



JUNOS® Software

MX Series Ethernet Services Routers Layer 2 Configuration Guide

Release 10.0

Juniper Networks, Inc.

1194 North Mathilda Avenue
Sunnyvale, California 94089
USA

408-745-2000

www.juniper.net

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Editing: Joanne McClintock

Illustration: Nathaniel Woodward

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Abbreviated Table of Contents

	About This Guide	xxi
Part 1	Overview	
Chapter 1	Overview of Layer 2 Services for MX Series Routers	3
Part 2	Configuration Basics for Layer 2 Services	
Chapter 2	Configuring Routing Instances and Basics for MX Series Ethernet Services Routers Layer 2 Services	9
Chapter 3	Configuring Layer 2 Port Mirroring	19
Chapter 4	Configuring Link Layer Discovery Protocol	43
Chapter 5	Summary of Link Layer Discovery Protocol Configuration Statements	49
Part 3	Layer 2 Bridging	
Chapter 6	Configuring Layer 2 Bridging	61
Chapter 7	Summary of Bridge Domain Configuration Statements	85
Part 4	Layer 2 Address Learning and Forwarding	
Chapter 8	Configuring Layer 2 Address Learning and Forwarding	105
Chapter 9	Summary of Layer 2 Address Learning and Forwarding Configuration Statements	109
Part 5	Spanning Tree Protocols	
Chapter 10	Configuring Spanning Tree Protocols	119
Chapter 11	Summary of Spanning Tree Protocol Configuration Statements	141
Part 6	Indexes	
	Index	179
	Index of Statements and Commands	185

Table of Contents

About This Guide	xxi
JUNOS Documentation and Release Notes	xxi
Objectives	xxii
Audience	xxii
Supported Routing Platforms	xxiii
Using the Indexes	xxiii
Using the Examples in This Manual	xxiii
Merging a Full Example	xxiii
Merging a Snippet	xxiv
Documentation Conventions	xxiv
Documentation Feedback	xxvi
Requesting Technical Support	xxvi
Self-Help Online Tools and Resources	xxvii
Opening a Case with JTAC	xxvii

Part 1

Overview

Chapter 1

Overview of Layer 2 Services for MX Series Routers	3
MX Series Router Architecture	3
Architecture Features	4
DPCs	4
MX Series Routers Layer 3 and Layer 2 Functions and Configuration	5
MX Series Routers Snooping	5
Understanding Ethernet Frame Statistics	5

Part 2**Configuration Basics for Layer 2 Services****Chapter 2****Configuring Routing Instances and Basics for MX Series Ethernet Services Routers Layer 2 Services 9**

Routing Instances Overview	9
Complete Routing Instance Configuration Statements for Layer 2 Networks	10
Configuring Routing Instance Types for Layer 2 Networks	11
Minimum Configuration for Layer 2 Control Protocol Routing Instances	12
Minimum Configuration for Virtual Switch Routing Instances	13
Minimum Configuration for VPLS Routing Instances	13
Multicast Snooping and STP	14
Load Balancing and Ethernet Link Aggregation	15
Enabling Layer 2 Address Learning in Logical Systems	16

Chapter 3**Configuring Layer 2 Port Mirroring 19**

Layer 2 Port Mirroring Overview	19
Layer 2 Port Mirroring Features	20
Different Port-Mirroring Properties for Different Router Interfaces	20
Input Packet-Sampling Properties	21
Mirror Destination Properties	21
Layer 2 Port-Mirroring Restrictions	21
Configuring Global Layer 2 Port Mirroring Properties	22
Configuring Packet-Sampling and Mirror Destination Properties	22
Configuring Mirror-Once Mode	23
Configuring Layer 2 Port Mirroring for Specific DPCs or Packet Forwarding Engines	23
Configuring Layer 2 Port-Mirroring Instances	24
Determining the Number of DPCs in an MX Series Router	25
Binding a Layer 2 Port-Mirroring Instance to a DPC	25
Binding a Layer 2 Port-Mirroring Instance to a Packet Forwarding Engine	26
Precedence of Port-Mirroring Instances at Different Levels of the Chassis	26
Configuring Layer 2 Port Mirroring for Logical Interfaces, Forwarding Tables, or Flood Tables	27
Configuring a Layer 2 Port-Mirroring Firewall Filter	27
Applying a Layer 2 Port-Mirroring Filter to a Logical Interface	28
Behavior of a Port-Mirroring Filter Applied to an Aggregated Ethernet Interface	29
Applying a Layer 2 Port-Mirroring Filter to the Forwarding Table on a Bridge Domain	30
Applying a Layer 2 Port-Mirroring Filter to the Flood Table on a VPLS Routing Instance	30
Layer 2 Port Mirroring with Next-Hop Groups	31
Layer 2 Port Mirroring and Multiple Instances	32

Example: Configuring Layer 2 Port Mirroring for a Logical Interface	34
Example: Configuring Layer 2 Port Mirroring for a Layer 2 VPN	36
Example: Configuring Layer 2 Port Mirroring for a Layer 2 VPN with Aggregated Ethernet Links	38
Example: Configuring Layer 2 Port Mirroring with Next-Hop Groups	41

Chapter 4 Configuring Link Layer Discovery Protocol 43

LLDP Overview	43
Configuring LLDP	44
Example: Configuring LLDP	46
Tracing LLDP Operation	47

Chapter 5 Summary of Link Layer Discovery Protocol Configuration Statements 49

advertisement-interval	49
disable	50
hold-multiplier	50
interface	51
lldp	52
lldp-configuration-notification-interval	53
ptopo-configuration-maximum-hold-time	53
ptopo-configuration-trap-interval	54
traceoptions	55
transmit-delay	57

Part 3 Layer 2 Bridging

Chapter 6 Configuring Layer 2 Bridging 61

Layer 2 Bridging Overview	61
Configuring Bridge Domains	62
Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances	63
Configuring Integrated Routing and Bridging for Bridge Domains	67
Configuring Bridge Domains as Switches for Layer 2 Trunk Ports	69
Configuring Layer 2 Virtual Switches	69
Configuring a Layer 2 Virtual Switch	70
Configuring a Layer 2 Virtual Switch with a Layer 2 Trunk Port	72
Configuring VPLS Ports in a Virtual Switch	73
Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch	75
Configuring Layer 2 Learning and Forwarding for Bridge Domains	76
Disabling MAC Learning for a Bridge Domain or Logical Interface	77
Configuring Static MAC Addresses for Logical Interfaces in a Bridge Domain	78

Configuring the Size of the MAC Address Table	78
Limiting the Number of MAC Addresses Learned from an Interface in a Bridge Domain	79
Enabling MAC Accounting for a Bridge Domain	80
Configuring Layer 2 Learning and Forwarding for Bridge Domains Functioning as Switches with Layer 2 Trunk Ports	81
Disabling MAC Learning for a Set of Bridge Domains	81
Limiting the Number of MAC Addresses Learned from a Trunk Port	81
Modifying the Size of the MAC Address Table for a Set of Bridge Domains	82
Enabling MAC Accounting for a Set of Bridge Domains	83
Configuring Layer 3 Tunnel Services Interfaces on MX Series Routers	83

Chapter 7**Summary of Bridge Domain Configuration Statements 85**

bandwidth	85
bridge-domains	86
bridge-options	87
domain-type	88
interface	89
interface-mac-limit	90
mac-statistics	91
mac-table-size	92
no-mac-learning	93
packet-action	94
routing-interface	95
static-mac	96
switch-options	97
tunnel-services	98
vlan-id	99
vlan-id-list	100
vlan-tags	101

Part 4**Layer 2 Address Learning and Forwarding****Chapter 8****Configuring Layer 2 Address Learning and Forwarding 105**

Layer 2 Address Learning and Forwarding Overview	105
Disabling MAC Learning	106
Configuring the MAC Table Timeout Interval	106
Enabling MAC Accounting	106
Limiting the Number of MAC Addresses Learned from Each Interface	107
Configuring MAC Move Parameters	107

Chapter 9	Summary of Layer 2 Address Learning and Forwarding Configuration Statements	109
	global-mac-limit	109
	global-mac-move	110
	global-mac-statistics	110
	global-mac-table-aging-time	111
	global-no-mac-learning	111
	l2-learning	112
	notification-time	113
	threshold-count	114
	threshold-time	115
 Part 5	 Spanning Tree Protocols	
 Chapter 10	 Configuring Spanning Tree Protocols	 119
	Spanning Tree Protocols Overview	119
	Configuring Rapid Spanning Tree Protocol	120
	Enabling a Spanning Tree Protocol	121
	Configuring the BPDU Destination MAC Address	121
	Configuring the Bridge Priority	121
	Configuring the Maximum Age Timer	122
	Configuring the Hello Timer	122
	Forcing the Spanning-Tree Version	123
	Configuring the Forwarding Delay	123
	Configuring the Extended System Identifier	123
	Configuring the Interface	124
	Configuring the Interface Priority	124
	Configuring the Interface Cost	125
	Configuring the Interface Mode	126
	Configuring an Edge Port	126
	Configuring Root Protect	127
	Tracing STP Traffic	128
	Example: Tracing STP Traffic	129
	Configuring Multiple Spanning Tree Protocol	129
	Configuring the MSTP MSTI Instance Identifier	129
	Configuring the MSTP Region Configuration Name	130
	Configuring the MSTP Revision Level	130
	Configuring the MSTP Maximum Hops	130
	Configuring the MSTI Interface	131
	Configuring the MSTI VLAN	131
	Disabling the MSTP Instance	131
	Configuring VLAN Spanning Tree Protocol	131

Configuring Layer 2 Protocol Tunneling	132
Enabling Layer 2 Protocol Tunneling	132
Configuring the Layer 2 Protocol Tunnel Interface	133
Configuring the Layer 2 Protocol to be Tunneled	133
Configuring BPDU Protection for Spanning Tree Protocols	133
Configuring STP Loop Protection	135
Configuring VPLS Root Protection Topology Change Actions	137

Chapter 11

Summary of Spanning Tree Protocol Configuration Statements 141

backup-bridge-priority	141
bpdu-block	142
bpdu-block-on-edge	142
bpdu-destination-mac-address	143
bpdu-timeout-action	144
bridge-priority	145
configuration-name	146
cost	147
disable	148
disable-timeout	148
edge	149
extended-system-id	150
force-version	150
forward-delay	151
hello-time	152
interface	153
interface (BPDU Blocking)	153
interface (Layer 2 Protocol Tunneling)	153
interface (Spanning Tree)	154
layer2-control	155
mac-rewrite	156
max-age	156
max-hops	157
mode	158
msti	159
mstp	160
no-root-port	161
priority	162
priority-hold-time	163
protocol	163
protocols	164
revision-level	165
rstp	166
system-id	167
traceoptions	168
vlan	171
vlan (MSTP)	171
vlan (VSTP)	172
vpls-flush-on-topology-change	173
vstp	174

Part 6**Indexes**

Index	179
Index of Statements and Commands	185

List of Figures

Part 1

Overview

Chapter 1	Overview of Layer 2 Services for MX Series Routers	3
	Figure 1: MX Series Router Packet Forwarding and Data Flow	4

Part 5

Spanning Tree Protocols

Chapter 10	Configuring Spanning Tree Protocols	119
	Figure 2: VPLS Multihoming Configuration	138

List of Tables

About This Guide	xxi
Table 1: Notice Icons	XXV
Table 2: Text and Syntax Conventions	XXV

Part 3

Layer 2 Bridging

Chapter 6	Configuring Layer 2 Bridging	61
	Table 3: Statement Usage and Input Rewrite Operations for VLAN Identifiers for a Bridge Domain	66
	Table 4: Statement Usage and Output Rewrite Operations for VLAN Identifiers for a Bridge Domain	67

About This Guide

This preface provides the following guidelines for using the *JUNOS® Software MX Series Ethernet Services Routers Layer 2 Configuration Guide*:

- JUNOS Documentation and Release Notes on page xxi
- Objectives on page xxii
- Audience on page xxii
- Supported Routing Platforms on page xxiii
- Using the Indexes on page xxiii
- Using the Examples in This Manual on page xxiii
- Documentation Conventions on page xxiv
- Documentation Feedback on page xxvi
- Requesting Technical Support on page xxvi

JUNOS Documentation and Release Notes

For a list of related JUNOS documentation, see <http://www.juniper.net/techpubs/software/junos/>.

If the information in the latest release notes differs from the information in the documentation, follow the *JUNOS Software Release Notes*.

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Objectives

This guide is designed for network administrators who are configuring and monitoring the Layer 2 services supported on a Juniper Networks MX Series Ethernet Services Router.



NOTE: For additional information about JUNOS Software—either corrections to or information that might have been omitted from this guide—see the software release notes at <http://www.juniper.net/>.

Audience

This guide is designed for network administrators who are configuring and monitoring a Juniper Networks M Series, MX Series, T Series, EX Series, or J Series router or switch.

To use this guide, you need a broad understanding of networks in general, the Internet in particular, networking principles, and network configuration. You must also be familiar with one or more of the following Internet routing protocols:

- Border Gateway Protocol (BGP)
- Distance Vector Multicast Routing Protocol (DVMRP)
- Intermediate System-to-Intermediate System (IS-IS)
- Internet Control Message Protocol (ICMP) router discovery
- Internet Group Management Protocol (IGMP)
- Multiprotocol Label Switching (MPLS)
- Open Shortest Path First (OSPF)
- Protocol-Independent Multicast (PIM)
- Resource Reservation Protocol (RSVP)
- Routing Information Protocol (RIP)
- Simple Network Management Protocol (SNMP)

Personnel operating the equipment must be trained and competent; must not conduct themselves in a careless, willfully negligent, or hostile manner; and must abide by the instructions provided by the documentation.

Supported Routing Platforms

For the Layer 2 features described in this manual, the JUNOS software currently supports the following routing platforms:

- MX Series Ethernet Services Routers

Using the Indexes

This reference contains two indexes: a complete index that includes topic entries, and an index of statements and commands only.

In the index of statements and commands, an entry refers to a statement summary section only. In the complete index, the entry for a configuration statement or command contains at least two parts:

- The primary entry refers to the statement summary section.
- The secondary entry, *usage guidelines*, refers to the section in a configuration guidelines chapter that describes how to use the statement or command.

Using the Examples in This Manual

If you want to use the examples in this manual, you can use the **load merge** or the **load merge relative** command. These commands cause the software to merge the incoming configuration into the current candidate configuration. If the example configuration contains the top level of the hierarchy (or multiple hierarchies), the example is a *full example*. In this case, use the **load merge** command.

If the example configuration does not start at the top level of the hierarchy, the example is a *snippet*. In this case, use the **load merge relative** command. These procedures are described in the following sections.

Merging a Full Example

To merge a full example, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration example into a text file, save the file with a name, and copy the file to a directory on your routing platform.

For example, copy the following configuration to a file and name the file **ex-script.conf**. Copy the **ex-script.conf** file to the **/var/tmp** directory on your routing platform.

```
system {
  scripts {
    commit {
      file ex-script.xsl;
    }
  }
}
```

```

    }
    interfaces {
        fxp0 {
            disable;
            unit 0 {
                family inet {
                    address 10.0.0.1/24;
                }
            }
        }
    }
}

```

2. Merge the contents of the file into your routing platform configuration by issuing the `load merge` configuration mode command:

```

[edit]
user@host# load merge /var/tmp/ex-script.conf
load complete

```

Merging a Snippet

To merge a snippet, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration snippet into a text file, save the file with a name, and copy the file to a directory on your routing platform.

For example, copy the following snippet to a file and name the file `ex-script-snippet.conf`. Copy the `ex-script-snippet.conf` file to the `/var/tmp` directory on your routing platform.

```

commit {
    file ex-script-snippet.xsl; }

```

2. Move to the hierarchy level that is relevant for this snippet by issuing the following configuration mode command:

```

[edit]
user@host# edit system scripts
[edit system scripts]

```

3. Merge the contents of the file into your routing platform configuration by issuing the `load merge relative` configuration mode command:

```

[edit system scripts]
user@host# load merge relative /var/tmp/ex-script-snippet.conf
load complete

```

For more information about the `load` command, see the *JUNOS CLI User Guide*.

Documentation Conventions

Table 1 on page xxv defines notice icons used in this guide.

Table 1: Notice Icons





Icon	Meaning	Description
	Informational note	Indicates important features or instructions.
	Caution	Indicates a situation that might result in loss of data or hardware damage.
	Warning	Alerts you to the risk of personal injury or death.
	Laser warning	Alerts you to the risk of personal injury from a laser.

Table 2 on page xxv defines the text and syntax conventions used in this guide.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
Bold text like this	Represents text that you type.	To enter configuration mode, type the configure command: user@host> configure
Fixed-width text like this	Represents output that appears on the terminal screen.	user@host> show chassis alarms No alarms currently active
<i>Italic text like this</i>	<ul style="list-style-type: none"> Introduces important new terms. Identifies book names. Identifies RFC and Internet draft titles. 	<ul style="list-style-type: none"> A policy <i>term</i> is a named structure that defines match conditions and actions. <i>JUNOS System Basics Configuration Guide</i> RFC 1997, <i>BGP Communities Attribute</i>
<i>Italic text like this</i>	Represents variables (options for which you substitute a value) in commands or configuration statements.	Configure the machine's domain name: [edit] root@# set system domain-name <i>domain-name</i>
Plain text like this	Represents names of configuration statements, commands, files, and directories; IP addresses; configuration hierarchy levels; or labels on routing platform components.	<ul style="list-style-type: none"> To configure a stub area, include the stub statement at the [edit protocols ospf area area-id] hierarchy level. The console port is labeled CONSOLE.
< > (angle brackets)	Enclose optional keywords or variables.	stub <default-metric <i>metric</i> >;

Table 2: Text and Syntax Conventions (*continued*)

Convention	Description	Examples
(pipe symbol)	Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.	broadcast multicast (string1 string2 string3)
# (pound sign)	Indicates a comment specified on the same line as the configuration statement to which it applies.	rsvp { # Required for dynamic MPLS only
[] (square brackets)	Enclose a variable for which you can substitute one or more values.	community name members [community-ids]
Indentation and braces ({ })	Identify a level in the configuration hierarchy.	[edit] routing-options { static { route default { nexthop address; retain; } } }
;(semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
J-Web GUI Conventions		
Bold text like this	Represents J-Web graphical user interface (GUI) items you click or select.	<ul style="list-style-type: none">■ In the Logical Interfaces box, select All Interfaces.■ To cancel the configuration, click Cancel.
> (bold right angle bracket)	Separates levels in a hierarchy of J-Web selections.	In the configuration editor hierarchy, select Protocols > Ospf .

Documentation Feedback

We encourage you to provide feedback, comments, and suggestions so that we can improve the documentation. You can send your comments to techpubs-comments@juniper.net, or fill out the documentation feedback form at <https://www.juniper.net/cgi-bin/docbugreport/>. If you are using e-mail, be sure to include the following information with your comments:

- Document or topic name
- URL or page number
- Software release version (if applicable)

Requesting Technical Support

Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active J-Care or JNAS support

contract, or are covered under warranty, and need postsales technical support, you can access our tools and resources online or open a case with JTAC.

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the JTAC User Guide located at <http://www.juniper.net/customers/support/downloads/710059.pdf> .
- Product warranties—For product warranty information, visit <http://www.juniper.net/support/warranty/> .
- JTAC Hours of Operation —The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

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For quick and easy problem resolution, Juniper Networks has designed an online self-service portal called the Customer Support Center (CSC) that provides you with the following features:

- Find CSC offerings: <http://www.juniper.net/customers/support/>
- Search for known bugs: <http://www2.juniper.net/kb/>
- Find product documentation: <http://www.juniper.net/techpubs/>
- Find solutions and answer questions using our Knowledge Base: <http://kb.juniper.net/>
- Download the latest versions of software and review release notes: <http://www.juniper.net/customers/csc/software/>
- Search technical bulletins for relevant hardware and software notifications: <https://www.juniper.net/alerts/>
- Join and participate in the Juniper Networks Community Forum: <http://www.juniper.net/company/communities/>
- Open a case online in the CSC Case Management tool: <http://www.juniper.net/cm/>

To verify service entitlement by product serial number, use our Serial Number Entitlement (SNE) Tool: <https://tools.juniper.net/SerialNumberEntitlementSearch/>

Opening a Case with JTAC

You can open a case with JTAC on the Web or by telephone.

- Use the Case Management tool in the CSC at <http://www.juniper.net/cm/> .
- Call 1-888-314-JTAC (1-888-314-5822 toll-free in the USA, Canada, and Mexico).

For international or direct-dial options in countries without toll-free numbers, visit us at <http://www.juniper.net/support/requesting-support.html>

Part 1

Overview

- Overview of Layer 2 Services for MX Series Routers on page 3

Chapter 1

Overview of Layer 2 Services for MX Series Routers

This chapter provides the following information about configuring Layer 2 services for Juniper Networks MX Series Ethernet Services Routers:

- MX Series Router Architecture on page 3
- Architecture Features on page 4
- DPCs on page 4
- MX Series Routers Layer 3 and Layer 2 Functions and Configuration on page 5
- MX Series Routers Snooping on page 5
- Understanding Ethernet Frame Statistics on page 5

MX Series Router Architecture

The key components of each Juniper Networks MX Series Ethernet Services Router are Dense Port Concentrators (DPCs), the Routing Engine, and the Switch Control Board.

The DPCs are optimized for Ethernet density and are capable of supporting up to 40 Gigabit Ethernet or 4 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).

The Routing Engine is an Intel-based PC platform that runs the Juniper Networks JUNOS Software. Software processes that run on the Routing Engine maintain the routing tables, manage the routing protocols used on the router, control the router interfaces, control some chassis components, and provide the interface for system management and user access to the router. Routing Engines communicate with DPCs via dedicated out-of-band management channels, providing a clear distinction between the controls and forwarding planes.

The Switch Control Board (SCB) powers cards on and off; controls clocking, resets and booting; and monitors and controls systems functions, including fan speed, board power status, PDM status and control, and the system front panel. Integrated into the SCB is the switch fabric, which interconnects all of the DPCs within the

chassis, supporting up to 48 Packet Forwarding Engines. The Routing Engine installs directly into the SCB.

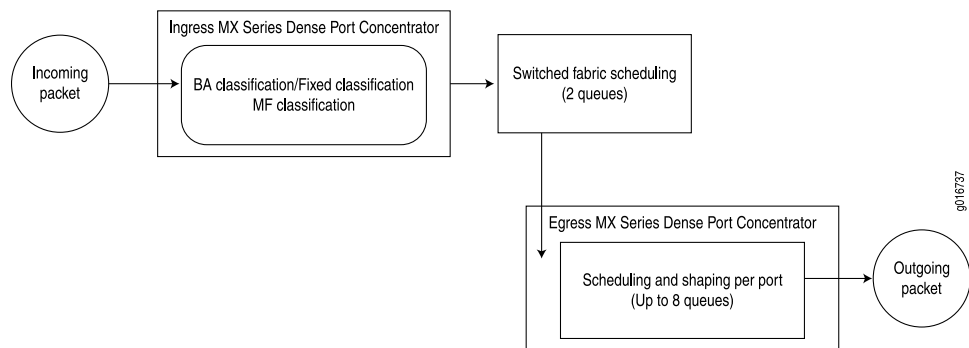
The MX Series router has been optimized for Ethernet services. Examples of the wide range of Ethernet services provided by the MX Series include:

- Virtual private LAN service (VPLS) for multipoint connectivity—Native support for VPLS services
- Virtual leased line (VLL) for point-to-point services—Native support for point-to-point services
- RFC 2547.bis IP/MPLS VPN (L3VPN)—Full support for MPLS VPNs throughout the Ethernet network
- Video distribution IPTV services
- Ethernet aggregation at the campus/enterprise edge—Supports dense 1-Gigabit Ethernet and 10-Gigabit Ethernet configurations, and provides full Layer 3 support for campus edge requirements
- Ethernet aggregation at the multiservice edge—Supports up to 480 1-Gigabit Ethernet ports or 48 10-Gigabit Ethernet ports for maximum Ethernet density along, with full Layer 2 and Layer 3 VPN support for MSE applications

Architecture Features

The architecture for Juniper Networks MX Series Ethernet Services Routers such as the MX960 Ethernet Services Router is similar in concept, but different in particulars, from other routing platforms. The general architecture for the MX Series router is shown in Figure 1 on page 4.

Figure 1: MX Series Router Packet Forwarding and Data Flow



DPCs

Juniper Networks MX Series Ethernet Services Routers process incoming and outgoing packets with the Dense Port Concentrators (DPCs) or the more traditional Flexible Port Concentrators (FPCs) used by the Juniper Networks T Series Core Routers and many of the Juniper Networks M Series Multiservice Edge Routers. FPCs are populated

with PICs for various interface types. The DPCs support a variety of port configurations and combine the functions of FPCs and the PICs.

The MX960 router has 12 DPC slots. The MX480 router has 7 DPC slots. The MX240 router has 4 DPC slots.



NOTE: In the JUNOS 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.

In addition to Layer 3 routing capabilities, the DPCs also have many Layer 2 functions that allow MX Series routers to be used for many virtual LAN (VLAN) and other Layer 2 network applications.

MX Series Routers Layer 3 and Layer 2 Functions and Configuration

You can configure Layer 2 or Layer 3 features and functions on MX Series routers. This book discusses Layer 2 configurations, including Layer 2 statement summaries and configuration statement examples. For more complete configuration examples, see the *JUNOS MX Series Ethernet Services Routers Solutions Guide*.

For more information about configuring Layer 3 features and functions (such as class of service), see the relevant JUNOS configuration guides.

MX Series Routers Snooping

MX Series routers can support both Layer 3 and Layer 2 functions at the same time. For example, you can configure the Layer 3 multicast protocols Protocol Independent Multicast (PIM) and the Internet Group Membership Protocol (IGMP) as well as Layer 2 VLANs on the MX Series router. In many cases, Layer 2 protocols run on some interfaces, and Layer 3 protocols run on others.

Normal encapsulation rules restrict Layer 2 processing to accessing information in the frame header and Layer 3 processing to accessing information in the packet header. However, in some cases, an interface running a Layer 2 protocol needs information available only at Layer 3. For example, in multicast applications, the VLANs need the group membership information and multicast tree information available to the Layer 3 IGMP and PIM protocols. In these cases, the Layer 3 configurations can use PIM or IGMP snooping to provide the needed information at the VLAN level.

Snooping configuration statements and examples are not included in this configuration guide. For more information about configuring PIM and IGMP snooping, see the *JUNOS Multicast Protocols Configuration Guide*.

Understanding Ethernet Frame Statistics

On Juniper Networks MX Series Ethernet Services Routers, no interface counters count the 7-byte Ethernet frame preamble and the frame delimiter byte. The frame

size for Media Access Control (MAC) statistical purposes includes the MAC header and cyclical redundancy check (CRC) and *before* any VLAN rewrite or other rules are applied. In traffic statistics, the frame size includes the Layer 2 header without the trailer CRC and *after* any VLAN rewrite or other rules are applied.

Part 2

Configuration Basics for Layer 2 Services

- Configuring Routing Instances and Basics for MX Series Ethernet Services Routers Layer 2 Services on page 9
- Configuring Layer 2 Port Mirroring on page 19
- Configuring Link Layer Discovery Protocol on page 43
- Summary of Link Layer Discovery Protocol Configuration Statements on page 49

Chapter 2

Configuring Routing Instances and Basics for MX Series Ethernet Services Routers Layer 2 Services

- Routing Instances Overview on page 9
- Complete Routing Instance Configuration Statements for Layer 2 Networks on page 10
- Configuring Routing Instance Types for Layer 2 Networks on page 11
- Multicast Snooping and STP on page 14
- Load Balancing and Ethernet Link Aggregation on page 15
- Enabling Layer 2 Address Learning in Logical Systems on page 16

Routing Instances Overview

A routing instance is a routing entity for a router. You can create multiple instances of BGP, IS-IS, OSPF, OSPFv3, RIP, and static routes. Each instance contains a routing table, applied routing policies, routing table group, interfaces that belong to that instance, and a protocol-specific route configuration related to that instance.

You configure a primary routing instance at the [edit protocols] hierarchy level. You configure additional routing instances at the [edit routing-instances] or [edit logical-systems *logical-system-name* routing-instance] hierarchy level.

You use routing instances to:

- Create administrative separation in a large network to segregate customer traffic and associated settings. The customers see only the routes belonging to them.
- Create overlay networks in which separate services are routed only towards routers participating in that service, such as voice. The overlay network isolates routes belonging to one service from another service by exporting routes, applying tags, and filtering based on tags.

Each routing instance consists of sets of the following:

- A set of routing tables
- A set of interfaces that belong to these routing tables
- A set of routing option configurations

Each routing instance has a unique name and a corresponding IP unicast table. For example, if you configure a routing instance with the name `my-instance`, its corresponding IP unicast table will be `my-instance.inet.0`. All routes for `my-instance` are installed into `my-instance.inet.0`.

Routes are installed into the default routing instance `inet.0` by default, unless a routing instance is specified.

For details about configuring interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

Complete Routing Instance Configuration Statements for Layer 2 Networks

To configure routing instances for Layer 2 networks, include the following statements:

```
routing-instances {
  routing-instance-name {
    bridge-domains {
      ...bridge-domains-configuration ...
    }
    description text;
    forwarding-options {
      ...forwarding-options...
    }
    instance-type (layer2-control | virtual-switch | vpls);
    interface interface-name;
    no-vrf-advertise;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-export [ policy-names ];
    vrf-import [ policy-names ];
    vrf-table-label;
    vrf-target {
      export community-name;
      import community-name;
    }
    protocols {
      ... protocols-configuration ...
    }
    routing-options {
      ... routing-options-configuration ...
    }
    bridge-domains {
      bridge-domain-name {
        domain-type bridge;
        interface interface-name;
        routing-interface routing-interface-name;
        vlan-id (none | all | number);
        vlan-tags outer number inner number;
        bridge-options {
          interface-mac-limit limit {
            packet-action drop;
          }
        }
        interface interface-name {
          interface-mac-limit limit {
            packet-action drop;
          }
        }
      }
    }
  }
}
```

```

    }
  }
  mac-statistics;
  mac-table-size limit {
    packet-action drop;
  }
  no-mac-learning;
  static-mac mac-address;
}
}
}
}
}

```

With the exception of the `instance-type virtual-switch` statement (which configures a virtual-switch routing instance), you can include the statements at the following hierarchy levels:

- `[edit]`
- `[edit logical-systems logical-system-name]`

The `instance-type virtual-switch` statement is not supported at the `[edit logical-systems logical-system-name]` hierarchy level.

Configuring Routing Instance Types for Layer 2 Networks

Although routing instances are primarily intended to maintain separation of tables and protocols at Layer 3 (mirroring the traditional IP network separation at Layer 3), many aspects of routing instances make them convenient to use for Layer 2 applications and architectures as well. In Layer 2 applications, routing instances still help to maintain table, interface, and customer insulation, but with regard to media access control (MAC) addresses and VLAN tags as much as IP addresses.

You can configure three types of routing instances in Layer 2 networks on MX Series routers, as described in the indicated sections:

- **layer2-control** (MX Series routers only)—Layer 2 control protocol routing instance. For configuration information, see “Configuring Spanning Tree Protocols” on page 119.
- **virtual-switch** (MX Series routers only)—Virtual switch routing instance. For configuration information, see “Configuring Layer 2 Virtual Switches” on page 69.
- **vpls**—Virtual private LAN service (VPLS) routing instance. For configuration information, see “Configuring Layer 2 Bridging” on page 61.

The other five types of routing instances are configured only for Layer 3 networks, and are described in the indicated JUNOS configuration guide:

- **forwarding**—Forwarding instance. For more information, see the *JUNOS Routing Protocols Configuration Guide*.
- **l2vpn**—Layer 2 VPN routing instance. For more information, see the *JUNOS VPNs Configuration Guide*.
- **no-forwarding**—Nonforwarding routing instance. For more information, see the *JUNOS Routing Protocols Configuration Guide*.
- **virtual-router**—Virtual routing instance. For more information, see the *JUNOS Routing Protocols Configuration Guide*.
- **vrf**—VPN routing and forwarding (VRF) instance. For more information, see the *JUNOS Routing Protocols Configuration Guide*.

For information about the minimum configuration for the three types of routing instances for Layer 2 networks on MX Series routers, see the following sections:

- Minimum Configuration for Layer 2 Control Protocol Routing Instances on page 12
- Minimum Configuration for Virtual Switch Routing Instances on page 13
- Minimum Configuration for VPLS Routing Instances on page 13

Minimum Configuration for Layer 2 Control Protocol Routing Instances

On MX Series routers only, use the **layer2-control** routing instance type for Rapid Spanning Tree Protocol (RSTP) or Multiple Spanning Tree Protocol (MSTP) in customer edge interfaces of a VPLS routing instance. Layer 2 control protocols enable features such as Layer 2 protocol tunneling or nonstop bridging. This instance type cannot be used if the customer edge interface is multihomed to two provider edge interfaces. If the customer edge interface is multihomed to two provider edge interfaces, use the default bridge protocol data unit (BPDU) tunneling.

To create a routing instance for Layer 2 control protocols, include at least the following statements in the configuration:

```
routing-instances {
  routing-instance-name {
    instance-type layer2-control;
    interface interface-name;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
      mstp {
        ... interface options ...
        msti msti-id {
          ... MSTP MSTI configuration ...
        }
      }
    }
  }
}
```


You can include these statements at the following hierarchy levels:

- [edit]
- [edit logical-systems *logical-system-name*]

Minimum Configuration for Virtual Switch Routing Instances

On MX Series routers only, use the `virtual-switch` routing instance type to isolate a LAN segment with its STP instance and to separate its VLAN ID space. A bridge domain consists of a set of ports that share the same flooding or broadcast characteristics. Each virtual switch represents a Layer 2 network. You can optionally configure a virtual switch to support Integrated Routing and Bridging (IRB), which facilitates simultaneous Layer 2 bridging and Layer 3 IP routing on the same interface. You can also configure Layer 2 control protocols to provide loop resolution. Protocols supported include the Spanning Tree Protocol (STP), RSTP, and MSTP.

To create a routing instance for a virtual switch, include at least the following statements in the configuration:

```
[edit]
routing-instances {
  routing-instance-name
  instance-type virtual-switch;
  bridge-domains {
    bridge-domain-name {
      domain-type bridge;
      interface interface-name;
      vlan-id (all | none | number);
      vlan-tags outer number inner number;
    }
  }
  protocols {
    mstp {
      ...mstp-configuration ...
    }
  }
}
```

The `instance-type virtual-switch` statement is not supported at the [edit logical-systems *logical-system-name*] hierarchy level.

For more information about configuring virtual switches, see “Configuring Layer 2 Virtual Switches” on page 69.

Minimum Configuration for VPLS Routing Instances

Use the `vpls` routing instance type for point-to-multipoint LAN implementations between a set of sites in a VPN.

To create a routing instance for VPLS, include at least the following statements in the configuration:

```
routing-instances {
```

```

routing-instance-name {
    instance-type vpls;
    interface interface-name;
    route-distinguisher (as-number:number | ip-address:number);
    vrf-import [ policy-names ];
    vrf-export [ policy-names ];
    protocols {
        vpls {
            ... vpls configuration ...
        }
    }
}

```

You can include these statements at the following hierarchy levels:

- [edit]
- [edit logical-systems *logical-system-name*]

For more information about configuring VPLS, see the *JUNOS VPNs Configuration Guide*. For a detailed VPLS example configuration, see the *JUNOS Feature Guide*.

Multicast Snooping and STP

Snooping occurs when a Layer 2 protocol such as a Spanning Tree Protocol (STP) is aware of the operational details of a Layer 3 protocol such as the Internet Group Management Protocol (IGMP) or other multicast protocol. Snooping is necessary when Layer 2 devices such as VLAN switches must be aware of Layer 3 information such as the Media Access Control (MAC) addresses of members of a multicast group.

Root protection is an STP process in which only one interface in a multihomed environment is actively forwarding STP protocol frames. This protects the root of the spanning tree against bridging loops, but also prevents both devices in the multihomed topology from snooped information, such as IGMP membership reports. For example, consider a collection of multicast-capable hosts connected to two customer edge (CE) routers (CE1 and CE2) which are connected to each other (a CE1–CE2 link is configured) and multihomed to two provider edge (PE) routers (PE1 and PE2, respectively). The active PE will only receive forwarded STP information on the active PE–CE link, due to root protection operation. As long as the CE1–CE2 link is operational, this is not a problem. However, if the link between CE1 and CE2 fails, and the other PE becomes the active STP link, no multicast snooping information is available on the new active PE. The new active PE will not forward multicast traffic to the CE and the hosts serviced by this CE router.

The service outage is corrected once the hosts send new group membership IGMP reports to the CE routers. However, the service outage is avoidable using the **ignore-stp-topology-changes** statement, which ensures that multicast snooping information is available to both PEs in spite of normal STP root protection operation. You configure the **ignore-stp-topology-changes** statement at the [edit routing-instances *routing-instance-name* bridge-domains *bridge-domain-name* multicast-snooping-options] hierarchy level. You can include this statement for the vpls and virtual-switch type of routing instance.

This example configures the multicast snooping option for a bridge domain named **Ignore-STP** in a VPLS routing instance named **multihomed-CEs**:

```
[edit routing-instances]
multihomed-CEs {
  instance-type vpls;
  bridge-domains Ignore-STP {
    multicast-snooping-options {
      ignore-stp-topology-change;
    }
  }
}
```



NOTE: This is not a complete router configuration.

For more information about multicast snooping, see the *JUNOS Multicast Protocols Configuration Guide*. For more information about STPs (xSTP), see “Configuring Spanning Tree Protocols” on page 119.

Load Balancing and Ethernet Link Aggregation

You can create a link aggregation group (LAG) for a group of Ethernet ports. Layer 2 bridging traffic is load balanced across the member links of this group, making the configuration attractive for congestion concerns as well as for redundancy. You can configure up to 480 LAG bundles on a Juniper Networks MX Series Ethernet Services Router. Each LAG bundle contains up to 16 links.

By default, the hash key mechanism to load-balance frames across LAG interfaces is based on Layer 2 fields (such as frame source and destination address) as well as the input logical interface (unit). No Layer 3 or Layer 4 fields are examined and are part of the default hash process, so the default is not optimized for Layer 2 switching (the frame source and destination MAC addresses are the same). In a Layer 2 switch, one link is overutilized and other links are underutilized.

You can configure the load balancing hash key for Layer 2 traffic to use fields in the Layer 3 and Layer 4 headers inside the frame payload for load-balancing purposes using the **payload** statement. You can configure the statement to look at **layer-3** (and **source-address-only** or **destination-address-only** packet header fields) or **layer-4** fields. You configure this statement at the **[edit forwarding-options hash-key family multiservice]** hierarchy level.

This example configures the load-balancing hash key to use the source Layer 3 IP address option and Layer 4 header fields as well as the source and destination MAC addresses for load balancing on a LAG link:

```
[edit forwarding-options hash-key]
family multiservice {
  source-mac;
  destination-mac;
  payload {
    ip {
      layer-3 {
        source-address-only;
      }
    }
  }
}
```

```

    }
    layer-4;
  }
}

```

You can configure Layer 3 or Layer 4 options, or both. The **source-address-only** or **destination-address-only** options are mutually exclusive. The **layer-3-only** statement is not available on MX Series routers.

For more information about LAG configuration, see the *JUNOS Network Interfaces Configuration Guide*.

Enabling Layer 2 Address Learning in Logical Systems

On MX Series routers only, you can enable Layer 2 address learning or spanning tree protocols in a logical systems for bridge domains and other virtual-switch routing instances. To configure Layer 2 address learning or spanning tree protocols in a logical systems for bridge domains and other virtual-switch routing instances, include the **bridge-domains** or **switch-options** or **protocols (mstp | rstp | vstp)** statements at the **[edit logical-systems *logical-system-name*]** hierarchy level.

The following example configures a logical system and routing instance with its own bridge domain (**bd1**), switch options and spanning tree protocol (**rstp**).

```

[edit interfaces]
ge-5/0/1 {
  flexible-vlan-tagging;
}
[edit logical-systems]
logical-sys1 {
  interfaces {
    ge-5/0/1 {
      unit 0 {
        family bridge {
          interface-mode trunk;
          vlan-id-list 1–5;
        }
      }
      unit 3 {
        family bridge {
          interface-mode trunk;
          vlan-id-list 11–15;
        }
      }
    }
  }
  ge-5/0/2 {
    unit 0 {
      family bridge {
        interface-mode trunk;
        vlan-id-list 1–5;
      }
    }
  }
}

```

```

routing-instances {
  routing-inst-1 {
    interface ge-5/0/2;
    instance-type virtual-switch;
    bridge-domains {
      vlan-id 1;
    }
    protocols {
      rstp {
        interface ge-5/0/2;
      }
    }
  }
}
bridge-domains {
  bd-1 {
    vlan-id 1;
  }
}
switch-options {
  interface ge-5/0/1.3 {
    interface-mac-limit {
      1400;
    }
    packet-action drop;
  }
}
protocols {
  rstp {
    interface ge-5/01;
  }
}
}

```



NOTE: This is not a complete router configuration.

You can only configure 16 logical systems. Logging is performed for the entire device and not per logical system. You cannot restart Layer 2 learning for an individual logical system.

Chapter 3

Configuring Layer 2 Port Mirroring

This chapter describes how to configure Layer 2 port mirroring on Juniper Networks MX Series Ethernet Services Routers.

- Layer 2 Port Mirroring Overview on page 19
- Layer 2 Port Mirroring Features on page 20
- Layer 2 Port-Mirroring Restrictions on page 21
- Configuring Global Layer 2 Port Mirroring Properties on page 22
- Configuring Layer 2 Port Mirroring for Specific DPCs or Packet Forwarding Engines on page 23
- Configuring Layer 2 Port Mirroring for Logical Interfaces, Forwarding Tables, or Flood Tables on page 27
- Layer 2 Port Mirroring with Next-Hop Groups on page 31
- Layer 2 Port Mirroring and Multiple Instances on page 32
- Example: Configuring Layer 2 Port Mirroring for a Logical Interface on page 34
- Example: Configuring Layer 2 Port Mirroring for a Layer 2 VPN on page 36
- Example: Configuring Layer 2 Port Mirroring for a Layer 2 VPN with Aggregated Ethernet Links on page 38
- Example: Configuring Layer 2 Port Mirroring with Next-Hop Groups on page 41

Layer 2 Port Mirroring Overview

On routing platforms that contain an Internet Processor II ASIC, you can send a copy of any incoming packet from the routing platform to an external host address or a packet analyzer for analysis. This is known as port mirroring.

In JUNOS Release 9.3 and later, Juniper Networks MX Series Ethernet Services Routers support port mirroring for Layer 2 bridging traffic. Layer 2 port mirroring enables you to specify the manner in which incoming and outgoing packets at specified ports in a bridging environment are monitored and sampled and the manner in which copies of the sampled packet are forwarded to another destination, where the packets can be analyzed.

MX Series routers support Layer 2 port mirroring by performing flow monitoring functions using a class-of-service (CoS) architecture that is in concept similar to, but in particulars different from, other routing platforms. For general information about

packet flow within MX Series routers and other routers, see the *JUNOS Class of Service Configuration Guide*.

In a Layer 2 environment, MX Series routers support port mirroring of VPLS (family **bridge** or family **vpls**) traffic. MX Series routers also support port mirroring for Layer 2 VPNs (L2 VPNs) with family **ccc**. In a Layer 3 environment, MX Series routers support port mirroring of IPv4 (family **inet**) and IPv6 (family **inet6**) traffic. Like the M120 Multiservice Edge Router and M320 Multiservice Edge Routers, MX Series routers support port mirroring of IPv4, IPv6, and VPLS packets simultaneously.

This chapter describes port mirroring of Layer 2 bridging traffic that passes through an MX Series router. For information about Layer 3 port mirroring, see the *JUNOS Policy Framework Configuration Guide*.

Layer 2 Port Mirroring Features

This section describes the features of Layer 2 port mirroring:

- Different Port-Mirroring Properties for Different Router Interfaces on page 20
- Input Packet-Sampling Properties on page 21
- Mirror Destination Properties on page 21

Different Port-Mirroring Properties for Different Router Interfaces

You can configure different sets of Layer 2 port-mirroring properties, known as port-mirroring instances, for different interfaces on an MX Series router:

- All ports in the chassis—The set of Layer 2 port mirroring properties configured at the [edit forwarding-options port-mirroring] hierarchy level is known as the global port-mirroring instance. If configured, these properties implicitly apply to all VPLS packets received on all ports in the router chassis. For detailed configuration information, see “Configuring Global Layer 2 Port Mirroring Properties” on page 22.
- Ports for a specific DPC or Packet Forwarding Engine—You can configure multiple, named port-mirroring instances, with each instance specifying different input sampling properties and output mirror destination properties. A named port-mirroring instance can be applied to a specific DPC to override the port-mirroring properties configured by the global port-mirroring instance. A named port-mirroring instance can also be applied to a specific Packet Forwarding Engine to override the port-mirroring properties configured for the DPC or for the global port-mirroring instance. For detailed configuration information, see “Configuring Layer 2 Port Mirroring for Specific DPCs or Packet Forwarding Engines” on page 23.
- A logical interface or a bridge domain forwarding table—You can configure a Layer 2 port-mirroring firewall filter that can be applied to a logical interface (including an aggregated Ethernet interface), the forwarding table of a bridge domain, or the flood table of a VPLS routing instance. A Layer 2 port-mirroring firewall filter uses the input sampling properties and output mirror destination properties configured in the global port-mirroring instance. In a Layer 2 port-mirroring firewall filter configuration, you can include one or more actions (under the **then** statement along with the **port-mirror** action modifier) that are to

be taken on the mirrored packets. For detailed configuration information, see “Configuring Layer 2 Port Mirroring for Logical Interfaces, Forwarding Tables, or Flood Tables” on page 27.

Input Packet-Sampling Properties

The input packet-sampling properties of Layer 2 port-mirroring instance specify how the input packets are to be selected for mirroring:

- The **rate** specifies the number of packets in each sample.
- The **run-length** specifies the number of packets to mirror from each sample.

Mirror Destination Properties

The mirror destination properties of a Layer 2 port-mirroring instance specify the destination of the mirrored packets:

- The number of port-mirroring destinations supported for an MX Series router is limited to the number of Packet Forwarding Engines contained on the dense port concentrators (DPCs) installed in the router chassis. To determine the number and type of DPCs in an MX Series router chassis, use the **show chassis hardware** command.
- If port mirroring is enabled at both ingress and egress interfaces, you can prevent the MX Series router from sending duplicate packets to the same destination (which would complicate the analysis of the mirrored traffic) by enabling the **mirror-once** option.



NOTE: In typical applications, you send the sampled packets to an analyzer or a workstation for analysis, not to another router. If you must send this traffic over a network, you should use tunnels. For Layer 2 VPN implementations, you can use the Layer 2 VPN routing instance type **l2vpn** to tunnel the packets to a remote destination. For information about configuring a routing instance for Layer 2 VPN, see the *JUNOS VPNs Configuration Guide*. For a detailed Layer 2 VPN example configuration, see the *JUNOS Feature Guide*. For information about tunnel interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

Layer 2 Port-Mirroring Restrictions

The following restrictions apply to Layer 2 port mirroring:

- The port-mirrored input interface should not participate in any kind of routing activity.
- The mirror destination device should be on a dedicated bridge domain and should not participate in any bridging activity: The mirror destination device should not have a route to the ultimate traffic destination, and the mirror destination device should not send the sampled packets back to the source address.

For example, if the VPLS packets sampled at 192.168.20.5 have a destination address of 192.168.9.10 and the port-mirrored traffic is sent to 192.168.20.15 for analysis, the device associated with 192.168.20.15 must not know a route to 192.168.9.10 and not send the mirrored packets back to 192.168.20.5.

- Only Layer 2 transit data can be mirrored. Packets generated by the Routing Engine (such as Layer 2 control packets) are not mirrored.
- For either the global port-mirroring instance or a named port-mirroring instance, you can configure only one mirror output interface per port-mirroring instance and packet address family. If you include more than one `interface` statement under the `family (bridge | vpls) output` statement, the previous `interface` statement is overridden.
- Layer 2 port mirroring of input or output to a logical interface, input to a forwarding table in a bridge domain, or input to a flood table for a VPLS routing instance is not supported for logical systems.

Configuring Global Layer 2 Port Mirroring Properties

This section describes how to configure the set of Layer 2 port-mirroring properties that apply to all ports in the chassis:

- Configuring Packet-Sampling and Mirror Destination Properties on page 22
- Configuring Mirror-Once Mode on page 23

Configuring Packet-Sampling and Mirror Destination Properties

To configure global port-mirroring properties for a Layer 2 packet address family, include the `input` statement and the `family (bridge | ccc | vpls) output` statement at the `[edit forwarding-options port-mirroring]` hierarchy level:

```
[edit]
forwarding-options {
  port-mirroring {
    input { # Input packet-sampling properties
      maximum-run-length number;
      rate number;
      run-length number;
    }
    family (bridge | ccc | vpls) {
      output { # Mirror destination properties
        interface interface-name;
        no-filter-check; # Optional
      }
    }
  }
}
```

To configure input packet-sampling properties, include the `input` statement at the `[edit forwarding-options port-mirroring]` hierarchy level. To specify the number of packets in a sample, include the `rate number` statement. To specify the number of sampled packets to mirror, include the `run-length number` statement.

To configure the length to which mirrored packets are truncated, include the `maximum-packet-length` statement at the `[edit forwarding-options port-mirroring input]` hierarchy level. The default value is 0, which means the mirrored packets are not truncated. The valid range is 0 through 9216.

To configure the mirror destination properties, include the `family (bridge | ccc | vpls) output` statement at the `[edit forwarding-options port-mirroring]` hierarchy level. To specify the physical interface on which to send the duplicate packets, include the `interface interface-name` statement.



NOTE: Under the `[edit forwarding-options port-mirroring]` hierarchy level, the protocol family statement `family bridge` is an alias for `family vpls`. The command-line interface (CLI) displays Layer 2 port-mirroring configurations as `family vpls`, even for Layer 2 port-mirroring configured as `family bridge`.

If you need to allow configuration of filters on the destination interface for the global port-mirroring instance, include the `no-filter-check` statement. If you apply a filter to an interface that is a Layer 2 port-mirroring destination, a commit failure is returned unless you included the `no-filter-check` option at the `[edit forwarding-options port-mirroring family (bridge | ccc | vpls) output]` hierarchy level.

Configuring Mirror-Once Mode

When an MX Series router is configured to Layer 2 port mirroring at both ingress and egress interfaces, and the same packet could be mirrored twice. You can configure an MX Series router to mirror traffic only once, so that the router does not send duplicate sampled packets to the same mirroring destination. To configure, include the `mirror-once` statement at the `[edit forwarding-options port-mirroring]` hierarchy level.

```
[edit]
forwarding-options {
  port-mirroring {
    mirror-once; # Mirror destinations do not receive duplicate packets
    input {
      ... input-sampling-configuration ...
    }
    family (bridge | ccc | vpls) {
      output {
        ... mirroring-destination-configuration ...
      }
    }
  }
}
```

Configuring Layer 2 Port Mirroring for Specific DPCs or Packet Forwarding Engines

You can configure multiple instances of Layer 2 port mirroring to enable different Packet Forwarding Engines to mirror packets to different destinations. You can bind a port-mirroring instance to a specific Dense Port Concentrator (DPC) or to a specific Packet Forwarding Engine.



NOTE: MX Series routers use DPCs rather than Flexible Port Concentrators (FPCs) and therefore do not support PICs. In the JUNOS CLI, however, 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.

The following sections describe how to configure Layer 2 port mirroring for a specific DPC or Packet Forwarding Engine:

- Configuring Layer 2 Port-Mirroring Instances on page 24
- Determining the Number of DPCs in an MX Series Router on page 25
- Binding a Layer 2 Port-Mirroring Instance to a DPC on page 25
- Binding a Layer 2 Port-Mirroring Instance to a Packet Forwarding Engine on page 26
- Precedence of Port-Mirroring Instances at Different Levels of the Chassis on page 26

Configuring Layer 2 Port-Mirroring Instances

A Layer 2 port-mirroring instance is a named set of port-mirroring properties that you can associate with a particular Packet Forwarding Engine to mirror packets to different destinations. To configure a Layer 2 port-mirroring instance, include the instance *pm-instance-name* statement at the [edit forwarding-options port-mirroring] hierarchy level:

```
[edit]
forwarding-options {
  port-mirroring {
    instance {
      pm-instance-name-a { # One port-mirroring instance for this router
        input {
          maximum-run-length number;
          rate number;
          run-length number;
        }
        family (bridge | ccc | vpls) {
          output {
            interface interface-name;
            no-filter-check; # Optional
          }
        }
      }
      pm-instance-name-z { # Another port-mirroring instance for this router
        input {
          maximum-run-length number;
          rate number;
          run-length number;
        }
        family (bridge | ccc | vpls) {
          output {
            interface interface-name;
            no-filter-check; # Optional
          }
        }
      }
    }
  }
}
```

```

    }
  }
}

```

To configure input packet-sampling properties, include the `input` statement at the `[edit forwarding-options port-mirroring instance pm-instance-name]` hierarchy level. To specify the number of packets in a sample, include the `rate number` statement. To specify the number of sampled packets to mirror, include the `run-length number` statement.

To configure the mirror destination properties, include the `family (bridge | vpls) output` statement at the `[edit forwarding-options port-mirroring instance pm-instance-name]` hierarchy level. To specify the physical interface on which to send the duplicate packets, include the `interface interface-name` statement.



NOTE: Under the `[edit forwarding-options port-mirroring instance pm-instance-name]` hierarchy level, the protocol family statement `family bridge` is an alias for `family vpls`. The CLI displays Layer 2 port-mirroring configurations as `family vpls`, even for Layer 2 port-mirroring configured as `family bridge`.

If you need to allow configuration of filters on the destination interface for a named port-mirroring instance, include the `no-filter-check` statement. If you apply a filter to an interface that is a Layer 2 port-mirroring destination, a commit failure is returned unless you included the `no-filter-check` option at the `[edit forwarding-options port-mirroring instance pm-instance-name family (bridge | vpls) output]` hierarchy level.

Determining the Number of DPCs in an MX Series Router

To display information about the number and types of DPCs in an MX Series router, the number of Packet Forwarding Engines on each DPC, and the number and types of ports per Packet Forwarding Engine, use one of the following chassis operational mode commands:

- `show chassis hardware`
- `show chassis fabric fpcs`

For more information about chassis operational mode commands, see the *JUNOS System Basics and Services Command Reference*.

Binding a Layer 2 Port-Mirroring Instance to a DPC

You can bind a Layer 2 port-mirroring instance with a specific DPC so that the port-mirroring properties in that instance are applied to all Packet Forwarding Engines (and their associated ports) on that DPC. Port-mirroring properties that are bound to a DPC override the global port-mirroring properties (if the `port-mirroring` statement has been included at the `[edit forwarding-options]` hierarchy level).

To bind a named port-mirroring instance to a specific DPC and its Packet Forwarding Engines, include the `port-mirror-instance pm-instance-name` statement at the `[edit chassis fpc slot-number]` hierarchy level.

```
[edit]
chassis {
  fpc slot-number {
    port-mirror-instance pm-instance-name;
  }
}
```

Binding a Layer 2 Port-Mirroring Instance to a Packet Forwarding Engine

You can bind a Layer 2 port-mirroring instance to a specific Packet Forwarding Engine so that the port-mirroring properties in that instance are applied to all ports associated with that Packet Forwarding Engine. Port-mirroring properties that are bound to a Packet Forwarding Engine override port-mirroring properties bound to the DPC (if the `port-mirroring` statement has been included at the `[edit forwarding-options]` hierarchy level).



NOTE: For MX960 routers, there is a one-to-one mapping of Packet Forwarding Engines to Ethernet ports. Therefore, on MX960 routers only, you can configure port-specific bindings of port-mirroring instances.

To associate a port-mirroring instance with a Packet Forwarding Engine and its associated ports, include the `port-mirror-instances pm-instance-name-b` statement at the `[edit chassis fpc slot-number pic slot-number]` hierarchy level:

```
[edit]
  fpc slot-number {
    port-mirror-instance pm-instance-name-a;
    pic slot-number {
      port-mirror-instance pm-instance-name-b;
    }
  }
}
```

Precedence of Port-Mirroring Instances at Different Levels of the Chassis

If port-mirroring instances are configured at multiple levels in the Juniper networks MX Series Ethernet Services Router hierarchy, the port-mirroring properties are applied as follows:

1. **Chassis-level port-mirroring properties apply to all ports in the chassis.** If an MX Series router is configured with the global port-mirroring instance, those chassis-level properties apply to all DPCs and their Packet Forwarding Engines and their associated ports.
2. **FPC-level port-mirroring properties override chassis-level properties.** If a DPC is bound to a named port-mirroring instance, those FPC-level properties apply to all Packet Forwarding Engines (and their associated ports) on the DPC and override the properties bound at the chassis level (if the `port-mirroring` statement has been included at the `[edit forwarding-options]` hierarchy level).

3. **PIC-level port-mirroring properties override FPC-level properties.** If a Packet Forwarding Engine is bound to a named port-mirroring instance, those PIC-level port-mirroring properties apply to all ports associated with the Packet Forwarding Engine and override the properties bound at the FPC level (if the `port-mirror-instance pm-instance-name-a` statement has been included at the [edit chassis fpc slot-number] hierarchy level).

Configuring Layer 2 Port Mirroring for Logical Interfaces, Forwarding Tables, or Flood Tables

You can configure Layer 2 port mirroring by configuring a firewall filter action and then applying the filter at various input or output points in the MX Series Ethernet Services Router. A Layer 2 port-mirroring firewall filter can be applied to an input or output to a logical interface, including aggregated Ethernet, to an input to a forwarding table for a bridge domain, or to an input to a flood table for a VPLS routing instance:

- Configuring a Layer 2 Port-Mirroring Firewall Filter on page 27
- Applying a Layer 2 Port-Mirroring Filter to a Logical Interface on page 28
- Behavior of a Port-Mirroring Filter Applied to an Aggregated Ethernet Interface on page 29
- Applying a Layer 2 Port-Mirroring Filter to the Forwarding Table on a Bridge Domain on page 30
- Applying a Layer 2 Port-Mirroring Filter to the Flood Table on a VPLS Routing Instance on page 30

Configuring a Layer 2 Port-Mirroring Firewall Filter

For the VPLS (family bridge or family vpls) traffic only, MX Series router firewall filters can be configured to perform port mirroring if the packet matches the conditions configured in the firewall filter term. A firewall filter configured to perform port mirroring can be applied to input or output logical interfaces, including aggregated Ethernet logical interfaces, or to input to forwarding tables or input to flood tables of bridge domains or VPLS routing instances.

To configure a Layer 2 port-mirroring firewall filter, include the following statements:

```
[edit]
firewall {
  family (bridge | ccc | vpls) {
    filter pm-filter-name {
      term term-name {
        from { # Do not specify match conditions based on route source address
        }
        then {
          action; # Recommended action is 'accept'
          port-mirror;
        }
      }
    }
  }
}
```

To configure a firewall filter, include the **filter** *pm-filter-name* statement at the [edit firewall family (bridge | ccc | vpls)] hierarchy level.

To configure a firewall filter term, include the **term** *term-name* statement at the [edit firewall family (bridge | ccc | vpls)] filter *pm-filter-name* hierarchy level.

Under the [edit firewall family (bridge | ccc | vpls)] filter *pm-filter-name* term *term-name* hierarchy level, do not include the optional **from** statement that specifies match conditions based on the route source address. Omit this statement so that all packets are considered to match and all actions specified in the **then** statement are taken.

To configure the actions to be taken on matching packets, include the **then** statement under the [edit firewall family (bridge | vpls)] filter *pm-filter-name* term *term-name* hierarchy level. Within the term, specify an optional **action** and the **port-mirror** action modifier:

- If you do not specify an action, all input packets are accepted. The recommended action is **accept**.
- The **port-mirror** action modifier causes the firewall filter to use the input packet-sampling properties and address family-specific mirror destination properties configured for the Layer 2 port-mirroring global instance of the same family (configured at the [edit forwarding-options port-mirroring] hierarchy level).

Because the **port-mirror** filter action modifier relies on the global port-mirroring properties, which are configured at the [edit forwarding-options port-mirroring] hierarchy level, the **port-mirror** filter action is not supported for logical systems.

For detailed information about configuring firewall filters in general (including in a Layer 3 environment), see the *JUNOS Policy Framework Configuration Guide*.

Applying a Layer 2 Port-Mirroring Filter to a Logical Interface

If you apply a Layer 2 port-mirroring firewall filter to a logical interface, only packets received on that logical interface are mirrored. To apply a port-mirroring firewall filter to an input or output logical interface, include the **input** or **output** statement at the [edit interfaces *interface-name* unit *logical-unit-number* family (bridge | ccc | vpls) filter] hierarchy level.

- If the filter is to be evaluated when packets are received on the interface, include the **input** *filter-name* statement.
- If the filter is to be evaluated when packets are sent on the interface, include the **output** *filter-name* statement.



NOTE: A port-mirroring firewall filter can also be applied to an aggregated-Ethernet logical interface.

```
[edit]
interfaces {
  interface-name {
    vlan-tagging;
```



```

encapsulation extended-vlan-bridge;
unit number { # Apply a filter to the input of this interface
    vlan-id number;
    family (bridge | ccc | vpls) {
        filter {
            input pm-filter-name-a;
        }
    }
}
unit number { # Apply a filter to the output of this interface
    vlan-id number;
    family (bridge | ccc | vpls) {
        filter {
            output pm-filter-name-b;
        }
    }
}
}
}

```

If port-mirroring firewall filters are applied at both the input and output of a logical interface, two copies of each packet are mirrored. To prevent the router from forwarding duplicate packets to the same destination, include the optional `mirror-once` statement at the [edit forwarding-options] hierarchy level.

Behavior of a Port-Mirroring Filter Applied to an Aggregated Ethernet Interface

You can apply a Layer 2 port-mirroring firewall filter to an aggregated Ethernet interface to configure port-mirroring at the parent interface. However, if any child interfaces are bound to different Layer 2 port-mirroring instances, packets received at the child interfaces will be mirrored to the destinations specified by their respective port-mirroring instances. Thus, multiple child interfaces can mirror packets to multiple destinations.

For example, suppose the parent aggregated Ethernet interface instance `ae0` has two child interfaces:

- `xe-2/0/0`
- `xe-3/1/2`

Also suppose that these child interfaces on `ae0` are each bound to a different Layer 2 port-mirroring instance:

- `pmi-A`—Layer 2 port-mirroring instance bound to child interface `xe-2/0/0`
- `pmi-B`—Layer 2 port-mirroring instance bound to child interface `xe-3/1/2`

If you apply a Layer 2 port-mirroring firewall filter to `ae0.0` (logical unit 0 on the aggregated Ethernet interface instance 0). This enables port mirroring on `ae0.0`, which has the following effect on the processing of traffic received on the child interfaces for which Layer 2 port-mirroring properties are specified:

- The packets received on `xe-2/0/0.0` are mirrored to the output interfaces configured in port-mirroring instance `pmi-A`.

- The packets received on `xe-3/1/2.0` are mirrored to the output interfaces configured in port-mirroring instance `pmi-B`.

Because `pmi-A` and `pmi-B` might specify different input packet-sampling properties or mirror destination properties, the packets received on `xe-2/0/0.0` and `xe-3/1/2.0` can mirror different packets to different destinations.

Applying a Layer 2 Port-Mirroring Filter to the Forwarding Table on a Bridge Domain

If a port-mirroring firewall filter is applied to the forwarding table on a bridge domain, any packet received in the bridge domain that matches the filter is mirrored.

To apply a Layer 2 port-mirroring firewall filter to the forwarding table of a bridge domain, include the following statements:

```
bridge-domains {
  bridge-domain-name {
    domain-type bridge;
    interface interface-name;
    forwarding-options {
      filter {
        input pm-filter-name;
      }
    }
  }
}
```

You can include the statements at the following hierarchy levels:

- `[edit]`
- `[edit routing-instances routing-instance-name]`

Specify the Layer 2 port-mirroring firewall filter in the input `pm-filter-name` statement.

Applying a Layer 2 Port-Mirroring Filter to the Flood Table on a VPLS Routing Instance

If a port-mirroring firewall filter is applied to the flood table on a VPLS routing instance, any packet received in the VPLS routing instance that matches the filter is mirrored.

To apply a Layer 2 port-mirroring firewall filter to the flood table of a VPLS routing instance, include the input `pm-filter-name` statement at the `[edit forwarding-options family vpls flood]` hierarchy level:

```
[edit]
forwarding-options {
  family vpls {
    flood {
      input pm-filter-name
    }
  }
}
```

Layer 2 Port Mirroring with Next-Hop Groups

You can mirror a packet to multiple destinations using next-hop groups. Port mirroring sends a copy of a packet to a destination other than the normal next-hop link. On MX Series routers, you can mirror packets to next-hop groups that contain Layer 2 members, Layer 3 members, and either unit list (mirroring packets to each interface) or load-balanced (mirroring packets to one of several interfaces) subgroups. The configured next-hop groups are used in firewall filters attached to tunnel interfaces (vt- or lt-) and mirrors packets to multiple destinations. You can also reference two port-mirroring instances in the same firewall filter.



NOTE: The mirroring of packets to multiple destinations without the use of tunnel interfaces and tunnel PICs is not supported. The use of IPv6 addresses in next-hop groups is not supported. The use of subgroups for load-balancing mirrored traffic is not supported.

You configure Layer 2 port mirroring next-hop group parameters with the **group-type** (**inet** | **layer-2**) statement. By default, the group type for a next-hop group is **inet**. You configure the **group-type** statement at the [edit forwarding-options port-mirroring family *family-name* next-hop-group *next-hop-group-name*] hierarchy level. The members of the next-hop group can be physical interfaces, services PICs (**sp-**), or next-hop subgroups. You can configure more than one subgroup under a next-hop group.

This example shows the configuration options for Layer 2 port mirroring with next-hop groups:

```
[edit forwarding-options port-mirroring]
next-hop-group ftp-traffic {
  group-type inet; # This will be default group type
  interface ge-4/3/0.0 {
    next-hop 10.12.1.2;
  }
  interface ge-0/3/0.0 {
    next-hop 10.13.1.2;
  }
}
next-hop-group l2-traffic-nhg {
  group-type layer-2; # Next-hop group of L2 (bridge) interfaces
  interface ge-2/1/0.0;
  interface ge-2/1/1.0;
  next-hop-subgroup l2-subg {
    interface ge-4/0/0.2;
    interface ge-3/2/1.4;
  }
}
next-hop-group serv-pics-nhg {
  group-type layer-2; # Services interfaces
  interface sp-0/1/0.0;
  interface sp-0/1/1.0;
  next-hop-subgroup serv-pic-subg1 {
    interface sp-0/2/1.0;
```

```

        interface sp-0/3/1.0;
        interface sp-0/4/1.0;
    }
    next-hop-subgroup serv-pic-subg2 {
        ...
    }
}

```



NOTE: This is not a complete port-mirroring configuration.

For a more complete example of Layer 2 port mirroring with next-hop groups, see “Example: Configuring Layer 2 Port Mirroring with Next-Hop Groups” on page 41.

Layer 2 Port Mirroring and Multiple Instances

You can configure up to two port-mirroring instances at either the FPC or PIC level of the chassis. However, you can configure only one instance at the global instance level [edit forwarding-options port-mirroring]. The system looks at port-mirroring parameters established at the PIC level first, then at the FPC level, and finally at the global level.

The following examples establish two port-mirroring instances, first both at the PIC level, then at both the FPC and PIC levels, and finally both at the FPC level.

Two Instances at the PIC Level

```

[edit chassis]
fpc 2 {
  pic 0 {
    port-mirror-instance pm1;
    port-mirror-instance pm2;
  }
}

```

Instances at the FPC and PIC Level

```

[edit chassis]
fpc 2 {
  port-mirror-instance pm1;
  pic 0 {
    port-mirror-instance pm2;
  }
}

```

Two Instances at the FPC Level

```

[edit chassis]
fpc 2 {
  port-mirror-instance pm1;
  port-mirror-instance pm2;
}

```

Because you can configure more than one port-mirroring instance, care is required when specifying which instance is meant. If you use the **port-mirror** statement, then this applies to the first instance or the global instance (this is done for backward compatibility). To refer to a particular instance for port mirroring, use the **port-mirror-instance *instance-name*** statement.

Consider the following example of port mirroring with multiple instances:

```
[edit firewall]
family inet {
  filter pm_ipv4_filter1 {
    term pm {
      then port-mirror-instance pm_inst1;
    }
  }
  filter pm_ipv4_filter2 {
    term pm {
      then port-mirror;
    }
  }
}
[edit chassis]
fpc 2{
  pic 0{
    port-mirror-instance pm_inst1;
    port-mirror-instance pm_inst2;
  }
}
[edit interfaces]
ge-2/0/1 {
  flexible-vlan-tagging;
  encapsulation flexible-ethernet-services;
  unit 0 {
    vlan-id 201;
    family inet {
      filter {
        input pm_ipv4_filter1; # Uses port-mirror-instance
      }
    }
  }
  unit 1 {
    vlan-id 202;
    family inet {
      filter {
        input pm_ipv4_filter2; # Uses port-mirror
      }
    }
  }
}
```

When the **port-mirror** statement is used, if multiple instances are bound to the PFE, the instance which was bound first (or the only instance) is used. This is done mainly for backward compatibility. In the example, filter **pm_ipv4_filter2** on interface **ge-2/0/1.1** uses **port-mirror** and mirrors using instance **pm_inst-1**, the first instance configured under the chassis hierarchy.

If the PFE inherits the global instance (that is, there is a global instance and none on the PFE), the global instance is used if and only if the **port-mirror** statement is used. However, if the **port-mirror-instance** statement is used and there is no instance defined at the PFE level, the global instance is not used even if defined. In the example, if the **[edit chassis]** hierarchy is deactivated, no port mirroring will take place with filter **pm_ipv4_filter1** on interface **ge-2/0/1.0** with the statement **port-mirror-instance pm_inst1**.

because the `port-mirror-instance` statement cannot be used to reference the global port-mirroring instance. However, even without the `[edit chassis]` hierarchy, interface `ge-2/0/1.1` will still mirror because it references the global instance with the `port-mirror` statement.

Example: Configuring Layer 2 Port Mirroring for a Logical Interface

The following steps describe an example in which the global port-mirroring instance and a port-mirroring firewall filter are used to configure Layer 2 port mirroring for the input to a logical interface.

1. Configure the bridge domain `example-bd-with-analyzer`, which contains the external packet analyzer, and the bridge domain `example-bd-with-traffic`, which contains the source and destination of the Layer 2 traffic being mirrored:

```
[edit]
bridge-domains {
  example-bd-with-analyzer { # Contains an external traffic analyzer
    vlan-id 1000;
    interface ge-2/0/0.0; # External analyzer
  }
  example-bd-with-traffic { # Contains traffic input and output interfaces
    vlan-id 1000;
    interface ge-2/0/6.0; # Traffic input port
    interface ge-3/0/1.2; # Traffic output port
  }
}
```

Assume that logical interface `ge-2/0/0.0` is associated with an external traffic analyzer that is to receive port-mirrored packets. Assume that logical interfaces `ge-2/0/6.0` and `ge-3/0/1.2` will be traffic input and output ports, respectively.

2. Configure Layer 2 port-mirroring for the global instance, with the port-mirroring destination being the bridge domain interface associated with the external analyzer (logical interface `ge-2/0/0.0` on bridge domain `example-bd-with-analyzer`). Be sure to enable the option that allows filters to be applied to this port-mirroring destination:

```
[edit]
forwarding-options {
  port-mirroring {
    input {
      rate 10;
      run-length 5;
    }
    family bridge {
      output {
        interface ge-2/0/0.0; # Mirror packets to the external analyzer
        no-filter-check; # Allow filters on the mirror destination interface
      }
    }
  }
}
```

The **input** statement under the **[edit forwarding-options port-mirroring]** hierarchy level specifies that sampling begins every tenth packet and that each of the first five packets sampled are to be mirrored.

The **output** statement under the **[edit forwarding-options port-mirroring family bridge]** hierarchy level specifies the output mirror interface for Layer 2 packets in a bridging environment:

- Logical interface **ge-2/0/0.0**, which is associated with the external packet analyzer, is configured as the port-mirroring destination.
- The optional **no-filter-check** statement allows filters to be configured on this destination interface.

3. Configure the Layer 2 port-mirroring firewall filter **example-bridge-pm-filter**:

```
firewall {
  family bridge {
    filter example-bridge-pm-filter {
      term example-filter-terms {
        then {
          accept;
          port-mirror;
        }
      }
    }
  }
}
```

When this firewall filter is applied to the input or output of a logical interface for traffic in a bridging environment, Layer 2 port mirroring is performed according to the input packet-sampling properties and mirror destination properties configured for the Layer 2 port mirroring global instance. Because this firewall filter is configured with the single, default filter action **accept**, all packets selected by the input properties (**rate = 10** and **run-length = 5**) match this filter.

4. Configure the logical interfaces:

```
[edit]
interfaces {
  ge-2/0/0 { # Define the interface to the external analyzer
    encapsulation ethernet-bridge;
    unit 0 {
      family bridge;
    }
  }
  ge-2/0/6 { # Define the traffic input port
    flexible-vlan-tagging;
    encapsulation extended-vlan-bridge;
    unit 0 {
      vlan-id 100;
      family bridge {
        filter {
          input example-bridge-pm-filter; # Apply the port-mirroring firewall filter
        }
      }
    }
  }
}
```

```

    }
    ge-3/0/1 { # Define the traffic output port
        flexible-vlan-tagging;
        encapsulation extended-vlan-bridge;
        unit 2 {
            vlan-tags outer 10 inner 20;
            family bridge;
        }
    }
}

```

Packets received at logical interface **ge-2/0/6.0** on bridge domain **example-bd-with-traffic** are evaluated by the port-mirroring firewall filter **example-bridge-pm-filter**. The firewall filter acts on the input traffic according to the filter actions configured in the firewall filter itself plus the input packet-sampling properties and mirror destination properties configured in the global port-mirroring instance:

- All packets received at **ge-2/0/6.0** are forwarded to their (assumed) normal destination at logical interface **ge-3/0/1.2**.
- For every ten input packets, copies of the first five packets in that sample are forwarded to the external analyzer at logical interface **ge-0/0/0.0** in the other bridge domain, **example-bd-with-analyzer**.

If you configure the port-mirroring firewall filter **example-bridge-pm-filter** to take the **discard** action instead of the **accept** action, all original packets are discarded while copies of the packets selected using the global port-mirroring **input** properties are sent to the external analyzer.

Example: Configuring Layer 2 Port Mirroring for a Layer 2 VPN

The following example is not a complete configuration, but shows all the steps needed to configure port mirroring on an L2VPN using family **ccc**.

1. Configure the bridge domain **port-mirror-bd**, which contains the external packet analyzer:

```

[edit]
bridge-domains {
    port-mirror-bd { # Contains an external traffic analyzer
        interface ge-2/2/9.0; # External analyzer
    }
}

```

2. Configure the Layer 2 VPN CCC to connect interface **ge-2/0/1.0** and interface **ge-2/0/1.1**:

```

[edit]
protocols {
    mpls {
        interface all;
    }
}
connections {

```



```

        interface-switch if_switch {
            interface ge-2/0/1.0;
            interface ge-2/0/1.1;
        }
    }
}

```

3. Configure Layer 2 port mirroring for the global instance, with the port-mirroring destination being the bridge domain interface associated with the external analyzer (logical interface `ge-2/2/9.0` on bridge domain `example-bd-with-analyzer`):

```

[edit]
forwarding-options {
    port-mirroring {
        input {
            rate 1;
            maximum-packet-length 200;
        }
        family ccc {
            output {
                interface ge-2/2/9.0; # Mirror packets to the external analyzer
            }
        }
        instance {
            inst1 {
                input {
                    rate 1;
                    maximum-packet-length 300;
                }
                family ccc {
                    output {
                        interface ge-2/2/9.0;
                    }
                }
            }
        }
    }
}

```

4. Configure for firewall filter `pm-ccc` for family `ccc`:

```

[edit]
firewall {
    family ccc {
        filter pm_ccc {
            term pm {
                then port-mirror;
            }
        }
    }
}

```

5. Apply the port mirror instance to the chassis:

```

[edit]
chassis {

```

```
fpc 2 {
    port-mirror-instance inst1;
}
```

6. Configure interfaces `ge-2/0/1` (for the VLANs) and `ge-2/2/9` (for port mirroring) with the `pm-ccc` filter:

```
[edit]
interfaces {
    ge-2/0/1 {
        vlan-tagging;
        encapsulation extended-vlan-ccc;
        unit 0 {
            vlan-id 10;
            family ccc {
                filter {
                    input pm_ccc;
                }
            }
        }
        unit 1 {
            vlan-id 20;
            family ccc {
                filter {
                    output pm_ccc;
                }
            }
        }
    }
    ge-2/2/9 {
        encapsulation ethernet-bridge;
        unit 0 {
            family bridge;
        }
    }
}
```

Example: Configuring Layer 2 Port Mirroring for a Layer 2 VPN with Aggregated Ethernet Links

The following example is not a complete configuration, but shows all the steps needed to configure port mirroring on an L2VPN using `family ccc` and aggregated Ethernet (AE) links.

1. Configure the bridge domain `port-mirror-bd`, which contains the external packet analyzer:

```
[edit]
bridge-domains {
    port-mirror-bd { # Contains an external traffic analyzer
        interface ge-2/2/8.0; # External analyzer
    }
}
```

2. Configure the Layer 2 VPN CCC to connect interface `ae0.0` and interface `ae0.1`:

```
[edit]
protocols {
  mpls {
    interface all;
  }
  connections {
    interface-switch if_switch {
      interface ae0.0;
      interface ae0.1;
    }
  }
}
```

3. Configure Layer 2 port mirroring for the global instance, with the port-mirroring destination being the bridge domain interface associated with the external analyzer (logical interface `ge-2/2/9.0` on bridge domain `example-bd-with-analyzer`):

```
[edit]
forwarding-options {
  port-mirroring {
    input {
      rate 1;
      maximum-packet-length 200;
    }
    family ccc {
      output {
        interface ge-2/2/8.0; # Mirror packets to the external analyzer
      }
    }
    instance {
      inst1 {
        input {
          rate 1;
          maximum-packet-length 300;
        }
        family ccc {
          output {
            interface ge-2/2/8.0;
          }
        }
      }
    }
  }
}
```

4. Configure for firewall filter `pm-ccc` for family `ccc`:

```
[edit]
firewall {
  family ccc {
    filter pm_ccc {
      term pm {
        then port-mirror;
      }
    }
  }
}
```

```

    }
  }
}

```

5. Apply the aggregated Ethernet interfaces and port mirror instance to the chassis:

```

[edit]
chassis {
  aggregated-devices {
    ethernet {
      device-count 10;
    }
  }
  fpc 2 {
    port-mirror-instance inst1;
  }
}

```

6. Configure interfaces `ae0` and `ge-2/0/2` (for aggregated Ethernet) and `ge-2/2/8` (for port mirroring) with the `pm_ccc` filter:

```

[edit]
interfaces {
  ae0 {
    vlan-tagging;
    encapsulation extended-vlan-ccc;
    unit 0 {
      vlan-id 10;
      family ccc {
        filter {
          input pm_ccc;
        }
      }
    }
    unit 1 {
      vlan-id 20;
      family ccc {
        filter {
          output pm_ccc;
        }
      }
    }
  }
  ge-2/0/2 {
    gigether-options {
      802.3ad ae0;
    }
  }
  ge-2/2/8 {
    encapsulation ethernet-bridge;
    unit 0 {
      family bridge;
    }
  }
}

```

Example: Configuring Layer 2 Port Mirroring with Next-Hop Groups

The following example is not a complete router configuration, but shows all the steps needed to configure Layer 2 port mirroring to a vt- interface with next-hop groups.

1. Configure the firewall filter `collect_pkts`, which uses an FTP next-hop group:

```
[edit]
firewall {
  family inet {
    filter collect_pkts {
      term ftp-term {
        # This term sends FTP traffic to an FTP next-hop group.
        from {
          protocol ftp;
        }
        then next-hop-group ftp-traffic;
      }
      term default {
        # This term sends all remaining traffic to a final next-hop group.
        then next-hop-group default-collectors;
      }
    }
  }
}
```

2. Configure the tunnel interface `vt-3/3/10.1` and apply the input filter `collect_pkts`:

```
[edit]
interfaces {
  vt-3/3/10 {
    unit 1 {
      family inet {
        filter {
          input collect_pkts;
        }
      }
    }
  }
}
```

3. Configure the port mirroring forwarding options and apply to the `bridge` family:

```
[edit]
forwarding-options {
  port-mirroring {
    input {
      rate 10; # start mirroring every 10th
      run-length 5; # mirror 5 packets
    }
    family bridge {
      output {
        interface vt-3/3/10.1;
        no-filter-check;
      }
    }
  }
}
```

```

    }
  }
}

```

4. Configure the chassis for tunnel services:

```

[edit]
chassis {
  fpc 3 {
    pic 3 {
      tunnel-services {
        bandwidth 1g;
      }
    }
  }
}

```

Chapter 4

Configuring Link Layer Discovery Protocol

This chapter describes how to configure the Link Layer Discovery Protocol (LLDP) on a Juniper Networks MX Series Ethernet Services Router.

- LLDP Overview on page 43
- Configuring LLDP on page 44
- Example: Configuring LLDP on page 46
- Tracing LLDP Operation on page 47

LLDP Overview

The Link Layer Discovery Protocol (LLDP) is an industry-standard, vendor-neutral method to allow networked devices to advertise capabilities, identity, and other information onto a LAN. The Layer 2 protocol, detailed in IEEE 802.1AB-2005, replaces several proprietary protocols implemented by individual vendors for their equipment.

LLDP allows network devices that operate at the lower layers of a protocol stack (such as Layer 2 bridges and switches) to learn some of the capabilities and characteristics of LAN devices available to higher layer protocols, such as IP addresses. The information gathered through LLDP operation is stored in a network device and is queried with SNMP. Topology information can also be gathered from this database.

Some of the information that can be gathered by LLDP (only minimal information is mandatory) is:

- System name and description
- Port name and description
- VLAN name and identifier
- IP network management address
- Capabilities of the device (for example, switch, router, or server)
- MAC address and physical layer information
- Power information
- Link aggregation information

LLDP frames are sent at fixed intervals on each port that runs LLDP. LLDP protocol data units (LLDP PDUs) are sent inside Ethernet frames and identified by their destination Media Access Control (MAC) address (01:80:C2:00:00:0E) and Ethertype

(0x88CC). Mandatory information supplied by LLDP is chassis ID, port ID, and a time-to-live value for this information.

LLDP is a powerful way to allow Layer 2 devices to gather details about other network-attached devices.

Configuring LLDP

You configure LLDP by including the `lldp` statement and associated parameters at the `[edit protocols]` hierarchy level. By default, LLDP is not enabled on interfaces. Minimally, include the `enable` statement at the `[edit protocols lldp]` hierarchy level to enable LLDP on the device. Several enabled features have default values, while others must be configured explicitly. The complete set of LLDP statements follows:

```
lldp {
  advertisement-interval seconds;
  disable;
  hold-multiplier number;
  interface (all | interface-name) {
    disable;
  }
  lldp-configuration-notification-interval seconds;
  ptopo-configuration-maximum-hold-time seconds;
  ptopo-configuration-trap-interval seconds;
  traceoptions {
    file filename <files number> <size size> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
  }
}
```

The following statements have default values that are applied when LLDP is enabled:

- **advertisement-interval**—The default value is 30 seconds. The allowable range is from 5 through 32768 seconds.
- **hold-multiplier**—The default values is 4. The allowable range is from 2 through 10.
- **transmit-delay**—The default values is 2 seconds. The allowable range is from 1 through 8192 seconds.
- **ptopo-configuration-maximum-hold-time**—The default value is 300 seconds. The allowable range is from 1 through 2147483647 seconds.

The following statements must be explicitly configured:

- **lldp-configuration-notification-interval**—The allowable range is from 0 through 3600 seconds. There is no default value.
- **ptopo-configuration-trap-interval**—The allowable range is from 1 through 2147483647 seconds. There is no default value.

To disable LLDP on all or a particular interface, include the `interfaces` statement at the `[edit protocols lldp]` hierarchy level:

```
interface (all | interface-name) {
```



```
    disable;
}
```

To disable LLDP on all interfaces, use the **all** option. To disable LLDP on a particular interface, include the **disable** statement with the interface name.



NOTE: The **interface-name** must be the physical interface (for example, **ge-1/0/0**) and not a logical interface (unit).

The advertisement interval determines the frequency that an LLDP interface sends LLDP advertisement frames. The default value is 30 seconds. The allowable range is from 5 through 32768 seconds. You adjust this parameter by including the **advertisement-interval** statement at the **[edit protocols lldp]** hierarchy level.

The hold multiplier determines the multiplier to apply to the advertisement interval. The resulting value in seconds is used to cache learned LLDP information before discard. The default value is 4. When used with the default advertisement interval value of 30 seconds, this makes the default cache lifetime 120 seconds. The allowable range of the hold multiplier is from 2 through 10. You adjust this parameter by including the **hold-multiplier** statement at the **[edit protocols lldp]** hierarchy level.

The transmit delay determines the delay between any two consecutive LLDP advertisement frames. The default value is 2 seconds. The allowable range is from 1 through 8192 seconds. You adjust this parameter by including the **transmit-delay** statement at the **[edit protocols lldp]** hierarchy level.

The physical topology configuration maximum hold time determines the time interval for which an agent device maintains physical topology database entries. The default value is 300 seconds. The allowable range is from 1 through 2147483647 seconds. You adjust this parameter by including the **ptopo-configuration-maximum-hold-time** statement at the **[edit protocols lldp]** hierarchy level.

The LLDP configuration notification interval determines the period for which trap notifications are sent to the SNMP Master Agent when changes occur in the database of LLDP information. This capability is disabled by default. The allowable range is from 0 (disabled) through 3600 seconds. You adjust this parameter by including the **lldp-configuration-notification-interval** statement at the **[edit protocols lldp]** hierarchy level.

The physical topology configuration trap interval determines the period for which trap notifications are sent to the SNMP Master Agent when changes occur in the global physical topology statistics. This capability is disabled by default. The allowable range is from 0 (disabled) through 3600 seconds. The LLDP agent sends traps to the SNMP Master Agent if this interval has a value greater than 0 and there is any change during the **lldp-configuration-notification-interval** trap interval. You adjust this parameter by including the **ptopo-configuration-trap-interval** statement at the **[edit protocols lldp]** hierarchy level.

Example: Configuring LLDP

The following example configures LLDP on interface **ge-1/1/1** but disables LLDP on all other interfaces, explicitly configures the default values for all automatically enabled features, and configures a value of 30 seconds for the LLDP configuration notification interval and a value of 30 seconds for the physical topology trap interval.

```
[edit protocols]
lldp {
  advertisement-interval 30;
  hold-multiplier 4;
  interface all {
    disable;
  }
  interface ge-1/1/1;
  lldp-configuration-notification-interval 30;
  ptopo-configuration-maximum-hold-time 300;
  ptopo-configuration-trap-interval 30;
  transmit-delay 2;
}
```

You verify operation of LLDP with several show commands:

- `show lldp <detail>`
- `show lldp neighbors interface-name`
- `show lldp statistics interface-name`
- `show lldp local-information`
- `show lldp remote-global-statistics`

You can clear LLDP neighbor information or statistics globally or on an interface:

- `clear lldp neighbors interface-name`
- `clear lldp statistics interface-name`

You can display basic information about LLDP with the `show lldp detail` command:

```
user@host> show lldp detail
LLDP                : Enabled
Advertisement interval : 30 Second(s)
Transmit delay       : 2 Second(s)
Hold timer           : 4 Second(s)
Notification interval : 30 Second(s)
Config Trap Interval : 300 Second(s)
Connection Hold timer : 60 Second(s)
```

Interface	LLDP	Neighbor count
ge-1/1/1	Enabled	0

LLDP basic TLVs supported:

Chassis identifier, Port identifier, Port description, System name, System description, System capabilities, Management address.

LLDP 802 TLVs supported:

Link aggregation, Maximum frame size, MAC/PHY Configuration/Status, Port VLAN ID, Port VLAN name.

For more details about the output of these commands, see the *JUNOS Routing Protocols and Policies Command Reference*.

Tracing LLDP Operation

To trace LLDP operation traffic, you can specify options in the global `traceoptions` statement included at the `[edit routing-options]` hierarchy level, and you can specify LLDP-specific options by including the `traceoptions` statement:

```
traceoptions {
  file filename <files number> <size size> <world-readable | no-world-readable>;
  flag flag <flag-modifier> <disable>;
}
```

You can include this statement at the following hierarchy levels:

- `[edit protocols lldp]`
- `[edit routing-instances routing-instance-name protocols lldp]`

You can specify the following LLDP-specific options in the LLDP `traceoptions` statement:

- `all`—Trace all operations.
- `config`—Log configuration events.
- `interface`—Trace interface update events.
- `protocol`—Trace protocol information.
- `rtsock`—Trace real-time socket events.
- `vlan`—Trace VLAN update events.



NOTE: Use the trace flag `all` with caution. This flag may cause the CPU to become very busy.

For general information about tracing and global tracing options, see the statement summary for the global `traceoptions` statement in the *JUNOS Routing Protocols Configuration Guide*.

Chapter 5

Summary of Link Layer Discovery Protocol Configuration Statements

The following sections explain each of the Link Layer Discovery Protocol (LLDP) configuration statements. The statements are organized alphabetically.

advertisement-interval

Syntax	advertisement-interval <i>seconds</i> ;
Hierarchy Level	[edit protocols lldp], [edit routing-instances <i>routing-instance-name</i> protocols lldp]
Release Information	Statement introduced in JUNOS Release 9.6.
Description	(MX Series routers only) Configure an interval for LLDP advertisement.
Options	<i>seconds</i> —Interval between LLDP advertisement. Default: 30 Range: 5 through 32768
Usage Guidelines	See “Configuring LLDP” on page 44.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

disable

Syntax	disable;
Hierarchy Level	[edit protocols lldp], [edit protocols lldp interface (all <i>interface-name</i>)], [edit routing-instances <i>routing-instance-name</i> protocols lldp], [edit routing-instances <i>routing-instance-name</i> protocols lldp interface (all <i>interface-name</i>)]
Release Information	Statement introduced in JUNOS Release 9.6.
Description	(MX Series routers only) Disable LLDP globally or on an interface.
Usage Guidelines	See “Configuring LLDP” on page 44.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

hold-multiplier

Syntax	hold-multiplier <i>number</i> ;
Hierarchy Level	[edit protocols lldp], [edit routing-instances <i>routing-instance-name</i> protocols lldp]
Release Information	Statement introduced in JUNOS Release 9.6.
Description	(MX Series routers only) Configure a value for the LLDP hold multiplier.
Options	<i>number</i> —Advertisement interval multiplier for LLDP cache discard. Default: 4 (giving 120 second LLDP cache lifetime with other defaults) Range: 2 through 10
Usage Guidelines	See “Configuring LLDP” on page 44.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

interface

Syntax interface (all | *interface-name*) {
 disable;
}

Hierarchy Level [edit protocols lldp],
[edit routing-instances *routing-instance-name* protocols lldp]

Release Information Statement introduced in JUNOS Release 9.6.

Description (MX Series routers only) Specify an LLDP interface.

Options *interface-name*—A valid physical interface name.



NOTE: On MX Series routers, you run LLDP on a physical interface, such as **ge-1/0/0**, and not at the logical interface (unit) level.

all—Run LLDP on all interfaces.

Usage Guidelines See “Configuring LLDP” on page 44.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

lldp

Syntax	<pre>lldp { advertisement-interval <i>seconds</i>; disable; hold-multiplier <i>number</i>; interface (all <i>interface-name</i>) { disable; } lldp-configuration-notification-interval <i>seconds</i>; ptopo-configuration-maximum-hold-time <i>seconds</i>; ptopo-configuration-trap-interval <i>seconds</i>; traceoptions { file <i>filename</i> <files <i>number</i>> <size <i>maximum-file-size</i>> <world-readable no-world-readable>; flag <i>flag</i> <disable>; } }</pre>
Hierarchy Level	[edit protocols], [edit routing-instances <i>routing-instance-name</i> protocols]
Release Information	Statement introduced in JUNOS Release 9.6.
Description	(MX Series routers only) Specify LLDP configuration parameters.
Options	The statements are explained separately.
Usage Guidelines	See “Configuring LLDP” on page 44.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

lldp-configuration-notification-interval

Syntax	lldp-configuration-notification-interval <i>seconds</i> ;
Hierarchy Level	[edit protocols lldp], [edit routing-instances <i>routing-instance-name</i> protocols lldp]
Release Information	Statement introduced in JUNOS Release 9.6.
Description	(MX Series routers only) Configure a time for the period of SNMP trap notifications to the Master Agent to wait regarding changes in database information.
Options	<i>seconds</i> —Time for the period of SNMP trap notifications about the LLDP database. This feature is disabled by default. Range: 0 through 3600
Usage Guidelines	See “Configuring LLDP” on page 44.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ptopo-configuration-maximum-hold-time

Syntax	ptopo-configuration-maximum-hold-time <i>seconds</i> ;
Hierarchy Level	[edit protocols lldp], [edit routing-instances <i>routing-instance-name</i> protocols lldp]
Release Information	Statement introduced in JUNOS Release 9.6.
Description	(MX Series routers only) Configure a time to maintain dynamic topology entries.
Options	<i>seconds</i> —Time to maintain interval dynamic topology entries. Default: 300 Range: 1 through 2147483647
Usage Guidelines	See “Configuring LLDP” on page 44.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

ptopo-configuration-trap-interval

Syntax	ptopo-configuration-trap-interval <i>seconds</i> ;
Hierarchy Level	[edit protocols lldp], [edit routing-instances <i>routing-instance-name</i> protocols lldp]
Release Information	Statement introduced in JUNOS Release 9.6.
Description	(MX Series routers only) Configure a time for the period of SNMP trap notifications to the Master Agent to wait regarding changes in topology global statistics.
Options	<i>seconds</i> —Time for the period of SNMP trap notifications about global statistics. This feature is disabled by default. Range: 0 through 3600
Usage Guidelines	See “Configuring LLDP” on page 44.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

traceoptions

Syntax	<pre> traceoptions { file <i>filename</i> <files <i>number</i>> <size <i>maximum-file-size</i>> <world-readable no-world-readable>; flag <i>flag</i> <disable>; } </pre>
Hierarchy Level	[edit protocols lldp], [edit routing-instances <i>routing-instance-name</i> protocols lldp]
Release Information	Statement introduced in JUNOS Release 9.6.
Description	Set LLDP protocol-level tracing options.
Default	The default LLDP protocol-level trace options are inherited from the global traceoptions statement.
Options	<p>disable—(Optional) Disable the tracing operation. One use of this option is to disable a single operation when you have defined a broad group of tracing operations, such as all.</p> <p>file <i>filename</i>—Name of the file to receive the output of the tracing operation. Enclose the name in quotation marks. We recommend that you place STP tracing output in the file <code>/var/log/stp-log</code>.</p> <p>files <i>number</i>—(Optional) Maximum number of trace files. When a trace file named <i>trace-file</i> reaches its maximum size, it is renamed <i>trace-file.0</i>, then <i>trace-file.1</i>, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.</p> <p>If you specify a maximum number of files, you must also specify a maximum file size with the size option.</p> <p>Range: 2 through 1000 files Default: 1 trace file only</p> <p>flag—Tracing operation to perform. To specify more than one tracing operation, include multiple flag statements. The following are the LLDP-specific tracing options:</p> <ul style="list-style-type: none"> ■ all—Trace all operations. ■ config—Log configuration events. ■ interface—Trace interface update events. ■ protocol—Trace protocol information. ■ rtsock—Trace socket events. ■ vlan—Trace vlan update events.

The following are the global tracing options:

- **all**—All tracing operations.
- **config-internal**—Trace configuration internals.
- **general**—Trace general events.
- **normal**—All normal events.
Default: If you do not specify this option, only unusual or abnormal operations are traced.
- **parse**—Trace configuration parsing.
- **policy**—Trace policy operations and actions.
- **regex-parse**—Trace regular-expression parsing.
- **route**—Trace routing table changes.
- **state**—Trace state transitions.
- **task**—Trace protocol task processing.
- **timer**—Trace protocol task timer processing.

no-world-readable—(Optional) Prevent any user from reading the log file.

Default: If you do not include this option, tracing output is appended to an existing trace file.

size *maximum-file-size*—(Optional) Maximum size of each trace file, in kilobytes (KB) or megabytes (MB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1* and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

If you specify a maximum file size, you must also specify a maximum number of trace files with the *files* option.

Syntax: *xk* to specify KB, *xm* to specify MB, or *xg* to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing LLDP Operation” on page 47.

Required Privilege Level routing—To view this statement in the configuration.
 routing-control—To add this statement to the configuration.

transmit-delay

Syntax	transmit-delay <i>seconds</i> ;
Hierarchy Level	[edit protocols lldp], [edit routing-instances <i>routing-instance-name</i> protocols lldp]
Release Information	Statement introduced in JUNOS Release 9.6.
Description	(MX Series routers only) Configure a delay between two successive LLDP advertisements.
Options	<i>seconds</i> —Delay between two successive LLDP advertisements. Default: 2 Range: 1 through 8192
Usage Guidelines	See “Configuring LLDP” on page 44.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

Part 3

Layer 2 Bridging

- Configuring Layer 2 Bridging on page 61
- Summary of Bridge Domain Configuration Statements on page 85

Chapter 6

Configuring Layer 2 Bridging

This chapter describes how you can configure one or more bridge domains on Juniper Networks MX Series Ethernet Services Routers to perform Layer 2 bridging. The Layer 2 bridging functions of the MX Series routers include integrated routing and bridging (IRB) for support for Layer 2 bridging and Layer 3 IP routing on the same interface, and virtual switches that isolate a LAN segment with its Spanning Tree Protocol (STP) instance and separate its VLAN ID space.

- Layer 2 Bridging Overview on page 61
- Configuring Bridge Domains on page 62
- Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances on page 63
- Configuring Integrated Routing and Bridging for Bridge Domains on page 67
- Configuring Bridge Domains as Switches for Layer 2 Trunk Ports on page 69
- Configuring Layer 2 Virtual Switches on page 69
- Configuring Layer 2 Learning and Forwarding for Bridge Domains on page 76
- Configuring Layer 2 Learning and Forwarding for Bridge Domains Functioning as Switches with Layer 2 Trunk Ports on page 81
- Configuring Layer 3 Tunnel Services Interfaces on MX Series Routers on page 83

Layer 2 Bridging Overview

On Juniper Networks MX Series Ethernet Services Routers only, you can configure one or more bridge domains to perform Layer 2 bridging. A bridge domain is a set of logical ports that share the same flooding or broadcast characteristics. Like a virtual LAN (VLAN), a bridge domain spans one or more ports of multiple devices. Thus, MX Series routers can function as Layer 2 switches, each with multiple bridging, or broadcast, domains that participate in the same Layer 2 network. You can also configure Layer 3 routing support for a bridge domain. Integrated routing and bridging (IRB) provides support for Layer 2 bridging and Layer 3 IP routing on the same interface. IRB enables you to route packets to another routed interface or to another bridge domain that has a Layer 3 protocol configured.

You can also group one or more bridge domains within a single instance, or virtual switch. The MX Series routers also support multiple virtual switches, each of which operates independently of other virtual switches on the router. Virtual switches isolate a LAN segment with its STP instance and separate its VLAN ID space. Thus, each virtual switch can participate in a different Layer 2 network.

In JUNOS Release 9.2 and later, bridge domains provide support for a Layer 2 trunk port. A Layer 2 trunk interface enables you to configure a single logical interface to represent multiple VLANs on a physical interface. You can configure a set of bridge domains and VLAN identifiers that are automatically associated with one or more Layer 2 trunk interfaces. Packets received on a trunk interface are forwarded within a bridge domain that has the same VLAN identifier. A Layer 2 trunk interface also supports IRB within a bridge domain. In addition, you can configure Layer 2 learning and forwarding properties that apply to the entire set of bridge domains.

In JUNOS Release 9.3 and later, you can configure VPLS ports in a virtual switch instead of a dedicated routing instance of type `vpls` so that the logical interfaces of the Layer 2 bridge domains in the virtual switch can handle VPLS routing instance traffic. Packets received on a Layer 2 trunk interface are forwarded within a bridge domain that has the same VLAN identifier.

Configuring Bridge Domains

A bridge domain must include a set of logical interfaces that participate in Layer 2 learning and forwarding. You can optionally configure a VLAN identifier and a routing interface for the bridge domain to also support Layer 3 IP routing. For more detailed information about how to configure IRB for a bridge domain, see “Configuring Integrated Routing and Bridging for Bridge Domains” on page 67. To enable a bridge domain, include the following statements:

```
[edit]
bridge-domains {
  bridge-domain-name {
    domain-type bridge;
    interface interface-name;
    routing-interface routing-interface-name;
    vlan-id (none | all | number);
    vlan-id-list [ vlan-id-numbers ];
    vlan-tags outer number inner number;
  }
}
protocols {
  mstp {
    ...mstp-configuration ...
  }
}
```

For the `vlan-id` statement, you can specify either a valid VLAN identifier or the `none` or `all` options. For information about VLAN identifiers and VLAN tags for a bridge domain, see “Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances” on page 63.

To include one or more logical interfaces in the bridge domain, specify an *interface-name* for an Ethernet interface you configured at the `[edit interfaces]` hierarchy level.



NOTE: A maximum of 4000 active logical interfaces are supported on a bridge domain or on each mesh group in a virtual private LAN service (VPLS) instance configured for Layer 2 bridging.

By default, each bridge domain maintains a Layer 2 forwarding database that contains media access control (MAC) addresses learned from packets received on the ports that belong to the bridge domain. You can modify Layer 2 forwarding properties, including disabling MAC learning for the entire system or a bridge domain, adding static MAC addresses for specific logical interfaces, and limiting the number of MAC addresses learned by the entire system, the bridge domain, or a logical interface. For more information about how to configure Layer 2 forwarding properties for a bridge domain, see “Configuring Layer 2 Learning and Forwarding for Bridge Domains” on page 76. For more information about how to configure Layer 2 forwarding properties for a set of bridge domains with a Layer 2 trunk port, see “Configuring Layer 2 Learning and Forwarding for Bridge Domains Functioning as Switches with Layer 2 Trunk Ports” on page 81. You can also configure Layer 2 address learning and forwarding properties for an MX Series router as a whole. For more information, see “Configuring Layer 2 Address Learning and Forwarding” on page 105.

You can also configure spanning tree protocols to prevent forwarding loops at the `[edit protocols mstp]` hierarchy level. For more information, see “Configuring Spanning Tree Protocols” on page 119.

In JUNOS Release 8.5 and later, you can configure IGMP snooping for a bridge domain. For more information, see the *JUNOS Multicast Protocols Configuration Guide*.

Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances

You can configure VLAN identifiers for a bridge domain or a VPLS routing instance in the following ways:

- By using the `input-vlan-map` and the `output-vlan-map` statements at the `[edit interfaces interface-name]` or `[edit logical-systems logical-system-name interfaces interface-name]` hierarchy level to configure VLAN mapping. For information about configuring input and output VLAN maps to stack and rewrite VLAN tags in incoming or outgoing frames, see the *JUNOS Network Interfaces Configuration Guide*.
- By using either the `vlan-id` statement or the `vlan-tags` statement to configure a normalizing VLAN identifier. This topic describes how normalizing VLAN identifiers are processed and translated in a bridge domain or a VPLS routing instance.

The `vlan-id` and `vlan-tags` statements are used to specify the normalizing VLAN identifier under the bridge domain or VPLS routing instance. The normalizing VLAN identifier is used to perform the following functions:

- Translate, or normalize, the VLAN tags of received packets received into a learn VLAN identifier.

- Create multiple learning domains that each contain a learn VLAN identifier. A learning domain is a MAC address database to which MAC addresses are added based on the learn VLAN identifier.



NOTE: You cannot configure VLAN mapping using the `input-vlan-map` and `output-vlan-map` statements if you configure a normalizing VLAN identifier for a bridge domain or VPLS routing instance using the `vlan-id` or `vlan-tags` statements.

To configure a VLAN identifier for a bridge domain, include either the `vlan-id` or the `vlan-tags` statement at the [edit interfaces *interface-name* unit *logic-unit-number* family bridge] or [edit logical-systems *logical-system-name* interfaces *interface-name* unit *logic-unit-number* family bridge] hierarchy level, and then include that logical interface in the bridge domain configuration. For more information about configuring a bridge domain, see “Configuring Bridge Domains” on page 62.

For a VPLS routing instance, include either the `vlan-id` or `vlan-tags` statement at the [edit interfaces *interface-name* unit *logic-unit-number*] or [edit logical-systems *logical-system-name* interfaces *interface-name* unit *logic-unit-number*] hierarchy level, and then include that logical interface in the VPLS routing instance configuration. For more information about configuring a VPLS routing instance, see the *JUNOS VPNs Configuration Guide*.



NOTE: For a single bridge domain or VPLS routing instance, you can include either the `vlan-id` or the `vlan-tags` statement, but not both.

The VLAN tags associated with the inbound logical interface are compared with the normalizing VLAN identifier. If the tags are different, they are rewritten as described in Table 3 on page 66. The source MAC address of a received packet is learned based on the normalizing VLAN identifier.



NOTE: You do not have to specify a VLAN identifier for a bridge domain that is performing Layer 2 switching only. To support Layer 3 IP routing, you must specify either a VLAN identifier or a pair of VLAN tags. However, you cannot specify the same VLAN identifier for more than one bridge domain within a routing instance. Each bridge domain must have a unique VLAN identifier.

If the VLAN tags associated with the outbound logical interface and the normalizing VLAN identifier are different, the normalizing VLAN identifier is rewritten to match the VLAN tags of the outbound logical interface, as described in Table 4 on page 67.

For the packets sent over the VPLS routing instance to be tagged by the normalizing VLAN identifier, include one of the following configuration statements:

- `vlan-id number` to tag all packets that are sent over the VPLS virtual tunnel (VT) interfaces with the VLAN identifier.
- `vlan-tags outer number inner number` to tag all packets sent over the VPLS VT interfaces with dual outer and inner VLAN tags.

Use the **vlan-id none** statement to have the VLAN tags removed from packets associated with an inbound logical interface when those packets are sent over VPLS VT interfaces. Note that those packets might still be sent with other customer VLAN tags.

The **vlan-id all** statement enables you to configure bridging for several VLANs with a minimum amount of configuration. Configuring this statement creates a learning domain for:

- Each inner VLAN, or learn VLAN, identifier of a logical interface configured with two VLAN tags
- Each VLAN, or learn VLAN, identifier of a logical interface configured with one VLAN tag

The **vlan-id-list [*vlan-id-numbers*]** statement enables you to configure bridging for multiple VLANs on a trunk interface. Configuring this statement creates a learning domain for:

- Each VLAN listed: **vlan-id-list [100 200 300]**
- Each VLAN in a range: **vlan-id-list [100-200]**
- Each VLAN in a list and range combination: **vlan-id-list [50, 100-200, 300]**

The following steps outline the process for bridging a packet received over a Layer 2 logical interface when you specify a normalizing VLAN identifier using either the **vlan-id number** or **vlan-tags** statement for a bridge domain or a VPLS routing instance:

1. When a packet is received on a physical port, it is accepted only if the VLAN identifier of the packet matches the VLAN identifier of one of the logical interfaces configured on that port.
2. The VLAN tags of the received packet are then compared with the normalizing VLAN identifier. If the VLAN tags of the packet are different from the normalizing VLAN identifier, the VLAN tags are rewritten as described in Table 3 on page 66.
3. If the source MAC address of the received packet is not present in the source MAC table, it is learned based on the normalizing VLAN identifier.
4. The packet is then forwarded toward one or more outbound Layer 2 logical interfaces based on the destination MAC address. A packet with a known unicast destination MAC address is forwarded only to one outbound logical interface. For each outbound Layer 2 logical interface, the normalizing VLAN identifier configured for the bridge domain or VPLS routing instance is compared with the VLAN tags configured on that logical interface. If the VLAN tags associated with an outbound logical interface do not match the normalizing VLAN identifier configured for the bridge domain or VPLS routing instance, the VLAN tags are rewritten as described in Table 4 on page 67.

The tables below show how VLAN tags are applied for traffic sent to and from the bridge domain, depending on how the **vlan-id** and **vlan-tags** statements are configured for the bridge domain and on how VLAN identifiers are configured for the logical interfaces in a bridge domain or VPLS routing instance. Depending on your configuration, the following rewrite operations are performed on VLAN tags:

- **pop**—Remove a VLAN tag from the top of the VLAN tag stack.
- **pop-pop**—Remove both the outer and inner VLAN tags of the frame.
- **pop-swap**—Remove the outer VLAN tag of the frame and replace the inner VLAN tag of the frame.
- **swap**—Replace the VLAN tag of the frame.
- **push**—Add a new VLAN tag to the top of the VLAN stack.
- **push-push**—Push two VLAN tags in front of the frame.
- **swap-push**—Replace the VLAN tag of the frame and add a new VLAN tag to the top of the VLAN stack.
- **swap-swap**—Replace both the outer and inner VLAN tags of the frame.

Table 3 on page 66 shows specific examples of how the VLAN tags for packets sent to the bridge domain are processed and translated, depending on your configuration. “–” means that the statement is not supported for the specified logical interface VLAN identifier. “No operation” means that the VLAN tags of the received packet are not translated for the specified input logical interface.

Table 3: Statement Usage and Input Rewrite Operations for VLAN Identifiers for a Bridge Domain

VLAN Identifier of Logical Interface	VLAN Configurations for Bridge Domain			
	vlan-id none	vlan-id 200	vlan-id all	vlan tags outer 100 inner 300
none	No operation	push 200	–	push 100, push 300
200	pop 200	No operation	No operation	swap 200 to 300, push 100
1000	pop 1000	swap 1000 to 200	No operation	swap 1000 to 300, push 100
vlan-tags outer 2000 inner 300	pop 2000, pop 300	pop 2000, swap 300 to 200	pop 2000	swap 2000 to 100
vlan-tags outer 100 inner 400	pop 100, pop 400	pop 100, swap 400 to 200	pop 100	swap 400 to 300
vlan-id-range 10-100	–	–	No operation	–
vlan-tags outer 200 inner-range 10-100	–	–	pop 200	–

Table 4 on page 67 shows specific examples of how the VLAN tags for packets sent from the bridge domain are processed and translated, depending on your configuration. “–” means that the statement is not supported for the specified logical interface VLAN identifier. “No operation” means that the VLAN tags of the outbound packet are not translated for the specified output logical interface.

Table 4: Statement Usage and Output Rewrite Operations for VLAN Identifiers for a Bridge Domain

VLAN Identifier of Logical Interface	VLAN Configurations for Bridge Domain			
	vlan-id none	vlan-id 200	vlan-id all	vlan tags outer 100 inner 300
none	no operation	pop 200	–	pop 100, pop 300
200	push 200	No operation	No operation	pop 100, swap 300 to 200
1000	push 1000	swap 200 to 1000	No operation	pop 100, swap 300 to 1000
vlan-tags outer 2000 inner 300	push 2000, push 300	swap 200 to 300, push 2000	push 2000	swap 100 to 2000
vlan-tags outer 100 inner 400	push 100, push 400	swap 200 to 400, push 100	push 100	swap 300 to 400
vlan-id-range 10-100	–	–	No operation	–
vlan-tags outer 200 inner-range 10-100	–	–	push 200	–

Configuring Integrated Routing and Bridging for Bridge Domains

Integrated routing and bridging (IRB) provides simultaneous support for Layer 2 bridging and Layer 3 routing on the same interface. IRB enables you to route packets to another routed interface or to another bridge domain that has an IRB interface configured. You configure a logical routing interface by including the `irb` statement at the `[edit interfaces]` hierarchy level and include that interface in the bridge domain. For more information about how to configure a routing interface, see the *JUNOS Network Interfaces Configuration Guide*.



NOTE: You can include only one routing interface in a bridge domain.

To configure a bridge domain with IRB support, include the following statements:

```
[edit]
bridge-domains {
  bridge-domain-name {
    domain-type bridge;
    interface interface-name;
    routing-interface routing-interface-name;
    vlan-id (none | number);
    vlan-tags outer number inner number;
  }
}
```

For each bridge domain that you configure, specify a *bridge-domain-name*. You must also specify the value **bridge** for the **domain-type** statement.

For the **vlan-id** statement, you can specify either a valid VLAN identifier or the **none** option. For more information about configuring VLAN identifiers, see “Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances” on page 63.



NOTE: If you configure a routing interface to support IRB in a bridge domain, you cannot use the **all** option for the **vlan-id** statement.

The **vlan-tags** statement enables you to specify a pair of VLAN identifiers; an **outer** tag and an **inner** tag.



NOTE: For a single bridge domain, you can include either the **vlan-id** statement or the **vlan-tags** statement, but not both.

To include one or more logical interfaces in the bridge domain, specify the *interface-name* for each Ethernet interface to include that you configured at the **[edit interfaces]** hierarchy level.



NOTE: A maximum of 4000 active logical interfaces are supported on a bridge domain or on each mesh group in a VPLS routing instance configured for Layer 2 bridging.

To associate a routing interface with a bridge domain, include the **routing-interface** *routing-interface-name* statement and specify a *routing-interface-name* you configured at the **[edit interfaces irb]** hierarchy level. You can configure only one routing interface for each bridge domain. For more information about how to configure logical and routing interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

In JUNOS Release 9.0 and later, IRB interfaces are supported for multicast snooping. For more information about multicast snooping, see the *JUNOS Multicast Protocols Configuration Guide*.

In JUNOS Release 9.6 and later, in multihomed VPLS configurations, you can configure VPLS to keep a VPLS connection up if only an IRB interface is available by configuring the **irb** option for the **connectivity-type** statement at the **[edit routing-instances routing-instance-name protocols vpls]** hierarchy level. The **connectivity-type** statement has two options, **ce** and **irb**. The **ce** option is the default and specifies that a CE interface is required to maintain the VPLS connection. By default, if only an IRB interface is available, the VPLS connection is brought down. For more information about configuring VPNs, see the *JUNOS VPN Configuration Guide*.

Configuring Bridge Domains as Switches for Layer 2 Trunk Ports

You can configure a set of bridge domains that are associated with a Layer 2 trunk port. The set of bridge domains function as a switch. Packets received on a trunk interface are forwarded within a bridge domain that has the same VLAN identifier. A trunk interface also provides support for IRB, which provides support for Layer 2 bridging and Layer 3 IP routing on the same interface.

To configure a Layer 2 trunk port and set of bridge domains, include the following statements:

```
[edit interfaces]
interface-name {
  unit number {
    family bridge {
      interface-mode access;
      vlan-id number;
    }
  }
}
interface-name {
  native-vlan-id number;
  unit number {
    family bridge {
      interface-mode trunk;
      vlan-id-list [ vlan-id-numbers ];
    }
  }
}
[edit bridge-domains]
bridge-domain-name {
  vlan-id number;
  vlan-id-list [ vlan-id-numbers ];
  . . .
}
```

For interface-mode trunk, you can include the `vlan-id-list` statement.

You must configure a bridge domain and VLAN identifier for each VLAN associated with the trunk interface. You can configure one or more trunk or access interfaces at the `[edit interfaces]` hierarchy level. An access interface enables you to accept packets with no VLAN identifier. For more information about configuring trunk and access interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

Configuring Layer 2 Virtual Switches

On MX Series routers only, you can group one or more bridge domains to form a virtual switch to isolate a LAN segment with its Spanning Tree Protocol (STP) instance and separate its VLAN ID space. A bridge domain consists of a set of logical ports that share the same flooding or broadcast characteristics. Like a virtual LAN, a bridge domain spans one or more ports of multiple devices. You can configure multiple virtual switches, each of which operates independently of the other virtual switches

on the routing platform. Thus, each virtual switch can participate in a different Layer 2 network.

You can configure a virtual switch to participate only in Layer 2 bridging and optionally to perform Layer 3 routing. In addition, you can configure one of three Layer 2 control protocols—Spanning Tree Protocol, Rapid Spanning Tree Protocol, or Multiple Spanning Tree Protocol—to prevent forwarding loops. For more information about Layer 2 control protocols, see “Configuring Spanning Tree Protocols” on page 119. For more information about how to configure Layer 2 logical ports on an interface, see the *JUNOS Network Interfaces Configuration Guide*.

In JUNOS Release 9.2 and later, you can associate one or more logical interfaces configured as trunk interfaces with a virtual switch. A trunk interface, or Layer 2 trunk port, enables you to configure a logical interface to represent multiple VLANs on the physical interface. Packets received on a trunk interface are forwarded within a bridge domain that has same VLAN identifier. For more information about how to configure trunk interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

You can also configure Layer 2 forwarding and learning properties for the virtual switch as well as any bridge domains that belong to a virtual switch. For more information about configuring Layer 2 forwarding and learning properties for a bridge domain, see “Configuring Layer 2 Learning and Forwarding for Bridge Domains” on page 76.

For more information about configuring a routing instance for Layer 2 VPN, see the *JUNOS VPNs Configuration Guide*. For a detailed Layer 2 VPN example configuration, see the *JUNOS Feature Guide*.

For information about configuring Layer 2 protocol tunneling, see “Configuring Layer 2 Protocol Tunneling” on page 132.

For more information about how to configure Layer 2 routing instances, see the following sections:

- Configuring a Layer 2 Virtual Switch on page 70
- Configuring a Layer 2 Virtual Switch with a Layer 2 Trunk Port on page 72
- Configuring VPLS Ports in a Virtual Switch on page 73
- Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch on page 75

Configuring a Layer 2 Virtual Switch

A Layer 2 virtual switch, which isolates a LAN segment with its Spanning Tree Protocol (STP) instance and separates its VLAN ID space, filters and forwards traffic only at the data link layer. Layer 3 routing is not performed. Each bridge domain consists of a set of logical ports that participate in Layer 2 learning and forwarding. A virtual switch represents a Layer 2 network.

Two main types of interfaces are used in virtual switch hierarchies:

- Layer 2 logical interface—This type of interface uses the VLAN-ID as a virtual circuit identifier and the scope of the VLAN-ID is local to the interface port. This type of interface is often used in service-provider-centric applications.
- Access or trunk interface—This type of interface uses a VLAN-ID with global significance. The access or trunk interface is implicitly associated with bridge domains based on VLAN membership. Access or trunk interfaces are typically used in enterprise-centric applications.



NOTE: The difference between access interfaces and trunk interfaces is that access interfaces can be part of one VLAN only and the interface is normally attached to an end-user device (packets are implicitly associated with the configured VLAN). In contrast, trunk interfaces multiplex traffic from multiple VLANs and usually interconnect switches.

To configure a Layer 2 virtual switch, include the following statements:

```
[edit]
routing-instances {
  routing-instance-name (
    instance-type virtual-switch;
    bridge-domains {
      bridge-domain-name {
        domain-type bridge;
        interface interface-name;
        vlan-id (all | none | number); # Cannot be used with 'vlan-tags' statement
        vlan-id-list [ vlan-id-numbers ];
        vlan-tags outer number inner number; # Cannot be used with 'vlan-id'
          statement
      }
    }
  }
  protocols {
    mstp {
      ...mstp-configuration ...
    }
  }
}
```

To enable a virtual switch, you must specify **virtual-switch** as the **instance-type**.

For each bridge domain that you configure for the virtual switch, specify a **bridge-domain-name**. You must also specify the value **bridge** for the **domain-type** statement.

For the **vlan-id** statement, you can specify either a valid VLAN identifier or the **none** or **all** options. If you specify a valid VLAN identifier, you cannot also use the **none** option. These statements are mutually exclusive. For more information about configuring VLAN identifiers and VLAN tags for a bridge domain, see “Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances” on page 63.

The **all** option is not supported with IRB. For more information about how to configure IRB, see “Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch” on page 75.



NOTE: You do not have to specify a VLAN identifier for a bridge domain. However, you cannot specify the same VLAN identifier for more than one bridge domain within a virtual switch. Each bridge domain within a virtual switch must have a unique VLAN identifier.



NOTE: For a single bridge domain, you can include either the **vlan-id** statement or the **vlan-tags** statement, but not both.

To specify one or more logical interfaces to include in the bridge domain, specify an *interface-name* for an Ethernet interface you configured at the [edit interfaces] hierarchy level. For more information, see the *JUNOS Network Interfaces Configuration Guide*.

For information about how to configure spanning tree protocols, see the *JUNOS Feature Guide*.

Configuring a Layer 2 Virtual Switch with a Layer 2 Trunk Port

You can associate one or more Layer 2 trunk interfaces with a virtual switch. A Layer 2 trunk interface enables you to configure a logical interface to represent multiple VLANs on the physical interface. Within the virtual switch, you configure a bridge domain and VLAN identifier for each VLAN identifier configured on the trunk interfaces. Packets received on a trunk interface are forwarded within a bridge domain that has the same VLAN identifier. Each virtual switch you configure operates independently and can participate in a different Layer 2 network.

A virtual switch configured with a Layer 2 trunk port also supports IRB within a bridge domain. IRB provides simultaneous support for Layer 2 bridging and Layer 3 IP routing on the same interface. Only an interface configured with the **interface-mode (access | trunk)** statement can be associated with a virtual switch. An access interface enables you to accept packets with no VLAN identifier. For more information about configuring trunk and access interfaces, see the *JUNOS Network Interfaces Configuration Guide*.

In addition, you can configure Layer 2 learning and forwarding properties for the virtual switch. For more information, see “Configuring Layer 2 Learning and Forwarding for Bridge Domains Functioning as Switches with Layer 2 Trunk Ports” on page 81.

To configure a virtual switch with a Layer 2 trunk interface, include the following statements:

```
[edit]
routing-instances {
  routing-instance-name {
    instance-type virtual-switch;
```

```

interface interface-name;
bridge-domains {
    bridge-domain-name {
        vlan-id number;
    }
}
}

```



NOTE: You must configure a bridge domain and VLAN identifier for each VLAN identifier configured for the trunk interface.

Configuring VPLS Ports in a Virtual Switch

In JUNOS Release 9.3 and later, you can configure VPLS ports in a virtual switch so that the logical interfaces of the Layer 2 bridge domains in the virtual switch can handle VPLS routing instance traffic. VPLS configuration no longer requires a dedicated routing instance of type `vpls`. Packets received on a Layer 2 trunk interface are forwarded within a bridge domain that has the same VLAN identifier.

A trunk interface is implicitly associated with bridge domains based on VLAN membership. Whereas access interfaces can be part of one VLAN only, trunk interfaces multiplex traffic from multiple VLANs and usually interconnect switches. A Layer 2 trunk port also supports IRB.

To configure VPLS ports in a virtual switch, perform the following tasks:

1. To configure the Layer 2 trunk ports that you will associate with the bridge domains in the virtual switch, include the following statements in the configuration:

```

[edit]
interfaces {
    interface-name {
        unit logical-unit-number { # Call this 'L2-trunk-port-A'
            family bridge {
                interface-mode trunk;
                vlan-id-list [ vlan-id-numbers ] ; # Trunk mode VLAN membership for this
                interface
            }
        }
    }
    .
    .
    .
    interface-name {
        unit logical-unit-number { # Call this 'L2-trunk-port-B'
            family bridge {
                interface-mode trunk;
                vlan-id-list [ vlan-id-numbers ] ; # Trunk mode VLAN membership for this
                interface
            }
        }
    }
}

```

```
    }
}
```

To configure a logical interface as a trunk port, include the `interface-mode` statement and the `trunk` option at the `[edit interfaces interface-name unit logical-unit-number family bridge]` hierarchy level.

To configure all the VLAN identifiers to associate with a Layer 2 trunk port, include the `vlan-id-list [vlan-id-numbers]` statement at the `[edit interfaces interface-name unit logical-unit-number family bridge]` hierarchy level.

Each of the logical interfaces “*L2-trunk-port-A*” and “*L2-trunk-port-B*” accepts packets tagged with any VLAN ID specified in the respective `vlan-id-list` statements.

2. To configure a virtual switch consisting of a set of bridge domains that are associated with one or more logical interfaces configured as a trunk ports, include the following statements in the configuration:

```
[edit]
routing-instance {
  routing-instance-name
  instance-type virtual-switch;
  interface L2-trunk-port-A; # Include one trunk port
  interface L2-trunk-port-B; # Include the other trunk port
  bridge-domains {
    bridge-domain-name-0 {
      domain-type bridge;
      interface L2-trunk-port-A;
      vlan-id number;
    }
    bridge-domain-name-1 {
      domain-type bridge;
      interface L2-trunk-port-B;
      vlan-id number;
    }
  }
  protocols {
    vpls {
      vlan-id number;
      ... vpls-configuration ...
    }
  }
}
```

To begin configuring a virtual switch, include the `instance-type` statement and the `virtual-switch` option at the `[edit routing-instances routing-instance-name]` hierarchy level.

To configure a virtual switch consisting of a set of bridge domains that are associated with one or more logical interfaces configured as a trunk ports, you must identify each logical interface by including the `interface interface-name` statement at the `[edit routing-instances routing-instance-name]` hierarchy level.

For each VLAN configured for a trunk port, you must configure a bridge-domain that includes the trunk port logical interface and uses a VLAN identifier within

the range carried by that trunk interface. To configure, include the `domain-type bridge`, `vlan-id number`, and interface `interface-name-trunk-port` statements at the [edit routing-instances *routing-instance-name* bridge-domain *bridge-domain-name*] hierarchy level.

Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch

Integrated routing and bridging (IRB) provides simultaneous support for Layer 2 bridging and Layer 3 IP routing on the same interface. IRB enables you to route local packets to another routed interface or to another bridge domain that has a Layer 3 protocol configured. You configure a logical routing interface by including the `irb` statement at [edit interfaces] hierarchy level and include that interface in the bridge domain. For more information about how to configure a routing interface, see the *JUNOS Network Interfaces Configuration Guide*.



NOTE: You can include only one routing interface in a bridge domain.

To configure a virtual switch with IRB support, include the following statements:

```
[edit]
routing-instances {
  routing-instance-name {
    instance-type virtual-switch;
    bridge-domains {
      bridge-domain-name {
        domain-type bridge;
        interface interface-name;
        routing-interface routing-interface-name;
        vlan-id (none | number);
        vlan-tags outer number inner number;
      }
    }
  }
}
```

To enable a virtual switch, you must specify `virtual-switch` as the `instance-type`. The `instance-type virtual-switch` statement is not supported at the [edit logical-systems *logical-system-name*] hierarchy level.

For each bridge domain that you configure for the virtual switch, specify a *bridge-domain-name*. You must also specify the value `bridge` for the `domain-type` statement.

For the `vlan-id` statement, you can specify either a valid VLAN identifier or the `none` option. For more information about configuring VLAN identifiers, see “Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances” on page 63.



NOTE: For a single bridge domain, you can include either the `vlan-id` statement or the `vlan-tags` statement, but not both.

To include one or more logical interfaces in the bridge domain, specify the *interface-name* for each Ethernet interface to include that you configured at the `[edit interfaces irb]` hierarchy level.

To associate a routing interface with a bridge domain, include the `routing-interface` *routing-interface-name* statement and specify a *routing-interface-name* you configured at the `[edit interfaces irb]` hierarchy level. You can configure only one routing interface for each bridge domain. For more information about how to configure logical and routing interfaces, see the *JUNOS Network Interfaces Configuration Guide*.



NOTE: If you configure a routing interface to support IRB in a bridge domain, you cannot use the `all` option for the `vlan-id` statement.

Configuring Layer 2 Learning and Forwarding for Bridge Domains

When you configure a bridge domain, Layer 2 address learning is enabled by default. The bridge domain learns unicast media access control (MAC) addresses to avoid flooding the packets to all the ports in the bridge domain. Each bridge domain creates a source MAC entry in its source and destination MAC tables for each source MAC address learned from packets received on the ports that belong to the bridge domain.



NOTE: Traffic is not flooded back onto the interface on which it was received. However, because this “split horizon” occurs at a late stage, the packet statistics displayed by commands such as `show interfaces queue` will include flood traffic.

You can optionally disable MAC learning either for the entire router or for a specific bridge domain or logical interface. You can also configure the following Layer 2 learning and forwarding properties:

- Static MAC entries for logical interfaces only
- Limit to the number of MAC addresses learned from a specific logical interface or from all the logical interfaces in a bridge domain
- Size of the MAC address table for the bridge domain
- MAC accounting for a bridge domain

For more information about how to configure Layer 2 learning and forwarding properties for an MX Series router, see “Configuring Layer 2 Address Learning and Forwarding” on page 105.

For more information about how to configure Layer 2 learning and forwarding properties for a bridge domain, see the following sections:

- Disabling MAC Learning for a Bridge Domain or Logical Interface on page 77
- Configuring Static MAC Addresses for Logical Interfaces in a Bridge Domain on page 78
- Configuring the Size of the MAC Address Table on page 78
- Limiting the Number of MAC Addresses Learned from an Interface in a Bridge Domain on page 79
- Enabling MAC Accounting for a Bridge Domain on page 80

Disabling MAC Learning for a Bridge Domain or Logical Interface

You can disable MAC learning for all logical interfaces in a specified bridge domain, or for a specific logical interface in a bridge domain. Disabling dynamic MAC learning prevents the specified interfaces from learning source MAC addresses. You can also disable MAC learning for an MX Series router. For more information, see “Disabling MAC Learning” on page 106.

To disable MAC learning for all logical interfaces in a bridge domain in a virtual switch, include the `no-mac-learning` statement at the `[edit bridge-domains bridge-domain-name bridge-options]` hierarchy level:

```
[edit]
bridge-domains {
  bridge-domain-name {
    domain-type bridge;
    interface interface-name;
    bridge-options {
      no-mac-learning;
    }
  }
}
```

To disable MAC learning for a specific logical interface in a bridge domain, include the `no-mac-learning` statement at the `[edit bridge-domains bridge-domain-name bridge-options interface interface-name]` hierarchy level.

```
[edit]
bridge-domains {
  bridge-domain-name {
    domain-type bridge;
    interface interface-name;
    bridge-options {
      interface interface-name {
        no-mac-learning;
      }
    }
  }
}
```



NOTE: When you disable MAC learning, source MAC addresses are not dynamically learned, and any packets sent to these source addresses are flooded into the bridge domain.

For more information about how to disable MAC learning for the entire MX Series router, see “Disabling MAC Learning” on page 106.



NOTE: When you gather interfaces into a bridge domain, the `no-mac-learn-enable` statement at the `[edit interfaces interface-name gigether-options ethernet-switch-profile]` hierarchy level is not supported. You must use the `no-mac-learning` statement at the `[edit bridge-domains bridge-domain-name bridge-options interface interface-name]` hierarchy level to disable MAC learning on an interface in a bridge domain.

Configuring Static MAC Addresses for Logical Interfaces in a Bridge Domain

You can manually add static MAC entries for the logical interfaces in a bridge domain. You can specify one or more static MAC addresses for each logical interface. To add a static MAC address for a logical interface in a bridge domain, include the `static-mac mac-address` statement at the `[edit bridge-domains bridge-domain-name bridge-options interface interface-name]` hierarchy level.

```
[edit]
bridge-domains {
  bridge-domain-name {
    domain-type bridge;
    bridge-options {
      interface interface-name {
        static-mac mac-address {
          <vlan-id number>;
        }
      }
    }
  }
}
```

You can optionally specify a VLAN identifier for the static MAC address by using the `vlan-id` statement. To specify a VLAN identifier for a static MAC address, you must use the `all` option when configuring a VLAN identifier for the bridge domain.



NOTE: If a static MAC address you configure for a logical interface appears on a different logical interface, packets sent to that interface are dropped.

Configuring the Size of the MAC Address Table

You can modify the size of the MAC address table for each bridge domain. The default table size is 5120 addresses. The minimum you can configure is 16 addresses, and the maximum is 1,048,575 addresses.

If the MAC table limit is reached, new addresses can no longer be added to the table. Unused MAC addresses are removed from the MAC address table automatically. This frees space in the table, allowing new entries to be added.

To modify the size of the MAC table, include the `mac-table-size limit` statement at the `[edit bridge-domains bridge-domain-name bridge-options]` hierarchy level:

```
[edit]
bridge-domains {
  bridge-domain-name {
    domain-type bridge;
    bridge-options {
      mac-table-size limit {
        packet-action drop;
      }
    }
  }
}
```

Limiting the Number of MAC Addresses Learned from an Interface in a Bridge Domain

You can configure a limit on the number of MAC addresses learned from a specific bridge domain or from a specific logical interface that belongs to a bridge domain.

To configure a limit for the number of MAC addresses learned from each logical interface in a bridge domain, include the `interface-mac-limit limit` statement at the `[edit bridge-domains bridge-domain-name bridge-options]` hierarchy level:

```
[edit]
bridge-domains {
  bridge-domain-name {
    domain-type bridge;
    interface interface-name;
    bridge-options {
      interface-mac-limit limit;
    }
  }
}
```

To limit the number of MAC addresses learned from a specific logical interface in a bridge domain or an entire bridge domain, include the `interface-mac-limit limit` statement at the `[edit bridge-domains bridge-domain-name bridge-options interface interface-name]` or `[edit bridge-domains bridge-domain-name bridge-options]` hierarchy level:

```
[edit]
bridge-domains {
  bridge-domain-name {
    domain-type bridge;
    interface interface-name;
    bridge-options {
      interface-mac-limit limit {
        packet-action drop;
      }
    }
  }
}
```

```

        interface interface-name {
            interface-mac-limit limit{
                packet-action drop;
            }
        }
    }
}

```

The value you configure for a specific logical interface overrides any value you specify for the entire bridge domain at the [edit bridge-domains *bridge-domain-name* bridge-options] hierarchy level.

The default limit to the number of MAC addresses that can be learned on a logical interface is 1024. The range that you can configure for a specific logical interface is 1 through 131,071.

After the MAC address limit is reached, the default is for any incoming packets with a new source MAC address to be forwarded. You can specify that the packets be dropped by including the **packet-action drop** statement. To specify that packets be dropped for the entire bridge domain, include the **packet-action drop** statement at the [edit bridge-domains *bridge-domain-name* bridge-options interface-mac-limit *limit*] hierarchy level:

```

[edit bridge-domains bridge-domain-name bridge-options interface-mac-limit limit]
packet-action drop;

```

To specify that the packets be dropped for a specific logical interface in a bridge domain, include the **packet-action drop** statement at the [edit bridge-domains *bridge-domain-name* bridge-options interface *interface-name* interface-mac-limit *limit*] hierarchy level:

```

[edit bridge-domains bridge-domain-name bridge-options interface interface-name
 interface-mac-limit limit]
packet-action drop;

```

You can also configure a limit to the number of MAC addresses learned for an MX Series router. For more information, see “Limiting the Number of MAC Addresses Learned from Each Interface” on page 107.

Enabling MAC Accounting for a Bridge Domain

By default, MAC accounting is disabled. You can enable packet counting for a bridge domain. When you enable packet accounting, the JUNOS software maintains packet counters for each MAC address learned on the interfaces in the bridge domain.

To enable MAC accounting for a bridge domain, include the **mac-statistics** statement at the [edit bridge-domains *bridge-domain-name* bridge-options] hierarchy level:

```

[edit bridge-domains bridge-domain-name bridge-options]
mac-statistics;

```

Configuring Layer 2 Learning and Forwarding for Bridge Domains Functioning as Switches with Layer 2 Trunk Ports

Layer 2 learning is enabled by default. A set of bridge domains, configured to function as a switch with a Layer 2 trunk port, learns unicast media access control (MAC) addresses to avoid flooding packets to the trunk port.



NOTE: Traffic is not flooded back onto the interface on which it was received. However, because this “split horizon” occurs at a late stage, the packet statistics displayed by commands such as `show interfaces queue` will include flood traffic.

You can optionally disable Layer 2 learning for the entire set of bridge domains as well as modify the following Layer 2 learning and forwarding properties:

- Limit the number of MAC addresses learned from the Layer 2 trunk port associated with the set of bridge domains
- Modify the size of the MAC address table for the set of bridge domains
- Enable MAC accounting for the set of bridge domains

For more information about how to configure Layer 2 learning and forwarding properties for a set of bridge domains, see the following sections:

- Disabling MAC Learning for a Set of Bridge Domains on page 81
- Limiting the Number of MAC Addresses Learned from a Trunk Port on page 81
- Modifying the Size of the MAC Address Table for a Set of Bridge Domains on page 82
- Enabling MAC Accounting for a Set of Bridge Domains on page 83

Disabling MAC Learning for a Set of Bridge Domains

You can disable MAC learning for a set of bridge domains. Disabling dynamic MAC learning prevents the Layer 2 trunk port associated with the set of bridge domains from learning source and destination MAC addresses. When you disable MAC learning, source MAC addresses are not dynamically learned, and any packets sent to these source addresses are flooded into the switch.

To disable MAC learning for a set of bridge domains, include the `no-mac-learning` statement at the `[edit switch-options]` hierarchy level:

```
[edit switch-options]
no-mac-learning;
```

Limiting the Number of MAC Addresses Learned from a Trunk Port

You can configure a limit on the number of MAC addresses learned from a trunk port or from a specific trunk or access interface.

To limit the number of MAC addresses learned through a trunk port associated with a set of bridge domains, include the `interface-mac-limit limit` statement at the `[edit switch-options]` hierarchy level:

```
[edit switch-options]
interface-mac-limit limit;
```

To limit the number of MAC addresses learned from a specific logical interface configured as an access interface or a trunk interface, include the `interface-mac-limit limit` statement at the `[edit switch-options interface interface-name]` hierarchy level:

```
[edit switch-options interface interface-name]
interface-mac-limit limit;
```

The default value for the number MAC addresses that can be learned from a logical interface is 1024. You can specify a limit either for a set of bridge domains or for a specific logical interface in the range from 1 through 131,071. The value you configure for a specific logical interface overrides any value you specify for the set of bridge domains.

After the specified MAC address limit is reached, the default is for any incoming packets with a new source MAC address to be forwarded. You can specify that the packets be dropped for the entire virtual switch after the MAC address limit is reached by including the `packet-action drop` statement at the `[edit switch-options interface-mac-limit limit]` hierarchy level:

```
[edit switch-options interface interface-name interface-mac-limit limit]
packet-action drop;
```

To specify that the packets be dropped from a specific logical interface in a set of bridge domains with a trunk port after the MAC address limit is reached, include the `packet-action drop` statement at the `[edit routing-instances routing-instance-name interface interface-name interface-mac-limit limit]` hierarchy level:

```
[edit routing-instances routing-instance-name interface interface-name interface-mac-limit
limit]
packet-action drop;
```

Modifying the Size of the MAC Address Table for a Set of Bridge Domains

You can modify the size of the MAC address table for a set of bridge domains. The minimum you can configure is 16 addresses, and the maximum is 1,048,575 addresses. The default table size is 5120 addresses.

If the MAC table limit is reached, new addresses can no longer be added to the table. Unused MAC addresses are removed from the MAC address table automatically. This frees space in the table, allowing new entries to be added to the table.

To modify the size of the MAC table for a set of bridge domains, include the `mac-table-size` statement at the `[edit switch-options]` hierarchy level:

```
[edit switch-options]
mac-table-size limit;
```

Enabling MAC Accounting for a Set of Bridge Domains

By default, MAC accounting is disabled. You can enable packet counting for a set of bridge domains. After you enable packet accounting, the JUNOS software maintains packet counters for each MAC address learned on the trunk port associated with the set of bridge domains.

To enable MAC accounting for a set of bridge domains, include the `mac-statistics` statement at the `[edit switch-options]` hierarchy level:

```
[edit switch-options]
mac-statistics;
```

Configuring Layer 3 Tunnel Services Interfaces on MX Series Routers

The MX Series routers support Dense Port Concentrators (DPCs) with built-in Ethernet ports and therefore do not support Tunnel Services PICs. To create tunnel interfaces on an MX Series router, you configure a DPC and the corresponding Packet Forwarding Engine to use for tunneling services at the `[edit chassis]` hierarchy level. You also configure the amount of bandwidth reserved for tunnel services. The JUNOS software creates tunnel interfaces on the Packet Forwarding Engine. To create tunnel interfaces on MX Series routers, include the following statements at the `[edit chassis]` hierarchy level:

```
[edit chassis]
fpc slot-number {
  pic number {
    tunnel-services {
      bandwidth (1g | 10g);
    }
  }
}
```

Include the `fpc slot-number` statement to specify the slot number of the DPC. If two SCBs are installed, the range is 0 through . If three SCBs are installed, the range is 0 through 5 and 7 through .

Include the `pic number` statement to specify the number of the Packet Forwarding Engine on the DPC. The range is 0 through 3.

You can also specify the amount of bandwidth to allocate for tunnel traffic on each Packet Forwarding Engine by including the `bandwidth (1g | 10g)` statement at the `[edit chassis fpc slot-number pic pic-number]` hierarchy level:

- **1g** indicates that 1 Gbps of bandwidth is reserved for tunnel traffic. Configure this option only for a Packet Forwarding Engine on a Gigabit Ethernet 40-port DPC.
- **10g** indicates that 10 Gbps of bandwidth is reserved for tunnel traffic. Configure this option only for a Packet Forwarding Engine on a 10-Gigabit Ethernet 4-port DPC.

If you specify a bandwidth that is not compatible with the type of DPC and Packet Forwarding Engine, tunnel services are not activated. For example, you cannot specify a bandwidth of 1 Gbps for a Packet Forwarding Engine on a 10-Gigabit Ethernet 4-port DPC.

When you configure tunnel interfaces on the Packet Forwarding Engine of a 10-Gigabit Ethernet 4-port DPC, the Ethernet interfaces for that port are removed from service and are no longer visible in the command-line interface (CLI). The Packet Forwarding Engine of a 10-Gigabit Ethernet 4-port DPC supports either tunnel interfaces or Ethernet interfaces, but not both. Each port on the 10-Gigabit Ethernet 4-port DPC includes two LEDs, one for tunnel services and one for Ethernet services, to indicate which type of service is being used. On the Gigabit Ethernet 40-port DPC, you can configure both tunnel and Ethernet interfaces at the same time.

To verify that the tunnel interfaces have been created, issue the `show interfaces terse` operational mode command. For more information, see the *JUNOS Interfaces Command Reference*.

For additional information about tunnel services, see the “Tunnel Services” chapter in the *JUNOS Services Interfaces Configuration Guide*.

Chapter 7

Summary of Bridge Domain Configuration Statements

The following sections explain each of the bridge domain configuration statements. The statements are organized alphabetically.

bandwidth

Syntax bandwidth (1g | 10g);

Hierarchy Level [edit chassis fpc *slot-number* pic *number* tunnel-services]

Release Information Statement introduced in JUNOS Release 8.2.

Description On MX Series routers only, specify the amount of bandwidth to reserve for tunnel services.

Options 1g—Specify a bandwidth of 1 Gbps on the Packet Forwarding Engine connected to a Gigabit Ethernet 40-port Dense Port Concentrator (DPC).

10g—Specify a bandwidth of 10 Gbps on the Packet Forwarding Engine connected to 10-Gigabit Ethernet 4-port DPC.



NOTE: If you specify a bandwidth that is not compatible with the type of DPC and Packet Forwarding Engine, tunnel services are not activated. For example, you cannot specify a bandwidth of 1 Gbps for a Packet Forwarding Engine on a 10-Gigabit Ethernet 4-port DPC.

Usage Guidelines See “Configuring Layer 3 Tunnel Services Interfaces on MX Series Routers” on page 83.

Required Privilege Level interface—To view this statement in the configuration.
interface-control—To add this statement to the configuration.

bridge-domains

Syntax

```
bridge-domains {
  bridge-domain-name {
    bridge-options {
      ...bridge-options-configuration...
    }
    domain-type bridge;
    interface interface-name;
    routing-interface routing-interface-name;
    vlan-id (all | none | number);
    vlan-id-list [ vlan-id-numbers ];
    vlan-tags outer number inner number;
    bridge-options {
      interface interface-name {
        static-mac mac-address;
      }
      interface-mac-limit limit;
      mac-statistics;
      mac-table-size limit;
      no-mac-learning;
    }
  }
}
```

Hierarchy Level [edit],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name*],
[edit routing-instances *routing-instance-name*]

Release Information Statement introduced in JUNOS Release 8.4.
Support for logical systems added in JUNOS Release 9.6.

Description (MX Series routers only) Configure a domain that includes a set of logical ports that share the same flooding or broadcast characteristics in order to perform Layer 2 bridging.

Options *bridge-domain-name*—Name of the bridge domain.

The remaining statements are explained separately.

Usage Guidelines See “Configuring Bridge Domains” on page 62, “Configuring a Layer 2 Virtual Switch” on page 70, and “Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch” on page 75.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Topics instance-type

bridge-options

Syntax	<pre>bridge-options { interface <i>interface-name</i>; static-mac <i>static-mac-address</i>; } interface-mac-limit <i>limit</i>; packet-action drop; } mac-statistics; mac-table-size <i>limit</i>; no-mac-learning; }</pre>
Hierarchy Level	<pre>[edit bridge-domains <i>bridge-domain-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>]</pre>
Release Information	<p>Statement introduced in JUNOS Release 8.4.</p> <p>Support for logical systems added in JUNOS Release 9.6.</p>
Description	<p>(MX Series routers only) Configure Layer 2 learning and forwarding properties for a bridge domain or a virtual switch.</p> <p>The remaining statements are explained separately.</p>
Usage Guidelines	See “Configuring Layer 2 Learning and Forwarding for Bridge Domains” on page 76.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	I2-learning, switch-options

domain-type

Syntax	domain-type bridge;
Hierarchy Level	[edit bridge-domains <i>bridge-domain-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Define the type of domain for a Layer 2 bridge domain.
Usage Guidelines	See “Configuring Bridge Domains” on page 62, “Configuring a Layer 2 Virtual Switch” on page 70, and “Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch” on page 75.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

interface

Syntax	<code>interface interface-name;</code>
Hierarchy Level	[edit bridge-domains <i>bridge-domain-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>], [edit bridge-domains <i>bridge-domain-name</i>],
Release Information	Statement introduced in JUNOS Release 8.4. Support for top-level configuration for the virtual-switch type of routing instance added in JUNOS Release 9.2. In JUNOS Release 9.1 and earlier, the routing instances hierarchy supported this statement only for a VPLS instance or a bridge domain configured within a virtual switch. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Specify the logical interfaces to include in the bridge domain, VPLS instance, or virtual switch.
Options	<i>interface-name</i> —Name of a logical interface. For more information about how to configure logical interfaces, see the <i>JUNOS Network Interfaces Configuration Guide</i> .
Usage Guidelines	See “Configuring Bridge Domains” on page 62, “Configuring a Layer 2 Virtual Switch” on page 70, “Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch” on page 75, and “Configuring a Layer 2 Virtual Switch with a Layer 2 Trunk Port” on page 72.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	routing-interface

interface-mac-limit

Syntax	interface-mac-limit <i>limit</i> { packet-action drop; }
Hierarchy Level	[edit bridge-domains <i>bridge-domain-name</i> bridge-options], [edit bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options], [edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> switch-options], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> switch-options interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> switch-options], [edit logical-systems <i>logical-system-name</i> switch-options interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> switch-options], [edit routing-instances <i>routing-instance-name</i> switch-options interface <i>interface-name</i>], [edit switch-options], [edit switch-options interface <i>interface-name</i>]
Release Information	Statement introduced in JUNOS Release 8.4. Support for the switch-options statement added in JUNOS Release 9.2. Support for top-level configuration for the virtual-switch type of routing instance added in JUNOS Release 9.2. In JUNOS Release 9.1 and earlier, the routing instances hierarchy supported this statement only for a VPLS instance or a bridge domain configured within a virtual switch. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Configure a limit to the number of MAC addresses that can be learned from a bridge domain, virtual switch, or set of bridge domains.
Default	1024 MAC addresses for each logical interface.
Options	<i>limit</i> —Maximum number of MAC addresses learned from an interface. Range: 1 through 131,071 MAC addresses per interface The remaining statement is explained separately.
Usage Guidelines	See “Limiting the Number of MAC Addresses Learned from an Interface in a Bridge Domain” on page 79 and “Limiting the Number of MAC Addresses Learned from a Trunk Port” on page 81.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Topics global-mac-limit and the *JUNOS VPNs Configuration Guide*

mac-statistics

Syntax mac-statistics;

Hierarchy Level [edit bridge-domains *bridge-domain-name* bridge-options],
[edit logical-systems *logical-system-name* bridge-domains *bridge-domain-name* bridge-options],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* bridge-domains *bridge-domain-name* bridge-options],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* switch-options],
[edit logical-systems *logical-system-name* switch-options],
[edit routing-instances *routing-instance-name* bridge-domains *bridge-domain-name* bridge-options],
[edit routing-instances *routing-instance-name* switch-options],
[edit switch-options]

Release Information Statement introduced in JUNOS Release 8.4.
Support for the **switch-options** statement added in JUNOS Release 9.2.
Support for top-level configuration for the **virtual-switch** type of routing instance added in JUNOS Release 9.2. In JUNOS Release 9.1 and earlier, the routing instances hierarchy supported this statement only for a VPLS instance or a bridge domain configured within a virtual switch.
Support for logical systems added in JUNOS Release 9.6.

Description (MX Series routers only) Enable MAC accounting either for a specific bridge domain, or for a set of bridge domains associated with a Layer 2 trunk port.

Default disabled

Usage Guidelines See “Enabling MAC Accounting for a Bridge Domain” on page 80 and “Enabling MAC Accounting for a Set of Bridge Domains” on page 83.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Topics global-mac-statistics

mac-table-size

Syntax	mac-table-size <i>limit</i> { packet-action drop; }
Hierarchy Level	[edit bridge-domains <i>bridge-domain-name</i> bridge-options], [edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> switch-options], [edit logical-systems <i>logical-system-name</i> switch-options], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options], [edit routing-instances <i>routing-instance-name</i> switch-options], [edit switch-options]
Release Information	Statement introduced in JUNOS Release 8.4. Support for the switch-options statement added in JUNOS Release 9.2. Support for top-level configuration for the virtual-switch type of routing instance added in JUNOS Release 9.2. In JUNOS Release 9.1 and earlier, the routing instances hierarchy supported this statement only for a VPLS instance or a bridge domain configured within a virtual switch. Support for logical systems added in JUNOS Release 9.6.
Description	Modify the size of the MAC address table for the bridge domain, a set of bridge domains associated with a trunk port, or a virtual switch. The default is 5120 MAC addresses.
Options	<i>limit</i> —Specify the maximum number of addresses in the MAC address table. Range: 16 through 1,048,575 MAC addresses Default: 5120 MAC addresses The remaining statement is explained separately.
Usage Guidelines	See “Configuring the Size of the MAC Address Table” on page 78 and “Modifying the Size of the MAC Address Table for a Set of Bridge Domains” on page 82.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	interface-mac-limit and the <i>JUNOS VPNs Configuration Guide</i>

no-mac-learning

Syntax	no-mac-learning;
Hierarchy Level	[edit bridge-domains <i>bridge-domain-name</i> bridge-options], [edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options], [edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> switch-options], [edit logical-systems <i>logical-system-name</i> switch-options], [edit bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> switch-options], [edit switch-options]
Release Information	Statement introduced in JUNOS Release 8.4. Support for the switch-options statement added in JUNOS Release 9.2. Support for top-level configuration for the virtual-switch type of routing instance added in JUNOS Release 9.2. In JUNOS Release 9.1 and earlier, the routing instances hierarchy supported this statement only for a VPLS instance or bridge domain configured within a virtual switch. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Disable MAC learning for a virtual switch, for a bridge domain, for a specific logical interface in a bridge domain, or for a set of bridge domains associated with a Layer 2 trunk port.
Default	MAC learning is enabled. Use no-mac-learning to disable MAC learning.
Usage Guidelines	See and “Disabling MAC Learning for a Bridge Domain or Logical Interface” on page 77 and “Disabling MAC Learning for a Set of Bridge Domains” on page 81.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	global-no-mac-learning

packet-action

Syntax	packet-action drop;
Hierarchy Level	<p>[edit bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i> interface-mac-limit <i>limit</i>],</p> <p>[edit bridge-domains <i>bridge-domain-name</i> bridge-options interface-mac-limit <i>limit</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i> interface-mac-limit <i>limit</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface-mac-limit <i>limit</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols l2-learning global-mac-limit <i>limit</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i> interface-mac-limit <i>limit</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface-mac-limit <i>limit</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> switch-options interface <i>interface-name</i> interface-mac-limit <i>limit</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> switch-options interface-mac-limit <i>limit</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> switch-options interface-mac-limit <i>limit</i>],</p> <p>[edit protocols l2-learning global-mac-limit <i>limit</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i> interface-mac-limit <i>limit</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface-mac-limit <i>limit</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> switch-options interface <i>interface-name</i> interface-mac-limit <i>limit</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> switch-options interface-mac-limit <i>limit</i>],</p> <p>[edit switch-options interface-mac-limit <i>limit</i>]</p>
Release Information	<p>Statement introduced in JUNOS Release 8.4.</p> <p>Support for the switch-options statement added in JUNOS Release 9.2.</p> <p>Support for top-level configuration for the virtual-switch type of routing instance added in JUNOS Release 9.2. In JUNOS Release 9.1 and earlier, the routing instances hierarchy supported this statement only for a VPLS instance or a bridge domain configured within a virtual switch.</p> <p>Support for logical systems added in JUNOS Release 9.6.</p>
Description	(MX Series routers only) Specify that packets for new source MAC addresses be dropped after the MAC address limit is reached. If this statement is not configured, then packets for new source MAC addresses are forwarded by default.
Default	Disabled. The default is for packets for new source MAC addresses to be forwarded after the MAC address limit is reached.
Usage Guidelines	See “Limiting the Number of MAC Addresses Learned from an Interface in a Bridge Domain” on page 79 and “Limiting the Number of MAC Addresses Learned from a Trunk Port” on page 81.
Required Privilege Level	routing—To view this statement in the configuration.

routing-control—To add this statement to the configuration.

Related Topics interface-mac-limit and the *JUNOS VPNs Configuration Guide*

routing-interface

Syntax routing-interface *routing-interface-name*;

Hierarchy Level [edit bridge-domains *bridge-domain-name*],
[edit logical-systems *logical-system-name* bridge-domains *bridge-domain-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name*
bridge-domains *bridge-domain-name*],
[edit routing-instances *routing-instance-name* bridge-domains *bridge-domain-name*]

Release Information Statement introduced in JUNOS Release 8.4.
Support for logical systems added in JUNOS Release 9.6.

Description (MX Series routers only) Specify a routing interface to include in a bridge domain or a VPLS routing instance.

Options *routing-interface-name*—Name of the routing interface to include in the bridge domain or the VPLS routing instance. The format of the routing interface name is *irb.x*, where *x* is the unit number of the routing interface you configured at the [edit interfaces *irb*] hierarchy level. For more information about how to configure a routing interface, see the *JUNOS Network Interfaces Configuration Guide*.



NOTE: You can specify only one routing interface for each bridge domain or VPLS instance.

Usage Guidelines See “Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch” on page 75 and “Configuring Bridge Domains” on page 62.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

Related Topics interface and the *JUNOS VPNs Configuration Guide*

static-mac

Syntax	static-mac <i>mac-address</i> { vlan-id <i>number</i> ; }
Hierarchy Level	[edit bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i> bridge-options interface <i>interface-name</i>]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Configure a static MAC address for a logical interface in a bridge domain.
Options	<i>mac-address</i> —MAC address vlan-id <i>number</i> —(Optional) VLAN identifier to associate with static MAC address.
Usage Guidelines	See “Configuring Static MAC Addresses for Logical Interfaces in a Bridge Domain” on page 78.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.



switch-options

Syntax	<pre>switch-options { interface <i>interface-name</i> { interface-mac-limit <i>limit</i>; } interface-mac-limit <i>limit</i> { packet-action drop; } mac-statistics; mac-table-size <i>limit</i> { packet-action drop; } no-mac-learning; }</pre>
Hierarchy Level	[edit], [edit logical-systems <i>logical-system-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i>], [edit routing-instances <i>routing-instance-name</i>]
Release Information	Statement introduced in JUNOS Release 9.2. Support for logical systems added in JUNOS Release 9.6.
Description	Configure Layer 2 learning and forwarding properties for a set of bridge domains.
Options	The remaining statements are explained separately.
Usage Guidelines	See “Configuring Layer 2 Learning and Forwarding for Bridge Domains Functioning as Switches with Layer 2 Trunk Ports” on page 81.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	bridge-options, l2-learning

tunnel-services

Syntax	tunnel-services { bandwidth (1g 10g); }
Hierarchy Level	[edit chassis fpc <i>slot-number</i> pic <i>number</i>]
Release Information	Statement introduced in JUNOS Release 8.2.
Description	For MX Series routers, configure the amount of bandwidth for tunnel services.
Options	The statements are explained separately.
Usage Guidelines	See “Configuring Layer 3 Tunnel Services Interfaces on MX Series Routers” on page 83.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

vlan-id

Syntax	<code>vlan-id (all none <i>number</i>);</code>
Hierarchy Level	[edit bridge-domains <i>bridge-domain-name</i>], [edit logical-systems <i>logical-system-name</i> bridge-domainss <i>bridge-domain-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>]
Release Information	Statement introduced in JUNOS Release 8.4. Support for Layer 2 trunk ports added in JUNOS Release 9.2. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Specify a VLAN identifier to include in the packets sent to and from the bridge domain or a VPLS routing instance.
Options	<i>number</i> —A valid VLAN identifier. If you configure multiple bridge domains with a valid VLAN identifier, you must specify a unique VLAN identifier for each domain. However, you can use the same VLAN identifier for bridge domains that belong to different virtual switches. Use this option to send singly tagged frames with the specified VLAN identifier over VPLS VT interfaces.
	NOTE: If you specify a VLAN identifier, you cannot also use the <i>all</i> option. They are mutually exclusive.
	<i>all</i> —Specify that the bridge domain spans all the VLAN identifiers configured on the member logical interfaces.
	NOTE: You cannot specify the <i>all</i> option if you include a routing interface in the bridge domain.
	<i>none</i> —Specify to enable shared VLAN learning or to send untagged frames over VPLS VT interfaces.
Usage Guidelines	See “Configuring Bridge Domains” on page 62, “Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances” on page 63, “Configuring Bridge Domains as Switches for Layer 2 Trunk Ports” on page 69, “Configuring a Layer 2 Virtual Switch” on page 70, “Configuring VPLS Ports in a Virtual Switch” on page 73, and “Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch” on page 75.
Required Privilege Level	<i>routing</i> —To view this statement in the configuration. <i>routing-control</i> —To add this statement to the configuration.
Related Topics	<i>vlan-tags</i> and the <i>JUNOS VPNs Configuration Guide</i>

vlan-id-list

Syntax	<code>vlan-id-list [<i>vlan-id-numbers</i>];</code>
Hierarchy Level	[edit bridge-domains <i>bridge-domain-name</i>], [edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>]
Release Information	Statement introduced in JUNOS Release 9.4. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Specify a VLAN identifier list to use for a bridge domain in trunk mode.
Options	<i>vlan-id-numbers</i> —Valid VLAN identifiers. You can combine individual numbers with range lists including a hyphen. Range: 0 through 4095
Usage Guidelines	See “Configuring Bridge Domains” on page 62 and “Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances” on page 63.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	vlan-id and the <i>JUNOS VPNs Configuration Guide</i>

vlan-tags

Syntax	<code>vlan-tags outer <i>number</i> inner <i>number</i>;</code>
Hierarchy Level	[edit bridge-domains <i>bridge-domain-name</i>], [edit logical-systems <i>logical-system-name</i> bridge-domains <i>bridge-domain-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>], [edit routing-instances <i>routing-instance-name</i> bridge-domains <i>bridge-domain-name</i>]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Specify dual VLAN identifier tags for a bridge domain or a VPLS routing instance.
Options	<i>outer number</i> —A valid VLAN identifier. <i>inner number</i> —A valid VLAN identifier.
Usage Guidelines	See “Configuring Bridge Domains” on page 62, “Configuring VLAN Identifiers for Bridge Domains and VPLS Routing Instances” on page 63, “Configuring a Layer 2 Virtual Switch” on page 70, and “Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch” on page 75.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	vlan-id and the <i>JUNOS Network Interfaces Configuration Guide</i>

Part 4

Layer 2 Address Learning and Forwarding

- Configuring Layer 2 Address Learning and Forwarding on page 105
- Summary of Layer 2 Address Learning and Forwarding Configuration Statements on page 109

Chapter 8

Configuring Layer 2 Address Learning and Forwarding

This chapter describes how you can configure Layer 2 MAC address and VLAN learning and forwarding on the Juniper Networks MX Series Ethernet Services Routers to support Layer 2 bridging.

- Layer 2 Address Learning and Forwarding Overview on page 105
- Disabling MAC Learning on page 106
- Configuring the MAC Table Timeout Interval on page 106
- Enabling MAC Accounting on page 106
- Limiting the Number of MAC Addresses Learned from Each Interface on page 107
- Configuring MAC Move Parameters on page 107

Layer 2 Address Learning and Forwarding Overview

On Juniper Networks MX Series Ethernet Services Routers only, you can configure Layer 2 address learning and forwarding properties in support of Layer 2 bridging. The router learns unicast media access control (MAC) addresses to avoid flooding the packets to all the ports in a bridge domain. The MX Series router creates a source MAC entry in its source and destination MAC tables for each MAC address learned from packets received on ports that belong to the bridge domain.

By default, Layer 2 address learning is enabled. You can disable MAC learning for the router or for a specific bridge domain or logical interfaces. You can also configure the following Layer 2 forwarding properties for an MX Series router:

- Timeout interval for MAC entries
- MAC accounting
- A limit to the number of MAC addresses learned from the logical interfaces

For more information about how to configure bridge domains and virtual switches, see “Configuring Layer 2 Bridging” on page 61 and “Configuring Layer 2 Virtual Switches” on page 69.

Disabling MAC Learning

Disabling dynamic MAC learning on an MX Series routers prevents all the logical interfaces on the router from learning source and destination MAC addresses.

To disable MAC learning for an MX Series router, include the `global-no-mac-learning` statement at the `[edit protocols l2-learning]` hierarchy level:

```
[edit protocols l2-learning]
global-no-mac-learning;
```

For more information about how to disable MAC learning for a bridge domain or a specific logical interface, see “Disabling MAC Learning for a Bridge Domain or Logical Interface” on page 77. For more information about how to configure a virtual switch, see “Configuring a Layer 2 Virtual Switch” on page 70 and “Configuring Integrated Routing and Bridging for a Bridge Domain Within a Layer 2 Virtual Switch” on page 75.

Configuring the MAC Table Timeout Interval

By default, the timeout interval for all entries in the MAC table is 300 seconds. You can modify the timeout interval for MAC table entries on an MX Series router. You cannot modify the timeout interval only for specific MAC table entries, such as for a bridge domain or a virtual switch.



NOTE: The timeout interval applies only to dynamically learned MAC addresses. This value does not apply to configured static MAC addresses, which never time out. For more information about configuring static MAC addresses, see “Configuring Static MAC Addresses for Logical Interfaces in a Bridge Domain” on page 78.

To modify the timeout interval for the MAC table for the entire routing platform, include the `global-mac-table-aging-time seconds` statement at the `[edit protocols l2-learning]` hierarchy level:

```
[edit protocols l2-learning]
global-mac-table-aging-time seconds;
```

The range for `seconds` is from 10 through 1,000,000.

Enabling MAC Accounting

By default, MAC accounting is disabled. On MX Series routers, you can enable packet accounting either for the router as a whole or for a specific bridge domain. After you enable packet accounting, the JUNOS software maintains packet counters for each MAC address learned.

To enable MAC accounting for an MX Series router, include the `global-mac-statistics` statement at the `[edit protocols l2-learning]` hierarchy level:

```
[edit protocols l2-learning]
global-mac-statistics;
```

Limiting the Number of MAC Addresses Learned from Each Interface

You can configure a limit to the number of MAC addresses learned from the logical interfaces on an MX Series routers.

To configure a limit to the total number of MAC addresses that can be learned from the logical interfaces, include the `global-mac-limit limit` statement at the `[edit protocols l2-learning]` hierarchy level:

```
[edit protocols l2-learning]
global-mac-limit limit;
```

The default limit to the number of MAC addresses that can be learned the router as a whole is 393,215. The range that you can configure for the router as a whole is 20 through 1,048,575.

After the configured MAC address limit is reached, the default is for packets to be forwarded. You can specify that the packets be dropped by including the `packet-action drop` statement at the `[edit protocols l2-learning global-mac-limit]` hierarchy level:

```
[edit protocols l2-learning global-mac-limit limit]
packet-action drop;
```

You can also configure a limit to the number of MAC address learned from all the interfaces in a bridge domain or from a specific logical interface only. For more information, see “Limiting the Number of MAC Addresses Learned from an Interface in a Bridge Domain” on page 79.



NOTE: On MX Series routers running JUNOS Release 8.4 and later, statistics for an aged destination MAC entry are not retained. In addition, source and destination statistics are reset during a MAC move. In previous releases, only source statistics were reset during a MAC move.

Configuring MAC Move Parameters

When a MAC address appears on a different physical interface or within a different unit of the same physical interface and this behavior occurs frequently, it is considered a MAC move. You can configure the router to report a MAC address move based on the following parameters: the number of times a MAC address move occurs, a specified period of time over which the MAC address move occurs, and specified number of times a MAC address move occurs in one second. You can only configure the `global-mac-move` statement at the global hierarchy level.

To configure MAC address move reporting if the MAC address moves at least a specified number of times in one second, include the `threshold-time` statement at the `[edit l2-learning global-mac-move]` hierarchy level. The default threshold time is 1 second.

To configure reporting of a MAC address move if the MAC address moves for a specified period of time, include the **notification-time** statement at the **[edit l2-learning global-mac-move]** hierarchy level. The default notification timer is 1 second.

To configure reporting of a MAC address move if the MAC address moves a specified number of times, include the **threshold-count** statement at the **[edit l2-learning global-mac-move]** hierarchy level. The default threshold count is 50 moves.

Use the **show l2-learning mac-move-buffer** command to view detailed information about MAC address moves.

The following example sets the notification time for MAC moves to 1 second, the threshold time to 1 second, and the threshold count to 50 moves.

```
[edit protocols l2-learning]
global-mac-move {
  notification-time 1;
  threshold-count 50;
  threshold-time 1;
}
```


Chapter 9

Summary of Layer 2 Address Learning and Forwarding Configuration Statements

The following sections explain each of the Layer 2 address learning and forwarding configuration statements. These statements are organized alphabetically.

global-mac-limit

Syntax	<code>global-mac-limit <i>limit</i> { packet-action drop; }</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols l2-learning], [edit protocols l2-learning]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Limit the number of media access control (MAC) addresses learned from the logical interfaces on the router.
Default	393,215 MAC addresses
Options	<i>limit</i> —Number of MAC addresses that can be learned systemwide. Range: 20 through 1,048,575 The remaining statement is explained separately in the “Summary of Bridge Domain Configuration Statements” chapter.
Usage Guidelines	See “Limiting the Number of MAC Addresses Learned from Each Interface” on page 107.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	interface-mac-limit

global-mac-move

Syntax	global-mac-move { notification-time <i>seconds</i> ; threshold-count <i>count</i> ; threshold-time <i>seconds</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols l2-learning], [edit protocols l2-learning]
Release Information	Statement introduced in JUNOS Release 9.4. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Set parameters for media access control (MAC) address move reporting.
Default	By default, MAC moves notify every second, with a threshold time of 1 second and a threshold count of 50.
Usage Guidelines	See “Configuring MAC Move Parameters” on page 107
Required Privilege Level	view-level—To view this statement in the configuration. control-level—To add this statement to the configuration.

global-mac-statistics

Syntax	global-mac-statistics;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols l2-learning], [edit protocols l2-learning]
Release Information	Statement introduced in JUNOS Release 9.2. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Enable MAC accounting for the entire router,
Default	disabled
Usage Guidelines	See “Enabling MAC Accounting” on page 106.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	mac-statistics

global-mac-table-aging-time

Syntax	global-mac-table-aging-time <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols l2-learning], [edit protocols l2-learning]
Release Information	Statement introduced in JUNOS Release 9.2. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Configure the timeout interval for entries in the MAC table.
Default	300 seconds
Options	<i>seconds</i> —Time elapsed before MAC table entries are timed out and entries are deleted from the table. Range: 10 through 1 million
Usage Guidelines	See “Configuring the MAC Table Timeout Interval” on page 106.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	<i>JUNOS VPNs Configuration Guide</i>

global-no-mac-learning

Syntax	global-no-mac-learning;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols l2-learning], [edit protocols l2-learning]
Release Information	Statement introduced in JUNOS Release 9.2. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Disable MAC learning for the entire router.
Default	MAC learning is enabled.
Usage Guidelines	See “Disabling MAC Learning” on page 106.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	no-mac-learning

I2-learning

Syntax	<pre> I2-learning { global-mac-limit <i>limit</i>; global-mac-move { notification-time <i>seconds</i>; threshold-count <i>count</i>; threshold-time <i>seconds</i>; } global-mac-statistics; global-mac-table-aging-time <i>seconds</i>; global-no-mac-learning; } </pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols], [edit protocols]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	<p>(MX Series routers only) Configure Layer 2 address learning and forwarding properties globally.</p> <p>The statements are explained separately.</p>
Usage Guidelines	See “Configuring Layer 2 Address Learning and Forwarding” on page 105.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>
Related Topics	bridge-options, switch-options

notification-time

Syntax	notification-time <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols l2-learning global-mac-move], [edit protocols l2-learning global-mac-move]
Release Information	Statement introduced in JUNOS Release 9.4. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Configure the notification time value for MAC move reports that a MAC address moves before counting against the threshold values.
Default	1 second
Options	<i>seconds</i> —Time elapsed before MAC move reports are generated.
Usage Guidelines	See “Configuring MAC Move Parameters” on page 107.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	See <i>threshold-count</i> See <i>threshold-time</i> .

threshold-count

Syntax	<code>threshold-count count;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols l2-learning global-mac-move], [edit protocols l2-learning global-mac-move]
Release Information	Statement introduced in JUNOS Release 9.4. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Configure the threshold count value for MAC move reports.
Default	50
Options	<i>count</i> —Number of MAC moves needed in the notification time to generate a MAC move report.
Usage Guidelines	See “Configuring MAC Move Parameters” on page 107.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	See notification-time. See threshold-time.

threshold-time

Syntax	threshold-time <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols l2-learning global-mac-move], [edit protocols l2-learning global-mac-move]
Release Information	Statement introduced in JUNOS Release 9.4. Support for logical systems added in JUNOS Release 9.6.
Description	(MX Series routers only) Configure the threshold time value for MAC move reports when the MAC address moves at least a specified number of times (threshold count) in the configured interval.
Default	1 second
Options	<i>seconds</i> —Timer threshold before MAC move reports are generated.
Usage Guidelines	See “Configuring MAC Move Parameters” on page 107.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.
Related Topics	See notification-time See threshold-count

Part 5

Spanning Tree Protocols

- Configuring Spanning Tree Protocols on page 119
- Summary of Spanning Tree Protocol Configuration Statements on page 141

Chapter 10

Configuring Spanning Tree Protocols

This chapter describes how you can configure the various versions of the Spanning Tree Protocol (STP) supported on Juniper Networks MX Series Ethernet Services Routers to create a loop-free topology in Layer 2 networks.

- Spanning Tree Protocols Overview on page 119
- Configuring Rapid Spanning Tree Protocol on page 120
- Configuring Multiple Spanning Tree Protocol on page 129
- Configuring VLAN Spanning Tree Protocol on page 131
- Configuring Layer 2 Protocol Tunneling on page 132
- Configuring BPDU Protection for Spanning Tree Protocols on page 133
- Configuring STP Loop Protection on page 135
- Configuring VPLS Root Protection Topology Change Actions on page 137

Spanning Tree Protocols Overview

The Spanning Tree Protocol (STP) is used to create a loop-free topology in Layer 2 networks.

STP is a Layer 2 protocol that calculates the best path through a switched network that contains redundant paths. STP uses bridge protocol data unit (BPDU) packets to exchange information with other switches. STP uses the information provided by the BPDUs to elect a root bridge, identify root ports for each switch, identify designated ports for each physical LAN segment, and prune specific redundant links to create a loop-free tree topology. The resulting tree topology provides a single active Layer 2 data path between any two end stations. In discussions of STP, the terms *bridge* and *switch* are used interchangeably.

The original Spanning Tree Protocol is defined in the IEEE 802.1D 1998 specification. A newer version called Rapid Spanning Tree Protocol (RSTP) was originally defined in the IEEE 802.1w draft specification and later incorporated into the IEEE 802.1D-2004 specification. A recent version called Multiple Spanning Tree Protocol (MSTP) was originally defined in the IEEE 802.1s draft specification and later incorporated into the IEEE 802.1Q-2003 specification.

RSTP provides faster reconvergence time than the original STP by identifying certain links as point to point and by using protocol handshake messages rather than fixed timeouts. When a point-to-point link fails, the alternate link can transition to the forwarding state without waiting for any protocol timers to expire.

MSTP provides the capability to logically divide a Layer 2 network into regions. Every region has a unique identifier and can contain multiple instances of spanning trees. All regions are bound together using a Common Instance Spanning Tree (CIST), which is responsible for creating a loop-free topology across regions, whereas the Multiple Spanning Tree Instance (MSTI) controls topology inside regions. MSTP uses RSTP as a converging algorithm and is fully interoperable with earlier versions of STP.

The VLAN Spanning Tree Protocol (VSTP) is compatible with the Per-VLAN Spanning Tree Plus (PVST+) and Rapid-PVST+ protocols supported on Cisco Systems routers and switches. VSTP maintains a separate spanning-tree instance for each VLAN. Different VLANs can use different spanning-tree paths and VSTP can support up to 4094 different spanning-tree topologies. When different VLANs can use different spanning-tree paths, the CPU processing resources being consumed increase as more VLANs are configured. VSTP BPDU packets are tagged with the corresponding VLAN identifier and are transmitted to the multicast destination media access control (MAC) address 01-00-0c-cc-cc-cd with a protocol type of 0x010b. VSTP BPDUs are tunneled by pure IEEE 802.1q bridges.

The Juniper Networks MX Series Ethernet Services Routers support STP, RSTP, MSTP, and VSTP.



NOTE: All virtual switch routing instances configured on an MX Series router are supported using only one spanning-tree process. The Layer 2 control protocol process is named l2cpd.

For more information about the various versions of STP, see the appropriate IEEE specification.

Configuring Rapid Spanning Tree Protocol

This section discusses configuration statements and options for RSTP. Most of these statements also apply to MSTP and VSTP.

- Enabling a Spanning Tree Protocol on page 121
- Configuring the BPDU Destination MAC Address on page 121
- Configuring the Bridge Priority on page 121
- Configuring the Maximum Age Timer on page 122
- Configuring the Hello Timer on page 122
- Forcing the Spanning-Tree Version on page 123
- Configuring the Forwarding Delay on page 123
- Configuring the Extended System Identifier on page 123
- Configuring the Interface on page 124
- Configuring the Interface Priority on page 124
- Configuring the Interface Cost on page 125
- Configuring the Interface Mode on page 126
- Configuring an Edge Port on page 126

- Configuring Root Protect on page 127
- Tracing STP Traffic on page 128
- Example: Tracing STP Traffic on page 129

Enabling a Spanning Tree Protocol

On an MX Series router you can enable the use of a spanning tree protocol under a user-created routing instance of type **virtual-switch** or **layer2-control**. Configure the version of spanning tree protocol to be used as MSTP, RSTP, or VSTP.

```
(mstp | rstp | vstp);
```

You can include this statement at the following hierarchy levels:

- [edit protocols]
- [edit routing-instances *routing-instance-name* protocols]

Configuring the BPDU Destination MAC Address

A provider network can bridge the customer STP BPDU packets between customer sites by default. Simultaneously the provider network can prevent forwarding loops using STP in the provider network.

To configure a bridge to participate in the provider RSTP instance, include the following statement:

```
bpdu-destination-mac-address provider-bridge-group;
```

You can include this statement at the following hierarchy levels:

- [edit protocols rstp]
- [edit routing-instances *routing-instance-name* protocols rstp]

When the **provider-bridge-group** option is specified, the destination MAC address of the BPDU packets transmitted is the provider bridge group address **01:80:c2:00:00:08**, as defined in the IEEE 802.1ad specification. Received BPDU packets with this destination MAC address are accepted and passed to the Routing Engine.

Configuring the Bridge Priority

Use the bridge priority to control which bridge is elected as the root bridge. Also use the bridge priority to control which bridge is elected the root bridge when the initial root bridge fails.

The root bridge for each STP instance is determined by the bridge ID. The bridge ID consists of a configurable bridge priority and the MAC address of the bridge. The bridge with the lowest bridge ID is elected as the root bridge. If the bridge priorities are equal or if the bridge priority is not configured, the bridge with the lowest MAC address is elected the root bridge.

The bridge priority can also be used to determine which bridge becomes the designated bridge for a LAN segment. If two bridges have the same path cost to the root bridge, the bridge with the lowest bridge ID becomes the designated bridge.

The bridge priority can be set only in increments of 4096.

To configure the bridge priority, include the following statement:

```
bridge-priority priority;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp)]
- [edit protocols mstp msti *msti-id*]
- [edit protocols vstp vlan *vlan-id*]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp)]
- [edit routing-instances *routing-instance-name* protocols mstp msti *msti-id*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id*]

Configuring the Maximum Age Timer

The maximum age timer specifies the maximum expected arrival time of hello BPDUs. If the maximum age timer expires, the bridge detects that the link to the root bridge has failed and initiates a topology reconvergence. The maximum age timer should be longer than the configured hello timer.

To configure the maximum age timer, include the following statement:

```
max-age seconds;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp)]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp)]
- [edit protocols vstp vlan *vlan-id*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id*]

Configuring the Hello Timer

The hello timer specifies the time interval at which the root bridge transmits configuration BPDUs.

To configure the hello timer, include the following statement:

```
hello-time seconds;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp)]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp)]
- [edit protocols vstp vlan *vlan-id*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id*]

Forcing the Spanning-Tree Version

The `force-version` statement forces the spanning-tree version to run as the original IEEE 802.1D version. Use this statement for compatibility with older bridges that do not support RSTP or VSTP.

To force the spanning-tree version, include the following statement:

```
force-version stp;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (rstp | vstp)]
- [edit routing-instances *routing-instance-name* protocols (rstp | vstp)]

Configuring the Forwarding Delay

The forwarding delay timer specifies the length of time an STP bridge port remains in the listening and learning states before transitioning to the forwarding state. Setting the interval too short could cause unnecessary spanning-tree reconvergence. Before changing this parameter, you should have a thorough understanding of STP.

To configure the forwarding delay timer, include the following statement:

```
forward-delay seconds;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp)]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp)]
- [edit protocols vstp vlan *vlan-id*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id*]

Configuring the Extended System Identifier

The extended system identifier is used to specify different bridge identifiers for different RSTP or STP routing instances.

To configure the extended system identifier, include the following statement:

```
extended-system-id identifier;
```

You can include this statement at the following hierarchy levels:

- [edit protocols rstp]
- [edit routing-instances *routing-instance-name* protocols rstp]

Configuring the Interface

STP and RSTP are limited to a single instance on any physical interface. Use the **interface** statement to configure which interfaces participate in the STP or RSTP instance. MSTP supports multiple instances on a single physical interface. Use the **interface** statement to configure which logical interfaces participate in MSTP.

For VSTP, interfaces can be configured at the global level or at the VLAN level. Interfaces configured at the global VSTP level will be enabled for all the configured VLANs. If an interface is configured at both the global and VLAN levels, the configuration at the VLAN level overrides the global configuration.

To configure the interface, include the following statements:

```
interface interface-name {
    cost cost;
    edge;
    mode (p2p | shared);
    priority interface-priority;
}
```

You can include these statements at the following hierarchy levels:

- [edit protocols (mstp | rstp | vstp)]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp)]
- [edit protocols vstp vlan *vlan-id*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id*]

Configuring the Interface Priority

The root port is the interface on the nonroot bridge with the lowest path cost to the root bridge. When multiple interfaces have the same path cost to the root bridge, the interface with the lowest interface priority is selected as the root port.

If the interface priority is not configured and multiple interfaces have the same path cost to the root bridge, the interface with the lowest interface identifier is selected as the root port.

If the interface priority is configured under the MSTP protocol, this becomes the default value for all interfaces. If the interface priority is configured under the MSTI interface, the value overrides the default for that interface.

If the interface priority is configured at both the VSTP global and VLAN levels, the configuration at the VLAN level overrides the global configuration.

To configure the interface priority, include the following statement:

```
priority interface-priority;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp | vstp) interface *interface-name*]
- [edit protocols mstp msti *msti-id* interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp) interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols mstp msti *msti-id* interface *interface-name*]
- [edit protocols vstp vlan *vlan-id* interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id* interface *interface-name*]

Configuring the Interface Cost

The path cost used to calculate the root path cost from any given LAN segment is determined by the total cost of each link in the path. By default, the link cost is determined by the speed of the link. The interface cost can be configured to override the default cost and control which bridge is the designated bridge and which port is the designated port. In MSTP the CIST external path cost is determined by the link speed and the number of hops.

If the interface cost is not configured, the cost is determined by the speed of the interface. For example, a 100-Mbps link has a default path cost of 19, a 1000-Mbps link has a default path cost of 4, and a 10-Gbps link has a default path cost of 2.

If the interface cost is configured under MSTP, this becomes the default value for all interfaces. If the interface cost is configured under the MSTI interface, the value overrides the default for that interface.

If the interface cost is configured at both the VSTP global and VLAN levels, the configuration at the VLAN level overrides the global configuration.

The interface cost should be set the same for all interfaces connected to the same LAN segment.

To configure the interface cost, include the following statement:

```
cost cost;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp | vstp) interface *interface-name*]
- [edit protocols mstp msti *msti-id* interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp) interface *interface-name*]

- [edit routing-instances *routing-instance-name* protocols mstp msti *msti-id* interface *interface-name*]
- [edit protocols vstp vlan *vlan-id* interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id* interface *interface-name*]

Configuring the Interface Mode

The interface mode allows RSTP, MSTP, and VSTP to converge faster than the original STP on point-to-point links. The protocol does not need to wait for timers on point-to-point links. Configure interfaces that have a point-to-point link to another Layer 2 bridge as **p2p**. This parameter is ignored if the STP is configured to run the original spanning-tree version.

If the interface mode is configured at both the VSTP global and VLAN levels, the configuration at the VLAN level overrides the global configuration.

To configure the interface mode, include the following statement:

```
mode (p2p | shared);
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp | vstp) interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp) interface *interface-name*]
- [edit protocols vstp vlan *vlan-id* interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id* interface *interface-name*]

Configuring an Edge Port

An edge port allows RSTP and MSTP to converge faster than the original STP. The protocol does not need to wait for BPDUs to be received on edge ports. Configure interfaces that are not connected to any Layer 2 bridge as edge ports. The JUNOS software supports automatic identification of edge ports as described in the RSTP standard. This parameter is ignored if the STP is configured to run the original spanning-tree version.

If the edge port is configured at both the VSTP global and VLAN levels, the configuration at the VLAN level overrides the global configuration.

To configure the interface as an edge port, include the following statement:

```
edge;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp | vstp) interface *interface-name*]
- [edit protocols mstp msti *msti-id* interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp) interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols mstp msti *msti-id* interface *interface-name*]
- [edit protocols vstp vlan *vlan-id* interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id* interface *interface-name*]

Configuring Root Protect

Root protect helps to enforce the STP root bridge placement in a Layer 2 switched network. Enable root protect on interfaces that should not receive superior BPDUs from the root bridge. Typically, these ports are STP-designated ports on an administrative boundary.

If the bridge receives superior STP BPDUs on a port that has root protect enabled, that port is transitioned to a root-prevented STP state and the interface is blocked. This prevents a bridge that should not be the root bridge from being elected the root bridge.

After the bridge stops receiving superior STP BPDUs on the port with root protect enabled and the received BPDUs time out, that port is transitioned back to the STP designated port state.

When root protect is enabled on an interface, it is enabled for all STP instances on that interface. The interface is blocked only for those instances that receive superior BPDUs.

By default, root protect is disabled. To enable root protect, include the following statement:

```
no-root-port;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp | vstp) interface *interface-name*]
- [edit protocols vstp vlan *vlan-id* interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp) interface *interface-name*]
- [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id* interface *interface-name*]

Tracing STP Traffic

To trace STP traffic, you can specify options in the global **traceoptions** statement included at the **[edit routing-options]** hierarchy level, and you can specify STP-specific options by including the **traceoptions** statement:

```
traceoptions {
  file filename <files number> <size size> <world-readable | no-world-readable>;
  flag flag <flag-modifier> <disable>;
}
```

For a list of hierarchy levels at which you can include this statement, see the statement summary section for the STP **traceoptions** statement.

You can specify the following STP-specific options in the STP **traceoptions** statement:

- **all**—Trace all operations.
- **all-failures**—Trace all failure conditions.
- **bpdu**—Trace BPDU reception and transmission.
- **bridge-detection-state-machine**—Trace the bridge detection state machine.
- **events**—Trace events of the protocol state machine.
- **port-information-state-machine**—Trace the port information state machine.
- **port-migration-state-machine**—Trace the port migration state machine.
- **port-receive-state-machine**—Trace the port receive state machine.
- **port-role-transit-state-machine**—Trace the port role transit state machine.
- **port-role-select-state-machine**—Trace the port role selection state machine.
- **port-transmit-state-machine**—Trace the port transmit state machine.
- **port-state-transit-state-machine**—Trace the port state transit state machine.
- **ppmd**—Trace the state and events for the ppm process.
- **state-machine-variables**—Trace when the state machine variables change.
- **timers**—Trace protocol timers.
- **topology-change-state-machine**—Trace the topology change state machine.



NOTE: Use the trace flag **all** with caution. This flag may cause the CPU to become very busy.

For general information about tracing and global tracing options, see the statement summary for the global **traceoptions** statement in the *JUNOS Routing Protocols Configuration Guide*.

Example: Tracing STP Traffic

Trace only unusual or abnormal operations to `/var/log/stp-log`:

```
[edit]
routing-options {
  traceoptions {
    file /var/log/routing-log;
    flag errors;
  }
}
protocols {
  rstp {
    traceoptions {
      file /var/log/stp-log;
    }
  }
}
```

Configuring Multiple Spanning Tree Protocol

The following sections discuss the parameters that are specific to MSTP:

- Configuring the MSTP MSTI Instance Identifier on page 129
- Configuring the MSTP Region Configuration Name on page 130
- Configuring the MSTP Revision Level on page 130
- Configuring the MSTP Maximum Hops on page 130
- Configuring the MSTI Interface on page 131
- Configuring the MSTI VLAN on page 131
- Disabling the MSTP Instance on page 131

Configuring the MSTP MSTI Instance Identifier

Each MSTP Multiple Spanning Tree Instance (MSTI) is identified by a number. The Common Instance Spanning Tree (CIST) is always MSTI ID 0. Each instance of an MSTI can be numbered 1 through 64. MSTI IDs are local to each region.

To configure the MSTI instance identifier, include the following statements:

```
msti msti-id {
  bridge-priority priority;
  vlan vlan-id;
  interface interface-name {
    cost cost;
    edge;
    priority interface-priority;
  }
}
```

You can include these statements at the following hierarchy levels:

- [edit protocols mstp]
- [edit routing-instances *routing-instance-name* protocols mstp]

Configuring the MSTP Region Configuration Name

The configuration name is the MSTP region name carried in the MSTP BPDUs. The configuration name can be a maximum of 32 characters. The configuration name helps define the logical boundary of the network. All switches in an MSTP region must have the same configuration name configured.

To configure the configuration name, include the following statement:

```
configuration-name configuration-name;
```

You can include this statement at the following hierarchy levels:

- [edit protocols mstp]
- [edit routing-instances *routing-instance-name* protocols mstp]

Configuring the MSTP Revision Level

The MSTP revision level is the revision number of the configuration. All switches in an MSTP region must have the same revision level configured.

To configure the MSTP revision level, include the following statement:

```
revision-level revision-level;
```

You can include this statement at the following hierarchy levels:

- [edit protocols mstp]
- [edit routing-instances *routing-instance-name* protocols mstp]

Configuring the MSTP Maximum Hops

The MSTP maximum hops value is the maximum number of hops in the region. The MSTI root bridge sends BPDUs with the hop count set to the maximum value. When a bridge receives this BPDU, it decrements the remaining hop count by one and propagates this hop count in the BPDUs it sends. When a bridge receives a BPDU with a hop count of zero, the bridge discards the BPDU.

To configure the MSTP maximum hops, include the following statement:

```
max-hops hops;
```

You can include this statement at the following hierarchy levels:

- [edit protocols mstp]
- [edit routing-instances *routing-instance-name* protocols mstp]

Configuring the MSTI Interface

To configure the MSTI logical interface-specific parameters, include the following statement:

```
interface interface;
```

You can include this statement at the following hierarchy levels:

- [edit protocols mstp msti *msti-id*]
- [edit routing-instances *routing-instance-name* protocols mstp msti *msti-id*]

Configuring the MSTI VLAN

An MSTI can map to a range of VLANs just as a logical port can map to a range of VLANs. The MSTP VLAN specifies the VLAN or VLAN range to which this MSTI is mapped. The *vlan-id* is configured under the logical interface.

To configure the VLAN, include the following statement:

```
vlan vlan-id;
```

You can include this statement at the following hierarchy levels:

- [edit protocols mstp msti *msti-id*]
- [edit routing-instances *routing-instance-name* protocols mstp msti *msti-id*]

Disabling the MSTP Instance

To disable the entire MSTP instance, include the following statement:

```
disable;
```

You can include this statement at the following hierarchy levels:

- [edit protocols mstp]
- [edit routing-instances *routing-instance-name* protocols mstp]

Configuring VLAN Spanning Tree Protocol

This section describes configuration statements for the VLAN Spanning Tree Protocol (VSTP). For VSTP, the *bridge-priority*, *max-age*, *hello-time*, *forward-delay*, *priority*, *cost*, *mode*, and *edge* statements all have the same meaning as they do for STP, RSTP, and MSTP.

The configuration of VSTP instances, in contrast, is specific to VSTP. To enable a VSTP instance for a specified VLAN, include the *vlan* statement:

```
vlan vlan-id;
```

You can include this statement at the following hierarchy levels:

- [edit protocols vstp]
- [edit routing-instances *routing-instance-name* protocols vstp]

Configuring Layer 2 Protocol Tunneling

Layer 2 protocol tunneling allows Layer 2 protocol data units (PDUs) to be tunneled through a network. This is useful to provide a single STP domain for subscribers across a service provider network. It is also useful for tunneling Cisco Discovery Protocol (CDP) or VLAN Trunk Protocol (VTP) PDUs across a network.

When a control packet for STP, CDP, or VTP is received on a service provider edge port configured for Layer 2 protocol tunneling, the multicast destination MAC address is rewritten with the predefined multicast tunnel MAC address of 01:00:0c:cd:cd:d0. The packet is transported across the provider network transparently to the other end of the tunnel and the original multicast destination MAC address is restored when the packet is transmitted.

If a packet is received on a tunnel interface that already has a destination multicast MAC address of 01:00:0c:cd:cd:d0, the port enters an error state and is shut down. To clear the error condition, the administrator must enter the **clear error mac-rewrite interface *interface-name*** command.

Layer 2 protocol tunneling is supported on MX Series routers with enhanced queueing Dense Port Concentrators (DPCs).

- Enabling Layer 2 Protocol Tunneling on page 132
- Configuring the Layer 2 Protocol Tunnel Interface on page 133
- Configuring the Layer 2 Protocol to be Tunneled on page 133

Enabling Layer 2 Protocol Tunneling

To enable the Layer 2 protocol tunneling feature, include the **mac-rewrite** statement at the [edit protocols layer2-control] hierarchy level:

```
[edit protocols layer2-control]
mac-rewrite;
```

Include the **mac-rewrite** statement only for untagged and single identifier tagged interfaces, and not on double identifier tagged interfaces. For tagged ports, configure a logical interface with the native VLAN identifier. This configuration associates the untagged control packets with a logical interface.

The destination multicast tunnel MAC address of 01:00:0c:cd:cd:d0 is installed in the MAC table when the **mac-rewrite** statement is configured.

Configuring the Layer 2 Protocol Tunnel Interface

The Layer 2 protocol tunneling configuration must be done on the interfaces at each end of the tunnel.

To configure the interface where Layer 2 protocol tunneling is enabled, include the interface *ge-fpc/pic/port* statement at the [edit protocols layer2-control mac-rewrite] hierarchy level:

```
[edit protocols layer2-control mac-rewrite]
interface ge-fpc/pic/port;
```

Configuring the Layer 2 Protocol to be Tunneled

To configure the protocol that is tunneled by the Layer 2 protocol tunnel, include the protocol (cdp | stp | vtp) statement at the [edit protocols layer2-control mac-rewrite interface *ge-fpc/pic/port*] hierarchy level:

```
[edit protocols layer2-control mac-rewrite interface ge-fpc/pic/port]
protocol (cdp | stp | vtp);
```

For each protocol specified, a static destination MAC address corresponding to the protocol being tunneled is installed in the MAC table.

When CDP, STP, or VTP is configured for tunneling on a customer-facing port in a provider bridge, the corresponding protocol should not be enabled for operation on that interface.

Configuring BPDU Protection for Spanning Tree Protocols

The Spanning Tree Protocol (STP) family is designed to break possible loops in a Layer 2 bridged network. Loop prevention avoids damaging broadcast storms that can potentially render the network useless. STP processes on bridges exchange bridge protocol data units (BPDUs) to determine the LAN topology, decide the root bridge, stop forwarding on some ports, and so on. However, a misbehaving user application or device can interfere with the operation of the STP protocols and cause network problems.

On the MX Series routers only, you can configure BPDU protection to ignore BPDUs received on interfaces where none should be expected (for example, a LAN interface on a network edge with no other bridges present). If a BPDU is received on a blocked interface, the interface is disabled and stops forwarding frames. By default, all BPDUs are accepted and processed on all interfaces.

You can enable BPDU protection on individual interfaces or on all the edge ports of the bridge.

You can configure BPDU protection on interfaces with the following encapsulation types:

- ethernet-bridge
- ethernet-vpls
- extended-vlan-bridge
- vlan-vpls
- extended-vlan-vpls

To configure BPDU blocking on one or more interfaces, include the **bpdu-block** statement:

```
bpdu-block {
  interface interface-name;
  disable-timeout seconds;
}
```

You can include these statements at the following hierarchy levels:

- [edit protocols layer2-control]
- [edit routing-instances *routing-instance-name* protocols layer2-control]

To configure the interfaces on which the system should not expect to receive BPDUs, include the **interfaces *interface-name*** statement at the [edit protocols layer2-control bpdu-block] hierarchy level. You can apply this statement to aggregated Ethernet interfaces. By default, the system accepts all BPDUs received on any interface unless you include this statement. If you configure this statement on a blocked interface, and a BPDU is received on the interface, the system will disable the interface and stop forwarding frames out the interface until the bridging process is restarted. You can alter this behavior with the **disable-timeout** statement.

To configure the amount of time that interfaces should wait before enabling a blocked interface that has received a BPDU, include the **disable-timeout *seconds*** statement at the [edit protocols layer2-control bpdu-block] hierarchy level. By default, if a BPDU is received on a blocked interface, the system will disable the interface and stop forwarding frames out the interface until the interface is cleared. You can alter this behavior with the **disable-timeout** statement. You specify the time the system waits before unblocking the interface that has received the BPDU. The range is from 10 through 3600 seconds (one hour). A **disable-timeout** value of 0 is allowed, but this results in the default behavior (the interface is blocked until the interface is cleared).

The following example, when used with a full bridge configuration with aggregated Ethernet, blocks BPDUs on aggregated interface **ae0** for ten minutes (600 seconds) before enabling the interface again:

```
[edit protocols layer2-control]
bpdu-block {
  interface ae0;
  disable-timeout 600;
}
```

You check the status of the interface with the **show interfaces** command. If the value in the **BPDU Error** field is **Detected** and the link is down, the interface is blocked. If the interface is enabled, the value of the **BPDU Error** field is **none**.

You clear the blocked status of an interface with the **clear error bpd**
interface interface-name command. (Note that the **disable-timeout** interval automatically clears interfaces after the specified interval unless the interval is 0.)

In some cases, the topology determined by one STP bridge protocol might differ from the topology determined by another STP family member. In this case, edge ports to MSTP (for example) might not be edge ports to VSTP. You can block a particular STP family member by blocking BPDU reception on edge ports that should not be receiving BPDUs. In contrast to the **bpd** statement, **bpd** disables designated edge ports and does not enable them again.

To configure edge port blocking for a particular STP family member, include the **bpd** statement for **mstp**, **rstp**, or **vstp**:

```
bpd-block-on-edge;  
interface interface-name;
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp | vstp)]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp)]

You must still fully configure the interfaces and STP protocol.

Configuring STP Loop Protection

The Spanning Tree Protocol (STP) family is responsible for breaking loops in a network of bridges with redundant links. However, hardware failures can create forwarding loops (STP loops) and cause major network outages. STP breaks loops by blocking ports (interfaces). Errors occur when a blocked port transitions erroneously to a forwarding state.

Ideally, an STP port remains blocked as long as a superior alternate path to the root bridge exists for a connected LAN segment. This designated port is determined by receiving superior bridge protocol data units (BPDUs) from a peer on that port. When other ports no longer receive BPDUs, the STP considers the topology to be loop free. However, if a blocked or alternate port moves into a forwarding state, this creates a loop.

You can configure STP loop protection to improve the stability of Layer 2 networks. STP loop protection enhances the normal checks the STP performs on interfaces by performing a specified action when BPDUs are not received on a non-designated port interface. You can choose to block the interface or issue an alarm when BPDUs are not received on the port. By default (that is, without STP loop protection configured), an interface that stops receiving BPDUs will assume the designated port role and possibly result in an STP loop. You configure STP loop protection to prevent selected interfaces from interpreting the lack of BPDUs as a “false positive” for making the interface the designated port. STP loop protection is enabled for all STP instances on the interface, but blocks or alarms only those instances that stop receiving BPDUs.

We recommend you configure loop protection only on non-designated interfaces such as the root or alternate interfaces. Otherwise, if you configure loop protection on both sides of a designated link, then certain STP configuration events (such as setting the root bridge priority to an inferior value in a topology with many loops) can cause both interfaces to transition to blocking mode.

To configure STP loop protection, include the **bpdu-timeout-action** statement with either the **block** or **alarm** option for the STP interface:

```
[edit protocols]
mstp {
  interface interface-name {
    bpdu-timeout-action (alarm | block);
  }
}
rstp {
  interface interface-name {
    bpdu-timeout-action (alarm | block);
  }
}
vstp {
  interface interface-name {
    bpdu-timeout-action (alarm | block);
  }
  vlan vlan-id {
    interface interface-name {
      bpdu-timeout-action (alarm | block);
    }
  }
}
```

You can include this statement at the following hierarchy levels:

- [edit protocols (mstp | rstp | vstp)]
- [edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp)]

This example blocks the non-designated RSTP port **ge-1/2/0** after the BPDU timeout interval expires:

```
[edit protocols]
rstp {
  interface ge-1/2/0 {
    bpdu-timeout-action block;
  }
}
```

You must still fully configure the interfaces and RSTP protocol.

You can display the loop protection characteristics on an interface using the **show spanning-tree interface** command.

Configuring VPLS Root Protection Topology Change Actions

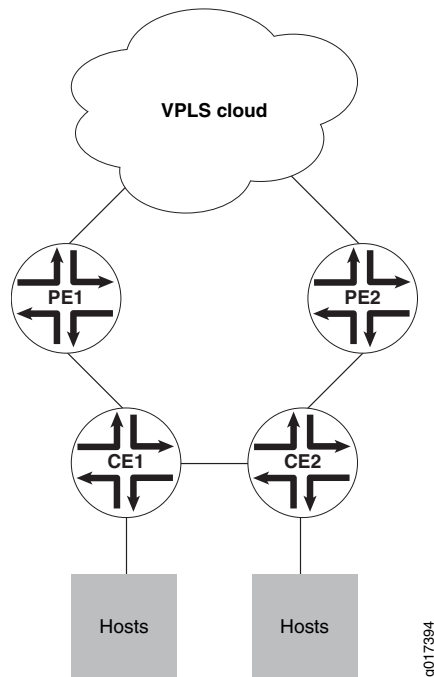
Redundancy is built into many networks through the use of alternate links and paths, which often take the shape of rings. In the case of multiple hosts attached to customer edge (CE) routers and provider edge (PE) routers to secure Virtual Private LAN Service (VPLS), this practice is often called *multihoming*. In other words, hosts attach to CE routers, which are attached to each other as well as to the PE routers that access the VPLS network cloud. Any single link between the edge routers can fail without impacting the hosts' access to the VPLS services. This Layer 2 ring connects to the multiprotocol link switching (MPLS) infrastructure through two PE routers, and link breaks on the ring are protected by running a version of the spanning tree protocol (STP) in combination with the root-protect option. However, the virtual private network (VPN) protocols at Layer 3 are not aware of the blocking state that results from this root protection setup (rings or loops are not permitted at Layer 2 because the Layer 2 protocols will not function properly).

To keep the Layer 2 ring functioning in a multihomed environment with link failures, the VPN protocols have to act on the blocking and unblocking of interfaces by the STP protocol. Specifically, media access control (MAC) flush messages need to be sent by the blocking PE router to LDP peers in order to flush the MAC addresses learned when other interface ports were blocked.

Also, if an active PE router with root protection bridging enabled loses VPLS connectivity, root protection requires that the bridge switch to the other PE router to maintain connectivity. The STP needs to be aware of the status of the VPLS connectivity on the PE router. If the MAC address cache is not flushed when the topology changes, frames could be sent to the wrong device.

You can control the actions taken by the MX Series router when the topology changes in a multihomed Layer 2 ring VPLS environment using root protection. Specifically, MAC flush messages are sent from the blocked PE to LDP peers based on system identifier to IP address mapping. To configure VPLS root protection topology change actions, include the `backup-bridge-priority`, `priority-hold-time`, `system-id`, and `vpls-flush-on-topology-change` statements at the `[edit protocols (mstp | rstp | vstp)]` hierarchy level (to control global STP behavior) or the `[edit protocols vstp vlan-id]` hierarchy level (to control a particular VLAN).

Figure 2 on page 138 shows hosts connected to CE routers and to a VPLS network through two PE routers. The CE routers are also connected, forming a kind of ring structure.

Figure 2: VPLS Multihoming Configuration

The two PE routers have their own links to a VPLS network service, but are not directly connected to each other. All four edge routers run some type of STP with root protection enabled, and only one PE interface will be in the forwarding state, the other being blocked. Assume this forwarding interface is through PE1. If the link between CE1 and CE2 fails, then the blocking PE2 interface must detect a root protection switch and move to the forwarding state. All of the MAC addresses learned by CE2 that connect to the VPLS network service through PE1 need to be flushed. In the same way, when the link between CE1 and CE2 is restored, PE2 again detects the root protection switch and begins blocking again. Now all of the MAC addresses learned by CE2 that connect through PE2 need to be flushed. All of this is controlled by configuring VPLS root protection topology change actions on the CE routers.

Also, at a global level, each type of spanning tree protocol will have a priority hold time associated with it. This is the number of seconds in the range from 1 through 255 seconds that the system waits to switch to the primary priority when the first core domain comes up. The default is 2 seconds. This allows the maximum number of core domains to come up, and some might be slower than others.

To configure VPLS root protection topology change actions to control global STP behavior, include the following statements at the [edit protocols (mstp | rstp | vstp)] hierarchy level:

```
[edit protocols (mstp | rstp | vstp)]
  bridge-priority priority;
  priority-hold-time seconds;
  backup-bridge-priority priority;
  system-id system-id-value {
    ip-address(es);
  }
```

```
vpls-flush-on-topology-change;
```

To configure VPLS root protection topology change actions to control a particular VLAN, include the following statements at the `[edit protocols vstp vlan vlan-id]` hierarchy level:

```
[edit protocols vstp]
vlan vlan-id {
    bridge-priority priority;
    backup-bridge-priority priority;
    system-id system-id-value {
        ip-address(es);
    }
    vpls-flush-on-topology-change;
}
```

The bridge priorities are configured in multiples of 4096 (4k), and the valid range is from 0 through 61,440 (60k). The default value is 32,768 (8k). The system identifier is configured in the format *nnnnnn:nnnnnn*, where *n* = any digit from 0 to 9. The IP address is a valid host address with a /32 mask. There is no default system identifier or IP addresses. By default, the device does not flush MAC addresses on a topology change. These statements are configured independently of root protection, STP parameters, or VPLS configuration.

This example configures a bridge priority of 36k, a backup bridge priority of 44k, a priority hold time value of 60 seconds, a system identifier of 000203:040506 for IP address 10.1.1.1/32, and sets the bridge to flush the MAC cache on a topology change for MSTP only.

```
[edit protocols]
mstp {
    bridge-priority 36k;
    backup-bridge-priority 44k;
    priority-hold-time 60;
    system-id 000203:040506 {
        10.1.1.1/32;
    }
    vpls-flush-on-topology-change;
}
```


Chapter 11

Summary of Spanning Tree Protocol Configuration Statements

The following sections explain each of the Rapid Spanning Tree Protocol (RSTP) and Multiple Spanning Tree Protocol (MSTP) configuration statements. The statements are organized alphabetically.

backup-bridge-priority

Syntax	<code>backup-bridge-priority <i>priority</i>;</code>
Hierarchy Level	<code>[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp)],</code> <code>[edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i>],</code> <code>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp)],</code> <code>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>],</code> <code>[edit protocols (mstp rstp)],</code> <code>[edit protocols vstp vlan <i>vlan-id</i>],</code> <code>[edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp)],</code> <code>[edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>]</code>
Release Information	Statement introduced in JUNOS Release 10.0.
Description	Determine the priority of the backup bridge in a VPLS multihomed Layer 2 ring with MPLS infrastructure.
Options	<i>priority</i> —The backup bridge priority can be set only in increments of 4096. Range: 0 through 61,440 Default: 32,768
Usage Guidelines	See “Configuring VPLS Root Protection Topology Change Actions” on page 137.
Required Privilege Level	<code>routing</code> —To view this statement in the configuration. <code>routing-control</code> —To add this statement to the configuration.

bpdu-block

Syntax	bpdu-block { interface <i>interface-name</i> ; disable-timeout <i>seconds</i> ; }
Hierarchy Level	[edit protocols layer2-control], [edit routing-instances <i>routing-instance-name</i> protocols layer2-control]
Release Information	Statement introduced in JUNOS Release 9.4.
Description	Enable BPDU blocking on an interface. The remaining statements are described separately.
Usage Guidelines	See “Configuring BPDU Protection for Spanning Tree Protocols” on page 133.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

bpdu-block-on-edge

Syntax	bpdu-block-on-edge;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp vstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp)], [edit protocols (mstp rstp vstp)], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp)]
Release Information	Statement introduced in JUNOS Release 9.4. Support for logical systems added in JUNOS Release 9.6.
Description	Enable BPDU blocking on the edge ports of a virtual switch.
Usage Guidelines	See “Configuring BPDU Protection for Spanning Tree Protocols” on page 133.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

bpdu-destination-mac-address

Syntax	bpdu-destination-mac-address provider-bridge-group;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rstp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rstp], [edit protocols rstp], [edit routing-instances <i>routing-instance-name</i> protocols rstp]
Release Information	Statement introduced in JUNOS Release 9.2. Support for logical systems added in JUNOS Release 9.6.
Description	Participate in the provider Rapid Spanning Tree Protocol (RSTP) instance.
Default	If the bpdu-destination-mac-address statement is not configured, the bridge participates in the customer RSTP instance, transmitting and receiving standard RSTP BPDU packets.
Options	provider-bridge-group —The destination MAC address of the BPDU packets transmitted is the provider bridge group address 01:80:c2:00:00:08. Received BPDU packets with this destination MAC address are accepted and passed to the Routing Engine.
Usage Guidelines	See “Configuring the BPDU Destination MAC Address” on page 121
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

bpdu-timeout-action

Syntax	bpdu-timeout-action (alarm block);
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp vstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp)], [edit protocols (mstp rstp vstp)], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp)]
Release Information	Statement introduced in JUNOS Release 9.4. Support for logical systems added in JUNOS Release 9.6.
Description	Provide STP loop protection for a given STP family protocol interface.
Default	If the bpdu-timeout-action statement is not configured, an interface that stops receiving BPDUs will transition to the designated port (forwarding) state, creating a potential loop.
Options	<p>alarm—The interface raises an alarm condition if it has not received BPDUs during the timeout interval.</p> <p>block—The interface is blocked if it has not received BPDUs during the timeout interval.</p>
Usage Guidelines	See “Configuring STP Loop Protection” on page 135.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

bridge-priority

Syntax	<code>bridge-priority <i>priority</i>;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> protocols mstp msti <i>msti-id</i>], [edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols mstp msti <i>msti-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>], [edit protocols (mstp rstp)], [edit protocols mstp msti <i>msti-id</i>], [edit protocols vstp vlan <i>vlan-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit routing-instances <i>routing-instance-name</i> protocols mstp msti <i>msti-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>]</pre>
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Determine which bridge is elected as the root bridge. If two bridges have the same path cost to the root bridge, the bridge priority determines which bridge becomes the designated bridge for a LAN segment.
Options	<p><i>priority</i>—The bridge priority can be set only in increments of 4096.</p> <p>Range: 0 through 61,440</p> <p>Default: 32,768</p>
Usage Guidelines	See “Configuring the Bridge Priority” on page 121.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

configuration-name

Syntax	configuration-name <i>configuration-name</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols mstp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols mstp], [edit protocols mstp], [edit routing-instances <i>routing-instance-name</i> protocols mstp]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	The configuration name is the MSTP region name carried in the MSTP BPDUs.
Usage Guidelines	See “Configuring the MSTP Region Configuration Name” on page 130.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

cost

Syntax	cost cost;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>], [edit protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>]</pre>
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Configure link cost to control which bridge is the designated bridge and which port is the designated port. By default, the link cost is determined by the link speed.
Options	cost—(Optional) Link cost associated with the port. Range: 1 through 200,000,000
Usage Guidelines	See “Configuring the Interface Cost” on page 125.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

disable

Syntax	disable;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols mstp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols mstp], [edit protocols mstp], [edit routing-instances <i>routing-instance-name</i> protocols mstp]
Release Information	Statement introduced in JUNOS Release 9.1. Support for logical systems added in JUNOS Release 9.6.
Description	Disable the entire MSTP instance.
Usage Guidelines	See “Disabling the MSTP Instance” on page 131
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

disable-timeout

Syntax	disable-timeout <i>seconds</i> ;
Hierarchy Level	[edit protocols layer2-control bpdu-block], [edit routing-instances <i>routing-instance-name</i> protocols layer2-control bpdu-block]
Release Information	Statement introduced in JUNOS Release 9.4.
Description	Configure the timeout value to periodically check to see if an interface is still disabled with BPDU blocking. If this option is not configured, the interface is not periodically checked and remains disabled.
Options	<i>seconds</i> —Disable timeout value. Range: 10 through 3600 Default: If this option is not configured, the interface is not periodically checked and remains disabled.
Usage Guidelines	See “Configuring BPDU Protection for Spanning Tree Protocols” on page 133.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

edge

Syntax	edge;
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>], [edit protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>]</pre>
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Configure interfaces as edge ports. Edge ports do not expect to receive BPDUs. If a BPDU is received, the port becomes a nonedge port.
Usage Guidelines	See “Configuring an Edge Port” on page 126.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

extended-system-id

Syntax	extended-system-id <i>identifier</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols rstp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols rstp], [edit protocols rstp], [edit routing-instances <i>routing-instance-name</i> protocols rstp]
Release Information	Statement introduced in JUNOS Release 8.3. Support for logical systems added in JUNOS Release 9.6.
Description	The extended system ID is used to specify different bridge identifiers for different RSTP or STP routing instances.
Options	<i>identifier</i> —Specify the system identifier to use for the RSTP or STP instance. Range: 0 through 4095
Usage Guidelines	See “Configuring the Extended System Identifier” on page 123
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

force-version

Syntax	force-version stp;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (rstp vstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (rstp vstp)], [edit protocols (rstp vstp)], [edit routing-instances <i>routing-instance-name</i> protocols (rstp vstp)]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Force the spanning-tree version to be the original IEEE 803.1D STP.
Usage Guidelines	See “Forcing the Spanning-Tree Version” on page 123.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

forward-delay

Syntax	forward-delay <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>], [edit protocols (mstp rstp)], [edit protocols vstp vlan <i>vlan-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Specify the length of time an STP bridge port remains in the listening and learning states before transitioning to the forwarding state.
Options	<i>seconds</i> —(Optional) Number of seconds the bridge port remains in the listening and learning states. Range: 4 through 30 Default: 15 seconds
Usage Guidelines	See “Configuring the Forwarding Delay” on page 123.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

hello-time

Syntax	hello-time <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>], [edit protocols (mstp rstp)], [edit protocols vstp vlan <i>vlan-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Specify the number of seconds between transmissions of configuration BPDUs by the root bridge.
Options	<i>seconds</i> —(Optional) Number of seconds between transmissions of configuration BPDUs. Range: 1 through 10 Default: 2 seconds
Usage Guidelines	See “Configuring the Hello Timer” on page 122.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

interface

See the following sections:

- interface (BPDU Blocking) on page 153
- interface (Layer 2 Protocol Tunneling) on page 153
- interface (Spanning Tree) on page 154

interface (BPDU Blocking)

Syntax	interface <i>interface-name</i> ;
Hierarchy Level	[edit protocols layer2-control bpdu-block], [edit routing-instances <i>routing-instance-name</i> protocols layer2-control bpdu-block]
Release Information	Statement introduced in JUNOS Release 9.4.
Description	Configure the interface to participate in BPDU blocking.
Options	<i>interface-name</i> —Name of a Gigabit Ethernet or 10-Gigabit Ethernet interface.
Usage Guidelines	See “Configuring BPDU Protection for Spanning Tree Protocols” on page 133.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

interface (Layer 2 Protocol Tunneling)

Syntax	interface <i>interface-name</i> { protocol (cdp stp vtp); }
Hierarchy Level	[edit protocols layer2-control mac-rewrite], [edit routing-instances <i>routing-instance-name</i> protocols layer2-control mac-rewrite]
Release Information	Statement introduced in JUNOS Release 9.1.
Description	Configure an interface for Layer 2 protocol tunneling. The remaining statement is described separately.
Usage Guidelines	See “Configuring the Layer 2 Protocol Tunnel Interface” on page 133.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

interface (Spanning Tree)

Syntax interface *interface-name* {
 cost *cost*;
 edge;
 mode (p2p | shared);
 no-root-port;
 priority *interface-priority*;
 }

Hierarchy Level [edit logical-systems *logical-system-name* protocols (mstp | rstp | vstp)],
 [edit logical-systems *logical-system-name* protocols vstp vlan *vlan-id*],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 (mstp | rstp | vstp)],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols
 vstp vlan *vlan-id*],
 [edit protocols (mstp | rstp | vstp)],
 [edit protocols vstp vlan *vlan-id*],
 [edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp)],
 [edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id*]

Release Information Statement introduced in JUNOS Release 8.4.
 Support for logical systems added in JUNOS Release 9.6.

Description Configure the interface to participate in the RSTP or MSTP instance.

Options *interface-name*—Name of a Gigabit Ethernet or 10-Gigabit Ethernet interface.

The remaining statements are explained separately.

Usage Guidelines See “Configuring the Interface” on page 124.

Required Privilege Level routing—To view this statement in the configuration.
 routing-control—To add this statement to the configuration.

layer2-control

Syntax

```
layer2-control {
  bpd-block {
    interface interface-name;
    disable-timeout seconds;
  }
  mac-rewrite {
    interface interface-name {
      protocol (cdp | stp | vtp);
    }
  }
  nonstop-bridging;
}
```

Hierarchy Level [edit protocols],
[edit routing-instances *routing-instance-name* protocols]

Release Information Statement introduced in JUNOS Release 8.4.
bpd-block statement added in JUNOS Release 9.4.

Description Configure Layer 2 control protocols to enable features such as Layer 2 protocol tunneling or nonstop bridging.

The remaining statements are described separately.

Usage Guidelines See “Configuring Layer 2 Protocol Tunneling” on page 132 and “Configuring BPDU Protection for Spanning Tree Protocols” on page 133.



NOTE: Configuring the **nonstop-bridging** statement is covered in detail the *JUNOS High Availability Configuration Guide*. When this statement is configured on routing platforms with two Routing Engines, a master Routing Engine switches over gracefully to a backup Routing Engine and preserves Layer 2 Control Protocol (L2CP) information.

Required Privilege Level interface—To view this statement in the configuration.
interface-control—To add this statement to the configuration.

Related Topics nonstop-bridging statement in the *JUNOS High Availability Configuration Guide*.

mac-rewrite

Syntax	mac-rewrite { interface <i>interface-name</i> { protocol (cdp stp vtp); } }
Hierarchy Level	[edit protocols layer2-control], [edit routing-instances <i>routing-instance-name</i> protocols layer2-control]
Release Information	Statement introduced in JUNOS Release 9.1.
Description	Enable rewriting of the MAC address for Layer 2 protocol tunneling. The remaining statements are described separately.
Usage Guidelines	See “Enabling Layer 2 Protocol Tunneling” on page 132
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

max-age

Syntax	max-age <i>seconds</i> ;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>], [edit protocols (mstp rstp)], [edit protocols vstp vlan <i>vlan-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Specify the maximum expected arrival time of hello BPDUs.
Options	<i>seconds</i> —(Optional) Number of seconds expected between hello BPDUs. Range: 6 through 40 Default: 20 seconds
Usage Guidelines	See “Configuring the Maximum Age Timer” on page 122.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

max-hops

Syntax	<code>max-hops hops;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols mstp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols mstp], [edit protocols mstp], [edit routing-instances <i>routing-instance-name</i> protocols mstp]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Configure the maximum number of hops a BPDU can be forwarded in the MSTP region.
Options	<i>hops</i> —(Optional) Number of hops the BPDU can be forwarded. Range: 1 through 255 Default: 19 hops
Usage Guidelines	See “Configuring the MSTP Maximum Hops” on page 130.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

mode

Syntax	mode (p2p shared);
Hierarchy Level	<p>[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>],</p> <p>[edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>],</p> <p>[edit protocols (mstp rstp vstp) interface <i>interface-name</i>],</p> <p>[edit protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>],</p> <p>[edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>]</p>
Release Information	<p>Statement introduced in JUNOS Release 8.4.</p> <p>Support for logical systems added in JUNOS Release 9.6.</p>
Description	Configure link mode to identify point-to-point links.
Default	When the link is configured as full-duplex, the default link mode is p2p . When the link is configured half-duplex, the default link mode is shared .
Options	<p>p2p—The link is point to point.</p> <p>shared—The link is shared media.</p>
Usage Guidelines	See “Configuring the Interface Mode” on page 126.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

msti

Syntax	<pre> msti <i>msti-id</i> { bridge-priority <i>priority</i>; vlan <i>vlan-id</i>; interface <i>interface-name</i> { cost <i>cost</i>; edge; priority <i>interface-priority</i>; } } </pre>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols mstp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols mstp], [edit protocols mstp], [edit routing-instances <i>routing-instance-name</i> protocols mstp]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Configure the Multiple Spanning Tree Protocol (MSTI) instance identifier.
Options	<i>msti-id</i> —MSTI instance identifier. Range: 1 through 64 The remaining statements are explained separately.
Usage Guidelines	See “Configuring the MSTP MSTI Instance Identifier” on page 129.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

mstp

Syntax mstp {
 bpdu-block-on-edge;
 bridge-priority *priority*;
 configuration-name *configuration-name*;
 disable;
 forward-delay *seconds*;
 hello-time *seconds*;
 max-age *seconds*;
 max-hops *hops*;
 priority-hold-time *seconds*;
 revision-level *revision-level*;
 interface *interface-name* {
 bpdu-timeout-action (alarm | block);
 cost *cost*;
 edge;
 mode (p2p | shared);
 no-root-port;
 priority *interface-priority*;
 }
 msti *msti-id* {
 bridge-priority *priority*;
 vlan *vlan-id*;
 interface *interface-name* {
 cost *cost*;
 edge;
 priority *interface-priority*;
 }
 }
 traceoptions {
 file *filename* <files *number*> <size *size*> <world-readable | no-world-readable>;
 flag *flag* <flag-modifier> <disable>;
 }
}

Hierarchy Level [edit logical-systems *logical-system-name* protocols],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name*
 protocols],
 [edit protocols],
 [edit routing-instances *routing-instance-name* protocols]

Release Information Statement introduced in JUNOS Release 8.4.
 bpdu-block-on-edge statement added in JUNOS Release 9.4.
 bpdu-timeout-action statement added in JUNOS Release 9.4.
 Support for logical systems added in JUNOS Release 9.6.

Description Configure MSTP parameters.

Options The statements are explained separately.

Usage Guidelines See “Configuring Multiple Spanning Tree Protocol” on page 129 and “Configuring BPDU Protection for Spanning Tree Protocols” on page 133.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

no-root-port

Syntax no-root-port;

Hierarchy Level [edit logical-systems *logical-system-name* protocols (mstp | rstp | vstp) interface *interface-name*],
[edit logical-systems *logical-system-name* protocols vstp vlan *vlan-id* interface *interface-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols (mstp | rstp | vstp) interface *interface-name*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name* protocols vstp vlan *vlan-id* interface *interface-name*],
[edit protocols (mstp | rstp | vstp) interface *interface-name*],
[edit protocols vstp vlan *vlan-id* interface *interface-name*],
[edit routing-instances *routing-instance-name* protocols (mstp | rstp | vstp) interface *interface-name*],
[edit routing-instances *routing-instance-name* protocols vstp vlan *vlan-id* interface *interface-name*]

Release Information Statement introduced in JUNOS Release 9.1.
Support for logical systems added in JUNOS Release 9.6.

Description Ensure the port is the spanning-tree designated port. If the port receives superior bridge protocol data unit (BPDU) packets, root protect moves this port to a root-prevented spanning-tree state.

Usage Guidelines See “Configuring Root Protect” on page 127.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

priority

Syntax	<code>priority interface-priority;</code>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>], [edit protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp) interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols mstp msti <i>msti-id</i> interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i> interface <i>interface-name</i>]</pre>
Release Information	<p>Statement introduced in JUNOS Release 8.4.</p> <p>Support for logical systems added in JUNOS Release 9.6.</p>
Description	Use the interface priority to control which interface is elected as the root port. The interface priority must be set in increments of 16.
Options	<p><i>priority</i>—(Optional) Interface priority.</p> <p>Range: 0 through 240</p>
Usage Guidelines	See “Configuring the Interface Priority” on page 124.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

priority-hold-time

Syntax	<code>priority-hold-time seconds;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit protocols (mstp rstp)], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp)],
Release Information	Statement introduced in JUNOS Release 10.0.
Description	Specify the number of seconds to hold before switching to the primary priority when the first core domain comes up.
Options	<i>seconds</i> —Number of seconds to hold before switching to primary priority. Range: 1 through 255 Default: 2 seconds
Usage Guidelines	See “Configuring VPLS Root Protection Topology Change Actions” on page 137.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

protocol

Syntax	<code>protocol (cdp stp vtp);</code>
Hierarchy Level	[edit protocols layer2-control mac-rewrite interface <i>interface-name</i>], [edit routing-instances <i>routing-instance-name</i> protocols layer2-control mac-rewrite interface <i>interface-name</i>]
Release Information	Statement introduced in JUNOS Release 9.1.
Description	Configure the protocol to be tunneled on an interface for Layer 2 protocol tunneling. To tunnel multiple protocols, include multiple protocol statements.
Options	<i>cdp</i> —Tunnel the Cisco discovery protocol. <i>stp</i> —Tunnel all versions of the spanning tree protocol. <i>vtp</i> —Tunnel the VLAN trunk protocol.
Usage Guidelines	See “Configuring the Layer 2 Protocol to be Tunneled” on page 133.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

protocols

Syntax	<pre> protocols { mstp { ... } rstp { ... } vstp { ... } } </pre>
Hierarchy Level	<pre> [edit], [edit logical-systems <i>logical-system-name</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i>], [edit routing-instances <i>routing-instance-name</i>] </pre>
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Configure the Spanning Tree Protocol type as MSTP, RSTP, or VSTP.
Options	<p>mstp—Configure the protocol as Multiple Spanning Tree.</p> <p>rstp—Configure the protocol as Rapid Spanning Tree.</p> <p>vstp—Configure the protocol as VLAN Spanning Tree.</p>
Usage Guidelines	See “Configuring Rapid Spanning Tree Protocol” on page 120, “Configuring Multiple Spanning Tree Protocol” on page 129, and “Configuring VLAN Spanning Tree Protocol” on page 131
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

revision-level

Syntax	<code>revision-level <i>revision-level</i>;</code>
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols mstp], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols mstp], [edit protocols mstp], [edit routing-instances <i>routing-instance-name</i> protocols mstp]
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Set the revision number of the MSTP configuration.
Options	<i>revision-level</i> —Configure the revision number of the MSTP region configuration. Range: 0 through 65,535
Usage Guidelines	See “Configuring the MSTP Revision Level” on page 130.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

rstp

Syntax `rstp {`
 `bpdu-block-on-edge;`
 `bpdu-destination-mac-address provider-bridge-group;`
 `bridge-priority priority;`
 `extended-system-id;`
 `force-version stp;`
 `forward-delay seconds;`
 `hello-time seconds;`
 `max-age seconds;`
 `interface interface-name {`
 `bpdu-timeout-action (alarm | block);`
 `cost cost;`
 `edge;`
 `mode (p2p | shared);`
 `no-root-port;`
 `priority interface-priority;`
 `}`
 `priority-hold-time seconds;`
 `traceoptions {`
 `file filename <files number> <size size> <world-readable | no-world-readable>;`
 `flag flag <flag-modifier> <disable>;`
 `}`
 `}`

Hierarchy Level [edit logical-systems *logical-system-name* protocols],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name*
 protocols],
 [edit protocols],
 [edit routing-instances *routing-instance-name* protocols]

Release Information Statement introduced in JUNOS Release 8.4.
 `bpdu-block-on-edge` statement added in JUNOS Release 9.4.
 `bpdu-timeout-action` statement added in JUNOS Release 9.4.
 Support for logic systems added in JUNOS Release 9.6.

Description Configure RSTP parameters.

Options The statements are explained separately.

Usage Guidelines See “Configuring Rapid Spanning Tree Protocol” on page 120 and “Configuring BPDU Protection for Spanning Tree Protocols” on page 133.

Required Privilege Level routing—To view this statement in the configuration.
 routing-control—To add this statement to the configuration.

system-id

Syntax	system-id <i>system-id-value</i> { <i>ip-address(es)</i> ; }
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>], [edit protocols (mstp rstp)], [edit protocols vstp vlan <i>vlan-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>]
Release Information	Statement introduced in JUNOS Release 10.0.
Description	Determine the system identifier value for bridges in a VPLS multihomed Layer 2 ring with MPLS infrastructure.
Options	<p><i>system-id-value</i>—System identifier in the format <i>nnnnnn:nnnnnn</i> where <i>n</i> = any digit from 0 through 9.</p> <p>Range: Any valid value</p> <p>Default: None</p> <p><i>ip-address(es)</i>—Valid IP host addresses in the format <i>ip-address/32</i>.</p> <p>Range: Any valid IP address</p> <p>Default: None</p>
Usage Guidelines	See “Configuring VPLS Root Protection Topology Change Actions” on page 137.
Required Privilege Level	<p>routing—To view this statement in the configuration.</p> <p>routing-control—To add this statement to the configuration.</p>

traceoptions

Syntax	<pre>traceoptions { file <i>filename</i> <files <i>number</i>> <size <i>size</i>> <world-readable no-world-readable>; flag <i>flag</i> <flag-modifier> <disable>; }</pre>
Hierarchy Level	<pre>[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp vstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp)], [edit protocols (mstp rstp vstp)], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp vstp)]</pre>
Release Information	Statement introduced in JUNOS Release 8.4. Support for logical systems added in JUNOS Release 9.6.
Description	Set STP protocol-level tracing options.
Default	The default STP protocol-level trace options are inherited from the global traceoptions statement.
Options	<p>disable—(Optional) Disable the tracing operation. One use of this option is to disable a single operation when you have defined a broad group of tracing operations, such as all.</p> <p>file <i>filename</i>—Name of the file to receive the output of the tracing operation. Enclose the name in quotation marks. We recommend that you place STP tracing output in the file <code>/var/log/stp-log</code>.</p> <p>files <i>number</i>—(Optional) Maximum number of trace files. When a trace file named <i>trace-file</i> reaches its maximum size, it is renamed <i>trace-file.0</i>, then <i>trace-file.1</i>, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.</p> <p>If you specify a maximum number of files, you must also specify a maximum file size with the size option. Range: 2 through 1000 files Default: 1 trace file only</p> <p>flag—Tracing operation to perform. To specify more than one tracing operation, include multiple flag statements. The following are the STP-specific tracing options:</p> <ul style="list-style-type: none"> ■ all—Trace all operations. ■ all-failures—Trace all failure conditions. ■ bpdu—Trace BPDU reception and transmission. ■ bridge-detection-state-machine—Trace the bridge detection state machine. ■ events—Trace events of the protocol state machine.

- `port-information-state-machine`—Trace the port information state machine.
- `port-migration-state-machine`—Trace the port migration state machine.
- `port-receive-state-machine`—Trace the port receive state machine.
- `port-role-transit-state-machine`—Trace the port role transit state machine.
- `port-role-select-state-machine`—Trace the port role selection state machine.
- `port-state-transit-state-machine`—Trace the port state transit state machine.
- `port-transmit-state-machine`—Trace the port transmit state machine.
- `ppmd`—Trace the state and events for the ppm process.
- `state-machine-variables`—Trace when the state machine variables change.
- `timers`—Trace protocol timers.
- `topology-change-state-machine`—Trace the topology change state machine.

The following are the global tracing options:

- `all`—All tracing operations.
 - `config-internal`—Trace configuration internals.
 - `general`—Trace general events.
 - `normal`—All normal events.
- Default:** If you do not specify this option, only unusual or abnormal operations are traced.
- `parse`—Trace configuration parsing.
 - `policy`—Trace policy operations and actions.
 - `regex-parse`—Trace regular-expression parsing.
 - `route`—Trace routing table changes.
 - `state`—Trace state transitions.
 - `task`—Trace protocol task processing.
 - `timer`—Trace protocol task timer processing.

`no-world-readable`—(Optional) Prevent any user from reading the log file.

size *size*—(Optional) Maximum size of each trace file, in kilobytes (KB) or megabytes (MB). When a trace file named *trace-file* reaches this size, it is renamed *trace-file.0*. When the *trace-file* again reaches its maximum size, *trace-file.0* is renamed *trace-file.1* and *trace-file* is renamed *trace-file.0*. This renaming scheme continues until the maximum number of trace files is reached. Then the oldest trace file is overwritten.

If you specify a maximum file size, you must also specify a maximum number of trace files with the *files* option.

Syntax: *xk* to specify KB, *xm* to specify MB, or *xg* to specify GB

Range: 10 KB through the maximum file size supported on your system

Default: 1 MB

world-readable—(Optional) Allow any user to read the log file.

Usage Guidelines See “Tracing STP Traffic” on page 128.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

vlan

See the following sections:

- vlan (MSTP) on page 171
- vlan (VSTP) on page 172

vlan (MSTP)

Syntax `vlan vlan-id;`

Hierarchy Level [edit logical-systems *logical-system-name* protocols mstp msti *msti-id*],
[edit logical-systems *logical-system-name* routing-instances *routing-instance-name*
protocols mstp msti *msti-id*],
[edit protocols mstp msti *msti-id*],
[edit routing-instances *routing-instance-name* protocols mstp msti *msti-id*]

Release Information Statement introduced in JUNOS Release 8.4.
Support for logical systems added in JUNOS Release 9.6.

Description Configure the VLAN of an MSTI or VSTP instance or configure the VLAN range of an MSTI instance.

Options *vlan-id*—The VLAN identifier associated with the MSTI.

vlan-id-range—Range of VLAN identifiers associated with the MSTI in the form
minimum-vlan-id-maximum-vlan-id. VLAN identifier ranges are not supported for
VSTP.

Range: 1 through 4096

Usage Guidelines See “Configuring the MSTI VLAN” on page 131.

Required Privilege Level routing—To view this statement in the configuration.
routing-control—To add this statement to the configuration.

vlan (VSTP)

Syntax `vlan vlan-id {
 bridge-priority priority;
 forward-delay seconds;
 hello-time seconds;
 max-age seconds;
 interface interface-name {
 cost cost;
 edge;
 mode (p2p | shared);
 no-root-port;
 priority interface-priority;
 }
 }`

Hierarchy Level [edit logical-systems *logical-system-name* protocolsvstp],
 [edit protocols vstp]

Release Information Statement introduced in JUNOS Release 9.0.
 Support for logical systems added in JUNOS Release 9.6.

Description Configure VSTP VLAN parameters.

Options The statements are explained separately.

Usage Guidelines See “Configuring VLAN Spanning Tree Protocol” on page 131.

Required Privilege Level routing—To view this statement in the configuration.
 routing-control—To add this statement to the configuration.

vpls-flush-on-topology-change

Syntax	vpls-flush-on-topology-change;
Hierarchy Level	[edit logical-systems <i>logical-system-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> protocols vstp vlan <i>vlan-id</i>], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit logical-systems <i>logical-system-name</i> routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>], [edit protocols (mstp rstp)], [edit protocols vstp vlan <i>vlan-id</i>], [edit routing-instances <i>routing-instance-name</i> protocols (mstp rstp)], [edit routing-instances <i>routing-instance-name</i> protocols vstp vlan <i>vlan-id</i>]
Release Information	Statement introduced in JUNOS Release 10.0.
Description	Determine the action the bridge should take when the topology of a multihomed Layer 2 ring with MPLS infrastructure changes: flush the media access control (MAC) cache or not. By default, the bridge does not flush the cache when the topology changes.
Usage Guidelines	See “Configuring VPLS Root Protection Topology Change Actions” on page 137.
Required Privilege Level	routing—To view this statement in the configuration. routing-control—To add this statement to the configuration.

vstp

Syntax

```
vstp {
  bpdu-block-on-edge;
  force-version stp;
  interface interface-name {
    bpdu-timeout-action (alarm | block);
    cost cost;
    edge;
    mode (p2p | shared);
    no-root-port;
    priority interface-priority;
  }
  priority-hold-time seconds;
  vlan vlan-id {
    bridge-priority priority;
    forward-delay seconds;
    hello-time seconds;
    max-age seconds;
    interface interface-name {
      bpdu-timeout-action (alarm | block);
      cost cost;
      edge;
      mode (p2p | shared);
      no-root-port;
      priority interface-priority;
    }
  }
  traceoptions {
    file filename <files number> <size size> <world-readable | no-world-readable>;
    flag flag <flag-modifier> <disable>;
  }
}
```

Hierarchy Level [edit logical-systems *logical-system-name* protocols],
 [edit logical-systems *logical-system-name* routing-instances *routing-instance-name*
 protocols],
 [edit protocols],
 [edit routing-instances *routing-instance-name* protocols]

Release Information Statement introduced in JUNOS Release 9.0.
 bpdu-block-on-edge statement added in JUNOS Release 9.4.
 bpdu-timeout-action statement added in JUNOS Release 9.4.
 Support for logical systems added in JUNOS Release 9.6.

Description Configure VSTP parameters.

Options The statements are explained separately.

Usage Guidelines See “Configuring VLAN Spanning Tree Protocol” on page 131, “Configuring Rapid Spanning Tree Protocol” on page 120, and “Configuring BPDU Protection for Spanning Tree Protocols” on page 133.

Required Privilege Level routing—To view this statement in the configuration.
 routing-control—To add this statement to the configuration.

Part 6

Indexes

- Index on page 179
- Index of Statements and Commands on page 185

Index

Symbols

#, comments in configuration statements.....	xxvi
(), in syntax descriptions.....	xxvi
< >, in syntax descriptions.....	xxv
[], in configuration statements.....	xxvi
{ }, in configuration statements.....	xxvi
(pipe), in syntax descriptions.....	xxvi

A

address learning, Layer 2	
logical systems.....	16
advertisement-interval statement.....	49
all-failures (tracing flag)	
STP.....	168

B

backup-bridge-priority statement.....	141
configuration guidelines.....	137
bandwidth statement.....	85
usage guidelines.....	83
bpdu (tracing flag).....	168
BPDU blocking	
Layer 2 control.....	142
BPDU protection	
Layer 2 control.....	133
bpdu-block	
configuration guidelines.....	133
bpdu-block statement.....	142
bpdu-block-on-edge	
configuration guidelines.....	133
bpdu-block-on-edge statement.....	142
bpdu-destination-mac-address statement.....	143
usage guidelines.....	121
bpdu-timeout-action	
configuration guidelines.....	135
bpdu-timeout-action statement.....	144
braces, in configuration statements.....	xxvi
brackets	
angle, in syntax descriptions.....	xxv
square, in configuration statements.....	xxvi

bridge domain	
dual VLAN tags.....	101
routing interface.....	95
VLAN identifier.....	99
VLAN identifier list.....	62, 63
bridge-detection-state-machine (tracing flag).....	168
bridge-domains statement.....	86
bridge-options statement.....	87
bridge-priority statement.....	145
usage guidelines.....	121

C

comments, in configuration statements.....	xxvi
configuration-name statement.....	146
usage guidelines.....	130
configuring	
LLDP.....	44
conventions	
text and syntax.....	xxv
cost statement.....	147
usage guidelines.....	125
curly braces, in configuration statements.....	xxvi
customer support.....	xxvi
contacting JTAC.....	xxvi

D

Dense Port Concentrator <i>See</i> DPC	
disable statement	
LLDP.....	50
mstp.....	148
usage guidelines.....	131
disable-timeout	
configuration guidelines.....	133
disable-timeout statement.....	148
documentation	
comments on.....	xxvi
domain-type statement.....	88
DPC	
bound to a Layer 2 port-mirroring instance.....	25
description.....	4
displaying chassis information.....	25

E

edge statement.....	149
usage guidelines.....	126
Ethernet	
frame counters and statistics.....	5
Ethernet link aggregation	
and load balancing.....	15
events (tracing flag)	
STP.....	168
example	
LLDP.....	46
example of next-hop groups	
and Layer 2 port mirroring.....	41
example of port mirroring, Layer 2	
next-hop groups.....	41
extended-system-id statement.....	150
usage guidelines.....	123

F

firewall filter-driven port mirroring, Layer 2	
for a bridge domain forwarding table.....	30
for a logical interface.....	28
for a VPLS routing instance flood table.....	30
for an aggregated Ethernet interface.....	29
overview.....	27
font conventions.....	xxv
force-version statement.....	150
usage guidelines.....	123
forward-delay statement.....	151
usage guidelines.....	123
FPC <i>See</i> DPC	
frames	
Ethernet counters and statistics.....	5

G

global-mac-limit statement.....	109
usage guidelines.....	107
global-mac-move statement.....	110
usage guidelines.....	107
global-mac-statistics statement.....	110
usage guidelines.....	106
global-mac-table-aging-time statement.....	111
usage guidelines.....	106
global-no-mac-learning statement.....	111
usage guidelines.....	106

H

hardware components	
Dense Port Concentrator (DPC).....	4
hello-time statement.....	152
usage guidelines.....	122
hold-multiplier statement.....	50

I

icons defined, notice.....	xxiv
instance-type statement	
usage guidelines.....	11
interface	
configuration guidelines.....	133
interface statement	
BPDU blocking.....	153
bridge domain.....	89
Layer 2 protocol tunneling.....	153
LLDP.....	51
spanning tree.....	154
STP	
usage guidelines.....	124
usage guidelines.....	131
virtual switch.....	89
interface-mac-limit statement.....	90
set of bridge domains	
usage guidelines.....	81
trunk port	
usage guidelines.....	81
usage guidelines.....	79

L

L2 learning	
MAC move parameters.....	107
l2-learning statement.....	112
layer2-control statement.....	155
Layer 2 control	
BPDU blocking.....	142
BPDU protection.....	133
Layer 2 protocol tunneling.....	153, 156, 163
LLDP	
configuration statements.....	56
configuring.....	44
example.....	46
overview.....	43
tracing operations.....	47
lldp statement	
LLDP.....	52
lldp-configuration-notification-interval statement.....	53
load balancing	
and Ethernet link aggregation.....	15
loop protection	
STP.....	135

M

MAC move parameters	
L2 learning.....	107
mac-rewrite statement.....	156

mac-statistics statement.....	91
set of bridge domains	
usage guidelines.....	83
trunk port	
usage guidelines.....	83
usage guidelines.....	80
mac-table-size statement.....	92
set of bridge domains	
usage guidelines.....	82
trunk port	
usage guidelines.....	82
usage guidelines.....	78
manuals	
comments on.....	xxvi
max-age statement.....	156
usage guidelines.....	122
max-hops statement.....	157
usage guidelines.....	130
mode statement.....	158
usage guidelines.....	126
msti statement.....	159
usage guidelines.....	129
MSTP.....	119
VLAN.....	171
mstp	
disabling.....	148
mstp statement.....	160
multicast snooping	
and spanning tree protocols.....	14
multiple instances	
and Layer 2 port mirroring.....	32
Multiple Spanning Tree Protocol <i>See</i> MSTP	

N

next-hop groups	
and Layer 2 port mirroring.....	31
and Layer 2 port mirroring example.....	41
no-mac-learning statement.....	93
set of bridge domains	
usage guidelines.....	81
trunk port	
usage guidelines.....	81
usage guidelines.....	77
no-root-port statement.....	161
usage guidelines.....	127
notice icons defined.....	xxiv
notification-time statement.....	113
usage guidelines.....	107

O

overview	
LLDP.....	43

P

Packet Forwarding Engine	
bound to a Layer 2 port-mirroring instance.....	26
description.....	4
displaying chassis information.....	25
packet-action statement.....	94
parentheses, in syntax descriptions.....	xxvi
PIC <i>See</i> Packet Forwarding Engine	
port mirroring	
family ccc.....	36
family ccc with AE.....	38
L2VPN.....	36
L2VPN with AE.....	38
port mirroring, Layer 2	
configuring a firewall filter.....	27
configuring named port-mirroring instances.....	24
configuring the global port-mirroring	
instance.....	22
example configuration.....	34
for a bridge domain forwarding table.....	30
for a logical interface.....	28
for a specific DPC.....	25
for a specific PFE.....	26
for a VPLS routing instance flood table.....	30
for all ports in the chassis.....	22
for an aggregated Ethernet interface.....	29
next-hop groups example.....	41
option to mirror traffic only once.....	23
order of precedence if applied at multiple	
levels.....	26
overview.....	19
with multiple instances.....	32
with next-hop groups.....	31
port-information-state-machine (tracing flag).....	169
port-migration-state-machine (tracing flag).....	169
port-mirroring firewall filter, Layer 2	
applying to a bridge domain forwarding	
table.....	30
applying to a logical interface.....	28
applying to a VPLS routing instance flood	
table.....	30
configuring.....	27
example configuration.....	34
overview.....	27
port-mirroring instance, Layer 2	
binding to a specific DPC.....	25
binding to a specific PFE.....	26
configuring.....	24
overview.....	23
port-receive-state-machine (tracing flag)	
STP.....	169
port-role-select-state-machine (tracing flag)	
STP.....	169
port-role-transit-state-machine (tracing flag)	
STP.....	169

port-state-transit-state-machine (tracing flag)	
STP.....	169
port-transmit-state-machine (tracing flag)	
STP.....	169
ppmd (tracing flag)	
STP.....	169
priority statement	
spanning tree.....	162
STP	
usage guidelines.....	124
priority-hold-time statement.....	163
configuration guidelines.....	137
protocol statement.....	163
protocols statement.....	164
ptopo-configuration-maximum-hold-time	
statement.....	53
ptopo-configuration-trap-interval statement.....	54

R

Rapid Spanning Tree Protocol <i>See</i> RSTP	
revision-level statement.....	165
usage guidelines.....	130
routing instances	
basic configuration.....	10
types used in Layer 2 networking.....	11
routing instances for VPLS	
VLAN identifier list.....	63
routing-instances statement	
usage guidelines.....	11
routing-interface statement.....	95
RSTP.....	119
rstp statement.....	166

S

Spanning Tree Protocol <i>See</i> STP	
spanning tree protocols	
and multicast snooping.....	14
state-machine-variables (tracing flag)	
STP.....	169
static-mac statement.....	96
usage guidelines.....	78
STP.....	119
configuration statements.....	170
loop protection.....	135
tracing operations.....	128
support, technical <i>See</i> technical support	
switch-options statement.....	97
syntax conventions.....	xxv
system-id statement.....	167
configuration guidelines.....	137

T

technical support	
contacting JTAC.....	xxvi
threshold-count statement.....	114
usage guidelines.....	107
threshold-time statement.....	115
usage guidelines.....	107
timers (tracing flag)	
STP.....	169
topology-change-state-machine (tracing flag)	
STP.....	169
tracoptions statement	
LLDP.....	55
usage guidelines.....	47
STP.....	168
usage guidelines.....	128
tracing flags	
all.....	168
all-failures	
STP.....	168
bpdu.....	168
bridge-detection-state-machine.....	168
events	
STP.....	168
port-information-state-machine.....	169
port-migration-state-machine.....	169
port-receive-state-machine	
STP.....	169
port-role-select-state-machine	
STP.....	169
port-role-transit-state-machine	
STP.....	169
port-state-transit-state-machine	
STP.....	169
port-transmit-state-machine	
STP.....	169
ppmd	
STP.....	169
state-machine-variables	
STP.....	169
timers	
STP.....	169
topology-change-state-machine	
STP.....	169
tracing operations	
LLDP.....	47, 55
STP.....	128, 168
transmit-delay statement	
LLDP.....	57
tunnel interfaces	
configuring, MX Series routers.....	83
tunnel-services statement.....	98
usage guidelines.....	83

V

virtual switch	
configuring.....	69
dual VLAN tags.....	101
routing interface.....	95
VLAN identifier.....	99
with VPLS ports.....	73
virtual-switch statement	
usage guidelines.....	71
VLAN identifiers	
configuring.....	63
VLAN Spanning Tree Protocol <i>See</i> VSTP	
vlan statement.....	171
usage guidelines.....	131
vlan-id statement.....	99
vlan-id-list	
usage guidelines.....	62
vlan-id-list statement.....	100
vlan-tags statement.....	101
VPLS ports in a virtual switch.....	73
vpls-flush-on-topology-change statement.....	173
configuration guidelines.....	137
VSTP.....	119
VLAN.....	172
vstp statement.....	174
usage guidelines.....	131

Index of Statements and Commands

A

advertisement-interval statement.....49

B

backup-bridge-priority statement.....141
bandwidth statement.....85
bpdu-block statement.....142
bpdu-block-on-edge statement.....142
bpdu-destination-mac-address statement.....143
bpdu-timeout-action statement.....144
bridge-domains statement.....86
bridge-options statement.....87
bridge-priority statement.....145

C

configuration-name statement.....146
cost statement.....147

D

disable statement
 LLDP.....50
 mstp.....148
disable-timeout statement.....148
domain-type statement.....88

E

edge statement.....149
extended-system-id statement.....150

F

force-version statement.....150
forward-delay statement.....151

G

global-mac-limit statement.....109
global-mac-move statement.....110
global-mac-statistics statement.....110
global-mac-table-aging-time statement.....111

global-no-mac-learning statement.....111

H

hello-time statement.....152
hold-multiplier statement.....50

I

interface statement
 BPDU blocking.....153
 bridge domain.....89
 Layer 2 protocol tunneling.....153
 LLDP.....51
 spanning tree.....154
interface-mac-limit statement.....90

L

l2-learning statement.....112
layer2-control statement.....155
lldp statement
 LLDP.....52
lldp-configuration-notification-interval statement.....53

M

mac-rewrite statement.....156
mac-statistics statement.....91
mac-table-size statement.....92
max-age statement.....156
max-hops statement.....157
mode statement.....158
msti statement.....159
mstp statement.....160

N

no-mac-learning statement.....93
no-root-port statement.....161
notification-time statement.....113

P

packet-action statement.....94

priority statement	
spanning tree.....	162
priority-hold-time statement.....	163
protocol statement.....	163
protocols statement.....	164
ptopo-configuration-maximum-hold-time	
statement.....	53
ptopo-configuration-trap-interval statement.....	54

R

revision-level statement.....	165
routing-interface statement.....	95
rstp statement.....	166

S

static-mac statement.....	96
switch-options statement.....	97
system-id statement.....	167

T

threshold-count statement.....	114
threshold-time statement.....	115
traceoptions statement	
LLDP.....	55
STP.....	168
transmit-delay statement	
LLDP.....	57
tunnel-services statement.....	98

V

vlan statement.....	171
vlan-id statement.....	99
vlan-id-list statement.....	100
vlan-tags statement.....	101
vpls-flush-on-topology-change statement.....	173
vstp statement.....	174