ZebOS-XP®
Network Platform

Version 1.4
Extended Performance

Layer 2 Configuration Guide

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IP Infusion Inc.
3965 Freedom Circle, Suite 200
Santa Clara, CA 95054
+1 408-400-1900
http://www.ipinfusion.com/

For support, questions, or comments via E-mail, contact:
support@ipinfusion.com

Contents

Preface

This guide describes how to configure Layer 2 protocols in ZebOS-XP.

Audience

This guide is intended for network administrators and other engineering professionals who configure Layer 2 protocols.

Conventions

Table P-1 shows the conventions used in this guide.

Table P-1: Conventions

Convention	Description
Italics	Emphasized terms; titles of books
Note:	Special instructions, suggestions, or warnings
`monospaced type`	Code elements such as commands, functions, parameters, files, and directories

Contents

This guide contains these chapters:

- Chapter 1, *Spanning Tree Protocol Configuration*
- Chapter 2, *RSTP Configuration*
- Chapter 3, *MSTP Configuration*
- Chapter 4, *RPVST+ Configuration*
- Chapter 5, *Disable Spanning Tree Configuration*
- Chapter 6, *Maximum MST Instances Configuration*
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- Chapter 8, *VLAN Configuration*
- Chapter 9, *802.1X Configuration*
- Chapter 10, *LACP Configuration*
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- Chapter 12, *MC-LAG Configuration*
- Chapter 13, *GMRP Configuration*
- Chapter 14, *MAC Authentication Configuration*

- Chapter 15, *GVRP Configuration*

Related Documents

Use this guide with the *Layer 2 Command Reference* for details about the commands used in the configurations.

This configurations in this guide are for the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer 2/Layer 3 module, see the *Hybrid Switch Router Configuration Guide*.

Note: All ZebOS-XP technical manuals are available to licensed customers at http://www.ipinfusion.com/support/document_list.

Chapter Organization

The chapters in this guide are organized into these major sections:

- An overview that explains a configuration in words
- Topology with a diagram that shows the devices and connections used in the configuration
- Configuration steps in a table for each device where the left-hand side shows the commands you enter and the right-hand side explains the actions that the commands perform
- Validation which shows commands and their output that verify the configuration

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CHAPTER 1 Spanning Tree Protocol Configuration

This chapter contains a complete sample STP configuration. STP prevents duplication of packets by eliminating loops in the network.

Topology

The following example is a simple multi-bridge topology.

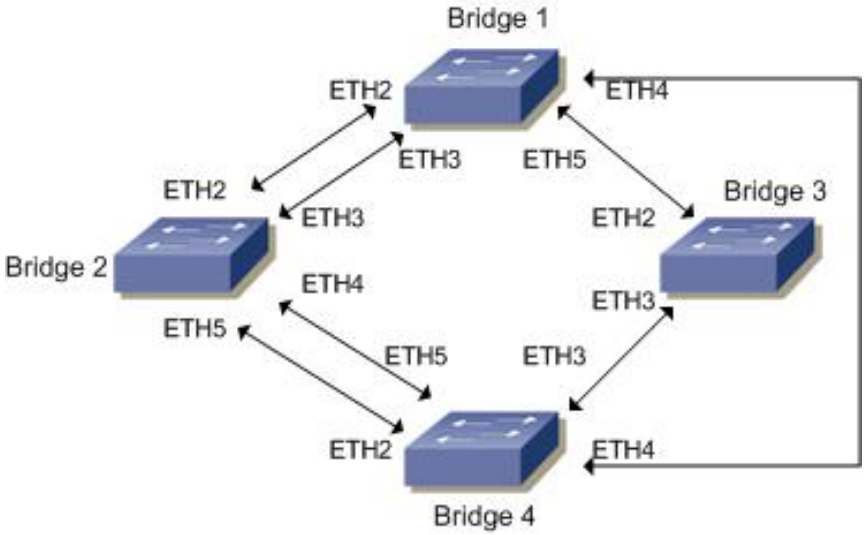


Figure 1-1: STP Topology

Note: This configuration assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

Bridge 1

`Bridge1#configure terminal`	Enter configure mode.
`Bridge1(config)#bridge 1 protocol ieee`	Add a bridge `(1)` to the spanning tree table
`Bridge1(config)#interface eth2`	Enter interface mode.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth3`	Enter interface mode.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth4`	Enter interface mode.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.

`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth5`	Enter interface mode
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.

Bridge 2

`Bridge2#configure terminal`	Enter configure mode.
`Bridge2(config)#bridge 2 protocol ieee`	Add a bridge (`2`) to the spanning tree table
`Bridge2(config)#interface eth2`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth3`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth4`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth5`	Enter interface mode
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.

Bridge 4

`Bridge4#configure terminal`	Enter configure mode.
`Bridge4(config)#bridge 4 protocol ieee`	Add a bridge (`4`) to the spanning tree table
`Bridge4(config)#interface eth2`	Enter interface mode.
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth3`	Enter interface mode.
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth4`	Enter interface mode.
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth5`	Enter interface mode
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.

Bridge 3

`Bridge3#configure terminal`	Enter configure mode.
`Bridge3(config)#bridge 3 protocol ieee`	Add a bridge `(3)` to the spanning tree table
`Bridge3(config)#interface eth2`	Enter interface mode.
`Bridge3(config-if)#bridge-group 3`	Associate the interface with bridge group `3`.
`Bridge3(config-if)#exit`	Exit interface mode.
`Bridge3(config)#interface eth3`	Enter interface mode.
`Bridge3(config-if)#bridge-group 3`	Associate the interface with bridge group `3`.

Validation

show spanning-tree, show spanning-tree interface <if-name>

CHAPTER 2 RSTP Configuration

This chapter contains a complete sample Rapid Spanning Tree Protocol (RSTP) configuration. RSTP provides rapid convergence of a spanning tree. It speeds up the reconfiguration of the tree after a change by using alternate ports.

Topology

The following example is a simple multi-bridge topology.

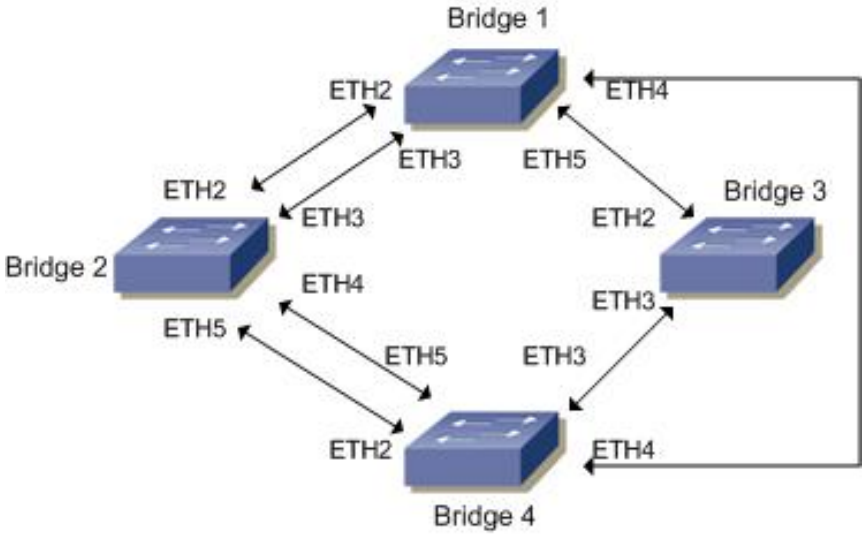


Figure 2-2: RSTP Topology

Note: This configuration assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

Bridge 1

`Bridge1#configure terminal`	Enter configure mode.
`Bridge1(config)#bridge 1 protocol rstp`	Add a bridge (`1`) to the rapid spanning tree table
`Bridge1(config)#interface eth2`	Enter interface mode.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group 1.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth3`	Enter interface mode.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth4`	Enter interface mode.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.

`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth5`	Enter interface mode
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.

Bridge 2

`Bridge2#configure terminal`	Enter configure mode.
`Bridge2(config)#bridge 2 protocol rstp`	Add a bridge (`2`) to the rapid spanning tree table
`Bridge2(config)#interface eth2`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth3`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth4`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth5`	Enter interface mode
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.

Bridge 3

`Bridge3#configure terminal`	Enter configure mode.
`Bridge3(config)#bridge 3 protocol rstp`	Add a bridge `(3)` to the rapid spanning tree table
`Bridge3(config)#interface eth2`	Enter interface mode.
`Bridge3(config-if)#bridge-group 3`	Associate the interface with bridge group `3`.
`Bridge3(config-if)#exit`	Exit interface mode.
`Bridge3(config)#interface eth3`	Enter interface mode.
`Bridge3(config-if)#bridge-group 3`	Associate the interface with bridge group `3`.

Bridge 4

`Bridge4#configure terminal`	Enter configure mode.
`Bridge4(config)#bridge 4 protocol rstp`	Add a bridge `(4)` to the rapid spanning tree table
`Bridge4(config)#interface eth2`	Enter interface mode.
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#exit`	Exit interface mode.

`Bridge4(config)#interface eth3`	Enter interface mode.
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth4`	Enter interface mode.
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth5`	Enter interface mode
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.

Validation

show spanning-tree, show spanning-tree interface <if-name>

CHAPTER 3 MSTP Configuration

This chapter contains a complete sample Multiple Spanning Tree Protocol (MSTP) configuration. MSTP allows multiple VLANs to be grouped into one spanning-tree instance. Every MST instance has a spanning-tree that is independent of other spanning-tree instances providing multiple forwarding paths for data traffic.

Note: The `spanning-tree mode` command is applicable for the default bridge only and is not supported by hardware platforms.

Topology

This example gives a simple multi-bridge topology and its configuration.

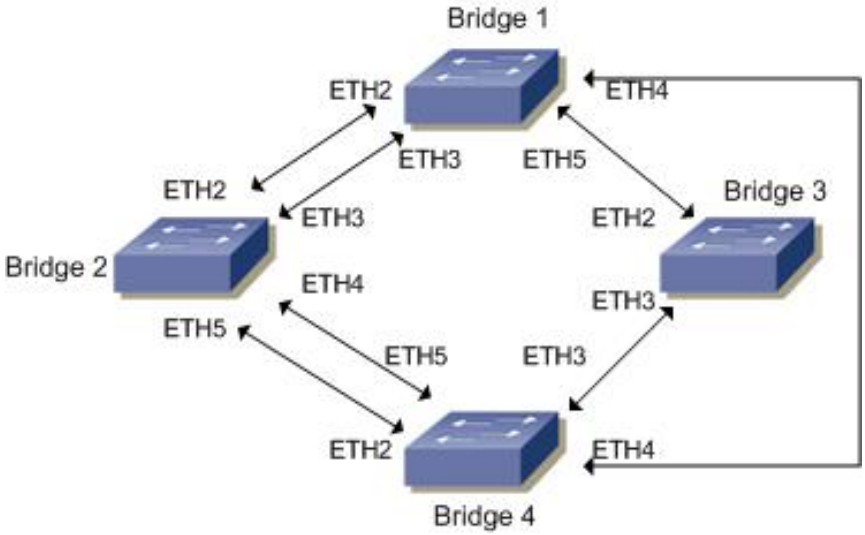


Figure 3-3: MSTP Topology

Note: This configuration assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

Bridge 1

`Bridge1#configure terminal`	Enter configure mode.
`Bridge1(config)#bridge 1 protocol mstp`	Add a bridge (1) to the multiple spanning tree table.
`Bridge1(config)#vlan 2-5 bridge 1`	Add VLAN from 2-5 to bridge 1.
`Bridge1(config)#spanning-tree mst configuration`	Enter the Multiple Spanning Tree
`Bridge1(config-mst)#bridge 1 instance 2 vlan 2`	Create an instance of VLAN. The VLANs must be created before being associating with an MST instance (MSTI). If the VLAN range is not specified the MSTI will not be created.

`Bridge1(config-mst)#bridge 1 instance 3 vlan 3`	Create another instance of VLAN. The VLANs must be created before being associating with an MST instance (MSTI). If the VLAN range is not specified the MSTI will not be created.
`Bridge1(config-mst)#bridge 1 instance 4 vlan 4`	same as mention above.
`Bridge1(config-mst)#bridge 1 instance 5 vlan 5`	same as mention above.
`Bridge1(config-mst)#exit`	Exit MST Configuration mode.
`Bridge1(config)#`**`interface eth2`**	Enter the Interface mode for eth2
`Bridge1(config-if)#bridge-group 1`	Associating the interface to bridge-group 1
`Bridge1(config-if)#bridge-group 1 instance 2`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 3`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 4`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 5`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#`**`interface eth3`**	Enter the Interface mode for eth3.
`Bridge1(config-if)#bridge-group 1`	Associating the interface to bridge-group 1
`Bridge1(config-if)#bridge-group 1 instance 2`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 3`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 4`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 5`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#`**`interface eth4`**	Enter the Interface mode for eth4.
`Bridge1(config-if)#bridge-group 1`	Associating the interface to bridge-group 1
`Bridge1(config-if)#bridge-group 1 instance 2`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 3`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 4`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 5`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth5`	Enter the Interface mode for eth5.
`Bridge1(config-if)#bridge-group 1`	Associating the interface to bridge-group 1
`Bridge1(config-if)#bridge-group 1 instance 2`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 3`	Assigning bridge-group 1 to this instance

`Bridge1(config-if)#bridge-group 1 instance 4`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#bridge-group 1 instance 5`	Assigning bridge-group 1 to this instance
`Bridge1(config-if)#exit`	Exit interface mode.

Bridge 2

`Bridge2#configure terminal`	Enter configure mode.
`Bridge2(config)#bridge 2 protocol mstp`	Add a bridge (2) to the multiple spanning
`Bridge2(config)#bridge 2 priority 4096`	Assign priority to this bridge.
`Bridge2(config)#vlan 2-5 bridge 2`	Add VLAN from 2-5 to bridge 2.
`Bridge2(config)#spanning-tree mst configuration`	Enter the Multiple Spanning Tree
`Bridge2(config-mst)#bridge 2 instance 2 vlan 2`	Create an instance of VLAN. The VLANs
`Bridge2(config-mst)#bridge 2 instance 3 vlan 3`	same as mention above.
`Bridge2(config-mst)#bridge 2 instance 4 vlan 4`	same as mention above.
`Bridge2(config-mst)#bridge 2 instance 5 vlan 5`	same as mention above.
`Bridge2(config-mst)#exit`	Exit MST Configuration mode.
`Bridge2(config)#interface eth2`	Enter the Interface mode for eth2
`Bridge2(config-if)#bridge-group 2`	Associating the interface to bridge-group 2
`Bridge2(config-if)#bridge-group 2 instance 2`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 3`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 4`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 5`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth3`	Enter the Interface mode for eth2
`Bridge2(config-if)#bridge-group 2`	Associating the interface to bridge-group 2
`Bridge2(config-if)#bridge-group 2`	Associating the interface to bridge-group 2
`Bridge2(config-if)#bridge-group 2 instance 2`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 3`	Assigning bridge-group 2 to this instance

`Bridge2(config-if)#bridge-group 2 instance 3 priority 16`	Assign bridge-group 2 to this instance and set a port priority in order of 16 for it. MSTP uses port priority as a tiebreaker to determine which port should forward frames for a particular instance on a LAN, or which port should be the root port for an instance. A lower value implies better priority.
`Bridge2(config-if)#bridge-group 2 instance 4`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 4 priority 16`	
`Bridge2(config-if)#bridge-group 2 instance 5`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#exit`	Exit interface mode
`Bridge2(config)#interface eth4`	Enter the Interface mode for eth2
`Bridge2(config-if)#bridge-group 2`	
`Bridge2(config-if)#bridge-group 2 instance 2`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 3`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 4`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 5`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth5`	Enter the Interface mode for eth2
`Bridge2(config-if)#bridge-group 2`	Associating the interface to bridge-group 2
`Bridge2(config-if)#bridge-group 2 instance 2`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 3`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 4`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#bridge-group 2 instance 5`	Assigning bridge-group 2 to this instance
`Bridge2(config-if)#exit`	Exit interface mode.

Bridge 3

`Bridge3#configure terminal`	Enter configure mode.
`Bridge3(config)#bridge 3 protocol mstp`	Add a bridge (3) to the multiple spanning tree table
`Bridge3(config)#vlan 2-5 bridge 3`	Add VLAN from 2-5 to bridge 3.
`Bridge3(config)#spanning-tree mst configuration`	Enter the Multiple Spanning Tree Configuration mode.

`Bridge3(config-mst)#bridge 3 instance 2 vlan 2`	Create an instance of VLAN. The VLANs must be created before being associating with an MST instance (MSTI). If the VLAN range is not specified the MSTI will not be created.
`Bridge3(config-mst)#bridge 3 instance 3 vlan 3`	same as mention above.
`Bridge3(config-mst)#bridge 3 instance 4 vlan 4`	same as mention above.
`Bridge3(config-mst)#bridge 3 instance 5 vlan 5`	same as mention above.
`Bridge3(config-mst)#exit`	Exit MST Configuration mode.
`Bridge3(config)#interface eth2`	Enter the Interface mode for eth2
`Bridge3(config-if)#bridge-group 3`	Associating the interface to bridge-group 3
`Bridge3(config-if)#bridge-group 3 instance 2`	Assigning bridge-group 3 to this instance
`Bridge3(config-if)#bridge-group 3 instance 3`	Assigning bridge-group 3 to this instance
`Bridge3(config-if)#bridge-group 3 instance 4`	Assigning bridge-group 3 to this instance
`Bridge3(config-if)#bridge-group 3 instance 5`	Assigning bridge-group 3 to this instance
`Bridge3(config-if)#exit`	Exit interface mode.
`Bridge3(config)#interface eth3`	Enter the Interface mode for eth2
`Bridge3(config-if)#bridge-group`	Associating the interface to bridge-group 3
`Bridge3(config-if)#bridge-group 3 instance 2`	Assigning bridge-group 3 to this instance
`Bridge3(config-if)#bridge-group 3 instance 3`	Assigning bridge-group 3 to this instance
`Bridge3(config-if)#bridge-group 3 instance 4`	Assigning bridge-group 3 to this instance
`Bridge3(config-if)#bridge-group 3 instance 5`	Assigning bridge-group 3 to this instance
`Bridge3(config-if)#exit`	Exit interface mode.

Bridge 4

`Bridge4#configure terminal`	Enter configure mode.
`Bridge4(config)#bridge 4 protocol mstp`	Add a bridge (4) to the multiple spanning tree table
`Bridge4(config)#vlan 2-5 bridge 4`	Add VLAN from 2-5 to bridge 4.
`Bridge4(config)#spanning-tree mst configuration`	Enter the Multiple Spanning Tree Configuration mode.
`Bridge4(config-mst)#bridge 4 instance 2 vlan 2`	Create an instance of VLAN. The VLANs must be created before being associating with an MST instance (MSTI). If the VLAN range is not specified the MSTI will not be created.

`Bridge4(config-mst)#bridge 4 instance 3 vlan 3`	same as mention above.
`Bridge4(config-mst)#bridge 4 instance 4 vlan 4`	same as mention above.
`Bridge4(config-mst)#bridge 4 instance 5 vlan 5`	same as mention above.
`Bridge4(config-mst)#exit`	Exit MST Configuration mode.
`Bridge4(config)#interface eth2`	Enter the Interface mode for eth2
`Bridge4(config-if)#bridge-group  4`	Associating the interface to bridge-group 4
`Bridge4(config-if)#bridge-group 4 instance 2`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 3`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 4`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 5`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth3`	Enter the Interface mode for eth2
`Bridge4(config-if)#bridge-group  4`	Associating the interface to bridge-group 4
`Bridge4(config-if)#bridge-group 4 instance 2`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 3`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 4`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 5`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth4`	Enter the Interface mode for eth2
`Bridge4(config-if)#bridge-group  4`	Associating the interface to bridge-group 4
`Bridge4(config-if)#bridge-group 4 instance 2`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 3`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 4`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 5`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth5`	Enter the Interface mode for eth2
`Bridge4(config-if)#bridge-group  4`	Associating the interface to bridge-group 4
`Bridge4(config-if)#bridge-group 4 instance 2`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 3`	Assigning bridge-group 4 to this instance

`Bridge4(config-if)#bridge-group 4 instance 4`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#bridge-group 4 instance 5`	Assigning bridge-group 4 to this instance
`Bridge4(config-if)#exit`	Exit interface mode.

Validation

show spanning-tree, show spanning-tree mst detail

CHAPTER 4 RPVST+ Configuration

This chapter contains a complete example of an RPVST+ configuration.

Note: The `spanning-tree mode` command is applicable for the default bridge only and is not supported by hardware platforms.

Topology

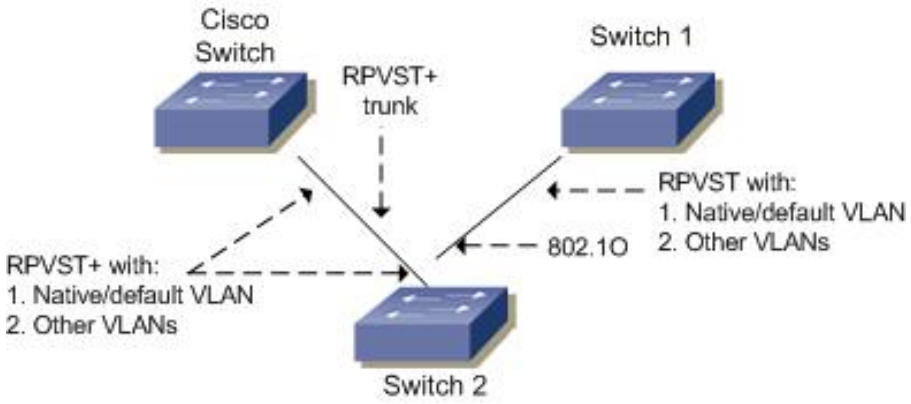


Figure 4-4: RPVST+ Topology

Switch 2

`Switch2#configure terminal`	Enter configure mode for the switch.
`Switch2(config)#bridge 1 protocol rpvst+`	Configure bridge 1 as an RPVST+ bridge.
`Switch2(config)#spanning-tree mode rpvst+`	Configure spanning tree mode as `rpvst+`.
`Switch2(config)#vlan 2-3 bridge 1`	Configure VLAN 2 and 3 and associate it to bridge 1.
`Switch2(config)#spanning-tree rpvst+ configuration`	Enter Rapid Per-VLAN Spanning Tree configuration mode.
`Switch2(config-rpvst+)#bridge 1 vlan 2`	Associate a configured VLAN with bridge 1, which automatically assigns it to an MSTI (MST instance).
`Switch2(config-rpvst+)#bridge 1 vlan 3`	Associate a configured VLAN with bridge 1, which automatically assigns it to an MSTI (MST instance).
`Switch2(config-rvpst+)#exit`	Exit RPVST+ configuration mode.
`Switch2(config)#interface eth1`	Enter the interface mode for `eth1`.
`Switch2(config-if)#switchport`	Configure `eth1` as a Layer 2 port.
`Switch2(config-if)#bridge-group 1`	Associate bridge to interface.
`Switch2(config-if)#switchport mode trunk`	Configure port as trunk.
`Switch2(config-if)#switchport trunk allowed vlan add 2,3`	Configure VLAN 2 and VLAN 3 on interface.

`Switch2(config-if)#bridge-group 1 vlan 2`	Configure bridge group to interface with VLAN 2.
`Switch2(config-if)#bridge-group 1 vlan 3`	Configure bridge group to interface with VLAN 3.
`Switch2(config-if)#exit`	Exit interface mode.
`Switch2(config)#interface eth2`	Enter interface mode for `eth2`.
`Switch2(config-if)#switchport`	Configure `eth2` as a Layer 2 port.
`Switch2(config-if)#bridge-group 1`	Associate bridge to interface/
`Switch2(config-if)#switchport mode trunk`	Configure port as trunk
`Switch2(config-if)#switchport trunk allowed vlan add 2,3`	Configure VLAN 2 and VLAN 3 on interface.
`Switch2(config-if)#bridge-group 1 vlan 2`	Configure bridge group to interface with VLAN 2.
`Switch2(config-if)#bridge-group 1 vlan 3`	Configure bridge group to interface with VLAN3.
`Switch2(config-if)#exit`	Exit interface mode.

Switch 1

`Switch1#configure terminal`	Enter configure mode for the switch.
`Switch1(config)#bridge 1 protocol rstp vlan-bridge`	Configure bridge 1 as an RSTP bridge/
`Switch1(config)#spanning-tree mode rstp`	Configure spanning tree mode as `rstp`.
`Switch1(config)#vlan 2-3 bridge 1`	Configure VLAN 2 and 3 and associate it to bridge 1.
`Switch1(config)#interface eth1`	Enter the Interface mode for `eth1`.
`Switch1(config-if)#switchport`	Configure `eth1` as a Layer 2 port.
`Switch1(config-if)#bridge-group 1`	Associate bridge to interface.
`Switch1(config-if)#switchport mode trunk`	Configure port as trunk.
`Switch1(config-if)#switchport trunk allowed vlan add 2,3`	Configure VLAN 2 and VLAN 3 on interface.
`Switch1(config-if)#exit`	Exit interface mode.

Cisco Switch

`Switch(config)#spanning-tree mode rpvst+`	Configure spanning tree mode as `rpvst+`.
`Switch(config)#spanning-tree vlan 2 priority 2`	Associate VLAN's to spanning tree.
`Switch(config)#interface FastEthernet0/24`	Enter interface mode.
`Switch(config-if)#switchport trunk allowed vlan 1-1000`	Add VLAN's to trunk mode interface.

Validation

show spanning-tree, show spanning-tree rpvst+ detai

CHAPTER 5 Disable Spanning Tree Configuration

This chapter describes disabling spanning tree operation on a per Multiple Spanning Tree Instance (MSTI) basis.

Topology

Figure 5-5: Disable Spanning Tree Topology

Note: This configuration sample assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

Bridge 1

`Bridge1#configure terminal`	Enter configure mode.
`Bridge1(config)#bridge 1 protocol mstp`	Add `bridge 1` to the multiple spanning tree (`mstp`) table.
`Bridge1(config)#vlan 2 bridge 1`	Configure VLAN 2 and associate it to bridge 1.
`Bridge1(config)#spanning-tree te-msti configuration`	Enter the `te-msti configuration` mode.
`Bridge1(config-te-msti)#bridge 1 te-msti vlan 2`	Create an instance of VLAN. The VLANs must be created before being associating with an MST instance (MSTI). If not specified, the MSTI is not created.
`Bridge1(config-te-msti)#exit`	Exit `te-msti configuration` mode.
`Bridge1(config)#interface eth1`	Enter the `Interface` mode for `eth1`
`Bridge1(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`.
`Bridge1(config-if)#switchport mode access`	Set the switching characteristics of this interface to `access` mode.
`Bridge1(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying the VLAN ID 2 on this interface.
`Bridge1(config-if)#bridge-group 1 instance te-msti`	Assign `bridge-group 1` to this `instance`.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth2`	Enter the `Interface` mode for `eth2`.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`.
`Bridge1(config-if)#switchport mode access`	Set the switching characteristics of this interface to `access` mode.
`Bridge1(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying the VLAN ID 2 on this interface.

`Bridge1(config-if)#bridge-group 1 instance te-msti`	Assign `bridge-group 1` to this `instance`.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#no bridge 1 te-msti`	Disable spanning tree on the `te-msti`.

Bridge 2

`Bridge2#configure terminal`	Enter configure mode.
`Bridge2(config)#bridge 1 protocol mstp`	Add a `bridge 1` to the multiple spanning tree table.
`Bridge2(config)#vlan 2 bridge 1`	Configure VLAN 2 and associate it to bridge 1.
`Bridge2(config)#spanning-tree te-msti configuration`	Enter the `te-msti configuration` mode.
`Bridge2(config-te-msti)#bridge 1 te-msti vlan 2`	Create an instance of VLAN. The VLAN must be created before being associating it with an MST instance (MSTI). If not specified, MSTI is not created.
`Bridge2(config-te-msti)#exit`	Exit `te-msti configuration` mode.
`Bridge2(config)#interface eth1`	Enter the `Interface` mode for `eth1`.
`Bridge2(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`.
`Bridge2(config-if)#switchport mode access`	Set the switching characteristics of this interface to `access` mode.
`Bridge2(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying the VLAN ID 2 on this interface.
`Bridge2(config-if)#bridge-group 1 instance te-msti`	Assign `bridge-group 1` to this instance.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth2`	Enter the `Interface` mode for `eth2`.
`Bridge2(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`.
`Bridge2(config-if)#switchport mode access`	Set the switching characteristics of this interface to `access` mode.
`Bridge2(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying the VLAN ID 2 on this interface.
`Bridge2(config-if)#bridge-group 1 instance te-msti`	Assign `bridge-group 1` to this instance.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#no bridge 1 te-msti`	Disable spanning tree on `the te-msti.`

Validation

show spanning-tree, show spanning-tree interface

CHAPTER 6 Maximum MST Instances Configuration

This chapter describes the configuration support for extending the maximum number of Multiple Spanning Tree instances from 16 to 64.

Topology

Figure 6-6: Maximum Spanning Tree Topology

Note: This configuration sample assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

Bridge 1

`Bridge1#configure terminal`	Enter configure mode.
`Bridge1(config)#bridge 1 protocol mstp`	Add `bridge (1)` to the multiple spanning tree table.
`Bridge1(config)#vlan 2 bridge 1`	Configure VLAN 2 and associate it to bridge 1.
`Bridge1(config)#spanning-tree mst configuration`	Enter the Multiple Spanning Tree Configuration mode.
`Bridge1(config-mst)#bridge 1 instance 63 vlan 2`	Create an instance of VLAN. The VLANs must be created before being associating with an MST instance (MSTI). If the VLAN range is not specified, the MSTI is not created.
`Bridge1(config-te-msti)#exit`	Exit `te-msti configuration` mode.
`Bridge1(config)#interface eth1`	Enter the `Interface` mode for `eth1`.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`
`Bridge1(config-if)#switchport mode access`	Set the switching characteristics of this interface to `access` mode.
`Bridge1(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying VLAN ID 2 on this interface.
`Bridge1(config-if)#bridge-group 1 instance 63`	Assign `bridge-group 1` to this instance.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth2`	Enter the `Interface` mode for `eth2`
`Bridge1(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`
`Bridge1(config-if)#switchport mode access`	Set the switching characteristics of this interface to `access` mode.

`Bridge1(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying VLAN ID 2 on this interface.
`Bridge1(config-if)#bridge-group 1 instance 63`	Assign `bridge-group 1` to this instance.
`Bridge1(config-if)#exit`	Exit interface mode.

Bridge 2

`Bridge2#configure terminal`	Enter configure mode.
`Bridge2(config)#bridge 1 protocol mstp`	Add `bridge 1` to the multiple spanning tree table.
`Bridge2(config)#vlan 2 bridge 1`	Configure VLAN 2 and associate it to bridge 1.
`Bridge2(config)#spanning-tree mst configuration`	Enter the Multiple Spanning Tree Configuration mode.
`Bridge2(config-mst)#bridge 1 instance 63 vlan 2`	Create an instance of VLAN. The VLANs must be created before being associating with an MST instance (MSTI). If the VLAN range is not specified, the MSTI is not created.
`Bridge2(config-te-msti)#exit`	Exit `te-msti configuration` mode.
`Bridge2(config)#interface eth1`	Enter the `Interface` mode for `eth1`.
`Bridge2(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`.
`Bridge2(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`Bridge2(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying the VLAN ID 2 on this interface.
`Bridge2(config-if)#bridge-group 1 instance 63`	Assign `bridge-group 1` to this instance.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth2`	Enter the `Interface` mode for `eth2`.
`Bridge2(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`.
`Bridge2(config-if)#switchport mode access`	Set the switching characteristics of this interface to `access` mode.
`Bridge2(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying the VLAN ID 2 on this interface.
`Bridge2(config-if)#bridge-group 1 instance 63`	Assign `bridge-group 1` to this instance.
`Bridge2(config-if)#exit`	Exit interface mode.

Validation

show spanning-tree, show spanning-tree mst detail

CHAPTER 7 Layer 2 Gateway Port Configuration

This chapter contains the commands used to configure a Layer 2 Gateway Port (L2GP). L2GP enables a you to have redundant links connecting to a PBBN (provider backbone bridge network) without creating loops.

Topology

The basic topology is two switches connected back-to-back via two Ethernet interfaces.

Figure 7-7: Layer 2 Gateway Port Topology

Note: This configuration sample assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

Switch A

`SwitchA#configure terminal`	Enter configure mode.
`SwitchA(config)#bridge 1 protocol mstp`	Add `bridge 1` to the multiple spanning tree table.
`SwitchA(config)#vlan 2 bridge 1`	Configure VLAN 2 and associate it to bridge 1.
`SwitchA(config)#spanning-tree mst configuration`	Enter the Multiple Spanning Tree Configuration mode.
`SwitchA(config-mst)#bridge 1 instance 2 vlan 2`	Create an instance of VLAN. The VLAN must be created before being associating with an MST instance (MSTI). If the VLAN range is not specified, the MSTI is not created.
`SwitchA(config-mst)#exit`	Exit `mst configuration` mode.
`SwitchA(config)#bridge 1 priority 4096`	Assigning priority to bridge.
`SwitchA(config)#interface eth1`	Enter the `Interface` mode for `eth1`.
`SwitchA(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`.
`SwitchA(config-if)#switchport mode access`	Set the switching characteristics of this interface to `access` mode
`SwitchA(config-if)#bridge-group 1 instance 2`	Assign `bridge-group 1` to this instance and set a port priority for it.
`SwitchA(config-if)#switchport l2gp psuedoRootId [ROOTID:MAC] enableBPDUrx`	Assign the port as `l2gp`, assign the root priority ,and set the BPDU transmission flag.

Note: PsuedoRootID configured as priority/mac-address (`xxxxx/xxxx.xxxx.xxxx`) is the root ID that belongs to Switch B. This configuration is such that root resides in the other administrative domain.

Switch B

`SwitchB#configure terminal`	Enter configure mode.
`SwitchB(config)#bridge 1 protocol mstp`	Add `bridge 1` to the multiple spanning tree table.
`SwitchB(config)#vlan 2 bridge 1`	Configure VLAN 2 and associate it to bridge 1.
`SwitchB(config)#spanning-tree mst configuration`	Enter the Multiple Spanning Tree Configuration mode.
`SwitchB(config-mst)#bridge 1 instance 2 vlan 2`	Create an instance of VLAN. The VLAN must be created before being associating with an MST instance (MSTI). If the VLAN range is not specified, the MSTI is not created.
`SwitchB(config-mst)#exit`	Exit `mst configuration` mode.
`SwitchB(config)#bridge 1 priority 0`	Assign a `priority` to bridge.
`SwitchB(config)#interface eth1`	Enter the `Interface` mode for `eth1`.
`SwitchB(config-if)#bridge-group 1`	Associate the interface with `bridge-group 1`.
`SwitchB(config-if)#switchport mode access`	Set the switching characteristics of this interface to `access` mode.
`SwitchB(config-if)#bridge-group 1 instance 2`	Assign `bridge-group 1` to this instance.

Validation

show spanning-tree, show spanning-tree mst detail

CHAPTER 8 VLAN Configuration

This chapter contains a complete VLAN configuration.

Configuring VLAN Tags

Topology

This shows configuring a spanning tree bridge with VLAN tags on forwarding frames. VLAN port access is configured on port `eth2` on bridge 2, port `eth2` and `eth4` on bridge 1 and port `eth4` on bridge 4. Incoming tagged packets to bridge 2 will be forwarded only on these ports configured with VLAN port access.

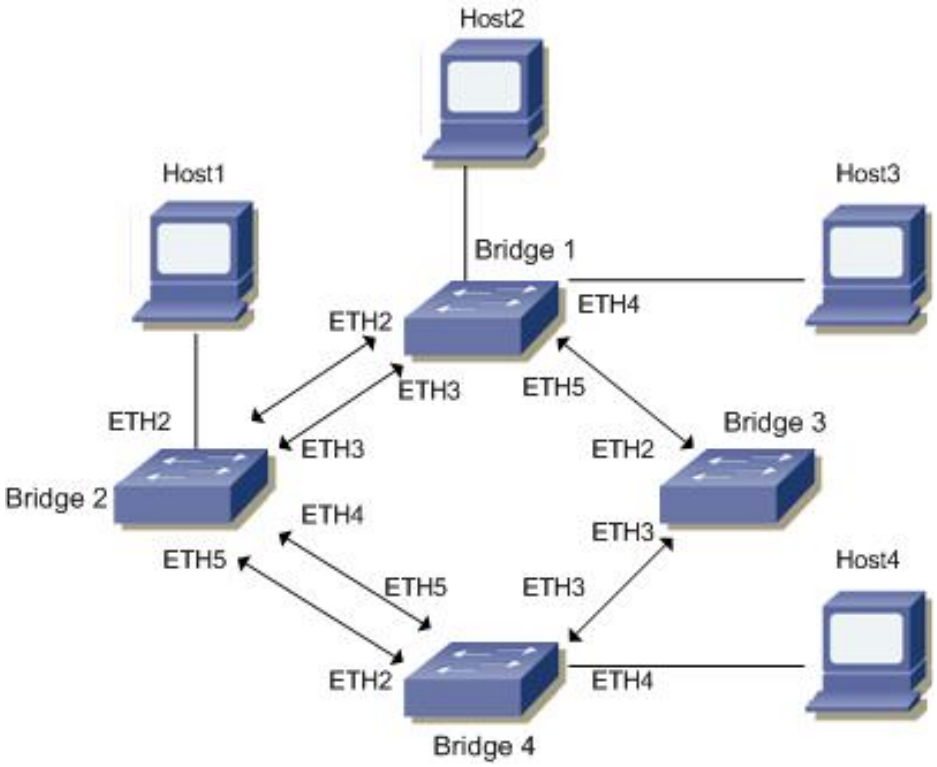


Figure 8-8: VLAN Topology

Note: This configuration assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

Bridge 1

`Bridge1#configure terminal`	Enter configure mode.
`Bridge1(config)#bridge 1 protocol ieee vlan-bridge`	Specify VLAN for bridge `1`.

`Bridge1(config)#vlan 5 bridge 1`	Configure VLAN 5 and associate it to bridge 1.
`Bridge1(config)#interface eth2`	Enter interface mode.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.
`Bridge1(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`Bridge1(config-if)#switchport access vlan 5`	Enable VLAN port access by specifying the VLAN ID `5` on this interface.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth3`	Enter interface mode.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.
`Bridge1(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge1(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth4`	Enter interface mode.
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.
`Bridge1(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`Bridge1(config-if)#switchport access vlan 5`	Enable VLAN port access by specifying the VLAN ID `5` on this interface.
`Bridge1(config-if)#exit`	Exit interface mode.
`Bridge1(config)#interface eth5`	Enter interface mode
`Bridge1(config-if)#bridge-group 1`	Associate the interface with bridge group `1`.
`Bridge1(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge1(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.

Bridge 2

`Bridge2#configure terminal`	Enter configure mode.
`Bridge2(config)#bridge 2 protocol ieee vlan-bridge`	Specify VLAN for bridge `2`.
`Bridge2(config)#vlan 5 bridge 2`	Configure VLAN 5 and associate it to bridge 2.
`Bridge2(config)#interface eth2`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`Bridge2(config-if)#switchport access vlan 5`	Enable VLAN port access by specifying the VLAN ID `5` on this interface.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth3`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.

`Bridge2(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge2(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth4`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge2(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth5`	Enter interface mode
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge2(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.

Bridge 4

`Bridge4#configure terminal`	Enter configure mode.
`Bridge4(config)#bridge 4 protocol ieee vlan-bridge`	Specify VLAN for bridge `4`.
`Bridge4(config)#vlan 5 bridge 4`	Configure VLAN 5 and associate it to bridge 4.
`Bridge4(config)#interface eth2`	Enter interface mode.
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge4(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth3`	Enter interface mode.
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge4(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.
`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth4`	Enter interface mode.
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`Bridge4(config-if)#switchport access vlan 5`	Enable VLAN port access by specifying the VLAN ID `5` on this interface.

`Bridge4(config-if)#exit`	Exit interface mode.
`Bridge4(config)#interface eth5`	Enter interface mode
`Bridge4(config-if)#bridge-group 4`	Associate the interface with bridge group `4`.
`Bridge4(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge4(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.

Bridge 3

`Bridge3#configure terminal`	Enter configure mode.
`Bridge3(config)#bridge 3 protocol ieee vlan-bridge`	Specify VLAN for bridge `3`.
`Bridge3(config)#vlan 5 bridge 3`	Configure VLAN 5 and associate it to bridge 3.
`Bridge3(config)#interface eth2`	Enter interface mode.
`Bridge3(config-if)#bridge-group 3`	Associate the interface with bridge group `3`.
`Bridge3(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge3(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.
`Bridge3(config-if)#exit`	Exit interface mode.
`Bridge3(config)#interface eth3`	Enter interface mode.
`Bridge3(config-if)#bridge-group 3`	Associate the interface with bridge group `3`.
`Bridge3(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`Bridge3(config-if)#switchport trunk allowed vlan all`	Enable all VLAN IDs on this port.

Validation

show spanning-tree, show bridge, show vlan all bridge

VLAN Stacking

The ZebOS-XP VLAN stacking implementation can run multiple virtual LANs over a single circuit. It assigns two VLAN IDs to each frame header.

Topology

In this configuration example, two customer switches (C1 and C2) are connected to each other using two Service Provider switches (SP1 and SP2). VLAN stacking is enabled on interface `fe1` of switch SP1 and interface `fe2` of switch SP2. This allows tagged traffic of Customer Switches C1 and C2 through the edge ports of the Service Provider Switches SP1 and SP2.

Figure 8-9: VLAN Stacking Topology

Note: This configuration assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

SP1

`SP1#configure terminal`	Enter configure mode.
`SP1(config)#bridge 2 protocol ieee vlan-bridge`	Specify VLAN for bridge `2`.
`SP1(config)#vlan 2 bridge 2`	Configure VLAN 2 and associate it to bridge 2.
`SP1(config)#interface fe1`	Specify the interface (`fe1`) to be configured and enter the Interface mode.
`SP1(config-if)#no shutdown`	Bring the bridge instance into operation with the `no shutdown` command.
`SP1(config-if)#bridge-group 2`	Associate the interface `fe1` with bridge group `2`.
`SP1(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`SP1(config-if)#switchport vlan-stacking customer-edge-port`	Enable VLAN stacking on this interface.
`SP1(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying the VLAN ID `2` on this interface.
`SP1(config-if)#exit`	Exit interface mode.
`SP1(config)#interface fe2`	Specify the interface (`fe2`) to be configured and enter the Interface mode.
`SP1(config-if)#no shutdown`	Bring the bridge instance into operation with the `no shutdown` command.
`SP1(config-if)#bridge-group 2`	Associate the interface `fe2` with bridge group `2`.
`SP1(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to `trunk` mode.
`SP1(config-if)#switchport trunk allowed vlan add 2`	Enable VLAN ID 2 on this port.
`SP1(config-if)#switchport vlan-stacking provider-port`	Enable VLAN stacking on this interface.
`SP1(config-if)#exit`	Exit interface mode.

SP2

`SP2#configure terminal`	Enter configure mode.
`SP2(config)#bridge 2 protocol ieee vlan-bridge`	Specify VLAN for bridge `2`.

`SP2(config)#vlan 2 bridge 2`	Configure VLAN 2 and associate it to bridge 2.
`SP2(config)#interface fe2`	Specify the interface (`fe2`) to be configured and enter the Interface mode.
`SP2(config-if)#no shutdown`	Bring the bridge instance into operation with the `no shutdown` command.
`SP2(config-if)#bridge-group 2`	Associate the interface `fe2` with bridge group `2`.
`SP2(config-if)#switchport mode access`	Set the switching characteristics of this interface to access mode.
`SP2(config-if)#switchport vlan-stacking customer-edge-port`	Enable VLAN stacking on this interface.
`SP2(config-if)#switchport access vlan 2`	Enable VLAN port access by specifying the VLAN ID `2` on this interface.
`SP2(config-if)#exit`	Exit interface mode.
`SP2(config)#interface fe1`	Specify the interface (`fe1`) to be configured and enter the Interface mode.
`SP2(config-if)#no shutdown`	Bring the bridge instance into operation with the `no shutdown` command.
`SP2(config-if)#bridge-group 2`	Associate the interface `fe1` with bridge group `2`.
`SP2(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to `trunk` mode.
`SP2(config-if)#switchport trunk allowed vlan add 2`	Enable VLAN ID 2 on this port.
`SP2(config-if)#switchport vlan-stacking provider-port`	Enable VLAN stacking on this interface.
`SP2(config-if)#exit`	Exit interface mode.

VLAN Classifiers

ZebOS-XP can use VLAN classifiers to define rules to direct packets to selected VLANs based on protocol or subnet criteria. Sets of rules can be grouped (one group per interface).

Topology

In this configuration example, two VLAN classifier rules are created to direct IPv6 packets and packets sourced from subnet 1.1.1.1/24 to VLAN 5 from interface (`fe1`) on bridge 1. Packets that do not meet the criteria defined by the rules are passed by default to VLAN 6.

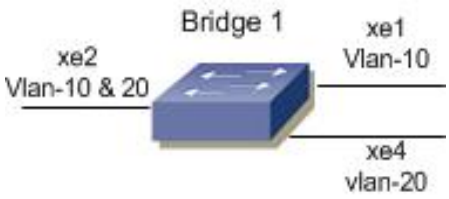


Figure 8-10: Configuring VLAN Classifiers

Subnet-Based VLAN Classifiers

`DUT#Configure Terminal`	Enter configure mode
`DUT(config)#bridge 1 protocol rstp vlan-bridge`	Create RSTP bridge 1
`DUT(config)#vlan 10 bridge 1`	Enable VLAN 10 on bridge 1
`DUT(config)#vlan 20 bridge 1`	Enable VLAN 20 on bridge 1
`DUT(config)#vlan classifier rule 1 ipv4 20.20.20.1/24 vlan 20`	Create a mac-based VLAN classifier rule (sources from subnet `20.20.20.1/24` are sent to VLAN 20)
`DUT(config)#vlan classifier group 1 add rule 1`	Create a group of rules (add rule 1 to group 1)
`DUT(config)#interface xe2`	Enter the Interface mode
`DUT(config-if)#switchport`	Switch to Layer 2 mode (if you were using the ZebOS-XP Hybrid Layer-2/Layer-3 module)
`DUT(config-if)#bridge-group 1`	Associate interface xe2 to bridge 1
`DUT(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode
`DUT(config-if)#switchport trunk allowed vlan add 10`	Enable all VLAN IDs on this port
`DUT(config-if)# switchport trunk allowed vlan add 20`	Enable all VLAN IDs on this port
`DUT(config-if)# vlan classifier activate 1`	Activate group 1 on interface xe1 Packets matching the group will be switched to VLAN 20
`DUT(config-if)#exit`	Exit interface mode
`DUT(config)#interface xe1`	Enter the Interface mode
`DUT(config-if)#switchport`	Switch to Layer 2 mode
`DUT(config-if)#bridge-group 1`	Associate interface xe1 to bridge 1

DUT(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#switchport trunk allowed vlan add 10	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#exit	Exit the VLAN configuration mode
DUT(config)#interface xe4	Enter the Interface mode
DUT(config-if)#switchport	Switch to Layer 2 mode
DUT(config-if)#bridge-group 1	Associate interface xe4 to bridge 1
DUT(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#switchport trunk allowed vlan add 20	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#exit	Exit interface mode

MAC-Based VLAN Classifiers

DUT#Configure Terminal	Enter configure mode
DUT(config)#bridge 1 protocol rstp vlan-bridge	Create RSTP bridge 1
DUT(config)#vlan 10 bridge 1	Enable VLAN 10 on bridge 1
DUT(config)#vlan 20 bridge 1	Enable VLAN 20 on bridge 1
DUT(config)#vlan classifier rule 1 mac 0000.0000.2222 vlan 20	Create a mac-based VLAN classifier rule (MAC 0000.0000.2222 are sent to VLAN 20)
DUT(config)#vlan classifier group 1 add rule 1	Create a group of rules (add rule 1 to group 1)
DUT(config)#interface xe2	Enter the Interface mode
DUT(config-if)#switchport	Switch to Layer 2 mode (if you were using the ZebOS-XP Hybrid Layer-2/Layer-3 module)
DUT(config-if)#bridge-group 1	Associate interface xe2 to bridge 1
DUT(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#switchport trunk allowed vlan add 10	Enable all VLAN IDs on this port
DUT(config-if)#switchport trunk allowed vlan add 20	Enable all VLAN IDs on this port
DUT(config-if)#vlan classifier activate 1	Activate group 1 on interface xe2 Packets matching the group will be switched to VLAN 20
DUT(config-if)#exit	Exit interface mode
DUT(config)#interface xe1	Enter the Interface mode
DUT(config-if)#switchport	Switch to Layer 2 mode
DUT(config-if)#bridge-group 1	Associate interface xe1 to bridge 1
DUT(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#switchport trunk allowed vlan add 10	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#exit	Exit the VLAN configuration mode
DUT(config)#interface xe4	Enter the Interface mode
DUT(config-if)#switchport	Switch to Layer 2 mode

DUT(config-if)#bridge-group 1	Associate interface xe4 to bridge 1
DUT(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#switchport trunk allowed vlan add 20	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#end	Exit interface mode

Protocol-Based VLAN Classifiers

DUT#Configure Terminal	Enter configure mode
DUT(config)#bridge 1 protocol rstp vlan-bridge	Create RSTP bridge 1
DUT(config)#vlan 10 bridge 1	Enable VLAN 10 on bridge 1
DUT(config)#vlan 20 bridge 1	Enable VLAN 20 on bridge 1
DUT(config)#vlan classifier rule 1 proto ip encap ethv2 vlan 20	Create a protocol-based VLAN classifier rule (IP packets with Ethernet encapsulation are sent to VLAN 20).
DUT(config)#vlan classifier group 1 add rule 1	Create a group of rules (add rule 1 to group 1)
DUT(config)#interface xe2	Enter the Interface mode
DUT(config-if)#switchport	Switch to Layer 2 mode (if you were using the ZebOS-XP Hybrid Layer-2/Layer-3 module)
DUT(config-if)#bridge-group 1	Associate interface xe2 to bridge 1
DUT(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#switchport trunk allowed vlan add 10	Enable all VLAN IDs on this port
DUT(config-if)#switchport trunk allowed vlan add 20	Enable all VLAN IDs on this port
DUT(config-if)#vlan classifier activate 1	Activate group 1 on interface xe2 Packets matching the group will be switched to vlan 20
DUT(config-if)#exit	Exit interface mode
DUT(config)#interface xe1	Enter the Interface mode
DUT(config-if)#switchport	Switch to Layer 2 mode
DUT(config-if)#bridge-group 1	Associate interface xe1 to bridge 1
DUT(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#switchport trunk allowed vlan add 10	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#exit	Exit the VLAN configuration mode
DUT(config)#interface xe4	Enter the Interface mode
DUT(config-if)#switchport	Switch to Layer 2 mode
DUT(config-if)#bridge-group 1	Associate interface xe4 to bridge 1
DUT(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#switchport trunk allowed vlan add 20	Set the switching characteristics of this interface to trunk mode
DUT(config-if)#end	Exit interface mode

Validation

show vlan classifier group, show vlan classifier rule

CHAPTER 9 802.1X Configuration

IEEE 802.1x restricts unauthenticated devices from connecting to a switch. Only after authentication is successful, traffic is allowed through the switch.

Topology

In this example, a radius server keeps the client information, validating the identity of the client and updating the switch about the authentication status of the client. The switch is the physical access between the two clients and the server. It requests information from the client, relays information to the server and then back to the client. To configure 802.1x authentication, enable authentication on ports eth0 and eth1 and specify the radius server IP address and port.

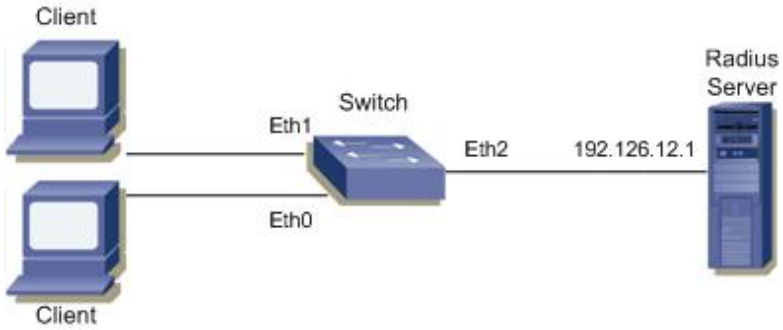


Figure 9-11: 802.1x Topology

Switch Configuration

`Switch#configure terminal`	Enter configure mode.
`Switch(config)#dot1x system-auth-ctrl`	Enable authentication globally.
`Switch(config)#interface eth0`	Enter interface mode.
`Switch(config-if)#dot1x port-control auto`	Enable authentication (via Radius) on port (`eth0`).
`Switch(config-if)#exit`	Exit interface mode.
`Switch(config)#interface eth1`	Enter interface mode.
`Switch(config-if)#dot1x port-control auto`	Enable authentication (via Radius) on port (`eth1`).
`Switch(config-if)#exit`	Exit interface mode.
`Switch(config)#radius-server host 192.126.12.1 auth-port 1812`	Specify the Radius Server address (`192.126.12.1`) and port.
`Switch(config)#radius-server key ipi`	Specify the shared key `ipi` between the radius server and the client.
`Switch(config)#interface eth2`	Enter interface mode.
`Switch(config-if)#ip address 192.126.12.0/24`	Set the IP address on interface `eth2`.

Validation

show dot1x, show dot1x all

CHAPTER 10 LACP Configuration

This chapter contains a complete sample Link Aggregation Control Protocol (LACP) configuration.

LACP is based on the 802.3ad IEEE specification. It allows bundling of several physical interfaces to form a single logical channel providing enhanced performance and redundancy. The aggregated interface is viewed as a single link to each switch. The spanning tree views it as one interface and not as two or three interfaces. When there is a failure in one physical interface, the other interfaces stay up and there is no disruption.

Topology

In this example, 3 links are configured between the two switches S1 and S2. These three links are assigned the same administrative key (1) so that they aggregate to form a single channel 1. They are viewed by the STP as one interface.

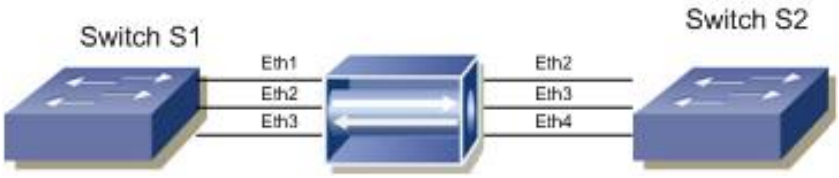


Figure 10-12: LACP Topology

S1

`S1#configure terminal`	Enter configure mode.
`S1(config)#bridge 1 protocol mstp`	Configure MSTP bridge.
`S1(config)#vlan 2 bridge 1 state enable`	Create VLAN 2 in MSTP bridge.
`S1(config)#lacp system-priority 20000`	Set the system priority of this switch. This priority is used for determining the system that is responsible for resolving conflicts in the choice of aggregation groups. A lower numerical value has a higher priority.
`S1(config)#interface eth1`	Enter interface mode.
`S1(config-if)#switchport`	Configure interface as switchport.
`S1(config-if)#channel-group 10 mode active`	Add this interface to channel group 10 and enable link aggregation so that it can be selected for aggregation by the local system.
`S1(config-if)#lacp port-priority 111`	Sets the LACP port priority.
`S1(config-if)#lacp timeout short`	Sets short LACP timeout for LACPDU receive at faster rate.
`S1(config-if)#exit`	Exit interface mode.
`S1(config)#interface eth2`	Enter interface mode.
`S1(config-if)#switchport`	Configure interface as switchport.
`S1(config-if)#channel-group 10 mode active`	Add this interface to channel group 10 and enable link aggregation so that it can be selected for aggregation by the local system.

`S1(config-if)#exit`	Exit interface mode.
`S1(config)#interface eth3`	Enter interface mode.
`S1(config-if)#switchport`	Configure interface as switchport.
`S1(config-if)#channel-group 10 mode active`	Add this interface to channel group 10 and enable link aggregation so that it can be selected for aggregation by the local system.
`S1(config-if)#exit`	Exit interface mode.
`S1(config)#interface po10`	Enter interface mode.
`S1(config-if)#bridge-group 1`	Add po interface to bridge 1.
`S1(config-if)#exit`	Exit interface mode.
`S1(config)#exit`	Exit configure mode.

S2

`S2#configure terminal`	Enter configure mode.
`S2(config)#bridge 1 protocol mstp`	Configure MSTP bridge.
`S2(config)#vlan 2 bridge 1 state enable`	Create VLAN 2 in MSTP bridge.
`S2(config)#lacp system-priority 20000`	Set the system priority of this switch. This priority is used for determining the system that is responsible for resolving conflicts in the choice of aggregation groups. A lower numerical value has a higher priority.
`S2(config)#interface eth2`	Enter interface mode.
`S2(config-if)#switchport`	Configure interface as switchport.
`S2(config-if)#channel-group 10 mode active`	Add this interface to channel group 10 and enable link aggregation so that it can be selected for aggregation by the local system.
`S2(config-if)#exit`	Exit interface mode.
`S2(config)#interface eth3`	Enter interface mode.
`S2(config-if)#switchport`	Configure interface as switchport.
`S2(config-if)#channel-group 10 mode active`	Add this interface to channel group 10 and enable link aggregation so that it can be selected for aggregation by the local system.
`S2(config-if)#exit`	Exit interface mode.
`S2(config)#interface eth4`	Enter interface mode.
`S2(config-if)#channel-group 10 mode active`	Add this interface to channel group 10 and enable link aggregation so that it can be selected for aggregation by the local system.
`S2(config-if)#exit`	Exit interface mode.
`S2(config)#interface po10`	Enter interface mode.
`S2(config-if)#bridge-group 1`	Add po interface to bridge 1.
`S2(config-if)#exit`	Exit interface mode.
`S2(config)#exit`	Exit configure mode.

Validation

```
#show etherchannel detail

  Mac address: 00:02:a5:4f:20:05
  Admin Key: 0010 - Oper Key 0010
  Actor LAG ID- 0x4e20,00-02-a5-4e-dd-9a,0x000a
  Receive link count: 1 - Transmit link count: 1
  Individual: 0 - Ready: 1
  Partner LAG ID- 0x4e20,78-ac-c0-a8-d0-29,0x000a
   Link: eth1 (4) sync: 1
   Link: eth2 (4) sync: 1
   Link: eth3 (5) sync: 1
\

#show port etherchannel eth1

 LACP link info: eth1 - 3
 LAG ID: 0x4e20,00-02-a5-4e-dd-9a,0x000a
 Partner oper LAG ID: 0x4e20,78-ac-c0-a8-d0-29,0x000a
 Actor Port priority: 0x006f (111)
 Admin key: 0x000a (10) Oper key: 0x000a (10)
 Physical admin key:(1)
 Receive machine state : Current
 Periodic Transmission machine state : Slow periodic
 Mux machine state : Collecting/Distributing
 Oper state: ACT:1 TIM:0 AGG:1 SYN:1 COL:1 DIS:1 DEF:0 EXP:0
 Partner oper state: ACT:0 TIM:0 AGG:1 SYN:1 COL:1 DIS:1 DEF:0 EXP:0
 Partner link info: admin port 0
 Partner oper port: 5
 Partner admin LAG ID: 0x0000-00:00:00:00:0000
 Admin state: ACT:1 TIM:0 AGG:1 SYN:0 COL:0 DIS:0 DEF:1 EXP:0
 Partner admin state: ACT:0 TIM:0 AGG:1 SYN:0 COL:0 DIS:0 DEF:1 EXP:0
 Partner system priority - admin:0x0000 - oper:0x4e20
 Partner port priority - admin:0x0000 - oper:0x8000
 Aggregator ID: 1000000

#show lacp-counter
 Traffic statistics
   Port        LACPDUs         Marker        Marker-Rsp        Pckt err
            Sent    Recv    Sent    Recv    Sent    Recv    Sent    Recv
 Aggregator po10 1000000
eth1        21      20      0       0       0       0       0       0
eth2        16      13      0       0       0       0       0       0
eth3        15      14      0       0       0       0       0       0
```

CHAPTER 11 LACP Peering in MEF UNI

This chapter contains samples of Link Aggregation Control Protocol (LACP) configuration for User Network Interface (UNI) within a Metro Ethernet Network (MEN) framework.

A User Network Interface (UNI) can be configured to peer, tunnel, or discard the Layer 2 protocols LACP and DOT1.X. The default behavior is peering. In the case of LACP Peering, all customer-edge ports configured for aggregation should be aggregated and synchronized with the host.

LACP Peering Configuration

Topology

In this example, PB 1 and PB 2 are provider-MSTP edge bridges that communicate directly with each other via eth0. The interfaces on Host 1 and Host 2 (eth1 and eth2) are Layer 2 interfaces. Depending upon what restrictions may be set, traffic can be sent from Host 1, passed through PB 1 and PB 2, and received on Host 2. Messages may be sent in the other direction, again depending upon provider and customer restrictions on the sending and receiving interfaces.

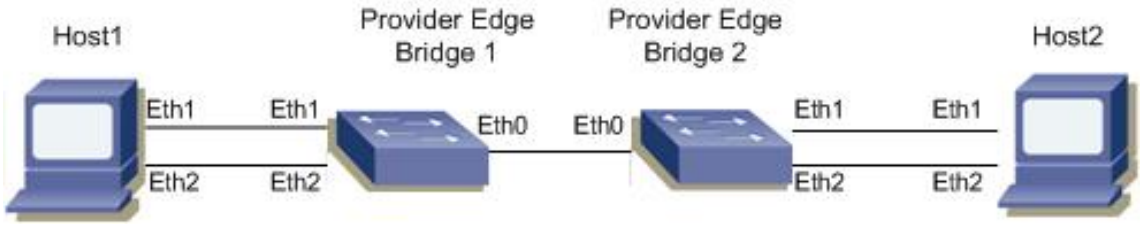


Figure 11-13: LACP Peering Topology

Provider Edge Bridge 1

`PB1#configure terminal`	Enter `Configure` mode for the router.
`PB1(config)#bridge 1 protocol provider-mstp edge`	Configure the bridge as a provider-MSTP edge bridge.
`PB1(config)#vlan 10 type service point-to-point bridge 1 state enable`	Configure VLAN 10 as service VLAN (point-to-point EVC) and associate it with bridge.
`PB1#configure terminal`	Enter `Configure` mode.
`PB1(config)#cvlan registration table map1 bridge 1`	Create CVLAN registration table, map1, and associate it with bridge 1.
`PB1(config-cvlan-registration)#cvlan 1 svlan 10`	Map CVLAN 1 (default VLAN) to SVLAN 10.
`PB1(config-cvlan-registration)#exit`	Exit `CVLAN-registration` mode.
`PB1#configure terminal`	Enter `Configure` mode.
`PB1(config)#interface eth1`	Enter `Interface` mode
`PB1(config-if)#switchport`	Configure the interface as Layer 2
`PB1(config-if)#bridge-group 1`	Associate it with bridge 1.

`PB1(config-if)#switchport mode customer-edge hybrid`	Configure the interface as customer-edge port in hybrid mode.
`PB1(config-if)#switchport customer-edge vlan registration map1`	Associate map1 (the CVLAN registration table) with the interface.
`PB1(config-if)#channel-group 2 mode passive`	Associate the interface to a channel group in passive mode, so that link aggregation is enabled on the interface.
`PB1(config-if)#exit`	Exit `Interface` mode.
`PB1#configure terminal`	Enter `Configure` mode
`PB1(config)#interface eth2`	Enter `Interface` mode
`PB1(config-if)#switchport`	Configure the interface as Layer 2.
`PB1(config-if)#bridge-group 1`	Associate it with bridge 1.
`PB1(config-if)#switchport mode customer-edge hybrid`	Configure the interface as customer-edge port in hybrid mode.
`PB1(config-if)#switchport customer-edge vlan registration map1`	Associate map1 (the CVLAN registration table) with the interface.
`PB1(config-if)#channel-group 2 mode passive`	Associate the interface to a channel group in passive mode, so that link aggregation is enabled on the interface.
`PB1(config-if)#exit`	Exit `Interface` mode.
`PB1#configure terminal`	Enter `Configure` mode.
`PB1(config)#interface eth0`	Enter `Interface` mode
`PB1(config-if)#switchport`	Configure the interface as Layer 2.
`PB1(config-if)#bridge-group 1`	Associate the interface with bridge 1.
`PB1(config-if)#switchport mode provider-network`	Configure the interface as a provider-network port.
`PB1(config-if)#switchport provider-network allowed vlan add 10`	Configure the provider-network port to allow SVLAN 10.
`PB1(config-if)#exit`	Exit `Interface` mode.

Provider Edge Bridge 2

`PB2#configure terminal`	Enter `Configure` mode.
`PB2(config)#bridge 1 protocol provider-mstp edge`	Configure the bridge as a provider-MSTP edge bridge.
`PB2(config)#vlan 10 type service point-to-point bridge 1 state enable`	Configure VLAN 10 as service VLAN, associate it with bridge 1, and enable point-to-point.
`PB2#configure terminal`	Enter `Configure` mode.
`PB2(config)#cvlan registration table map1 bridge 1`	Create a CVLAN registration table, map1, and associate it with bridge 1.
`PB2(config-cvlan-registration)#cvlan 1 svlan 10`	Map CVLAN 1 (default VLAN) with SVLAN 10.
`PB2(config-cvlan-registration)#exit`	Exit `Configure CVLAN Registration` mode.
`PB2#configure terminal`	Enter `Configure` mode.
`PB2(config)#interface eth1`	Enter `Interface` mode for eth1.
`PB2(config-if)#switchport`	Configure the interface as Layer 2.
`PB2(config-if)#bridge-group 1`	Associate it with bridge 1.

`PB2(config-if)#switchport mode customer-edge hybrid`	Configure the interface as a customer-edge port in hybrid mode.
`PB2(config-if)#switchport customer-edge vlan registration map1`	Associate map1 (the CVLAN registration table) with the interface.
`PB2(config-if)#channel-group 4 mode passive`	Associate the interface to a channel group in passive mode, so that link aggregation is enabled on the interface.
`PB2(config-if)#exit`	Exit `Interface` mode.

Host1

`HOST-1#configure terminal`	Enter `Configure` mode for the router.
`HOST-1(config)#interface eth1`	Enter `Interface` mode for eth1.
`HOST-1(config-if)#switchport`	Configure the interface as Layer 2.
`HOST-1(config-if)#channel-group 1 mode active`	Associate the interface to a channel group in active mode, so that link aggregation is enabled on the interface.
`HOST-1(config-if)#exit`	Exit `Interface` mode.
`HOST-1#configure terminal`	Enter `Configure` mode.
`HOST-1(config)#interface eth2`	Enter `Interface` mode for eth2.
`HOST-1(config-if)#switchport`	Configure the interface as Layer 2.
`HOST-1(config-if)#channel-group 1 mode active`	Associate the interface to a channel group in active mode, so that link aggregation is enabled on the interface.
`HOST-1(config-if)#exit`	Exit `Interface` mode.

Host2

`HOST-2#configure terminal`	Enter `Configure` mode for the router.
`HOST-2(config)#interface eth1`	Enter `Interface` mode for eth1.
`HOST-2(config-if)#switchport`	Configure the interface as Layer 2.
`HOST-2(config-if)#channel-group 3 mode active`	Associate the interface to a channel group in active mode, so that link aggregation is enabled on the interface.
`HOST-2(config-if)#exit`	Exit `Interface` mode.
`HOST-2(config)#interface eth2`	Enter `Interface` mode for eth2.
`HOST-2(config-if)#switchport`	Configure the interface as Layer 2.
`HOST-2(config-if)#channel-group 3 mode active`	Associate the interface to a channel group in active mode, so that link aggregation is enabled on the interface.
`HOST-2(config-if)#exit`	Exit `Interface` mode.

Validation

```
PB1#show cvlan registration table bridge 1
Bridge          Table Name       Port List
======          ==========       =========
1               map1             eth1, eth2
```

```
CVLAN ID        SVLAN ID
========        ========
1               10

PB2#show cvlan registration table bridge 1
Bridge          Table Name       Port List
======          ==========       =========
1               map1             eth1, eth2
CVLAN ID        SVLAN ID
========        ========
1               10
```

Show Run for HOST-1

```
PB1#show running-config
!
interface eth1
channel-group 3 mode active
lacp timeout long
!
interface eth2
channel-group 3 mode active
lacp timeout lg
!
interface po3
mac-address 0000.0000.0000
no multicast
!
end
```

Show Run for PB1

```
2QA136#show running-config
!
bridge 1 protocol provider-mstp edge
!
vlan database
 vlan 10 type service point-point bridge 1 name VLAN0010
 vlan 10 type service point-point bridge 1 state enable
!
cvlan registration table map1 bridge 1
 cvlan 1 svlan 10
!
interface eth0
 switchport
 bridge-group 1
 switchport mode provider-network
 switchport provider-network allowed vlan add 10
!
interface eth1
 switchport
```



```
 bridge-group 1
 switchport mode customer-edge hybrid
 switchport mode customer-edge hybrid acceptable-frame-type all
 switchport customer-edge vlan registration map1
 channel-group 2 mode passive
 lacp timeout long
!
interface eth2
 switchport
 bridge-group 1
 switchport mode customer-edge hybrid
 switchport mode customer-edge hybrid acceptable-frame-type all
 switchport customer-edge vlan registration map1
 channel-group 2 mode passive
 lacp timeout long
!
interface po2
 mac-address 0000.0000.0000
 switchport
 bridge-group 1
 switchport mode customer-edge hybrid
 switchport mode customer-edge hybrid acceptable-frame-type all
 switchport customer-edge vlan registration map1
 no multicast
!
end
```

Show Run for PB2

```
2QA4#show running-config
!
bridge 1 protocol provider-mstp edge
!
vlan database
 vlan 10 type service point-point bridge 1 name VLAN0010
 vlan 10 type service point-point bridge 1 state enable
!
cvlan registration table map1 bridge 1
 cvlan 1 svlan 10
!
interface eth0
 switchport
 bridge-group 1
 switchport mode provider-network
 switchport provider-network allowed vlan add 10
!
interface eth1
 switchport
 bridge-group 1
 switchport mode customer-edge hybrid
```

```
 switchport mode customer-edge hybrid acceptable-frame-type all
 switchport customer-edge vlan registration map1
 channel-group 4 mode passive
 lacp timeout long
!
interface eth2
 switchport
 bridge-group 1
 switchport mode customer-edge hybrid
 switchport mode customer-edge hybrid acceptable-frame-type all
 switchport customer-edge vlan registration map1
 channel-group 4 mode passive
 lacp timeout long
!
interface po4
 mac-address 0000.0000.0000
 switchport
 bridge-group 1
 switchport mode customer-edge hybrid
 switchport mode customer-edge hybrid acceptable-frame-type all
 switchport customer-edge vlan registration map1
 no multicast
!
end
```

Show Run for HOST-2

```
2QA71#show running-config
!
interface eth1
 channel-group 3 mode active
 lacp timeout long
!
interface eth2
 channel-group 3 mode active
 lacp timeout long
!
interface po3
 mac-address 0000.0000.0000
 no multicast
!
end
```

Verification for Peering

Host1

`HOST-1#configure terminal`	Enter `Configure` mode for the router.
`HOST-1(config)#interface po1`	Enter `Interface` mode.
`HOST-1(config-if)#no switchport`	Configure the interface as Layer 3.

`HOST-1(config-if)#ip address 3.3.3.1/2`	Configure IP address to `po1` (aggregated interface).
`HOST-1(config-if)#exit`	Exit `Interface` mode.

Host2

`HOST-2#configure terminal`	Enter `Configure` mode for the router.
`HOST-2(config)#interface po3`	Enter `Interface` mode.
`HOST-1(config-if)#no switchport`	Configure the interface as Layer 3.
`HOST-2(config-if)#ip address 3.3.3.2/24`	Configure IP address to `po3` (aggregated interface).
`HOST-2(config-if)#exit`	Exit `Interface` mode.

Aggregated interface allows packets to pass through.

```
[root@Host-2 root]#ping 3.3.3.1
  PING 3.3.3.1 (3.3.3.1) 56(84) bytes of data.
  64 bytes from 3.3.3.1: icmp_seq=1 ttl=64 time=0.606 ms
  64 bytes from 3.3.3.1: icmp_seq=2 ttl=64 time=0.551 ms
```

DOT1.X Tunneling in UNI Configuration

Topology

UNI can be configured to tunnel the layer 2 protocol DOT1.X. When DOT1.X is present, a tunneling xsupplicant on one side of a provider network is authenticated by RADIUS server, which is in other side of the provider network. The customer-edge port (UNI) of the Provider Network is configured to tunnel DOT1.X packets.

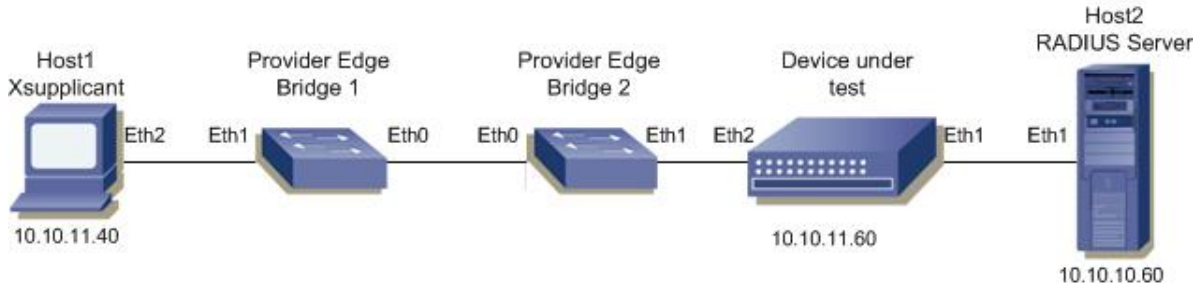


Figure 11-14: Topology for DOT1.X Tunneling in UNI

PB1

`PB1#configure terminal`	Enter `Configure` mode for the router.
`PB1(config)#bridge 1 protocol provider-mstp edge`	Configure the bridge as a provider-MSTP edge bridge.
`PB1(config)#vlan 10 type service point-to-point bridge 1 state enable`	Configure VLAN 10 as service VLAN (point-to-point EVC) and associate it with bridge 1.
`PB1(config)#cvlan registration table map1 bridge 1`	Create a CVLAN registration table, map1, and associate it with bridge 1.

`PB1(config-cvlan-registration)#cvlan 1 svlan 10`	Map CVLAN 1 (default VLAN) with SVLAN 10.
`PB1(config-cvlan-registration)#exit`	Exit `CVLAN registration` mode.
`PB1(config)#interface eth1`	Enter `Interface` mode for eth1.
`PB1(config-if)#switchport`	Configure the interface as Layer 2.
`PB1(config-if)#bridge-group 1`	Associate it with bridge 1.
`PB1(config-if)#switchport mode customer-edge hybrid`	Configure the interface as customer-edge port in hybrid mode.
`PB1(config-if)#switchport customer-edge vlan registration map1`	Associate map1 (the CVLAN registration table) with the interface.
`PB1(config-if)#l2protocol dot1x tunnel vlan 10`	Configure the interface to tunnel `dot1x` packets.
`PB1(config-if)#exit`	Exit `Interface` mode.
`PB1(config)#interface eth0`	Enter `Interface` mode
`PB1(config-if)#switchport`	Configure the interface as Layer 2.
`PB1(config-if)#bridge-group 1`	Associate it with bridge 1.
`PB1(config-if)#switchport mode provider-network`	Configure the interface as provider-network port.
`PB1(config-if)#switchport provider-network allowed vlan add 10`	Configure the provider-network port to allow SVLAN 10.
`PB1(config-if)#exit`	Exit `Interface` mode

PB2

`PB2#configure terminal`	Enter `Configure` mode for the router.
`PB2(config)#bridge 1 protocol provider-mstp edge`	Configure the bridge as a provider-MSTP edge bridge.
`PB2(config)#vlan 10 type service point-to-point bridge 1 state enable`	Configure VLAN 10 as a service VLAN (point-to-point EVC) and associate it with bridge 1.
`PB2(config)#cvlan registration table map1 bridge 1`	Create a CVLAN registration table, map1, and associate it with bridge 1.
`PB2(config-cvlan-registration)#cvlan 1 svlan 10`	Map CVLAN 1 (default VLAN) to SVLAN 10.
`PB2(config-cvlan-registration)#exit`	Exit `CVLAN-registration` mode.
`PB2(config)#interface eth1`	Enter `Interface` mode for eth1.
`PB2(config-if)#switchport`	Configure the interface as Layer 2.
`PB2(config-if)#bridge-group 1`	Associate it with bridge 1.
`PB2(config-if)#switchport mode customer-edge hybrid`	Configure the interface as customer-edge port in hybrid mode.
`PB2(config-if)#switchport customer-edge vlan registration map1`	Associate map1 (the CVLAN registration table) with the interface.
`PB2(config-if)#l2protocol dot1x tunnel vlan 10`	Configure the interface to tunnel DOT1.X packets.
`PB2(config-if)#exit`	Exit `Interface` mode.
`PB2(config)#interface eth0`	Enter the `Interface` mode for eth0.

`PB2(config-if)#switchport`	Configure the interface as Layer 2.
`PB2(config-if)#bridge-group 1`	Associate it with bridge 1.
`PB2(config-if)#switchport mode provider-network`	Configure the interface as provider-network port.
`PB2(config-if)#switchport provider-network allowed vlan add 10`	Configure the provider-network port to allow SVLAN 10.
`PB2(config-if)#exit`	Exit `Interface` mode.

DUT

`DUT#configure terminal`	Enter `Configure` mode for the router
`DUT(config)#radius-server host 10.10.10.40 auth-port 1812 key authd`	Configure the RADIUS server parameters: • `10.10.10.40`–IP address of the remote RADIUS server. • `1812`—UDP destination port for authentication requests. The default is 1812, and the range is <0 to 65536>. • `authd`—Authentication key used between the DUT and the RADIUS daemon running on the RADIUS server.
`DUT(config)#dot1x system-auth-ctrl`	Enable IEEE 802.1x authentication globally on the DUT.
`DUT(config)#interface eth1`	Enter `Interface` mode for eth1.
`DUT(config-if)#ip address 10.10.10.70/24`	Configure IP address to the interface.
`DUT(config-if)#exit`	Exit `Interface` mode.
`DUT(config)#interface eth2`	Enter `Interface` mode for eth2.
`DUT(config)#ip address 10.10.11.70/24`	Configure IP address to the interface.
`DUT(config-if)#dot1x port-control auto`	Enable IEEE 802.1x authentication on the port.
`DUT(config-if)#dot1x port-control dir in`	Configure the interface to allow control packets from xsupplicant.
`DUT(config-if)#dot1x protocol-version 1`	Configure the DOT1.X protocol version as 1.
`DUT(config-if)#exit`	Exit `Interface` mode

Host2 Radius Server

`[root@RADIUS-SERVER root]#ifconfig eth1 10.10.10.40 broadcast 10.10.10.255 netmask 255.255.255.0`	Configure IP address of interface eth1 on RADIUS Server.
`[root@RADIUS-SERVER root]#route add -net 10.10.11.0 netmask 255.255.255.0 gw 10.10.10.60`	Configure route to xsupplicant (10.10.11.40) through the eth1 of DUT (10.10.10.60) as the gateway.

Host1 Xsupplicant

`[root@XSUPPLICANT1 root]#ifconfig eth2 10.10.11.40 broadcast 10.10.11.255 netmask 255.255.255.0`	Configure IP address of interface eth2 on RADIUS Server.
`[root@XSUPPLICANT1 root]#route add -net 10.10.10.0 netmask 255.255.255.0 gw 10.10.11.60`	Configure route to RAIDUS server (10.10.10.40) through eth2 of DUT (10.10.11.60) as the gateway.

1. Start Radius daemon on Radius server:

```
[root@RADIUS-SERVER root]#radiusd -X
```

2. Start xsupplicant daemon in xsupplicant:

```
[root@XSUPPLICANT1 root]#xsupplicant -c /usr/local/etc/1x/md5-example.conf -f -d s
```

Validation

```
DUT#show dot1x all
802.1X Port-Based Authentication Enabled
 RADIUS server address: 10.10.10.40:1812
  Next radius message id: 2
  RADIUS client address: not configured
802.1X info for interface eth0
  Supplicant name: testuser
  Supplicant address: 0008.c73b.05ce
  portEnabled: true - portControl: Auto
  portStatus: Authorized - currentId: 17
  reAuthenticate: disabled
  reAuthPeriod: 3600
  abort:F fail:F start:F timeout:F success:T
  PAE: state: Authenticated - portMode: Auto
  PAE: reAuthCount: 0 - rxRespId: 0
  PAE: quietPeriod: 60 - reauthMax: 2 - txPeriod: 30
  BE: state: Idle - reqCount: 0 - idFromServer: 16
  BE: suppTimeout: 30 - serverTimeout: 30 - maxReq: 2
  CD: adminControlledDirections: in - operControlledDirections: in
  CD: bridgeDetected: false
  KR: rxKey: false
  KT: keyAvailable: false - keyTxEnabled: false
```

Verification

Xsupplicant should be able to ping RADIUS Server.

```
[root@XSUPPLICANT1 root]#ping 10.10.10.40
  PING 3.3.3.1 (3.3.3.1) 56(84) bytes of data.
  64 bytes from 10.10.10.40: icmp_seq=1 ttl=64 time=0.606 ms
  64 bytes from 10.10.10.40: icmp_seq=2 ttl=64 time=0.551 ms
```

Bundling in UNI Configuration

Topology

A UNI can be configured for bundling. A CVLAN registration table with only one SVLAN is supported on the UNI configured for bundling. Multiple CVLANs can be mapped to the SVLAN.

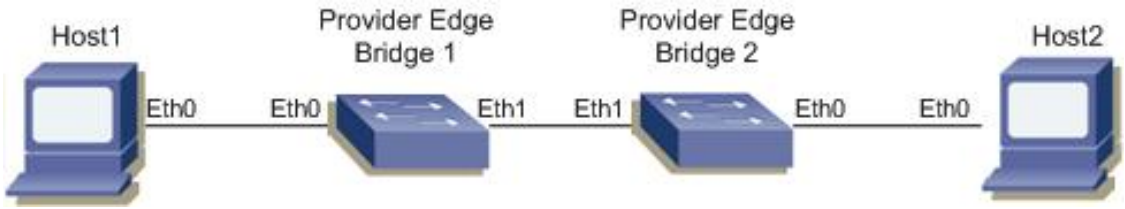


Figure 11-15: Bundling in UNI Topology

PB1

`PB1#configure terminal`	Enter `Configure` mode for the router.
`PB1(config)#bridge 1 protocol provider-mstp edge`	Configure the bridge as a provider-MSTP edge bridge.
`PB1(config)#vlan 2 type customer bridge 1 state enable`	Configure VLAN 2 as a customer VLAN and associate it with bridge 1.
`PB1(config)#vlan 3 type customer bridge 1 state enable`	Configure VLAN 3 as a customer VLAN and associate it with bridge 1.
`PB1(config)#vlan 4 type customer bridge 1 state enable`	Configure VLAN 4 as a customer VLAN and associate it with bridge 1.
`PB1(config)#vlan 20 type service point-point bridge 1 state enable`	Configure VLAN 20 as service VLAN (point-to-point EVC) and associate it with bridge 1.
`PB1(config)#vlan 30 type service point-to-point bridge 1 state enable`	Configure VLAN 30 as service VLAN (point-to-point EVC) and associate it with bridge 1.
`PB1(config)#cvlan registration table map1 bridge 1`	Create a CVLAN registration table, map1, and associate it with bridge 1.
`PB1(config-cvlan-registration)#cvlan 2 svlan 20`	Map CVLAN 2 (default VLAN) with SVLAN 20.
`PB1(config-cvlan-registration)#cvlan 3 svlan 20`	Map CVLAN 3 (default VLAN) with SVLAN 20.
`PB1(config-cvlan-registration)#exit`	Exit `CVLAN-registration` mode.
`PB1(config)#interface eth0`	Enter `Interface` mode for eth0.
`PB1(config-if)#switchport`	Configure the interface as Layer 2.
`PB1(config-if)#bridge-group 1`	Associate it with bridge 1.
`PB1(config-if)#switchport mode customer-edge hybrid`	Configure the interface as customer-edge port in hybrid mode.
`PB1(config-if)##switchport customer-edge hybrid allowed vlan add 2 egress-tagged enable`	Configure the customer-edge port to allow CVLAN 2, with egress-tagged enabled.

`PB1(config-if)##switchport customer-edge hybrid allowed vlan add 3 egress-tagged enable`	Configure the customer-edge port to allow CVLAN 3, with egress-tagged enabled.
`PB1(config-if)##switchport customer-edge hybrid allowed vlan add 4 egress-tagged enable`	Configure the customer-edge port to allow CVLAN 4, with egress-tagged enabled.
`PB1(config-if)#switchport customer-edge vlan registration map1`	Associate map1 (the CVLAN registration table) with the interface.
`PB1(config-if)#ethernet uni bundle`	Configure the UNI for bundling.
`PB1(config-if)#exit`	Exit `Interface` mode.
`PB1(config)#interface eth1`	Enter `Interface` mode for eth1.
`PB1(config-if)#switchport`	Configure the interface as Layer 2.
`PB1(config-if)#bridge-group 1`	Associate it with bridge 1.
`PB1(config-if)#switchport mode provider-network`	Configure the interface as a provider-network port.
`PB1(config-if)#switchport provider-network allowed vlan add 20`	Configure the provider-network port to allow SVLAN 20.
`PB1(config-if)#switchport provider-network allowed vlan add 30`	Configure the provider-network port to allow SVLAN 30.
`PB1(config-if)#exit`	Exit `Interface` mode.

PB2

`PB2#configure terminal`	Enter `Configure` mode for the router.
`PB2(config)#bridge 1 protocol provider-mstp edge`	Configure the bridge as a provider-MSTP edge bridge.
`PB2(config)#vlan 2 type customer bridge 1 state enable`	Configure VLAN 2 as a customer VLAN and associate it with bridge 1.
`PB2(config)#vlan 3 type customer bridge 1 state enable`	Configure VLAN 3 as a customer VLAN and associate it with bridge 1.
`PB2(config)#vlan 4 type customer bridge 1 state enable`	Configure VLAN 4 as a customer VLAN and associate it with bridge 1.
`PB2(config)#vlan 20 type service point-point bridge 1 state enable`	Configure VLAN 20 as service VLAN (point-to-point EVC) and associate it with bridge 1.
`PB2(config)#vlan 30 type service point-to-point bridge 1 state enable`	Configure VLAN 30 as service VLAN (point-to-point EVC) and associate it with bridge 1.
`PB2(config)#cvlan registration table map1 bridge 1`	Create a CVLAN registration table, map1, and associate it with bridge 1.
`PB2(config-cvlan-registration)#cvlan 2 svlan 20`	Map CVLAN 2 (default VLAN) to SVLAN 20.
`PB2(config-cvlan-registration)#cvlan 3 svlan 20`	Map CVLAN 3 (default VLAN) to SVLAN 20.
`PB2(config-cvlan-registration)#exit`	Exit `CVLAN registration` mode.
`PB2(config)#interface eth0`	Enter `Interface` mode for eth0.
`PB2(config-if)#switchport`	Configure the interface as Layer 2.
`PB2(config-if)#bridge-group 1`	Associate it with bridge 1.

`PB2(config-if)#switchport mode customer-edge hybrid`	Configure the interface as customer-edge port in hybrid mode.
`PB2(config-if)##switchport customer-edge hybrid allowed vlan add 2 egress-tagged enable`	Configure the customer-edge port to allow CVLAN 2, with egress-tagged enabled.
`PB2(config-if)##switchport customer-edge hybrid allowed vlan add 3 egress-tagged enable`	Configure the customer-edge port to allow CVLAN 3, with egress-tagged enabled.
`PB2(config-if)##switchport customer-edge hybrid allowed vlan add 4 egress-tagged enable`	Configure the customer-edge port to allow CVLAN 4, with egress-tagged enabled.
`PB2(config-if)#switchport customer-edge vlan registration map1`	Associate map1 (the CVLAN registration table) with the interface.
`PB2(config-if)#ethernet uni bundle`	Configure the UNI for bundling.
`PB2(config-if)#exit`	Exit `Interface` mode.
`PB2(config)#interface eth1`	Enter `Interface` mode for eth1.
`PB2(config-if)#switchport`	Configure the interface as Layer 2.
`PB2(config-if)#bridge-group 1`	Associate it with bridge 1.
`PB2(config-if)#switchport mode provider-network`	Configure the interface as provider-network port.
`PB2(config-if)#switchport provider-network allowed vlan add 20`	Configure the provider-network port to allow SVLAN 20.
`PB2(config-if)#switchport provider-network allowed vlan add 30`	Configure the provider-network port to allow SVLAN 30.
`PB2(config-if)#exit`	Exit `Interface` mode.

Host1

`[root@HOST-1 root]#vconfig add eth0 2`	Configure tagged interface for VLAN 2.
`[root@HOST-1 root]#ifconfig eth0.2 2.2.2.1`	Configure IP address for VLAN 2 tagged interface.
`[root@HOST-1 root]#vconfig add eth0 3`	Configure tagged interface for VLAN 3.
`[root@HOST-1 root]#ifconfig eth0.3 3.3.3.1`	Configure IP address for VLAN 3 tagged interface.
`[root@HOST-1 root]#vconfig add eth0 4`	Configure tagged interface for VLAN 4.
`[root@HOST-1 root]#ifconfig eth0.4 4.4.4.1`	Configure IP address for VLAN 4 tagged interface.

Host2

[

`[root@HOST-2 root]#vconfig add eth0 2`	Configure tagged interface for VLAN 2.
`[root@HOST-2 root]#ifconfig eth0.2 2.2.2.2`	Configure IP address for VLAN 2 tagged interface.
`[root@HOST-2 root]#vconfig add eth0 3`	Configure tagged interface for VLAN 3.
`[root@HOST-2 root]#ifconfig eth0.3 3.3.3.2`	Configure IP address for VLAN 3 tagged interface.
`[root@HOST-2 root]#vconfig add eth0 4`	Configure tagged interface for VLAN 4.
`[root@HOST-2 root]#ifconfig eth0.4 4.4.4.2`	Configure IP address for VLAN 4 tagged interface.

Validation

Show Run of PB1

```
PB1#show running-config
!
bridge 1 protocol provider-mstp edge
!
vlan database
 vlan 2 type customer bridge 1 name VLAN0002
 vlan 2 type customer bridge 1 state enable
 vlan 3 type customer bridge 1 name VLAN0003
 vlan 3 type customer bridge 1 state enable
 vlan 4 type customer bridge 1 name VLAN0004
 vlan 4 type customer bridge 1 state enable
 vlan 20 type service point-point bridge 1 name VLAN0020
 vlan 20 type service point-point bridge 1 state enable
 vlan 30 type service point-point bridge 1 name VLAN0030
 vlan 30 type service point-point bridge 1 state enable
!
cvlan registration table map2 bridge 1
 cvlan 2 svlan 20
 cvlan 3 svlan 20
!
interface eth1
 switchport
 bridge-group 1
 switchport mode provider-network
 switchport provider-network allowed vlan add 20
 switchport provider-network allowed vlan add 30
!
interface eth0
 switchport
 bridge-group 1
 switchport mode customer-edge hybrid
 switchport mode customer-edge hybrid acceptable-frame-type all
 switchport customer-edge hybrid allowed vlan add 2 egress-tagged enable
 switchport customer-edge hybrid allowed vlan add 3 egress-tagged enable
 switchport customer-edge hybrid allowed vlan add 4 egress-tagged enable
 switchport customer-edge vlan registration map1
 ethernet uni bundle
!
end
```

Show Run of PB2

```
PB1#show running-config
!
bridge 1 protocol provider-mstp edge
!
```

```
vlan database
 vlan 2 type customer bridge 1 name VLAN0002
 vlan 2 type customer bridge 1 state enable
 vlan 3 type customer bridge 1 name VLAN0003
 vlan 3 type customer bridge 1 state enable
 vlan 4 type customer bridge 1 name VLAN0004
 vlan 4 type customer bridge 1 state enable
 vlan 20 type service point-point bridge 1 name VLAN0020
 vlan 20 type service point-point bridge 1 state enable
 vlan 30 type service point-point bridge 1 name VLAN0030
 vlan 30 type service point-point bridge 1 state enable
!
cvlan registration table map2 bridge 1
 cvlan 2 svlan 20
 cvlan 3 svlan 20
!
interface eth1
 switchport
 bridge-group 1
 switchport mode provider-network
 switchport provider-network allowed vlan add 20
 switchport provider-network allowed vlan add 30
!
interface eth0
 switchport
 bridge-group 1
 switchport mode customer-edge hybrid
 switchport mode customer-edge hybrid acceptable-frame-type all
 switchport customer-edge hybrid allowed vlan add 2 egress-tagged enable
 switchport customer-edge hybrid allowed vlan add 3 egress-tagged enable
 switchport customer-edge hybrid allowed vlan add 4 egress-tagged enable
 switchport customer-edge vlan registration map1
 ethernet uni bundle
!
end
```

Verification for UNI

1. Verify whether frames with C-VLAN-ID, which is mapped to S-VLAN, passes through the UNI.

   Ping should go through eth0.2 of HOST-1 and eth0.2 of HOST-2:

   ```
   [root@HOST-1 root]#ping 2.2.2.2
   PING 2.2.2.2 (2.2.2.2) 56(84) bytes of data.
   64 bytes from 2.2.2.2: icmp_seq=1 ttl=64 time=1.41 ms
   64 bytes from 2.2.2.2: icmp_seq=2 ttl=64 time=0.776 ms

   --- 2.2.2.2 ping statistics ---
   2 packets transmitted, 2 received, 0% packet loss, time 1005ms
   rtt min/avg/max/mdev = 0.776/1.096/1.417/0.322 ms
   ```

Ping should go through eth0.3 of HOST-1 and eth0.3 of HOST-2:

```
[root@HOST-1 root]#ping 3.3.3.2
PING 3.3.3.2 (3.3.3.2) 56(84) bytes of data.
64 bytes from 3.3.3.2: icmp_seq=1 ttl=64 time=1.42 ms
64 bytes from 3.3.3.2: icmp_seq=2 ttl=64 time=0.752 ms

--- 3.3.3.2 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1009ms
rtt min/avg/max/mdev = 0.752/1.089/1.426/0.337 ms
```

2. Verify whether frames with C-VLAN-ID, which is mapped to S-VLAN, passes through the UNI.

   Ping should not go through eth0.4 of HOST-1 and eth0.4 of HOST-2:

```
[root@HOST-1 root]#ping 4.4.4.2
PING 4.4.4.2 (4.4.4.2) 56(84) bytes of data.
From 4.4.4.1 icmp_seq=1 Destination Host Unreachable
From 4.4.4.1 icmp_seq=2 Destination Host Unreachable
From 4.4.4.1 icmp_seq=3 Destination Host Unreachable

--- 2.2.2.3 ping statistics ---
4 packets transmitted, 0 received, +3 errors, 100% packet loss, time 3028ms
, pipe 3
```

3. Verify whether CVLAN registration table is not being modified in contradiction to configuration of UNI to which it is associated.

4. Modify CVLAN registration table (map1 of PB1) and try mapping CVLAN 4 to SVLAN 30.

   Map1 should not be modified as it is associated to customer-edge port (eth0 of PB1), which is configured for bundling.

```
PB1#configure terminal
```

5. Enter configuration commands, one per line. End with CNTL/Z.

```
PB1(config)#cvlan registration table map1 bridge 1
PB1(config-cvlan-registration)#cvlan 4 svlan 30
% CVLAN Map Contradicts the service attribute
PB1(config-cvlan-registration)#
```

CHAPTER 12 MC-LAG Configuration

This chapter contains a complete example of Multi-Chassis Link Aggregation (MC-LAG) configuration.

MC-LAG (also called DRNI, Distributed Resilient Network Interconnect) expands the concept of link aggregation so that it provides node-level redundancy by allowing two or more nodes to share a common LAG endpoint. It emulates multiple nodes to represent as a single logical node to the remote node running Link aggregation. As a result even if one of the nodes is down there exists a path to reach the destination via other nodes.

Note: MC-LAG is not supported for ZebIC releases.

Topology

As shown in Figure 12-16, switch s1 and switch s2 share a common endpoint in switch s3. Switches s1 and s2 are a single logical switch to switch s3. Even if switch s1 or switch s2 is down, there exists a path from switch s3 to reach other destinations.

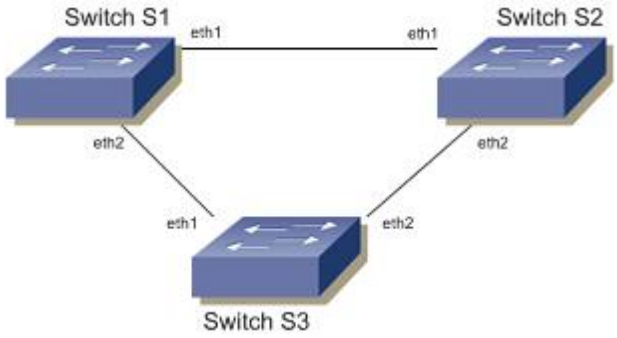


Figure 12-16: MC-LAG Topology

S1

`#configure terminal`	Enter configure mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Create STP bridge 1.
`(config)#vlan 2-100 bridge 1 state enable`	Create VLANs 2 to 100.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#switchport`	Configure the interface as Layer 2
`(config-if)#bridge-group 1`	Associate the interface with bridge group 1.
`(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`(config-if)#switchport trunk allowed vlan all`	Enable all VLAN identifiers on this interface.
`(config-if)#channel-group 1 mode active`	Add this interface to channel group 1 and enable link aggregation so that it can be selected for aggregation by the local system.
`(config-if)#exit`	Exit interface mode.

(config)#int po1	Enter interface mode.
(config-if)#mlag 1	Assign an MLAG-ID to the port channel. One port-channel interface can be bound with an MLAG instance.
(config-if)#exit	Exit interface mode.
(config)#mlag configuration 1	Enters MLAG configuration mode to configure Multi chassis Link aggregation features.
(config-mlag)#portal-system-number 1	Assign the portal system number used to configure portal address, which helps to identify the MLAG domain.
(config-mlag)#portal-name test1	Specify a locally significant name for distributed relay.
(config-mlag)#portal-priority 1	Specify the priority value associated with the portal system.
(config-mlag)#portal-address 0000.0000.0001	Set the portal address, which helps to identify the MLAG domain.
(config-mlag)#portal-topology 2-portal	Set the portal topology.
(config-mlag)#conversation alloc-mode auto	Set5 the conversation allocation mode to automatic.
(config-mlag)#intra-portal-link eth1 neighbor-portal-system 2	Configure the interface that connects two portal systems and a neighbor portal system connected through the IPP.
(config-mlag)#exit	Enter configure mode.

S2

#configure terminal	Enter configure mode.
(config)#bridge 1 protocol ieee vlan-bridge	Create STP bridge 1.
(config)#vlan 2-100 bridge 1 state enable	Create VLANs 2 to 100.
(config)#interface eth2	Enter interface mode.
(config-if)#switchport	Configure the interface as Layer 2.
(config-if)#bridge-group 1	Associate the interface with bridge group 1.
(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode.
(config-if)#switchport trunk allowed vlan all	Enable all VLAN identifiers on this port.
(config-if)#channel-group 1 mode active	Add this interface to channel group 1 and enable link aggregation so that it can be selected for aggregation by the local system.
(config-if)#exit	Exit interface mode.
(config)#int po1	Enter interface mode.
(config-if)#mlag 1	Assigns an MLAG-ID to a port channel. One port-channel interface can be bound with an MLAG instance.
(config-if)#exit	Exit interface mode.
(config)#mlag configuration 1	Enters MLAG configuration mode to configure Multi chassis Link aggregation features.
(config-mlag)#portal-system-number 2	Assigns portal system number used to configure portal address, which helps to identify the MLAG domain
(config-mlag)#portal-name test1	Set a locally significant name for distributed relay.
(config-mlag)#portal-priority 1	Set the priority value associated with the portal system.

(config-mlag)#portal-address 0000.0000.0001	Set the portal address, which helps to identify the MLAG domain.
(config-mlag)#portal-topology 2-portal	Set the portal topology.
(config-mlag)#conversation alloc-mode auto	Set the conversation allocation mode to automatic.
(config-mlag)#intra-portal-link eth1 neighbor-portal-system 1	Configure the interface that connects two portal systems and neighbor portal system connected through the IPP.
(config-mlag)#exit	Enter configure mode.

S3

#configure terminal	Enter configure mode.
(config)#bridge 1 protocol ieee vlan-bridge	Create STP bridge 1.
(config)#vlan 2-100 bridge 1 state enable	Create VLANs 2 to 100.
(config)#interface eth1	Enter interface mode.
(config-if)#switchport	Configure the interface as Layer 2.
(config-if)#bridge-group 1	Associate the interface with bridge group 1.
(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode.
(config-if)#switchport trunk allowed vlan all	Enable all VLAN identifiers on this port.
(config-if)#channel-group 1 mode active	Add this interface to channel group 1 and enable link aggregation so that it can be selected for aggregation by the local system.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Enter interface mode.
(config-if)#switchport	Configure the interface as Layer 2.
(config-if)#bridge-group 1	Associate the interface with bridge group 1.
(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode.
(config-if)#switchport trunk allowed vlan all	Enable all VLAN identifiers on this port.
(config-if)#channel-group 1 mode active	Add this interface to channel group 1 and enable link aggregation so that it may be selected for aggregation by the local system.
(config-if)#exit	Exit interface mode.

Validation

S1

```
#show mlag 1 summary
MLAG Configuration :
MLAG-ID            : 1
------------------------------------
```

```
Portal-System-Number : 1
Portal-Address       : 0000.0000.0001
Portal-Priority      : 1
Mapped Aggregator    : po1
Gateway-Algorithm    : Distribution based on C-VIDs
Port-Algorithm       : Distribution based on C-VIDs
Gateway-Digest       : 799710171191251261187516818511878126107 21
Port-Digest          : 123103220137132113180167127532251208115821838
Dest Mac address     : non-TPMR-group-address

Topology             : Two portal system connected by 1 IPL
Conv Alloc Mode      : Automatic

Master Portal System
Mlag Bandwidth       : 250000000

#show mlag 1 gateway-conversation-id

Gateway Conversation  Portal-System Priority
1    - 50             1             1
1    - 50             2             2
51   - 100            2             1
51   - 100            1             2

#show mlag 1 port-conversation-id

Port Conversation    Port-priority   Port-number Portal-System Priority
1    - 50            32768           6           1             1
1    - 50            32768           3           2             2
51   - 100           32768           3           2             1
51   - 100           32768           6           1             2

#show mlag 1 detail

Portal-System-Number : 1
Portal-Address       : 0000.0000.0001
Portal-Priority      : 1
Mapped Aggregator    : po1
Gateway-Algorithm    : Distribution based on C-VIDs
Port-Algorithm       : Distribution based on C-VIDs
Gateway-Digest       : 799710171191251261187516818511878126107 21
Port-Digest          : 123103220137132113180167127532251208115821838
Dest Mac address     : non-TPMR-group-address

Topology             : Two portal system connected by 1 IPL
Conv Alloc Mode      : Automatic

Master Portal System
Mlag Bandwidth       : 250000000
```

```
Intra Portal Interface          : eth1
Intra Portal Operational Status : Active
Intra Portal Admin Status       : Enabled
Home DRCP State:
 Home Gateway      : Operational
 Neighbor Gateway  : Operational
 Other Gateway     : Non-Operational
 IPP Activity      : Active
 DRCP Timeout      : Long Timeout
 Gateway Sync      : IN_SYNC
 Port Sync         : IN_SYNC
 Expired           :
Neighbour DRCP State:
 Home Gateway      : Operational
 Neighbor Gateway  : Operational
 Other Gateway     : Non-Operational
 IPP Activity      : Active
 DRCP Timeout      : Long Timeout
 Gateway Sync      : IN_SYNC
 Port Sync         : IN_SYNC
 Expired           :
State Machine States
 Receive state     : Current
 Periodic Tx state : Slow Periodic
 IPP Gateway State : IPP Gateway Update
 IPP Port State    : IPP Port Update

 Gateway Conversations Direction:
 51-100

 Port Conversations Passes:
 51-100

Portal State Machine State
 Portal System State : Portal System Update
 Gateway State       : Gateway Update
 Port State          : DRNI Port Update

Gateway Conversation  Portal-System Priority
1    - 50             1             1
1    - 50             2             2
51   - 100            2             1
51   - 100            1             2

Port Conversation    Port-priority   Port-number Portal-System Priority
1    - 50            32768           6           1             1
1    - 50            32768           3           2             2
51   - 100           32768           3           2             1
51   - 100           32768           6           1             2
```

```
Portal Gateway Conversation
 1-50

Portal Port conversation
 1-50

#show drcpdu statistics
Unknown DRCPDU received on the system : 0
Unknown DRCPDU frames received on portal :0
Intra Portal Interface  eth1
Number of valid DRCPDU Received   : 28
Number of invalid DRCPDU Received : 0
Number of DRCPDU Transmitted      : 29
```

S2

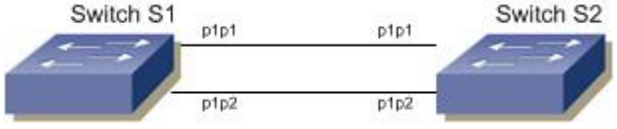
```
#show mlag 1 summary
MLAG Configuration :
MLAG-ID            : 1
-------------------------------------

Portal-System-Number : 2
Portal-Address       : 0000.0000.0001
Portal-Priority      : 1
Mapped Aggregator    : po1
Gateway-Algorithm    : Distribution based on C-VIDs
Port-Algorithm       : Distribution based on C-VIDs
Gateway-Digest       : 799710171191251261187516818511878126107 21
Port-Digest          : 123103220137132113180167127532251208115821838
Dest Mac address     : non-TPMR-group-address

Topology             : Two portal system connected by 1 IPL
Conv Alloc Mode      : Automatic

Slave Portal System
Ipp Connecting to Master : eth1
Mlag Bandwidth       : 250000000

#show mlag 1 gateway-conversation-id

Gateway Conversation  Portal-System Priority
1    - 50             1             1
1    - 50             2             2
51   - 100            2             1
51   - 100            1             2

#show mlag 1 port-conversation-id

Port Conversation    Port-priority   Port-number Portal-System Priority
1    - 50            32768           6           1             1
```

```
1    - 50            32768           3           2            2
51   - 100           32768           3           2            1
51   - 100           32768           6           1            2

#show  mlag 1 detail

Portal-System-Number : 2
Portal-Address       : 0000.0000.0001
Portal-Priority      : 1
Mapped Aggregator    : po1
Gateway-Algorithm    : Distribution based on C-VIDs
Port-Algorithm       : Distribution based on C-VIDs
Gateway-Digest       : 799710171191251261187516818511878126107 21
Port-Digest          : 123103220137132113180167127532251208115821838
Dest Mac address     : non-TPMR-group-address

Topology             : Two portal system connected by 1 IPL
Conv Alloc Mode      : Automatic

Slave Portal System
Ipp Connecting to Master : eth1
Mlag Bandwidth       : 250000000

Intra Portal Interface          : eth1
Intra Portal Operational Status : Active
Intra Portal Admin Status       : Enabled
Home DRCP State:
Home Gateway      : Operational
Neighbor Gateway  : Operational
Other Gateway     : Non-Operational
IPP Activity      : Active
DRCP Timeout      : Long Timeout
Gateway Sync      : IN_SYNC
Port Sync         : IN_SYNC
Expired           :
Neighbour DRCP State:
Home Gateway      : Operational
Neighbor Gateway  : Operational
Other Gateway     : Non-Operational
IPP Activity      : Active
DRCP Timeout      : Long Timeout
Gateway Sync      : IN_SYNC
Port Sync         : IN_SYNC
Expired           :
State Machine States
Receive state     : Current
Periodic Tx state : Periodic Tx
IPP Gateway State : IPP Gateway Update
IPP Port State    : IPP Port Update
```

```
Gateway Conversations Direction:
1-50

Port Conversations Passes:
1-50

Portal State Machine State
Portal System State : Portal System Update
Gateway State       : Gateway Update
Port State          : DRNI Port Update

Gateway Conversation  Portal-System Priority
1    - 50             1             1
1    - 50             2             2
51   - 100            2             1
51   - 100            1             2

Port Conversation    Port-priority   Port-number Portal-System Priority
1    - 50            32768           6           1             1
1    - 50            32768           3           2             2
51   - 100           32768           3           2             1
51   - 100           32768           6           1             2

Portal Gateway Conversation
 51-100

Portal Port conversation
 51-100

#show drcpdu statistics
Unknown DRCPDU received on the system : 0
Unknown DRCPDU frames received on portal :0
Intra Portal Interface  eth1
Number of valid DRCPDU Received   : 21
Number of invalid DRCPDU Received : 0
Number of DRCPDU Transmitted      : 28
```

LACPv2 Configuration

Topology



S1

`#configure terminal`	Enter configure mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Create STP bridge 1.
`(config)#vlan 2-40 bridge 1 state enable`	Create VLANs 2 to 40.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#switchport`	Configure the interface as Layer 2.
`(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`(config-if)#switchport trunk allowed vlan all`	Enable all VLAN identifiers on this port.
`(config-if)#channel-group 1 mode active`	Add this interface to channel group 1 and enable link aggregation so that it can be selected for aggregation by the local system.
`(config-if)#exit`	Exit interface mode.
`(config)#interface eth2`	Enter interface mode.
`(config-if)#switchport`	Configure the interface as Layer 2.
`(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.
`(config-if)#switchport trunk allowed vlan all`	Enable all VLAN identifiers on this port.
`(config-if)#channel-group 1 mode active`	Add this interface to channel group 1 and enable link aggregation so that it may be selected for aggregation by the local system.
`(config-if)#exit`	Exit interface mode.
`(config)#interface po1`	Enter interface mode.
`HOST-1(config-if)#no switchport`	Configure the interface as Layer 3.
`(config-if)#bridge-group 1`	Associate the interface po1 with bridge group 1.
`(config-if)#port-conv-id 1 20 port-priority 32768 port-number 7 portal-system 0 priority 1 port-priority 32768 port-number 8 portal-system 0 priority 2`	Configure port conversation identifiers 1 to 20 to the aggregation port which has port 7 and set the priority as 1. Assign the same port conversation identifiers to port 8 with the priority as 2.
`(config-if)#port-conv-id 21 40 port-priority 32768 port-number 8 portal-system 0 priority 1 port-priority 32768 port-number 7 portal-system 0 priority 2`	Configure port conversation identifiers 21 to 40 to the aggregation port which has port 8 and set the priority as 1. Assign the same port conversation identifiers to port 7 with the priority as 2.

S2

`#configure terminal`	Enter configure mode.
`(config)#bridge 1 protocol ieee vlan-bridge`	Create STP bridge 1.
`(config)#vlan 2-40 bridge 1 state enable`	Create VLANs 2 to 40.
`(config)#interface eth1`	Enter interface mode.
`(config-if)#switchport`	Configure the interface as Layer 2.
`(config-if)#switchport mode trunk`	Set the switching characteristics of this interface to trunk mode.

(config-if)#switchport trunk allowed vlan all	Enable all VLAN identifiers on this port.
(config-if)#channel-group 1 mode active	Add this interface to channel group 1 and enable link aggregation so that it can be selected for aggregation by the local system.
(config-if)#exit	Exit interface mode.
(config)#interface eth2	Enter interface mode.
(config-if)#switchport	Configure the interface as Layer 2
(config-if)#switchport mode trunk	Set the switching characteristics of this interface to trunk mode.
(config-if)#switchport trunk allowed vlan all	Enable all VLAN IDs on this port.
(config-if)#channel-group 1 mode active	Add this interface to channel group 1 and enable link aggregation so that it can be selected for aggregation by the local system.
(config-if)#exit	Exit interface mode.
(config)#interface po1	Enter interface mode.
HOST-1(config-if)#no switchport	Configure the interface as Layer 3.
(config-if)#bridge-group 1	Associate the interface po1 with bridge group 1.
(config-if)#port-conv-id 1 20 port-priority 32768 port-number 2 portal-system 0 priority 1 port-priority 32768 port-number 3 portal-system 0 priority 2	Configure port conversation identifiers 1 to 20 to the aggregation port which has port 2 and set the priority as 1. Assign the same port conversation identifiers to port 3 with the priority as 2.
(config-if)#port-conv-id 21 40 port-priority 32768 port-number 3 portal-system 0 priority 1 port-priority 32768 port-number 2 portal-system 0 priority 2	Configure port conversation identifiers 21 to 40 to the aggregation port which has port 3 and set the priority as 1. Assign the same port conversation identifiers to port 2 with the priority as 2.

Validation

S1

```
#show etherchannel summary
% Aggregator po1 1000000
% Admin Key: 0001 - Oper Key 0001
% Discard Wrong Conversation: FALSE
% Port Algo: C-VID
% Port Digest: 218237207806918962135145211157882476223 8
%   Link: p1p2 (8) sync: 1
%   Link: p1p1 (7) sync: 1

#show etherchannel 1
% Aggregator po1 1000000 Admin Key: 0001 - Oper Key 0001
% Actor Port Algorithm: C-VID
% Actor Conversation Port List Digest: 218237207806918962135145211157882476223 8
Port Conversation    Port-priority   Port-number Priority
1    - 20            32768           7           1
1    - 20            32768           8           2
21   - 40            32768           8           1
21   - 40            32768           7           2
% Partner LAG: 0x8000,00-02-a5-4e-d4-8c,0x0001
```

```
% Partner Oper Key 0001
% Partner Oper Port Algorithm: C-VID
% Partner Oper Conversation Port List Digest:
83208532112154720521715822522280182782411 57
% Partner Admin Conversation Port List Digest: 0000000000000000
% Differ Port Algorithm: FALSE
% Differ Port Conversation ID Digest: TRUE

#show etherchannel 1 port-conversation-id
% p1p1
% Conversation ID :  1-20
% p1p2
% Conversation ID :  21-40


#show port etherchannel p1p1
% LACP link info: p1p1 - 7
% LAG ID: 0x8000,00-07-e9-a5-1f-76,0x0001
% Partner oper LAG ID: 0x8000,00-02-a5-4e-d4-8c,0x0001
% Actor Port priority: 0x8000 (32768)
% Admin key: 0x0001 (1) Oper key: 0x0001 (1)
% Physical admin key:(4)
% Receive machine state : Current
% Periodic Transmission machine state : Slow periodic
% Mux machine state : Collecting/Distributing
% Oper state: ACT:1 TIM:0 AGG:1 SYN:1 COL:1 DIS:1 DEF:0 EXP:0
% Destination Mac: Multicast-group-address [01-80-c2-00-00-02]
% Actor version: 2
% ActPar Sync: 1
% Long LACPDU Transmit: FALSE
% Partner oper state: ACT:1 TIM:0 AGG:1 SYN:1 COL:1 DIS:1 DEF:0 EXP:0
% Partner link info: admin port 0
% Partner oper port: 2
% Partner admin LAG ID: 0x0000-00:00:00:00:0000
% Admin state: ACT:1 TIM:0 AGG:1 SYN:0 COL:0 DIS:0 DEF:1 EXP:0
% Partner admin state: ACT:0 TIM:0 AGG:1 SYN:0 COL:0 DIS:0 DEF:1 EXP:0
% Partner version : 2
% Partner ActPar Sync: 1
% Partner system priority - admin:0x0000 - oper:0x8000
% Partner port priority - admin:0x0000 - oper:0x8000
% Aggregator ID: 1000000
```

S2

```
#show etherchannel summary
% Aggregator po1 1000000
% Admin Key: 0001 - Oper Key 0001
% Discard Wrong Conversation: FALSE
% Port Algo: C-VID
% Port Digest: 83208532112154720521715822522280182782411 57
%   Link: p1p1 (2) sync: 1
%   Link: p1p2 (3) sync: 1
```

```
#show etherchannel 1
% Aggregator po1 1000000 Admin Key: 0001 - Oper Key 0001
% Actor Port Algorithm: C-VID
% Actor Conversation Port List Digest: 832085321121547205217158225222801827824115 7
Port Conversation    Port-priority   Port-number Priority
1    - 20            32768           2           1
1    - 20            32768           3           2
21   - 40            32768           3           1
21   - 40            32768           2           2
% Partner LAG: 0x8000,00-07-e9-a5-1f-76,0x0001
% Partner Oper Key 0001
% Partner Oper Port Algorithm: C-VID
% Partner Oper Conversation Port List Digest: 218237207806918962135145211157882476223 8
% Partner Admin Conversation Port List Digest: 0000000000000000
% Differ Port Algorithm: FALSE
% Differ Port Conversation ID Digest: TRUE


#show etherchannel 1 port-conversation-id
% p1p1
% Conversation ID :  1-20
% p1p2
% Conversation ID :  21-40


#show port etherchannel p1p1
% LACP link info: p1p1 - 2
% LAG ID: 0x8000,00-02-a5-4e-d4-8c,0x0001
% Partner oper LAG ID: 0x8000,00-07-e9-a5-1f-76,0x0001
% Actor Port priority: 0x8000 (32768)
% Admin key: 0x0001 (1) Oper key: 0x0001 (1)
% Physical admin key:(4)
% Receive machine state : Current
% Periodic Transmission machine state : Slow periodic
% Mux machine state : Collecting/Distributing
% Oper state: ACT:1 TIM:0 AGG:1 SYN:1 COL:1 DIS:1 DEF:0 EXP:0
% Destination Mac: Multicast-group-address [01-80-c2-00-00-02]
% Actor version: 2
% ActPar Sync: 1
% Long LACPDU Transmit: FALSE
% Partner oper state: ACT:1 TIM:0 AGG:1 SYN:1 COL:1 DIS:1 DEF:0 EXP:0
% Partner link info: admin port 0
% Partner oper port: 7
% Partner admin LAG ID: 0x0000-00:00:00:00:0000
% Admin state: ACT:1 TIM:0 AGG:1 SYN:0 COL:0 DIS:0 DEF:1 EXP:0
% Partner admin state: ACT:0 TIM:0 AGG:1 SYN:0 COL:0 DIS:0 DEF:1 EXP:0
% Partner version : 2
% Partner ActPar Sync: 1
```



```
% Partner system priority - admin:0x0000 - oper:0x8000
% Partner port priority - admin:0x0000 - oper:0x8000
% Aggregator ID: 1000000
```

CHAPTER 13 GMRP Configuration

GMRP (GARP Multicast Registration Protocol) GMRP allows bridges and hosts to register group membership information with the MAC bridges on the network.

Topology

In this example, bridges 2 is forwarding multicast packets coming from the Host to the gmrp-enabled bridge 3. To configure GMRP on a bridge, enable spanning tree on the bridge, disable IGMP snooping, and associate interfaces with the bridge group. Then enable GMRP on all ports for the bridge.

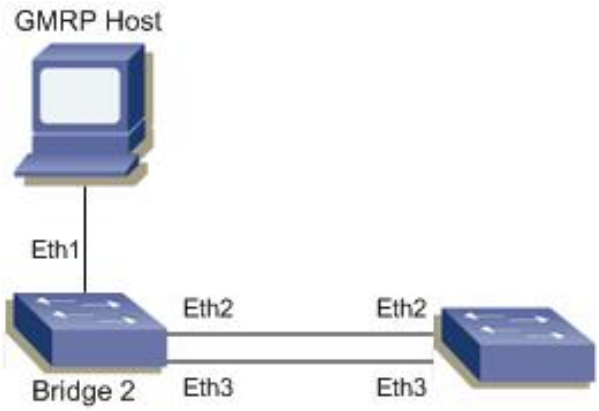


Figure 13-17: Configuring GMRP Topology

Note: This configuration assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

Bridge 2

`Bridge2#configure terminal`	Enter configure mode.
`Bridge2(config)#bridge 2 protocol ieee vlan-bridge`	Add a bridge (`2`) to the spanning tree table and make the bridge VLAN-aware
`Bridge2(config)#bridge 2 spanning-tree enable`	Enable the Spanning Tree Protocol commands on this bridge.
`Bridge2(config)#no igmp snooping`	Globally disable IGMP snooping.
`Bridge2(config)#interface eth2`	Enter interface mode.
`Bridge2(config-if)#switchport`	Configure the interface `eth2` for switching
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#interface eth3`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.

`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#vlan 5 bridge 2 state enable`	Enable vlan(5) on bridge 2Specifying the enable state allows forwarding of frames on this VLAN-aware bridge.
`Bridge2(config)#set gmrp enable bridge 2`	Enable GMRP on all ports for bridge `2`.
`Bridge2(config)#set port gmrp enable eth2`	Enable GMRP on port `eth2`.
`Bridge2(config)#set gmrp fwdall enable eth2`	Enable GMRP forwarding on port `eth2`.
`Bridge2(config)#set port gmrp enable eth3`	Enable GMRP on port `eth3`.
`Bridge2(config)#set gmrp fwdall enable eth3`	Enable GMRP forwarding on port `eth3`.

Bridge 3

`Bridge3#configure terminal`	Enter configure mode.
`Bridge3(config)#bridge 3 protocol ieee vlan-bridge`	Add a bridge (`3`) to the spanning tree table and make the bridge VLAN-aware
`Bridge3(config)#bridge 3 spanning-tree enable`	Enable the Spanning Tree Protocol commands on this bridge.
`Bridge3(config)#no igmp snooping`	Globally disable IGMP snooping.
`Bridge3(config)#interface eth2`	Enter interface mode.
`Bridge3(config-if)#switchport`	Configure the interface `eth2` for switching
`Bridge3(config-if)#bridge-group 3`	Associate the interface with bridge group `3`.
`Bridge3(config-if)#exit`	Exit interface mode.
`Bridge3(config)#interface eth3`	Enter interface mode.
`Bridge3(config-if)#bridge-group 3`	Associate the interface with bridge group `3`.
`Bridge3(config-if)#exit`	Exit interface mode.
`Bridge2(config)#vlan 5 bridge 3 state3 enable`	Enable vlan(5) on bridge 3, Specifying the enable state allows forwarding of frames on this VLAN-aware bridge.
`Bridge3(config)#set gmrp enable bridge 3`	Enable GMRP on all ports for bridge `3`.
`Bridge3(config)#set port gmrp enable eth2`	Enable GMRP on port `eth2`.
`Bridge3(config)#set gmrp fwdall enable eth2`	Enable GMRP forwarding on port `eth2`.
`Bridge3(config)#set port gmrp enable eth3`	Enable GMRP on port `eth3`.
`Bridge3(config)#set gmrp fwdall enable eth3`	Enable GMRP forwarding on port `eth3`.

Validation

show gmrp configuration bridge 1, show gmrp statistics vlanid <vlan-id> bridge <1-32>

CHAPTER 14 MAC Authentication Configuration

This chapter contains sample MAC (Multiple Access Control) Authentication configurations.

MAC Address Authentication

Authentication of MAC addresses is supported using a RADIUS server that contains a database of all valid users. When the `mac-auth` option is enabled on any interface, all source MAC addresses from any incoming frame is sent for authentication. If the username and password of the source address are configured in the RADIUS server, then authentication succeeds, otherwise it fails. When authentication succeeds, the source MAC is added to the forwarding table with forwarding enabled. In the case of failure, the source MAC either is added to the forwarding table as discarded or is added to a restricted VLAN.

Authentication for Multiple PCs

To have two or more PCs authenticated on one port by 802.1X, the incoming frames are sent to a RADIUS server for authentication. The RADIUS server contains a database of all valid users. If authentication is successful, the source MAC is added to the forwarding table with a status of forwarding enabled. If the authentication fails, the source MAC is added to the forwarding table with a status of discarded.

Topology

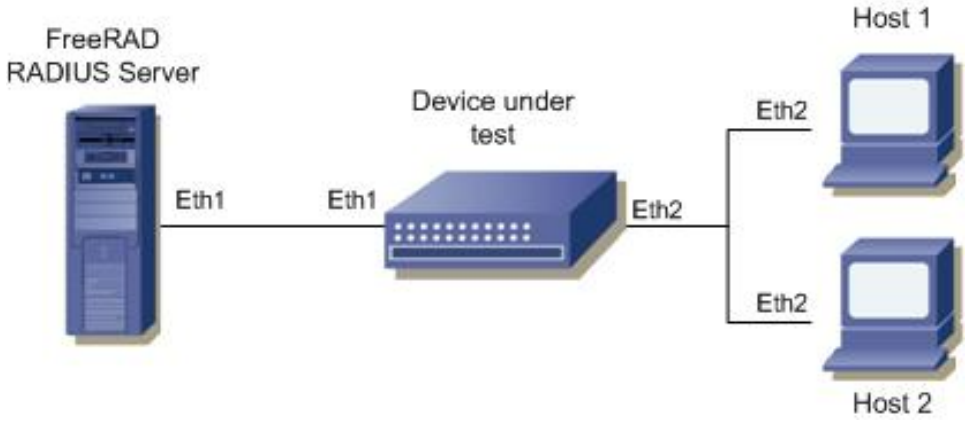


Figure 14-18: MAC Authentication Topology

Initial Configuration on the DUT

`DUT#configure terminal`	Enter configure mode.
`DUT(config)#bridge 1 protocol ieee vlan-bridge`	Enter the VLAN configuration mode.
`DUT(config)#radius-server host 10.10.10.40 auth-port 1812 timeout 10 retransmit 3 key authd`	Specify the RADIUS server address (`10.10.10.40`), port, timeout, retransmit time, and shared key (`authd`) between the RADIUS server and the client.

`DUT(config)#auth-mac system-auth-ctrl`	Enable MAC authentication globally.
`DUT(config)#interface eth1`	Enter interface mode
`DUT(config-if)#ip address 10.10.10.50/24`	Set the IP address on interface eth1.
`DUT(config-if)#exit`	Exit interface mode.
`DUT(config)#interface eth2`	Enter interface mode
`DUT(config-if)#switchport`	Set the switching characteristics on the interface.
`DUT(config-if)#bridge-group 1`	Associate interface eth1 with bridge group 1.
`DUT(config-if)#auth-mac enable`	Enable MAC authentication on interface eth2.

RADIUS Server

`root@RADIUS-SERVER: ifconfig eth1 10.10.10.40 broadcast 10.10.10.255 netmask 255.255.255.0`	Set the IP address on interface eth1 with broadcast address and netmask.
`root@RADIUS-SERVER:radiusd -X`	Start the RADIUS daemon, radiusd, on the RADIUS server.

MAC entries in the users' file of the RADIUS Server with VLAN ID are used for dynamic VLAN creation (VLAN 12).

```
MAC1
"00:50:8B:01:A3:49"     Auth-Type := eap, User-Password == "00:50:8B:01:A3:49"
                        Tunnel-Type = 13,
                        Tunnel-Medium-Type = 6,
                        Tunnel-Private-Group-ID = 12,
                        Reply-Message = "Hello, %u"
MAC2
"00:50:8B:01:A3:48"     Auth-Type := eap, User-Password == "00:50:8B:01:A3:48"
                        Tunnel-Type = 13,
                        Tunnel-Medium-Type = 6,
                        Tunnel-Private-Group-ID = 12,
                        Reply-Message = "Hello, %u"
MAC3
"00:50:8B:01:A4:35"     Auth-Type := eap, User-Password == "00:50:8B:01:A4:35"
                        Tunnel-Type = 13,
                        Tunnel-Medium-Type = 6,
                        Tunnel-Private-Group-ID = 12,
                        Reply-Message = "Hello, %u"
MAC4
"00:50:8B:01:A4:51"     Auth-Type := eap, User-Password == "00:50:8B:01:A4:51"
                        Tunnel-Type = 13,
                        Tunnel-Medium-Type = 6,
                        Tunnel-Private-Group-ID = 12,
                        Reply-Message = "Hello, %u"
```

Configuring auth-mac-fail-action on the DUT

`DUT#configure terminal`	Enter configure mode.
`DUT(config)#vlan 64 bridge 1 state enable`	Enable the state of VLAN 64 on bridge 1. Specifying an enable state allows forwarding of frames over VLAN 64 on bridge 1.
`DUT(config)#interface eth2`	Enter interface mode
`DUT(config-if)#auth-mac auth-fail-action drop-traffic`	Configure required action after authentication fails for any source as `drop-traffic`.
`DUT(config-if)#auth-mac auth-fail-action restrict-vlan <2-4094>`	Configure required action after authentication fails for any source as `restrict-vlan`. This means that unauthorized MAC address will be added to a restricted VLAN with an ID in the range of <2-4094>.

Validation

- To verify MAC address authentication mechanism when authentication is successful:

```
DUT#show bridge
bridge       VLAN port      mac              fwd timeout
1            1    eth2      0050.8b01.a349   1   4
```

When authentication is successful, the source MAC is added to forwarding table as forwarding enabled.

- To verify MAC address authentication mechanism when authentication fails and failure action is configured as `drop-traffic`:

```
DUT#show bridge
bridge       VLAN port      mac               fwd timeout
1            1    eth2      0050.8b01.b348    0   295
```

When authentication fails, the source MAC is added to forwarding table as discarding.

- To verify the MAC address authentication mechanism when authentication fails and failure action is configured `restrict-vlan`:

```
DUT#show bridge
bridge      VLAN port       mac               fwd timeout
1           64   eth2       0050.8b01.b349    1   10
```

When authentication fails, the source MAC is added to a restricted VLAN (VLAN 64).

Dynamic VLAN Assignment

To support dynamic VLAN assignment, a RADIUS server sends back access-accept messages when MAC authentication is successful. If the message carries a VLAN ID and that VLAN is available on the DUT, that port is removed from its default VLAN and added to a specified VLAN.

`DUT#configure terminal`	Enter configure mode.
`DUT(config)#vlan 12 bridge 1 state enable`	Enable the state of VLAN 12 on bridge 1. Specifying the enable state allows forwarding of frames over VLAN 12 on bridge 1.
`DUT(config)#interface eth2`	Enter interface mode

`DUT(config-if)#auth-mac dynamic-vlan-creation enable`	Enable dynamic VLAN creation. If dynamic VLAN creation is enabled, and authentication is successful, the MAC undergoing authentication is added to the VLAN ID attribute in the RADIUS server-configuration file.
`DUT(config-if)#auth-mac dynamic-vlan-creation disable`	Disable dynamic VLAN creation. If dynamic VLAN creation is disabled, after a successful authentication the MAC is added to the Forwarding Database with the default VLAN.

Validation

- To verify MAC address authentication mechanism when dynamic VLAN is enabled:

```
DUT#show bridge
bridge     VLAN port      mac                   fwd timeout
1          12   eth2      0050.8b01.a349        1    4
```

When authentication is successful, the port is removed from its default VLAN and added to the VLAN ID specified in RADIUS Server (VLAN 12).

- To verify MAC address authentication mechanism when dynamic VLAN is disabled:

```
DUT#show bridge
bridge     VLAN port      mac                   fwd timeout
1          1    eth2      0050.8b01.a351        1    4
```

When authentication fails, port is added to the default VLAN.

Configuration for auth-mac-aging

`DUT#configure terminal`	Enter configure mode.
`DUT(config)#interface eth2`	Enter interface mode
`DUT(config-if)#auth-mac mac-aging enable`	Enable MAC aging. If MAC aging is enabled, the MAC entry is added to the Forwarding Database, with aging time equal to the bridge aging time.
`DUT(config-if)#auth-mac mac-aging disable`	Disable MAC aging. If MAC aging is disabled, the MAC entry will not be aged out.

Validation

To verify MAC address authentication when MAC aging is enabled:

```
DUT#show bridge

bridge       VLAN port      mac                   fwd timeout
1            1    eth2      0050.8b01.b348        1    295
1            1    eth2      0050.8b01.b351        0    295
```

When authentication is successful, the source MAC is added to the forwarding table with `fwd flag` enabled and aging time equal to the bridge ageing time. When authentication fails, the source MAC is added to the forwarding table with `fwd flag` disabled and with aging time equal to the bridge aging time.

- To verify MAC address authentication when MAC aging is disabled:

```
DUT#show bridge

bridge       VLAN port      mac                   fwd timeout
```

```
1            1     eth2       0050.8b01.b348          1     0
1            1     eth2       0050.8b01.b351          0     0
```

When authentication is successful, the source MAC is added to the forwarding table with `fwd flag` enabled and aging time equal to zero. When authentication fails, the source MAC is added to the forwarding table with `fwd flag` disabled and with aging time equal to the zero.

Unconfiguring auth-mac

`DUT#configure terminal`	Enter configure mode.
`DUT(config)#interface eth2`	Enter interface mode
`DUT(config-if)#auth-mac disable`	Disable MAC authentication on the interface.
`DUT(config-if)#exit`	Exit interface mode.
`DUT(config)#no auth-mac system-auth-ctrl`	Disable MAC authentication globally.

CHAPTER 15 GVRP Configuration

GVRP (GARP VLAN Registration Protocol) allows the exchange of VLAN information between switches in a network. If one switch is manually configured with multiple VLANs, other switches in the network learn about these VLANs dynamically through GVRP.

Topology

To configure GVRP, you must enable GVRP on ports on each end of the trunk. Add a VLAN bridge (2), enable spanning tree protocol on this bridge and specify the VLAN as active. This active state allows forwarding of frames on this VLAN. Set GVRP globally for this bridge. Associate interfaces with this bridge and specify switching characteristics according to requirement.

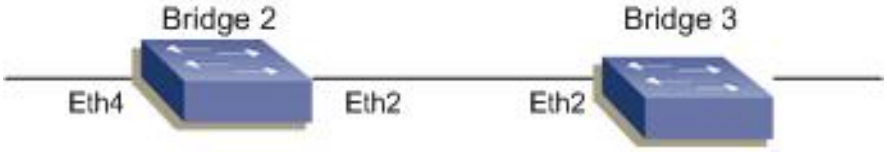


Figure 15-19: Configuring GVRP Topology

Note: This configuration assumes that you are running the ZebOS-XP Layer-2 module. If you are using the ZebOS-XP Hybrid Layer-2/Layer-3 module, run the `switchport` command on each port to change to Layer-2 mode.

Bridge 2

`Bridge2#configure terminal`	Enter configure mode.
`Bridge2(config)#bridge 2 protocol ieee vlan-bridge`	Specify VLAN for bridge `2`.
`Bridge2(config)#vlan 5 bridge 2 state enable`	Enable the state of a particular VLAN (5) on bridge 2.
`Bridge2(config)#interface eth2`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.
`Bridge2(config-if)#switchport mode trunk`	Set the switching characteristics of the Layer-2 interface as trunk and specify tagged frames only. Set the ingress filtering for received frames. Received frames that are not classified as trunk are discarded.
`Bridge2(config-if)#exit`	Exit interface mode.
`Bridge2(config)#set gvrp enable bridge 2`	Set GVRP globally for bridge `2`.
`Bridge2(config)#set port gvrp enable eth2`	Enable GVRP on port `eth2`.
`Bridge2(config)#set gvrp dynamic-vlan-creation enable bridge 2`	Enable dynamic VLAN creation for this bridge instance.
`Bridge2(config)#interface eth4`	Enter interface mode.
`Bridge2(config-if)#bridge-group 2`	Associate the interface with bridge group `2`.

`Bridge2(config-if)#switchport mode access`	Use this command to set the switching characteristics of the Layer-2 interface to access mode
`Bridge2(config-if)#switchport access vlan 5`	Use this command to change the default VLAN ID to `5` on `eth4`.
`Bridge2(config-if)#exit`	Exit interface mode.

Bridge 3

`Bridge3#configure terminal`	Enter configure mode.
`Bridge3(config)#bridge 3 protocol ieee vlan-bridge`	Specify VLAN for bridge `3`.
`Bridge3(config)#interface eth2`	Enter interface mode.
`Bridge3(config-if)#bridge-group 3`	Associate the interface with bridge group `3`.
`Bridge3(config-if)#exit`	Exit interface mode.
`Bridge3(config)#set gvrp enable bridge 3`	Set GVRP globally for bridge `3`.
`Bridge3(config)#set port gvrp enable eth2`	Enable GVRP on port `eth2`.
`Bridge3(config)#set gvrp dynamic-vlan-creation enable bridge 3`	Enable dynamic VLAN creation for this bridge instance.
`Bridge3(config)#interface eth2`	Specify the interface(`eth2`) to be configured and enter `Interface` mode.
`Bridge3(config-if)#switchport mode trunk`	Set the switching characteristics of the Layer-2 interface as trunk and specify tagged frames only. Set the ingress filtering for received frames. Received frames that are not classified as trunk are discarded.
`Bridge3(config-if)#exit`	Exit interface mode.

Validation

show gvrp configuration bridge 1, show gvrp statistics

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