without activity. • Yellow—Link is disabled.

RELATED DOCUMENTATION

MX Series MIC Overview | 29

100-Gigabit Ethernet MIC with CXP (4 Ports)



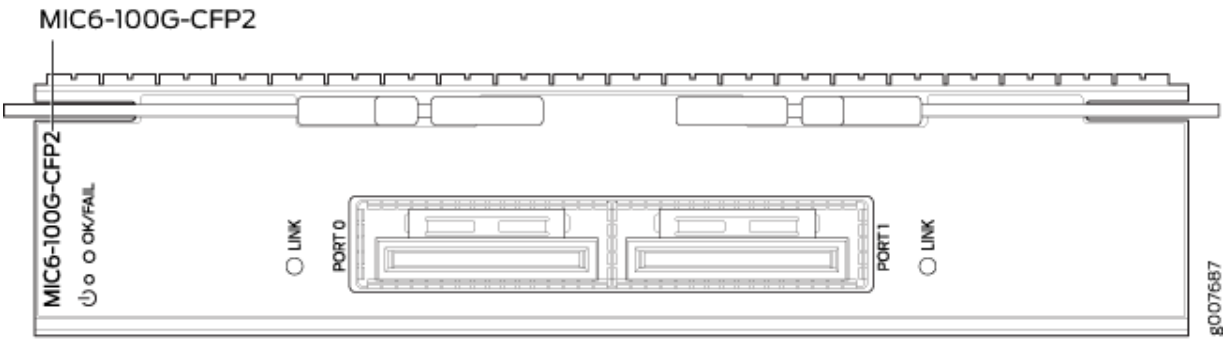
Software release	• Junos 13.3R2 and later For information about which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information about which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• Four 100-Gigabit Ethernet ports • Power requirement: 5.5 A @ 10.4 V (57 W) • Weight: 2.7 lb (1.22 kg) • Model number: MIC6-100G-CXP • Name in the CLI: `4X100GE CXP`
Hardware features	• Line-rate throughput of up to 100Gbps per port. • Supports 100GBASE-SR10 over CXP pluggable optics • Supports LOS-squelch, enabling Synchronous Ethernet fast-clock-failover on a port down event • Maximum transmission units (MTUs) of up to 9192 bytes

Software features	• Compliant to ITU-T specifications • Optical diagnostics and related alarms • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • IEEE 802.1ad support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • In-service software upgrade (Unified ISSU)
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
LEDs	**OK/FAIL** LED, one tricolor: • Green—MIC is functioning normally. • Yellow—MIC is coming online. • Red—MIC has failed. **LINK** LED, one bicolor per port: • Off—No link. • Green—Link is up. • Yellow—Link is disabled. The ports are labeled: • **Port 0** to **Port 3**

RELATED DOCUMENTATION

MX Series MIC Overview | 29

100-Gigabit Ethernet MIC with CFP2



Software release	• Junos 13.3R3 and later For information about which MPCs support this MIC, see *MIC/MPC Compatibility*. For information about which MICs are supported on MX Series routers, see *MICs Supported by MX Series Routers*.
Description	• Two 100-Gigabit Ethernet CFP2 ports • Power requirement: 2 A @ 52 V (104 W) • Weight: 2.4 lb (1.09 kg) • Model number: MIC6-100G-CFP2 • Name in the CLI: `2X100GE CFP2 OTN`
Hardware features	• Line-rate throughput of up to 100 Gbps per port • Supports CFP2 pluggable optics • Supports LAN (103.125 Gbps) and OTN/OTU4 (111.81 Gbps) on a per-port basis • Provides IEEE 1588 time-stamping at physical interface for improved accuracy • Maximum transmission units (MTUs) of up to 9192 bytes

Software features	• Optical transport network (OTN) support for 100-Gigabit Ethernet interfaces • Compliant with ITU-T specifications • Transparent transport of 100-Gigabit Ethernet signals with OTU4 framing • Optical diagnostics and related alarms • Configurable 100-Gigabit Ethernet or OTN options per port • Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q VLAN support • IEEE 802.1ad support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • In-service software upgrade (Unified ISSU)
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: • CFP2-100G-ER4-D is not NEBS compliant on the MX960 router in FPC slot 0 or FPC slot 11. • CFP2-DCO-T-WDM-1 is not NEBS compliant on the MX960 router or the MX2020 router in FPC slot 0 or FPC slot 11. Slots **0** and **11** can only work with an ambient temperature of up to 40° C. **NOTE**: When inserting the CFP2 transceiver, ensure that the transceiver sits tightly in the port. You will hear a distinct click sound when the latch locks into the corresponding port. The latch must be fully engaged in the corresponding port for the CFP2 transceiver to function properly. Failing to do so will result in loss of connection. To verify that the CFP2 transceiver module is inserted properly, give a gentle pull by grasping the sides of the module. The module should sit tightly.

LEDs	**OK/FAIL** LED, one tricolor: • Green—MIC is functioning normally. • Yellow—MIC is coming online. • Red—MIC has failed. **LINK** LED, one bicolor per port: • Off—No link. • Green—Link is up. • Yellow—Link is disabled. Port labels: • **Port 0** and **Port 1**

RELATED DOCUMENTATION

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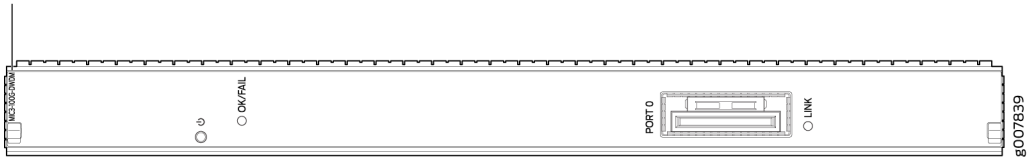
100-Gigabit DWDM OTN MIC with CFP2-ACO

MIC3-100G-DWDM



Software release	• Junos OS Release 15.1F5 and 15.1F6, Junos OS Release 17.1R1 and later For information about which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information about which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• One 100-Gigabit DWDM OTN port
	• Power requirements (including transceiver) at different temperatures:
	  • 55° C: 1.90 A @ 48 V (91 W)
	  • 25° C: 1.73 A @ 48 V (83 W)
	• Weight: 2.3 lb (1.04 kg)
	• Model number: MIC3-100G-DWDM
	• Name in the CLI: `1X100GE DWDM CFP2-ACO`

Hardware features

- Dual-wide MIC that installs into two MIC slots
- Supports CFP2 analog coherent optics (CFP2-ACO)
- Transparent transport of a 100-Gigabit Ethernet signal with OTU4V framing
- ITU-standard OTN performance monitoring and alarm management
- Dual-polarization quadrature phase shift keying (DP-QPSK) modulation
- Supports three types of forward error correction (FEC):
  - Soft-decision FEC (SD-FEC)
  - High-gain FEC (HG-FEC)
  - G.709 FEC (GFEC)
- 100 channels on C-band ITU grid with 50-GHz spacing
- Latency:
  - SD-FEC: 14 µs (TX + RX)
  - HG-FEC: 22 µs (TX + RX)
  - GFEC: 6 µs (TX + RX)
- Interoperable with the CFP-100GBASE-ZR transceiver supported on the 100-Gigabit Ethernet MIC with CFP (MIC3-3D-1X100GE-CFP) on MX Series routers and the 100-Gigabit Ethernet PIC with CFP (P1-PTX-2-100GE-CFP) on PTX Series routers.
- Interoperable with the 100-Gigabit DWDM OTN PIC with CFP2 (PTX-5-100G-WDM) on PTX Series routers when the 100-Gigabit DWDM OTN MIC is configured to use SD-FEC or GFEC.

  NOTE: The 1-port 100-Gigabit DWDM OTN MIC is not directly interoperable with the 2-port 100-Gigabit DWDM OTN PIC (P1-PTX-2-100G-WDM), but they can both operate over the same DWDM line system.

Software features

NOTE: For information about configuring the MIC, see Configuring OTN Interfaces on MIC3-100G-DWDM MIC. For information about upgrading the firmware on the PIC, see Upgrading Firmware on the 100-Gigabit DWDM OTN MIC (MIC3-100G-DWDM) .

- Compliant with ITU G.709 and G.798
- Provides a transport interface and state model (GR-1093)
- Performance monitoring features such as alarms, threshold-crossing alarms, OTU/ODU error seconds and FEC and bit error rate (BER) statistics
- SNMP management of the MIC based on *RFC 3591, Managed Objects for the Optical Interface Type*, including the following:
  - Set functionality
  - Black Link MIB
  - IFOTN MIB
  - Optics MIB
  - FRU MIB
- Pre-FEC BER monitoring provides interrupt-driven, BER-based detection of link signal degradation for MPLS fast reroute.
- User-configurable optics options:
  - Transmit (TX) laser enable and disable
  - TX output power
  - Wavelength
  - Receive (RX) LOS warning or alarm thresholds
  - Threshold crossing alarms (TCAs)

  User-configurable card options:
  - FEC mode (SD-FEC, HG-FEC, or GFEC)
  - TCAs

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: When inserting the C form-factor pluggable 2 (CFP2) transceiver, ensure that the transceiver sits tightly in the port. You hear a distinct click sound when the latch locks into the corresponding port. The latch must be fully engaged in the corresponding port for the CFP2 transceiver to function properly. Failing to do so can result in loss of connection. To verify that the CFP2 transceiver module is inserted properly, give a gentle pull by grasping the sides of the module. The module should sit tightly.
LEDs	**OK/FAIL** LED, one bicolor: • Off—MIC is powered off. • Green—MIC is initialized and online, functioning normally. • Amber—MIC is coming online, or is in fault state. **LINK** LED, one bicolor per port: • Off—Port is offline. • Solid green—Link is up. • Red—Port failure is detected. **NOTE**: The port is labeled **Port 0**.
Alarms, Errors, and Events	**NOTE**: For OTN alarms, see Table 38 on page 321. Chassis and MIC: • MIC (FRU) inserted or removed • MIC (FRU) Administrative State: In Service, Out Of Service • MIC (FRU) Operational State: Unequipped, Init, Normal, Mismatch, Fault, Upgrade • Mismatch equipment • Temperature alarm

Port (interface):

- Interface Administrative State: In Service, Out Of Service, Service MA, Out of Service MA
- Interface Operational State: Init, Normal, Fault, Degraded

Optical channel transport unit (OTU) TCAs:

- OTU-TCA-BBE—15-minute background block error TCA
- OTU-TCA-ES—15-minute far-end errored seconds TCA
- OTU-TCA-SES—15-minute severely errored seconds TCA
- OTU-TCA-UAS—15-minute unavailable seconds TCA

Optical channel data unit (ODU) TCAs:

- ODU-TCA-BBE—15-minute background block error TCA
- ODU-TCA-ES—15-minute far-end errored seconds TCA
- ODU-TCA-SES—15-minute severely errored seconds TCA
- ODU-TCA-UAS—15-minute unavailable seconds TCA

TIP: You can view OTU and ODU TCAs by using the `show interfaces transport pm otn` operational-mode CLI command.

NOTE: If you insert an invalid CFP module, the CLI displays `unsupported module` and a syslog message is generated.

Optics-related status:

- Module temperature
- Module voltage
- Module temperature alarm:
  - High alarm
  - Low alarm
  - High warning
  - Low warning
- Module voltage alarm:
  - High alarm
  - Low alarm
  - High warning
  - Low warning
- Module not ready alarm
- Module low power alarm
- Module initialization incomplete alarm
- Module fault alarm
- TX laser disabled alarm
- RX loss of signal alarm
- Modem lock state
- TX output power:
  - Current TX output power

    - Minimum over PM interval
    - Maximum over PM interval
    - Average over PM interval
- TX power alarm:
    - High alarm
    - Low alarm
    - High warning
    - Low warning
- RX input power (signal)
- RX input power (total):
    - Current RX input power (total)
    - Minimum over PM interval
    - Maximum over PM interval
    - Average over PM interval
- RX power alarm:
    - High alarm
    - Low alarm
    - High warning
    - Low warning
- RX loss of signal alarm
- Wavelength unlocked alarm

TIP: You can view optics-related status by using the `show interfaces transport pm optics` and `show interfaces diagnostics optics` operational-mode CLI commands.

Network lane receive-related status:

- Chromatic dispersion:
  - Current chromatic dispersion
  - Minimum over PM interval
  - Maximum over PM interval
  - Average over PM interval
- Differential group delay:
  - Current differential group delay
  - Minimum over PM interval
  - Maximum over PM interval
  - Average over PM interval
- Q^2-factor:
  - Current Q^2-factor
  - Minimum over PM interval
  - Maximum over PM interval
  - Average over PM interval
- Carrier frequency offset
  - Current carrier frequency offset
  - Minimum over PM interval
  - Maximum over PM interval
  - Average over PM interval
- Signal-to-noise ratio (SNR)
  - Current SNR
  - Minimum over PM interval

- Maximum over PM interval
- Average over PM interval

TIP: You can view network lane receive-related status by using the `show interfaces transport pm optics` operational-mode CLI command.

FEC statistics:

- Corrected Errors—the number of bits received that were in error, but corrected.
- Uncorrected Words—the number of FEC codewords received that were uncorrectable.
- Corrected Error Ratio—the number of corrected bits divided by the number of bits received

TIP: You can view FEC statistics by using the `show interfaces` *`interface-name`* `extensive` operational-mode CLI command.

Table 38 on page 321 describes the OTN alarms and defects that can occur on the MIC and the link status when the alarm or defect occurs.

TIP: You can view OTN alarms and defects by using the `show interfaces` *`interface-name`* `extensive` operational-mode CLI command.

Table 38: OTN Alarms and Defects

Category	Alarm	Description	Link Status
OTN	LOS	Loss of signal	Link down
	LOF	Loss of frame	Link down
	LOM	Loss of multiframe	Link down
OTN FEC	FEC Degrade (OTU-FEC-DEG)	Forward error correction degraded	Link down if signal degrade or backward FRR thresholds are met

Table 38: OTN Alarms and Defects *(Continued)*

Category	Alarm	Description	Link Status
	FEC Excessive (OTU-FEC-EXE)	There are uncorrected words and there are errors in the frame header	Possible link down
OTN OTU	OTU-AIS	Alarm indication signal or all ones signal	Link down
	OTU-BDI	Backward defect identification	Link down
	OTU-IAE	Incoming alignment error	Warning
	OTU-TTIM	Destination access point identifier (DAPI), source access point identifier (SAPI), or both mismatch from expected to received	Can cause the link to be down if `otu-ttim-act-enable` is configured at the `[edit interfaces` *`interface-name`* `otn-options]`hierarchy level
	OTU-BIAE	Backward incoming alignment error	Warning
	OTU-TSF	OTU trail signal fail	Warning
	OTU-SSF	OTU server signal fail	Warning
OTN ODU	ODU-AIS	Alarm indication signal or all ones signal	Link down
	ODU-OCI	Open connection error	Link down
	ODU-LCK	ODU lock triggers for path monitoring and TCM levels 1 through 6	Link down
	ODU-BDI	Backward defect indication	Link down

Table 38: OTN Alarms and Defects *(Continued)*

Category	Alarm	Description	Link Status
	ODU-TTIM	DAPI or SAPI mismatch from expected to received	Can cause the link to be down if `odu-ttim-act-enable` is configured at the `[edit interfaces` *`interface-name`* `otn-options]` hierarchy level
	ODU-IAE	Incoming alignment error	Warning
	ODU-LTC	Loss of tandem connection	Warning
	ODU-CSF	Client signal failure	Warning
	ODU-TSF	Trail signal fail	Warning
	ODU-SSF	Server signal fail	Warning
	ODU-PTIM	Payload type mismatch	Link down

RELATED DOCUMENTATION

100-Gigabit DWDM OTN CFP2-ACO Transceiver Wavelengths

MX Series MIC Overview | **29**

Configuring OTN Interfaces on MIC3-100G-DWDM MIC

Upgrading Firmware on the 100-Gigabit DWDM OTN MIC (MIC3-100G-DWDM)

show interfaces extensive

show interfaces transport pm

show interfaces diagnostics optics (Gigabit Ethernet, 10-Gigabit Ethernet, 40-Gigabit Ethernet, 100-Gigabit Ethernet, and Virtual Chassis Port)

Channelized SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP

Figure 37: 4-Port Channelized SONET/SDH OC3/STM1 (Multi-Rate) MIC with SFP

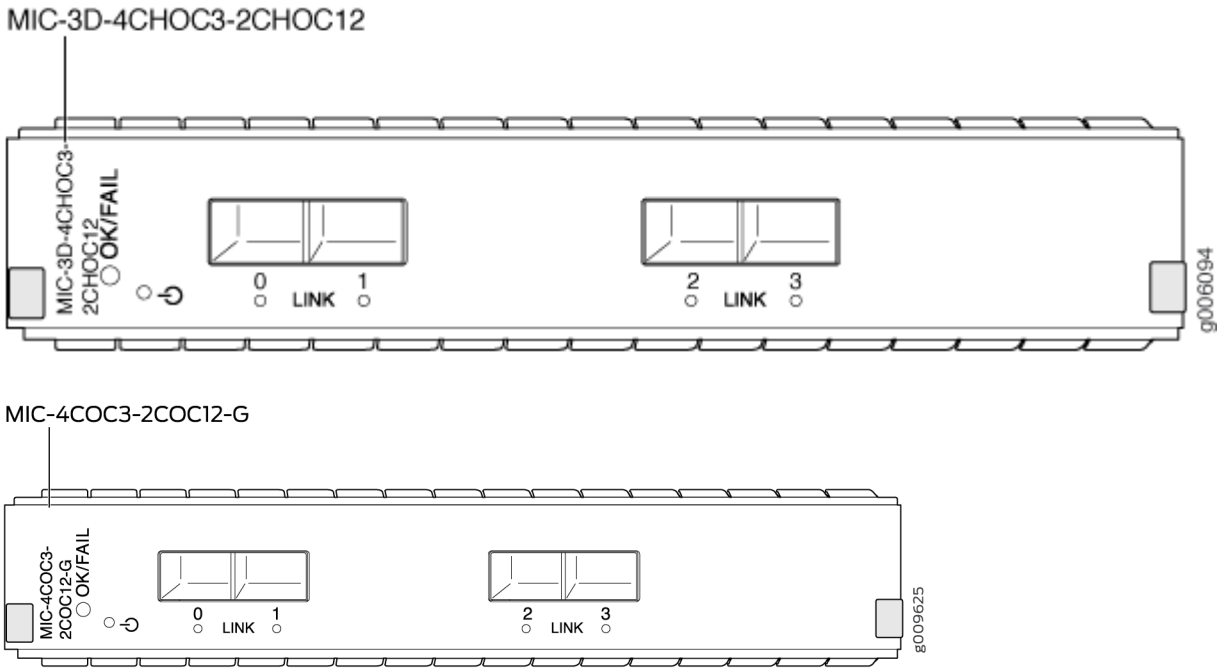
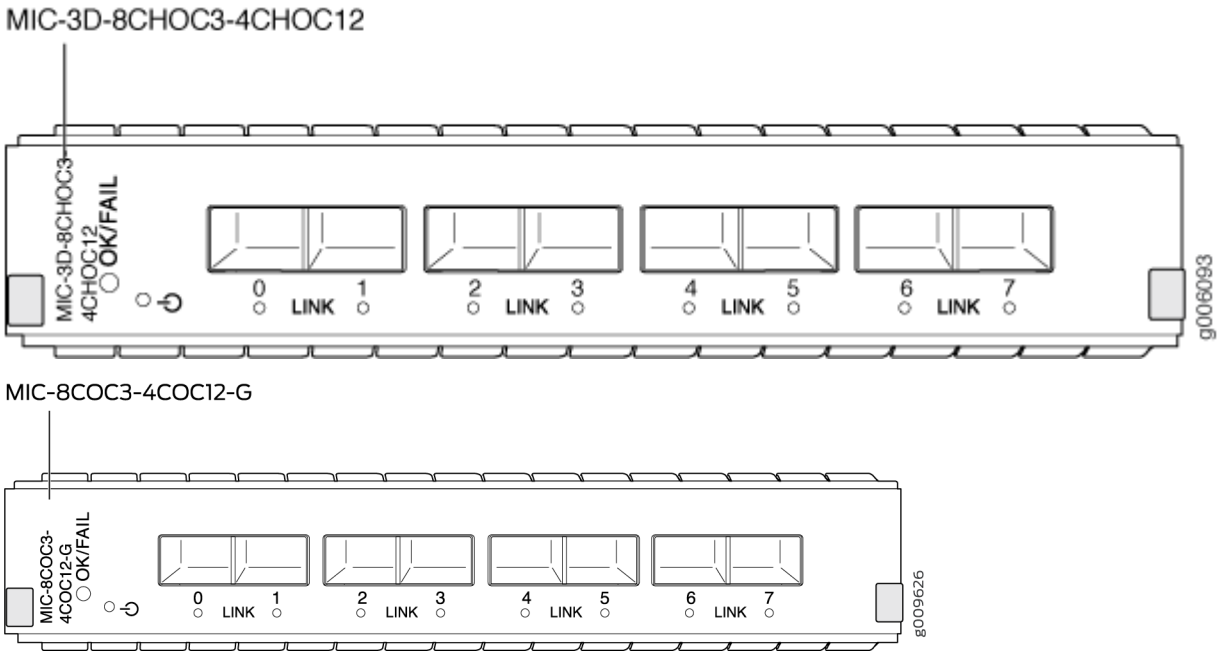


Figure 38: 8-Port Channelized SONET/SDH OC3/STM1 (Multi-Rate) MIC with SFP



Software release	• Junos OS Release 11.4 and later For information on which MPCs support these MICs, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• 4-port: Rate-selectable using one of the following rates:
	  • 4-port OC3/STM1
	  • 2-port OC12/STM4
	• 8-port: Rate-selectable using one of the following rates:
	  • 8-port OC3/STM1
	  • 4-port OC12/STM4
	• Channelization: OC3, DS3, DS1, DS0, E3, E1. For information on channelization numbers, see Channelized Interfaces User Guide for Routing Devices.
	• Power requirement:
	  • 4-port: 4.56 A @ 9 V (41 W)
	  • 8-port: 5.78 A @ 9 V (52 W)
	• Weight:
	  • 4-port: 4.4 lb (2 kg)
	  • 8-port: 4.4 lb (2 kg)
	• Model number:
	  • 4-port: MIC-3D-4CHOC3-2CHOC12
	  • 4-port: MIC-4COC3-2COC12-G
	  • 8-port: MIC-3D-8CHOC3-4CHOC12
	  • 4-port: MIC-4COC3-2COC12-G
	  • 8-port: MIC-3D-8CHOC3-4CHOC12
	  • 8-port: MIC-8COC3-4COC12-G
	  NOTE: MIC-4COC3-2COC12-G and MIC-8COC3-4COC12-G are RoHS 6/6 compliant.

Hardware features	• The ports are labeled:
	  • 4-port: 0-3
	  • 8-port: 0-7

Software features

- Maximum transmission units (MTUs) of up to 9192 bytes
- Per-port SONET/SDH framing
- Local and remote loopback on each port
- Optical diagnostics and monitoring
- Clocking options: internal or external/loop mode
- Encapsulations:
  - MPLS fast reroute
  - MPLS CCC (circuit cross-connection)
  - MPLS TCC (translational cross-connection)
  - Cisco High-Level Data Link Control (cHDLC)
  - Cisco HDLC CCC
  - Cisco HDLC TCC
  - Point-to-Point Protocol (PPP)
  - PPP for CCC
  - PPP for TCC
  - Flexible Frame Relay
  - Frame Relay
  - Frame Relay for CCC
  - Frame Relay for TCC
  - PPP over Frame Relay
  - Multilink-based protocols (Junos OS Release 12.1 and later):
    - Multilink Point-to-Point Protocol (MLPPP)
    - Multiclass MLPPP

	• Multilink Frame Relay (MLFR) end-to-end (FRF.15) • Multilink Frame Relay (MLFR) UNI NNI (FRF.16, also referred to as MFR) • Compressed Real-Time Transport Protocol (CRTP) **NOTE**: When you configure multilink services on a MIC in an MX Series router, ensure that a Multiservices DPC is present in the same router. **NOTE**: Ethernet over Frame Relay is not supported.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally • Red—MIC has failed **LINK** LED, one green per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	SONET alarms: • Loss of light (LOL) • Loss of signal (LOS) • Loss of frame (LOF) • Phase lock loop (PLL) • Severely errored frame (SEF) • Alarm indicator signal–line (AIS-L) • Alarm indicator signal–path (AIS-P) • Remote defect indicator–line (RDI-L) • Remote defect indicator–path (RDI-P) • Loss of pointer–path (LOP-P) • Bit error rate–signal degrade (BERR-SD) • Bit error rate–signal fail (BERR-SF) • Payload label mismatch–Path (PLM-P) • Unequipped–path (UNEQ-P) • Remote error indicator–path (REI-P) • Alarm indicator signal–virtual container (V-AIS) • Loss of pointer–virtual container (V-LOP) • Remote defect indicator–virtual container (V-RDI) • Unequipped–virtual container (V-UNEQ) • Mismatch–virtual container (V-MIS) SDH alarms: • Loss of light (LOL) • Phase lock loop (PLL)

- Loss of frame (LOF)
- Loss of signal (LOS)
- Severely errored frame (SEF)
- Multiplex-section alarm indicator signal (MS-AIS)
- Higher order path–alarm indication signal (HP-AIS)
- Loss of pointer (LOP)
- Bit error rate–signal degrade (BER-SD)
- Bit error rate–signal fail (BER-SF)
- Multiplex section–far end receive failure (MS-FERF)
- Higher order path—far-end receive failure (HP-FERF)
- Higher order path—payload label mismatch (HP-PLM)
- Remote error indicator (REI)
- Unequipped (UNEQ)
- Tributary unit–alarm indicator signal (TU-AIS)
- Tributary unit–loss of pointer (TU-LOP)
- Tributary unit–remote defect indicator (TU-RDI)
- Tributary unit–unequipped (TU-UNEQ)
- Tributary unit–mismatch (TU-MIS)

DS3 alarms:

- Alarm indication signal (AIS)
- Loss of frame (LOF)
- Loss of signal seconds (LOS)
- Phase lock loop (PLL)

DS3 error detection:

- C-bit code violations (CCV)

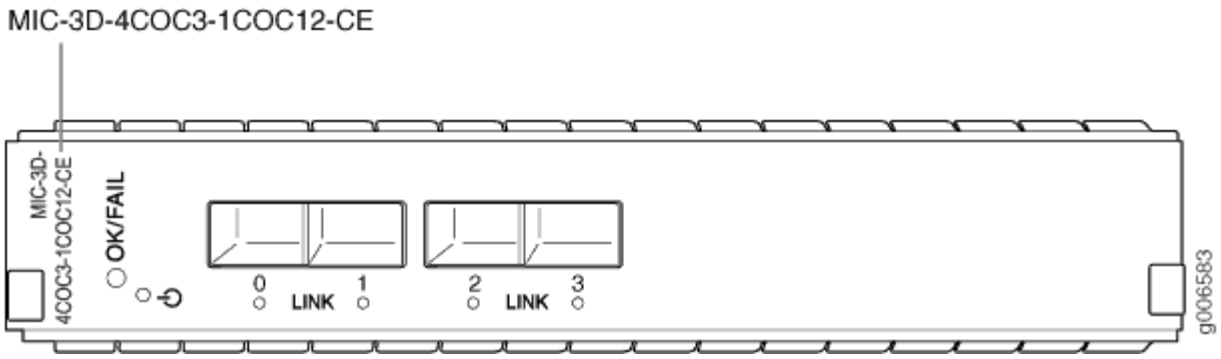
- C-bit errored seconds (CES)
- C-bit severely errored seconds (CSES)
- CRC errors
- Excessive zeros (EXZ)
- Far-end block error (FEBE)
- Far-end receive failure (FERF)
- Line errored seconds (LES)
- Parity bit (P-bit) code violations (PCV)
- Parity bit (P-bit) errored seconds (PES)
- Parity bit (P-bit) severely errored framing seconds (PSES)
- Severely errored framing seconds (SEFS)
- Unavailable seconds (UAS)

RELATED DOCUMENTATION

MX Series MIC Overview | 29

Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP

Figure 39: Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP



Software release	• Junos OS Release 12.2 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• Four OC3/STM1 ports
	• Rate-selectable using one of the following rates:
	  • 4-port OC3/STM1
	  • 1-port OC12/STM4
	• One channelized OC12/STM4 port (down to DS0)
	• SONET or SDH is configurable on a MIC level
	• OC3 channelization:
	  • 4 OC3 channel
	  • 336 DS1 channels
	  • 2016 DS0 channels (combination of nxDS0)
	• SDH channelization:
	  • 4 STM1 channel
	  • 252 E1 channels
	  • 2016 DS0 channels (combination of nxDS0)
	• Power requirement: 2.83 A @ 12 V (33.96 W)
	• Weight: 1.63 lb (0.74 kg)
	• Model number: MIC-3D-4COC3-1COC12-CE

Hardware features	• Ports are numbered 0 through 3

Software features	• Per-MIC SONET/SDH framing
	• Internal and loop clocking
	• Encapsulations:
	  • Pseudo Wire Emulation Edge-to-Edge (PWE3) Architecture (RFC 3985)
	  • Requirements for Pseudo-Wire Emulation Edge-to-Edge (PWE3) (RFC 3916)
	  • Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP) (RFC 4553)
	  • Structure-Aware Time Division Multiplexed (TDM) Circuit Emulation Service over Packet Switched Network (CESoPSN) (RFC 5086)
	  • Pseudowire Emulation Edge-to-Edge (PWE3) Control Word for Use over an MPLS PSN (RFC 4385)
	  • L2 Network Interconnections (protocol stitching):
	  • TDM LDP PWs to BGP L2VPN—see *Using the Layer 2 Interworking Interface to Interconnect a Layer 2 Circuit to a Layer 2 VPN* for more information. Note that stitching CESoPSN PW to BGP L2VPN is not supported.
	  • Unified in-service software upgrade (unified ISSU)

Interfaces	Syntax: *mediatype-fpc/pic/port* where: • mediatype: coc3, coc12, cstm1, cstm4, or ds • fpc: Slot in the router where the MPC is installed • pic: 0 when installed in MIC slot 0 or 2 when installed in MIC slot 1 • port: 0 through 3 For example, cstm4-1/2/0 is the channelized STM4 interface for port 0 on the MIC installed in MIC slot 1 on an MPC installed in slot 1.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: To extend the life of the laser, when a MIC is not being actively used with any valid links, take the MIC offline until you are ready to establish a link to another device. For information about taking a MIC offline, see the `request chassis pic offline` command in the *Junos OS System Basics and Services Command Reference*.
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally • Red—MIC has failed **LINK** LED, one tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	Structure-agnostic alarms for T1 and E1 interface: • Alarm indication signal (AIS) • Loss of signal (LOS) • Line code violation (LCV) • Errored seconds (ES) • Line-errored seconds (LES) • Severely errored seconds (SES) • Unavailable errored seconds (UAS) Structure aware alarms for T1 and E1 interface: • Severely errored frame (SEF) • Block error event (BEE) • Loss of frame (LOF) • Yellow alarm (remote alarm indication RAI) • Path code violation (PCV) • Severely errored frame seconds (SEFS) • Bursty errored seconds (BES)

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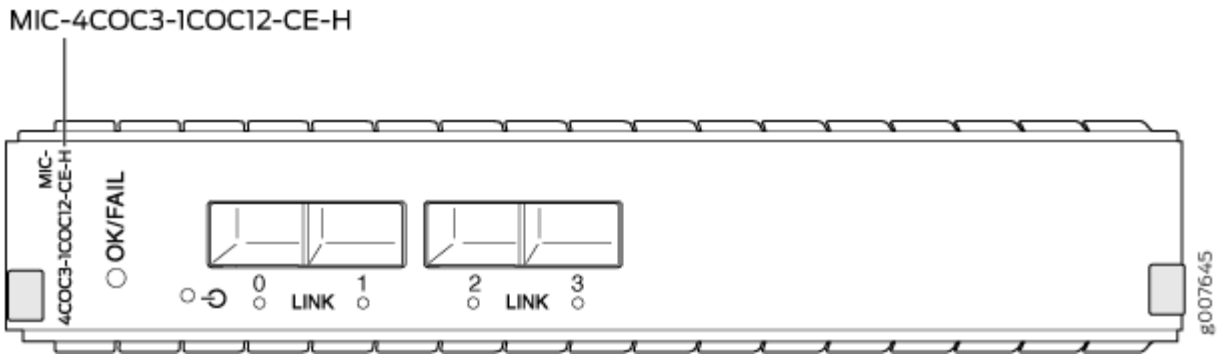
Using the Layer 2 Interworking Interface to Interconnect a Layer 2 Circuit to a Layer 2 VPN

Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP (H)

Figure 40: Channelized OC3/STM1 (Multi-Rate) Circuit Emulation MIC with SFP (H)



Software release	• Junos OS Release 13.2R2 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• Four OC3/STM1 ports
	• Rate-selectable using one of the following rates:
	  • 4-port OC3/STM1
	  • 1-port OC12/STM4
	• One channelized OC12/STM4 port (down to DS0)
	• SONET or SDH is configurable on a MIC level
	• SONET channelization:
	  • 4 OC3 channel
	  • 336 DS1 channels
	  • 2016 DS0 channels (combination of nxDS0)
	• SDH channelization:
	  • 4 STM1 channel
	  • 252 E1 channels
	  • 2016 DS0 channels (combination of nxDS0)
	• Power requirement: 2.83 A @ 12 V (33.96 W)
	• Weight: 1.63 lb (0.74 kg)
	• Model number: MIC-4COC3-1COC12-CE-H

Hardware features	• Ports are numbered 0 through 3 • Environmentally hardened for –40° F (–40° C) to 149° F (65° C) operating temperatures

Software features	• Per-MIC SONET/SDH framing
	• Internal and loop clocking
	• Encapsulations:
	  • Pseudo Wire Emulation Edge-to-Edge (PWE3) Architecture (RFC 3985)
	  • Requirements for Pseudo-Wire Emulation Edge-to-Edge (PWE3) (RFC 3916)
	  • Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP) (RFC 4553)
	  • Structure-Aware Time Division Multiplexed (TDM) Circuit Emulation Service over Packet Switched Network (CESoPSN) (RFC 5086)
	  • Pseudowire Emulation Edge-to-Edge (PWE3) Control Word for Use over an MPLS PSN (RFC 4385)

Interfaces	Syntax: *mediatype-fpc/pic/port* where: • mediatype: coc3, coc12, cstm1, cstm4, or ds • fpc: Slot in the router where the MPC is installed • pic: 0 when installed in MIC slot 0 or 2 when installed in MIC slot 1 • port: 0 through 3 For example, cstm4-1/2/0 is the channelized STM4 interface for port 0 on the MIC installed in MIC slot 1 on an MPC installed in slot 1.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: To extend the life of the laser, when a MIC is not being actively used with any valid links, take the MIC offline until you are ready to establish a link to another device. For information about taking a MIC offline, see the `request chassis pic offline` command in the *Junos OS System Basics and Services Command Reference*.

LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally • Red—MIC has failed **LINK** LED, one tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	Structure-agnostic alarms for T1 and E1 interface: • Alarm indication signal (AIS) • Loss of signal (LOS) • Line code violation (LCV) • Errored seconds (ES) • Line-errored seconds (LES) • Severely errored seconds (SES) • Unavailable errored seconds (UAS) Structure aware alarms for T1 and E1 interface: • Severely errored frame (SEF) • Block error event (BEE) • Loss of frame (LOF) • Yellow alarm (remote alarm indication RAI) • Path code violation (PCV) • Severely errored frame seconds (SEFS) • Bursty errored seconds (BES)

RELATED DOCUMENTATION

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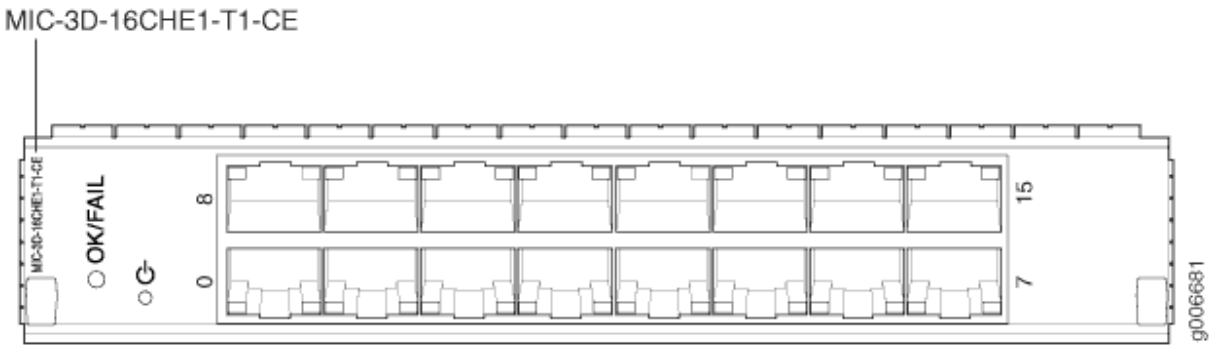
Channelized E1/T1 Circuit Emulation MIC

Figure 41: Channelized E1/T1 Circuit Emulation MIC



Software release	• Junos OS Release 12.3 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• Sixteen E1 or T1 ports
	• Per-MIC E1/T1 framing
	• DS1 channelization per port:
	  • 1 DS1 channel
	  • 24 DS0 channels
	• E1 channelization per port:
	  • 1 E1 channel
	  • 32 DS0 channels
	• Internal and loop clocking
	• Power requirement: 2.21 A @ 12 V (26.55 W)
	• Weight: 1.57 lb (0.71 kg)
	• Model number: MIC-3D-16CHE1-T1-CE

Hardware features	• Ports are numbered:
	  • Top row: 8 and 15 from left to right
	  • Bottom row: 0 and 7 from left to right

Software features	• Full bit error rate test (BERT)
	• DS1 and E1 interfaces are selectable on a per-port granularity
	• Per-port framing is not supported
	• You can configure the following framing modes using the CLI:
	  • T1—SF, ESF, D4/superframe, ESF (extended superframe)
	  • E1—G704, G704–no-crc4, unframed
	• Local, remote, and per-port loopback diagnostics
	• Encapsulations:
	  • Pseudowire Emulation Edge to Edge (PWE3) Architecture (RFC 3985)
	  • Requirements for Pseudowire Emulation Edge to Edge (PWE3) (RFC 3916)
	  • Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP) (RFC 4553)
	  • Structure-Aware Time Division Multiplexed (TDM) Circuit Emulation Service over Packet-Switched Network (CESoPSN) (RFC 5086)
	  • Pseudowire Emulation Edge to Edge (PWE3) Control Word for Use over an MPLS PSN (RFC 4385)
	• In-service software upgrade (Unified ISSU)

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. • RJ-48 connector

LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. One tricolor per port: • Off—Not enabled. • Green—Online with no alarms or failures. • Yellow—Online with alarms for remote failures. • Red—Active with a local alarm; router has detected a failure.

Alarms, errors, and events	• Structure-agnostic alarms for T1 and E1 interface:
	  • Alarm indication signal (AIS)
	  • Loss of signal (LOS)
	• Structure-aware alarms for T1 and E1 interface:
	  • Loss of signal (LOS)
	  • Alarm indication signal (AIS)
	  • Loss of frame (LOF)
	  • Remote alarm indication signal (RAIS)
	• Structure-agnostic error detection for T1 and E1 interface:
	  • Errored seconds (ES)
	  • Line code violation (LCV)
	  • Line errored seconds (LES)
	  • Severely errored seconds (SES)
	  • Unavailable seconds (UAS)
	  • Loss of signal seconds (LOSS)
	• Structure-aware error detection for T1 and E1 interface:
	  • Severely errored frame (SEF)
	  • Block error event (BEE)
	  • Line code violation (LCV)
	  • Path code violation (PCV)
	  • Line errored seconds (LES)
	  • Errored seconds (ES)
	  • Severely errored seconds (SES)
	  • Severely errored frame seconds (SEFS)

- Bursty errored seconds (BES)
- Unavailable seconds (UAS)
- Loss of signal seconds (LOSS)
- Loss of framing seconds (LOFS)
- Far-end block error (FEBE) (E1 only)
- CRC errors (E1 only)

RELATED DOCUMENTATION

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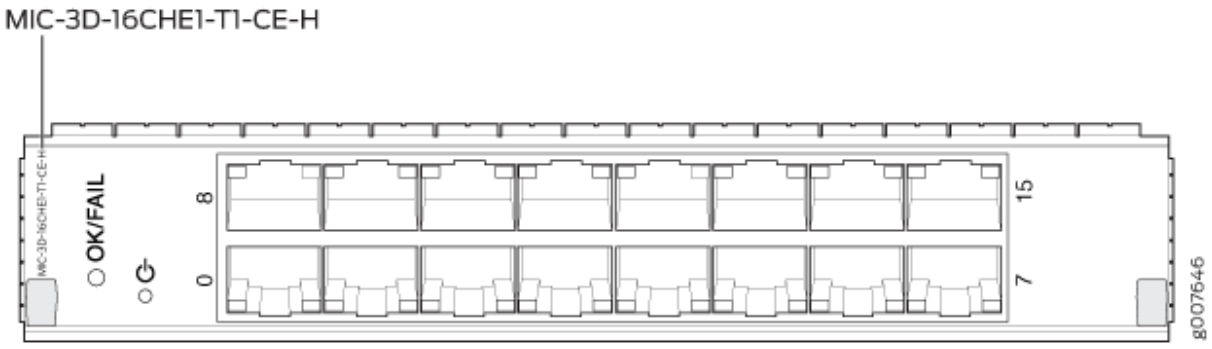
Channelized E1/T1 Circuit Emulation MIC (H)

Figure 42: Channelized E1/T1 Circuit Emulation MIC (H)



Software release

- Junos OS Release 13.2R2 and later

For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description

- Sixteen E1 or T1 ports
- Per-MIC E1/T1 framing
- DS1 channelization per port:
  - 1 DS1 channel
  - 24 DS0 channels
- E1 channelization per port:
  - 1 E1 channel
  - 32 DS0 channels
- Internal and loop clocking
- Power requirement: 2.21 A @ 12 V (26.55 W)
- Weight: 1.57 lb (0.71 kg)
- Model number: MIC-3D-16CHE1-T1-CE-H

Hardware features

- Ports are numbered:
  - Top row: 8 and 15 from left to right
  - Bottom row: 0 and 7 from left to right
- Environmentally hardened for –40° F (–40° C) to 149° F (65° C) operating temperatures

Software features	• Full bit error rate test (BERT)
	• DS1 and E1 interfaces are selectable on a per-port granularity
	• Per-port framing is not supported
	• You can configure the following framing modes using the CLI:
	  • T1—SF, ESF, D4/superframe, ESF (extended superframe)
	  • E1—G704, G704–no-crc4, unframed
	• Local, remote, and per-port loopback diagnostics
	• Encapsulations:
	  • Pseudowire Emulation Edge to Edge (PWE3) Architecture (RFC 3985)
	  • Requirements for Pseudowire Emulation Edge to Edge (PWE3) (RFC 3916)
	  • Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP) (RFC 4553)
	  • Structure-Aware Time Division Multiplexed (TDM) Circuit Emulation Service over Packet-Switched Network (CESoPSN) (RFC 5086)
	  • Pseudowire Emulation Edge to Edge (PWE3) Control Word for Use over an MPLS PSN (RFC 4385)

Interfaces	Syntax: *media-type-fpc/pic/port* where: • media-type: ct1, ds, t1, or e1 • fpc: Slot in the router where the MPC is installed • pic: 0 when installed in MIC slot 0 or 2 when installed in MIC slot 1 • port: 0 through 15 For example, t1-2/2/0 is the T1 interface for port 0 on the MIC installed in MIC slot 1 on an MPC installed in slot 2.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. • RJ-48 connector
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. One tricolor per port: • Off—Not enabled. • Green—Online with no alarms or failures. • Yellow—Online with alarms for remote failures. • Red—Active with a local alarm; router has detected a failure.

Alarms, errors, and events	• Structure-agnostic alarms for T1 and E1 interface:
	  • Alarm indication signal (AIS)
	  • Loss of signal (LOS)
	• Structure-aware alarms for T1 and E1 interface:
	  • Loss of signal (LOS)
	  • Alarm indication signal (AIS)
	  • Loss of frame (LOF)
	  • Remote alarm indication signal (RAIS)
	• Structure-agnostic error detection for T1 and E1 interface:
	  • Errored seconds (ES)
	  • Line code violation (LCV)
	  • Line errored seconds (LES)
	  • Severely errored seconds (SES)
	  • Unavailable seconds (UAS)
	  • Loss of signal seconds (LOSS)
	• Structure-aware error detection for T1 and E1 interface:
	  • Severely errored frame (SEF)
	  • Block error event (BEE)
	  • Line code violation (LCV)
	  • Path code violation (PCV)
	  • Line errored seconds (LES)
	  • Errored seconds (ES)
	  • Severely errored seconds (SES)
	  • Severely errored frame seconds (SEFS)

- Bursty errored seconds (BES)
- Unavailable seconds (UAS)
- Loss of signal seconds (LOSS)
- Loss of framing seconds (LOFS)
- Far-end block error (FEBE) (E1 only)
- CRC errors (E1 only)

RELATED DOCUMENTATION

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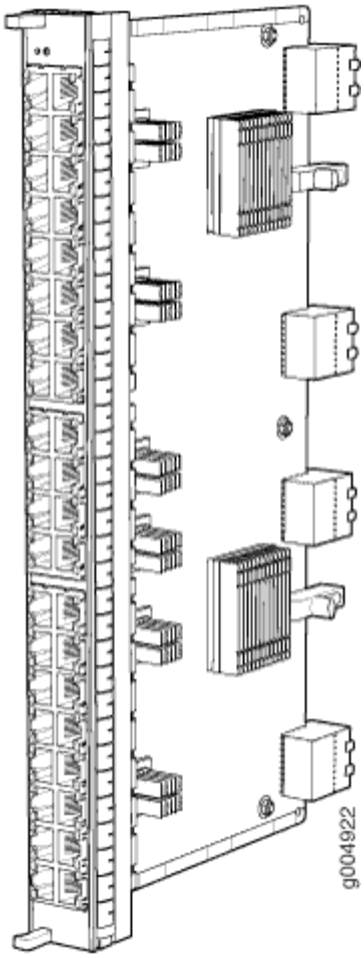
Tri-Rate MIC

Figure 43: 40-Port Tri-Rate MIC



Software release	• Junos 10.2 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• 40 autonegotiating 10BASE-T, 100BASE-TX, or 1000BASE-T Megabit Ethernet ports • Power requirement: 0.85 A @ 48 V (41 W) • Weight: 1.9 lb (0.9 kg) • Model number: MIC-3D-40GE-TX • Name in the CLI: `3D 40GE TX`
Hardware features	• Dual-wide MIC that installs into 2 slots. For information on how to install dual-wide MICs, see the *Installing Dual-Wide MIC* topic in the respective *MX Series Router Hardware Guide*. • High-performance throughput on each port at speeds of 10 Mbps, 100 Mbps, or 1000 Mbps • Up to 40-Gbps of full-duplex traffic • Autonegotiation between Gigabit Ethernet circuit partners • Maximum transmission units (MTUs) of up to 9192 bytes
Software features	• Virtual Router Redundancy Protocol (VRRP) support • IEEE 802.1Q virtual LANs (VLANs) support • Remote monitoring (RMON) EtherStats • Source MAC learning • MAC accounting and policing—Dynamic local address learning of source MAC addresses • Flexible Ethernet encapsulation • Multiple tag protocol identifiers (TPID)

Interfaces	Syntax: ge-*fpc/pic/port* where: • fpc: Slot in the router where the MPC is installed. • pic: The ports on the MPC are divided into four logical PICs numbered 0, 1, 2, and 3. • port: 0 through 9 For example, ge-2/3/0 is the interface for port 0 in logical PIC 3 on the MPC installed in slot 2. Figure 44 on page 356, Figure 45 on page 357, and Figure 46 on page 357 illustrate the port numbering for the Tri-Rate MIC installed in the MX960, MX480, and MX240, respectively.
Cables and connectors	• Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector • Pinout: MDI, MDI crossover • Maximum distance: 328 ft (100 m) **CAUTION**: Do not use RJ-45 cables with strain-relief boots exceeding 1.5 mm from the bottom of the connector. Cable boots that exceed this measurement can damage the port.
LEDs	OK/fail LED, one bicolor: • Green—MIC is functioning normally. • Red—MIC has failed. Link LED, one green per port: • Off—No link. • On steadily—Link is up.

Figure 44 on page 356, Figure 45 on page 357, and Figure 46 on page 357 illustrate the port numbering for the Tri-Rate MIC installed in the MX960, MX480, and MX240, respectively.

Figure 44: Port Numbering for the Tri-Rate MIC (MX960)

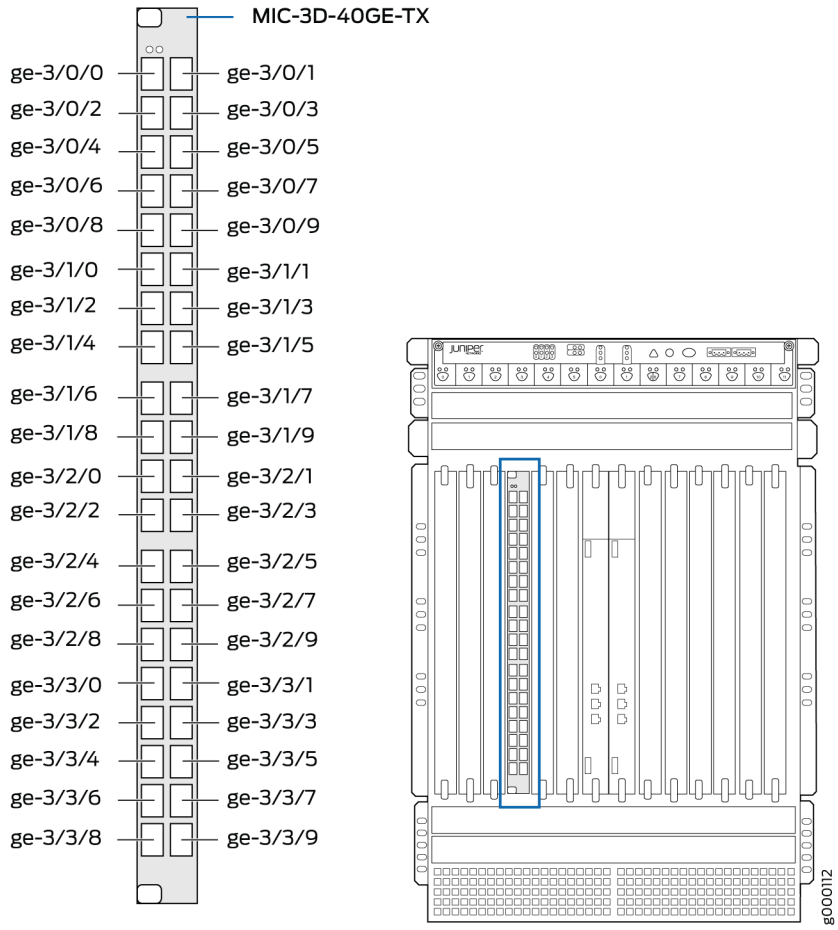


Figure 45: Port Numbering for the Tri-Rate MIC (MX480)

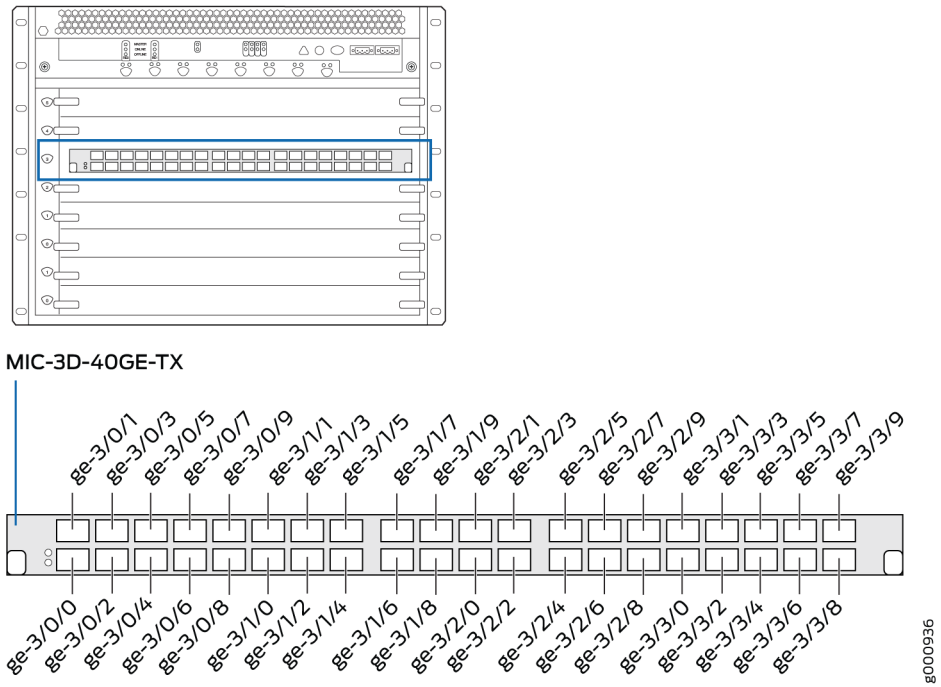
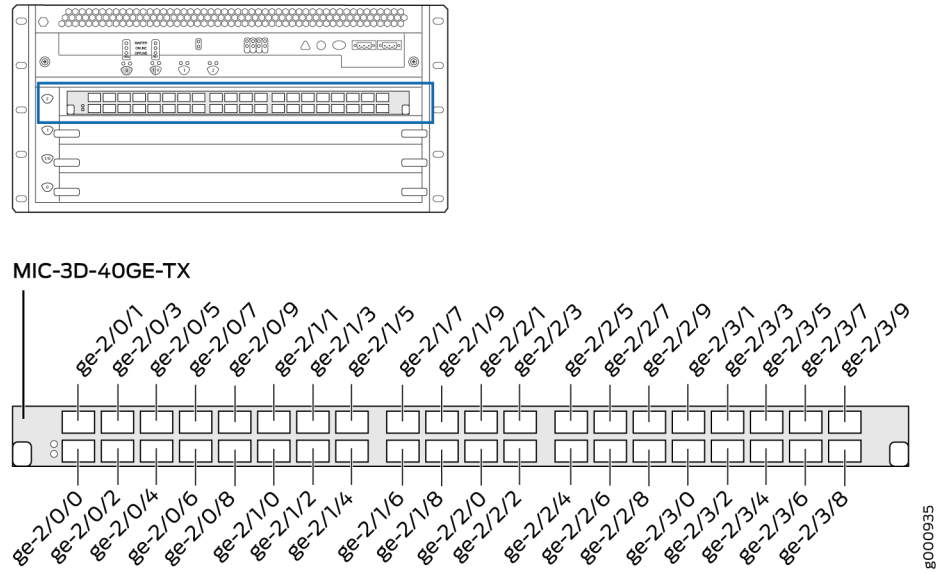


Figure 46: Port Numbering for the Tri-Rate MIC (MX240)



RELATED DOCUMENTATION

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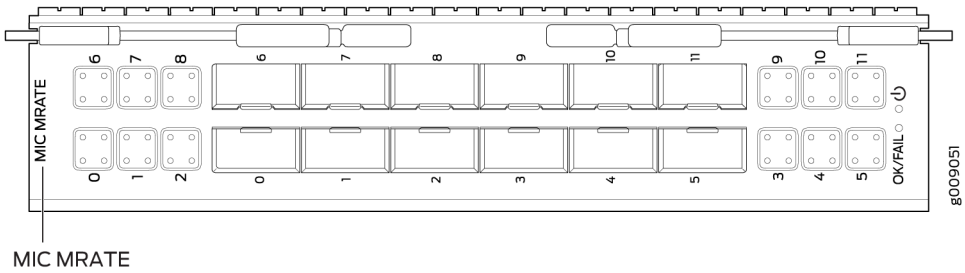
MIC MRATE

Figure 47: 12-Port Multi-Rate MIC with QSFP+



NOTE:

Description

- Twelve Gigabit Ethernet ports that support quad small form-factor pluggable plus (QSFP+) transceivers
- Power requirement;
  - When installed into MPC8E: 1.250 A @ 48 V (60 W)
  - When installed into MPC9E, or into MPC8E operating in 1.6 Tbps upgrade mode (licensed feature): 1.771 A @ 48 V (85 W)
- Weight: 3.9 lb (1.77 kg)
- Model number: MIC-MRATE
- Name in the CLI: `MRATE-12xQSFPP-XGE-XLGE-CGE`

Hardware features	• The ports are numbered **0** through **11**.
	• Twelve Gigabit Ethernet QSFP+ ports, each of which can be configured as a 40-Gigabit Ethernet port or as four 10-Gigabit Ethernet ports by using a breakout cable.
	• Eight out of the twelve ports can be configured as 100-Gigabit Ethernet ports. Port numbers **0** through **3**, and **6** through **9** are the eight 100-Gigabit Ethernet ports.
	• When used in MX2K-MPC8E:
	  • 4 ports out of the total 12 support 100-Gigabit Ethernet speed
	  • Maximum aggregate port capacity across ports **0** through **5** should not exceed 240 Gbps
	  • Maximum aggregate port capacity across ports 6 through 11 should not exceed 240 Gbps
	• When used in MX2K-MPC9E:
	  • 8 ports out of the total 12 support 100-Gigabit Ethernet speed
	  • Maximum aggregate port capacity across ports **0** through **5** should not exceed 400 Gbps
	  • Maximum aggregate port capacity across ports **6** through **11** should not exceed 400 Gbps
	Table 39 on page 360 lists the configurable Gbps Ethernet port speeds for each port.

Software features	• Supports rate selectability at the port level. • By default, the ports are configured as 10-Gigabit Ethernet ports. • Supports remote port identification.
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

LEDs

- **OK/FAIL** LED, one bicolor:
  - Steady green—MIC is functioning normally.
  - Red—MIC has failed.
- Link LED, one green per port (4 per QSFP+ cage):
  - Steady green—Link is up.
  - Off—Link is down or disabled.

  Each QSFP+ cage contains four LEDs, logically numbered from 0 through 3. These numbers help you identify the corresponding cable when a breakout cable (4x10 Gigabit) is connected to a port. On an installed MRATE MIC, the orientation of these LEDs is as follows: upper left **0**, upper right **1**, lower left **2**, and lower right **3**.

Table 39: MIC MRATE Gigabit Ethernet Port Speed Capabilities

Port #	4x10 Gbps Ethernet	40 Gbps Ethernet	100 Gbps Ethernet
0	yes	yes	yes
1	yes	yes	yes
2	yes	yes	yes
3	yes	yes	yes
4	yes	yes	no
5	yes	yes	no
6	yes	yes	yes
7	yes	yes	yes
8	yes	yes	yes

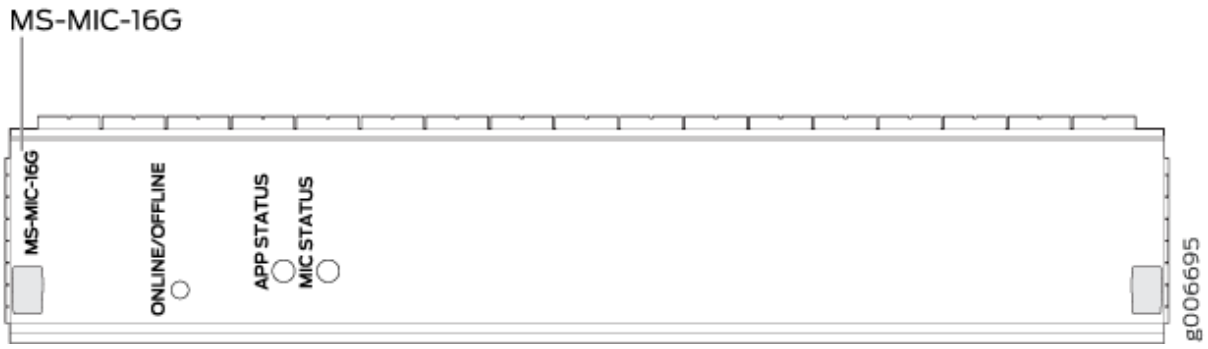
Table 39: MIC MRATE Gigabit Ethernet Port Speed Capabilities *(Continued)*

Port #	4x10 Gbps Ethernet	40 Gbps Ethernet	100 Gbps Ethernet
9	yes	yes	yes
10	yes	yes	no
11	yes	yes	no

For information about which MPCs support this MIC, see MIC/MPC Compatibility. For information about which MICs are supported on MX Series routers, see MICs Supported by MX Series Routers.

Multiservices MIC

Figure 48: MS-MIC-16G



Supported Junos OS Release	• Junos OS Release 13.2 and later • Model number: MS-MIC-16G • Name in the CLI: `MS-MIC-16G`
Description	The Multiservices Modular Interfaces Card (MS-MIC) provides improved scaling and high performance for MX series routers. The MS-MIC has enhanced memory (16 GB) and enhanced processing capabilities.

Software Features	• Active flow monitoring and export of flow monitoring version 9 records based on RFC 3954 • IP Security (IPsec) encryption • Network Address Translation (NAT) for IP addresses **NOTE**: The Multiservices MIC does not support Network Address Translation-Traversal (NAT-T) until Junos OS Release 17.4R1. • Port Address Translation (PAT) for port numbers • Traffic sampling • Stateful firewall with packet inspection—detects SYN attacks, ICMP and UDP floods, and ping-of-death attacks • Network Attack Protection (NAP) • Support for up to 6000 service sets • Support for MTUs up to 9192 bytes. • Multiple services can be supported. See Junos OS Services Interfaces Library for Routing Devices for more information. • See "Protocols and Applications Supported by the MS-MIC and MS-MPC" on page 594 for information about the protocols and applications that this MIC supports.
Hardware Features and Requirements	• MICs are hot-removable and hot-insertable • MS-MIC CPU Clock Cycle – 800MHz • Works with SCBs and SCBEs • Interoperable with MS-DPCs. Both MS-MPCs and MS-DPCs can co-exist in the same chassis • Chassis requires enhanced fan trays and high-capacity DC or AC power supplies **NOTE**: Only one Multiservices MIC is supported in each MPC. **NOTE**: Starting in Junos OS Release 13.3R3, 14.1R2, and 14.2R1, MX104 routers support only two Multiservices MICs.

Input/Output Power Requirements	MS-MIC—6.67 amps @ 9V (60W)
Weight and Dimensions	Weight: 2 lbs (.91 kg); Height: 0.9 in. (2.26 cm); Width: 6 in. (15.24 cm); Depth: 7 in. (17.78 cm)
LEDs	Application activity tricolor LED, labeled **APP STATUS**: • Off—Application is not running. • Red—Application has failed. • Yellow—Application is reconfiguring. • Green—Application is running. MIC activity tricolor LED, labeled **MIC STATUS**: • Off—MIC has failed. • Red—MIC has an error or failure. • Yellow—MIC is transitioning online or offline. • Green—MIC is functioning normally.

RELATED DOCUMENTATION

Multiservices MPC | **139**

MX Series MIC Overview | **29**

Junos OS Services Interfaces Library for Routing Devices

Protocols and Applications Supported by the MS-MIC and MS-MPC | **594**

MIC/MPC Compatibility | **46**

Example: Inter-Chassis Stateful High Availability for NAT and Stateful Firewall (MS-MIC, MS-MPC)

Example: Configuring Flow Monitoring on an MX Series Router with MS-MIC and MS-MPC

Inter-Chassis High Availability for MS-MIC and MS-MPC (Release 15.1 and earlier)

Example: Configuring Junos VPN Site Secure on MS-MIC and MS-MPC

ICMP, Ping, and Traceroute ALGs for MS-MICs and MS-MPCs

MICs Supported by MX Series Routers | **30**

SONET/SDH OC3/STM1 (Multi-Rate) MICs with SFP

Figure 49: 4-Port SONET/SDH OC3/STM1 (Multi-Rate) MIC with SFP

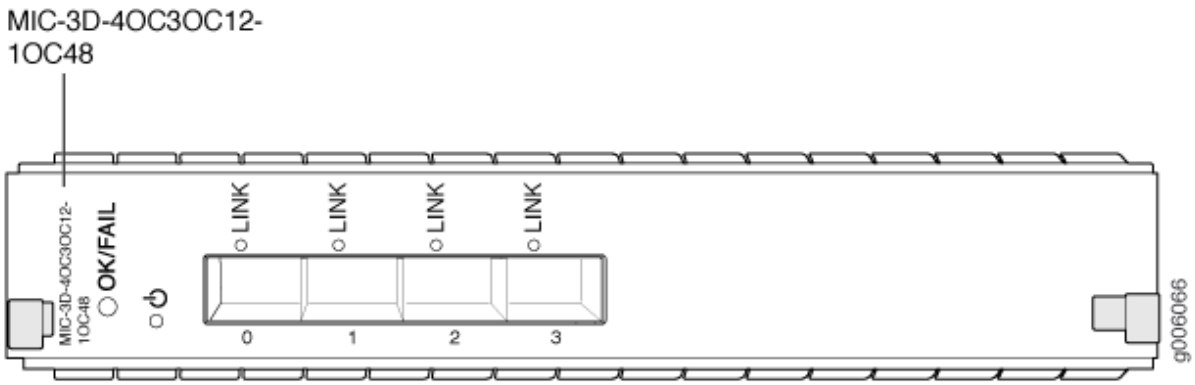
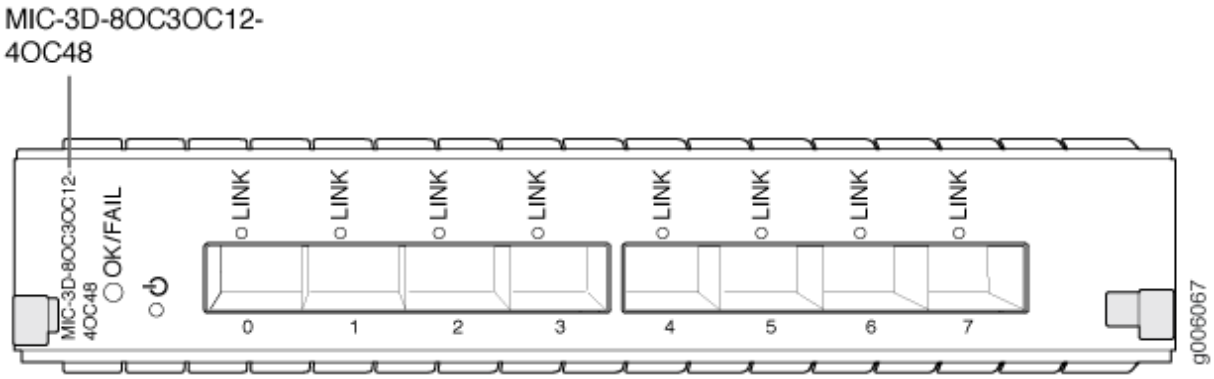


Figure 50: 8-Port SONET/SDH OC3/STM1 (Multi-Rate) MIC with SFP



Software release	• 4-port: Junos OS Release 11.2 and later • 8-port: Junos OS Release 11.2 and later For information on which MPCs support these MICs, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description	• 4-port: 4 OC3/STM1 or OC12/STM4 ports
	
	The ports can be configured to support a combination of OC3, OC12, and OC48 rates. In the combination, you can configure only one port (port 0) to support OC48, whereas OC3 or OC12 can be configured on all four ports.
	
	• 8-port: 8 OC3/STM1 or OC12/STM4 ports
	
	The ports can be configured to support a combination of OC3, OC12, and OC48 rates. In the combination (when the device is in the multi-rate mode), you can configure only two ports (port 0 and port 1) to support OC48, whereas you can configure all eight ports to support OC3 or OC12. If the multi-rate mode is disabled, you can configure four ports (port 0, port 1, port 2, and port 3) to support OC48. To disable the multi-rate mode, use the CLI statement `set chassis fpc` *`slot`* `pic` *`slot`* `no-multi-rate`.
	
	• Power requirement:
	  • 4-port: 2.6 A @ 9 V (23.4 W)
	  • 8-port: 3.1 A @ 9 V (27.9 W)
	
	• Weight:
	  • 4-port: 1.27 lb (0.58 kg)
	  • 8-port: 1.47 lb (0.67 kg)
	
	• Model number:
	  • 4-port: MIC-3D-4OC3OC12-1OC48
	  • 8-port: MIC-3D-8OC3OC12-4OC48

Hardware features	• The ports are labeled:
	  • 4-port: 0-3
	  • 8-port: 0-7
	
	• Maximum transmission units (MTUs) of up to 9192 bytes

Software features	• Per-port SONET/SDH framing
	• Local and remote loopback on each port
	• Optical diagnostics and monitoring
	• Clocking options: internal or external/loop mode.
	• Unified in-service software upgrade (unified ISSU)
	• Encapsulations:
	  • Multiprotocol Label Switching (MPLS) fast reroute
	  • MPLS CCC (circuit cross-connect)
	  • MPLS TCC (translational cross-connect)
	  • Cisco High-Level Data Link Control
	  • Cisco HDLC CCC
	  • Cisco HDLC TCC
	  • Point-to-Point Protocol (PPP)
	  • PPP for CCC
	  • PPP for TCC
	  • Flexible Frame Relay
	  • Frame Relay
	  • Frame Relay for CCC
	  • Frame Relay for TCC
	  • PPP over Frame Relay
	NOTE: Ethernet over Frame Relay is not supported.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally • Red—MIC has failed **LINK** LED, one green per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	SONET alarms: • Loss of light (LOL) • Loss of signal (LOS) • Loss of frame (LOF) • Phase lock loop (PLL) • Severely errored frame (SEF) • Alarm indicator signal–line (AIS-L) • Alarm indicator signal–path (AIS-P) • Remote defect indicator–line (RDI-L) • Remote defect indicator–path (RDI-P) • Loss of pointer–path (LOP-P) • Bit error rate–signal degrade (BERR-SD) • Bit error rate–signal fail (BERR-SF) • Payload label mismatch–Path (PLM-P) • Unequipped–path (UNEQ-P) • Remote error indicator–path (REI-P) SDH alarms: • Loss of light (LOL) • Phase lock loop (PLL) • Loss of frame (LOF) • Loss of signal (LOS) • Severely errored frame (SEF) • Multiplex-section alarm indicator signal (MS-AIS) • H Path alarm indicator signal (HP-AIS)

- Loss of pointer (LOP)
- Bit error rate–signal degrade (BER-SD)
- Bit error rate–signal fail (BER-SF)
- Multiplex section–far end receive failure (MS-FERF)
- High order path–far end receive failure (HP-FERF)
- High order path–payload label mismatch (HP-PLM)
- Remote error indicator (REI)
- Unequipped (UNEQ)

RELATED DOCUMENTATION

MX Series MIC Overview | 29

Multi-Rate Ethernet MIC

Figure 51: JNP-MIC1

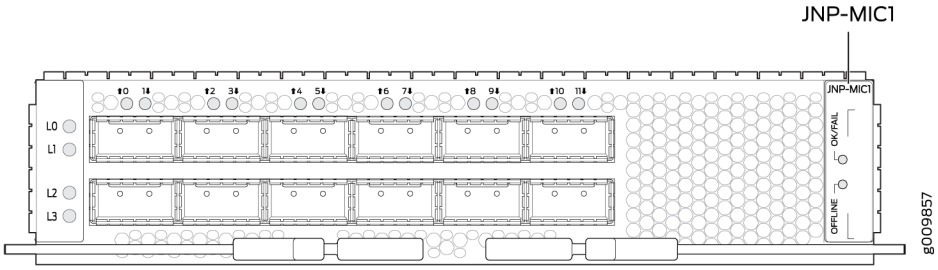


Figure 52: JNP-MIC1-MACSEC

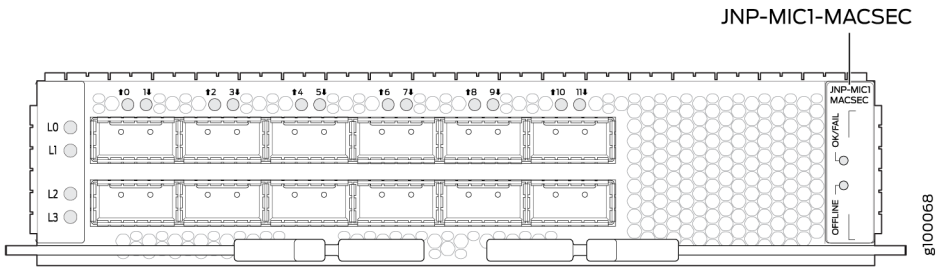
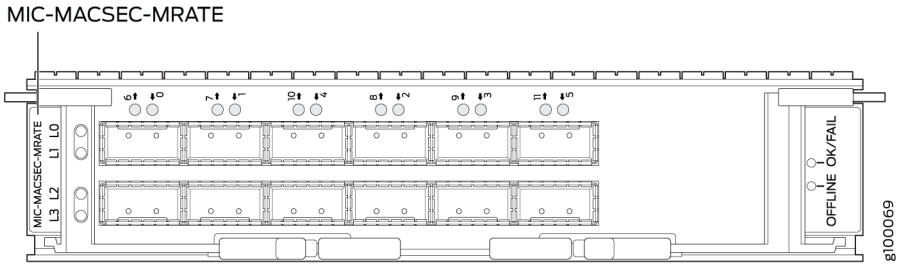


Figure 53: MIC-MACSEC-MRATE



Software release

- JNP-MIC1:

  Junos OS release 17.3R1 and later

- JNP-MIC1-MACSEC:

  Junos OS release 17.3R2 and later

- MIC-MACSEC-MRATE:

  Junos OS release 17.4R1 and later

For information about which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information about which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.

Description

- Weight: 3 lb (1.36 kg)
- Model numbers:

  Without MACsec support: JNP-MIC1

  With MACsec support: JNP-MIC1-MACSEC

  With MACsec support: MIC-MACSEC-MRATE
- Power requirement:
  - JNP-MIC1:

    85 W at 55° C

    80 W at 25° C
  - JNP-MIC1-MACSEC:

    130 W at 55° C

    125 W at 25° C
  - MIC-MACSEC-MRATE:

    110 W at 45° C

    105 W at 25° C
- Name in the CLI:

  JNP-MIC1: `MIC1`

  JNP-MIC1-MACSEC: `MIC1-MACSEC`

  MIC-MACSEC-MRATE: `MACSEC-12xQSFPP-XGE-XLGE-CGE`

Hardware features

- JNP-MIC1 and JNP-MIC1-MACSEC:
  - Twelve 100-Gigabit Ethernet ports that support quad small form-factor pluggable (QSFP28) transceivers
  - The ports are numbered **0** through **11**.
  - Each port can be configured as a 100-Gigabit Ethernet port, 40-Gigabit Ethernet port, or as four 10-Gigabit Ethernet ports (by using a breakout cable).

  Table 40 on page 373 lists the configurable Gigabit Ethernet port speeds for each port.

- MIC-MACSEC-MRATE:
  - Twelve Gigabit Ethernet QSFP+ ports, each of which can be configured as a 40-Gigabit Ethernet port or as four 10-Gigabit Ethernet ports (by using a breakout cable).
  - The ports are numbered **0** through **11**.
  - Eight out of the twelve ports can be configured as 100-Gigabit Ethernet ports. Port numbers **0** through **3**, and **6** through **9** are the eight 100-Gigabit Ethernet ports.
  - When used in MP8CE:
    - Four ports out of the total twelve ports support 100-Gigabit Ethernet speed
    - Maximum aggregate port capacity across ports **0** through **5** should not exceed 240 Gbps
    - Maximum aggregate port capacity across ports **6** through **11** should not exceed 240 Gbps
  - When used in MPC9E:
    - Eight ports out of the total twelve ports support 100-Gigabit Ethernet speed
    - Maximum aggregate port capacity across ports **0** through **5** should not exceed 400 Gbps
    - Maximum aggregate port capacity across ports **6** through **11** should not exceed 400 Gbp

  NOTE: Compared to other MICs, MIC-MACSEC-MRATE takes longer time (around 4 minutes) to boot as it is required to bring up two MICs in serial.

	Table 41 on page 374 lists the configurable Gigabit Ethernet port speeds for each port.
Software features	• Supports rate selectability at the port level. • By default, the ports are configured as 10-Gigabit Ethernet ports. • Supports remote port identification. • MICs with model numbers JNP-MIC1-MACSEC and MIC-MACSEC-MRATE support Media Access Control Security (MACsec)
Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

LEDs	• **OK/FAIL** LED, one bicolor:
	  • OFF—MIC is offline or MIC has fault.
	  • Red—MIC is in power failure state.
	  • Green—MIC is online.
	• Link LED, one green per port:
	  • Steady green—Link is up.
	  • Off—Link is down or disabled.
	• Like port status LED, each individual lane LED support four states as: OFF, AMBER, GREEN, RED. See *MPC and MIC Lane LED Scheme Overview* for more details.

Table 40: Multi-Rate Ethernet MIC Port Speed Capabilities for JNP-MIC1 and JNP-MIC1-MACSEC

Port #	4x10-Gigabit Ethernet	40-Gigabit Ethernet	100-Gigabit Ethernet
0	yes	yes	yes
1	yes	yes	yes

Table 40: Multi-Rate Ethernet MIC Port Speed Capabilities for JNP-MIC1 and JNP-MIC1-MACSEC *(Continued)*

Port #	4x10-Gigabit Ethernet	40-Gigabit Ethernet	100-Gigabit Ethernet
2	yes	yes	yes
3	yes	yes	yes
4	yes	yes	yes
5	yes	yes	yes
6	yes	yes	yes
7	yes	yes	yes
8	yes	yes	yes
9	yes	yes	yes
10	yes	yes	yes
11	yes	yes	yes

Table 41: Multi-Rate Ethernet MIC Port Speed Capabilities for MIC-MACSEC-MRATE

Port #	4x10-Gigabit Ethernet	40-Gigabit Ethernet	100-Gigabit Ethernet
0	yes	yes	yes
1	yes	yes	yes
2	yes	yes	yes

Table 41: Multi-Rate Ethernet MIC Port Speed Capabilities for MIC-MACSEC-MRATE *(Continued)*

Port #	4x10-Gigabit Ethernet	40-Gigabit Ethernet	100-Gigabit Ethernet
3	yes	yes	yes
4	yes	yes	no
5	yes	yes	no
6	yes	yes	yes
7	yes	yes	yes
8	yes	yes	yes
9	yes	yes	yes
10	yes	yes	no
11	yes	yes	no

RELATED DOCUMENTATION

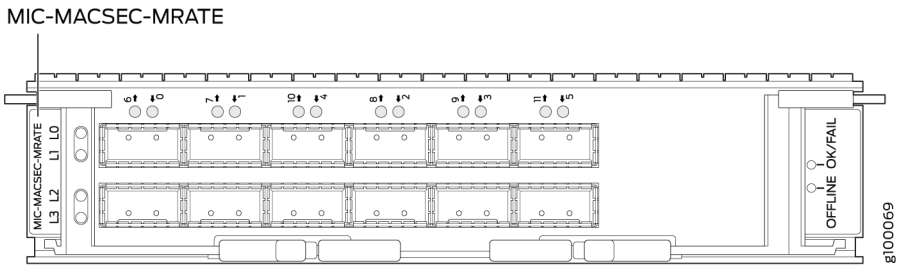
Configuring Port Speed on MX10003 MPC to Enable Different Port Speeds

MX10003 MPC Port Speed Overview

Port Speed for Routing Devices

Multi-Rate Ethernet MACSEC MIC

Figure 54: MIC-MACSEC-MRATE



Software release	Junos OS release 17.4R1 and later For information about which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information about which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• Weight: 3 lb (1.36 kg) • Model number: MIC-MACSEC-MRATE • Power requirement: 110 W at 45° C 105 W at 25° C • Name in the CLI: `MACSEC-12xQSFPP-XGE-XLGE-CGE`

Hardware features	• Twelve Gigabit Ethernet QSFP+ ports, each of which can be configured as a 40-Gigabit Ethernet port or as four 10-Gigabit Ethernet ports (by using a breakout cable).
	• The ports are numbered **0** through **11**.
	• Eight out of the twelve ports can be configured as 100-Gigabit Ethernet ports. Port numbers **0** through **3**, and **6** through **9** are the eight 100-Gigabit Ethernet ports.
	• When used in MP8CE:
	  • Four ports out of the total twelve ports support 100-Gigabit Ethernet speed
	  • Maximum aggregate port capacity across ports **0** through **5** should not exceed 240 Gbps
	  • Maximum aggregate port capacity across ports **6** through **11** should not exceed 240 Gbps
	• When used in MPC9E:
	  • Eight ports out of the total twelve ports support 100-Gigabit Ethernet speed
	  • Maximum aggregate port capacity across ports **0** through **5** should not exceed 400 Gbps
	  • Maximum aggregate port capacity across ports **6** through **11** should not exceed 400 Gbp
	• Table 42 on page 378 lists the configurable Gigabit Ethernet port speeds for each port.

Software features	• Supports rate selectability at the port level.
	• By default, the ports are configured as 10-Gigabit Ethernet ports.
	• Supports remote port identification.
	• Supports Media Access Control Security (MACsec). The following encryption algorithms are supported:
	  • gcm-aes-128
	  • gcm-aes-256

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.

LEDs	• **OK/FAIL** LED, one bicolor:
	  • OFF—MIC is offline or MIC has fault.
	  • Red—MIC is in power failure state.
	  • Green—MIC is online.
	• Link LED, one green per port:
	  • Steady green—Link is up.
	  • Off—Link is down or disabled.
	• Like port status LED, each individual lane LED support four states as: OFF, AMBER, GREEN, RED. See *MPC and MIC Lane LED Scheme Overview* for more details.

Table 42: Multi Rate Ethernet MIC Port Speed Capabilities for MIC-MACSEC-MRATE

Port #	4x10-Gigabit Ethernet	40-Gigabit Ethernet	100-Gigabit Ethernet
0	yes	yes	yes
1	yes	yes	yes
2	yes	yes	yes
3	yes	yes	yes
4	yes	yes	no
5	yes	yes	no
6	yes	yes	yes

Table 42: Multi Rate Ethernet MIC Port Speed Capabilities for MIC-MACSEC-MRATE *(Continued)*

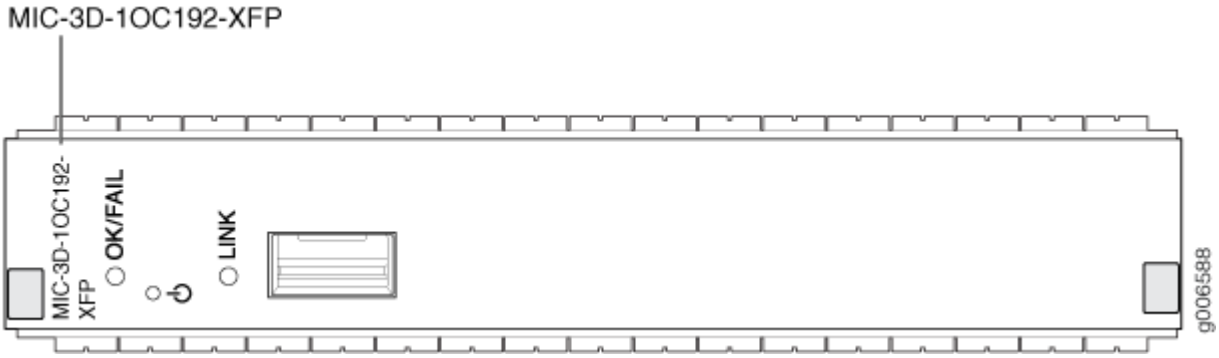
Port #	4x10-Gigabit Ethernet	40-Gigabit Ethernet	100-Gigabit Ethernet
7	yes	yes	yes
8	yes	yes	yes
9	yes	yes	yes
10	yes	yes	no
11	yes	yes	no

RELATED DOCUMENTATION

MPC and MIC Lane LED Scheme Overview

SONET/SDH OC192/STM64 MIC with XFP

Figure 55: SONET/SDH OC192/STM64 MIC with XFP



Software release	• Junos OS Release 12.2 and later For information on which MPCs support this MIC, see "MIC/MPC Compatibility" on page 46. For information on which MICs are supported on MX Series routers, see "MICs Supported by MX Series Routers" on page 30.
Description	• One OC192 port • Clear channel functionality • Power requirement: 4.25 A @ 9 V (38.25 W) • Weight: 1.34 lb (0.61 kg) • Model number: MIC-3D-1OC192-XFP
Hardware features	• Maximum transmission units (MTUs) of up to 9192 bytes • MIC bandwidth of up to 10 Gbps

Software features

- SONET/SDH framing
- Multiprotocol Label Switching (MPLS) fast reroute
- Ingress behavior aggregate (BA) classification
- Internal and loop clocking
- Encapsulations:
  - MPLS fast reroute
  - MPLS CCC (circuit cross-connection)
  - MPLS TCC (translational cross-connection)
  - Cisco High-Level Data Link Control (cHDLC)
  - Cisco HDLC CCC
  - Cisco HDLC TCC
  - Point-to-Point Protocol (PPP)
  - PPP for CCC
  - PPP for TCC
  - Flexible Frame Relay
  - Frame Relay
  - Frame Relay for CCC
  - Frame Relay for TCC
  - PPP over Frame Relay

    NOTE: Ethernet over Frame Relay is not supported.

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: To extend the life of the laser, when a MIC is not being actively used with any valid links, take the MIC offline until you are ready to establish a link to another device. For information about taking a MIC offline, see the `request chassis pic offline` command in the CLI Explorer.
LEDs	**OK/FAIL** LED, one bicolor: • Green—MIC is functioning normally • Red—MIC has failed **LINK** LED, one tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	SONET alarms: • Loss of light (LOL) • Phase lock loop (PLL) • Loss of signal (LOS) • Loss of frame (LOF) • Severely errored frame (SEF) • Alarm indicator signal–line (AIS-L) • Alarm indicator signal–path (AIS-P) • Remote defect indicator–line (RDI-L) • Remote defect indicator–path (RDI-P) • Loss of pointer–path (LOP-P) • Bit error rate–signal degrade (BERR-SD) • Bit error rate–signal fail (BERR-SF) • Payload label mismatch–Path (PLM-P) • Unequipped–path (UNEQ-P) • Remote error indicator–path (REI-P) SDH alarms: • Loss of light (LOL) • Phase lock loop (PLL) • Loss of frame (LOF) • Loss of signal (LOS) • Severely errored frame (SEF) • Multiplex-section alarm indicator signal (MS-AIS) • Higher order path–alarm indication signal (HP-AIS)

- Loss of pointer (LOP)
- Bit error rate–signal degrade (BER-SD)
- Bit error rate–signal fail (BER-SF)
- Multiplex section–far end receive failure (MS-FERF)
- Higher order path—far-end receive failure (HP-FERF)
- Higher order path—payload label mismatch (HP-PLM)
- Remote error indicator (REI)
- Unequipped (UNEQ)

RELATED DOCUMENTATION

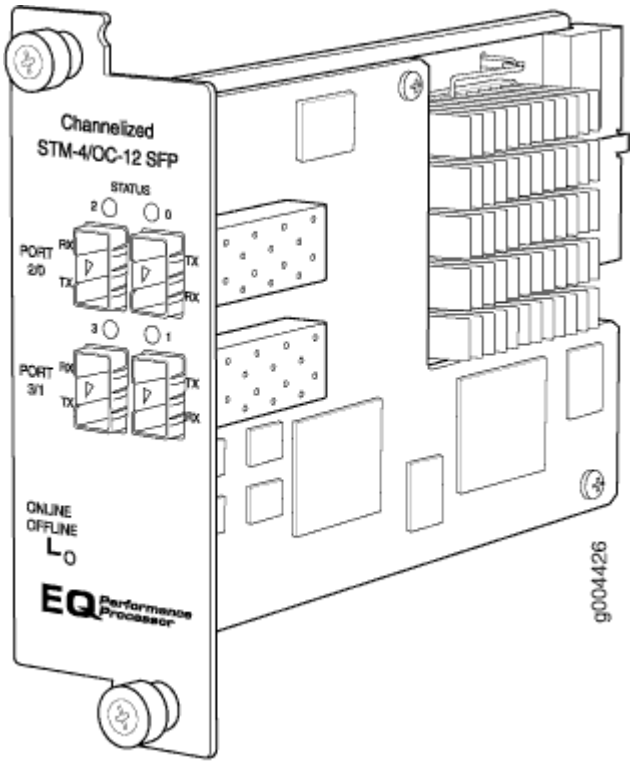
MX Series MIC Overview | 29

CHAPTER 12

MX Series PIC Descriptions

IN THIS CHAPTER

Channelized OC12/STM4 Enhanced IQ (IQE) PIC with SFP



Software release	• Junos 9.5 and later

RELATED DOCUMENTATION

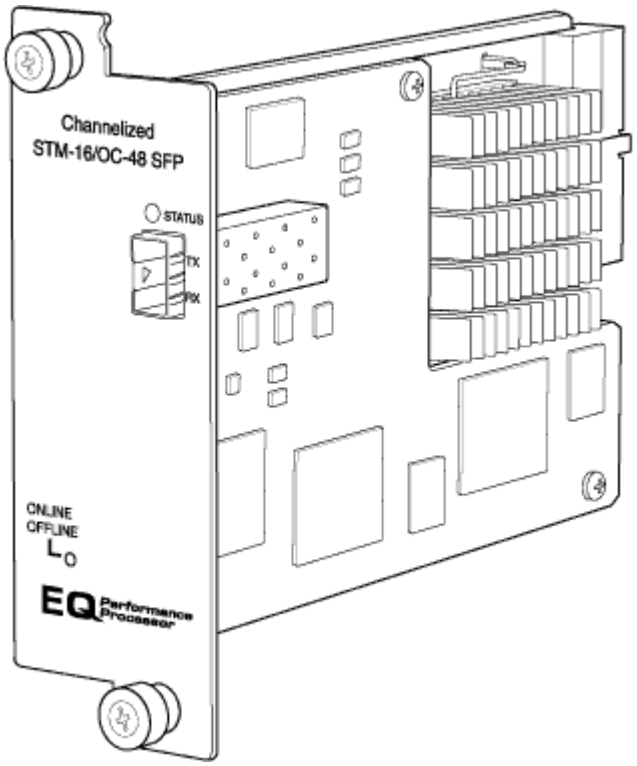
MX Series FPC and PIC Overview | **60**

FPCs Supported by MX240, MX480, and MX960 Routers | **61**

PICs Supported by MX240, MX480, and MX960 Routers | **62**

High Availability Features | **61**

Channelized OC48/STM16 Enhanced IQ (IQE) PIC with SFP



Software release	• Junos 9.5 and later

Description	• One OC48/STM16 port
	• SONET or SDH is configurable on a per-port granularity
	• SONET channelization:
	  • 4 OC12 channel
	  • 16 OC3 channels
	  • 48 DS3 channels
	  • 672 DS1 channels
	  • 975 DS0 channels
	• SDH channelization:
	  • 4 STM4 channel
	  • 16 STM1 channels
	  • 48 E3 channels
	  • 504 E1 channels
	  • 975 DS0 channels
	• Power requirement: 1.10 A @ 48V (53 W)
	• Model Number: PB-1CHOC48-STM16-IQE-SFP

Hardware features	• Port is numbered 0.

Software features	• Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	• Enhanced fine-grained queuing per logical interface. See the Junos OS Class of Service User Guide for Routing Devices for more information about class of service features.
	• Subrate and scrambling:
	  • Digital Link/Quick Eagle
	  • Kentrox
	  • Larscom
	  • ADTRAN
	  • Verilink
	• Packet buffering, Layer 2 parsing
	• M13/C-bit parity encoding
	• DS3 far-end alarm and control (FEAC) channel support
	• Local line, remote line, and remote payload loopback testing
	• Simple Network Management Protocol (SNMP): OC12, OC3 MIB, DS3 MIB, T1 MIB
	• Dynamic, arbitrary channel configuration
	• Full bit error rate test (BERT)
	• Encapsulations:
	  • Circuit cross-connect (CCC)
	  • Translational cross-connect (TCC)
	  • Extended Frame Relay for CCC and TCC
	  • Flexible Frame Relay
	  • Frame Relay
	  • Frame Relay for CCC

	• Frame Relay for TCC
	• Frame Relay port CCC
	• High-Level Data Link Control (HDLC)
	• HDLC framing for CCC
	• HDLC framing for TCC
	• MPLS CCC
	• MPLS TCC
	• Multilink Frame Relay (MLFR) UNI NNI (MFR FRF.16)
	• Point-to-Point Protocol (PPP)
	• PPP for CCC
	• PPP for TCC
	• Encapsulations available only for DS1:
	  • Multilink Frame Relay end-to-end (MLFR FRF.15)
	  • Multilink PPP (MLPPP)
	  • PPP over Frame Relay

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	SONET alarms: • Alarm indication signal—line (AIS-L) • Alarm indication signal—path (AIS-P) • Bit error rate—signal degrade (BERR-SD) • Bit error rate—signal fail (BERR-SF) • Loss of frame (LOF) • Loss of light (LOL) • Loss of pointer (LOP) • Loss of signal (LOS) • Payload label mismatch (PLM-P) • Remote defect indication—line (RDI-L) • Remote defect indication—path (RDI-P) • Remote error indication (REI) • Payload unequipped (unequipped STS at path level) (UNEQ-P) • Virtual container—alarm indication signal (VAIS) • Virtual container—loss of pointer (VLOP) • Virtual container—mismatch (VMIS) • Virtual container—remote defect indication (VRD1) • Virtual container—unequipped (VUNEQ) SDH alarms: • Administrative unit alarm indication signal (AU-AIS) • Bit error rate—signal degrade (BERR-SD) • Bit error rate—signal fail (BERR-SF) • Bit interleaved parity (BIP) error B1, B2, B3

- Higher order path—alarm indication signal (HP-AIS)
- Higher order path—far-end receive failure (HP-FERF)
- Higher order path—payload label mismatch (HP-PLM)
- Higher order path—loss of pointer (HP-LOP)
- Higher order path—remote defect indication (HP-RDI)
- Higher order path—unequipped (HP-UNEQ)
- Loss of frame (LOF)
- Loss of light (LOL)
- Loss of signal (LOS)
- Multiplex section—alarm indication signal (MS-AIS)
- Multiplex section—far-end receive failure (MS-FERF)
- Multiplex section—remote defect indication (MS-RDI)
- Multiplex section—remote error indication (MS-REI)
- Phase lock loop (PLL)
- Remote error indication (REI)
- Severely errored frame (SEF)
- Tributary unit—alarm indication signal (TU-AIS)
- Tributary unit—loss of pointer (TU-LOP)
- Tributary unit—mismatch (TU-MIS)
- Tributary unit—remote defect indication (TU-RD1)
- Tributary unit—unequipped (TU-UNEQ)

DS1 alarms:

- Alarm indication signal (AIS)
- Loss of frame (LOF)

- Remote alarm indication signal (RAIS)
-
- DS1 error detection:
  - Bursty errored seconds (BES)
  - CRC errors
  - Errored seconds (ES)
  - Line errored seconds (LES)
  - Loss of framing seconds (LOFS)
  - Severely errored seconds (SES)
  - Severely errored framing seconds (SEFS)
  - Unavailable seconds (UAS)
  - DS3 alarms:
    - Alarm indication signal (AIS)
    - Loss of frame (LOF)
    - Yellow alarm
  - DS3 error detection:
    - C-bit code violations (CCV)
    - C-bit errored seconds (CES)
    - C-bit severely errored framing seconds (CEFS)
    - CRC errors
    - Excessive zeros (EXZ)
    - Far-end block error (FEBE)

- Far-end receive failure (FERF)
- Line errored seconds (LES)
- Parity bit (P-bit) code violations (PCV)
- Parity bit (P-bit) errored seconds (PES)
- Parity bit (P-bit) severely errored framing seconds (PSES)
- Severely errored framing seconds (SEFS)
- Unavailable seconds (UAS)

Instrumentation (counters)	• Layer 2 per-queue and per-channel packet and byte counters

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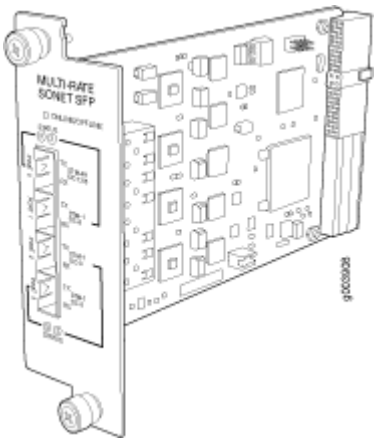
FPCs Supported by MX240, MX480, and MX960 Routers | **61**

PICs Supported by MX240, MX480, and MX960 Routers | **62**

High Availability Features | **61**

SONET/SDH OC3/STM1 (Multi-Rate) PIC with SFP



Software release	• Junos 9.5 and later

Description	• Rate-selectable using one of the following rates:
	  • 1-port OC12/STM4
	  • 1-port OC12c/STM4c
	  • 4-port OC3c/STM1c
	• Power requirement: 0.40 A @ 48 V (19 W)
	• Model Number: PB-4OC3-1OC12-SON-SFP

Hardware features	• Multiplexing and demultiplexing • Rate policing on input • Rate shaping on output • Packet buffering, Layer 2 parsing

Software features	• Optical diagnostics and related alarms
	• Per-port SONET/SDH framing
	• Link aggregation
	• Alarm and event counting and detection
	• Dual-router automatic protection switching (APS)
	• Multiprotocol Label Switching (MPLS) fast reroute
	• Encapsulations:
	  • Circuit cross-connect (CCC)
	  • Translational cross-connect (TCC)
	  • Frame Relay
	  • High-Level Data Link Control (HDLC)
	  • Point-to-Point Protocol (PPP)

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the `request chassis pic offline` command in the CLI Explorer.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- SONET alarms:
  - Alarm indication signal—line (AIS-L)
  - Alarm indication signal—path (AIS-P)
  - Bit error rate—signal degrade (BERR-SD)
  - Bit error rate—signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Far-end bit error: remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
  - Far-end bit error: remote error indication—path (REI-P), far-end path coding violations (CV-PFE)
  - Loss of frame (LOF)
  - Loss of pointer (LOP-P)
  - Loss of signal (LOS)
  - Payload label mismatch (PLM-P)
  - Payload unequipped (unequipped STS at path level) (UNEQ-P)
  - Remote defect indication—line (RDI-L)
  - Remote defect indication—path (RDI-P)
- SDH alarms:
  - Administrative unit alarm indication signal (AU-AIS)
  - Bit error rate signal degrade (BERR-SD)
  - Bit error rate signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Higher order path—payload label mismatch (HP-PLM)
  - Higher order path—loss of pointer (HP-LOP)

    - Higher order path—remote defect indication (HP-RDI)
    - Higher order path—unequipped (HP-UNEQ)
    - Loss of frame (LOF)
    - Loss of signal (LOS)
    - Multiplex section—alarm indication signal (MS-AIS)
    - Multiplex section—remote defect indication (MS-RDI)
    - Multiplex section—remote error indication (MS-REI)
- Error detection:
    - Errored seconds (ES-S, ES-L, ES-P)
    - Far-end errored seconds (ES-LFE, ES-PFE)
    - Far-end severely errored seconds (SES-LFE, SES-PFE)
    - Far-end unavailable seconds (UAS-LFE, UAS-PFE)
    - Severely errored frames (SEF)
    - Severely errored framing seconds (SEFS-S)
    - Severely errored seconds (SES-S, SES-L, SES-P)
    - Unavailable seconds (UAS-L, UAS-P)

RELATED DOCUMENTATION

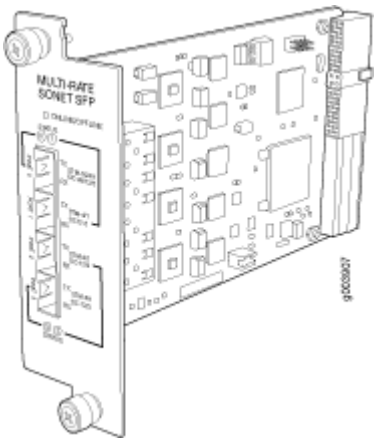
MX Series FPC and PIC Overview | **60**

FPCs Supported by MX240, MX480, and MX960 Routers | **61**

PICs Supported by MX240, MX480, and MX960 Routers | **62**

High Availability Features | **61**

SONET/SDH OC12/STM4 (Multi-Rate) PIC with SFP



Software release	• Junos 9.5 and later

Description	• Rate-selectable using one of the following rates:
	  • 1-port OC12
	  • 1-port OC48
	  • 1-port OC48c
	  • 4-port OC3c
	  • 4-port OC12c
	• Power requirement: 0.40 A @ 48 V (19 W)
	• Model Number: PB-4OC3-4OC12-SON-SFP

Hardware features	• Multiplexing and demultiplexing • Rate policing on input • Rate shaping on output • Packet buffering, Layer 2 parsing

Software features	• Optical diagnostics and related alarms
	• Per-port SONET/SDH framing
	• Link aggregation
	• Alarm and event counting and detection
	• Dual-router automatic protection switching (APS)
	• Multiprotocol Label Switching (MPLS) fast reroute
	• Encapsulations:
	  • Circuit cross-connect (CCC)
	  • Translational cross-connect (TCC)
	  • Frame Relay
	  • High-Level Data Link Control (HDLC)
	  • Point-to-Point Protocol (PPP)

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the `request chassis pic offline` command in the CLI Explorer.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- SONET alarms:
  - Alarm indication signal—line (AIS-L)
  - Alarm indication signal—path (AIS-P)
  - Bit error rate—signal degrade (BERR-SD)
  - Bit error rate—signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Far-end bit error: remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
  - Far-end bit error: remote error indication—path (REI-P), far-end path coding violations (CV-PFE)
  - Loss of frame (LOF)
  - Loss of pointer (LOP-P)
  - Loss of signal (LOS)
  - Payload label mismatch (PLM-P)
  - Payload unequipped (unequipped STS at path level) (UNEQ-P)
  - Remote defect indication—line (RDI-L)
  - Remote defect indication—path (RDI-P)
- SDH alarms:
  - Administrative unit alarm indication signal (AU-AIS)
  - Bit error rate signal degrade (BERR-SD)
  - Bit error rate signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Higher order path—payload label mismatch (HP-PLM)
  - Higher order path—loss of pointer (HP-LOP)

- Higher order path—remote defect indication (HP-RDI)
- Higher order path—unequipped (HP-UNEQ)
- Loss of frame (LOF)
- Loss of signal (LOS)
- Multiplex section—alarm indication signal (MS-AIS)
- Multiplex section—remote defect indication (MS-RDI)
- Multiplex section—remote error indication (MS-REI)

- Error detection:
  - Errored seconds (ES-S, ES-L, ES-P)
  - Far-end errored seconds (ES-LFE, ES-PFE)
  - Far-end severely errored seconds (SES-LFE, SES-PFE)
  - Far-end unavailable seconds (UAS-LFE, UAS-PFE)
  - Severely errored frames (SEF)
  - Severely errored framing seconds (SEFS-S)
  - Severely errored seconds (SES-S, SES-L, SES-P)
  - Unavailable seconds (UAS-L, UAS-P)

RELATED DOCUMENTATION

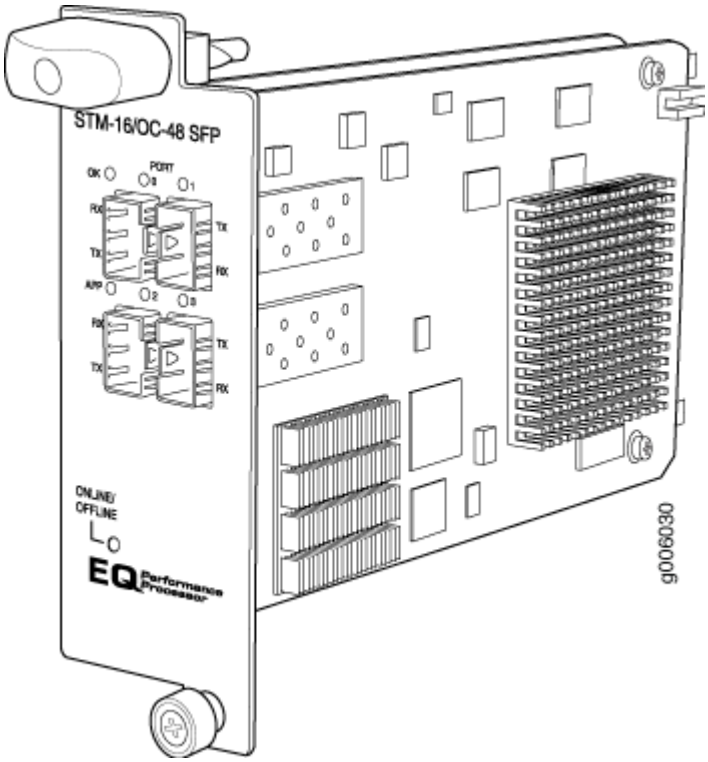
MX Series FPC and PIC Overview | **60**

FPCs Supported by MX240, MX480, and MX960 Routers | **61**

PICs Supported by MX240, MX480, and MX960 Routers | **62**

High Availability Features | **61**

SONET/SDH OC48/STM16 Enhanced IQ (IQE) PIC with SFP



Software release	• Junos OS Release 10.4R2 and later (Type 3)
Description	• Four OC48/STM16 ports • Clear channel functionality • SONET and SDH is configured on a per-port granularity • Power requirement: 1.06 A @ 48 V (51 W) • Weight: 1.6 lb (0.725 kg) • Model number: PC-4OC48-STM16-IQE-SFP

Hardware features	• Ports are numbered:
	  • Top row: 0 and 1 from left to right
	  • Bottom row: 2 and 3 from left to right
	• Maximum transmission units (MTUs) of up to 9192 bytes

Software features

- Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
- Fine-grained egress queuing per logical interface. See the Junos OS Class of Service User Guide for Routing Devices for more information about class-of-service features
- Packet buffering
- Local line and remote payload loopback testing
- Optical diagnostics and monitoring
- Clocking options: internal or external/loop mode. Each OC48 transmitter port is configured either in internal or external mode. The default clocking option is internal mode.
- Encapsulations:
  - Extended Frame Relay for circuit cross-connect (CCC) and translational cross-connect (TCC)
  - Flexible Frame Relay
  - Frame Relay
  - Frame Relay for CCC
  - Frame Relay for TCC
  - Frame Relay port CCC
  - High-Level Data Link Control (HDLC)
  - HDLC framing for CCC
  - HDLC framing for TCC
  - MPLS CCC
  - MPLS TCC
  - Point-to-Point Protocol (PPP)
  - PPP for CCC
  - PPP for TCC

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the `request chassis pic offline` command in the CLI Explorer.
LEDs	OK LED, one tricolor: • Off—PIC is offline and safe to remove from the router • Green—PIC is operating normally • Yellow—PIC is initializing • Red—PIC has an error or failure APP LED, one green per port: • Off—Service is not running • Green—Service is running under acceptable load Port LEDs, one tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	SONET alarms: • Loss of light (LOL) • Phase lock loop (PLL) • Loss of frame (LOF) • Loss of signal (LOS) • Severely errored frame (SEF) • Alarm indicator signal—line (AIS-L) • Alarm indicator signal—path (AIS-P) • Loss of pointer (LOP) • Bit error rate—signal degrade (BERR-SD) • Bit error rate—signal fail (BERR-SF) • Remote defect indicator—line (RDI-L) • Remote defect indicator—path (RDI-P) • Remote error indicator (REI) • Unequipped (UNEQ) • Payload label mismatch—path (PLM-P) SDH alarms: • Loss of light (LOL) • Phase lock loop (PLL) • Loss of frame (LOF) • Loss of signal (LOS) • Severely errored frame (SEF) • Multiplex-section alarm indicator signal (MS-AIS) • H Path alarm indicator signal (HP-AIS)

- Loss of pointer (LOP)
- Bit error rate—signal degrade (BERR-SD)
- Bit error rate—signal fail (BERR-SF)
- Multiplex section—far end receive failure (MS-FERF)
- High order path—far end receive failure (HP-FERF)
- Remote error indicator (REI)
- Unequipped (UNEQ)
- High order path—payload label mismatch - Path (HP-PLM)

Optical diagnostics related alarms:

NOTE: Transceivers from some vendors do not support these fields.

- Temperature high/low alarms and warnings
- Supply voltage high/low alarms and warnings
- Tx bias current high/low alarms and warnings
- Tx output power high/low alarms and warnings
- Rx received power high/low alarms and warnings

RELATED DOCUMENTATION

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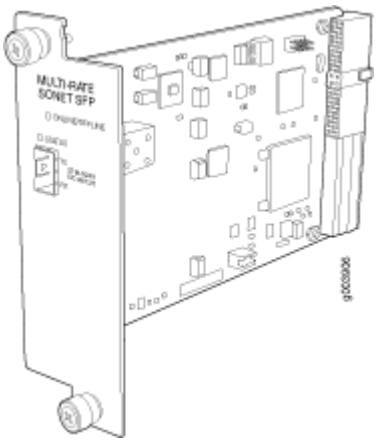
FPCs Supported by MX240, MX480, and MX960 Routers | **61**

PICs Supported by MX240, MX480, and MX960 Routers | **62**

High Availability Features | **61**

SONET/SDH OC48/STM16 (Multi-Rate) PIC with SFP



Software release	• Junos 9.5 and later

Description	• Rate-selectable using one of the following rates:
	  • 1-port OC3c/STM1c
	  • 1-port OC12/STM4
	  • 1-port OC12c/STM4c
	  • 1-port OC48/STM16
	  • 1-port OC48c/STM16c
	• Power requirement: 0.20 A @ 48 V (9.5 W)
	• Model Number: PB-1OC48-SON-B-SFP

Hardware features	• Multiplexing and demultiplexing • Rate policing on input • Rate shaping on output • Packet buffering, Layer 2 parsing

Software features	• Optical diagnostics and related alarms
	• Per-port SONET/SDH framing
	• Link aggregation
	• Alarm and event counting and detection
	• Dual-router automatic protection switching (APS)
	• Multiprotocol Label Switching (MPLS) fast reroute
	• Encapsulations:
	  • Circuit cross-connect (CCC)
	  • Translational cross-connect (TCC)
	  • Frame Relay
	  • High-Level Data Link Control (HDLC)
	  • Point-to-Point Protocol (PPP)

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the `request chassis pic offline` command in the CLI Explorer.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- SONET alarms:
  - Alarm indication signal—line (AIS-L)
  - Alarm indication signal—path (AIS-P)
  - Bit error rate—signal degrade (BERR-SD)
  - Bit error rate—signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Far-end bit error: remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
  - Far-end bit error: remote error indication—path (REI-P), far-end path coding violations (CV-PFE)
  - Loss of frame (LOF)
  - Loss of pointer (LOP-P)
  - Loss of signal (LOS)
  - Payload label mismatch (PLM-P)
  - Payload unequipped (unequipped STS at path level) (UNEQ-P)
  - Remote defect indication—line (RDI-L)
  - Remote defect indication—path (RDI-P)
- SDH alarms:
  - Administrative unit alarm indication signal (AU-AIS)
  - Bit error rate signal degrade (BERR-SD)
  - Bit error rate signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Higher order path—payload label mismatch (HP-PLM)
  - Higher order path—loss of pointer (HP-LOP)

    - Higher order path—remote defect indication (HP-RDI)
    - Higher order path—unequipped (HP-UNEQ)
    - Loss of frame (LOF)
    - Loss of signal (LOS)
    - Multiplex section—alarm indication signal (MS-AIS)
    - Multiplex section—remote defect indication (MS-RDI)
    - Multiplex section—remote error indication (MS-REI)
- Error detection:
    - Errored seconds (ES-S, ES-L, ES-P)
    - Far-end errored seconds (ES-LFE, ES-PFE)
    - Far-end severely errored seconds (SES-LFE, SES-PFE)
    - Far-end unavailable seconds (UAS-LFE, UAS-PFE)
    - Severely errored frames (SEF)
    - Severely errored framing seconds (SEFS-S)
    - Severely errored seconds (SES-S, SES-L, SES-P)
    - Unavailable seconds (UAS-L, UAS-P)

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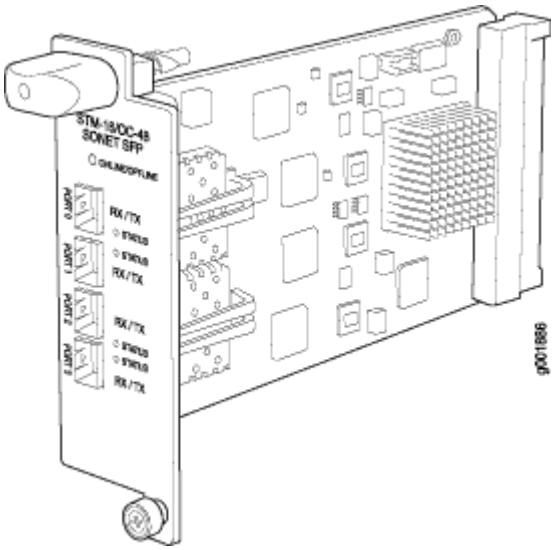
PICs Supported by MX240, MX480, and MX960 Routers | **62**

High Availability Features | **61**

SONET/SDH OC48/STM16 PIC with SFP



Software release	• Junos 9.4 and later
Description	• Four OC48 ports • Power requirement: 0.86 A @ 48 V (41.4 W) • Model Number: PC-4OC48-SON-SFP
Hardware features	• Rate policing on input • Rate shaping on output • Packet buffering, Layer 2 parsing

Software features	• Optical diagnostics and related alarms
	• Configuration of SONET or SDH framing on a per-port basis
	• SONET/SDH framing
	• Link aggregation
	• Alarm and event counting and detection
	• Dual-router automatic protection switching (APS)
	• Multiprotocol Label Switching (MPLS) fast reroute
	• Encapsulations:
	  • High-Level Data Link Control (HDLC)
	  • Frame Relay
	  • Circuit cross-connect (CCC)
	  • Translational cross-connect (TCC)
	  • Point-to-Point Protocol (PPP)

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. **NOTE**: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the `request chassis pic offline` command in the CLI Explorer.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- SONET alarms:
  - Alarm indication signal—line (AIS-L)
  - Alarm indication signal—path (AIS-P)
  - Bit error rate—signal degrade (BERR-SD)
  - Bit error rate—signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Far-end bit error: remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
  - Far-end bit error: remote error indication—path (REI-P), far-end path coding violations (CV-PFE)
  - Loss of frame (LOF)
  - Loss of pointer (LOP-P)
  - Loss of signal (LOS)
  - Payload label mismatch (PLM-P)
  - Payload unequipped (unequipped STS at path level) (UNEQ-P)
  - Remote defect indication—line (RDI-L)
  - Remote defect indication—path (RDI-P)
- SDH alarms:
  - Administrative unit alarm indication signal (AU-AIS)
  - Bit error rate signal degrade (BERR-SD)
  - Bit error rate signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Higher order path—payload label mismatch (HP-PLM)
  - Higher order path—loss of pointer (HP-LOP)

    - Higher order path—remote defect indication (HP-RDI)
    - Higher order path—unequipped (HP-UNEQ)
    - Loss of frame (LOF)
    - Loss of signal (LOS)
    - Multiplex section—alarm indication signal (MS-AIS)
    - Multiplex section—remote defect indication (MS-RDI)
    - Multiplex section—remote error indication (MS-REI)
- Error detection:
    - Errored seconds (ES-S, ES-L, ES-P)
    - Far-end errored seconds (ES-LFE, ES-PFE)
    - Far-end severely errored seconds (SES-LFE, SES-PFE)
    - Far-end unavailable seconds (UAS-LFE, UAS-PFE)
    - Severely errored framing (SEF)
    - Severely errored framing seconds (SEFS-S)
    - Severely errored seconds (SES-S, SES-L, SES-P)
    - Unavailable seconds (UAS-L, UAS-P)

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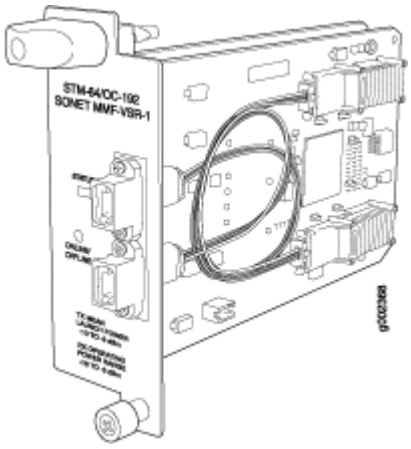
PICs Supported by MX240, MX480, and MX960 Routers | **62**

High Availability Features | **61**

SONET/SDH OC192c/STM64 PIC



Software release	• Junos 9.4 and later
Description	• One OC192 port • Power requirement: 0.45 A @ 48 V (21.6 W) • Model Number: PC-1OC192-SON-VSR
Hardware features	• Multiplexing and demultiplexing • Rate policing on input • Rate shaping on output • Packet buffering, Layer 2 parsing

Software features	• SONET/SDH framing
	• Link aggregation
	• Alarm and event counting and detection
	• Dual-router automatic protection switching (APS)
	• Multiprotocol Label Switching (MPLS) fast reroute
	• Encapsulations:
	  • High-Level Data Link Control (HDLC)
	  • Frame Relay
	  • Circuit cross-connect (CCC)
	  • Translational cross-connect (TCC)
	  • Point-to-Point Protocol (PPP)

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. The list of supported transceivers for the MX Series is located at https://pathfinder.juniper.net/hct/category/#catKey=100001&modelType;=All&pf;=MX+Series. • Very short reach (VSR 1): 12-ribbon multimode fiber with MTP connector (Rx and Tx) • Fiber-optic 10-gigabit small form-factor pluggable (XFP) transceivers: 10GBASE-S very short reach (VSR-1) (model number: XFP-10G-S) **NOTE**: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the `request chassis pic offline` command in the CLI Explorer.

LEDs	One tricolor LED per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- SONET alarms:
  - Alarm indication signal—line (AIS-L)
  - Alarm indication signal—path (AIS-P)
  - Bit error rate—signal degrade (BERR-SD)
  - Bit error rate—signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Far-end bit error: remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
  - Far-end bit error: remote error indication—path (REI-P), far-end path coding violations (CV-PFE)
  - Loss of frame (LOF)
  - Loss of pointer (LOP-P)
  - Loss of signal (LOS)
  - Payload label mismatch (PLM-P)
  - Payload unequipped (unequipped STS at path level) (UNEQ-P)
  - Remote defect indication—line (RDI-L)
  - Remote defect indication—path (RDI-P)
- SDH alarms:
  - Administrative unit alarm indication signal (AU-AIS)
  - Bit error rate signal degrade (BERR-SD)
  - Bit error rate signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Higher order path—payload label mismatch (HP-PLM)
  - Higher order path—loss of pointer (HP-LOP)

    - Higher order path—remote defect indication (HP-RDI)
    - Higher order path—unequipped (HP-UNEQ)
    - Loss of frame (LOF)
    - Loss of signal (LOS)
    - Multiplex section—alarm indication signal (MS-AIS)
    - Multiplex section—remote defect indication (MS-RDI)
    - Multiplex section—remote error indication (MS-REI)
- Error detection:
    - Errored seconds (ES-S, ES-L, ES-P)
    - Far-end errored seconds (ES-LFE, ES-PFE)
    - Far-end severely errored seconds (SES-LFE, SES-PFE)
    - Far-end unavailable seconds (UAS-LFE, UAS-PFE)
    - Severely errored framing (SEF)
    - Severely errored framing seconds (SEFS-S)
    - Severely errored seconds (SES-S, SES-L, SES-P)
    - Unavailable seconds (UAS-L, UAS-P)

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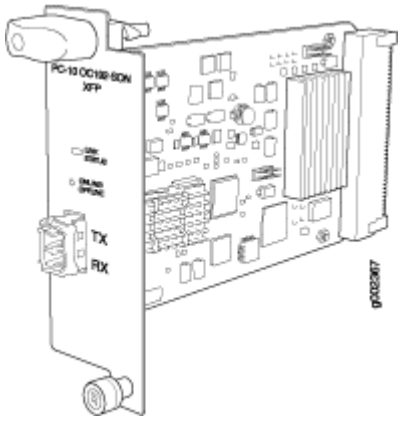
SONET/SDH OC192c/STM64 PIC with XFP



Software release	• Junos 9.4 and later
Description	• One OC192 port • Power requirement: 0.52A @ 48 V (25 W) • Model number: PB-1OC192-SON-XFP
Hardware features	• Multiplexing and demultiplexing • Rate policing on input • Rate shaping on output • Packet buffering, Layer 2 parsing

Software features	• SONET/SDH framing
	• Link aggregation
	• Alarm and event counting and detection
	• Dual-router automatic protection switching (APS)
	• Multiprotocol Label Switching (MPLS) fast reroute
	• Encapsulations:
	  • Circuit cross-connect (CCC)
	  • Translational cross-connect (TCC)
	  • Frame Relay
	  • High-Level Data Link Control (HDLC)
	  • Point-to-Point Protocol (PPP)

Cables and connectors	**TIP**: You can use the Hardware Compatibility Tool to find information about the pluggable transceivers supported on your Juniper Networks device. **NOTE**: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the `request chassis pic offline` command in the CLI Explorer.
LEDs	One tricolor LED per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- SONET alarms:
  - Alarm indication signal—line (AIS-L)
  - Alarm indication signal—path (AIS-P)
  - Bit error rate—signal degrade (BERR-SD)
  - Bit error rate—signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Far-end bit error: remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
  - Far-end bit error: remote error indication—path (REI-P), far-end path coding violations (CV-PFE)
  - Loss of frame (LOF)
  - Loss of pointer (LOP-P)
  - Loss of signal (LOS)
  - Payload label mismatch (PLM-P)
  - Payload unequipped (unequipped STS at path level) (UNEQ-P)
  - Remote defect indication—line (RDI-L)
  - Remote defect indication—path (RDI-P)
- SDH alarms:
  - Administrative unit alarm indication signal (AU-AIS)
  - Bit error rate signal degrade (BERR-SD)
  - Bit error rate signal fail (BERR-SF)
  - Bit interleaved parity (BIP) error B1, B2, B3
  - Higher order path—payload label mismatch (HP-PLM)
  - Higher order path—loss of pointer (HP-LOP)

    - Higher order path—remote defect indication (HP-RDI)
    - Higher order path—unequipped (HP-UNEQ)
    - Loss of frame (LOF)
    - Loss of signal (LOS)
    - Multiplex section—alarm indication signal (MS-AIS)
    - Multiplex section—remote defect indication (MS-RDI)
    - Multiplex section—remote error indication (MS-REI)
- Error detection:
    - Errored seconds (ES-S, ES-L, ES-P)
    - Far-end errored seconds (ES-LFE, ES-PFE)
    - Far-end severely errored seconds (SES-LFE, SES-PFE)
    - Far-end unavailable seconds (UAS-LFE, UAS-PFE)
    - Severely errored framing (SEF)
    - Severely errored framing seconds (SEFS-S)
    - Severely errored seconds (SES-S, SES-L, SES-P)
    - Unavailable seconds (UAS-L, UAS-P)

RELATED DOCUMENTATION

MX Series FPC and PIC Overview | **60**

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PART 3

Protocol and Application Support

CHAPTER 13

DPC Protocol and Application Support for MX240, MX480, and MX960

IN THIS CHAPTER

Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R)

Table 43 on page 428 contains the first Junos OS Release support for protocols and applications on the MX240, MX480, and MX960 DPCs and Enhanced DPCs. A dash indicates that the protocol or application is not supported.

Table 43: Protocols and Applications Supported by the DPCs and Enhanced DPCs (DPC and DPCE-R)

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)				
	DPC-R-4XGE-XFP DPC-R-40GE-SFP (DPC)	DPCE-R-2XGE-XFP (Enhanced DPC)	DPCE-R-4XGE-XFP DPCE-R-40GE-SFP (Enhanced DPC)	DPCE-R-40GE-TX (Tri-Rate Enhanced DPC)	DPCE-R-20GE-2XGE (Multi-Rate Enhanced DPC)
Access Node Control Protocol (ANCP)	9.4	9.4	9.4	9.4	9.4
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	8.2	9.1	8.4	9.1	9.2
Bidirectional Forwarding Detection protocol (BFD)	8.2	9.1	8.4	9.1	9.2
Border Gateway Protocol (BGP)	8.2	9.1	8.4	9.1	9.2
BGP/ *Multiprotocol Label Switching (MPLS)* virtual private networks (VPNs)	8.2	9.1	8.4	9.1	9.2
Distance Vector Multicast Routing Protocol (DVMRP) and generic routing encapsulation (GRE) support—access side and server side	8.2	9.1	8.4	9.1	9.2
IEEE 802.1ag Ethernet OAM Continuity Check protocol	8.4	9.1	8.4	9.1	9.2
IEEE 802.1ag Ethernet OAM Linktrace protocol	9.0	9.1	9.0	9.1	9.2

Table 43: Protocols and Applications Supported by the DPCs and Enhanced DPCs (DPC and DPCE-R) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)				
	DPC-R-4XGE-XFP DPC-R-40GE-SFP (DPC)	DPCE-R-2XGE-XFP (Enhanced DPC)	DPCE-R-4XGE-XFP DPCE-R-40GE-SFP (Enhanced DPC)	DPCE-R-40GE-TX (Tri-Rate Enhanced DPC)	DPCE-R-20GE-2XGE (Multi-Rate Enhanced DPC)
IEEE 802.1ag Ethernet OAM Loopback protocol	9.1	9.1	9.1	9.1	9.2
Firewall filters	8.2	9.1	8.4	9.1	9.2
Flexible Ethernet encapsulation	8.2	9.1	8.4	9.1	9.2
Graceful Routing Engine Switchover (GRES)	8.3	9.1	8.4	9.1	9.2
Ingress hierarchical quality of service (HQoS) shaping and *hierarchical-scheduler*: • Group of virtual LANs (VLANs) level • Virtual LAN (VLAN) level • Port level	–	–	–	–	–
IPv4	8.2	9.1	8.4	9.1	9.2
IP multicast	8.2	9.1	8.4	9.1	9.2
IPv6	8.2	9.1	8.4	9.1	9.2

Table 43: Protocols and Applications Supported by the DPCs and Enhanced DPCs (DPC and DPCE-R) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)				
	DPC-R-4XGE-XFP DPC-R-40GE-SFP (DPC)	DPCE-R-2XGE-XFP (Enhanced DPC)	DPCE-R-4XGE-XFP DPCE-R-40GE-SFP (Enhanced DPC)	DPCE-R-40GE-TX (Tri-Rate Enhanced DPC)	DPCE-R-20GE-2XGE (Multi-Rate Enhanced DPC)
IPv6 multicast	8.2	9.1	8.4	9.1	9.2
IPv6 Neighbor Discovery	8.2	9.1	8.4	9.1	9.2
Intermediate System-to-Intermediate System (IS-IS)	8.2	9.1	8.4	9.1	9.2
Layer 2 frame filtering	8.2	9.1	8.4	9.1	9.2
IEEE 802.3ad link aggregation	8.2	9.1	8.4	9.1	9.2
Link Aggregation Control Protocol (LACP)	8.2	9.1	8.4	9.1	9.2
Local loopback	8.2	9.1	8.4	9.1	9.2
MAC learning, policing, accounting, and filtering	8.2	9.1	8.4	9.1	9.2
IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) (part of IEEE 802.1Q VLANs)	8.4	9.1	8.4	9.1	9.2

Table 43: Protocols and Applications Supported by the DPCs and Enhanced DPCs (DPC and DPCE-R) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)				
	DPC-R-4XGE-XFP DPC-R-40GE-SFP (DPC)	DPCE-R-2XGE-XFP (Enhanced DPC)	DPCE-R-4XGE-XFP DPCE-R-40GE-SFP (Enhanced DPC)	DPCE-R-40GE-TX (Tri-Rate Enhanced DPC)	DPCE-R-20GE-2XGE (Multi-Rate Enhanced DPC)
Multi-chassis link aggregation (MC-AE)	10.0	10.0	10.0	10.0	10.0
Multiple tag protocol identifiers (TPIDs)	8.2	9.1	8.4	9.1	9.2
Multiprotocol Label Switching (MPLS)	8.2	9.1	8.4	9.1	9.2
mvrp	10.1	10.1	10.1	10.1	10.1
IEEE 802.3ah OAM • Discovery and link monitoring • *Fault signaling and detection* • *Remote loopback*	8.2	9.1	8.4	9.1	9.2
Multitopology Routing (MTR)	9.0	9.1	9.0	9.1	9.2
Open Shortest Path First (OSPF)	8.2	9.1	8.4	9.1	9.2
Packet mirroring	8.2	9.1	8.4	9.1	9.2
IEEE 802.1ah provider backbone bridges (PBB)	10.0	10.0	10.0	10.0	10.0

Table 43: Protocols and Applications Supported by the DPCs and Enhanced DPCs (DPC and DPCE-R) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)				
	DPC-R-4XGE-XFP DPC-R-40GE-SFP (DPC)	DPCE-R-2XGE-XFP (Enhanced DPC)	DPCE-R-4XGE-XFP DPCE-R-40GE-SFP (Enhanced DPC)	DPCE-R-40GE-TX (Tri-Rate Enhanced DPC)	DPCE-R-20GE-2XGE (Multi-Rate Enhanced DPC)
Quality of service (QoS) per port: • 8 queues per port • Shaping at queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Random early detection (RED) • Weighted random early detection (WRED)	8.2	9.1	8.4	9.1	9.2
• Shaping at port level	–	–	–	–	–
Quality of service (QoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	8.2	9.1	8.4	9.1	9.2
Quality of service (QoS) queuing per virtual LAN (VLAN)	–	–	–	–	–

Table 43: Protocols and Applications Supported by the DPCs and Enhanced DPCs (DPC and DPCE-R) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)				
	DPC-R-4XGE-XFP DPC-R-40GE-SFP (DPC)	DPCE-R-2XGE-XFP (Enhanced DPC)	DPCE-R-4XGE-XFP DPCE-R-40GE-SFP (Enhanced DPC)	DPCE-R-40GE-TX (Tri-Rate Enhanced DPC)	DPCE-R-20GE-2XGE (Multi-Rate Enhanced DPC)
IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)	8.4	9.1	8.4	9.1	9.2
Per-VLAN Spanning Tree (PVST)+	9.0	9.1	9.0	9.1	9.2
RSVP Overview	8.2	9.1	8.4	9.1	9.2
Routing Information Protocol (RIP)	8.2	9.1	8.4	9.1	9.2
SNMP	8.2	9.1	8.4	9.1	9.2
IEEE 802.1D Spanning Tree Protocol (STP)	8.4	9.1	8.4	9.1	9.2
Subscriber Management: **NOTE**: Starting in Junos OS Release 15.1R4, MS-DPCs are not supported for subscriber management on MX Series routers.	9.2	9.2	9.2	9.2	9.2
• Access Node Control Protocol (ANCP)	9.4	9.4	9.4	9.4	9.4
• Dynamic profiles	9.2	9.2	9.2	9.2	9.2

Table 43: Protocols and Applications Supported by the DPCs and Enhanced DPCs (DPC and DPCE-R) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)				
	DPC-R-4XGE-XFP DPC-R-40GE-SFP (DPC)	DPCE-R-2XGE-XFP (Enhanced DPC)	DPCE-R-4XGE-XFP DPCE-R-40GE-SFP (Enhanced DPC)	DPCE-R-40GE-TX (Tri-Rate Enhanced DPC)	DPCE-R-20GE-2XGE (Multi-Rate Enhanced DPC)
• Dynamic VLANs	–	9.5	9.5	9.5	9.5
• Enhanced Dynamic Host Configuration Protocol (DHCP) local server	9.3	9.3	9.3	9.3	9.3
• Enhanced DCHP relay	9.3	9.3	9.3	9.3	9.3
• Firewall filters	9.2	9.2	9.2	9.2	9.2
• Internet Group Management Protocol (IGMP)	9.2	9.2	9.2	9.2	9.2
• QoS	9.2	9.2	9.2	9.2	9.2
• Subscriber Secure Policy	9.4	9.4	9.4	9.4	9.4
Two-Way Active Measurement Protocol (TWAMP)	9.5	9.5	9.5	9.5	9.5

Table 43: Protocols and Applications Supported by the DPCs and Enhanced DPCs (DPC and DPCE-R) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)				
	DPC-R-4XGE-XFP DPC-R-40GE-SFP (DPC)	DPCE-R-2XGE-XFP (Enhanced DPC)	DPCE-R-4XGE-XFP DPCE-R-40GE-SFP (Enhanced DPC)	DPCE-R-40GE-TX (Tri-Rate Enhanced DPC)	DPCE-R-20GE-2XGE (Multi-Rate Enhanced DPC)
IEEE 802.1Q VLANs: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	8.2	9.1	8.4	9.1	9.2
Virtual private LAN service (VPLS)	8.2	9.1	8.4	9.1	9.2
Virtual private network (VPN)	8.2	9.1	8.4	9.1	9.2
Virtual Router Redundancy Protocol (VRRP) for IPv4	8.2	9.1	8.4	9.1	9.2

RELATED DOCUMENTATION

DPCs Supported on MX240, MX480, and MX960 Routers | 9

Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X) | 436

Protocols and Applications Supported by Enhanced Queuing IP Services DPCs (DPCE-R-Q) | 444

Protocols and Applications Supported by Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) | 453

Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X)

Table 44 on page 436 contains the first Junos OS Release support for protocols and applications on the MX240, MX480, and MX960 Enhanced Ethernet Services DPCs. A dash indicates that the protocol or application is not supported.

Table 44: Protocols and Applications Supported by the Enhanced Ethernet Services DPCs (DPCE-X)

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-X-4XGE-XFP DPCE-X-40GE-SFP (Enhanced Ethernet Services DPC)	DPCE-X-40GE-TX (Tri-Rate Enhanced Ethernet Services DPC)	DPCE-X-20GE-2XGE (Multi-Rate Enhanced Ethernet Services DPC)
Access Node Control Protocol (ANCP)	9.4	9.4	9.4
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	8.4	9.1	9.2
Bidirectional Forwarding Detection protocol (BFD)	8.4	9.1	9.2
Border Gateway Protocol (BGP)	8.4	9.1	9.2
BGP/Multiprotocol Label Switching (MPLS) virtual private networks (VPNs)	8.4	9.1	9.2
Distance Vector Multicast Routing Protocol (DVMRP) and generic routing encapsulation (GRE) support—access side and server side	8.4	9.1	9.2

Table 44: Protocols and Applications Supported by the Enhanced Ethernet Services DPCs (DPCE-X) ***(Continued)***

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-X-4XGE-XFP DPCE-X-40GE-SFP (Enhanced Ethernet Services DPC)	DPCE-X-40GE-TX (Tri-Rate Enhanced Ethernet Services DPC)	DPCE-X-20GE-2XGE (Multi-Rate Enhanced Ethernet Services DPC)
IEEE 802.1ag Ethernet OAM Continuity Check protocol	8.4	9.1	9.2
IEEE 802.1ag Ethernet OAM Linktrace protocol	9.0	9.1	9.2
IEEE 802.1ag Ethernet OAM Loopback protocol	9.1	9.1	9.2
Firewall filters	8.4 (Limited filter terms)	9.1 (Limited filter terms)	9.2 (Limited filter terms)
Flexible Ethernet encapsulation	8.4	9.1	9.2
Graceful Routing Engine Switchover (GRES)	8.4	9.1	9.2
Ingress hierarchical quality of service (HQoS) shaping and scheduling: • Group of virtual LANs (VLANs) level • Virtual LAN (VLAN) level • Port level	–	–	–

Table 44: Protocols and Applications Supported by the Enhanced Ethernet Services DPCs (DPCE-X) ***(Continued)***

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-X-4XGE-XFP DPCE-X-40GE-SFP (Enhanced Ethernet Services DPC)	DPCE-X-40GE-TX (Tri-Rate Enhanced Ethernet Services DPC)	DPCE-X-20GE-2XGE (Multi-Rate Enhanced Ethernet Services DPC)
Intermediate System-to-Intermediate System (IS-IS)	8.4	9.1	9.2
IPv4 (No BGP)	8.4	9.1	9.2)
IP multicast (No BGP)	8.4	9.1	9.2
IPv6 (No BGP)	8.4	9.1	9.2)
IPv6 multicast (No BGP)	8.4	9.1	9.2)
IPv6 Neighbor Discovery (No BGP)	8.4	9.1)	9.2)
Layer 2 frame filtering	8.4	9.1	9.2
IEEE 802.3ad link aggregation	8.4	9.1	9.2
Link Aggregation Control Protocol (LACP)	8.4	9.1	9.2
Local loopback	8.4	9.1	9.2
MAC learning, policing, accounting, and filtering	8.4	9.1	9.2

Table 44: Protocols and Applications Supported by the Enhanced Ethernet Services DPCs (DPCE-X) ***(Continued)***

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-X-4XGE-XFP DPCE-X-40GE-SFP (Enhanced Ethernet Services DPC)	DPCE-X-40GE-TX (Tri-Rate Enhanced Ethernet Services DPC)	DPCE-X-20GE-2XGE (Multi-Rate Enhanced Ethernet Services DPC)
IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) (part of IEEE 802.1Q VLANs)	8.4	9.1	9.2
Multiple tag protocol identifiers (TPIDs)	8.4	9.1	9.2
Multiprotocol Label Switching (MPLS)	8.4	9.1	9.2
IEEE 802.3ah OAM • Discovery and link monitoring • Fault signaling and detection • Remote loopback	8.4	9.1	9.2
Multitopology Routing (MTR)	9.0	9.1	9.2
Open Shortest Path First (OSPF)	8.4	9.1	9.2
Packet mirroring	8.4	9.1	9.2

Table 44: Protocols and Applications Supported by the Enhanced Ethernet Services DPCs (DPCE-X) ***(Continued)***

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-X-4XGE-XFP DPCE-X-40GE-SFP (Enhanced Ethernet Services DPC)	DPCE-X-40GE-TX (Tri-Rate Enhanced Ethernet Services DPC)	DPCE-X-20GE-2XGE (Multi-Rate Enhanced Ethernet Services DPC)
Quality of service (QoS) per port: • 8 queues per port • Shaping at queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Random early detection (RED) • Weighted random early detection (WRED)	8.4	9.1	9.2
Quality of service (QoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	8.4	9.1	9.2
Quality of service (QoS) queuing per virtual LAN (VLAN)	–	–	–
IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)	8.4	9.1	9.2

Table 44: Protocols and Applications Supported by the Enhanced Ethernet Services DPCs (DPCE-X) ***(Continued)***

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-X-4XGE-XFP DPCE-X-40GE-SFP (Enhanced Ethernet Services DPC)	DPCE-X-40GE-TX (Tri-Rate Enhanced Ethernet Services DPC)	DPCE-X-20GE-2XGE (Multi-Rate Enhanced Ethernet Services DPC)
Per-VLAN Spanning Tree (PVST)+	9.0	9.1	9.2
RSVP	8.4	9.1	9.2
Routing Information Protocol (RIP)	8.4	9.1	9.2
SNMP	8.4	9.1	9.2
IEEE 802.1D Spanning Tree Protocol (STP)	8.4	9.1	9.2
Subscriber Management: Starting in Junos OS Release 15.1R4, MS-DPCs are not supported for subscriber management on MX Series routers.	9.4	9.4	9.4
• Access Node Control Protocol (ANCP)	9.4	9.4	9.4
• Dynamic profiles	9.2	9.2	9.2
• Dynamic VLANs	9.5	9.5	9.5

Table 44: Protocols and Applications Supported by the Enhanced Ethernet Services DPCs (DPCE-X) ***(Continued)***

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-X-4XGE-XFP DPCE-X-40GE-SFP (Enhanced Ethernet Services DPC)	DPCE-X-40GE-TX (Tri-Rate Enhanced Ethernet Services DPC)	DPCE-X-20GE-2XGE (Multi-Rate Enhanced Ethernet Services DPC)
• Enhanced Dynamic Host Configuration Protocol (DHCP) local server	9.3	9.3	9.3
• Enhanced DCHP relay	9.3	9.3	9.3
• Firewall filters	9.2	9.2	9.2
• Internet Group Management Protocol (IGMP)	9.2	9.2	9.2
• QoS	9.2	9.2	9.2
• Subscriber Secure Policy	9.4	9.4	9.4
Two-Way Active Measurement Protocol (TWAMP)	9.5	9.5	9.5

Table 44: Protocols and Applications Supported by the Enhanced Ethernet Services DPCs (DPCE-X) ***(Continued)***

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-X-4XGE-XFP DPCE-X-40GE-SFP (Enhanced Ethernet Services DPC)	DPCE-X-40GE-TX (Tri-Rate Enhanced Ethernet Services DPC)	DPCE-X-20GE-2XGE (Multi-Rate Enhanced Ethernet Services DPC)
IEEE 802.1Q VLANs: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	8.4	9.1	9.2
Virtual private LAN service (VPLS)	8.4	9.1	9.2
Virtual private network (VPN) (L2 VPN only)	8.4	9.1	9.2
Virtual Router Redundancy Protocol (VRRP) for IPv4	8.4	9.1	9.2

RELATED DOCUMENTATION

DPCs Supported on MX240, MX480, and MX960 Routers | **9**

Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R) | **427**

Protocols and Applications Supported by Enhanced Queuing IP Services DPCs (DPCE-R-Q) | **444**

Protocols and Applications Supported by Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) | **453**

Protocols and Applications Supported by the Multiservices DPC (MS-DPC) | **459**

Protocols and Applications Supported by Enhanced Queuing IP Services DPCs (DPCE-R-Q)

Table 45 on page 444 contains the first Junos OS Release support for protocols and applications on the MX240, MX480, and MX960 Enhanced Queuing IP Services DPCs. A dash indicates that the protocol or application is not supported.

Table 45: Protocols and Applications Supported by the Enhanced Queuing IP Services DPCs (DPCE-R-Q)

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-R-Q-4XGE-XFP DPCE-R-Q-40GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-2XGE Enhanced Queuing IP Services Multi-Rate DPC
Access Node Control Protocol (ANCP)	9.4	9.4	9.4
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	8.5	9.1	9.3
Bidirectional Forwarding Detection protocol (BFD)	8.5	9.1	9.3
Border Gateway Protocol (BGP)	8.5	9.1	9.3
BGP/Multiprotocol Label Switching (MPLS) virtual private networks (VPNs)	8.5	9.1	9.3
Distance Vector Multicast Routing Protocol (DVMRP) and generic routing encapsulation (GRE) support—access side and server side	8.5	9.1	9.3

Table 45: Protocols and Applications Supported by the Enhanced Queuing IP Services DPCs (DPCE-R-Q) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-R-Q-4XGE-XFP DPCE-R-Q-40GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-2XGE Enhanced Queuing IP Services Multi-Rate DPC
IEEE 802.1ag Ethernet OAM Continuity Check protocol	8.5	9.1	9.3
IEEE 802.1ag Ethernet OAM Linktrace protocol	9.0	9.1	9.3
IEEE 802.1ag Ethernet OAM Loopback protocol	9.1	9.1	9.3
Firewall filters	8.5	9.1	9.3
Flexible Ethernet encapsulation	8.5	9.1	9.3
Graceful Routing Engine Switchover (GRES)	8.5	9.1	9.3
Ingress hierarchical quality of service (HQoS) shaping and scheduling: • Group of virtual LANs (VLANs) level • Virtual LAN (VLAN) level • Port level	9.0	9.1	9.3

Table 45: Protocols and Applications Supported by the Enhanced Queuing IP Services DPCs (DPCE-R-Q) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-R-Q-4XGE-XFP DPCE-R-Q-40GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-2XGE Enhanced Queuing IP Services Multi-Rate DPC
Intermediate System-to-Intermediate System (IS-IS)	8.5	9.1	9.3
IPv4	8.5	9.1	9.3
IP multicast	8.5	9.1	9.3
IPv6	8.5	9.1	9.3
IPv6 multicast	8.5	9.1	9.3
IPv6 Neighbor Discovery	8.5	9.1	9.3
Layer 2 frame filtering	8.5	9.1	9.3
IEEE 802.3ad link aggregation	8.5	9.1	9.3
Link Aggregation Control Protocol (LACP)	8.5	9.1	9.3
Local loopback	8.5	9.1	9.3
MAC learning, policing, accounting, and filtering	8.5	9.1	9.3

Table 45: Protocols and Applications Supported by the Enhanced Queuing IP Services DPCs (DPCE-R-Q) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-R-Q-4XGE-XFP DPCE-R-Q-40GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-2XGE Enhanced Queuing IP Services Multi-Rate DPC
IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) (part of IEEE 802.1Q VLANs)	8.5	9.1	9.3
Multiple tag protocol identifiers (TPIDs)	8.5	9.1	9.3
Multiprotocol Label Switching (MPLS)	8.5	9.1	9.3
IEEE 802.3ah OAM • Discovery and link monitoring • Fault signaling and detection • Remote loopback	8.5	9.1	9.3
Multitopology Routing (MTR)	9.0	9.1	9.3
Open Shortest Path First (OSPF)	8.5	9.1	9.3
Packet mirroring	8.5	9.1	9.3

Table 45: Protocols and Applications Supported by the Enhanced Queuing IP Services DPCs (DPCE-R-Q) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-R-Q-4XGE-XFP DPCE-R-Q-40GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-2XGE Enhanced Queuing IP Services Multi-Rate DPC
Quality of service (QoS) per port: • 8 queues per port • Shaping at port level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Random early detection (RED) • Weighted random early detection (WRED)	8.5	9.1	9.3

Table 45: Protocols and Applications Supported by the Enhanced Queuing IP Services DPCs (DPCE-R-Q) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-R-Q-4XGE-XFP DPCE-R-Q-40GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-2XGE Enhanced Queuing IP Services Multi-Rate DPC
Quality of service (QoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking • Shaping at queue and port level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Random early detection (RED) • Weighted random early detection (WRED)	8.5	9.1	9.3
Quality of service (QoS) queuing per virtual LAN (VLAN)	8.5	9.1	9.3
IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)	8.5	9.1	9.3
Per-VLAN Spanning Tree (PVST)+	9.0	9.1	9.3

Table 45: Protocols and Applications Supported by the Enhanced Queuing IP Services DPCs (DPCE-R-Q) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-R-Q-4XGE-XFP DPCE-R-Q-40GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-2XGE Enhanced Queuing IP Services Multi-Rate DPC
RSVP	8.5	9.1	9.3
Routing Information Protocol (RIP)	8.5	9.1	9.3
SNMP	8.5	9.1	9.3
IEEE 802.1D Spanning Tree Protocol (STP)	8.5	9.1	9.3
Subscriber Management: **NOTE**: Starting in Junos OS Release 15.1R4, MS-DPCs are not supported for subscriber management on MX Series routers.	9.4	9.4	9.4
• Access Node Control Protocol (ANCP)	9.4	9.4	9.4
• Dynamic profiles	9.2	9.2	9.2
• Dynamic VLANs	9.5	9.5	9.5
• Enhanced Dynamic Host Configuration Protocol (DHCP) local server	9.3	9.3	9.3

Table 45: Protocols and Applications Supported by the Enhanced Queuing IP Services DPCs (DPCE-R-Q) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-R-Q-4XGE-XFP DPCE-R-Q-40GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-2XGE Enhanced Queuing IP Services Multi-Rate DPC
• Enhanced DCHP relay	9.3	9.3	9.3
• Firewall filters	9.2	9.2	9.2
• Internet Group Management Protocol (IGMP)	9.2	9.2	9.2
• QoS	9.2	9.2	9.2
• Subscriber Secure Policy	9.4	9.4	9.4
• VLAN demux	–	–	–
Two-Way Active Measurement Protocol (TWAMP)	9.5	9.5	9.5

Table 45: Protocols and Applications Supported by the Enhanced Queuing IP Services DPCs (DPCE-R-Q) *(Continued)*

Protocol or Application	First Junos OS Release Supported by DPC Model Number (DPC Name)		
	DPCE-R-Q-4XGE-XFP DPCE-R-Q-40GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-SFP Enhanced Queuing IP Services DPC	DPCE-R-Q-20GE-2XGE Enhanced Queuing IP Services Multi-Rate DPC
IEEE 802.1Q VLANs: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	8.5	9.1	9.3
Virtual private LAN service (VPLS)	8.5	9.1	9.3
Virtual private network (VPN)	8.5	9.1	9.3
Virtual Router Redundancy Protocol (VRRP) for IPv4	8.5	9.1	9.3

RELATED DOCUMENTATION

DPCs Supported on MX240, MX480, and MX960 Routers | **9**

Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R) | **427**

Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X) | **436**

Protocols and Applications Supported by Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) | **453**

Protocols and Applications Supported by Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q)

Table 46 on page 453 contains the first Junos OS Release support for protocols and applications on the MX240, MX480, and MX960 Enhanced Queuing Ethernet Services DPCs. A dash indicates that the protocol or application is not supported.

Table 46: Protocols and Applications Supported by the Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q)

Protocol or Application	DPCE-X-Q-4XGE-XFP DPCE-X-Q-40GE-SFP (Enhanced Queuing Ethernet Services DPC)
Access Node Control Protocol (ANCP)	9.4
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	8.5
Bidirectional Forwarding Detection protocol (BFD)	8.5
Border Gateway Protocol (BGP)	8.5
BGP/Multiprotocol Label Switching (MPLS) virtual private networks (VPNs)	8.5
Distance Vector Multicast Routing Protocol (DVMRP) and generic routing encapsulation (GRE) support—access side and server side	8.5
IEEE 802.1ag Ethernet OAM Continuity Check protocol	8.5
IEEE 802.1ag Ethernet OAM Linktrace protocol	9.0

Table 46: Protocols and Applications Supported by the Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) *(Continued)*

Protocol or Application	DPCE-X-Q-4XGE-XFP DPCE-X-Q-40GE-SFP (Enhanced Queuing Ethernet Services DPC)
IEEE 802.1ag Ethernet OAM Loopback protocol	9.1
Firewall filters	8.5 (Limited filter terms)
Flexible Ethernet encapsulation	8.5
Graceful Routing Engine Switchover (GRES)	8.5
Ingress hierarchical quality of service (HQoS) shaping and scheduling: • Group of virtual LANs (VLANs) level • Virtual LAN (VLAN) level • Port level	9.0
Intermediate System-to-Intermediate System (IS-IS)	8.5
IPv4 (No BGP)	8.5
IP multicast (No BGP)	8.5
IPv6 (No BGP)	8.5
IPv6 multicast (No BGP)	8.5
IPv6 Neighbor Discovery (No BGP)	8.5

Table 46: Protocols and Applications Supported by the Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) *(Continued)*

Protocol or Application	DPCE-X-Q-4XGE-XFP DPCE-X-Q-40GE-SFP (Enhanced Queuing Ethernet Services DPC)
Layer 2 frame filtering	8.5
IEEE 802.3ad link aggregation	8.5
Link Aggregation Control Protocol (LACP)	8.5
Local loopback	8.5
MAC learning, policing, accounting, and filtering	8.5
IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) (part of IEEE 802.1Q VLANs)	8.5
Multiple tag protocol identifiers (TPIDs)	8.5
Multiprotocol Label Switching (MPLS)	8.5
IEEE 802.3ah OAM • Discovery and link monitoring • Fault signaling and detection • Remote loopback	8.5
Multitopology Routing (MTR)	9.0
Open Shortest Path First (OSPF)	8.5

Table 46: Protocols and Applications Supported by the Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) *(Continued)*

Protocol or Application	DPCE-X-Q-4XGE-XFP DPCE-X-Q-40GE-SFP (Enhanced Queuing Ethernet Services DPC)
Packet mirroring	8.5
Quality of service (QoS) per port: • 8 queues per port • Shaping at port level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Random early detection (RED) • Weighted random early detection (WRED)	8.5
Shaping at queue level	–
Quality of service (QoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking • Shaping at port level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Random early detection (RED) • Weighted random early detection (WRED)	8.5

Table 46: Protocols and Applications Supported by the Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) *(Continued)*

Protocol or Application	DPCE-X-Q-4XGE-XFP DPCE-X-Q-40GE-SFP (Enhanced Queuing Ethernet Services DPC)
Shaping at queue level	–
Quality of service (QoS) queuing per virtual LAN (VLAN)	8.5
IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)	8.5
Per-VLAN Spanning Tree (PVST)+	9.0
Remote loopback	8.5
RSVP	8.5
Routing Information Protocol (RIP)	8.5
SNMP	8.5
IEEE 802.1D Spanning Tree Protocol (STP)	8.5
Subscriber Management: Starting in Junos OS Release 15.1R4, MS-DPCs are not supported for subscriber management on MX Series routers.	9.4
• Access Node Control Protocol (ANCP)	9.4
• Dynamic profiles	9.2

Table 46: Protocols and Applications Supported by the Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) *(Continued)*

Protocol or Application	DPCE-X-Q-4XGE-XFP DPCE-X-Q-40GE-SFP (Enhanced Queuing Ethernet Services DPC)
• Dynamic VLANs	9.5
• Enhanced Dynamic Host Configuration Protocol (DHCP) local server	9.3
• Enhanced DCHP relay	9.3
• Firewall filters	9.2
• Internet Group Management Protocol (IGMP)	9.2
• QoS	9.2
• Subscriber Secure Policy	9.4
• VLAN demux	–
Two-Way Active Measurement Protocol (TWAMP)	9.5
IEEE 802.1Q VLANs: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	8.5

Table 46: Protocols and Applications Supported by the Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) ***(Continued)***

Protocol or Application	DPCE-X-Q-4XGE-XFP DPCE-X-Q-40GE-SFP (Enhanced Queuing Ethernet Services DPC)
Virtual private LAN service (VPLS)	8.5
Virtual private network (VPN)	8.5 (L2 VPN only)
Virtual Router Redundancy Protocol (VRRP) for IPv4	8.5

RELATED DOCUMENTATION

- DPCs Supported on MX240, MX480, and MX960 Routers | **9**
- Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R) | **427**
- Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X) | **436**
- Protocols and Applications Supported by Enhanced Queuing IP Services DPCs (DPCE-R-Q) | **444**
- Protocols and Applications Supported by the Multiservices DPC (MS-DPC) | **459**

Protocols and Applications Supported by the Multiservices DPC (MS-DPC)

Table 47 on page 460 contains the first Junos OS Release support for protocols and applications on the MX240, MX480, and MX960 Multiservices DPCs. A dash indicates that the protocol or application is not supported.

NOTE: The maximum number of supported MS-DPCs is as follows:

- MX240 router: 2
- MX480 router: 4
- MX960 router: 8

Table 47: Protocols and Applications Supported by the Multiservices DPC (MS-DPC)

Protocol or Application	MS-DPC
Accepts traffic destined for GRE tunnels	9.3
Active flow monitoring exports cflowd version 5 and version 8 records	9.3
Active flow monitoring exports flow monitoring version 9 records, based on RFC 3954	9.3
Graceful Routing Engine Switchover (GRES)	9.4
GRE dont fragment	9.3
GRE Key	9.3
GRE reassembly	9.3
IP Security (IPSec) encryption	9.3
Network Address Translation (NAT) for IP addresses **NOTE**: The MX960 supports 8 MS-DPCs using this feature.	9.3
NAPT - Preserve parity	15.1
NAPT - Preserve range	15.1
No translation	15.1

Table 47: Protocols and Applications Supported by the Multiservices DPC (MS-DPC) ***(Continued)***

Protocol or Application	MS-DPC
Twice NAT	15.1
Packet-triggered dynamic subscribers and policy control (PTSP) **NOTE**: Starting in Junos OS Release 13.1R1, the packet-triggered subscribers and policy control (PTSP) feature is no longer supported.	10.2
Port Address Translation (PAT) for port numbers	9.3
Real-time Performance Monitoring (RPM)	9.3
Stateful firewall with packet inspection: detects SYN attacks, ICMP and UDP floods, and ping-of-death attacks **NOTE**: The MX960 supports 8 MS-DPCs using this feature.	9.3
Tunnel services:	
• GRE unicast tunneling-Supports GRE fragmentation	9.3
• IP-IP unicast tunneling	9.4
• Multicast tunneling	9.4
• Protocol Independent Multicast (PIM) sparse mode unicast tunneling	9.4
• Virtual loopback tunneling (VT)	9.4
Voice over IP (VoIP) services: • Border Gateway Function (BGF) using external H.248/Ia control • Integrated Multi-Service Gateway (IMSG)–Session Border Controller	10.2

RELATED DOCUMENTATION

DPCs Supported on MX240, MX480, and MX960 Routers | 9

Protocols and Applications Supported by DPCs and Enhanced DPCs (DPC and DPCE-R) | 427

Protocols and Applications Supported by Enhanced Ethernet Services DPCs (DPCE-X) | 436

Protocols and Applications Supported by Enhanced Queuing IP Services DPCs (DPCE-R-Q) | 444

Protocols and Applications Supported by Enhanced Queuing Ethernet Services DPCs (DPCE-X-Q) | 453

CHAPTER 14

SPC Protocol and Application Support for MX240, MX480, and MX960

IN THIS CHAPTER

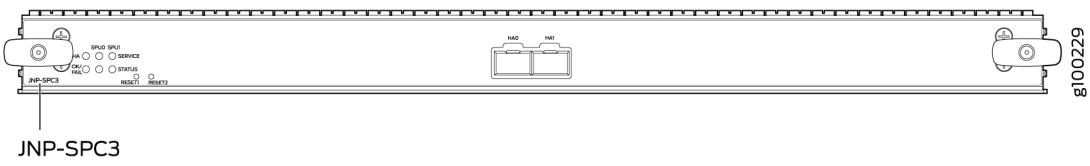
MX-SPC3 Services Card

The MX-SPC3 (Model number: JNP-SPC3) is a Services Processing Card (SPC) that provides additional processing power to run Next Gen Services. Next Gen Services provide capabilities for manipulating traffic before it's delivered to its destination. The MX-SPC3 Services Card is supported on MX240, MX480, and MX960 routers.

It contains two Services Processing Units (SPUs) with 128 GB of memory per SPU. Line cards such as DPCs, MICs, and MPCs intelligently distribute all traffic traversing the router to the SPUs to have services processing applied to it (see Figure 56 on page 463).

You can install the MX-SPC3 in any of the slots that are not reserved for Switch Control Board (SCB). If a slot is not occupied by a card, you must install a blank panel to shield the empty slot and to allow cooling air to circulate properly through the device.

Figure 56: MX-SPC3 Services Card



Software release	• Junos OS Release 19.3R2 and later

Description	Services Processing Card (SPC) with two SPUs of 256 GB memory. • Model number: JNP-SPC3 • Power requirement: 650 W maximum • Weight: Approximately 18 lb (8.3 kg)

Hardware features	• Two 10–Gigabit Ethernet small form-factor pluggable plus (SFP+) chassis cluster control ports for connecting multiple devices into a redundant chassis cluster.
	• Fabric interfaces
	• One Gigabit Ethernet switch that provides control connectivity to the Routing Engine.
	• Two interfaces from the SCBs that enable the boards to be powered on and controlled.
	• Physical SPC connectors
	• Midplane connectors and power circuitry
	• Each SPU includes:
	  • Two 2.3-GHz CPUs
	  • One Crypto Engine
	  • 128 GB memory
	• Two 128 GB solid state-drives (SSDs).
	• LEDs on the faceplate that indicate the SPC and SPU status.

Supported Slots	• MX240–Any slot, except the bottom slot **0** () which is reserved for SCB/RE. • MX480–Any slot, except the bottom slots **0** () or **1** () which are reserved for SCB/RE. • MX960–Any slot, except slot **11** () , and slots **0** () or **1** () which are reserved for SCB/RE.

Compatibility	The MX-SPC3 services card is compatible end-to-end with the MX Series Switch Fabrics, Routing Engines and MPC line cards. See Table 48 on page 468.

LEDs

OK/FAIL LED, one bicolor:

- Steady green–The SPC is operating normally.
- Red–The SPC has failed and is not operating normally.
- Off–The SPC is powered down.

STATUS LED, one tricolor for each SPU **SPU 0** and **SPU 1**:

- Off–The SPU is offline.
- Blinking Amber–The SPU is initializing.
- Green–The SPU initialization is done and it is operating normally.
- Red–The SPU has encountered an error or a failure.

SERVICE LED, one tricolor for each SPU **SPU 0** and **SPU 1**:

- Off–The SPU is offline.
- Blinking Red–The SPU initialization is done.
- Blinking Amber–Service is initializing on the SPU.
- Green–Service is running on the SPU under acceptable load.
- Solid Red–Service encountered an error or a failure.

HA LED, one tricolor:

- Green–Clustering is operating normally. All cluster members and monitored links are available, and no error conditions are detected.
- Red–A critical alarm is present on clustering. A cluster member is missing or unreachable, or the other node is no longer part of a cluster because it has been disabled by the dual membership and detection recovery process in reaction to a control-link or fabric-link failure.
- Amber–All cluster members are present, but an error condition has compromised the performance and resiliency of the cluster. The reduced bandwidth could cause packets to be dropped or could result in reduced resiliency because a single point of failure might exist. The error condition might be caused by:
  - The loss of chassis cluster links which causes an interface monitoring failure.

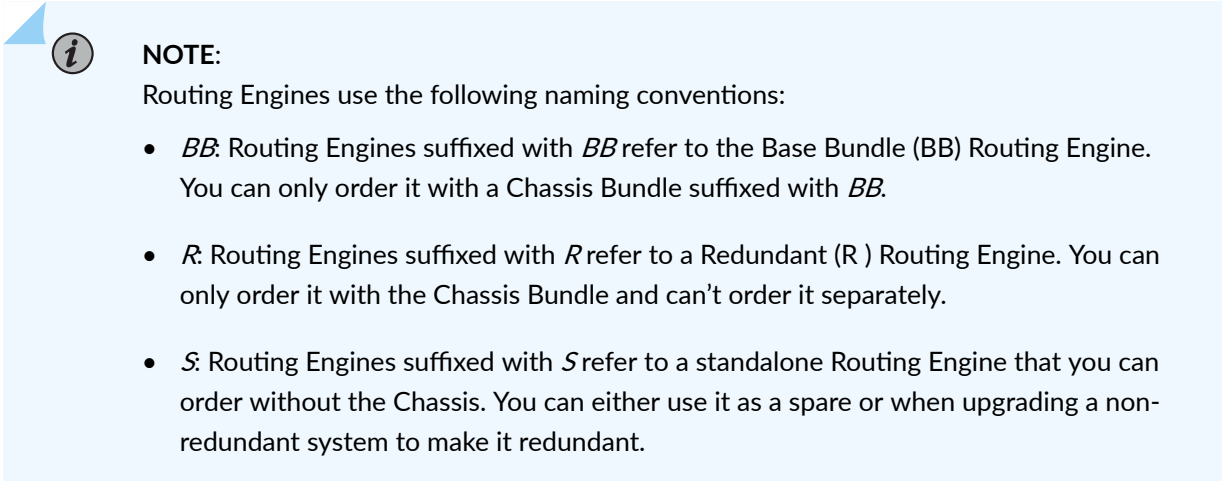
- An error in an SPU or NPU.
- Failure of the spu-monitoring or cold-sync-monitoring processes.
- A chassis cluster IP monitoring failure.

- Off–The node is not configured for clustering or it has been disabled by the dual membership and detection recovery process in reaction to a control link or fabric link failure.

LINK/ACT LED, one for each of the two ports **CHASSIS CLUSTER CONTROL 0** and **CHASSIS CLUSTER CONTROL 1**:

- Green–Chassis cluster control port link is active.
- Off–No link.

The MX-SPC3 services card is compatible end-to-end with the MX Series Switch Fabrics, Routing Engines and MPC line cards on MX240, MX480, and MX960 routers. See Table 48 on page 468.



NOTE:
Routing Engines use the following naming conventions:

- *BB*: Routing Engines suffixed with *BB* refer to the Base Bundle (BB) Routing Engine. You can only order it with a Chassis Bundle suffixed with *BB*.
- *R*: Routing Engines suffixed with *R* refer to a Redundant (R) Routing Engine. You can only order it with the Chassis Bundle and can't order it separately.
- *S*: Routing Engines suffixed with *S* refer to a standalone Routing Engine that you can order without the Chassis. You can either use it as a spare or when upgrading a non-redundant system to make it redundant.

Table 48: MX-SPC3 Services Card Compatibility with MX Series Switch Fabrics, Routing Engines and MPC Line Cards

Switch Fabric	Route Engine	MPC Line Cards
SCBE	RE-S-1800X4-16G-BB RE-S-1800X4-16G-UPG-BB RE-S-1800X4-16G-S RE-S-1800X4-16G-R RE-S-1800X4-32G-BB RE-S-1800X4-32G-UB RE-S-1800X4-32G-S RE-S-1800X4-32G-R	MPC2E-3D MPC2-3D-NG MPC3E and MPC3E-3D-NG MPC4E-3D MPC-3D-16XGE
SCBE2	RE-S-1800X4-16G-BB RE-S-1800X4-16G-UPG-BB RE-S-1800X4-16G-S RE-S-1800X4-16G-R RE-S-1800X4-32G-BB RE-S-1800X4-32G-UB RE-S-1800X4-32G-S RE-S-1800X4-32G-R RE-S-X6-64G-UB RE-S-X6-64G-S RE-S-X6-64G-R RE-S-X6-64G-BB RE-S-X6-128G-S-S RE-S-X6-128G-S-R RE-S-X6-128G-S-BB	MPC2E-3D MPC2-3D-NG MPC3E and MPC3E-3D-NG MPC4E-3D MPC5E and MPC5EQ MPC7E and MPC7EQ MPC-3D-16XGE

Table 48: MX-SPC3 Services Card Compatibility with MX Series Switch Fabrics, Routing Engines and MPC Line Cards *(Continued)*

Switch Fabric	Route Engine	MPC Line Cards
SCBE3	RE-S-1800X4-16G-BB RE-S-1800X4-16G-UPG-BB RE-S-1800X4-16G-S RE-S-1800X4-16G-R RE-S-1800X4-32G-BB RE-S-1800X4-32G-UB RE-S-1800X4-32G-S RE-S-1800X4-32G-R RE-S-X6-64G-BB RE-S-X6-64G-UB RE-S-X6-64G-S RE-S-X6-64G-R RE-S-X6-128G-S-BB RE-S-X6-128G-S-S RE-S-X6-128G-S-R	MPC2-3D-NG MPC4E-3D MPC5E and MPC5EQ MPC7E and MPC7EQ MPC-3D-16XGE MPC10E-10C MPC10E-15C

Table 49 on page 469 provides a summary of Next Gen Services supported by MX-SPC3.

Table 49: Next Gen Services Supported by MX-SPC3 Services Card

Feature Category / Feature		First Supported Junos OS Release
Carrier Grade NAT	Basic-NAT44	19.3R2
	Basic-NAT66	19.3R2
	Dynamic-NAT44	19.3R2

Table 49: Next Gen Services Supported by MX-SPC3 Services Card *(Continued)*

Feature Category / Feature		First Supported Junos OS Release
	Static Destination NAT	19.3R2
	Basic-NAT-PT	19.3R2
	NAPT-PT	19.3R2
	NAPT44	19.3R2
	NAPT66	19.3R2
	Port Block Allocation	19.3R2
	Deterministic-nat44 and nat64	19.3R2
	End Point Independent Mapping (EIM)/End Point	19.3R2
	Independent Filtering (EIF)	19.3R2
	Persistent NAT – Application Pool Pairing (APP)	19.3R2
	Twice-NAT44 – Basic, Dynamic and NAPT	19.3R2
	NAT64	19.3R2
	XLAT-464	19.3R2
	NPTv6	19.3R2

Table 49: Next Gen Services Supported by MX-SPC3 Services Card *(Continued)*

Feature Category / Feature		First Supported Junos OS Release
	Port Control Protocol (PCP) – v1 and v2	20.1R1
	DS-Lite	20.2R1
	NAT46	20.2R1
Stateful Firewall Services		19.3R2
Intrusion Detection Services (IDS)		19.3R2
Traffic Load Balancer		19.3R2
DNS Request Filtering		19.3R2
Aggregated Multiservices Interfaces		19.3R2
Inter-chassis High Availability	CGNAT, Stateful Firewall, and IDS Flows	19.3R2
URL Filtering		20.1R1
HTTP Content Manager (HCM)		20.2R1
IPsec		21.1R1

CHAPTER 15

MPC Protocol and Application Support for MX240, MX480, MX960, MX2010, MX2020, and MX10003

IN THIS CHAPTER

Protocols and Applications Supported on MPCs for MX Series Routers

Table 50 on page 473 contains the first Junos OS Release support for protocols and applications on the MX240, MX480, MX960, MX2010, and MX2020 MPCs.

NOTE: The MX2010 router supports protocols and applications in Junos OS 12.3R3 and later. Features added after the Junos OS 12.3R3 release are supported on the MX2010 router in the release indicated.

NOTE: The MX2020 router supports protocols and applications in Junos OS 12.3R2 and later. Features added after the Junos OS 12.3R2 release are supported on the MX2020 router in the release indicated.

A dash indicates that the protocol or application is not supported.

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
Access Node Control Protocol (ANCP)	–	10.2	10.2	10.2	10.2	10.2
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	10.0R2	10.2	10.1	10.2	10.1	10.1
Active-active bridging in multichassis link aggregation	13.1	13.1	13.1	13.1	13.1	13.1
Bidirectional Forwarding Detection protocol (BFD)	10.0R2	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
Border Gateway Protocol (BGP)	10.0R2	10.2	10.1	10.2	10.1	10.1
BGP/Multiprotocol Label Switching (MPLS) virtual private networks (VPNs)	10.0R2	10.2	10.1	10.2	10.1	10.1
Distance Vector Multicast Routing Protocol (DVMRP) and generic routing encapsulation (GRE) support—access side and server side	10.0R2	10.2	10.1	10.2	10.1	10.1
Distributed denial-of-service (DDoS) protection	11.2	11.2	11.2	11.2		11.2
IEEE 802.1ag Ethernet OAM Continuity Check protocol	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
IEEE 802.1ag Ethernet OAM Linktrace protocol	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)
IEEE 802.1ag Ethernet OAM Loopback protocol	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)	10.2 (bridge family supported in 10.4)
Firewall filters	10.0R2	10.2	10.1	10.2	10.1	10.1
Flexible Ethernet encapsulation	10.0R2	10.2	10.1	10.2	10.1	10.1
Graceful Routing Engine Switchover (GRES)	10.0R2	10.2	10.1	10.2	10.1	10.1
Ingress Differentiated Services code point (DSCP) rewrite	10.0R2	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
Ingress hierarchical quality-of-service (HQoS) shaping and scheduling: • Group of virtual LANs (VLANs) level • Virtual LAN (VLAN) level • Port level	12.1R3	12.1R3	12.1R3	12.1R3	12.1R3	12.1R3
Intelligent oversubscription	10.0R2	10.2	10.1	10.2	10.1	10.1
Integrated routing and bridging (IRB)	10.1	10.2	10.1	10.2	10.1	10.1
Intermediate System-to-Intermediate System (IS-IS)	10.0R2	10.2	10.1	10.2	10.1	10.1
Internet Group Management Protocol (IGMP) (excluding snooping)	10.0R2	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
Internet Group Management Protocol (IGMP) snooping	11.4	11.4	11.4	11.4	11.4	11.4
IPv4	10.0R2	10.2	10.1	10.2	10.1	10.1
IP multicast	10.0R2	10.2	10.1	10.2	10.1	10.1
IPv6	10.2	10.2	10.2	10.2	10.2	10.2
IPv6 MLD	10.2	10.2	10.2	10.2	10.2	10.2
IPv6 multicast	10.2	10.2	10.2	10.2	10.2	10.2
IPv6 Neighbor Discovery	10.2	10.2	10.2	10.2	10.2	10.2
Label Distribution Protocol (LDP)	10.0R2	10.2	10.1	10.2	10.1	10.1
Labeled switched paths (LSPs) including accounting, policers, and filtering	10.0R2	10.2	10.1	10.2	10.1	10.1
LAN-PHY mode	10.0R2	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
Layer 2 frame filtering	10.0R2	10.2	10.1	10.2	10.1	10.1
Layer 2 Tunneling Protocol (L2TP): (MX2010, MX2020: 12.3R4, 13.2R2, 13.3)						
• L2TP access concentrator (LAC)	10.4	10.4	10.4	10.4	10.4	10.4
• L2TP network server (LNS)	11.4	11.4	11.4	11.4	11.4	11.4
• LNS inline service support with CoS per-session shaping	11.4	11.4	11.4	11.4	11.4	11.4
• LNS inline service support without CoS per-session shaping	11.4	11.4	11.4	11.4	11.4	11.4
• Peer interface	–	11.4	11.4	11.4	11.4	11.4
• Inline IP reassembly	13.1	13.1	13.1	13.1	13.1	13.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
IEEE 802.3ad link aggregation	10.0R2	10.2	10.1	10.2	10.1	10.1
Link Aggregation Control Protocol (LACP)	10.0R2	10.2	10.1	10.2	10.1	10.1
Local loopback	10.0R2	10.2	10.1	10.2	10.1	10.1
MAC learning, policing, accounting, and filtering	10.0R2	10.2	10.1	10.2	10.1	10.1
Mobile IP	–	–	–	–	–	–
Multi-chassis link aggregation	11.1	11.1	11.1	11.1	11.1	11.1
Multiple Tag Protocol Identifiers (TPIDs)	10.0R2	10.2	10.1	10.2	10.1	10.1
Multiprotocol Label Switching (MPLS)	10.0R2	10.2	10.1	10.2	10.1	10.1
Nonstop active routing (NSR)	10.0R2	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
IEEE 802.3ah OAM • Discovery and link monitoring • Fault signaling and detection • Remote loopback	11.1	11.1	11.1	11.1	11.1	11.1
Multi-topology routing (MTR)	10.0R2	10.2	10.1	10.2	10.1	10.1
Open Shortest Path First (OSPF)	10.0R2	10.2	10.1	10.2	10.1	10.1
Packet mirroring	10.0R2	10.2	10.1	10.2	10.1	10.1
IEEE 802.1ah provider backbone bridges (PBB)	–	–	–	–	–	–

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
Quality of service (QoS) per port: • Eight queues per port • Excess-rate configuration at the traffic-control-profile level • Excess-rate and excess-priority configuration at the queue level • Shaping at port level • Shaping at queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Tricolor marking • Weighted random early detection (WRED)	10.0R2	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
Quality of service (QoS) per virtual LAN (VLAN):						
• Accounting, filtering, and policing	10.0R2	10.2	10.1	10.2	10.1	10.1
• IEEE 802.1p rewrite	10.0R2	10.2	10.1	10.2	10.1	10.1
• Classification	10.0R2	10.2	10.1	10.2	10.1	10.1
• Excess-rate configuration at the traffic-control-profile level	–	–	–	10.2	10.1	10.1
• Excess-rate and excess-priority configuration at the queue level	–	–	–	10.2	10.1	10.1
• Tricolor marking	10.0R2	10.2	10.1	10.2	10.1	10.1
• Shaping at the queue level	–	–	–	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
• Scheduling of queues based on weighted round-robin (WRR) per priority class	–	–	–	10.2	10.1	10.1
• Weighted random early detection (WRED)	–	–	–	10.2	10.1	10.1
Quality of service (QoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces:						
• Accounting, filtering, and policing	–	10.2	10.1	10.2	10.1	10.1
• IEEE 802.1p rewrite	–	10.2	10.1	10.2	10.1	10.1
• Classification	–	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
• Excess-rate configuration at the traffic-control-profile level	–	–	–	10.2	10.1	10.1
• Excess-rate and excess-priority configuration at the queue level	–	–	–	10.2	10.1	10.1
• Tricolor marking	–	10.2	10.1	10.2	10.1	10.1
• Shaping at the queue level	–	–	–	10.2	10.1	10.1
• Scheduling of queues based on weighted round-robin (WRR) per priority class	–	–	–	10.2	10.1	10.1
• Weighted random early detection (WRED)	–	–	–	10.2	10.1	10.1
RSVP	10.0R2	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
RIP	10.0R2	10.2	10.1	10.2	10.1	10.1
SNMP	10.0R2	10.2	10.1	10.2	10.1	10.1
Spanning Tree Protocols: • IEEE 802.1D Spanning Tree Protocol (STP) • IEEE 802.1s Multiple Spanning Tree Protocol • Per-VLAN Spanning Tree (PVST)+ • IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)	10.2	10.2	10.2	10.2	10.2	10.2
Subscriber management and services: (MX2010, MX2020: 12.3R4, 13.2R2, 13.3)						

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
• Aggregated Ethernet over static VLANs	–	10.2	10.1	10.2	10.1	10.1
• Aggregated Ethernet over dynamic VLANs	–	10.2	10.2	10.2	10.2	10.2
• Access Node Control Protocol (ANCP) and ANCP agent	–	10.2	10.2	10.2	10.2	10.2
• DHCP access model	–	10.2	10.1	10.2	10.1	10.1
• Dynamic adjustment of shapers	–	10.2	10.1	10.2	10.1	10.1
• Dynamic PPPoE subscriber interface creation based on PPPoE service name table configuration	–	10.2	10.1	10.2	10.1	10.1
• Dynamic profiles	–	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
• Dynamic shaping, scheduling, and queuing	–	10.2	10.1	10.2	10.1	10.1
• Dynamic VLANs	–	10.2	10.2	10.2	10.2	10.2
• Enhanced subscriber management	15.1R4	15.1R4	15.1R4	15.1R4	15.1R4	15.1R4
• Static and dynamic PPPoE subscriber interfaces	–	10.2	10.1	10.2	10.1	10.1
Synchronous Ethernet (SyncE)	11.2R4	12.3 with SCBE and later	12.3 with SCBE and later	12.3 with SCBE and later	12.3 with SCBE and later	12.3 with SCBE and later

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
Tunnel services: • GRE unicast tunneling-Supports GRE fragmentation • IP-IP unicast tunneling • Multicast tunneling • Protocol Independent Multicast (PIM) sparse mode unicast tunneling • Virtual loopback tunneling (VT)	10.0R2	10.2	10.1	10.2	10.1	10.1
Two-Way Active Measurement Protocol (TWAMP)	10.0R2	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
IEEE 802.1Q VLANs: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	10.0R2	10.2	10.1	10.2	10.1	10.1
Virtual Chassis redundancy	11.2	11.2	11.2	11.2	11.2	11.2
Virtual private LAN service (VPLS)	10.0R2	10.2	10.1	10.2	10.1	10.1
Virtual private network (VPN)	10.0R2	10.2	10.1	10.2	10.1	10.1
Virtual Router Redundancy Protocol (VRRP) for IPv4	10.0R2	10.2	10.1	10.2	10.1	10.1

Table 50: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPCs *(Continued)*

Protocol or Application	First Junos OS Release Supported by MPC Model Number (MPC Name)					
	MPC-3D-16XGE-SFPP (16x10GE MPC)	MX-MPC1-3D (MPC1)	MX-MPC2-3D (MPC2)	MX-MPC1-3D-Q (MPC1 Q)	MX-MPC2-3D-Q (MPC2 Q)	MX-MPC2-3D-EQ (MPC2 EQ)
VRRP over integrated routing and bridging (IRB) on multichassis link aggregation	13.1	13.1	13.1	13.1	13.1	13.1
WAN-PHY mode	–	10.2	10.2	10.2	10.2	10.2

RELATED DOCUMENTATION

- MX Series MPC Overview | **15**
- MPCs Supported by MX Series Routers | **16**
- *ANCP and the ANCP Agent Overview*
- *Understanding BGP*
- *Understanding MPLS Inter-AS Link Protection*
- *IEEE 802.1ag OAM Connectivity Fault Management Overview*
- *Understanding IGMP*
- *Understanding IPv6*
- *Understanding LDP-IGP Synchronization*
- *mc-ae*

Protocols and Applications Supported on the MPC1E for MX Series Routers

Table 51 on page 491 contains the first Junos OS Release support for protocols and applications on the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPCEs).

NOTE: The MX2010 and M2020 routers support protocols and applications in Junos OS 12.3 and later. Features added after the Junos OS 12.3 release are supported on the MX2010 and MX2020 routers in the release indicated.

A dash indicates that the protocol or application is not supported.

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es)

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
Access Node Control Protocol (ANCP)	11.2R4	11.2R4
Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels	11.2R4	11.2R4
Bidirectional Forwarding Detection protocol (BFD)	11.2R4	11.2R4
Border Gateway Protocol (BGP)	11.2R4	11.2R4
BGP/Multiprotocol Label Switching (MPLS) virtual private networks (VPNs)	11.2R4	11.2R4
Distance Vector Multicast Routing Protocol (DVMRP) and generic routing encapsulation (GRE) support—access side and server side	11.2R4	11.2R4
IEEE 802.1ag Ethernet OAM Continuity Check protocol	11.2R4	11.2R4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
IEEE 802.1ag Ethernet OAM Linktrace protocol	11.2R4	11.2R4
IEEE 802.1ag Ethernet OAM Loopback protocol	11.2R4	11.2R4
Firewall filters	11.2R4	11.2R4
Flexible Ethernet encapsulation	11.2R4	11.2R4
Graceful Routing Engine Switchover (GRES)	11.2R4	11.2R4
Ingress Differentiated Services code point (DSCP) rewrite	11.2R4	11.2R4
Hierarchical quality-of-service (HQoS)	-	12.1R3
Intelligent oversubscription	11.2R4	11.2R4
Integrated routing and bridging (IRB)	11.2R4	11.2R4
Intermediate System-to-Intermediate System (IS-IS)	11.2R4	11.2R4
Internet Group Management Protocol (IGMP) (excluding snooping)	11.2R4	11.2R4
Internet Group Management Protocol (IGMP) snooping	11.2R4	11.2R4
IPv4	11.2R4	11.2R4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
IP multicast	11.2R4	11.2R4
IPv6	11.2R4	11.2R4
IPv6 MLD	11.2R4	11.2R4
IPv6 multicast	11.2R4	11.2R4
IPv6 Neighbor Discovery	11.2R4	11.2R4
Label Distribution Protocol (LDP)	11.2R4	11.2R4
Labeled switched paths (LSPs) including accounting, policers, and filtering	11.2R4	11.2R4
LAN-PHY mode	11.2R4	11.2R4
Layer 2 frame filtering	11.2R4	11.2R4
Layer 2 Tunneling Protocol (L2TP):		
• L2TP access concentrator (LAC)	11.3	11.3
• L2TP network server (LNS)	11.4	11.4
• LNS inline service support with CoS per-session shaping	11.4	11.4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
• LNS inline service support without CoS per-session shaping	11.4	11.4
• Peer interface	11.4	11.4
• Inline IP Reassembly	13.1	13.1
IEEE 802.3ad link aggregation	11.2R4	11.2R4
Link Aggregation Control Protocol (LACP)	11.2R4	11.2R4
Local loopback	11.2R4	11.2R4
MAC learning, policing, accounting, and filtering	11.2R4	11.2R4
Mobile IP	–	–
Multi-chassis link aggregation	11.2R4	11.2R4
Multiple Tag Protocol Identifiers (TPIDs)	11.2R4	11.2R4
Multiprotocol Label Switching (MPLS)	11.2R4	11.2R4
Nonstop active routing (NSR)	11.2R4	11.2R4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
IEEE 802.3ah OAM • Discovery and link monitoring • Fault signaling and detection • Remote loopback	11.2R4	11.2R4
Multitopology routing	11.2R4	11.2R4
OSPF	11.2R4	11.2R4
Packet mirroring	11.2R4	11.2R4
Per-unit scheduling	12.1R3	12.1R3
Precision Time Protocol (PTP) or IEEE 1588v2	12.3	12.3
IEEE 802.1ah provider backbone bridges (PBB)	11.2R4	11.2R4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
Quality of service (QoS) per port: • Eight queues per port • Excess-rate configuration at the traffic-control-profile level • Excess-rate and excess-priority configuration at the queue level • Shaping at port level • Shaping at queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Tricolor marking • Weighted random early detection (WRED)	11.2R4	11.2R4
Quality of service (QoS) per virtual LAN (VLAN):		
• Accounting, filtering, and policing	11.2R4	11.2R4
• IEEE 802.1p rewrite	11.2R4	11.2R4
• Classification	11.2R4	11.2R4
• Excess-rate configuration at the traffic-control-profile level	–	11.2R4
• Excess-rate and excess-priority configuration at the queue level	–	11.2R4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
• Tricolor marking	11.2R4	11.2R4
• Shaping at the queue level	–	11.2R4
• Scheduling of queues based on weighted round-robin (WRR) per priority class	–	11.2R4
• Weighted random early detection (WRED)	–	11.2R4
Quality of service (QoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces:		
• Accounting, filtering, and policing	11.2R4	11.2R4
• IEEE 802.1p rewrite	11.2R4	11.2R4
• Classification	11.2R4	11.2R4
• Excess-rate configuration at the traffic-control-profile level	–	11.2R4
• Excess-rate and excess-priority configuration at the queue level	–	11.2R4
• Tricolor marking	11.2R4	11.2R4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
• Shaping at the queue level	–	11.2R4
• Scheduling of queues based on weighted round-robin (WRR) per priority class	–	11.2R4
• Weighted random early detection (WRED)	–	11.2R4
RSVP	11.2R4	11.2R4
RIP	11.2R4	11.2R4
SNMP	11.2R4	11.2R4
Spanning Tree Protocols: • IEEE 802.1D Spanning Tree Protocol (STP) • IEEE 802.1s Multiple Spanning Tree Protocol • Per-VLAN Spanning Tree (PVST)+ • IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)	11.2R4	11.2R4
Subscriber Management:		
• Aggregated Ethernet over static VLANs	11.2R4	11.2R4
• Aggregated Ethernet over dynamic VLANs	11.2R4	11.2R4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
• DHCP access model	11.2R4	11.2R4
• Dynamic adjustment of shapers	11.2R4	11.2R4
• Dynamic PPPoE subscriber interface creation based on PPPoE service name table configuration	11.2R4	11.2R4
• Dynamic profiles	11.2R4	11.2R4
• Dynamic shaping, scheduling, and queuing	11.2R4	11.2R4
• Dynamic VLANs	11.2R4	11.2R4
• Enhanced subscriber management	15.1R4	15.1R4
• Static and dynamic PPPoE subscriber interfaces	11.2R4	11.2R4
Synchronous Ethernet (SyncE)	11.2R4	11.2R4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
Tunnel services: • Clear DF-Bit (Don't Fragment Bit) • GRE unicast tunneling-Supports GRE fragmentation • IP-IP unicast tunneling • Multicast tunneling • Protocol Independent Multicast (PIM) sparse mode unicast tunneling • Virtual loopback tunneling (VT)	11.2R4	11.2R4
Two-Way Active Measurement Protocol (TWAMP)	11.2R4	11.2R4
IEEE 802.1Q VLANs: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	11.2R4	11.2R4
Virtual Chassis redundancy	11.2R4	11.2R4
Virtual private LAN service (VPLS)	11.2R4	11.2R4
Virtual private network (VPN)	11.2R4	11.2R4
Virtual Router Redundancy Protocol (VRRP) for IPv4	11.2R4	11.2R4

Table 51: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 Enhanced MPCs (MPC1Es) *(Continued)*

First Junos OS Release Supported by MPC1E Model Number (MPCE Name)		
Protocol or Application	MX-MPC1E-3D (MPC1E)	MX-MPC1E-3D-Q (MPC1E Q)
WAN-PHY mode	11.2R4	11.2R4

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Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E

Table 52 on page 502 contains the first Junos OS Release support for protocols and applications on the MX240, MX480, MX960, MX2010, and MX2020 MPC2E.

A dash indicates that the protocol or application is not supported.

NOTE: The MX2010 and M2020 routers support protocols and applications in Junos OS 12.3 and later. Features added after the Junos OS 12.3 release are supported on the MX2010 and MX2020 routers in the release indicated.

A dash indicates that the protocol or application is not supported.

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2E Q)	MX-MPC2E-3D-EQ (MPC2E EQ)	MX-MPC2E-3D-P (MPC2E P)	MX-MPC2E-3D-NG (MPC2E NG)	MX-MPC2E-3D-NG-Q (MPC2E NG-Q)
Access Node Control Protocol (ANCP)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Accepts traffic destined for generic routing encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Manual	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Bidirectional Forwarding Detection protocol (BFD)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Border Gateway Protocol (BGP)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
BGP/*MPLS* virtual private networks (VPNs)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
DVMRP and GRE support—access side and server side	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Understanding How Dynamic Power Management Enables Better Utilization of Power	—	—	—	—	15.1	15.1

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2E Q)	MX-MPC2E-3D-EQ (MPC2E EQ)	MX-MPC2E-3D-P (MPC2E P)	MX-MPC2E-3D-NG (MPC2E NG)	MX-MPC2E-3D-NG-Q (MPC2E NG-Q)
Flexible Queuing Mode **NOTE**: Flexible queuing mode is supported only on non-HQoS variants.	—	—	—	—	15.1	—
IEEE 802.1ag Ethernet OAM Continuity Check protocol	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
IEEE 802.1ag Ethernet OAM Linktrace protocol	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
IEEE 802.1ag Ethernet OAM Loopback protocol	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Firewall filters	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Flexible Ethernet encapsulation	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Graceful Routing Engine Switchover (GRES)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Ingress Differentiated Services code point (DSCP) rewrite	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2E Q)	MX-MPC2E-3D-EQ (MPC2E EQ)	MX-MPC2E-3D-P (MPC2E P)	MX-MPC2E-3D-NG (MPC2E NG)	MX-MPC2E-3D-NG-Q (MPC2E NG-Q)
Ingress hierarchical quality-of-service (HQoS) shaping and *hierarchical-scheduler*: • Group of virtual LANs (VLANs) level • Virtual LAN (VLAN) level • Port level	–	–	–	–	15.1R1	15.1R1
Inline flow monitoring	12.1	12.1	12.1	12.1	14.1R4	14.1R4
Hierarchical quality-of-service (HQoS)	–	12.1R3	12.1R3	–	-	15.1R1
Intelligent Oversubscription on MIC and MPC Interfaces Overview	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Integrated routing and bridging (IRB)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Unified *In-service software upgrade (Unified ISSU)*	11.2R1	11.2R1	11.2R1	11.2R1	17.1R1	17.1R1
IS-IS	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Internet Group Management Protocol (IGMP) (excluding snooping)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2E Q)	MX-MPC2E-3D-EQ (MPC2E EQ)	MX-MPC2E-3D-P (MPC2E P)	MX-MPC2E-3D-NG (MPC2E NG)	MX-MPC2E-3D-NG-Q (MPC2E NG-Q)
Internet Group Management Protocol (IGMP) snooping	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
IPv4	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
IP multicast	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
IPv6	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
IPv6 MLD	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
IPv6 multicast	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
IPv6 Neighbor Discovery	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Label Distribution Protocol (LDP)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
LAN-PHY mode	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Layer 2 frame filtering	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2EQ)	MX-MPC2E-3D-EQ (MPC2EEQ)	MX-MPC2E-3D-P (MPC2EP)	MX-MPC2E-3D-NG (MPC2ENG)	MX-MPC2E-3D-NG-Q (MPC2ENG-Q)
Layer 2 Tunneling Protocol (L2TP):					14.1R4	14.1R4
• L2TP access concentrator (LAC)	11.3	11.3	11.3	12.2	14.1R4	14.1R4
• L2TP network server (LNS)	11.4	11.4	11.4	12.2	14.1R4	14.1R4
• LNS inline service support with CoS per-session shaping	11.4	11.4	11.4	12.2	14.1R4	14.1R4
• LNS inline service support without CoS per-session shaping	11.4	11.4	11.4	12.2	14.1R4	14.1R4
• Peer interface	11.4	11.4	11.4	12.2	14.1R4	14.1R4
• Inline IP Reassembly	13.1	13.1	13.1	13.1	14.1R4	14.1R4
Link aggregation (IEEE 802.3ad)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Link Aggregation Control Protocol (LACP)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Local loopback	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2E Q)	MX-MPC2E-3D-EQ (MPC2E EQ)	MX-MPC2E-3D-P (MPC2E P)	MX-MPC2E-3D-NG (MPC2E NG)	MX-MPC2E-3D-NG-Q (MPC2E NG-Q)
MAC learning, policing, accounting, and filtering	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Mobile IP	–	–	–	–		
Multi-chassis link aggregation	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Multiple Tag Protocol Identifiers (TPIDs)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Multiprotocol Label Switching (*MPLS*)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Nonstop active routing (NSR)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
IEEE 802.3ah OAM • Discovery and link monitoring • Fault signaling and detection • Remote loopback	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Multitopology routing	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
OSPF	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2EQ)	MX-MPC2E-3D-EQ (MPC2EEQ)	MX-MPC2E-3D-P (MPC2EP)	MX-MPC2E-3D-NG (MPC2ENG)	MX-MPC2E-3D-NG-Q (MPC2ENG-Q)
Packet mirroring	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Precision Time Protocol (PTP) or IEEE 1588v2	12.3	12.3	12.3	12.2	15.1R2	15.1R2
IEEE 802.1ah provider backbone bridges (PBB)	–	–	–	–	–	–
Quality of service (QoS) per port: • Eight queues per port • Excess-rate configuration at the traffic-control-profile level • Excess-rate and excess-priority configuration at the queue level • Shaping at port level • Shaping at queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Tricolor marking • Weighted random early detection (WRED)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2E Q)	MX-MPC2E-3D-EQ (MPC2E EQ)	MX-MPC2E-3D-P (MPC2E P)	MX-MPC2E-3D-NG (MPC2E NG)	MX-MPC2E-3D-NG-Q (MPC2E NG-Q)
Quality of service (QoS) per virtual LAN (VLAN):				–	14.1R4	14.1R4
• Accounting, filtering, and policing	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• IEEE 802.1p rewrite	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Classification	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Excess-rate configuration at the traffic-control-profile level	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Excess-rate and excess-priority configuration at the queue level	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Tricolor marking	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Shaping at the queue level	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Scheduling of queues based on weighted round-robin (WRR) per priority class	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2E Q)	MX-MPC2E-3D-EQ (MPC2E EQ)	MX-MPC2E-3D-P (MPC2E P)	MX-MPC2E-3D-NG (MPC2E NG)	MX-MPC2E-3D-NG-Q (MPC2E NG-Q)
• Weighted random early detection (WRED)	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Quality of service (QoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces:					14.1R4	14.1R4
• Accounting, filtering, and policing	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• IEEE 802.1p rewrite	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Classification	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Excess-rate configuration at the traffic-control-profile level	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Excess-rate and excess-priority configuration at the queue level	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Tricolor marking	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Shaping at the queue level	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2E Q)	MX-MPC2E-3D-EQ (MPC2E EQ)	MX-MPC2E-3D-P (MPC2E P)	MX-MPC2E-3D-NG (MPC2E NG)	MX-MPC2E-3D-NG-Q (MPC2E NG-Q)
• Scheduling of queues based on weighted round-robin (WRR) per priority class	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Weighted random early detection (WRED)	–	11.2R4	11.2R4	12.2	14.1R4	14.1R4
RSVP	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
RIP	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
SNMP	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Spanning Tree Protocols: • IEEE 802.1D Spanning Tree Protocol (STP) • IEEE 802.1s Multiple Spanning Tree Protocol • Per-VLAN Spanning Tree (PVST)+ • IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Subscriber Management:					14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2E Q)	MX-MPC2E-3D-EQ (MPC2E EQ)	MX-MPC2E-3D-P (MPC2E P)	MX-MPC2E-3D-NG (MPC2E NG)	MX-MPC2E-3D-NG-Q (MPC2E NG-Q)
• Aggregated Ethernet over static VLANs	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Aggregated Ethernet over dynamic VLANs	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• DHCP access model	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Dynamic adjustment of shapers	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Dynamic PPPoE subscriber interface creation based on PPPoE service name table configuration	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Dynamic profiles	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Dynamic shaping, scheduling, and queuing	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Dynamic VLANs	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
• Enhanced subscriber management	15.1R4	15.1R4	15.1R4	15.1R4	15.1R4	15.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2EQ)	MX-MPC2E-3D-EQ (MPC2EEQ)	MX-MPC2E-3D-P (MPC2EP)	MX-MPC2E-3D-NG (MPC2ENG)	MX-MPC2E-3D-NG-Q (MPC2ENG-Q)
• Static and dynamic PPPoE subscriber interfaces	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Synchronous Ethernet (SyncE)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Tunnel services: • Clear DF-Bit (Don't Fragment Bit) • GRE unicast tunneling-Supports GRE fragmentation • IP-IP unicast tunneling • Multicast tunneling • Protocol Independent Multicast (PIM) sparse mode unicast tunneling • Virtual loopback tunneling (VT)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Two-Way Active Measurement Protocol (TWAMP)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4

Table 52: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC2E *(Continued)*

Protocol or Application	First Supported Junos OS Release					
	MX-MPC2E-3D (MPC2E)	MX-MPC2E-3D-Q (MPC2EQ)	MX-MPC2E-3D-EQ (MPC2EEQ)	MX-MPC2E-3D-P (MPC2EP)	MX-MPC2E-3D-NG (MPC2ENG)	MX-MPC2E-3D-NG-Q (MPC2ENG-Q)
VLANs IEEE 802.1Q • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Virtual Chassis redundancy	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Virtual private LAN service (VPLS)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Virtual private network (VPN)	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
Virtual Router Redundancy Protocol (VRRP) for IPv4	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4
WAN-PHY mode	11.2R4	11.2R4	11.2R4	12.2	14.1R4	14.1R4

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Protocols and Applications Supported by the MPC3E on MX Series Routers

Table 53 on page 515 lists the first supported Junos OS Release for MPC3E protocols and applications for the MX240, MX480, MX960, MX2010, and MX2020 routers. The protocols and applications support feature parity with Junos OS Release 10.4.

> **NOTE**: The MX2010 and M2020 routers support protocols and applications in Junos OS 12.3 and later. Features added after the Junos OS 12.3 release are supported on the MX2010 and MX2020 routers in the release indicated.

A dash indicates that the protocol or application is not supported.

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Access Node Control Protocol (ANCP)	—	14.1R4	14.1R4
Bidirectional Forwarding Detection protocol (BFD)	12.1	14.1R4	14.1R4
Border Gateway Protocol (BGP)	12.1	14.1R4	14.1R4
Bridge protocol data units (BPDUs)	12.2	14.1R4	14.1R4
BGP/*MPLS* virtual private networks (VPNs)	12.1	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Class of service (CoS): • Maintain CoS across internal tunnel interfaces • Packet rewrites • Rate limit option for per-port queues • Configurable 802.1p inheritance: push and swap from the hidden tag • Configurable shaping overhead for scheduling • Behavior aggregate (BA) classification • BA classification based on 802.1p of “payload” for core-facing VPLS interfaces • BA DSCP classification of MPLS packets for L3VPN/VPLS LSI and MPLS interfaces • BA DSCP classification for VPLS/CCC family	12.1	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED) **NOTE**: Fine-grained queuing and input queuing are not supported for the MPC3E-3D.	12.1	14.1R4	14.1R4
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	12.1	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Tricolor marking • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	—	14.1R4	14.1R4
Distributed Denial-of-Service (DDoS) Protection	12.1	14.1R4	14.1R4
DVMRP and GRE support—access side and server side	—	14.1R4	14.1R4
Dynamic Power Management	15.1	15.1	15.1
Push a tag on Ethernet VPLS and Ethernet CCC tag encapsulations	12.1	14.1R4	14.1R4
Enhanced subscriber management	—	15.1R4	15.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	—	14.1R4	14.1R4
Flexible Queuing Mode **NOTE**: Flexible queuing mode is supported only on non-HQoS variants.	15.1	15.1	15.1
IEEE 802.1ag Ethernet OAM Continuity Check protocol	12.2	14.1R4	14.1R4
IEEE 802.1ag Ethernet OAM Linktrace protocol	12.2	14.1R4	14.1R4
IEEE 802.1ag Ethernet OAM Loopback protocol	12.2	14.1R4	14.1R4
IEEE 802.1ag Maintenance Association Intermediate Point (MIP) support, continuity check message (CCM), stacked VLAN tagging, trunk ports, support for VPLS/VPWS, VLAN circuit cross-connect (CCC) encapsulation and translational cross-connect (TCC) encapsulation	12.2	14.1R4	14.1R4
IEEE 802.1ag Optional type, length, and value (TLVs) support *Port Status TLV and Interface Status TLV*	—	14.1R4	14.1R4
IEEE 802.3ah distributed periodic packet management (PPM) process , alarm indication signal (AIS), and remote defect indication (RDI)	12.2	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Firewall filters and policers: • Policer support for aggregated Ethernet • Aggregate firewall-based policer for all families of a logical interface • Intelligent hierarchical policers **NOTE**: Intelligent hierarchical policers are supported from Junos OS Release 13.3. • Set forwarding class and loss priority for Routing Engine-generated packets by using a firewall • Physical interface policers, applying policers to the entire port • Lower policer limit from 32K to 8K • Egress IEEE 802.1p multi-field (MF) and BA classification for VPLS • Differentiated Services Code Point (DSCP) rewrite for IPv4 and IPv6 **NOTE**: The packet length used for the policer included in the Layer 2 header is not supported for the MPC3E-3D in release 12.2.	12.1	14.1R4	14.1R4
Flexible Ethernet encapsulation	12.1	14.1R4	14.1R4
Generic Routing Encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Manual	12.1	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Graceful Routing Engine Switchover (GRES)	12.1	14.1R4	14.1R4
Hierarchical Quality of Service (HQoS)	—	14.1R4	14.1R4
IGMP snooping with bridging, IRB, and VPLS	—	14.1R4	14.1R4
IGMPv3 support with snooping disabled	12.1	14.1R4	14.1R4
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: • Group of virtual LANs (VLANs) level • VLAN level • Port level	—	14.1R4	14.1R4
Inline flow monitoring	12.3R1	14.1R4	14.1R4
Intelligent Oversubscription on MIC and MPC Interfaces Overview	12.1	14.1R4	14.1R4
Integrated routing and bridging (IRB)	12.2	14.1R4	14.1R4
Unified *In-service software upgrade (Unified ISSU).* **NOTE**: ISSU is not supported on MPC3E-NG with 14.1R4.	13.3	17.1R1	17.1R1
Interoperability with MPCs and existing DPCs	12.1	14.1R4	14.1R4
Interoperability with multiservices DPCs	12.2	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Interoperability with MX Series Flexible PIC Concentrators (MX-FPC)	—	14.1R4	14.1R4
IPv4	12.1	14.1R4	14.1R4
IPv4 multicast	12.1	14.1R4	14.1R4
IPv6	12.1	14.1R4	14.1R4
IPv6 MLD	12.1	14.1R4	14.1R4
IPv6 multicast	12.1	14.1R4	14.1R4
IPv6 Neighbor Discovery	12.1	14.1R4	14.1R4
IS-IS	12.1	14.1R4	14.1R4
ITU-T Y.1731 timestamping support on MX Series routers	—	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Flow monitoring and services: • Active monitoring (multiple v8 version j-flow templates) • Active monitoring (cflowed version 9 templates) • Port mirroring family VPLS, bridge CCC encapsulation (VPWS) • Packet slice for port mirroring • Inline flow monitoring on MPC3E • Flow monitoring on multiservices DPCs **NOTE**: Flow monitoring on Multiservices DPCs and Inline flow monitoring on MPC3E are not supported for the MPC3E-3D in release 12.2.	12.2	14.1R4	14.1R4
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	12.1	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Layer 2 features: • Trunk ports • Layer 2 support for MX Series Virtual Chassis • Layer 2 and Layer 2.5, IRB and Spanning Tree Protocols (xSTP) • IEEE 802.1ad provider bridges • Layer 2 protocol tunneling (L2PT) support • Layer 2 Tunneling Protocol (L2TP) • Multi-chassis LAG—active/active and active/standby • Multi-chassis LAG—active/active with IGMP snooping • Link aggregation group (LAG)—VLAN-CCC encapsulation **NOTE**: LAG features and IGMP snooping with bridging, IRB, and VPLS are not supported for the MPC3E-3D in release 12.2.	12.2	14.1R4	14.1R4
Layer 2 VPN interfaces support VLAN ID list	12.1	14.1R4	14.1R4
Label Distribution Protocol (*LDP*)	12.1	14.1R4	14.1R4
Link aggregation (IEEE 802.3ad)	12.1	14.1R4	14.1R4
Link Aggregation Control Protocol (LACP)	12.1	14.1R4	14.1R4
Link Layer Discovery Protocol (LLDP)	—	14.1R4	14.1R4
Local loopback	12.1	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
MAC learning, policing, accounting, and filtering	12.1	14.1R4	14.1R4
Mobile IP	—	14.1R4	14.1R4
Multichassis link aggregation	—	14.1R4	14.1R4
Multiple Tag Protocol Identifiers (TPIDs)	12.1	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
MPLS: • Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN) • LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV) • RSVP graceful restart interoperability with Cisco using Nodal Hello • Failure action on BFD session down of RSVP LSPs • OSPF and IS-IS loop-free alternates (LFA) • 4/5 label MPLS operation • Virtual circuit connectivity verification (VCCV) BFD • Point to multipoint using the enhanced-ip command (support for NG-MVPN and P2MP load balancing over aggregated Ethernet) • MPLS-FRR bypass link protection • Load sharing across 64 ECMP next hops • MPLS-FRR VPLS instance prioritization • Five label stack on ingress	12.1	14.1R4	14.1R4
MPLS node protection, link protection, and statistics for static LSPs	12.1	14.1R4	14.1R4
mvrp	—	14.1R4	14.1R4
Multitopology routing	12.1	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Nonstop active routing (NSR)	12.1	14.1R4	14.1R4
OSPF	12.1	14.1R4	14.1R4
Packet mirroring	12.2	14.1R4	14.1R4
Precision Time Protocol (PTP) (IEEE 1588)	12.2	17.2R1	17.2R1
IEEE 802.1ah Provider Bridging (PBB)	—	14.1R4	14.1R4
RSVP	12.1	14.1R4	14.1R4
RIP	12.1	14.1R4	14.1R4
SNMP	12.1	14.1R4	14.1R4
Spanning Tree Protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • Spanning-Tree Protocols (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush (in VPLS multi-homing, flush all MACs when there is a change in the STP interface state due to root protect)	12.2	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Subscriber management and services (MX2010, MX2020: 12.3R4, 13.2R2, 13.3): • Aggregated Ethernet over static VLANs • Aggregated Ethernet over dynamic VLANs • *ANCP and the ANCP Agent Overview* • DHCP access model • Dynamic adjustment of shapers • Dynamic PPPoE subscriber interface creation based on PPPoE service name tables • Dynamic profiles • Dynamic shaping, scheduling, and queuing • Dynamic VLANs • Per unit scheduling • Static and dynamic PPPoE subscriber interfaces	–	14.1R4	14.1R4
Synchronous Ethernet	13.2	14.1R4	14.1R4
Two-Way Active Measurement Protocol (TWAMP)	—	14.1R4	14.1R4
Tunnel services • Clear DF-Bit (Don't Fragment Bit)	12.1	14.1R4	14.1R4
Unified in-service software upgrade (ISSU) **NOTE**: ISSU is not supported on MPC3E-NG with 14.1R4.	13.3	17.1R1	17.1R1

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
Unnumbered Ethernet Interface	12.1	14.1R4	14.1R4
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	12.1	14.1R4	14.1R4
Virtual Chassis: MPLS IPv4 and IPv6, unicast, multicast forwarding, VPLS, NSR for Layer 3/MPLS services	13.2R1	14.1R4	14.1R4
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG	12.1	14.1R4	14.1R4
Virtual private network (VPN)	12.1	14.1R4	14.1R4
Virtual Router Redundancy Protocol (VRRP) for IPv4	12.1	14.1R4	14.1R4

Table 53: Protocols and Applications Supported by MPC3E Cards for MX Series Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release		
	MPC3E-3D	MPC3E–3D-NG	MPC3E–3D-NG-Q
VPLS packet flooding to the right set of interfaces across mesh groups	—	14.1R4	14.1R4
WAN-PHY mode	12.2	14.1R4	14.1R4

RELATED DOCUMENTATION

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Protocols and Applications Supported on the MPC4E for MX Series Routers

Table 54 on page 530 contains the first Junos OS Release support for protocols and applications on the MPC4E. The protocols and applications support feature parity with Junos OS Release 12.2. A dash indicates that the protocol or application is not supported.

Table 54: Protocols and Applications Supported by the MX Series MPC4E

Protocol or Application	First Supported Junos OS Release
Bidirectional Forwarding Detection protocol (BFD)	12.3R2
Border Gateway Protocol (BGP)	12.3R2
Bridge protocol data units (BPDUs)	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Class of service (CoS): • Behavior Aggregate (BA) classification • Forwarding class loss priority through logical tunnels (LT) • Static VLAN mapping to a specific forwarding class using a multi-field (MF) classifier • Packet rewrites • *Configurable IEEE 802.1p inheritance* • Rate-limit option for per-port queues • Configurable shaping overhead for scheduling • Weighted Random Early Detection (WRED) • *Intelligent oversubscription on MIC and MPC interfaces* • *Class of Service on Ethernet pseudowires on Logical Tunnel (LT) interfaces* • Fine-grained authentication for RE-generated packets • IEEE 802.1ad S-TAG, exiting/incoming core with label-switched interfaces (LSIs) • Egress IEEE 802.1p multifield (MF) and BA classification for VPLS (MX series only)	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configuration at the queue level • Shaping at the port level and queue level • Scheduling of queues based on weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED) • Rate limit option for per-port queues	12.3R2 **NOTE**: Fine-grained queuing and input queuing are not supported.
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Connectivity Fault Management (CFM) protocols and features (IEEE 802.1ag): • *Ethernet OAM Continuity Check Message (CCM) protocol* • *Ethernet OAM Linktrace protocol* • *Ethernet OAM Loopback protocol* • *Configuring Maintenance Intermediate Points (MIPs)* • Stacked VLAN tagging • Trunk ports • VPLS/VPWS • VLAN circuit cross-connect (CCC) encapsulation • Transitional cross-connect (TCC) encapsulation	12.3R2
Distributed Denial-of-Service (DDoS) Protection	12.3R2
Distributed Periodic Packet Management Process (PPMP) For more information, see *Periodic Packet Management*.	12.3R2
Distance Vector Multicast Routing Protocol (DVMRP) Tunnels—access side and server side	12.3R2
Ethernet Alarm Indication Signal (ETH-AIS) Function Overview	12.3R2
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Firewall filters and policers: • *Intelligent Hierarchical Policers* • Policer support for aggregated Ethernet • Aggregate firewall-based policer for all families of a logical interface • *Layer 2 policers* • Set forwarding class loss priority for Routing Engine (RE)-generated packets by using a firewall • Physical interface policers, applying policer to the entire port • *Prefix-Specific Counting and Policing Actions*	12.3R2
Flexible Ethernet encapsulation	12.3R2
Graceful routing engine switchover (GRES)	12.3R2
Configuring Generic Routing Encapsulation Tunneling—access side and server side	12.3R2
IGMPv3 support with snooping disabled	12.3R2
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: • Group of virtual LANs (VLANs) level • VLAN level • Port level	–
Inline flow monitoring	12.3R2
Intelligent oversubscription on the Trio MPC/MIC interfaces	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Integrated Routing and Bridging (IRB)	12.3R2
Unified *In-service software upgrade (Unified ISSU)*	13.3
Interoperability with MX Series Flexible PIC Concentrators (MX-FPC)	12.3R2
Interoperability with MPCs and existing DPCs	12.3R2
Interoperability with Juniper Networks 100-Gigabit Ethernet PIC	12.3R2
Interoperability with MX Series Application Services Modular Line Card (AS-MLC)	12.3R2
IPv4	12.3R2
IPv4 multicast	12.3R2
IPv6	12.3R2
IPv6 Multicast Listener Discovery (MLD)	12.3R2
IPv6 multicast	12.3R2
IPv6 Neighbor Discovery Protocol (NDP)	12.3R2
Immediate System-to-Intermediate System (IS-IS)	12.3R2
ITU-T Y.1731 timestamping support (MX Series routers)	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release

Flow monitoring and services:
• Active monitoring (multiple v9 j-flow templates)
• Active monitoring: cflowd v9 IPv6 templates
• Active Monitoring: cflowd V9 per-PFE sampling support
• Port mirroring for Layer 2 bridging traffic (family ethernet-switching)
  • Port mirroring for Layer 2 VPLS traffic (family vpls)
  • Port mirroring for Layer 2 VPN traffic over a circuit cross-connect (CCC)
  • Virtual private wire service (VPWS)
  • Flow monitoring on Multiservices DPCs
  • Packet slice for port mirroring
  • Inline Jflow monitoring (IPFIX)
	12.3R2

Labeled-switched-paths (LSPs) including accounting, policers, and filtering	12.3R2
Label Distribution Protocol (LDP)	12.3R2
Subscriber Management	-

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Layer 2 features:	Release
• Integrated Routing and Bridging (IRB)	• 12.3R2
• Spanning Tree Protocols	• 12.3R2
• Link Layer Discovery Protocol (LLDP)	• 13.3R1 , 12.3R4
• Bridge Protocol Data Unit (BPDU) guard	• 12.3R2
• Bridge Protocol Data Unit (BPDU) loop guard	• 12.3R2
• Layer 2 Tunneling Protocol (L2TP)	• -
• Trunk ports	• 13.3R1
• IEEE 802.1ad provider bridges	• 13.3R1
• Multi-chassis Link Aggregation Group (MC-LAG)—active/active and active/standby	• 13.3R1
• MC-LAG—active/active with IGMP snooping	• –
• MC-LAG VLAN –ccc interface encapsulation	• 13.3R1
• Layer 2 Protocol Tunneling (L2PT) support	• 13.3R1
• IGMP snooping with bridging, IRB, and VPLS	• 12.3R2
• *Layer 2 Learning and Forwarding in a Logical System Overview*	• 12.3R2
• Static Route Support	• 13.2R1
• 64 members in a link aggregation group	• 13.2R1
• Periodic packet management daemon (ppmd) and distributed PPMD for Link Aggregation Control Protocol process (LACPd)	

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Layer 3 Features:	Release
• IPv6	• 12.3R2
• Protocol Independent Multicast Source-Specific Multicast (PIM SSM)	• 12.3R2
• Bidirectional Forwarding Detection (BFD)	• 12.3R2
• Any-source multicast (ASM) group override of source-specific multicast (SSM) range	• 12.3R2
• Connectionless Network Service (CLNS)	• 12.3R2
• Data Multicast Domain Tunnels (MDT) Subsequent Address Family Identifiers (SAFI)	• 12.3R2
• Draft-Rosen 7 Multicast VPNs	• 12.3R2
• Multicast over Integrated Routing and Bridging (IRB) interfaces	• 12.3R2
• Composite next hop with External and Internal BGP (EIBGP) paths	• 12.3R2
• VPN load balancing and IP header filtering of traffic across External and Internal BGP (EIBGP) paths	• 13.2R1
• Multiprotocol Label Switching (MPLS) over Generic Routing Encapsulation (GRE)	• 13.2R1
• *Configuring Logical Tunnel Interfaces*	• 13.2R1
Link aggregation (IEEE 802.3ad)	12.3R2
Link Aggregation Control Protocol (LACP)	12.3R2
Link Layer Discovery Protocol (LLDP)	–
Local loopback	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
MAC learning, policing, accounting, and filtering	12.3R2
Mobile IP	–
Multiservices DPC (MS-DPC): • *Junos Address Aware Network Addressing Overview* • Intrusion Detection Service (IDS) • Graceful Routing Engine Switchover (GRES) for NAT • Intrusion Detection and Prevention (IDP) interoperability • IP Security (IPSec) detection • Two-Way Active Measurement Protocol (TWAMP) interoperability • Real-Time Performance Monitor (RPM) interoperabilitiy • GRE interoperability	13.2R1
Multi-chassis Link Aggregation (MC-LAG)	13.3R1
Multiple Tag Protocol Identifiers (TPIDs)	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Multiprotocol Label Switching (MPLS): • Switching of pseudowire segments (multi-segment pseudowires with BGP-L2VPN) • LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV) • RSVP graceful restart interoperability with Cisco using Nodal Hello • Failure action on BFD session down of RSVP LSPs • OSPF and IS-IS loop-free alternates (LFA) • 4/5 label MPLS operation • Virtual circuit connection verification (VCCV) BFD • Point-to-multipoint using the `enhanced-ip` command (support for NG-MVPN and P2MP load balancing over aggregated Ethernet) • MPLS-FRR bypass link protection • Load sharing across 64 ECMP next hops • MPLS-FRR VPLS instance prioritization • Five label stack on ingress • Generic Routing Encapsulation (GRE) keepalive messages • MPLS node protection, link protection, and statistics for static LSPs	12.3R2
mvrp	–
Multitopology routing (MTR)	–
Nonstop Active Routing (NSR)	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Open Shortest Path First (OSPF)	12.3R2
Packet mirroring	12.3R2
Precision Time Protocol (PTP) (IEEE 1588)	15.1R1
IEEE 802.1ah provider backbone bridges (PBB)	–
Periodic Packet Management Process (PPMP) and Distributed PPMP	12.3R2
Push a tag on Ethernet VPLS and Ethernet CCC tag encapsulations	–
Remote Defect Indication (RDI)	12.3R2
Resource Reservation Protocol (RSVP)	12.3R2
Routing Information Protocol (RIP)	12.3R2
SNMP	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Spanning Tree Protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge Protocol Data Units (BPDUs) guard and loop guard • STP interprotocol action profiles and MAC flush (in VPLS multihoming, flush all MACs when there is a change in the STP interface state due to root protect)	12.3R2
Synchronous Ethernet (SyncE)	12.3 with SCBE and later
Two-Way Active Measurement Protocol (TWAMP)	13.2
Tunnel services • Clear DF-Bit (Don't Fragment Bit)	12.3R2
Type, Length, and Value (TLVs) support (IEEE 802.1ag)	–
Unnumbered Ethernet Interface	12.3R2
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	12.3R2

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Virtual Chassis (MX Series): • *Class of Service (CoS) Support for Virtual Ports* • Layer 2 support • DHCP Access Model and authentication, authorization, and accounting (AAA) services • Layer 3 Provider Edge (PE) router support • Dynamic Lawful Intercept (DLI) • *Layer 2 Access Node Control Protocol (ANCP)* • *Wireline Subscriber Management scaling to 64K subscribers* • Non-stop active routing (NSR) support for Layer 3 services • Local, Global, and VCCP Graceful Routing Engine Switchover (GRES) • SNMP trap generation when `vc-port` command fails • Virtual Chassis Port (VCP) masking • *Access to the Virtual Chassis Through the Management Interface*	13.2R1 (12.3R4 TRD)

Table 54: Protocols and Applications Supported by the MX Series MPC4E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Virtual Private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG • Configurable multichassis link aggregation (MC-LAG) interfaces to improve the Layer 2 and Layer 3 convergence time to subsecond values when a multichassis aggregated Ethernet link goes down or comes up in a bridge domain • *MAC Pinning to control MAC moves in a bridging environment and in VPLS networks*	12.3R2
Virtual private network (VPN): • *Multiprotocol Label Switching (MPLS)*	12.3R2
Virtual Router Redundancy Protocol (VRRP) for IPv4 • Scale VRRP using instance grouping • Periodic Packet Management Process (PPMP) and Distributed Periodic Packet Management Process (PPMP) For more information, see *Periodic Packet Management*.	12.3R2
VPLS packet flooding to the right set of interfaces across mesh groups	12.3R2
WAN-PHY mode	12.3R2

RELATED DOCUMENTATION

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Protocols and Applications Supported by the MPC5E for MX Series Routers

Table 55 on page 545 contains the first Junos OS Release support for protocols and applications in the MPC5E installed on the MX240, MX480, MX960, MX2010, and MX2020 routers. The protocols and applications support feature parity with Junos OS Release 12.3.

A dash indicates that the protocol or application is not supported.

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E

Protocol or Application	First Supported Junos OS Release
Access Node Control Protocol (ANCP)	-
Accepts traffic destined for generic routing encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Manual	13.3R3
Bidirectional Forwarding Detection protocol (BFD)	13.3R3
Border Gateway Protocol (BGP)	13.3R3
Bridge protocol data units (BPDUs)	13.3R3
BGP/*MPLS* virtual private networks (VPNs)	13.3R3

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Class of service (CoS): • Maintain CoS across internal tunnel interfaces • Packet rewrites • Behavior aggregate (BA) classification • BA classification based on 802.1p of *payload* for core-facing VPLS interfaces • BA DSCP classification of MPLS packets for Layer 3 VPN/VPLS LSI and MPLS interfaces • Rate limit option for per-port queues • BA DSCP classification for VPLS/CCC family • Configurable .1p inheritance: push and swap from the hidden tag • Configurable shaping overhead for scheduling	13.3R3
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	13.3R3

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	13.3R3
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Tricolor marking • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	13.3R3
Damping	15.1R2
Distributed Denial-of-Service (DDoS) Protection	13.3R3
DVMRP and GRE support—access side and server side	13.3R3

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	13.3R3
IEEE 802.1ag Ethernet OAM Continuity Check protocol	13.3R3
IEEE 802.1ag Ethernet OAM Linktrace protocol	13.3R3
IEEE 802.1ag Ethernet OAM Loopback protocol	13.3R3
IEEE 802.1ag Maintenance Association Intermediate Point (MIP) support, continuity check message (CCM), stacked VLAN tagging, trunk ports, support for VPLS/VPWS, VLAN circuit cross-connect (CCC) encapsulation and translational cross-connect (TCC) encapsulation	13.3R3
Port Status TLV and Interface Status TLV	-
IEEE 802.3ah distributed periodic packet management (PPM) process, alarm indication signal (AIS), and remote defect indication (RDI)	13.3R3

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Firewall filters and policers: • Policer support for aggregated Ethernet • Aggregate firewall-based policer for all families of a logical interface • Set forwarding class and loss priority for Routing Engine-generated packets by using a firewall • Physical interface policers, applying policers to the entire port • Lower policer limit from 32,000 to 8000 • Egress .1p MF and BA classification for VPLS • Differentiated Services Code Point (DSCP) rewrite for IPv4 and IPv6	13.3R3
Flexible Ethernet encapsulation	13.3R3
Flexible Queuing Mode **NOTE**: Flexible queuing mode is supported only on non-HQoS variants.	14.1R1
Graceful Routing Engine Switchover (GRES)	13.3R3
IGMPv3 support with snooping disabled	13.3R3
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: • Group of virtual LANs (VLANs) level • VLAN level • Port level	13.3R3

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Hierarchical CoS on generic routing encapsulation (GRE) tunnels	15.1R2
Inline active flow monitoring	13.3R3
Intelligent Oversubscription	13.3R3
Integrated routing and bridging (IRB)	13.3R3
Unified In-service software upgrade (Unified ISSU) For more information, see *Performing a Unified ISSU*.	16.1R1
Interoperability with MPCs and existing DPCs	-
Interoperability with Multiservices DPCs	13.3R3
Interoperability with MX Series Flexible PIC Concentrators (MX-FPC)	13.3R3
Interoperability with Juniper Networks 100-Gigabit Ethernet PIC	13.3R3
Interoperability with MX Series Application Services Modular Line Card (AS-MLC)	13.3R3
IPv4	13.3R3
IPv4 multicast	13.3R3
IPv6	13.3R3
IPv6 MLD	13.3R3

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
IPv6 multicast	13.3R3
IPv6 Neighbor Discovery	13.3R3
IS-IS	13.3R3
ITU-T Y.1731 timestamping support on MX Series routers	13.3R3
Flow monitoring and services: • Active monitoring (multiple version 8 j-flow templates) • Active monitoring (cflowed version 9 templates) • Port mirroring family VPLS, bridge CCC encapsulation (VPWS) • Packet slice for port mirroring • Flow monitoring on Multiservices DPCs • Inline active flow monitoring on MPC5E	Release • 13.3R3 • 13.3R3 • 13.3R3 • 13.3R3 • - • 13.3R3
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	13.3R3
LDP	13.3R3

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Layer 2 features:	Release
• Trunk ports	• 13.3R3
• Layer 2 support for MX Series Virtual Chassis	• 13.3R3
• Layer 2 and Layer 2.5, IRB, and Spanning Tree Protocols (xSTP)	• -
• IEEE 802.1ad provider bridges	• 13.3R3
• Layer 2 protocol tunneling (L2PT) support	• 13.3R3
• Layer 2 Tunneling Protocol (L2TP)	• 13.3R3
• Multichassis LAG—active/active and active/standby	• 13.3R3
• Multichassis LAG—active/active with IGMP snooping	• 13.3R3
• Link aggregation group (LAG)—VLAN-CCC encapsulation	• 13.3R3
• IGMP snooping with bridging, IRB, and VPLS	• 13.3R3
Layer 2 VPN interfaces support VLAN ID list	13.3R3
Link aggregation (IEEE 802.3ad)	13.3R3
Link Aggregation Control Protocol (LACP)	13.3R3
Link Layer Discovery Protocol (LLDP)	13.3R3
Local loopback	13.3R3
MAC learning, policing, accounting, and filtering	13.3R3
Mobile IP	-

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Multichassis link aggregation	-
Multiple Tag Protocol Identifiers (TPIDs)	13.3R3
MPLS: • Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN) • LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV) • RSVP graceful restart interoperability with Cisco using Nodal Hello • Failure action on BFD session down of RSVP LSPs • OSPF and IS-IS loop-free alternates (LFA) • 4/5 label MPLS operation • Virtual circuit connectivity verification (VCCV) BFD • *Point to multipoint* using the `enhanced-ip` command (support for NG-MVPN and *point-to-multipoint* load balancing over aggregated Ethernet) • MPLS-FRR bypass link protection • Load sharing across 64 ECMP next hops • MPLS-FRR VPLS instance prioritization • Five label stack on ingress	13.3R3
MPLS node protection, link protection, and statistics for static LSPs	13.3R3
mvrp	-
Multitopology routing	-

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Nonstop active routing (NSR)	13.3R3
OSPF	13.3R3
Packet mirroring	13.3R3
Precision Time Protocol (PTP) (IEEE 1588)	14.2R2
IEEE 802.1ah provider backbone bridging (PBB)	-
Push a tag on Ethernet VPLS and Ethernet CCC tag encapsulations	13.3R3
RSVP	13.3R3
RIP	13.3R3
SNMP	13.3R3
Spanning Tree Protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush	13.3R3

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Subscriber management and services:(MX2010, MX2020: 12.3R4, 13.3R2, 13.3)	Release
• Aggregated Ethernet over static VLANs	• 13.3R3
• Aggregated Ethernet over dynamic VLANs	• 13.3R3
• *ANCP and the ANCP Agent Overview*	• 13.3R3
• DHCP access model	• 13.3R3
• Dynamic adjustment of shapers	• 13.3R3
• Dynamic PPPoE subscriber interface creation based on PPPoE service name tables	• 13.3R3
• Dynamic profiles	• 13.3R3
• Dynamic shaping, scheduling, and queuing	• 13.3R3
• Dynamic VLANs	• 13.3R3
• Enhanced subscriber management	• 15.1R4
• Static and dynamic PPPoE subscriber interfaces	• 13.3R3
Synchronous Ethernet	13.3R3
Two-Way Active Measurement Protocol (TWAMP)	13.3R3
Tunnel services • Clear DF-Bit (Don't Fragment Bit)	13.3R3
Unnumbered Ethernet Interface	13.3R3

Table 55: Protocols and Applications Supported by the MX240, MX480, MX960, MX2010, and MX2020 MPC5E *(Continued)*

Protocol or Application	First Supported Junos OS Release
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	13.3R3
Virtual Chassis: MPLS IPv4 and IPv6, unicast, multicast forwarding, VPLS, NSR for Layer 3/MPLS services	13.3R3
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast traffic hashing over LAG	13.3R3
Virtual private network (VPN)	13.3R3
Virtual Router Redundancy Protocol (VRRP) for IPv4	13.3R3
VPLS packet flooding to the right set of interfaces across mesh groups	13.3R3
WAN-PHY mode	13.3R3

RELATED DOCUMENTATION

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Protocols and Applications Supported by the MPC6E for MX2000 Routers

Table 56 on page 557 contains the first Junos OS Release support for protocols and applications on the MX2010 and MX2020 MPC6E. The protocols and applications support feature parity with Junos OS Release 13.3.

A dash indicates that the protocol or application is not supported.

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E

Protocol or Application	First Supported Junos OS Release
Access Node Control Protocol (ANCP)	-
Accepts traffic destined for generic routing encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Manual	13.3R3
Bidirectional Forwarding Detection protocol (BFD)	13.3R3
Border Gateway Protocol (BGP)	13.3R3
Bridge protocol data units (BPDUs)	13.3R3
BGP/*MPLS* virtual private networks (VPNs)	13.3R3

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Class of service (CoS): • Maintain CoS across internal tunnel interfaces • Packet rewrites • Behavior aggregate (BA) classification • BA classification based on 802.1p of *payload* for core-facing VPLS interfaces • BA DSCP classification of MPLS packets for L3VPN/VPLS LSI and MPLS interfaces • Rate limit option for per-port queues • BA DSCP classification for VPLS/CCC family • Configurable .1p inheritance: push and swap from the hidden tag • Configurable shaping overhead for scheduling	13.3R3
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	13.3R2

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	13.3R3
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Tricolor marking • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	13.3R3
Damping	15.1R2
Distributed Denial-of-Service (DDoS) Protection	13.3R3
DVMRP and GRE support—access side and server side	13.3R3
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	13.3R3

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
IEEE 802.1ag Ethernet OAM Continuity Check protocol	13.3R3
IEEE 802.1ag Ethernet OAM Linktrace protocol	13.3R3
IEEE 802.1ag Ethernet OAM Loopback protocol	13.3R3
IEEE 802.1ag Maintenance Association Intermediate Point (MIP) support, continuity check message (CCM), stacked VLAN tagging, trunk ports, support for VPLS/VPWS, VLAN circuit cross-connect (CCC) encapsulation and translational cross-connect (TCC) encapsulation	13.3R3
IEEE 802.1ag optional type, length, and value (TLV) (*Port Status TLV and Interface Status TLV*)	-
IEEE 802.3ah distributed periodic packet management (PPM) process, alarm indication signal (AIS), and remote defect indication (RDI)	13.3R3
Firewall filters and policers: • Policer support for aggregated Ethernet • Aggregate firewall-based policer for all families of a logical interface • Set forwarding class and loss priority for Routing Engine-generated packets by using a firewall • Physical interface policers, applying policers to the entire port • Lower policer limit from 32,000 to 8000 • Egress .1p MF and BA classification for VPLS • Differentiated Services Code Point (DSCP) rewrite for IPv4 and IPv6	13.3R3
Flexible Ethernet encapsulation	13.3R3

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Graceful Routing Engine Switchover (GRES)	13.3R3
IGMPv3 support with snooping disabled	13.3R3
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: • Group of virtual LANs (VLANs) level • VLAN level • Port level	13.3R3
Inline active flow monitoring	13.3R3
Intelligent oversubscription on MIC and MPC interfaces	13.3R3
Integrated routing and bridging (IRB)	13.3R3
Unified In-service software upgrade (Unified ISSU) For more information, see *Performing a Unified ISSU*.	16.1R1
Interoperability with MPCs and existing DPCs	13.3R3
Interoperability with Multiservices DPCs	13.3R3
Interoperability with MX Series Flexible PIC Concentrators (MX-FPC)	13.3R3
IPv4	13.3R3
IPv4 multicast	13.3R3

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
IPv6	13.3R3
IPv6 MLD	13.3R3
IPv6 multicast	13.3R3
IPv6 neighbor discovery	13.3R3
IS-IS	13.3R3
ITU-T Y.1731 timestamping support on MX Series routers	13.3R3
Flow monitoring and services: • Active monitoring (multiple v8 version j-flow templates) • Active monitoring (cflowed version 9 templates) • Port mirroring family VPLS, bridge CCC encapsulation (VPWS) • Packet slice for port mirroring • Flow monitoring on Multiservices DPCs • Inline active flow monitoring on MPC5E	Release • 13.3R3 • 13.3R3 • 13.3R3 • 13.3R3 • - • 13.3R3
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	13.3R3
LDP	13.3R3

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Layer 2 features:	Release
• Trunk ports	• 13.3R3
• Layer 2 support for MX Series Virtual Chassis	• 13.3R3
• Layer 2 and Layer 2.5, IRB and Spanning Tree Protocols (xSTP)	• 15.1R2
• IEEE 802.1ad provider bridges	• 13.3R3
• Layer 2 protocol tunneling (L2PT) support	• 13.3R3
• Layer 2 Tunneling Protocol (L2TP)	• 13.3R3
• Multichassis LAG—active/active and active/standby	• 13.3R3
• Multichassis LAG—active/active with IGMP snooping	• 13.3R3
• Link aggregation group (LAG)—VLAN-CCC encapsulation	• 15.1R2
• IGMP snooping with bridging, IRB, and VPLS	• 13.3R2
Layer 2 VPN interfaces	
Link aggregation (IEEE 802.3ad)	13.3R3
Link Aggregation Control Protocol (LACP)	13.3R3
Link Layer Discovery Protocol (LLDP)	-
Local loopback	13.3R3
MAC learning, policing, accounting, and filtering	13.3R3
Mobile IP	-

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Multichassis link aggregation	-
Multiple Tag Protocol Identifiers (TPIDs)	13.3R3
MPLS: • Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN) • LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV) • RSVP graceful restart interoperability with Cisco using Nodal Hello • Failure action on BFD session down of RSVP LSPs • OSPF and IS-IS loop-free alternates (LFA) • 4/5 label MPLS operation • Virtual circuit connectivity verification (VCCV) BFD • Point to multipoint using the `enhanced-ip` command (support for NG-MVPN and P2MP load balancing over aggregated Ethernet) • MPLS-FRR bypass link protection • Load sharing across 64 ECMP next hops • MPLS-FRR VPLS instance prioritization • Five label stack on ingress	13.3R3
MPLS node protection, link protection, and statistics for static LSPs	13.3R3
mvrp	-
Multitopology routing	-

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Nonstop active routing (NSR)	-
OSPF	13.3R3
Packet mirroring	13.3R3
Precision Time Protocol (PTP) (IEEE 1588)	-
IEEE 802.1ah provider backbone bridging (PBB)	-
Push a tag on Ethernet VPLS and Ethernet CCC tag encapsulations	13.3R3
RSVP	13.3R3
RIP	13.3R3
SNMP	13.3R3
Spanning Tree Protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush	13.3R3

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
Subscriber management and services(MX2010, MX2020: 12.3R4, 13.3R2, 13.3):	Release
• Aggregated Ethernet over static VLANs	• 13,3R3
• Aggregated Ethernet over dynamic VLANs	• 13.3R3
• *ANCP and the ANCP Agent Overview*	• 13.3R3
• DHCP access model	• 13.3R3
• Dynamic adjustment of shapers	• 13.3R3
• Dynamic PPPoE subscriber interface creation based on PPPoE service name tables	• 13.3R3
• Dynamic profiles	• 13.3R3
• Dynamic shaping, scheduling, and queuing	• 13.3R3
• Dynamic VLANs	• 13.3R3
• Enhanced subscriber management (uplink services)	• 15.1R4
• Static and dynamic PPPoE subscriber interfaces	• 13.3R3
Synchronous Ethernet	13.3R3
Two-Way Active Measurement Protocol (TWAMP)	13.3R3
Tunnel services	13.3R3
Unnumbered Ethernet Interface	13.3R3

Table 56: Protocols and Applications Supported by the MX2010 and MX2020 MPC6E *(Continued)*

Protocol or Application	First Supported Junos OS Release
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	13.3R3
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unknown unicast, and multicast traffic hashing over LAG	13.3R3
Virtual private network (VPN)	13.3R3
Virtual Router Redundancy Protocol (VRRP) for IPv4	13.3R3
VPLS packet flooding to the right set of interfaces across mesh groups	13.3R3
WAN-PHY mode	13.3R3

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Protocols and Applications Supported by the MPC7E for MX Series Routers

IN THIS SECTION

Table 57 on page 568 contains the first Junos OS Release support for protocols and applications on the MX240, MX480, MX960, MX2010, and MX2020 MPC7Es ("MPC7E-10G" on page 202 and "MPC7E-MRATE" on page 198). The protocols and applications support feature parity with Junos OS Release 15.1R1.

A dash indicates that the protocol or application is not supported.

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Access Node Control Protocol (ANCP)	-	-
Accepts traffic destined for generic routing encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Manual	15.1F4	15.1F5
Bidirectional Forwarding Detection protocol (BFD)	15.1F4	15.1F5
Border Gateway Protocol (BGP)	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Bridge protocol data units (BPDUs)	15.1F4	15.1F5
BGP/*MPLS* virtual private networks (VPNs)	15.1F4	15.1F5
Class of service (CoS): • Maintain CoS across internal tunnel interfaces • Packet rewrites • Behavior aggregate (BA) classification • BA classification based on 802.1p of payload for core-facing VPLS interfaces • BA DSCP classification of MPLS packets for L3VPN/VPLS LSI and MPLS interfaces • Rate limit option for per-port queues • BA DSCP classification for VPLS/CCC family • Configurable .1p inheritance: push and swap from the hidden tag • Configurable shaping overhead for scheduling	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	15.1F4 **NOTE**: MPC7E-MRATE MPC supports 5 guaranteed and 4 excess priorities.	15.1F5 **NOTE**: MPC7E-10G MPC supports 5 guaranteed and 4 excess priorities.
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Tricolor marking • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	17.2R1	17.2R1
Distributed Denial-of-Service (DDoS) Protection	15.1F4	15.1F5
DVMRP and GRE support—access side and server side	15.1F4	15.1F5
Dynamic Power Management	15.1F4	15.1F5
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	15.1F4	15.1F5
Flexible Queuing Mode	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
IEEE 802.1ag Ethernet OAM Continuity Check protocol	15.1F4	15.1F5
IEEE 802.1ag Ethernet OAM Linktrace protocol	15.1F4	15.1F5
IEEE 802.1ag Ethernet OAM Loopback protocol	15.1F4	15.1F5
IEEE 802.1ag maintenance association intermediate point (MIP) support, continuity check message (CCM), stacked VLAN tagging, trunk ports, support for VPLS/VPWS, VLAN circuit cross-connect (CCC) encapsulation and translational cross-connect (TCC) encapsulation	15.1F4	15.1F5
IEEE 802.1ag optional type, length, and value (TLVs) support *Port Status TLV and Interface Status TLV*	15.1F4	15.1F5
IEEE 802.3ah distributed periodic packet management (PPM) process , alarm indication signal (AIS), and remote defect indication (RDI)	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Firewall filters and policers: • Policer support for aggregated Ethernet • Aggregate firewall-based policer for all families of a logical interface • Intelligent hierarchical policers • Set forwarding class and loss priority for Routing Engine-generated packets by using a firewall • Physical interface policers, applying policers to the entire port • Lower policer limit from 32K to 8K • Egress .1p MF and BA classification for VPLS • Differentiated Services Code Point (DSCP) rewrite for IPv4 and IPv6	15.1F4 **NOTE**: Layer 2 overhead adjustment (packet length used for the policer included in the Layer 2 header) is not supported in 15.1F4.	15.1F5 **NOTE**: Layer 2 overhead adjustment (packet length used for the policer included in the Layer 2 header) is not supported in 15.1F5.
Flexible Ethernet encapsulation	15.1F4	15.1F5
Graceful Routing Engine Switchover (GRES)	15.1F4	15.1F5
IGMPv3 support with snooping disabled	15.1F4	15.1F5
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: • Group of virtual LANs (VLANs) level • VLAN level • Port level	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Inline flow monitoring	15.1F4	15.1F5
Intelligent Oversubscription on MIC and MPC Interfaces Overview	15.1F4	15.1F5
Integrated routing and bridging (IRB)	15.1F4	15.1F5
Unified *In-service software upgrade (Unified ISSU)*	17.4R1	17.4R1
Interoperability with MPCs	15.1F4	15.1F5
Interoperability with MS-DPCs	-	-
Interoperability with MX Series Flexible PIC Concentrators (MX-FPC)	-	-
IPv4	15.1F4	15.1F5
IPv4 multicast	15.1F4	15.1F5
IPv6	15.1F4	15.1F5
IPv6 MLD	15.1F4	15.1F5
IPv6 multicast	15.1F4	15.1F5
IPv6 Neighbor Discovery	15.1F4	15.1F5
IS-IS	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
ITU-T Y.1731 timestamping support on MX Series routers	15.1F4	15.1F5
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	15.1F4	15.1F5
Minimum LDP Configuration	15.1F4	15.1F5
Layer 2 VPN interfaces support VLAN ID list	15.1F4	15.1F5
Link aggregation (IEEE 802.3ad)	15.1F4	15.1F5
Link Aggregation Control Protocol (LACP)	15.1F4	15.1F5
Link Layer Discovery Protocol (LLDP)	15.1F4	15.1F5
Local loopback	15.1F4	15.1F5
MAC learning, policing, accounting, and filtering	15.1F4	15.1F5
Mobile IP	-	-
Multichassis link aggregation	15.1F4	15.1F5
Multiple Tag Protocol Identifiers (TPIDs)	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
MPLS: • Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN) • LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV) • RSVP graceful restart interoperability with Cisco using Nodal Hello • Failure action on BFD session down of RSVP LSPs • OSPF and IS-IS loop-free alternates (LFA) • 4/5 label MPLS operation • Virtual circuit connectivity verification (VCCV) BFD • Point to multipoint using the enhanced-ip command (support for NG-MVPN and P2MP load balancing over aggregated Ethernet) • MPLS-FRR bypass link protection • Load sharing across 64 ECMP next hops • MPLS-FRR VPLS instance prioritization • Five label stack on ingress	15.1F4	15.1F5
MPLS node protection, link protection, and statistics for static LSPs	15.1F4	15.1F5
mvrp	15.1F4	15.1F5
Multitopology routing	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Nonstop active routing (NSR)	15.1F4	15.1F5
OSPF	15.1F4	15.1F5
Packet mirroring	15.1F4	15.1F5
Precision Time Protocol (PTP) (IEEE 1588)	17.4R1	17.4R1
IEEE 802.1ah provider backbone bridging (PBB)	-	-
Push a tag on Ethernet VPLS and Ethernet CCC tag encapsulations	15.1F4	15.1F5
RSVP Overview	15.1F4	15.1F5
RIP	15.1F4	15.1F5
SNMP	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Spanning Tree Protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush (in VPLS multi-homing, flush all MACs when there is a change in the STP interface state due to root protect)	15.1F4	15.1F5
Subscriber management and services: • Enhanced subscriber management	16.1R4; 17.1R1	16.1R4; 17.1R1
Synchronous Ethernet	16.1R1	16.1R1
Two-Way Active Measurement Protocol (TWAMP)	16.1R4 **NOTE**: TWAMP is not supported on the MX2020 and MX2010 chassis.	16.1R4 **NOTE**: TWAMP is not supported on the MX2020 and MX2010 chassis.
Tunnel services • Clear DF-Bit (Don't Fragment Bit)	15.1F4	15.1F5
Unified in-service software upgrade (ISSU)	-	-

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Unnumbered Ethernet Interface	15.1F4	15.1F5
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	15.1F4	15.1F5
Virtual Chassis: MPLS IPv4 and IPv6, unicast, multicast forwarding, VPLS, NSR for Layer 3/MPLS services	17.3R1	17.3R1
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG	15.1F4	15.1F5
Virtual private network (VPN)	15.1F4	15.1F5
Virtual Router Redundancy Protocol (VRRP) for IPv4	15.1F4	15.1F5
VPLS packet flooding to the right set of interfaces across mesh groups	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
WAN-PHY mode	-	-
Flow Monitoring		
Inline IP Flow Information Export (IPFIX)	15.1F4	15.1F5
Active monitoring	15.1F4	15.1F5
Port mirroring family VPLS, bridge CCC encapsulation (VPWS)	15.1F4	15.1F5
Packet slice for port mirroring	15.1F4	15.1F5
Flow monitoring on MS-MPCs	17.3R1	17.3R1
Inline flow monitoring	15.1F4	15.1F5
Layer 2 Features		
Trunk ports	15.1F4	15.1F5
Layer 2 support for MX Series Virtual Chassis	17.3R1	17.3R1
Layer 2 and Layer 2.5, IRB and Spanning Tree Protocols (xSTP)	15.1F4	15.1F5
IEEE 802.1ad provider bridges	15.1F4	15.1F5
Layer 2 protocol tunneling (L2PT) support	15.1F4	15.1F5
Layer 2 Tunneling Protocol (L2TP)	15.1F4	15.1F5

Table 57: Protocols and Applications Supported by MPC7Es in the MX240, MX480, MX960, MX2010, and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC7E-MRATE	First Supported Junos OS Release for MPC7E-10G
Multichassis LAG—active/active and active/standby	15.1F4	15.1F5
Multichassis LAG—active/active with IGMP snooping	15.1F4	15.1F5
Link aggregation group (LAG)—VLAN-CCC encapsulation	15.1F4	15.1F5
IGMP snooping with bridging, IRB, and VPLS	15.1F4	15.1F5
MACSec		
GCM-AES-128 MACSec Encryption, 802.1AE-2006	-	16.1R1
GCM-AES-256 MACSec Encryption, 802.1AEbn-2011	-	16.2R1

Limitations

The following limitations apply to MPC7E-10G with LAG at 1Gbps speed:

- Unequal traffic load balancing when MPC7E-10G is used with MPC2E-NG/MPC3E-NG: Unbalanced load distribution when MPC2NG and MPC7 are used on the same LAG with a 1Gbps member link.
- No LAG support when MPC7E-10G and MPC2/MPC2E are used together: LAG between MPC7 and MPC2/MPC2E cannot be configured.

NOTE: For MPC7E-10G with LAG at 1Gbps, you must explicity enable auto-negotiation by configuring it. See https://www.juniper.net/documentation/us/en/software/junos/cli-reference/topics/ref/statement/auto-negotiation-edit-interfaces.html?doc-askai-citation.

RELATED DOCUMENTATION

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Protocols and Applications Supported by the MPC8E and MPC9E on the MX2010 and MX2020 Routers

Table 58 on page 582 lists the protocols and applications supported by MPC8E and MPC9E on the MX2010 and MX2020 routers.

An en dash indicates that the protocol or application is not supported.

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Access Node Control Protocol (ANCP)	-	-
Accepts traffic destined for generic routing encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Manual	15.1F5	15.1F5
Bidirectional Forwarding Detection protocol (BFD)	15.1F5	15.1F5
Border Gateway Protocol (BGP)	15.1F5	15.1F5
Bridge protocol data units (BPDUs)	15.1F5	15.1F5
BGP/*MPLS* virtual private networks (VPNs)	15.1F5	15.1F5

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Class of service (CoS): • Maintain CoS across internal tunnel interfaces • Packet rewrites • Behavior aggregate (BA) classification • BA classification based on 802.1p of payload for core-facing VPLS interfaces • BA DSCP classification of MPLS packets for L3VPN/VPLS LSI and MPLS interfaces • Rate-limit option for per-port queues • BA DSCP classification for VPLS/CCC family • Configurable .1p inheritance: push and swap from the hidden tag • Configurable shaping overhead for scheduling	15.1F5	15.1F5
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	15.1F5	15.1F5

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	15.1F5	15.1F5
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Tricolor marking • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	-	-
Physical Interface Damping Overview	16.1R1	16.1R1
Distributed Denial-of-Service (DDoS) Protection	15.1F5	15.1F5
DVMRP and GRE support—access side and server side	15.1F5	15.1F5

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Dynamic Power Management	15.1F5	15.1F5
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	15.1F5	15.1F5
Flexible Queuing Mode	15.1F5	15.1F5
IEEE 802.1ag Ethernet OAM Continuity Check protocol	15.1F5	15.1F5
IEEE 802.1ag Ethernet OAM Linktrace protocol	15.1F5	15.1F5
IEEE 802.1ag Ethernet OAM Loopback protocol	15.1F5	15.1F5
IEEE 802.1ag maintenance association intermediate point (MIP) support, continuity check message (CCM), stacked VLAN tagging, trunk ports, support for VPLS/VPWS, VLAN circuit cross-connect (CCC) encapsulation and translational cross-connect (TCC) encapsulation	15.1F5	15.1F5
IEEE 802.1ag optional type, length, and value (TLVs) support *Port Status TLV and Interface Status TLV*	15.1F5	15.1F5
IEEE 802.3ah distributed periodic packet management (PPM) process, alarm indication signal (AIS), and remote defect indication (RDI)	15.1F5	15.1F5

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Firewall filters and policers: • Policer support for aggregated Ethernet • Aggregate firewall-based policer for all families of a logical interface • Intelligent hierarchical policers • Set forwarding class and loss priority for Routing Engine-generated packets by using a firewall • Physical interface policers, applying policers to the entire port • Lower policer limit from 32,000 to 8000 • Egress .1p MF and BA classification for VPLS • Differentiated Services Code Point (DSCP) rewrite for IPv4 and IPv6	15.1F5	15.1F5
Flexible Ethernet encapsulation	15.1F5	15.1F5
Graceful Routing Engine Switchover (GRES)	15.1F5	15.1F5
IGMPv3 support with snooping disabled	15.1F5	15.1F5
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: • Set of Interfaces • VLAN level • Port level	15.1F5	15.1F5
Inline flow monitoring	15.1F5	15.1F5

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Intelligent Oversubscription	15.1F5	15.1F5
Integrated routing and bridging (IRB)	15.1F5	15.1F5
Unified *In-service software upgrade (Unified ISSU)*	17.4R1	17.4R1
Interoperability with existing MPCs	15.1F5	15.1F5
IPv4	15.1F5	15.1F5
IPv4 multicast	15.1F5	15.1F5
IPv6	15.1F5	15.1F5
IPv6 MLD	15.1F5	15.1F5
IPv6 multicast	15.1F5	15.1F5
IPv6 Neighbor Discovery	15.1F5	15.1F5
IS-IS	15.1F5	15.1F5
ITU-T Y.1731 timestamping support on MX Series routers	15.1F5	15.1F5

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Flow monitoring and services: • Active monitoring (cflowed version 9 templates) • Port mirroring family VPLS, bridge CCC encapsulation (VPWS) • Packet slice for port mirroring • Flow monitoring on MS-DPCs • Inline flow monitoring on MPC8E and MPC9E	**Release** • 15.1F5 • 15.1F5 • 15.1F5 • - • 15.1F5	**Release** • 15.1F5 • 15.1F5 • 15.1F5 • - • 15.1F5
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	15.1F5	15.1F5
Minimum LDP Configuration	15.1F5	15.1F5
Layer 2 features: • Trunk ports • Layer 2 support for MX Series Virtual Chassis • Layer 2 and Layer 2.5, IRB and spanning tree protocols (xSTP) • IEEE 802.1ad provider bridges • Layer 2 protocol tunneling (L2PT) support • Layer 2 Tunneling Protocol (L2TP) • Multichassis LAG—active/active and active/standby • Multichassis LAG—active/active with IGMP snooping • IGMP snooping with bridging, IRB, and VPLS	Release • 15.1F5 • 17.3R1 • 15.1F5 • 15.1F5 • 15.1F5 • 15.1F5 • 15.1F5 • 15.1F5 • 15.1F5	Release • 15.1F5 • 17.3R1 • 15.1F5 • 15.1F5 • 15.1F5 • 15.1F5 • 15.1F5 • 15.1F5 • 15.1F5

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Layer 2 VPN interfaces support VLAN ID list	15.1F5	15.1F5
Link aggregation (IEEE 802.3ad)	15.1F5	15.1F5
Link Aggregation Control Protocol (LACP)	15.1F5	15.1F5
Link Layer Discovery Protocol (LLDP)	15.1F5	15.1F5
Local loopback	15.1F5	15.1F5
MAC learning, policing, accounting, and filtering	15.1F5	15.1F5
Mobile IP	-	-
Multichassis Link Aggregation	15.1F5	15.1F5
Multiple Tag Protocol Identifiers (TPIDs)	15.1F5	15.1F5

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
MPLS: • Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN) • LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV) • RSVP graceful restart interoperability with Cisco using Nodal Hello • Failure action on BFD session down of RSVP LSPs • OSPF and IS-IS loop-free alternates (LFA) • 4/5 label MPLS operation • Virtual circuit connectivity verification (VCCV) BFD • MPLS-FRR bypass link protection • Load sharing across 64 ECMP next hops • MPLS-FRR VPLS instance prioritization • Five label stack on ingress	15.1F5	15.1F5
MPLS node protection, link protection, and statistics for static LSPs	15.1F5	15.1F5
mvrp	-	-
Multitopology routing	15.1F5	15.1F5
Nonstop active routing (NSR)	15.1F5	15.1F5
OSPF	15.1F5	15.1F5

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Packet mirroring	15.1F5	15.1F5
Precision Time Protocol (PTP) (IEEE 1588)	17.4R1	17.4R1
IEEE 802.1ah provider backbone bridging (PBB)	-	-
RSVP Overview	15.1F5	15.1F5
RIP	15.1F5	15.1F5
SNMP	15.1F5	15.1F5
Spanning tree protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush (in VPLS multi-homing, flush all MACs when there is a change in the STP interface state due to root protect)	15.1F5	15.1F5
Subscriber management and services: • Enhanced subscriber management	16.1R4; 17.1R1	16.1R4; 17.1R1

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Synchronous Ethernet	16.1R1	16.1R1
Two-Way Active Measurement Protocol (TWAMP) Real-time Performance Monitoring (RPM)/TWAMP hardware timestamping	17.3R1	17.3R1
Tunnel services • Clear DF-Bit (Don't Fragment Bit)	15.1F5	15.1F5
Unnumbered Ethernet Interface	15.1F5	15.1F5
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	15.1F5	15.1F5
Virtual Chassis: MPLS IPv4 and IPv6, unicast, multicast forwarding, VPLS, NSR for Layer 3/MPLS services	17.3R1	17.3R1

Table 58: Protocols and Applications Supported by MPC8E and MPC9E on the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release	
	MPC8E	MPC9E
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG	15.1F5	15.1F5
Virtual private network (VPN)	15.1F5	15.1F5
Virtual Router Redundancy Protocol (VRRP) for IPv4	15.1F5	15.1F5
VPLS packet flooding to the right set of interfaces across mesh groups	15.1F5	-
MACSec Capabilities: Starting in Junos OS Release 17.4R1, the JNP-MIC-100G MIC extends Media Access Control Security (MACsec) capabilities on MPC8E and MPC9E MPCs installed in MX2010, MX2020, and MX2008 routers. Only MPC8E/9E with JNP-MIC-100G MIC supports MACsec feature. • GCM-AES-128 MACSec Encryption, 802.1AE-2006 • GCM-AES-256 MACSec Encryption, 802.1AEbn-2011 • GCM-AES-XPN-128 Cipher Suite, 802.1AEbw-2013 • GCM-AES-XPN-256 Cipher Suite, 802.1AEbw-2013	17.4R1	17.4R1

Change History Table

Feature support is determined by the platform and release you are using. Use Feature Explorer to determine if a feature is supported on your platform.

Release	Description
17.4R1	Starting in Junos OS Release 17.4R1, the JNP-MIC-100G MIC extends Media Access Control Security (MACsec) capabilities on MPC8E and MPC9E MPCs installed in MX2010, MX2020, and MX2008 routers.

RELATED DOCUMENTATION

Upgrading MPC8E to Provide Increased Bandwidth

MPC8E | **206**

MPC9E | **208**

Protocols and Applications Supported by the MS-MIC and MS-MPC

Table 59 on page 594 contains the first Junos OS Release support for protocols and applications on the MX104, MX240, MX480, MX960, MX2010, and MX2020 Multiservices MIC (MS-MIC) and Multiservices MPC (MS-MPC). A dash indicates that the protocol or application is not supported.

Table 59: Protocols and Applications Supported by the MS-MIC and MS-MPC

Software Feature	First Supported Junos OS Release
GRE Key	–
GRE dont-fragment	–
HTTP redirect services	15.1R4
Stateful firewall	13.2R4
Network Address Translation (NAT) for IP addresses	13.2R4

Table 59: Protocols and Applications Supported by the MS-MIC and MS-MPC *(Continued)*

Software Feature	First Supported Junos OS Release
Port Address Translation (PAT) for port numbers	13.2R4
IP Security (IPSec) encryption	13.2R4
Flow aggregation	–
Active flow monitoring exports cflowd version 5 and version 8 records	–
Active flow monitoring exports flow monitoring version 9 records, based on RFC 3954	13.2R4
Graceful Routing Engine Switchover (GRES)	13.3 **NOTE**: GRES is not supported for MS-MIC on MX104 router.
Passive flow monitoring	–
Passive flow collection	–
Flow-tap	–
Dynamic flow capture	–
Real-time performance monitoring	13.3
Link Services	–
MX Series Virtual Chassis with stateful firewall	14.2

Table 59: Protocols and Applications Supported by the MS-MIC and MS-MPC *(Continued)*

Software Feature	First Supported Junos OS Release
MX Series Virtual Chassis with IPv4-to-IPv4 basic NAT, dynamic NAT, static destination NAT, dynamic NAT with port mapping, and stateful NAT64	16.1R4 and 18.3R1. Starting in Junos OS Release 18.4R1, these features are supported on the MX Series Virtual Chassis for the Juniper broadband network gateway (BNG).
MX Series Virtual Chassis with DS-Lite	18.4R1
Traffic sampling	13.2R4
Tunnel services: • IP-IP unicast tunneling • GRE unicast tunneling—Supports GRE fragmentation • Protocol Independent Multicast (PIM) sparse mode unicast tunneling	–
Virtual tunnel interface for Layer 3 VPNs	–
Layer 2 Tunneling Protocol (L2TP)	–
Voice services: • Compressed Real-Time Transport Protocol (CRTP)	–
Encapsulations: • Multilink Frame Relay (MLFR) • Multilink Point-to-Point Protocol (MLPP)	–

RELATED DOCUMENTATION

MX Series MPC Overview | 15

MPCs Supported by MX Series Routers | 16

Multiservices MIC | 361

Multiservices MPC | 139

Protocols and Applications Supported by the MX10003 MPC (Multi-Rate) on the MX10003 Router

Table 60 on page 597 lists the protocols and applications supported by MX10003 MPC (Multi-Rate) on the MX10003 router.

An en dash indicates that the protocol or application is not supported.

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router

Protocol or Application	First Supported Junos OS Release
Access Node Control Protocol (ANCP)	-
Accepts traffic destined for generic routing encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Manual	17.3R1
Bidirectional Forwarding Detection protocol (BFD)	17.3R1
Border Gateway Protocol (BGP)	17.3R1
Bridge protocol data units (BPDUs)	17.3R1
BGP/*MPLS* virtual private networks (VPNs)	17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
Class of service (CoS): • Maintain CoS across internal tunnel interfaces • Packet rewrites • Behavior aggregate (BA) classification • BA classification based on 802.1p of payload for core-facing VPLS interfaces • BA DSCP classification of MPLS packets for L3VPN/VPLS LSI and MPLS interfaces • Rate-limit option for per-port queues • BA DSCP classification for VPLS/CCC family • Configurable .1p inheritance: push and swap from the hidden tag • Configurable shaping overhead for scheduling	17.3R1
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	17.3R1
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Tricolor marking • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	17.3R1
Physical Interface Damping Overview	17.3R1
Distributed Denial-of-Service (DDoS) Protection	17.3R1
DVMRP and GRE support—access side and server side	17.3R1
Dynamic Power Management	17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	17.3R1
Flexible Queuing Mode	17.3R1
IEEE 802.1ag Ethernet OAM Continuity Check protocol	17.3R1
IEEE 802.1ag Ethernet OAM Linktrace protocol	17.3R1
IEEE 802.1ag Ethernet OAM Loopback protocol	17.3R1
IEEE 802.1ag maintenance association intermediate point (MIP) support, continuity check message (CCM), stacked VLAN tagging, trunk ports, support for VPLS/VPWS, VLAN circuit cross-connect (CCC) encapsulation and translational cross-connect (TCC) encapsulation	17.3R1
IEEE 802.1ag optional type, length, and value (TLVs) support *Port Status TLV and Interface Status TLV*	17.3R1
IEEE 802.3ah distributed periodic packet management (PPM) process, alarm indication signal (AIS), and remote defect indication (RDI)	17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
Firewall filters and policers: • Policer support for aggregated Ethernet • Aggregate firewall-based policer for all families of a logical interface • Intelligent hierarchical policers • Set forwarding class and loss priority for Routing Engine-generated packets by using a firewall • Physical interface policers, applying policers to the entire port • Lower policer limit from 32,000 to 8000 • Egress .1p MF and BA classification for VPLS • Differentiated Services Code Point (DSCP) rewrite for IPv4 and IPv6	17.3R1
Flexible Ethernet encapsulation	17.3R1
Graceful Routing Engine Switchover (GRES)	17.3R1
IGMPv3 support with snooping disabled	17.3R1
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: • Set of Interfaces • VLAN level • Port level	17.3R1
Inline flow monitoring	17.3R1
Intelligent Oversubscription	17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
Integrated routing and bridging (IRB)	17.3R1
Interoperability with existing MPCs	17.3R1
IPv4	17.3R1
IPv4 multicast	17.3R1
IPv6	17.3R1
IPv6 MLD	17.3R1
IPv6 multicast	17.3R1
IPv6 Neighbor Discovery	17.3R1
IS-IS	17.3R1
ITU-T Y.1731 timestamping support on MX Series routers	-
Flow monitoring and services: • Active monitoring (cflowed version 9 templates) • Port mirroring family VPLS, bridge CCC encapsulation (VPWS) • Packet slice for port mirroring • Flow monitoring on MS-DPCs • Inline flow monitoring	Release • 17.3R1 • 17.3R1 • 17.3R1 • - • 17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	17.3R1
Minimum LDP Configuration	17.3R1
Layer 2 features: • Trunk ports • Layer 2 support for MX Series Virtual Chassis • Layer 2 and Layer 2.5, IRB and spanning tree protocols (xSTP) • IEEE 802.1ad provider bridges • Layer 2 protocol tunneling (L2PT) support • Layer 2 Tunneling Protocol (L2TP) • Multichassis LAG—active/active and active/standby • Multichassis LAG—active/active with IGMP snooping • IGMP snooping with bridging, IRB, and VPLS	Release • 17.3R1 • - • 17.3R1 • 17.3R1 • 17.3R1 • 17.3R1 • 17.3R1 • 17.3R1 • 17.3R1
Layer 2 VPN interfaces support VLAN ID list	17.3R1
Link aggregation (IEEE 802.3ad)	17.3R1
Link Aggregation Control Protocol (LACP)	17.3R1
Link Layer Discovery Protocol (LLDP)	17.3R1
Local loopback	17.3R1
MAC learning, policing, accounting, and filtering	17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
MACSec with GCM-AES-256 Encryption and GCM-AES-XPN-256 Encryption **NOTE**: MACSec is supported on JNP-MIC1-MACSEC only.	17.3R2
Mobile IP	-
Multichassis Link Aggregation	17.3R1
Multiple Tag Protocol Identifiers (TPIDs)	17.3R1
MPLS: • Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN) • LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV) • RSVP graceful restart interoperability with Cisco using Nodal Hello • Failure action on BFD session down of RSVP LSPs • OSPF and IS-IS loop-free alternates (LFA) • 4/5 label MPLS operation • Virtual circuit connectivity verification (VCCV) BFD • MPLS-FRR bypass link protection • Load sharing across 64 ECMP next hops • MPLS-FRR VPLS instance prioritization • Five label stack on ingress	17.3R1
MPLS node protection, link protection, and statistics for static LSPs	17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
mvrp	-
Multitopology routing	17.3R1
Nonstop active routing (NSR)	17.3R1
OSPF	17.3R1
Packet mirroring	17.3R1
Precision Time Protocol (PTP) (IEEE 1588)	17.3R1
IEEE 802.1ah provider backbone bridging (PBB)	-
RSVP Overview	17.3R1
RIP	17.3R1
SNMP	17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
Spanning tree protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush (in VPLS multi-homing, flush all MACs when there is a change in the STP interface state due to root protect)	17.3R1
Subscriber management and services: • Enhanced subscriber management	17.3R1
Synchronous Ethernet	17.3R1
Two-Way Active Measurement Protocol (TWAMP)	-
Tunnel services • Clear DF-Bit (Don't Fragment Bit)	17.3R1
Unnumbered Ethernet Interface	17.3R1

Table 60: Protocols and Applications Supported by MX10003MPC on the MX10003 Router *(Continued)*

Protocol or Application	First Supported Junos OS Release
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	17.3R1
Virtual Chassis: MPLS IPv4 and IPv6, unicast, multicast forwarding, VPLS, NSR for Layer 3/MPLS services	--
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG	17.3R1
Virtual private network (VPN)	17.3R1
Virtual Router Redundancy Protocol (VRRP) for IPv4	17.3R1
VPLS packet flooding to the right set of interfaces across mesh groups	-

Protocols and Applications Supported by the JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers

Table 61 on page 608 lists the protocols and applications supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 routers.

An en dash indicates that the protocol or application is not supported.

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers

Protocol or Application	JNP10K-LC2101
Access Node Control Protocol (ANCP)	-
Accepts traffic destined for generic routing encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Manual	18.2R1
Bidirectional Forwarding Detection protocol (BFD)	18.2R1
Border Gateway Protocol (BGP)	18.2R1
Bridge protocol data units (BPDUs)	18.2R1
BGP/*MPLS* virtual private networks (VPNs)	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Chassis: • Fabric Management • Redundancy Mode • Fabric Grant Bypass Mode • Hypermode • License Mode (IR, R, Base) • Port Identification • Rate Selectability • Lane LED • Smooth Upgrade	**Release** • 18.2R1 • 18.2R1 • - • 18.2R1 • - • 18.2R1 • 18.2R1 • 18.2R1 • NA

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Class of service (CoS): • Maintain CoS across internal tunnel interfaces • Packet rewrites • Behavior aggregate (BA) classification • BA classification based on 802.1p of payload for core-facing VPLS interfaces • BA DSCP classification of MPLS packets for L3VPN/VPLS LSI and MPLS interfaces • Rate-limit option for per-port queues • BA DSCP classification for VPLS/CCC family • Configurable .1p inheritance: push and swap from the hidden tag • Configurable shaping overhead for scheduling • Dedicated CoS Queues • Per Unit Queuing • Hierarchical Queuing • Per Priority Shaping and support for `enhanced-priority-mode` • Logical Interface Scheduling (DLCIs and VLANs)	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	18.2R1
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking • Cos Scaling on Non Queuing MPCs (per VLAN queuing)	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Tricolor marking • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	-
Physical Interface Damping Overview	18.2R1
Distributed Denial-of-Service (DDoS) Protection	18.2R1
DVMRP and GRE support—access side and server side	18.2R1
Dynamic Power Management	18.2R1
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Flexible Queuing Mode	18.2R1
IEEE 802.1ag Ethernet OAM Continuity Check protocol	18.2R1
IEEE 802.1ag Ethernet OAM Linktrace protocol	18.2R1
IEEE 802.1ag Ethernet OAM Loopback protocol	18.2R1
IEEE 802.1ag maintenance association intermediate point (MIP) support, continuity check message (CCM), stacked VLAN tagging, trunk ports, support for VPLS/VPWS, VLAN circuit cross-connect (CCC) encapsulation and translational cross-connect (TCC) encapsulation	18.2R1
IEEE 802.1ag optional type, length, and value (TLVs) support *Port Status TLV and Interface Status TLV*	18.2R1
IEEE 802.3ah distributed periodic packet management (PPM) process, alarm indication signal (AIS), and remote defect indication (RDI)	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Firewall filters and policers: • Policer support for aggregated Ethernet • Aggregate firewall-based policer for all families of a logical interface • Intelligent hierarchical policers • Set forwarding class and loss priority for Routing Engine-generated packets by using a firewall • Physical interface policers, applying policers to the entire port • Lower policer limit from 32,000 to 8000 • Egress .1p MF and BA classification for VPLS • Differentiated Services Code Point (DSCP) rewrite for IPv4 and IPv6 • Filter-based GRE Tunneling across IPv4 Networks • Filter-based L2TP Tunneling across IPv4 Networks	18.2R1
Flexible Ethernet encapsulation	18.2R1
Graceful Routing Engine Switchover (GRES)	18.2R1
IGMPv3 support with snooping disabled	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: • Set of Interfaces • VLAN level • Port level	18.2R1
Inline flow monitoring • 256K Flow entries for VPLS (IPv4 and IPv6) • 256K Flow entries for MPLS (IPv4 and IPv6)	18.2R1
Inline Video Monitoring	-
Inline 6rd and 6to4 Configuration Guidelines	-
Intelligent Oversubscription	18.2R1
Integrated routing and bridging (IRB)	18.2R1
Unified *In-service software upgrade (Unified ISSU)*	-
Interoperability • Interoperability with existing MPCs • Interoperability with 100-Gigabit Ethernet Interfaces	-
IPv4	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
IPv4 multicast	18.2R1
IPv6	18.2R1
IPv6 MLD	18.2R1
IPv6 multicast	18.2R1
IPv6 Neighbor Discovery	18.2R1
IS-IS	18.2R1
ITU-T Y.1731 timestamping support on MX Series routers	18.2R1
Flow monitoring and services: • Active monitoring (cflowed version 9 templates) • Port mirroring family VPLS, bridge CCC encapsulation (VPWS) • Packet slice for port mirroring	**Release** • 18.2R1 • 18.2R1 • 18.2R1
Junos Continuity Supported HW	NA
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	18.2R1
Minimum LDP Configuration	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Layer 2 features: • Trunk ports • Layer 2 support for MX Series Virtual Chassis • Layer 2 and Layer 2.5, IRB and spanning tree protocols (xSTP) • IEEE 802.1ad provider bridges • Layer 2 protocol tunneling (L2PT) support • Layer 2 Tunneling Protocol (L2TP) • Multichassis LAG—active/active and active/standby • Multichassis LAG—active/active with IGMP snooping • IGMP snooping with bridging, IRB, and VPLS	Release • 18.2R1 • - • 18.2R1 • 18.2R1 • 18.2R1 • 18.2R1 • 18.2R1 • 18.2R1 • 18.2R1
Layer 2 VPN interfaces support VLAN ID list	18.2R1
Link aggregation (IEEE 802.3ad)	18.2R1
Link Aggregation Control Protocol (LACP)	18.2R1
Link Layer Discovery Protocol (LLDP)	18.2R1
Local loopback	18.2R1
MAC learning, policing, accounting, and filtering	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Mobile IP	-
Multichassis Link Aggregation	18.2R1
Multiple Tag Protocol Identifiers (TPIDs)	18.2R1
MPLS: • Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN) • LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV) • RSVP graceful restart interoperability with Cisco using Nodal Hello • Failure action on BFD session down of RSVP LSPs • OSPF and IS-IS loop-free alternates (LFA) • 4/5 label MPLS operation • Virtual circuit connectivity verification (VCCV) BFD • MPLS-FRR bypass link protection • Load sharing across 64 ECMP next hops • MPLS-FRR VPLS instance prioritization • Five label stack on ingress	18.2R1
MPLS node protection, link protection, and statistics for static LSPs	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
mvrp	-
Multitopology routing	18.2R1
Nonstop active routing (NSR)	18.2R1
Network Edge Security (802.1x)	-
OSPF	18.2R1
Optical Transport Network • Link Degrade Monitoring • FEC Modes • Bit Error Rate (BER)	-
Packet mirroring	18.2R1
Precision Time Protocol (PTP) (IEEE 1588)	-
IEEE 802.1ah provider backbone bridging (PBB)	-
RSVP Overview	18.2R1
RIP	18.2R1
RFC2544 Benchmarking Tests	-
SNMP	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Spanning tree protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush (in VPLS multi-homing, flush all MACs when there is a change in the STP interface state due to root protect)	18.2R1
Stateful Load Balancing for Aggregated Ethernet Interfaces	-

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
Subscriber management and services: • Enhanced subscriber management • Aggregated Ethernet over static VLANs • Aggregated Ethernet over dynamic VLANs • DHCP access model • Dynamic adjustment of shapers • Dynamic PPPoE subscriber interface creation based on PPPoE service name table configuration • Dynamic profiles • Dynamic shaping, scheduling, and queuing • Dynamic VLANs • Static and dynamic PPPoE subscriber interfaces	21.2R1
Synchronous Ethernet • Hybrid Mode • Line Card Redundancy	-
Two-Way Active Measurement Protocol (TWAMP)	-
Tunnel services • Clear DF-Bit (Don't Fragment Bit)	18.2R1
Unnumbered Ethernet Interface	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	18.2R1
Virtual Chassis: MPLS IPv4 and IPv6, unicast, multicast forwarding, VPLS, NSR for Layer 3/MPLS services	-
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG	18.2R1
Virtual private network (VPN)	18.2R1
Virtual Router Redundancy Protocol (VRRP) for IPv4	18.2R1

Table 61: Protocols and Applications Supported by JNP10K-LC2101 on the MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	JNP10K-LC2101
VPLS packet flooding to the right set of interfaces across mesh groups	-

RELATED DOCUMENTATION

Downgrading JNP10K-LC2101 to Provide Decreased Bandwidth

Line card (MX10K-LC2101)

Protocols and Applications Supported by the MPC10E

Table 62 on page 623 contains protocols and applications supported by the MPC10E line cards (MPC10E-15C-MRATE and MPC10E-10C-MRATE) on the MX240, MX480, and MX960 routers.

A dash indicates that the protocol or application is not supported.

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers

Protocol or Application	First Supported Junos OS Release for MPC10E-15C-MRATE	First Supported Junos OS Release for MPC10E-10C-MRATE
Access Node Control Protocol (ANCP)	-	-
Accepts traffic destined for generic routing encapsulation (GRE) tunnels • *Dynamic* • Standard	Release • 19.3R1 • 19.1R1	Release • - • 19.2R1

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC10E-15C-MRATE	First Supported Junos OS Release for MPC10E-10C-MRATE
Accepts traffic destined for Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Standard	-	-
Bidirectional Forwarding Detection protocol (BFD) • Centralized BFD • Distributed BFD • Inline BFD (single-hop only) • Single-hop BFD • Multihop BFD • Micro BFD • BFD over Integrated routing and bridging (IRB) interfaces • BFD over Pseudowire over LT and RLT interfaces • Virtual circuit connectivity verification (VCCV) BFD for Layer2 VPNs and Layer2 circuits • VCCV BFD for VPLS • BFD authentication • Seamless BFD	Release • 19.1R1 • 19.1R1S1 • 19.1R1S1 • 19.1R1S1 • 19.1R1S1 • 19.3R1 • 19.3R1 • 19.3R1 • 19.3R1 • - • - • -	Release • 19.2R1 • 19.2R1 • 19.2R1 • 19.2R1 • 19.2R1 • 19.3R1 • 19.3R1 • 19.3R1 • 19.3R1 • - • - • -
Internet Control Message Protocol (ICMP) and ICMPv6	19.1R1	19.2R1

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MPC10E-15C-MRATE	First Supported Junos OS Release for MPC10E-10C-MRATE
Border Gateway Protocol (BGP)	19.1R1	19.2R1
Bridge protocol data units (BPDUs)	-	-
BGP/*MPLS* virtual private networks (VPNs)	19.1R1	19.2R1
Routing Instance: • Logical system • Virtual routing and forwarding (VRF)	19.1R1	19.2R1
Load Balancing	19.1R1	19.2R1
Dynamic Host Configuration Protocol (DHCP)	-	-

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

Maintain CoS across internal tunnel interfaces	19.1R1	19.2R1
Packet Rewrites on DSCP, Inet Precedence (both Ipv4 and IPv6) and EXP bits	19.1R1	19.2R1
Behavior aggregate (BA) classification (except IEEE classifiers)	19.1R1	19.2R1
BA classification based on 802.1p of payload for core-facing VPLS interfaces	19.4R1	19.4R1
BA DSCP classification of MPLS packets for L3VPN and MPLS interfaces	19.1R1	19.2R1

BA DSCP classification of MPLS packets for VPLS LSI interfaces	-	-
BA DSCP classification for VPLS/CCC family	19.4R1	19.4R1
Rate limit option for per-port queues	19.1R1	19.2R1
Queue depth monitoring	19.3R1	19.3R1
Configurable .1p inheritance: push and swap from the hidden tag	20.4R1	20.4R1
Configurable shaping overhead for scheduling	19.1R1	19.2R1
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	19.1R1	19.2R1

Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • IEEE 802.1p classification	Release • 19.1R1 • 19.4R1 (except for circuit cross connect or CCC) • 19.4R1 (except for circuit cross connect or CCC)	Release • 19.2R1 • 19.4R1 (except for circuit cross connect or CCC) • 19.4R1 (except for circuit cross connect or CCC)
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	Release • - • - • - • - • - • - • -	Release • - • - • - • - • - • - • -
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: **NOTE**: Only egress is supported. • Group of virtual LANs (VLANs) level • VLAN level • Port level	-	-
Distributed Denial-of-Service (DDoS) Protection	19.1R1	19.2R1

DVMRP and GRE support—access side and server side	-	-
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	-	-
Flexible Queuing Mode	-	-
IEEE 802.1ag Ethernet OAM Continuity Check protocol	-	-
IEEE 802.1ag Ethernet OAM Linktrace protocol	-	-
IEEE 802.1ag Ethernet OAM Loopback protocol	-	-
IEEE 802.1ag: • Maintenance association intermediate point (MIP) • Continuity check message (CCM) • Stacked VLAN tagging • Trunk ports • VPLS • VPWS • VLAN circuit cross-connect (CCC) encapsulation and • Translational cross-connect (TCC) encapsulation	Release • - • - • 19.1R1 • - • - • 19.1R1 • 19.1R1 • -	Release • - • - • 19.2R1 • - • - • 19.2R1 • 19.2R1 • -
IEEE 802.1ag optional type, length, and value (TLVs) support *Configuring Port Status TLV and Interface Status TLV*	19.1R1	19.2R1
IEEE 802.3ah distributed periodic packet management (PPM) process, alarm indication signal (AIS), and remote defect indication (RDI)	19.1R1	19.2R1

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

Family Inet/Inet6/MPLS	19.1R1	19.2R1
All the static match conditions/actions	19.1R1	19.2R1
Dynamic actions (port-mirroring, next hop, routing instance)	19.1R1	19.2R1
Interface-specific filters	19.1R1	19.2R1
BGP Flow specification	19.1R1	19.2R1
Two color and three color policers (SRTCM and TRTCM)	19.1R1	19.2R1
FTF (filter attachment on routing table)	19.1R1	19.2R1
Firewall attachment on Aggregated Ethernet Interfaces (AE)	19.1R1	19.2R1
Hierarchical Policers	19.4R1	19.4R1
Family Any/CCC (for firewall)	19.2R1	19.2R1
Percentage Bandwidth policers, Shared Bandwidth policers, Logical Interface policers	19.4R1	19.4R1
Physical interface policers	19.4R1	19.4R1
Firewall Based GRE ENCAP/DECAP	19.2R1	19.2R1
Fast lookup filter	19.2R1	19.2R1
Jvision (firewall filter counters only)	19.2R1	19.2R1

Filter-based tunneling: • GRE-in-UDP encapsulation and decapsulation • MPLS-over-UDP decapsulation	19.3R1	19.3R1
Filter-based forwarding: • Next-IP • Next-interface	19.3R1	19.3R1
Interface-group	19.3R1	19.3R1
Family bridge filter	19.3R1	19.3R1
VPLS family filter	19.3R1	19.3R1
Filter attachment on IRB, Pseudowire over LT and RLT interfaces, and bridge-domain	19.3R1	19.3R1
Flexible Ethernet encapsulation	19.1R1	19.2R1
Graceful Routing Engine Switchover (GRES)	19.1R1	19.2R1
IGMPv3 support with snooping disabled	19.1R1	19.2R1
Intelligent Oversubscription on MIC and MPC Interfaces Overview	19.1R1	19.2R1
Integrated routing and bridging (IRB)	19.4R1	19.4R1
Unified *In-service software upgrade (Unified ISSU)*	23.1R1	23.1R1
Interoperability with MPCs	19.1R1	19.2R1
Interoperability with MS-MPC/MS-MICs	20.2R1	20.2R1

Interoperability with MX Series Flexible PIC Concentrators (MX-FPC)	-	-
IPv4	19.1R1	19.2R1
IPv4 multicast • PIM sparse mode (PIM-SM) • PIM source-specific multicast (PIM-SSM) • Point to multipoint (P2MP) • Multicast-only fast reroute (MoFRR) • Draft-rosen MVPN	Release • 19.1R1 • 19.1R1 • 19.3R1 • 19.3R1 • 19.3R1	Release • 19.2R1 • 19.2R1 • 19.3R1 • 19.3R1 • 19.3R1
IPv6	19.1R1	19.2R1
IPv6 MLD	19.1R1	19.2R1
IPv6 multicast • PIM sparse mode (PIM-SM) • PIM source-specific multicast (PIM-SSM) • Point to multipoint (P2MP) • Multicast-only fast reroute (MoFRR) • Draft-rosen MVPN	Release • 19.1R1 • 19.1R1 • 19.3R1 • 19.3R1 • 19.3R1	Release • 19.2R1 • 19.2R1 • 19.3R1 • 19.3R1 • 19.3R1
IPv6 Neighbor Discovery	19.1R1	19.2R1
IS-IS	19.1R1	19.2R1
ITU-T Y.1731 timestamping support on MX Series routers	-	-

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN)	19.1R1	19.2R1
LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV)	19.4R1	19.4R1
RSVP graceful restart interoperability with Cisco using Nodal Hello	-	-
Failure action on BFD session down of RSVP LSPs	19.3R1	19.3R1
OSPF loop-free alternates (LFA)	20.2R1	20.2R1
4/5 label MPLS operation	19.1R1	19.2R1
Virtual circuit connectivity verification (VCCV) BFD	19.3R1	19.3R1
Point to multipoint using the enhanced-ip command (support for NG-MVPN and P2MP load balancing over aggregated Ethernet)	19.4R1	-
MPLS-FRR bypass link protection	19.1R1	19.2R1
Load sharing across 64 ECMP next hops	19.1R1	19.2R1
MPLS-FRR VPLS instance prioritization	-	-
Five label stack on ingress	19.1R1	19.2R1
MPLS node protection, link protection, and statistics for static LSPs	19.1R1	19.2R1
mvrp	-	-
Multitopology routing	-	-
Nonstop active routing (NSR)	19.1R1	19.2R1

OSPF	19.1R1	19.2R1
Packet mirroring	19.1R1	19.2R1
Precision Time Protocol (PTP) (IEEE 1588)	19.1R1	19.2R1
IEEE 802.1ah provider backbone bridging (PBB)	-	-
Push a tag on Ethernet VPLS and Ethernet CCC tag encapsulations	-	-
RSVP Overview	19.1R1	19.2R1
RIP	19.1R1	19.2R1
SNMP	19.1R1	19.2R1
Spanning Tree Protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush (in VPLS multi-homing, flush all MACs when there is a change in the STP interface state due to root protect)	-	-

Subscriber Management and Services

Subscriber Management and Services: Enhanced subscriber management—Uplink communications to the core network only	19.3R1	19.3R1

Subscriber Management and Services: Enhanced subscriber management—
• Basic and advanced class of service (CoS) and filters (IPv4 or dual stack) support for:
  • DVLAN with DHCP subscribers
  • DVLAN with Point-to-Point Protocol (PPP) subscribers
  • DVLAN and agent circuit identifier (ACI) with DHCP subscribers
  • DVLAN and ACI with PPP subscribers
  • Stacked DVLAN with DHCP subscribers
  • Stacked DVLAN with PPP subscribers
  • Pseudowire DVLAN with DHCP subscribers
  • Pseudowire DVLAN with PPP subscribers
• DVLAN with LAC (IPv4) basic and advanced CoS and filters
• DVLAN with LAC (IPv4) basic and advanced CoS and filters
• DVLAN with LNS (IPv4 and dual stack) basic CoS and filters
• Advanced CoS and filters (IPv4 or dual stack) support for:
  • IFLSET with DHCP subscribers
  • IFLSET with PPP subscribers
• L2TP tunnels (configured for each line card and each chassis)
• Subscriber services (customer solutions test scripts) processing
• Scaling and performance for the following features:
  • DHCP subscribers with authenticated dynamic VLAN
  • DHCP subscribers with authenticated dynamic S-VLAN
  • LNS subscribers
	22.4R1	22.4R1

• LAC subscribers • CoS service • Firewall service		
Synchronous Ethernet	19.2R1	19.2R1
Two-Way Active Measurement Protocol (TWAMP)	19.2R1	19.2R1
Tunnel services • Clear DF-Bit (Don't Fragment Bit)	19.3R1	19.3R1
Unified in-service software upgrade (ISSU)	-	-
Unnumbered Ethernet Interface	19.3R1	19.3R1
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Flexible VLAN tagging • Single VLAN tags • Dual VLAN tags • IP service for nonstandard TPID and stacked VLAN tags	19.1R1	19.2R1
Virtual Chassis: MPLS IPv4 and IPv6, unicast, multicast forwarding, VPLS, NSR for Layer 3/MPLS services	-	-

Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG	20.1R1 (Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG)	20.1R1 (Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG)
Virtual private network (VPN)	19.1R1	19.2R1
Support for the following features in hyper-mode: • Configuring ICMP redirects and generating ICMP redirect messages. • Padding VLAN packets to a minimum frame size of 68 bytes, by using the existing command set interfaces interface-name gigether-options pad-to-minimum-frame-size. • Collecting interface family statistics for IPv4 and IPv6, by using the existing command show interfaces statistics detail interface-name.	19.2R1	19.2R1
Virtual Router Redundancy Protocol (VRRP) for IPv4 and IPv6	19.3R2	19.3R2
VPLS packet flooding to the right set of interfaces across mesh groups	-	-

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

Flow monitoring and services	First Supported Junos OS Release for MPC10E-15C-MRATE	First Supported Junos OS Release for MPC10E-10C-MRATE
Inline IP Flow Information Export (IPFIX)	19.1R1	19.2R1
Inline flow monitoring for MPLS, MPLS-IPv4 and MPLS-IPv6 traffic (IPFIX and V9 formats)	19.3R1	19.3R1
Inline flow monitoring for IPv4 or IPv6 traffic on next-hop based GRE Tunnels and ps interfaces	19.3R1	19.3R1
Port mirroring for family bridge CCC encapsulation	19.3R1	19.3R1
Port mirroring with analyzer instance `[edit forwarding-options analyzer]`	-	-
Port mirroring for VPLS	19.4R1	19.4R1
Packet slice for port mirroring	-	-
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	19.1R1	19.2R1
Minimum LDP Configuration	19.1R1	19.2R1
Routing Engine-Based Sampling	-	-

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

MACSec	First Supported Junos OS Release for MPC10E-15C-MRATE	First Supported Junos OS Release for MPC10E-10C-MRATE
GCM-AES-128 MACSec Encryption, 802.1AE-2006	19.1R1	19.2R1
GCM-AES-256 MACSec Encryption, 802.1AEbn-2011	19.1R1	19.2R1
Mobile IP	-	-
Multichassis link aggregation	-	-
Multiple Tag Protocol Identifiers (TPIDs)	19.1R1	19.2R1

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

Layer 2 Features	First Supported Junos OS Release for MPC10E-15C-MRATE	First Supported Junos OS Release for MPC10E-10C-MRATE
Trunk ports	19.2R1	19.2R1
Layer 2 support for MX Series Virtual Chassis	19.2R1	19.2R1
Layer 2 and Layer 2.5, IRB and Spanning Tree Protocols (xSTP)	19.3R1	19.3R1
IEEE 802.1ad provider bridges	19.3R1	19.3R1
L2TP silent failover and peer interface	19.3R1	19.3R1

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

Layer 2 Features	First Supported Junos OS Release for MPC10E-15C-MRATE	First Supported Junos OS Release for MPC10E-10C-MRATE
Multichassis LAG—active/active and active/standby	-	-
Multichassis LAG—active/active with IGMP snooping	-	-
Link aggregation group (LAG)—VLAN-CCC encapsulation	19.3R1	19.3R1
IGMP snooping with bridging, IRB, and VPLS	19.3R1	19.3R1
Layer 2 VPN interfaces support VLAN ID list	19.3R1	19.3R1
Link aggregation (IEEE 802.3ad)	19.3R1	19.3R1
Link Aggregation Control Protocol (LACP)	19.2R1	19.2R1
Link Layer Discovery Protocol (LLDP)	19.3R1	19.3R1
Local loopback	19.3R1	19.3R1
MAC learning, policing, accounting, and filtering	19.3R1	19.3R1

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

MPLS	Features supported in Junos OS Release for MPC10E-15C-MRATE	Features supported in Junos OS Release for MPC10E-10C-MRATE
End-to-end LSP MPLS ping	20.2R1	20.2R1
LDP pseudowire auto-sensing	20.2R1	20.2R1
LSP ping for circuit cross-connect (CCC) and CCC secondary standby LSP	20.2R1	20.2R1
Edge node failure protection of LDP-signaled pseudowire	20.2R1	20.2R1
Link and node protection for static LSPs	20.2R1	20.2R1
Support of statistics for static LSPs	20.2R1	20.2R1
Stitching of pseudowire segments (multisegment pseudowires with BGP Layer 2 VPN)	20.2R1	20.2R1
Cross-connect logical interface to two unsignaled virtual circuits terminating on different egress Provider Edge (PE) devices	20.2R1	20.2R1
Generic Associated Channel Label (GAL) and Generic Associated Channel Header (G-Ach) and application to BFD or LSP ping	20.2R1	20.2R1
Remote loop-free alternates (LFA) over LDP tunnels in IS-IS networks.	19.1R1	19.1R1
Ultimate hop popping (UHP) support for LSPs	20.2R1	20.2R1

Table 62: Protocols and Applications Supported by MPC10E line cards in the MX240, MX480, and MX960 Routers *(Continued)*

MPLS	Features supported in Junos OS Release for MPC10E-15C-MRATE	Features supported in Junos OS Release for MPC10E-10C-MRATE
GMPLS co-routed packet LSPs	20.2R1	20.2R1
LDP downstream-on-demand	20.2R1	20.2R1
Seamless Multicast MPLS: intSegmented P2P and P2MP LSPs with MVPN interworking	20.2R1	20.2R1
PS Interface support for PW Redundancy Condition	20.2R1	20.2R1

RELATED DOCUMENTATION

MPC10E-15C-MRATE | **215**

MPC10E-10C-MRATE | **210**

Protocols and Applications Supported by the MX2K-MPC11E

Table 63 on page 642 contains protocols and applications supported by the MX2K-MPC11E line cards on the MX2010 and MX2020 routers.

NOTE: The MX2K-MPC11E line card is supported in Junos OS 19.3R2 and later 19.3 releases and in Junos OS 20.1R1 and later Junos OS releases. It is not supported in Junos OS 19.4.

A dash indicates that the protocol or application is not supported.

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers

Protocol or Application	First Supported Junos OS Release for MX2K-MPC11E
Access Node Control Protocol (ANCP)	-
Accepts traffic destined for generic routing encapsulation (GRE) tunnels • *Dynamic* • Standard	Release • - • 19.3R2
Accepts traffic destined for Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • *Dynamic* • Standard	-
Bidirectional Forwarding Detection protocol (BFD)	
Centralized BFD	19.3R2
Distributed BFD	19.3R2
Inline BFD (single-hop only)	19.3R2
Single-hop BFD	19.3R2
Multihop BFD	19.3R2
Micro BFD	19.3R2
BFD over Integrated routing and bridging (IRB) interfaces	19.3R2
BFD over Pseudowire over LT and RLT interfaces	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX2K-MPC11E
Virtual circuit connectivity verification (VCCV) BFD for Layer2 VPNs and Layer2 circuits	19.3R2
VCCV BFD for VPLS	-
BFD authentication	-
Seamless BFD	-
Internet Control Message Protocol (ICMP) and ICMPv6	19.3R2
Border Gateway Protocol (BGP)	19.3R2
Bridge protocol data units (BPDUs)	-
BGP/*MPLS* virtual private networks (VPNs)	19.3R2
Routing Instance: • Logical system • Virtual routing and forwarding (VRF)	19.3R2
Load Balancing	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Class of service (CoS)	First Supported Junos OS Release for MX2K-MPC11E
Maintain CoS across internal tunnel interfaces	19.3R2
Packet Rewrites on DSCP, Inet Precedence (both Ipv4 and IPv6) and EXP bits	19.3R2
Behavior aggregate (BA) classification	19.3R2
BA classification based on 802.1p of payload for core-facing VPLS interfaces	19.3R2
BA DSCP classification of MPLS packets for L3VPN and MPLS interfaces	19.3R2
BA DSCP classification of MPLS packets for VPLS LSI interfaces	19.3R2
Rate limit option for per-port queues	19.3R2
BA DSCP classification for VPLS/CCC family	19.3R2
Configurable shaping overhead for scheduling	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Class of service (CoS)	First Supported Junos OS Release for MX2K-MPC11E
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	19.3R2
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • IEEE 802.1p classification	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Class of service (CoS)	First Supported Junos OS Release for MX2K-MPC11E
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	Release • - • - • - • - • - • - • -
Ingress and egress hierarchical class-of-service (CoS) shaping and *hierarchical-scheduler*: **NOTE**: Only egress is supported. • Group of virtual LANs (VLANs) level • VLAN level • Port level	19.3R2
Queue depth monitoring	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Layer 2 Features	First Supported Junos OS Release for MX2K-MPC11E
Trunk ports	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Layer 2 Features	First Supported Junos OS Release for MX2K-MPC11E
Layer 2 support for MX Series Virtual Chassis	19.3R2
Layer 2 and Layer 2.5, IRB and Spanning Tree Protocols (xSTP)	19.3R2
IEEE 802.1ad provider bridges	19.3R2
L2TPv2 silent failover and peer interface	19.3R2
Multichassis LAG—active/active and active/standby	-
Multichassis LAG—active/active with IGMP snooping	-
Link aggregation group (LAG)—VLAN-CCC encapsulation	19.3R2
IGMP snooping with bridging, IRB, and VPLS	-
Layer 2 VPN interfaces support VLAN ID list	19.3R2
Link aggregation (IEEE 802.3ad)	19.3R2
Link Aggregation Control Protocol (LACP)	19.3R2
Link Layer Discovery Protocol (LLDP)	19.3R2
Local loopback	19.3R2
MAC learning and policing	19.3R2
MAC filtering	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Layer 2 Services supported with pseudowire headend termination (PWHT)	First Supported Junos OS Release for MX2K-MPC11E
Layer 2 circuit terminates into the following Layer 2 services over the logical tunnel (lt) and redundant logical tunnel (rlt) • Bridge domain • EVPN Single home • VPLS	20.1R1
VLAN cross-connect on transport interface	20.1R1
Psuedowire service Layer 2 interface • MAC clear, MAC limit, MAC move, MAC pinning, and Static MAC • Statistics	20.1R1

Psuedowire service interfaces • MAC Learning, MAC Table Aging, and forwarding on aggregated Ethernet interfaces • Simple dual tag bridging (with VLAN map operations) • BUM traffic handling including split horizon • Native outer VLAN, VLAN tags in routing instances • Outer list, Inner list, and Outer VLAN-id list • Static MAC and Stacked VLAN • input-vlan-maps and output-vlan-maps • implicit-vlan-rewrites • no-local-switching, local-switching, and policer/ filter • mac-table-size, mac-aging-time, and no-mac-learning • interface-mac-limit and interface-mac-pinning • tag-protocol-id for Layer 2 services over logical tunnel interface (lt)	20.1R1

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Firewall filters and policers	First Supported Junos OS Release for MX2K-MPC11E
Family Inet/Inet6/MPLS	19.3R2
All the static match conditions/actions	19.3R2
Dynamic actions (port-mirroring, next hop, routing instance)	19.3R2
Interface-specific filters	19.3R2
BGP Flow specification	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Firewall filters and policers	First Supported Junos OS Release for MX2K-MPC11E
Two color and three color policers (SRTCM and TRTCM)	19.3R2
FTF (filter attachment on routing table)	19.3R2
Firewall attachment on Aggregated Ethernet Interfaces (AE)	19.3R2
Hierarchical Policers	19.3R2
Family Any/CCC (for firewall)	19.3R2
Percentage Bandwidth policers	-
Shared Bandwidth policers	-
Logical Interface policers	19.3R2
Physical interface policers	-
Firewall Based GRE ENCAP/DECAP	19.3R2
Fast lookup filter	19.3R2
Jvision (firewall filter counters only)	19.3R2
Filter-based tunneling: • GRE-in-UDP encapsulation and decapsulation • MPLS-over-UDP decapsulation	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Firewall filters and policers	First Supported Junos OS Release for MX2K-MPC11E
Filter-based forwarding: • Next-IP • Next-interface	19.3R2
Interface-group	19.3R2
Family bridge filter	19.3R2
VPLS family filter	19.3R2
Filter attachment on IRB, PSoLT, PSoRLT and bridge-domain	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Other Features	First Supported Junos OS Release for MX2K-MPC11E
Distributed Denial-of-Service (DDoS) Protection	19.3R2
DVMRP and GRE support—access side and server side	-
Managing Power	19.3R2
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	-
Flexible Queuing Mode	-
IEEE 802.1ag Ethernet OAM Continuity Check protocol	-

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Other Features	First Supported Junos OS Release for MX2K-MPC11E
IEEE 802.1ag Ethernet OAM Linktrace protocol	-
IEEE 802.1ag Ethernet OAM Loopback protocol	-
IEEE 802.1ag: • Maintenance association intermediate point (MIP) • Continuity check message (CCM) • Stacked VLAN tagging • Trunk ports • VPLS • VPWS • VLAN circuit cross-connect (CCC) encapsulation and • Translational cross-connect (TCC) encapsulation	Release • - • - • 19.3R2 • - • - • 19.3R2 • 19.3R2 • -
IEEE 802.1ag optional type, length, and value (TLVs) support *Configuring Port Status TLV and Interface Status TLV*	19.3R2
IEEE 802.3ah distributed periodic packet management (PPM) process, alarm indication signal (AIS), and remote defect indication (RDI)	19.3R2
Flexible Ethernet encapsulation	19.3R2
Graceful Routing Engine Switchover (GRES)	19.3R2
IGMPv3 support with snooping disabled	19.3R2
Intelligent Oversubscription on MIC and MPC Interfaces Overview	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Other Features	First Supported Junos OS Release for MX2K-MPC11E
Integrated routing and bridging (IRB)	-
Unified *In-service software upgrade (Unified ISSU)* with Enhanced Mode	21.2R1
Unified ISSU with enhanced mode (On MPC11E with sub line cards (SLCs)	21.4R1
Interoperability with MPCs	19.3R2
Interoperability with MS-DPCs/MS-MPCs	-
Interoperability with MX Series Flexible PIC Concentrators (MX-FPC)	-
IPv4	19.3R2
IPv4 multicast	Release
• PIM sparse mode (PIM-SM)	• 19.3R2
• PIM source-specific multicast (PIM-SSM)	• 19.3R2
• Point to multipoint (P2MP)	• 19.3R2
• Multicast-only fast reroute (MoFRR)	• 19.3R2
• Draft-rosen MVPN	• 19.3R2
IPv6	19.3R2
IPv6 MLD	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Other Features	First Supported Junos OS Release for MX2K-MPC11E
IPv6 multicast	Release
• PIM sparse mode (PIM-SM)	• 19.3R2
• PIM source-specific multicast (PIM-SSM)	• 19.3R2
• Point to multipoint (P2MP)	• 19.3R2
• Multicast-only fast reroute (MoFRR)	• 19.3R2
• Draft-rosen MVPN	• 19.3R2
IPv6 Neighbor Discovery	19.3R2
IS-IS	19.3R2
ITU-T Y.1731 timestamping support on MX Series routers	-
Optimizing Fabric Path for Abstracted Fabric Interface	20.1R1

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

MPLS	Features supported in Junos OS Release for MX2K-MPC11E
Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN)	19.3R2
LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV)	-
RSVP graceful restart interoperability with Cisco using Nodal Hello	-

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

MPLS	**Features supported in Junos OS Release for MX2K-MPC11E**
Failure action on BFD session down of RSVP LSPs	19.3R2
OSPF and IS-IS loop-free alternates (LFA)	19.3R2
4/5 label MPLS operation	19.3R2
Virtual circuit connectivity verification (VCCV) BFD	19.3R2
Point to multipoint using the enhanced-ip command (support for NG-MVPN and P2MP load balancing over aggregated Ethernet)	-
MPLS-FRR bypass link protection	19.3R2
Load sharing across 64 ECMP next hops	19.3R2
MPLS-FRR VPLS instance prioritization	-
Five label stack on ingress	19.3R2
MPLS node protection, link protection, and statistics for static LSPs	19.3R2
End-to-end LSP MPLS ping	20.2R1
LDP pseudowire auto-sensing	20.2R1
LSP ping for circuit cross-connect (CCC) and CCC secondary standby LSP	20.2R1
Edge node failure protection of LDP-signaled pseudowire	20.2R1

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

MPLS	**Features supported in Junos OS Release for MX2K-MPC11E**
Link and node protection for static LSPs	20.2R1
Support of statistics for static LSPs	20.2R1
Stitching of pseudowire segments (multisegment pseudowires with BGP Layer 2 VPN)	20.2R1
Cross-connect logical interface to two unsignaled virtual circuits terminating on different egress Provider Edge (PE) devices	20.2R1
Generic Associated Channel Label (GAL) and Generic Associated Channel Header (G-Ach) and application to BFD or LSP ping	20.2R1
Ultimate hop popping (UHP) support for LSPs	20.2R1
GMPLS co-routed packet LSPs	20.2R1
LDP downstream-on-demand	20.2R1
Seamless Multicast MPLS: intSegmented P2P and P2MP LSPs with MVPN interworking	20.2R1
PS Interface support for PW Redundancy Condition	20.2R1
mvrp	-
Multitopology routing	-
Nonstop active routing (NSR)	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

MPLS	**Features supported in Junos OS Release for MX2K-MPC11E**
OSPF	19.3R2
Packet mirroring	19.3R2
IEEE 802.1ah provider backbone bridging (PBB)	-
Push a tag on Ethernet VPLS and Ethernet CCC tag encapsulations	-
RSVP Overview	19.3R2
RIP	19.3R2
SNMP	19.3R2
Spanning Tree Protocols: • *IEEE 802.1s Multiple Spanning Tree Protocol (MSTP)* (part of IEEE 802.1Q VLANs) • *IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)* • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush (in VPLS multi-homing, flush all MACs when there is a change in the STP interface state due to root protect)	-
Subscriber Management and Services: • Enhanced subscriber management—Uplink communications to the core network only	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

MPLS	**Features supported in Junos OS Release for MX2K-MPC11E**
Synchronous Ethernet	20.1R1
Two-Way Active Measurement Protocol (TWAMP)	19.3R2
Tunnel services • Clear DF-Bit (Don't Fragment Bit)	19.3R2
Unified in-service software upgrade (ISSU)	-
Unnumbered Ethernet Interface	-
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Flexible VLAN tagging • Single VLAN tags • Dual VLAN tags • IP service for nonstandard TPID and stacked VLAN tags	19.3R2
Virtual Chassis: MPLS IPv4 and IPv6, unicast, multicast forwarding, VPLS, NSR for Layer 3/MPLS services	-

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

MPLS	**Features supported in Junos OS Release for MX2K-MPC11E**
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG	-
Virtual private network (VPN)	19.3R2
Virtual Router Redundancy Protocol (VRRP) for IPv4	19.3R2
VPLS packet flooding to the right set of interfaces across mesh groups	-
WAN-PHY mode	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Flow monitoring and services	**First Supported Junos OS Release for MX2K-MPC11E**
Inline IP Flow Information Export (IPFIX)	19.3R2
Inline flow monitoring for MPLS, MPLS-IPv4 and MPLS-IPv6 traffic (IPFIX and V9 formats)	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

Flow monitoring and services	First Supported Junos OS Release for MX2K-MPC11E
Inline flow monitoring for IPv4 or IPv6 traffic on next-hop based GRE Tunnels and ps interfaces	19.3R2
Port mirroring family bridge CCC encapsulation	19.3R2
Port mirroring with analyzer instance `[edit forwarding-options analyzer]`	-
Packet slice for port mirroring	-
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	19.3R2
Minimum LDP Configuration	19.3R2

Table 63: Protocols and Applications Supported by MPC11E line cards in the MX2010 and MX2020 Routers *(Continued)*

MACSec	First Supported Junos OS Release for MX2K-MPC11E
GCM-AES-128 MACSec Encryption, 802.1AE-2006	19.3R2
GCM-AES-256 MACSec Encryption, 802.1AEbn-2011	19.3R2
Mobile IP	-
Multichassis link aggregation	-
Multiple Tag Protocol Identifiers (TPIDs)	19.3R2

Protocols and Applications Supported by MX10K-LC480 for MX Series Routers

Table 64 on page 661 contains the first Junos OS Release support for protocols and applications on the MX10K-LC480. The protocols and applications support feature parity with Junos OS Release 21.2R1.

A dash indicates that the protocol or application is not supported.

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Access Node Control Protocol (ANCP)	21.2R1
Accepts traffic destined for generic routing encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • Dynamic • Manual	21.2R1
Bidirectional Forwarding Detection protocol (BFD)	21.2R1
Border Gateway Protocol (BGP)	21.2R1
Bridge protocol data units (BPDUs)	21.2R1
BGP/MPLS virtual private networks (VPNs)	21.2R1
IEEE 802.1ag Ethernet OAM Continuity Check protocol	21.2R1
IEEE 802.1ag Ethernet OAM Linktrace protocol	21.2R1
IEEE 802.1ag Ethernet OAM Loopback protocol	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
IEEE 802.1ag maintenance association intermediate point (MIP) support, continuity check message (CCM), stacked VLAN tagging, trunk ports, support for VPLS/VPWS, VLAN circuit cross-connect (CCC) encapsulation and translational cross-connect (TCC) encapsulation	21.2R1
IEEE 802.1ag optional type, length, and value (TLVs) support Port Status TLV and Interface Status TLV	21.2R1
IEEE 802.3ah distributed periodic packet management (PPM) process , alarm indication signal (AIS), and remote defect indication (RDI)	21.2R1
IGMPv3 support with snooping disabled	21.2R1
Integrated routing and bridging (IRB)	21.2R1
IPv4	21.2R1
IPv4 multicast	21.2R1
IPv6	21.2R1
IPv6 MLD	21.2R1
IPv6 multicast	21.2R1
IPv6 Neighbor Discovery	21.2R1
Two-Way Active Measurement Protocol (TWAMP)	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
RSVP Overview	21.2R1
RIP	21.2R1
Protocol Independent Multicast	21.2R1
Class of Service	
Class of service (CoS): • Maintain CoS across internal tunnel interfaces • Packet rewrites • Behavior aggregate (BA) classification • BA classification based on 802.1p of payload for core-facing VPLS interfaces • BA DSCP classification of MPLS packets for L3VPN/VPLS LSI and MPLS interfaces • Rate limit option for per-port queues • BA DSCP classification for VPLS/CCC family • Configurable .1p inheritance: push and swap from the hidden tag • Configurable shaping overhead for scheduling	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	21.2R1
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Tricolor marking • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	21.2R1
Ingress and egress hierarchical class-of-service (CoS) shaping and hierarchical-scheduler: • Group of virtual LANs (VLANs) level • VLAN level • Port level	21.2R1
Flexible Queuing Mode	21.2R1
Intelligent Oversubscription on MIC and MPC Interfaces Overview	21.2R1
Firewall Filters, Policers, and Other Security Services	
Policer support for aggregated Ethernet	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Aggregate firewall-based policer for all families of a logical interface	21.2R1
Intelligent hierarchical policers	21.2R1
Set forwarding class and loss priority for Routing Engine-generated packets by using a firewall	21.2R1
Physical interface policers, applying policers to the entire port	21.2R1
Lower policer limit from 32K to 8K	21.2R1
Egress .1p MF and BA classification for VPLS	21.2R1
Differentiated Services Code Point (DSCP) rewrite for IPv4 and IPv6	21.2R1
Filter-Based Tunneling Across IPv4 and IPv4 Networks,Three-Color Policer	21.2R1
Distributed Denial-of-Service (DDoS) Protection	21.2R1
GCM-AES-128 MACSec Encryption, 802.1AE-2006	21.3R1
GCM-AES-256 MACSec Encryption, 802.1AEbn-2011	21.3R1
Network Management, Monitoring, Sampling, and Collection Services	
Active monitoring	21.2R1
Port mirroring family VPLS, bridge CCC encapsulation (VPWS)	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Packet slice for port mirroring	21.2R1
Inline flow monitoring	21.2R1
Inline Video Monitoring	21.2R1
FlowTapLite	21.2R1
Inline Monitoring Services Configuration	21.2R1
Real-Time Performance Monitoring	21.2R1
sFlow Technology	21.2R1
Port Mirroring	21.2R1
ITU-T Y.1731 timestamping support on MX Series routers	21.2R1
Link Fault Management (LFM) and Connectivity Fault Management (CFM)	21.2R1
SNMP	21.2R1
Layer 2 Features	
Trunk ports	21.2R1
Layer 2 support for MX Series Virtual Chassis	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Layer 2 and Layer 2.5, IRB and Spanning Tree Protocols (xSTP)	21.2R1
IEEE 802.1ad provider bridges	21.2R1
Layer 2 protocol tunneling (L2PT) support	21.2R1
Layer 2 Tunneling Protocol (L2TP)	21.2R1
Multichassis LAG—active/active and active/standby	21.2R1
Multichassis LAG—active/active with IGMP snooping	21.2R1
Link aggregation group (LAG)—VLAN-CCC encapsulation	21.2R1
IGMP snooping with bridging, IRB, and VPLS	21.2R1
Layer 2 VPN interfaces support VLAN ID list	21.2R1
Link aggregation (IEEE 802.3ad)	21.2R1
Link Aggregation Control Protocol (LACP)	21.2R1
Link Layer Discovery Protocol (LLDP)	21.2R1
Local loopback	21.2R1
MAC learning, policing, accounting, and filtering	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Mobile IP	-
Multichassis link aggregation	21.2R1
Multiple Tag Protocol Identifiers (TPIDs)	21.2R1
Packet mirroring	21.2R1
IEEE 802.1ah provider backbone bridging (PBB)	-
Push a tag on Ethernet VPLS and Ethernet CCC tag encapsulations	21.2R1
Spanning Tree Protocols: • IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) (part of IEEE 802.1Q VLANs) • IEEE 802.1w Rapid Spanning Tree Protocol (RSTP) • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush (in VPLS multihoming, flush all MACs when there is a change in the STP interface state due to root protect)	21.2R1
OSPF	21.2R1
mvrp	21.2R1
IS-IS	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Unnumbered Ethernet Interface	21.2R1
Tunnel services • allow-fragmentation and reassemble-packets • Clear DF-Bit (clear-dont-fragment-bit)	21.2R1
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	21.2R1
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG	21.2R1
Multihoming in an EVPN-MPLS environment, IRB interface on Ethernet VPN (EVPN)	21.2R1
EVPN-VXLAN (Multicast and Unicast), EVPN-VXLAN support for VXLAN Gateways using an IPv6 underlay	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Inter-VLAN and Intra-VLAN multicast forwarding modes for EVPN, Inclusive Multicast Ethernet Tag (IMET), Selective Multicast Ethernet Tag (SMET)	21.2R1
Virtual private network (VPN)	21.2R1
Virtual Router Redundancy Protocol (VRRP) for IPv4 For more information, see *Configuring VRRP*.	21.2R1
VPLS packet flooding to the right set of interfaces across mesh groups	21.2R1
WAN-PHY mode	-
MPLS	
Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN)	21.2R1
LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV)	21.2R1
RSVP graceful restart interoperability with Cisco using Nodal Hello	21.2R1
Failure action on BFD session down of RSVP LSPs	21.2R1
OSPF and IS-IS loop-free alternates (LFA)	21.2R1
Label Depth – 16	21.2R1
Virtual circuit connectivity verification (VCCV) BFD	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Point to multipoint using the enhanced-ip command (support for NG-MVPN and P2MP load balancing over aggregated Ethernet)	21.2R1
MPLS-FRR bypass link protection	21.2R1
Load sharing across 64 ECMP next hops	21.2R1
MPLS-FRR VPLS instance prioritization	21.2R1
Five label stack on ingress	21.2R1
MPLS node protection, link protection, and statistics for static LSPs	21.2R1
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	21.2R1
Minimum LDP Configuration	21.2R1
Flexible Ethernet encapsulation	21.2R1
Interfaces and Chassis	
Port speed support (1GbE and 10GbE)	21.2R1
Dynamic Power Management	21.2R1
Interoperability with LC2101	21.2R1
Resiliency and High Availability	
Platform software resiliency support	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
5+1 active fabric redundancy	21.2R1
Load Balancing on Aggregated Ethernet Interfaces	21.2R1
Unified In-service software upgrade (Unified ISSU)	-
Graceful Routing Engine Switchover (GRES)	21.2R1
Ethernet Ring Protection Switching with multiple G.8032 instances See *Understanding Ethernet Ring Protection Switching* for more information.	21.2R1
Timing and Synchronization	
Synchronous Ethernet	21.2R1
Precision Time Protocol (PTP) (IEEE 1588)	21.3R1
Subscriber management and services	
Enhanced subscriber management	21.2R1
Aggregated Ethernet over static VLANs	21.2R1
Aggregated Ethernet over dynamic VLANs	21.2R1
DHCP access model	21.2R1
Dynamic adjustment of shapers	21.2R1

Table 64: Protocols and Applications Supported by MX10K-LC480 for MX10004, MX10008, and MX10016 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC480
Dynamic PPPoE subscriber interface creation based on PPPoE service name table configuration	21.2R1
Dynamic profiles	21.2R1
Dynamic shaping, scheduling, and queuing	21.2R1
Dynamic VLANs	21.2R1
Static and dynamic PPPoE subscriber interfaces	21.2R1
Other Features	
Nonstop active routing (NSR)	21.2R1
Multitopology routing	21.2R1
Segment Routing	21.2R1
Inline NAT, Inline MAP-E, Inline 6rd	21.2R1
RFC 2544-based benchmarking tests (reflector function)	21.2R1

RELATED DOCUMENTATION

MPC7E-MRATE | **198**

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Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Series Routers

Table 65 on page 675 contains the first Junos OS Release support for protocols and applications on the MX10K-LC9600. The protocols and applications support feature parity with Junos OS Release 21.4R1.

A dash indicates that the protocol or application is not supported.

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Access Node Control Protocol (ANCP)	21.4R1
Accepts traffic destined for generic routing encapsulation (GRE) tunnels or Distance Vector Multicast Routing Protocol (DVMRP) (IP-in-IP) tunnels • Dynamic • Manual	21.4R1
Bidirectional Forwarding Detection protocol (BFD)	21.4R1
Border Gateway Protocol (BGP)	21.4R1
Bridge protocol data units (BPDUs)	21.4R1
BGP/MPLS virtual private networks (VPNs)	21.4R1
IEEE 802.1ag Ethernet OAM Continuity Check protocol	21.4R1
IEEE 802.1ag Ethernet OAM Linktrace protocol	21.4R1
IEEE 802.1ag Ethernet OAM Loopback protocol	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
IEEE 802.1ag maintenance association intermediate point (MIP) support, continuity check message (CCM), stacked VLAN tagging, trunk ports, support for VPLS/VPWS, VLAN circuit cross-connect (CCC) encapsulation and translational cross-connect (TCC) encapsulation	21.4R1
IEEE 802.1ag optional type, length, and value (TLVs) support Port Status TLV and Interface Status TLV	21.4R1
IEEE 802.3ah distributed periodic packet management (PPM) process , alarm indication signal (AIS), and remote defect indication (RDI)	21.4R1
IGMPv3 support with snooping disabled	21.4R1
Integrated routing and bridging (IRB)	21.4R1
IPv4	21.4R1
IPv4 multicast	21.4R1
IPv6	21.4R1
IPv6 MLD	21.4R1
IPv6 multicast	21.4R1
IPv6 Neighbor Discovery	21.4R1
Two-Way Active Measurement Protocol (TWAMP)	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
RSVP Overview	21.4R1
RIP	21.4R1
Protocol Independent Multicast	21.4R1
Class of Service	
Class of service (CoS): • Maintain CoS across internal tunnel interfaces • Packet rewrites • Behavior aggregate (BA) classification • BA classification based on 802.1p of payload for core-facing VPLS interfaces • BA DSCP classification of MPLS packets for L3VPN/VPLS LSI and MPLS interfaces • Rate limit option for per-port queues • BA DSCP classification for VPLS/CCC family • Configurable .1p inheritance: push and swap from the hidden tag • Configurable shaping overhead for scheduling	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Class of service (CoS) per port: • Eight queues per port • Excess-rate and excess-priority configurations at the queue level • Shaping at the port level • Shaping at the queue level • Scheduling of queues based on the weighted round-robin (WRR) per excess-priority class • Round-robin scheduling of the queues per priority class • Weighted random early detection (WRED)	21.4R1
Class of service (CoS) per virtual LAN (VLAN): • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Tricolor marking	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Class of service (CoS) per Point-to-Point Protocol over Ethernet (PPPoE) or Dynamic Host Configuration Protocol (DHCP) subscriber interfaces: • Accounting, filtering, and policing • IEEE 802.1p rewrite • Classification • Excess-rate and excess-priority configuration at the queue level • Tricolor marking • Shaping at the queue level • Scheduling of queues based on weighted round-robin (WRR) per priority class • Weighted random early detection (WRED)	21.4R1
Forwarding Class of Service (CoS) and Hierarchical Class of Service (CoS): • Classifiers • Rewrites • Port queuing • L3 only • Q-depth monitoring • Hierarchical Class of Service (CoS)	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Egress hierarchical class-of-service (CoS) shaping and hierarchical-scheduler: • Group of virtual LANs (VLANs) level • VLAN level • Port level	21.4R1
Ingress hierarchical class-of-service (CoS) shaping and hierarchical-scheduler: • Group of virtual LANs (VLANs) level • VLAN level • Port level	24.4R1
Flexible Queuing Mode	21.4R1
Intelligent Oversubscription on MIC and MPC Interfaces Overview	21.4R1
Firewall Filters, Policers, and Other Security Services	
Policer support for aggregated Ethernet	21.4R1
Aggregate firewall-based policer for all families of a logical interface	21.4R1
Intelligent hierarchical policers	21.4R1
Set forwarding class and loss priority for Routing Engine-generated packets by using a firewall	21.4R1
Physical interface policers, applying policers to the entire port	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Lower policer limit from 32K to 8K	21.4R1
Egress .1p MF and BA classification for VPLS	21.4R1
Differentiated Services Code Point (DSCP) rewrite for IPv4 and IPv6	21.4R1
Filter-Based Tunneling Across IPv4 and IPv4 Networks,Three-Color Policer	21.4R1
Distributed Denial-of-Service (DDoS) Protection	21.4R1
GCM-AES-128 MACSec Encryption, 802.1AE-2006	21.4R1
GCM-AES-256 MACSec Encryption, 802.1AEbn-2011	21.4R1
Network Management, Monitoring, Sampling, and Collection Services	
Active monitoring	21.4R1
Port mirroring family VPLS, bridge CCC encapsulation (VPWS)	21.4R1
Packet slice for port mirroring	21.4R1
Inline flow monitoring	21.4R1
Inline Video Monitoring	21.4R1
FlowTapLite	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Inline Monitoring Services Configuration	21.4R1
Real-Time Performance Monitoring	21.4R1
sFlow Technology	21.4R1
Port Mirroring	21.4R1
ITU-T Y.1731 timestamping support on MX Series routers	21.4R1
Link Fault Management (LFM) and Connectivity Fault Management (CFM)	21.4R1
SNMP	21.4R1
Layer 2 Protocols	21.4R1
VPLS	21.4R1
VPWS	21.4R1
Mesh Group	21.4R1
Multicast Snooping with PIM, IGMP, and MLD	21.4R1
Layer 2 Features	
Layer 2 bridging with trunk and access modes	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
MAC learning and aging	21.4R1
Handling BUM (broadcast, unknown unicast and multicast) traffic, including split horizon	21.4R1
MAC move	21.4R1
Layer 2 forwarding and flooding statics	21.4R1
Static MAC addresses	21.4R1
Bridging on untagged interfaces	21.4R1
Q-in-Q Tunneling and VLAN Translation	21.4R1
MAC learning and forwarding on AE interfaces	21.4R1
Forwarding CoS (Q-depth monitoring)	21.4R1
Layer 2 firewall forwarding support	21.4R1
Layer 2 forwarding (IRB, VLAN handling, and Q-in-Q tunneling)	21.4R1
Load balancing	21.4R1
Multicast features	21.4R1
Dynamic learning of source and destination MAC addresses on aggregated Ethernet interfaces	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
MAC statistics	21.4R1
VRRP	21.4R1
Link aggregation (IEEE 802.3ad)	21.4R1
Link Aggregation Control Protocol (LACP)	21.4R1
Link Layer Discovery Protocol (LLDP)	21.4R1
Local loopback	21.4R1
MAC learning, policing, accounting, and filtering	21.4R1
Mobile IP	-
Multiple Tag Protocol Identifiers (TPIDs)	21.4R1
Packet mirroring	21.4R1
IEEE 802.1ah provider backbone bridging (PBB)	-
Push a tag on Ethernet VPLS and Ethernet CCC tag encapsulations	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Spanning Tree Protocols: • IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) (part of IEEE 802.1Q VLANs) • IEEE 802.1w Rapid Spanning Tree Protocol (RSTP) • IEEE 802.1D Spanning Tree Protocol (STP) • Per-VLAN Spanning Tree (PVST) • Bridge protocol data units (BPDUs) guard and loop guard • STP inter-protocol action profiles and MAC flush (in VPLS multihoming, flush all MACs when there is a change in the STP interface state due to root protect)	21.4R1
OSPF	21.4R1
mvrp	21.4R1
IS-IS	21.4R1
Unnumbered Ethernet Interface	21.4R1
Tunnel services • allow-fragmentation and reassemble-packets • Clear DF-Bit (clear-dont-fragment-bit)	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
VLANs IEEE 802.1Q: • VLAN stacking and rewriting • Flexible VLAN tagging • IP service for nonstandard TPID and stacked VLAN tags	21.4R1
Virtual private LAN service (VPLS): • BGP multihoming for inter-AS VPLS • Gigabit Ethernet as core-facing interface • Configurable label block sizes • Hashing L3/L4 fields under Ethernet pseudowire for VPLS encapsulation, CCC encapsulation, and MPLS encapsulation • VPLS flood forwarding table filter (FTF), input FTF • Broadcast, unicast unknown, and multicast (BUM) traffic hashing over LAG	21.4R1
Multihoming in an EVPN-MPLS environment, IRB interface on Ethernet VPN (EVPN)	21.4R1
EVPN-VXLAN (Multicast and Unicast), EVPN-VXLAN support for VXLAN Gateways using an IPv6 underlay	21.4R1
Inter-VLAN and Intra-VLAN multicast forwarding modes for EVPN, Inclusive Multicast Ethernet Tag (IMET), Selective Multicast Ethernet Tag (SMET)	21.4R1
Virtual private network (VPN)	21.4R1
Virtual Router Redundancy Protocol (VRRP) for IPv4	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
VPLS packet flooding to the right set of interfaces across mesh groups	21.4R1
WAN-PHY mode	-

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Forwarding Layer 3 Features • Layer 3 VPN • RIP • Targeted broadcast • TCP maximum segment size (MSS) • BGP (multipath/v4-v6 labelled unicast) • IPv4 (forwarding and options) • IPv6 (forwarding and route accounting) • Load balancing (ECMP and FRR). Options supported: enhanced-hash-key family inet/inet6/mpls • Layer 2 VPN, CCC, and L2 Circuit • MPLS (Push/Pop/Swap, LDP, RSVP Aggregate, RSVP TE Admin Groups, RSVP-TE, OAM - LSP/VPN ping, Trace Route, Auto Bandwidth, and MPLS-FRR Link node protection. Options supported: No Decrement Ttl, No Propagate Ttl, MTU-signaling Splitting-merging, Primary/Secondary, ICMP Tunneling, IPv6 Tunneling, LDP Tunneling, Optimize Timer, Explicit-Null, UHP and PHP support. • OSPF (node-link-protection and node-link-degradation) • Protocols (ISIS, OSPF, OSPF V3 for V6, BGP + BGP-v6, BGP LU, BGP-LS, BGP optimal-route-reflection (ORR), BFD (Centralized), Micro BFD (Centralized), ICMP and ICMPv6 error handling, and LLDP). • Routing Instance Logical System VRF • Tunnel (Generic Routing Encapsulation (GRE), Logical Tunnel (LT), and Virtual Tunnel (VT))	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Layer 3 features • MPLS- Static, RSVP and LDP LSPs • Multicast- P2MP (RSVP-TE P2MP and multipoint LDP inband) and P2MP interface support for PIM, Rosen multicast VPNs, and multicast-only fast reroute (MoFRR) • Static Tunnel	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Forwarding Firewall • Filter Matches • Filter Actions (Basic, Advanced) • Dependent Firewall Actions • Filter attachment (Basic, Advanced) • Interface Types (Basic) • Pseudo interface Types (PsoLT, FTI) • Filter Based Tunneling • Policers (Basic, Advanced) • Interface-Group • Policer Overhead • Interface-Specific • Instance-shared • ARP Policer • Fast Update Filter (FUF) • Service Filter (SF) • Fast Lookup Filter (FLT) • Implicit Filter (Basic, Advanced) • JVISION • SNMP	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
MPLS	
Switching of pseudowire segments (multisegment pseudowires with BGP-L2VPN)	21.4R1
LDP signaling for VPLS (LDP-VPLS) and MAC flush message processing (MAC-FLUSH-TLV)	21.4R1
RSVP graceful restart interoperability with Cisco using Nodal Hello	21.4R1
Failure action on BFD session down of RSVP LSPs	21.4R1
OSPF and IS-IS loop-free alternates (LFA)	21.4R1
Label Depth – 16	21.4R1
Virtual circuit connectivity verification (VCCV) BFD	21.4R1
Point to multipoint using the enhanced-ip command (support for NG-MVPN and P2MP load balancing over aggregated Ethernet)	21.4R1
MPLS-FRR bypass link protection	21.4R1
Load sharing across 64 ECMP next hops	21.4R1
MPLS-FRR VPLS instance prioritization	21.4R1
Five label stack on ingress	21.4R1
MPLS node protection, link protection, and statistics for static LSPs	21.4R1

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Labeled-switched-paths (LSPs) including accounting, policers, and filtering	21.4R1
Minimum LDP Configuration	21.4R1
Flexible Ethernet encapsulation	21.4R1
Interfaces and Chassis	
Port speed support (10GbE to 400GbE)	21.4R1
Dynamic Power Management	21.4R1
Interoperability with LC2101 and LC480	21.4R1
Resiliency and High Availability	
Platform software resiliency support	21.4R1
5+1 active fabric redundancy	21.4R1
Load Balancing on Aggregated Ethernet Interfaces	21.4R1
Unified In-service software upgrade (Unified ISSU)	-
Graceful Routing Engine Switchover (GRES)	21.4R1
Ethernet Ring Protection Switching with multiple G.8032 instances	21.4R1
Timing and Synchronization	

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Synchronous Ethernet	21.4R1
Precision Time Protocol (PTP) (IEEE 1588)	21.4R1
Subscriber management and services	
Enhanced subscriber management	21.4R1
Aggregated Ethernet over static VLANs	21.4R1
Aggregated Ethernet over dynamic VLANs	21.4R1
DHCP access model	21.4R1
Dynamic adjustment of shapers	21.4R1
Dynamic PPPoE subscriber interface creation based on PPPoE service name table configuration	21.4R1
Dynamic profiles	21.4R1
Dynamic shaping, scheduling, and queuing	21.4R1
Dynamic VLANs	21.4R1
Static and dynamic PPPoE subscriber interfaces	21.4R1
Other Features	

Table 65: Protocols and Applications Supported by MX10K-LC9600 for MX10004 and MX10008 Routers *(Continued)*

Protocol or Application	First Supported Junos OS Release for MX10K-LC9600
Nonstop active routing (NSR)	21.4R1
Secure Boot	21.4R1
Junos telemetry interface (JTI) CPU and network processing unit (NPU) sensors	21.4R1
Seamless MPLS Layer 2 and Layer 3 features • Layer 2 feature: Pseudowire Headend Termination (PWHT) • Layer 3 features: Redundant logical tunnel interfaces and Pseudowire subscriber interfaces using either logical tunnel or redundant logical tunnel interfaces as anchor point.	21.4R1
Multitopology routing	21.4R1
Segment Routing	21.4R1
Inline NAT, Inline MAP-E, Inline 6rd	21.4R1
RFC 2544-based benchmarking tests (reflector function)	21.4R1
SR-TE statistics for uncolored SR-TE policies streaming on JTI	21.4R1