

U9016B For GE-PON

■ User Guide



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Preface

This preface provides the overview of U9016B user guide, which describes guide conventions, and lists other publications that may be useful.

Introduction

This guide provides the information required for configuring and operating the network environment after the installation of U9016B Layer 3 switch hardware.

The target readers of this guide are Ethernet-based network administrators and related engineers who are responsible for installing and setting network equipment. This guide will help them configure optimum networks and operate & manage them more effectively. This guide also provides the information on how to solve problems that may occur during the network operation. Therefore, this guide assumes that the readers have basic working knowledge of:

- Local Area Networks (LAN) and Metro Area Network (MAN)
- Ethernet, Fast Ethernet, and Gigabit Ethernet concepts
- Ethernet switching and bridging concepts
- Routing concepts
- TCP/IP (Transmission Control Protocol/Internet Protocol) concepts
- Routing Information Protocol (RIP) and Open Shortest Path First (OSPF)
- Simple Network Management Protocol (SNMP)

**Notice**



For more information on the installation and the initial configuration of U9016B switch hardware, refer to the hardware installation guide of each system.

Conventions

The following Conventions Table and list conventions and icons used throughout this guide.

| Text Convention | Description |
|-----------------------------|---|
| Screen displays | <ul style="list-style-type: none">• The information displayed on the OAM terminal screen as a result of command execution• This typeface indicates command syntax |
| Screen displays bold | <ul style="list-style-type: none">• This typeface indicates how you would type a particular command |
| [Key] Input | <ul style="list-style-type: none">• To indicate pressing a key of the keyboard, a square bracket is used with the key, for example, [Enter] or [Ctrl].• When two or more keys are pressed at the same time, the two keys are connected with '+', for example, [Ctrl] + [Z] |
| <i>Italic</i> | <ul style="list-style-type: none">• Used to emphasize a point or denote new terms where they are defined in the text.• Parameters that users enter in the system command syntax |

Notice and Warning Icons

| Icon | Type | Description |
|---|---------|--|
|  | Notice | Important features, characteristics, commands or tips |
|  | Warning | Danger that can cause bodily injury, data loss, or system damage |

Related Documents

For additional information on this equipment, refer to the following manuals.

| Manual | Contents |
|------------------------------------|---|
| <i>Hardware Installation Guide</i> | Switch hardware installation Initial operating environment configuration |



Notice

You can download or request the latest documents and information on the products of Ubiquoss Inc. including U9016B switch from the website (<http://www.ubiquoss.com>).

This document is the manual for all the U9016B switches.

Organization

The chapters of this manual are organized as follows:

Chapter 1.Overview

This chapter provides the following information required for the system user to set up the configuration and to start up U9016B Layer 3 switch.

Chapter 2.Interface

This chapter describes the Interface of the system.

Chapter 3.VLAN

This chapter describes the VLAN of system.

Chapter 4.IP Configuration

This chapter explains how to set IP address.

Chapter 5.DHCP

This chapter describes the DHCP configuration of system.

Chapter 6.RIP

This chapter introduces how to set up RIP (Routing Information Protocol). RIP has been used for many years and is still used for IGP (Interior Gateway Protocol) of small network.

Chapter 7.OSPF

This chapter introduces OSPF routing protocol used in U9016B. OSPF routing protocol is described in RFC 2328.

Chapter 8.BGP

This chapter introduces BGP among available IP Unicast routing protocols of U9016B.

Chapter 9.IGMP Snooping

This chapter introduces IGMP Snooping Configuration.

Chapter 10.Multicast Routing

This chapter describes IP multicast routing elements and IP multicast routing setting.

Chapter 11.Statistics Monitoring

This chapter describes the monitoring function for the system and statistics of U9016B OLT systems.

Chapter 12.STP and SLD

This chapter introduces how to configure the Spanning Tree Protocol (STP) and Rapid Spanning Tree Protocol (RSTP) on the switch. It also explains frame transmission from Bridge.

Chapter 13.BFD

This chapter describes BFD (Bidirectional Forwarding Detection). BFD is a protocol for rapid detecting the error of forwarding path. BFD independently runs regardless of network type and routing protocol.

Chapter 14.LACP

This chapter describes how to configure IEEE 802.3ad Link Aggregation Control Protocol (LACP) on the switch.

Chapter 15.IP-OPTION

This chapter describes the IP-OPTION of system.

Chapter 16.VRRP

This chapter describes the VRRP configuration of system.

Chapter 17.NTP

This chapter describes the NTP configuration of system.

Chapter 18.DAI

This chapter describes the function of dynamic Address Resolution Protocol (ARP) inspection (DAI) which is used for inspecting ARP packet.

Chapter 19.QoS and ACL

This chapter describes the QoS configuration and the ACL of system.

Chapter 20.Utilities

This chapter describes other functions required for operation of the system.

Chapter 21.Saving Config File and Software Upgrade

This chapter describes Flash File System management and using USB or Compact Flash (CF) memory. OS Image and Configuration File are saved in the File System provided by U9016B.

Chapter 22.GE-PON

This chapter describes how to make the setting in relation with GE-PON in the U9016B. This chapter consists of the following sections:

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Chapter 1. Overview

This chapter provides the following information required for the system user to set up the configuration and to start up U9016B Layer 3 switch.

- Command line edit and help
- Switch command mode
- Switch startup
- U9016B switch user interface
- Switch login and password setting
- SNMP configuration
- Viewing and saving the files and configuration of switch
- Access list
- Telnet Client

Command Line Editor and Help

This chapter provides the information on command line editor and help.

Command Syntax

The following is the steps to enter a command. For more information about using command-line interface is described in the following chapter.

To use command-line interface, do the following steps:

1. When entering a command at the prompt, make sure that you have the appropriate privilege level. Most configuration commands require the administrator privilege level.
2. Enter a command. If the command does not include a parameter or values, go to step 3.
 - If the command includes a parameter, enter the parameter name and values.
 - The value of the command specifies how you want the parameter to be set. Value includes numeric, strings, or addresses, depending on the parameter.
3. Press [Return].

**Notice**

When entering a command, you may receive a message - %Command incomplete. This means that the command you entered was not executed. If you press **Up** arrow key, your last command will be displayed.

The following shows the command that is entered and not executed.

```
Switch# show   
% Incomplete command.  
Switch #
```

Command Syntax Helper

The CLI of U9016B switch has built-in command syntax helper. Help may be requested at any point in a command by entering a question mark '?'. U9016B switch provides two styles of help.

Full Help

- Available when ready to enter a command argument (e.g. 'show?'). Describes each possible argument. (Note: a space between command and question mark is required).

Partial Help

- Provided when an abbreviated argument is entered and want to know what arguments match the input (e.g. 'show me?'.) There is no space between command and question mark.

The following shows an example of full help with 'show' command.

When '?' mark is used together with a space after 'show' command, the list of parameters and values that the administrator can use will be displayed. Then the cursor waits input from the administrator, blinking in the "Switch# show" prompt. The question mark '?' is not displayed on the terminal screen.

.Switch# show ?

| | |
|-------------------|--|
| access-list | List IP access lists |
| arp | Internet Protocol (IP) |
| bfd | BFD information |
| bgp | Border Gateway Protocol (BGP) |
| bootvar | Boot and related environment variable |
| bridge | Bridge information |
| cal | CAL show |
| calendar | Display the hardware calendar |
| class-map | Class map entry |
| cli | Show CLI tree of current mode |
| clock | Display the system clock |
| command | shell command |
| cpu | cpu status and configuration |
| debugging | Debugging functions (see also 'undebug') |
| disk1: | disk1: file system |
| dot1x | IEEE 802.1X Port-Based Access Control |
| environment | Temperature and FAN status information |
| etherchannel | EtherChannel information |
| flash: | display information about flash: file system |
| flowcontrol | IEEE 802.3x Flow Control |
| fm-status | Show the current status |
| history | Display the session command history |
| hosts | IP domain-name, lookup style and nameservers |
| idprom | show IDROMs for FRUs |
| inet-service | Display enabled internet services |
| interface | IP interface status and configuration |
| ip | Internet Protocol (IP) |
| ipv6 | Internet Protocol version 6 (IPv6) |
| lacp | LACP commands |
| lacp-counter | LACP commands |
| list | Show command lists |
| logging | Show the contents of logging buffers |
| mac-access-list | List MAC access lists |
| mac-address-table | MAC forwarding table |
| memory | Memory information |
| mirror | Port Mirroring |
| mls | mls global commands |
| module | Module Info |
| nsm | NSM |
| ntp | Network time protocol |
| policy-map | Policy map entry |
| port | port commands |
| port-mib | Port-Mib Count |
| power | Switch Power |
| pppoe | Point-to-Point over Ethernet (PPPoE) |

| | |
|-----------------|---|
| privilege | Display your current level of privilege |
| processes | Active process statistics |
| redundancy | Redundancy Facility (RF) information |
| reload | Scheduled reload information |
| rmon | Remote Monitoring Protocol (RMON) |
| route-map | route-map information |
| router-guard | Multicast Router-Guard Commands |
| router-id | Router ID |
| running-config | Current Operating configuration |
| service | Setup miscellaneous service |
| service-policy | Service Policy entry |
| slot | Slot Info |
| snmp | Show snmp statistics |
| spanning-tree | spanning-tree Display spanning tree information |
| startup-config | Contents of startup configuration |
| system | Display the system information |
| tech-support | Show system information for Tech-Support |
| uptime | Display elapsed time since boot |
| usbflash: | usbflash: file system |
| users | Display information about terminal lines |
| version | System software status |
| virtual-servers | Virtual-servers |
| vlan | Display VLAN information |
| vrrp | VRRP information |
| whoami | Display information about the current user |

Switch #show_

The result of 'show' command when the partial help function is used is as below. If '?' is entered after 'show' command, the description on the show command is displayed, and a blinking cursor waits the next command input.

```
Switch# show?
  show  Show running system information
Switch# show_
```

Enter 'p' and a question mark '?' with no space when you wish to check the status of a port, but do not know the right command. CLI helper provides a list of options for the remainder of command as below. The command entered by the administrator is displayed again, and a blinking cursor waits the next input.

```
Switch# show p?
  policy-map  Policy map entry
  port        port commands
  port-mib    Port-Mib Count
  power       Switch Power
  pppoe       Point-to-Point over Ethernet (PPPoE)
  privilege   Display your current level of privilege
  processes   Active process statistics
Switch# show p_
```

Abbreviated Syntax

U9016B switch CLI supports abbreviated syntax, the shortest, most unambiguous, allowable abbreviation of a command or parameter. Typically, this is the first two or three letters of the command.



Notice

When using abbreviated command syntax, user must enter enough characters to make the command unambiguous, and distinguishable to U9016B switch. The user may receive - %Ambiguous command, which means there are more than one commands with the same prefix that you have entered in the mode.

```
Switch# show [?]
% Ambiguous command: "show i"
Switch# show i[?]
      idprom          show IDPROMs for FRUs
      inet-service    Display enabled internet services
      interface       IP interface status and configuration
      ip              Internet Protocol (IP)
      ipv6            Internet Protocol version 6 (IPv6)
Switch# show i_
```

Command Symbols

Various symbols are used to describe the command syntax in this guide. These symbols explain how to enter the command and parameters. The following table summarizes the symbols applied to the system command syntax.

Table 1 Command Syntax Symbol

| Symbol | Name | Description |
|--------|-----------------|--|
| <>: | Angle brackets | Enclose a variable or value in the command syntax. You must specify the variable or value. For example, in the syntax access-list <1-99> {deny/permit} address You must supply standard access control list number for <1-99> when entering the command. |
| { }: | Braces | Enclose a required value or list of parameters in the command syntax. The administrator must enter at least one necessary item among the parameter list. For example, in the syntax router {rip/ospf} You must enter one of the two parameter list for specifying routing protocol. |
| []: | Square brackets | Enclose a required value or list of parameters in the command syntax. The administrator can specify necessary items among the list selectively. There may be no need to specify an item. For example, in the syntax |

| | | |
|---------------|--------------|--|
| | | show interfaces [<i>ifname</i>] You can enter the interface name for ifname or not. |
| : | Vertical bar | Separate mutually exclusive items in the list, one of which must be entered. For example, in the syntax switch port mode { <i>access/trunk</i> } You must specify either access or trunk mode of switch port in the command. Do not type the vertical bar. |
| <i>Italic</i> | | Variables to enter |
| Bold | | The command the administrator must enter |
| A.B.C.D | | IP address or subnet mask |
| A.B.C.D/M | | IP prefix (e.g. 192.168.0.0/24) |

Command Line Editing Key and Help Function

The CLI of U9016B supports Emacs-like line editing commands. The following table describes the line-editing keys used in the CLI.

Table 2 Basic Command Line Editing Command and Help

| Command | Description |
|-------------------------|--|
| [Ctrl] + [A] | Moves the cursor to the beginning of the line. |
| [Ctrl] + [E] | Moves the cursor to the end of the line. |
| [Ctrl] + [B] | Moves the cursor to the next word. |
| [Ctrl] + [F] | Moves the cursor to the left character. |
| Backspace | Deletes the character in front of the cursor. |
| [Ctrl] + [K] | Deletes all the characters from the cursor to the end of the line |
| [Ctrl] + [U] | Deletes all the letters from the cursor to the beginning of the line. |
| Tab | If you type a part of a command and press [tab], the commands with the same prefix on the prompt will be listed. If there is only one command with the prefix, the rest part of the command is completed. |
| [Ctrl] + [P] or ⬆ | Displays the history of the last 20 commands you have entered. |
| [Ctrl] + [N] or ⬇ | Displays the next command. |
| ? | Displays the list of the available commands on the prompt and the description on the commands. If you type '?' after a command, the parameters required after the command will be listed. If you type '?' right after a part of a command, the commands with the same prefix will be listed. |
| Return or Spacebar or Q | If you press [Return] in—More --, the next one line will be displayed. When you press spacebar, the next page will be displayed. Press Q to exit from the program and switch to the prompt state. |

Switch Command Mode

U9016B switch provides the following various CLI (Command Line Interface) access modes, as shown in the following table. Various commands of each switch offer different authority to an administrator.

Table 3 Switch Command Mode

| Access Mode | Prompt | Description |
|-----------------|--|---|
| User mode | Switch> | Displays common statistic information. |
| Privileged mode | Switch# | Uses Show or Debug command |
| Config mode | Switch(config) # | Changes the scope of switch configuration into global. |
| Interface mode | Switch(config-if-fa1/1)# Switch(config-if-vlan1)# | Changes the configuration of switch interface. |
| Router mode | Switch(config-rip)# Switch(config-ospf)# | Changes the configuration of routing protocols such as RIP or OSPF. |
| DHCP pool mode | Switch(config-dhcp)# | Configures the DHCP address pool. |



Notice

The command prompt uses the name of the U9016B as the host name in front of character(s) of each mode. The prompt 'Switch' will be used as common host name throughout this manual.

When you set up the configuration of U9016B, you will face various kinds of prompts.

The prompt shows the path where you are in the configuration mode. To change the configuration of the switch, you have to check prompts. Commands that are used to change command prompt mode are described in the following table.

Table 4 Change of Switch Command Modes

| Command | Description |
|--------------------------|--|
| enable | Moves from the User mode to the Privileged mode. Needs to enter the password of the Privileged mode. |
| disable | Moves from the Privileged mode to the User mode. |
| configure terminal | Moves from the Privileged mode to the Config mode. |
| interface [ifname] | Moves from the Config mode to the Interface mode. |
| router {rip ospf} | Moves from the Config mode to the router mode. |
| exit | Moves back to the former mode. |
| end | Moves from any mode to Privileged mode. Do not move from User mode. |
| ip dhcp pool <i>name</i> | Move from the Config mode to the DHCP pool mode |

U9016B Switch Startup

When starting up the switch for the first time, U9016B switch performs self test which loads OS image from the flash memory, and starts the system. When the system is booted, the switch loads the previous configuration (startup-config) saved in the flash memory.

**Notice**

For the purpose of system reliability, U9016B switch manages two OS images including Primary and Secondary. Primary OS image would be loaded by default setting. System Administrator can change the configuration in a switch boot mode or privileged mode.

User Interface

Network administrators can access the switch for configuration setting, configuration verification, and switch status management and etc. The simplest way to access the switch is by local OAM terminal connected to the separate console port that U9016B switch offers (*Out-of-band management*).

Another way to access the switch is to use Telnet program from a remote site. The switch does not support a separate port for the Telnet connection. Therefore, access must take place through the service port (*In-band management*).

The system administrator can use the following methods to manage U9016B.

- Access the CLI by connecting a local terminal to the switch console port
- Access the CLI over a TCP/IP network through Telnet connection
- Use SNMP network manager over a network running the IP protocol.

U9016B support up to multiple user sessions concurrently, as follows:

- 1 console session
- Up to 10 Telnet sessions

Connection through Console Port

The command-line interface built into the system is accessible by RJ-45 type Ethernet port console. OAM terminal (or workstation with terminal-emulation software) must support 9-pin, RS-232 DB9 port. Console port is located at the back of U9016B *SG/M* (Switching, Gigabit Ethernet I/O & Management Module).

Connect the terminal to the console port provided by Premier U9016B, as shown in the following figure. Once connection is established, you will see the switch prompt and you may log in.

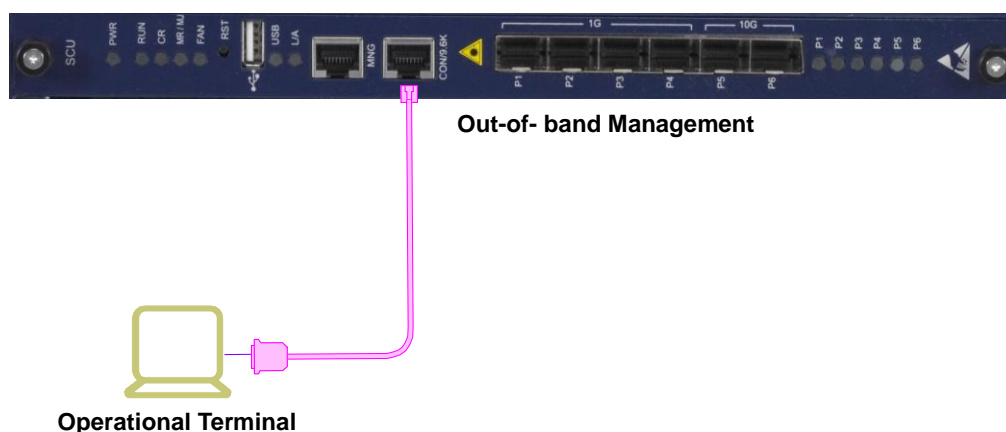


Figure 1 Connection of U9016B Switch and OAM Terminal



Notice

For the information on the terminal configuration and console port pinouts, refer to the U9016B switch Hardware Installation Guide.

Connection through Telnet

You can get connected to U9016B at any workstation with Telnet or TCP/IP. In order to use Telnet you must setup an ID and password first, and your switch must have at least one IP address.

```
telnet [<ipaddress> | <hostname>] [<port_number>]
```

After telnet connection is successfully completed, a prompt for user password will be displayed. When you type in the Telnet user password, you will enter into *User mode* of the switch.

For security purposes, you can use access list to restrict the Telnet connection.

Connection through SNMP Network Manager

Any network manager running the Simple Network Management Protocol (SNMP) can manage the U9016B switch.

**Notice**

For more information on SNMP Network Manager.

User Management

Add/Delete User

A system manager can connect to the system using a console port or telnet to configure or manage U9016B. You can manage users connected to the system by configuring ID and password, and give different authorities using privilege level.

The new new user has privilege level as 1 and can enter privileged mode. If you execute "enable" command in user mode, you can enter privileged mode.

The following list describes about privilege level.

- Privilege level 0 is non-privileged status.
- Privilege level 1-14 can execute user mode commands.
- Privilege level 15 can execute privilege mode commands.

Table 5 Commands for User Registration, Deletion, and management

| Command | Description | Mode |
|---|---|--------|
| username <i>name</i> {nopassword password [0 7] password secret [0 5] password} | Registers uer. nopassword: When you log in the system, the system does not ask password. password or secret: When you log in the system, the system ask. The password and secret ways are as follows: 0 – No encryption. 5 – MD5 encryption. 7 – DES encryption. | Config |
| no username <i>name</i> | Deletes user. In case that user is root, the password is changed as default value. | Config |
| username <i>name</i> privilege <0-15> | Changes user's privilege level. | Config |
| username <i>name</i> access-class <1-99> | Enables access-list. <1-99> : IP standard access list | Config |
| no username <i>name</i> access-class | Disable access-list. | Config |
| username <i>name</i> user-maxlinks <i>value</i> | Sets maximum session numbers | Config |
| no username <i>name</i> user-maxlinks <i>value</i> | Changes maximum session number as default value. Default: 32 | Config |
| username <i>name</i> unlimited-session-ip <i>A.B.C.D</i> | Enables unlimited session ip as user name. | Config |
| no username <i>name</i> unlimited-session-ip | Disables unlimited session ip as user name. | Config |

Add User

The following example shows how to set user name, password and privilege level.

```
Switch# configure terminal
Switch# configure terminal
Switch(config)# username testuser1 nopassword
Switch(config)# username testuser2 password testpw
Switch(config)# username testuser3 privilege 15 password testpw
Switch(config)# end
Switch # show running-config
!
username testuser1 nopassword
username testuser2 password 0 testpw
username testuser3 privilege 15 password 0 testpw
!
Switch#
```

The following shows an example where 'testusers3', privilege level 15 logs into privileged mode.

Ubiquoss L3 Switch

Switch login: **testuser3**
Password: **testuser3**

Hello.

Switch> enable
Switch#

**Notice**

After you set aaa authorization exec command, in case that your level is more than the privilege level 15, you can enter the privileged mode directly.

Password Setting

U9016B switch is able to configure user password and enable password for the system security.

For security purposes U9016B allows to setup user password and enable password.

Enable password

- Used for the security of the privileged mode.

User password

- Used by the user to access the switch through Telnet in the user mode.

The following table describes the commands related to enable password setting.

Table 6 Commands for Enable Password Setting

| Command | Description | Mode |
|---------|-------------|------|
|---------|-------------|------|

| | | |
|--|---|--------|
| enable password {password [0 7] password} secret [0 5] password} | Sets the password to access the privileged mode. password or secret: When you enter the Privileged mode, You need to enter password. The password and the secret value differ according to the encryption way. 0 – None Encryption. 5 – MD5 Encryption 7 – DES Encryption | Config |
| no enable password | Disables the password configuration to enter the privileged mode. | Config |

Setting Enable password

The following example shows how to enable password to enter to Privileged mode.

```
Switch# configure terminal
Switch(config)# enable password testpw
Switch(config)# end
Switch# show running-config
!
enable password 0 testpw
!
```

If you enter the set password, enter the privileged mode.

```
Ubiquoss L3 Switch
Switch login: root
Password:
Hello.
Switch>enable
Password: testpw
Switch#
```

As in the examples above, anybody can see passwords with **show running-config** command after password setting. For security purposes, the system supports encryption mode setting.

Table 7 Commands for Setting Password Encryption Mode

| Command | Description | Mode |
|--------------------------------|-------------------------------|--------|
| service password-encryption | Enables password-encryption. | Config |
| no service password-encryption | Disables password-encryption. | Config |



Notice

You can not decrypt with “**no service password-encryption**” command. This command is only to disable the encryption-password service.

Enabling Password Encryption Mode

If you enable password encryption mode, display the password as encryption status.

```
Switch# configure terminal
Switch(config)# service password-encryption
Switch(config)# end
Switch# show running-config
!
enable password 7 xxEp88GxHJlgc
username testuser1 nopassword
username testuser2 password 7 XX1LtDbOY4
username testuser3 privilege 15 password 7 XX1LtDbOY4
!
Switch#
```

AAA (Authentication Authorization Accounting)

The system can set up various types of user authentication. Normally, user authentication is given by user ID and password. But with RADIUS and TACACS+, the authorization to access to the subscriber database of each server is given.

Authentication

Three ways of user authentication are as follows:

- Local
- RADIUS
- TACACS+

You can set authentication more than one way. In case of setting various authentication ways, the system tries authentication by set order. In case that user does not get result about success or failure of authentication, you must set various authentication ways for trying authentication with ways of another authentication. In case of trying authentication with Local system, if the information about user who want to log in or enter privileged mode does not exist, the system tries authentication with the next set way.

Local authentication is always enabled. In case that you does not specify authentication setting, the system does user authentication with Local authentication way basically.

User Authentication

When using more than one way, you authenticate based on the authentication priority. If authentication is succeeded, login through set account. If it is not, authenticate with the next priority.

| Command | Description | Mode |
|---|---|--------|
| aaa authentication login default {local radius tacacs+} | Chooses authentication system (local, radius, and tacacs+). Various authentications are possible. | Config |
| no aaa authentication login default | Backs to default about authentication login. Default: Local | Config |
| aaa authentication login template-user <i>name</i> | User authenticated by RADIUS or TACACS+ can not login without local account. User should set up account to use. | Config |
| no aaa authentication login template-user | Clears the account of users without account | Config |
| aaa authentication login authen-type (chap pap) | In case of authentication with TACACS+, it sends authentication message by chap or pap way. Default: Ascii | Config |
| no aaa authentication login authen-type | Clears the account of users without account | Config |

Setting User Authentication

Three ways of user authentication are as following:

- Check access right with user ID and password
- Use RADIUS server
- Use TACACS+ server

When using more than one way, you authenticate based on the authentication priority. If authentication is succeeded, login through set account. If it is not, authenticate with the next priority.

```
Switch# configure terminal
Switch(config)# aaa authentication login default tacacs+ radius
Switch(config)# end
Switch#
```

Enable Password Authentication

When you want to enter the privileged mode, you can authenticate with enable password. In case of authentication with Local, it performs authentication via enable password set to system.

It can also perform authentication via RADIUS or TACACS+. When you do not set password to local system, the authentication always succeed. So you set enable password to perform authentication with privileged mode.

Table 8 Commands for Setting User Authentication of Privileged Mode

| Command | Description | Mode |
|--|---|--------|
| aaa authentication enable default {enable radius tacacs+} | Authenticates about enable password. | Config |
| no aaa authentication enable default | Backs to default. Default: enable password(Local system) | Config |

Setting User Authentication of Privileged Mode

If user enters the privileged mode, the system tries authentication to TACACS+ server about enable password. If the system does not receive response from TACACS+, it tries authentication to RADIUS server. In the same way, if the system does not receive response from RADIUS server, it tries authentication via the local way.

```
Switch# configure terminal
Switch(config)# aaa authentication enable default tacacs+ radius
Switch(config)# end
Switch#
```

Authorization

The system checks the authorization that can use the system resource via privilege level. When you execute EXEC shell, it compares user's privilege level with user's privilege level setting to local system or remote server (RADIUS or TACACS+). In case that user's privilege level which wants to use system resource is lower than the set privilege level, the system

shows error message and fails execution. When you also execute specific command, the system compares the privilege level of each command with the set privilege level. Then the system can check the executive authorization of relevant command via local system or remote server (TACACS+).

For preparing in case that the system does not receive the result from Authorization server or connects with Authorization server, you must always add the way of authorization checking from local system. In case of Authorization checking from local system, the system always fails the Authorization checking. In this case, you need change the setting via console. The user who logs in the system via console does not check Authorization.

Authorization for EXEC Activation

When you enter the privileged mode, the EXEC shell executed is user definition shell. The authorization that can execute EXEC shell makes sure with the user's privilege level to register to the system. In case that the system makes sure the user's EXEC shell execution authorization with RADIUS or TACACS+ server, you must set user's privilege information for checking authorization to relevant server.

Table 9 Commands for Setting EXEC Shell Authorization

| Command | Description | Mode |
|--|---|--------|
| aaa authorization exec default [local radius tacacs+] | Checks authorization to execute EXEC shell with user's privilege level. | Config |
| no aaa authorization exec default | Does not check authorization to execute EXEC shell. | Config |

Checking EXEC shell Execution Authorization with TACACS+ Server

When you execute EXEC shell, the system checks Authorization with referring to user's privilege level setting to TACACS+. Furthermore, in case that the system does not receive the result from TACACS+ server, the system can check Authorization from local system.

The following example shows how to set authorization for EXEC activation.

```
Switch# configure terminal
Switch(config)# aaa authorization exec default tacacs+ local
Switch(config)#
Switch# exit
```

In case that 'testuser1' user is registered in TACACS+ server and privilege level is set with 15, you can do EXEC shell after logging in as the following. In this case, as privilege level is more than 15, you can enter privileged mode directly.

```
Ubiquoss L3 Switch
Switch login: testuser1
Password: testuser1
Hello.
Switch#
```

Authorization of Command Execution

When you execute specific command, you can check the command execution authorization with privilege level given to command. Basically, the privilege level of each command has the privilege level of the mode that the command is executed and you can change the setting. The system can check the execution authorization of specific command with using local system or TACACS+ server.

You can set the command group for checking authorization with designating privilege level that command is executed. The system can check the executable authorization from local system or TACACS+ server about command having the relevant privilege level.

Table 10 Authorization of Command Execution

| Command | Description | Mode |
|----------------------------|--|--------|
| aaa authorization commands | Sets to do checking authorization to execute command in privilege level with TACACS+ | Config |

| | | |
|---|--|--------|
| <0-15> default tacacs+ | server. <0-15>: privilege level | |
| no aaa authorization commands <0-15> default | Sets to do not checking authorization to execute command in privilege level. <0-15>: privilege level | Config |

Checking Command Execution Authorization with TACACS+ Server

When you execute interface command in config mode, the following example shows how to do checking command execution authorization. After you set interface command with privilege level, do checking authorization about privilege level.

The following example shows how to check authorization of command execution with TACACS+.

```
Switch# configure terminal
Switch(config)# privilege config level 2 interface
Switch(config)# aaa authorization commands 2 default tacacs+
Switch(config)# end
Switch#
Switch# show command privilege
COMMAND-MODE          LEVEL    Command
=====
config                 2        interface
Switch#
```

When you execute interface command in case of authorization, the following error occurs.

```
Switch (config)# interface Vlan 1
% Command authorization failed
Switch (config)#
```

Accounting

The system can manage session access history and command execution history via accounting of AAA.

Session Access Management

You can record the system access history to TACACS+ server with the following command.

Table 11 Session Access Management

| Command | Description | Mode |
|--|--|--------|
| aaa accounting exec default (start-stop stop-only) tacacs+ | Sends system access history to TACACS+ server. start-stop: Records start-stop log stop-only: Only records stop log | Config |
| no aaa accounting exec default | Does not send system access history to TACACS+ server. | Config |

The following example shows how to send session access status to TACACS+ server.


```
Switch# configure terminal
Switch(config)# aaa accounting exec default start-stop tacacs+
```

Managing Command Execution History

When you execute specific command, you can manage execution history with TACACS+ server.

Basically, each command has privilege level, you can change the setting.

Table 12 Managing Command Execution History

| Command | Description | Mode |
|---|--|--------|
| aaa accounting commands <0-15> default tacacs+ | Records command execution history having relevant privilege level to TACACS+ server. <0-15>: privilege level. | Config |
| no aaa accounting commands <0-15> default | Does not record command execution history having relevant privilege level to TACACS+ server. <0-15>: privilege level. | Config |

Command Execution Status Management

The following example shows how to change privilege level of all show commands in the EXEC mode as 15 and send execution history to TACACS+ server. Basically, all commands being privilege level 15 also send the execution history to TACACS+ server.

```
Switch# configure terminal
Switch(config)# privilege exec level 15 show
Switch(config)# aaa accounting commands 15 default tacacs+
Switch(config)# end
Switch#
Switch# show command privilege
COMMAND-MODE      LEVEL   Command
=====
config             15      show
Switch#
```

Privilege level Configuration

The system can do authorization and accounting function about the specific command via privilege level. In case that you do not set the privilege level about specific command, each command refers to the executed mode of the privilege level.

Table 13 Privilege level Configuration

| Command | Description | Mode |
|---|---|------------|
| privilege <i>node</i> level <0-15> <i>command</i> | Assigns privilege level about specific command. <0-15>: privilege level | Config |
| no privilege <i>node</i> level <0-15> <i>command</i> | Changes privilege level to default value about specific command. Default: privilege level of command execution mode. | Config |
| show command privilege | Shows the current information. | Privileged |

Server Configuration

U9016B provide features such as authentication through remote server, authorization, and account management to control RADIUS or TACACS+ server. The following is configurations of RADIUS and TACAS+ server.

RADIUS Server Configuration

Table 14 RADIUS Server Configuration Commands

| Command | Description | Mode |
|---|---|--------|
| radius-server host <i>A.B.C.D</i> [key [0 7] <i>key-string</i>] | Sets RADIUS server. <i>A.B.C.D</i> : RADIUS server address key: Sets encryption key. 0 – Does not encryption 7 – DES encryption | Config |
| no radius-server host <i>A.B.C.D</i> | Deletes the set RADIUS server. <i>A.B.C.D</i> : RADIUS server address | Config |
| radius-server host <i>A.B.C.D</i> [auth-port <i>PORT</i>] | Sets RADIUS server and auth-port for using to server. <i>A.B.C.D</i> : RADIUS server address <i>PORT</i> : auth-port number | Config |
| no radius-server host <i>A.B.C.D</i> auth-port <i>PORT</i> | Sets auth-port for using to server with default value. Default: 1812 | Config |
| radius-server key [0 7] <i>key-string</i> | Sets common encryption key for using when the system connects to RADIUS server. | Config |
| no radius-server key | Deletes common encryption key. | Config |
| radius-server retransmit <i>count</i> | Sets count retransmitting AAA information to RADIUS server. <i>count</i> : Sets count number. | Config |
| no radius-server retransmit | Sets retransmitting number with default value. Default: 3 times | Config |
| radius-server timeout <i>seconds</i> | Sets timeout from RADIUS server. <i>seconds</i> : Timeout setting with second | Config |
| no radius-server timeout | Sets timeout with default value. Default: 5 seconds | Config |
| ip radius source-interface <i>ifname</i> | Sets source IP address of information for sending to RADIUS server. <i>ifname</i> : interface name information | Config |
| no ip radius source-interface | Disables the set source IP address. | Config |

The following example shows how to set some RADIUS server and common secret key with test 123. It sends AAA information to server. If the system does not receive response, it tries to send to next RADIUS server.

```
Switch# configure terminal
Switch(config)# radius-server host 192.168.0.1
Switch(config)# radius-server key test123
Switch(config)# radius-server host 192.168.0.2 key Ins
```

```
Switch(config)# radius-server host 192.168.0.2 auth-port 3000
Switch(config)# end
Switch# show running-config
!
radius-server key test123
radius-server host 192.168.0.1
radius-server host 192.168.0.2 key lns
radius-server host 192.168.0.3 auth-port 3000
!
Switch#
```

TACACS+ Server Configuration

You can set several TACACS+ servers. In the event of authentication fail due to communication with the primary server, authentication will be carried out in the secondary server.

Table 15 TACACS+ Server Commands

| Command | Description | Mode |
|--|---|--------|
| tacacs-server host <i>A.B.C.D</i> key [0 7] <i>key-string</i> | Sets TACACS+ server. <i>A.B.C.D</i> : TACACS+ server address key: Sets security key. 0 – None Encryption 7 – DES Encryption | Config |
| no tacacs-server host <i>A.B.C.D</i> | Deletes tacacs+ server setting. <i>A.B.C.D</i> : TACACS+ server address | Config |
| tacacs-server host <i>A.B.C.D</i> timeout <i>seconds</i> | Sets timeout value with TACACS+ server. <i>seconds</i> : Timeout value | Config |
| tacacs-server host <i>A.B.C.D</i> timeout | Sets default timeout Default: 5 seconds | Config |
| ip tacacs source-interface <i>ifname</i> | Sets source IP address of information sent to TACACS+ server. <i>ifname</i> : Interface name | Config |
| no ip tacacs source-interface | Remove source IP address. | Config |

The following example shows how to set TACACS+ Server.

```
Switch# configure terminal
Switch(config)# tacacs-server host 192.168.0.1 key lns
Switch(config)# tacacs-server host 192.168.0.2 key test123
Switch(config)# end
Switch# show running-config
tacacs-server host 192.168.0.1 key lns
tacacs-server host 192.168.0.2 key test123
!
Switch#
```

Setting Hostname

Hostname can be used to identify systems during the operation, and the prompt of the console/Telnet screen consists of the combination of hostname and current command mode. In U9016B switch, the system model name is the default hostname and the administrator can change the default hostname to a new hostname.

Table 16 Commands for Setting Hostname

| Command | Description | Mode |
|------------------------|------------------------------------|--------|
| hostname <i>string</i> | Changes hostname | Config |
| no hostname | Changes hostname with default name | Config |

The following example shows how to set or change the hostname.

```
Switch# configure terminal
Switch(config)# hostname U9016B
U9016B(config)# end
U9016B#
U9016B# configure terminal
U9016B(config)# no hostname
Switch(config)# end
Switch#
```

SNMP (Simple Network Management Protocol)

SNMP network manager can manage the switch that provides Management Information Base (MIB). The network manager provides user interface for easy management purpose. You have to properly configure the environment of switch in order to use the SNMP manager to manage the system.

SNMP Configuration

The following commands are for setting SNMP configuration.

Table 17 Commands for Setting SNMP Configuration

| Command | Description | Mode |
|------------------------------------|---|--------|
| snmp-server contact <i>string</i> | Enters the information of system manager | Config |
| no snmp-server contact | Deletes the information of system manager | Config |
| snmp-server location <i>string</i> | Enters the location information where switch is installed. | Config |
| no snmp-server location | Deletes Input the location information where switch is installed. | Config |

The following example shows how to set the information of system manager.

```
Switch# configure terminal
Switch(config)# snmp-server contact "gil-dong hong. hong@ubiquoss.com"
Switch(config)# end
Switch# show running-config
!
snmp-server contact "gil-dong hong. hong@ubiquoss.com"
!
Switch#
```

The following example shows how to set the system location information

```
Switch# configure terminal
Switch(config)# snmp-server location "jungdaero, songpagu, Seoul."
Switch(config)# end
Switch# show running-config
!
snmp-server location "jungdaero, songpagu, Seoul."
!
Switch#
```

SNMP Community

Network Operator can access SNMP agent and read or write MIB information. In connecting SNMP agent, network manager is authenticated as community. There are two types of community strings on U9016B switch.

Read-only community

- Access to the system in read-only mode

Read-write community

- Access to the system in read and write mode

Table 18 Setting SNMP Community

| Command | Description | Mode |
|--|---|--------|
| snmp-server community <i>string</i> [<i>access-type</i>] <i>view view-name</i> <1-99>] | Set the SNMP community access-type: SNMP Agent access type ro: read only rw: read write View: designates MIB access scope, the detail information refers to snmp-server view setting. <1-99>: Applies access-list about access host. | Config |
| no snmp-server community <i>string</i> | Deletes SNMP community. | Config |

The following example shows how to set 'testcom' community of read-write access type.

```
Switch# configure terminal
Switch(config)# snmp-server community testcom rw 99
Switch(config)# end
Switch# show running-config
!
snmp-server community testcom rw access-class 99
!
Switch#
```

SNMP Trap host

The system can provide the event like system running error or system status change to network manager with setting trap. The system provides the following trap version. Basically, if you can not set trap command or trap host, the trap does not occur.

SNMPv1 Trap

SNMPv2c Trap

- Basic trap version

SNMPv3 Trap

- Supports authentication and encryption function, you can set security model.
 1. noAuth: does not authentication and encryption.
 2. Auth: does authentication.
 3. Priv: does authentication and encryption.

Table 19 Commands for Setting SNMP Trap Host

| Command | Description | Mode |
|---|--|--------|
| snmp-server trap-host <i>A.B.C.D</i> [version 1 2c 3 <i>sec-level</i>] <i>community-string</i> | Sets the host for sending trap. <i>A.B.C.D</i> : trap host address version: trap version (Default: 2c) <i>sec-level</i> : In case of trap version , sets security model. <i>community-string</i> : community configuration | Config |
| no snmp-server trap-host <i>A.B.C.D</i> [version 1 2c 3 <i>sec-level</i>] <i>community-string</i> | Deletes trap host | Config |
| snmp-server trap-source <i>ifname</i> | Sets source IP address of trap for sending. <i>ifname</i> : interface name | Config |
| no snmp-server trap-source | Removes source IP address | Config |

Table 20 Commands for Setting Enable Basic SNMP Trap

| Command | Description | Mode |
|--|--|--------|
| snmp-server enable traps alarm [fallingAlarm risingAlarm] | Enables trap for sending RMON alar. | Config |
| no snmp-server enable traps alarm [fallingAlarm risingAlarm] | Disables trap for sending RMON alarm. | Config |
| snmp-server enable traps envmon [ext-supply fan supply temperature] | Enables trap for sending system environment (fan, power, etc) information. | Config |
| no snmp-server enable traps envmon [ext-supply fan supply temperature] | Disables trap for sending system environment (fan, power, etc) information. | Config |
| snmp-server enable traps fru-ctrl | Enables trap for sending module, slot status information. | Config |
| no snmp-server enable traps fru-ctrl | Disables trap for sending module, slot status information. | Config |
| snmp-server enable traps interface | Enables trap for sending interface information. | Config |
| no snmp-server enable traps interface | Disables trap for sending interface information. | Config |
| snmp-server enable traps resource [cpu-load-monitor memory-free-monitor] | Enable trap for sending system resource information. | Config |
| no snmp-server enable traps resource [cpu-load-monitor memory-free-monitor] | Disables trap for sending system resource information. | Config |
| snmp-server enable traps snmp [coldStart warmStart authFail] | Enables trap for sending Cold start, warm start, authentication failure information. | Config |

| | | |
|--|--|--------|
| no snmp-server enable traps snmp [coldStart warmStart authFail] | Disables trap for sending Cold start, warm start, authentication failure. | Config |
|--|--|--------|

SNMP Trap

The following example shows how to set to send trap of fan, power, and temperature information to 192.168.0.1 host.

```
Switch# configure terminal
Switch(config)# snmp-server host 192.168.0.1 public
Switch(config)# snmp-server enable traps envmon
Switch(config)# snmp-server enable traps snmp
Switch#(config)# end
Switch# show running-config
!
snmp-server enable traps interface
snmp-server enable traps envmon fan supply temperature ext-supply
snmp-server host 192.168.0.1 version 2c public
!
Switch#
```

SNMPv3 Configuration

The system provides SNMPv3 for system management. SNMPv3 provides authentication about user and encryption about data.

Table 21 Commands for Setting SNMPv3

| Command | Description | Mode |
|--|--|------------|
| snmp-server engineID <i>engineid-string</i> | Sets engine ID for dividing SNMP agent only. In case of changing SNMP engineID, you again set the set user because user setting makes MD5 and security digest of SHA using engine ID. | Config |
| no snmp-server engineID | Sets Engine ID with default value made automatically. Default value is made by enterprise OID (1.3.6.1.4.1.7800) of our company and first MAC address of system. | Config |
| show snmp engineID | Shows Engine ID. | Privileged |
| snmp-server group <i>groupname</i> {v1 v2c v3 <i>sec-level</i> } [read <i>read-view</i>] write <i>write-view</i>] | Sets SNMP group. <i>group-name</i> : Group name v1, v2c, v3: Group version <i>sec-level</i> : In case of trap version 3, sets security model. read: Read view setting. In case that you do not specify Read-view, the system sets default value with internet (1.3.6.1). write: Write view setting | Config |
| no snmp-server group | Deletes SNMP group | Config |

| | | |
|---|--|------------|
| <i>groupname</i> {v1 v2c v3 <i>sec-level</i> } | | |
| show snmp group | Displays SNMP group | Privileged |
| snmp-server user <i>username</i> <i>groupname</i> {v1 v2c v3 [auth (md5 sha) <i>auth-passwd</i>] [priv (des aes) <i>priv-passwd</i>] [access <1-99>]} | Sets SNMP user v1, v2c, v3: User versions auth: In case of SNMPv3, the system can do user authentication and you can set MD5 or SHA with the encryption ways. Auth-passwd: password setting for authentication. priv: You can encrypt SNMP PDU, set DES or AES with the encryption ways. priv-passwd: Setting password for encryption. access: applies access-list about user. <1-99> : IP standard access list | Config |
| no snmp-server user <i>username</i> <i>groupname</i> {v1 v2c v3} | Removes SNMP user | Config |
| show snmp user | Shows SNMP user. | Privileged |
| snmp-server view <i>viewname</i> <i>viewoid</i> {excluded included} | Sets SNMP view. <i>viewoid</i> : Designates scope of MIB that can do read / write function with User or community and can designate MIB name or OID. excluded included: Sets viewoid excluded or included. | Config |
| no snmp-server view <i>viewname</i> <i>viewoid</i> | Deletes SNMP view | Config |

SNMP engineID

The following example shows how to change SNMP engine ID of the system. If SNMPv3 user is already set, after you change engine ID, the network manager can access as relevant user.

```
Switch# show snmp engineID
Local SNMP engineID: 0x80001f8880236ed0864b7a760f
Switch#configure terminal
Switch(config)# snmp-server engineID 0x1234567890
Switch(config)# exit
Switch#
Switch# show snmp engineID
Local SNMP engineID: 0x1234567890
Switch#
```

User of SNMPv3

The following example shows how to make 'testuser' user that does authentication and encryption. 'testgroup' includes 'testuser', it apply 'testview' that reads or writes ifEntry(1.3.6.1.2.1.2.2.1).

```
Switch# configure terminal
Switch(config)# snmp-server user testuser testgroup v3 auth md5 mysecretpass priv
des myprivpass
Switch(config)# snmp-server group testgroup v3 priv read testview write testview
Switch(config)# snmp-server view testview 1.3.6.1 included
Switch(config)# snmp-server view testview 1.3.6.1.2.1.2.2.1 excluded
Switch#(config)# end
Switch# show running-config
!
snmp-server group testgroup v3 priv read readview write writeview
snmp-server view testview 1.3.6.1 included
snmp-server view testview 1.3.6.1.2.1.2.2.1 excluded
!
Switch#
Switch# show snmp user

User name : testuser
Engine ID : 0x80001f8880236ed0864b7a760f
storage-type: nonvolatile          active
Authentication Protocol: MD5
Group-name: testgroup
```

**Notice**

Because of password security of SNMPv3, user setting does not show with **show running-config** command. You can make sure **show snmp user** command.

ACL (Access Control List)

ACL enables the network manager to control the traffic delivered through the inter-network very closely. The manager can get the basic statistic data on the state of packet transmission and establish a security policy based on the data. In addition, the manager can protect the system from unauthorized accesses. ACL can be used to allow or reject the packets from the router, or can be used to access the router through Telnet (vty) or SNMP.

Access list is classified into the standard IP access list and the extended IP access list, each of which is assigned the numbers of <1-99>.

Table 22 Commands for setting ACL (Access Control List)

| Command | Description | Mode |
|---|---|--------|
| access-list <1-99> {deny permit} address | Set up the standard IP access list Set up the Source address/network only <i>address ::= {any A.B.C.D A.B.C.D host A.B.C.D}</i> | Config |
| no access-list <1-99> | Delete the access list | Config |

Rules for ACL Creation

- Declare the access list with smaller range first.
- Declare the access list that satisfies the condition more frequently first.
- If you don't specify 'permit any' at the end of an access-list, 'deny any' is set up as default.
- When you declare the conditions of an access list in many lines, you cannot delete or modify anything between lines, and the condition newly added will be added as the last line.

Configuration of Standard IP Access List

Permit any access

```
Switch# configure terminal
Switch(config)# access-list 1 permit any
Switch(config)# end
Switch# show running-config
!
access-list 1 permit any
!
```

Deny any access

```
Switch# configure terminal
Switch(config)# access-list 1 deny any
Switch(config)# end
Switch# show running-config
!
access-list 1 deny any
!
```

Permit the Access from a Specific Host Only

```
Switch# configure terminal
Switch(config)# access-list 1 permit host 192.168.0.3
Switch(config)# end
Switch# show running-config
!
access-list 1 permit host 192.168.0.3
!
```

Permit the Access from a Specific Network Only

```
Switch# configure terminal
Switch(config)# access-list 1 permit 192.168.0.0 255.255.255.0
Switch(config)# end
Switch# show running-config
!
access-list 1 permit 192.168.0.0 255.255.255.0
!
```

Deny the Access from a Specific Network Only

```
Switch# configure terminal
Switch(config)# access-list 1 deny 192.168.0.1 255.255.255.0
Switch(config)# access-list 1 permit any
Switch(config)# end
Switch# show running-config
!
access-list 1 deny 192.168.0.0 255.255.255.0
access-list 1 permit any
!
```

Configuration of Access List for Telnet Connection

Access list is applied by user and the configured access list can be set to permit/limit from remote access. The commands shown below are used to configure access list for Telnet connection.

The following example shows the procedure in case of creating access list allowing 192.168.0.0/24 network to access the switch and limiting the telnet access:

```
Switch# configure terminal
Switch(config)# access-list 1 permit 192.168.0.0 255.255.255.0
Switch(config)# username admin access-class 1
Switch# show running-config
username admin privilege 15 password 0 admin
username admin access-class 1
access-list 1 permit 192.168.0.0 255.255.255.0
Switch#
```

Banner Configuration

U9016B switch can register login banner and MOTD banner. Login banner is message displayed before user log in the system, MOTD banner is message displayed after logging in the system. You can send message like cautions to user via banner.

Table 23 Command for Login Banner and MOTD Banner

| Command | Description | Mode |
|--|--|--------|
| banner login <i>banner-string</i> | Registers login banner. <i>banner-string</i> : login banner message | Config |
| banner login default | default: default setting banner | |
| no banner login | Deletes login banner. | Config |
| banner motd <i>banner-string</i> | Registers MOTD banner. <i>banner-string</i> : MOTD banner message | Config |
| banner motd default | default: default MOTD banner message | |
| no banner motd | Deletes MOTD banner. | Config |

The system is basically registered as follows:

| | |
|---------------------------|-----------------|
| Ubiquoss L3 Switch | <- Login Banner |
| Switch login: root | |
| Password: | |
| Hello. | <- MOTD Banner |
| Switch >enable | |
| Switch # | |

The following example shows how to change logging in banner. The banner can enter several lines.

The banner message is registered while the same end-character appears with start-character.

Switch# configure terminal

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

Switch(config)# banner login

Enter TEXT message. End with the character '^'.

Ubiquoss U9016B Switch

Login Banner TEST!

Switch(config)#

Switch(config)#exit

Switch#**show running-config**

!

banner login

Ubiquoss U9016B Switch

Login Banner TEST!

!



Notice

When you make sure the set banner with '**show running-config**' command, start character and end character are '^C'

The following example shows the Login banner when logging in.

Ubiquoss U9016B Switch

Login Banner TEST!

Switch login: root

Password:

Hello.

Switch >

AFSMGR (Alarm Fault Status Manager)

AFS manager provides the log masking, report masking, fault class setting and management about Alarm, Status, and fault message in SNMP trap event occurring from system. Moreover it provides searching about current occurred fault and past history.

Setting AFS Alarm

Table 24 Commands for Setting AFS

| Command | Description | Mode |
|---|--|--------|
| <code>afs current clear [alarm-index]</code> | Clears alarm that does not clear in the AFS event. <i>alarm-index</i> : index <1-99999> | Config |
| <code>afs history clear</code> | removes the history of AFS event | Config |
| <code>afs mask enable/disable [afs-type [event-type [afs-id]]]</code> | Enables or disables the masking function about AFS event. If Masking enables, the event dose not occur. <i>afs-type</i> : type of message (alarm, fault, status) <i>event-type</i> : type of event (communications, environment, equipment, processing, protocol, qos, security) <i>afs-id</i> : A01001, S01001, F01001,... | Config |
| <code>afs severity critical major minor afs-id</code> | Changes class about AFS event. <i>afs-id</i> : A01001, S01001, F01001,... | Config |
| <code>afs snmp enable/disable [afs-type [event-type [afs-id]]]</code> | Enables or disables snmp trap reporting about AFS event. If SNMP trap reporting enable, the SNMP trap does not occur. <i>afs-type</i> : type of message (alarm, fault, status) <i>event-type</i> : type of event (communications, environment, equipment, processing, protocol, qos, security) <i>afs-id</i> : A01001, S01001, F01001,... | Config |
| <code>afs factory-default running-config [mask snmp]</code> | Changes the mask set to current afs running-config and snmp value with default-config. <i>mask</i> : changes mask configuration only <i>snm</i> : changes snmp configuration only | |

Clear AFS Alarm Event

You can forcibly clear about Alarm that the error is not clear while AFS Event.

```
Switch# show afs current
```

```
-----
no      id      type      level     date
-----
3       A04003  processing major     2006-09-07 10:43:59
-----
```

```
Switch# show afs current 3
```

```
-----
Probable Cause      MEMORY OVERLOAD ALARM
ID                  A04003
Type                processing
Level              major
Date               2006-09-07 10:43:59
Physical Location   sys<1>
Logical Location
Additional Text     vlaue<45> thres<50>
-----
```

```
Switch# configure terminal
```

```
Switch(config)# afs current clear
```

```
Switch# show afs current
```

```
-----
no      id      type      level     date
-----
-----
```

```
Switch#
```

Clearing AFS history

You can clear AFS history. The following example shows how to clear AFS history.

```
Switch# show afs history
```

```
2006-08-06 09:21:22 A04002 processing maj on sys<1> vlaue<4> thres<1>
2006-08-06 09:21:22 A04001 processing maj on sys<1> vlaue<4> thres<3>
2006-08-06 09:21:22 A04003 processing maj on sys<1> vlaue<49> thres<50>
2006-08-06 09:21:23 A01002 equipment maj off sys<1>
```

```
Switch# configure terminal
```

```
Switch(config)# afs history clear
```

```
Switch# show afs history
```

```
##### start history #####
```

```
Switch#
```

Setting AFS Masking Function

In AFS event, you can set AFS masking about specific event. Before the event set masking clears masking, any message does not occur.

Switch# **show afs running-config**

| ID | Type | Level | Mask | Snmp | Desc |
|--------|-----------|----------|---------|--------|-------------------------|
| A01001 | equipment | critical | disable | enable | system cold start alarm |
| A01002 | equipment | major | disable | enable | system warm start alarm |

Switch# **configure terminal**

Switch(config)# **afs mask enable alarm**

Switch(config)# **afs mask enable status equipment**

Switch(config)# **afs mask enable fault qos F03023**

Switch(config)# **end**

Switch# **show running-config**

!

afs snmp enable alarm equipment A01001

afs snmp enable alarm equipment A01002

afs snmp enable status equipment S01003

afs snmp enable status equipment S01006

afs snmp enable fault qos F03023

!

Switch# **show afs running-config**

| ID | Type | Level | Mask | Snmp | Desc |
|--------|-----------|----------|---------|--------|-------------------------|
| A01001 | equipment | critical | enable | enable | system cold start alarm |
| A01002 | equipment | major | disable | enable | system warm start alarm |

Switch#



Notice

Default value is disabled in Masking setting and follows setting value of default-config.

The default value of some message (S02009, S06002, and F02003) is enabled.

Setting AFS Severity Class

In the middle of AFS event you can change the alarm level of the event.

Switch# **show afs running-config**

| ID | Type | Level | Mask | Snmp | Desc |
|--------|-----------|----------|---------|--------|-------------------------|
| A01001 | equipment | critical | disable | enable | system cold start alarm |

```
A01002 equipment major disable enable system warm start alarm
```

```
Switch# configure terminal
```

```
Switch(config)# afs severity major A01001
```

```
Switch(config)# end
```

```
Switch# show running-config
```

```
!
```

```
afs severity major A01001
```

```
!
```

```
Switch# show afs running-config
```

| ID | Type | Level | Mask | Snmp | Desc |
|--------|-----------|-------|---------|--------|-------------------------|
| A01001 | equipment | major | disable | enable | system cold start alarm |
| A01002 | equipment | major | disable | enable | system warm start alarm |

```
Switch#
```



Notice Error class obeys the set value of AFS default-config.

Setting AFS SNMP Trap

You can set SNMP Trap about AFS event. Moreover, you can set about All of AFS event or according to each event.

```
Switch# show afs running-config
```

| ID | Type | Level | Mask | Snmp | Desc |
|--------|-----------|----------|---------|--------|---------------------------|
| A01001 | equipment | critical | disable | enable | system cold start alarm |
| A01002 | equipment | major | disable | enable | system warm start alarm |
| S01003 | equipment | warning | disable | enable | slot status change |
| S01006 | equipment | warning | disable | enable | gbic status change |
| F03023 | QoS | warning | disable | enable | crc count threshold alarm |

```
Switch# configure terminal
```

```
Switch(config)# afs snmp disable alarm
```

```
Switch(config)# afs snmp disable status equipment
```

```
Switch(config)# afs snmp disable fault qos F03023
```

```
Switch(config)# end
```

```
Switch# show running-config
```

```
afs snmp disable alarm equipment A01001
```

```
afs snmp disable alarm equipment A01002
```

```
afs snmp disable status equipment S01003
```

```
afs snmp disable status equipment S01006
```

```
afs snmp disable fault qos F03023
```

```
Switch# show afs running-config
```

| ID | Type | Level | Mask | Snmp | Desc |
|---------|-----------|----------|---------|---------|---------------------------|
| A01001 | equipment | critical | disable | disable | system cold start alarm |
| A01002 | equipment | major | disable | disable | system warm start alarm |
| S01003 | equipment | warning | disable | disable | slot status change |
| S01006 | equipment | warning | disable | disable | gbic status change |
| F03023 | QoS | warning | disable | disable | crc count threshold alarm |
| Switch# | | | | | |

**Notice**

Default snmp trap setting is disabled. It obeys AFS default-config value.

Changing AFS Configuration with default-config

You can change afs mask and snmp setting value in running to the current system. You can also change mask or snmp choicely.

Switch# show afs default-config

| ID | Type | Level | Mask | Snmp | Desc |
|--------|---------------|----------|---------|---------|-------------------------|
| A01001 | equipment | critical | disable | disable | system cold start alarm |
| A01002 | equipment | major | disable | disable | system warm start alarm |
| A01006 | equipment | major | disable | disable | power alarm |
| A01007 | equipment | critical | disable | disable | fan alarm |
| A01014 | equipment | critical | disable | disable | olt alarm |
| A02004 | communication | major | disable | disable | onu ld shutdown |
| A02005 | communication | critical | disable | disable | olt dying gasp alarm |
| A02006 | communication | critical | disable | disable | olt link fault alarm |

Switch# show afs running-config

| ID | Type | Level | Mask | Snmp | Desc |
|--------|---------------|----------|---------|---------|-------------------------|
| A01001 | equipment | critical | disable | disable | system cold start alarm |
| A01002 | equipment | major | enable | enable | system warm start alarm |
| A01006 | equipment | major | enable | disable | power alarm |
| A01007 | equipment | critical | enable | enable | fan alarm |
| A01014 | equipment | critical | disable | disable | olt alarm |
| A02004 | communication | major | disable | disable | onu ld shutdown |
| A02005 | communication | critical | disable | disable | olt dying gasp alarm |
| A02006 | communication | critical | disable | disable | olt link fault alarm |

Switch# configure terminal

Switch(config)# afs factory-default running-config

Switch(config)# **end**

Switch# show afs running-config

| ID | Type | Level | Mask | Snmp | Desc |
|--------|-----------|----------|---------|---------|-------------------------|
| A01001 | equipment | critical | disable | disable | system cold start alarm |
| A01002 | equipment | major | disable | disable | system warm start alarm |

| | | | | | |
|--------|---------------|----------|---------|---------|----------------------|
| A01006 | equipment | major | disable | disable | power alarm |
| A01007 | equipment | critical | disable | disable | fan alarm |
| A01014 | equipment | critical | disable | disable | olt alarm |
| A02004 | communication | major | disable | disable | onu ld shutdown |
| A02005 | communication | critical | disable | disable | olt dying gasp alarm |
| A02006 | communication | critical | disable | disable | olt link fault alarm |

Chapter 2. Interface

This chapter describes the Interface of the system.

Overview

The interfaces supported in U9016B switch are as follows.

Table 25 Interfaces supported in U9016B switch

| Interface | Type |
|-----------------------|--|
| Physical interfaces | Gigabit Ethernet <ul style="list-style-type: none">• 1000Base-T• 1000Base-X GE-PON InterfaceGPON Interface <ul style="list-style-type: none">• 2.5G 10 Gigabit Ethernet <ul style="list-style-type: none">• 10000Base-X |
| port-group interfaces | Port-group |
| VLAN Interfaces | VLAN |
| Loopback interface | Loopback |
| Management interface | Out of band interface for management |

To configure the interface environment, the following processes shall be performed in advance.

- Enter the config mode from the privileged mode using “configure terminal” command.
- Enter into the interface mode using “interface” command.
- Use the configuration commands for a particular interface.

Common Commands

The commands commonly used in Interface Configurations are as follows.

Table 26 Common Commands

| Command | Description |
|----------------------------------|---|
| interface <i>IFNAME</i> | <ul style="list-style-type: none"> Enters into the Interface. <i>IFNAME</i>: Name of specific interface for configuration. |
| description <i>string</i> | <ul style="list-style-type: none"> Registers descriptions for the interface. <i>string</i>: Description of the interface within the length of 80 characters |
| no description | <ul style="list-style-type: none"> Deletes the description of interface registered. |

Interface name

U9016B switch uses interface name in all interface configurations. Interface name consists of interface type identifier and interface ID as shown below.

Table 27 Interface name

| Interface | Interface type | Interface name | Example |
|----------------------|---------------------|--------------------------|-----------|
| Physical interface | Gigabit Ethernet | "Gi" + slot_id + port_id | Gi1/1 |
| | 10 Gigabit Ethernet | "Te" + slot_id + port_id | Te1/1 |
| | Gpon interface | "Gp" + slot_id + port_id | Gp1/1 |
| | EPON Interface | "Ep" + slot_id + port_id | Ep1/1 |
| Port-group interface | Port group | "po" + port-group id | po1 |
| VLAN interface | VLAN | "vlan" + vlan id | Vlan10 |
| Loopback interface | Loopback | "lo" + id | Loopback0 |
| Management interface | Fast Ethernet | "eth" + id | eth0 |

Interface id

Interface name consists of interface type and id. The following shows the naming of U9016B switch interface and range supported.

Table 28 Interface ID and range supported

| Model | Interface Type | ID | ID Range | Name |
|-------|---------------------|-------------------|-------------------------------|-----------|
| U9264 | Gigabit Ethernet | slot_id + port_id | slot_id: 1-12 port_id: 1-8 | Gi1/1 |
| | 10 Gigabit Ethernet | slot_id + port_id | slot_id: 1-12 port_id: 1-8 | Te1/1 |
| | Gpon Interface | slot_id + port_id | slot_id: 1-12 port_id: 1-8 | Gp1/1 |
| | Port group | port-group id | 1 – 256 | po1, po30 |
| | VLAN | vlan id | 1 – 4094 | Vlan1 |
| | LoopBack | interface id | 0 – 3 | Loopback0 |
| | management | interface id | 0 | eth0 |

Interface mode prompt

When you enter the interface mode with interface command, the following prompt will be displayed on the screen. You can configure and change interface environment in the interface mode.

```
Switch (config-if-Giga5/1)#
```

Description Command

The description command is used to add description on each interface. The description is the comment used to help the administrator remind of something and you can see the result with "show interfaces" command.

Show Interface Information

The following commands are used to view the interface configuration information, the status information, and the statistic data.

Table 29 Interface information and status related commands

| Command | Description | Mode |
|---|--|------------|
| show interface <i>IFNAME</i> | Shows the configuration, status, and statistics information of the interface. | Privileged |
| show interface status | Shows the link status, speed, duplex information of the physical interface. | Privileged |
| show interface transceiver [detail] | Shows DDM (Digital Diagnostic Monitoring) information of the physical interface. | Privileged |
| show idprom all show idprom <i>fru-type</i> show idprom interface <i>IFNAME</i> | <ul style="list-style-type: none">Shows system FRU information.all: Shows all the FRU type information<i>fru-type</i>: Shows the information of each FRU typeinterface <i>IFNAME</i>: Shows the interface information | Privileged |

Show Interface Command

Show interface command is used to view the interface configuration information, the link status, and the interface-related statistics. **Show interface** command shows the information on all the interfaced defined.

Switch# **show interface**

```
Giga5/1 is down, line protocol is down (notconnect)
  Hardware is Ethernet, address is 0007.7074.ff01 (bia 0007.7074.ff01)
  index 1101 metric 1 mtu 1500 arp ageing timeout 7200
  Full-duplex, Auto-speed, media type is 1000BaseLX
  <UP,BROADCAST,MULTICAST>
  VRF Binding: Not bound
  Bandwidth 1g
  inet 10.2.1.1/16 broadcast 10.2.255.255
  VRRP Master of : VRRP is not configured on this interface.
  Last clearing of "show interface" counters never
  60 seconds input rate 0 bits/sec, 0 packets/sec
  60 seconds output rate 0 bits/sec, 0 packets/sec
  L2/L3 in Switched: ucast 0 pkt - mcast 0 pkt
  L2/L3 out Switched: ucast 0 pkt - mcast 0 pkt
    0 packets input, 0 bytes
    Received 0 broadcast pkt (0 multicast pkt)
    0 CRC, 0 oversized, 0 dropped
    0 packets output, 0 bytes
    0 collisions
```

0 late collisions, 0 deferred

-- More--

Show Interface Status Command

This command is used to show the link, shutdown status, auto negotiation mode, speed/duplex mode, flow control, and interface type of all the physical interfaces.

Switch# **show interface status**

| Port | Name | Status | Vlan | Duplex | Speed | Type |
|--------|------------------|------------|------|--------|--------|----------------|
| Gp1/1 | | notconnect | 1 | full | auto | No Transceiver |
| Gp1/2 | | notconnect | 1 | full | auto | No Transceiver |
| Gp1/3 | | notconnect | 1 | full | auto | No Transceiver |
| Gp1/4 | | notconnect | 1 | full | auto | No Transceiver |
| Gp1/5 | | notconnect | 1 | full | auto | No Transceiver |
| Gp1/6 | | notconnect | 1 | full | auto | No Transceiver |
| Gp1/7 | | notconnect | 1 | full | auto | No Transceiver |
| Gp1/8 | | notconnect | 1 | full | auto | No Transceiver |
| Gi5/1 | 10/100/1000BaseT | notconnect | 700 | full | auto | |
| Gi5/2 | 10/100/1000BaseT | notconnect | 700 | full | auto | |
| Gi5/3 | 10/100/1000BaseT | connected | 100 | full | a-1000 | |
| Gi5/4 | 10/100/1000BaseT | connected | 100 | full | a-1000 | |
| Gi5/5 | 10/100/1000BaseT | connected | 200 | full | a-1000 | |
| Gi5/6 | 10/100/1000BaseT | connected | 200 | full | a-1000 | |
| Gi5/7 | 10/100/1000BaseT | notconnect | 700 | full | auto | |
| Gi5/8 | 10/100/1000BaseT | notconnect | 700 | full | auto | |
| Gi10/1 | | connected | 100 | full | a-1000 | 1000BaseLX |
| Gi10/2 | | connected | 200 | full | a-1000 | 1000BaseLX |
| Gi10/3 | | notconnect | 1 | full | auto | No Transceiver |
| Gi10/4 | | notconnect | 1 | full | auto | No Transceiver |
| Gi10/5 | | notconnect | 1 | full | auto | No Transceiver |
| Gi10/6 | | notconnect | 1 | full | auto | No Transceiver |
| Gi10/7 | | notconnect | 1 | full | auto | No Transceiver |
| Gi10/8 | | notconnect | 1 | full | auto | No Transceiver |

Show idprom Command

show idprom command shows FRU(Field Replaceable Unit) information of the system. U9016B switch can show the information for the below FRU types.

- Chassis
- FAN
- FMU
- Module
- SCU
- PMU
- Power
- Slot
- Tranceiver

The following is the example of showing all the FRU type of system using **show idprom all**.

```
Switch# show idprom all
IDPROM for chassis
  Name = 'UbiQuoss Evolution'
  Description = 'UbiQuoss Chassis System'
  SNMP index = '1'

IDPROM for scu 1
  Name = 'Physical Module SCU 1'
  Description = 'UbiQuoss Physical Module SCU 1'
  SNMP index = '2'

IDPROM for slot 1
  Name = 'Physical Slot 1'
  Description = 'UbiQuoss Physical Slot 1'
  SNMP index = '10'

IDPROM for slot 5
  Name = 'Physical Slot 1'
  Description = 'UbiQuoss Physical Slot 1'
  SNMP index = '14'

IDPROM for slot 10
  Name = 'Physical Slot 1'
  Description = 'UbiQuoss Physical Slot 1'
  SNMP index = '19'

... Omitted intentionally ...
```

Physical Port Configuration

The following commands are used for the configuration of physical ports.

Table 30 Physical port configuration commands

| Command | Description | Mode |
|---|---|-----------|
| shutdown no shutdown | Disables/enables the physical port | Interface |
| speed {10 100 1000} speed auto | Speed setting (Unit: Mbps) | Interface |
| duplex {full half} | Duplex mode setting | Interface |
| flowcontrol (send receive) (on off) flowcontrol both no flowcontrol | flow-control On and Off | Interface |
| carrier-delay <0-60> carrier-delay msec <0-1000> | Sets Carrier-delay in second unit or in ms unit | Interface |



Notice Those commands are not shown in GPON interface.

Shutdown

This command is to disable the physical port. To check the shutdown status of the physical port, use **show interface command**.

Switch # **configure terminal**

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

Switch (config)# **interface GigabitEthernet 5/1**

Switch (config-if-Giga5/1)# **shutdown** <- disable port

Switch (config-if-Giga5/1)# **no shutdown** <- enable port

Switch (config-if-Giga5/1)#

Speed and Duplex

The speed options supported in each interface of U9016B switch is as follows.

Table 31 Speed and Duplex

| Type | speed | duplex |
|------------|------------------|-----------|
| 1000Base-T | 10/100/1000/auto | full/half |
| | 1000 | full |
| 1000Base-X | 1000/auto | full |
| | 1000 | full |
| 10GBase-R | 10000 | full |

When configuring Speed or duplex, note the followings.

- 10-Gigabit Ethernet and Gigabit Ethernet support full duplex only.

Flow control

U9016B switch supports IEEE 802.3x Flow control for Gigabit Ethernet, 10-Gigabitethernet interfaces. Flow control is the function not to send any packet for specific time duration by sending IEEE 802.3x pause frame to the other interface when the receive buffer of any interface is full.

The following example shows how to send IEEE 802.3x pause frame to an interface and how to receive and process it in the interface.

```
Switch# configure terminal
```

```
Switch(config)#
```

```
Switch(config)# interface Giga5/1
```

```
Switch(config-if-Giga5/1)# flowcontrol send on
```

```
Switch(config-if-Giga5/1)# flowcontrol receive on
```

```
Switch(config-if-Giga5/1)# end
```

```
Switch# show flowcontrol
```

| Port | Send FlowControl | Receive FlowControl | RxPause | TxPause |
|-----------|------------------|---------------------|---------|---------|
| | admin | oper | admin | oper |
| ----- | ----- | ----- | ----- | ----- |
| Giga1/1/1 | on | on | off | 307 154 |

```
Switch#
```

flowcontrol send on is the command to set to send IEEE 802.3x pause frames, while **flowcontrol receive on** is the command to set not to send packets for specific time period upon reception of IEEE 802.3x pause frames. Use **show flowcontrol (IFNAME)** command to check those setting. To disable the setting, use **no flowcontrol** command.

Carrier delay

When there is any link up/down event occurred in an Interface, it's possible to set not to detect it as down if the link status changes up -> down -> up within the period of time shorter than the time set by carrier delay.

```
Switch# configure terminal
```

```
Switch(config)#
```

```
Switch(config)# interface Giga5/1
```

```
Switch(config-if-Giga5/1)# carrier-delay msec 500
```

```
Switch(config-if-Giga5/1)# end
```

```
Switch#
```

To disable this setting, use **no carrier-delay** command.

Broadcast Suppression

Broadcast suppression refers to a function that limits broadcast traffic from flowing in the system in order to prevent the system overload caused by the broadcast storm. A broadcast storm refers to a phenomenon where a broadcast/multicast packet is flooded in the subnet and too much traffic deteriorates the network performance.

Errors in protocol stack implementation or in network configuration can cause the broadcast storm. Broadcast suppression measures the rate of the broadcast traffic on the subnet, compares the value with the threshold, and discards the broadcast traffic over the threshold.

Table 32 Broadcast Suppression

| Command | Description | Mode |
|---|--|-----------|
| storm-control (<i>broadcast/multicast/unicast</i>) | Suppression of Multicast, broadcast, unicast, packet | Interface |
| storm-control level LEVEL no storm-control level | Sets broadcast suppression rate | Interface |

To set Broadcast suppression, it's required to set the rate first. Then the setting for the traffic is required.

The following example shows a configuration of storm-control.

Switch # **configure terminal**

Switch(config)#

Switch(config)# int GigabitEthernet 5/3

Switch(config-if-Giga5/3)# **storm-control level 50**

Switch(config-if-Giga5/3)# **storm-control broadcast**

Switch(config-if-Giga5/3)# **storm-control multicast**

Switch# **show interface counters storm-control**

| Port | TotalLevel | % UMB | UcastDiscards | McastDiscards | BcastDiscards |
|------|------------|-------|---------------|---------------|---------------|
|------|------------|-------|---------------|---------------|---------------|

.....

| | | | | | |
|-------|--------------|-----------|---|---|---|
| Gi5/1 | 0.00 | | 0 | 0 | 0 |
| Gi5/2 | 0.00 | | 0 | 0 | 0 |
| Gi5/3 | 50.00 | ** | 0 | 0 | 0 |
| Gi5/4 | 0.00 | | 0 | 0 | 0 |

.....

Switch#

To disable storm-control, use **no storm-control** command.

Port Mirroring

Port mirroring mirrors all the I/O traffic of a particular port (source port) to the destination port (target port) that the administrator has set and monitors all the packets of any port.

U9016B switch can monitor RX/TX traffic from different source ports with one port.

Table 33 Port Mirroring

| Command | Description | Mode |
|---|---|-----------|
| mirror interface IFNAME direction (receive transmit both) | Specifies the port to mirror and I/O packets. | Interface |
| no mirror interface IFNAME direction (receive transmit) | Disables the port to mirror. | Interface |

The following example shows a case of port mirroring.

Switch# **configure terminal**

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

Switch(config)# **int GigabitEthernet 5/1**

Switch(config-if-Giga5/1)# **mirror interface gi5/2 direction receive**

Switch(config-if-Giga5/1)# **mirror interface gi5/3 direction receive**

Switch(config-if-Giga5/1)# **mirror interface gi5/4 direction receive**

Switch(config-if-Giga5/1)# **end**

Switch# **show mirror**

Mirror Test Port Name: Giga5/1

Mirror option: Enabled

Mirror direction: receive

Monitored Port Name: Giga5/2

Mirror Test Port Name: Giga5/1

Mirror option: Enabled

Mirror direction: receive

Monitored Port Name: Giga5/3

Mirror Test Port Name: Giga5/1

Mirror option: Enabled

Mirror direction: receive

Monitored Port Name: Giga5/4

Switch#



Notice

Port mirroring can't work together with netflow at the same time. When Netflow is enabled, use **no mls netflow** command in config mode to use Port mirroring.

Layer 2 Interface Configuration

Layer 2 is an interface that works in the Layer 2 switching mode (IEEE 802.3 Bridged VLAN). In U9016B switch, the physical port and the port-group interface works in the Layer 2 switching mode.

This section describes the Layer 2 interface and the commands to set the physical port and the port-group as Layer 2 interface with the examples.

VLAN Trunking

Trunk refers to the point-to-point link between Ethernet switch and other network equipment (router, switch). Trunk can transmit multiple VLAN traffic to a link and you can extend VLAN to the entire network with trunks.

U9016B switch supports 802.1Q trunking encapsulation for all Ethernet interfaces and you can set up trunks in the single Ethernet interface or the port-trunk interface.

Layer 2 Interface mode

Layer 2 interface modes supported by U9016B switch are the trunk mode and the access mode.

Table 34 Layer 2 Interface mode supported in U9016B switch

| Mode | Description |
|------------------------|---|
| switchport mode access | Non trunking mode. Only native vlan can be configured |
| switchport mode hybrid | Single native vlan and multiple tagged, untagged VLAN can be configured |
| switchport mode trunk | Trunking mode. Single native VLAN and multiple tagged VLAN can be configured |

Layer 2 Interface Defaults

U9016B switch has the following default values when a physical port or a port-group is set as Layer 2 interface.

Table 35 Layer 2 Interface Defaults

| Item | Default |
|----------------|------------------------|
| interface mode | switchport mode access |
| native vlan | VLAN 1 |

Enabling/disabling Layer 2 Interface

The commands for Layer 2 interface configure/cancel are as follows.

Table 36 Commands to enable/disable Layer 2 interface configuration

| Command | Description | Mode |
|------------|--------------------------|-----------|
| switchport | Enables Layer2 interface | interface |

| | | |
|---------------|---------------------------|-----------|
| no switchport | Disables Layer2 interface | interface |
|---------------|---------------------------|-----------|

When an interface is set up as the first Layer 2 interface, the interface will have the defaults of Layer 2 interface and when the Layer 2 interface configuration is canceled, VLAN settings are also canceled, but if Layer 2 interface is enabled by switchport command, the previous configurations are recovered.



Notice All the physical ports of U9016B switch are configured as Layer 3 interface by default.

Trunk Port Setting

The following commands are used to set a physical port or a port-group interface as Layer 2 trunk port.

Table 37 Commands for Trunk port configuration

| Command | Description | Mode |
|---|--|-----------|
| switchport mode trunk | Configures trunk mode | Interface |
| switchport trunk native <1-4094> | Configures trunk port native VLAN | Interface |
| no switchport trunk native | Sets trunk port native VLAN to default | Interface |
| switchport trunk allowed vlan add <2-4094> | Registers a trunk port tagged VLAN | Interface |
| switchport trunk remove <2-4094> switchport trunk remove all | Removes a trunk port tagged VLAN | Interface |

The following example shows how to set a physical port as a Layer 2 trunk port.

```
Switch# configure terminal
Switch(config)# interface gi1/1
Switch(config-if-gi1/1)# switchport                ! layer2 interface set
Switch(config-if-gi1/1)# switchport mode trunk      ! trunk port set
Switch(config-if-gi1/1)# switchport trunk native 2  ! native vlan set
Switch(config-if-gi1/1)# switchport trunk add 3     ! tagged vlan reg.
Switch(config-if-gi1/1)# switchport trunk add 4
Switch(config-if-gi1/1)# end
```

The following example shows how to set a port-group interface as a Layer 2 trunk port.

```
Switch# configure terminal
Switch(config)# interface po2
Switch(config-if-po2)# switchport                ! layer2 interface set
Switch(config-if-po2)# switchport mode trunk      ! trunk port set
Switch(config-if-po2)# switchport trunk native 2  ! native VLAN set
Switch(config-if-po2)# switchport trunk add 3     ! tagged vlan reg.
Switch(config-if-po2)# switchport trunk add 4
Switch(config-if-po2)# end
```

Access Port Setting

The commands to set a physical port or a port-group interface as a Layer 2 access port.

Table 38 Access port configuration commands

| Command | Description | Mode |
|---------------------------------|--------------------------------------|-----------|
| switchport mode access | Sets to access mode | Interface |
| switchport access vlan <1-4094> | Sets native vlan | Interface |
| no switchport access vlan | Sets native vlan to default (VLAN 1) | Interface |

The following example shows how to configure a physical port as Layer 2 access port.

```
Switch# configure terminal
Switch(config)# interface gi1/1
Switch(config-if-gi1/1)# switchport          ! layer2 interface set
Switch(config-if-gi1/1)# switchport mode access    ! access port set
Switch(config-if-gi1/1)# switchport access vlan 5  ! native vlan set
```

The following example shows how to configure a port-group interface as a Layer 2 access port.

```
Switch# configure terminal
Switch(config)# interface po2
Switch(config-if-po2)# switchport          ! layer2 interface set
Switch(config-if-po2)# switchport mode access    ! access port set
Switch(config-if-po2)# switchport access vlan 5  ! native vlan set
```



Notice

For more detailed information on VLAN configuration, refer to the VLAN manual.

Port group

Overview of Port Group

Port group is used to bring together many physical ports into a logical group to increase bandwidth and to get the link redundancy. A port group interface in U9016B switch can be used as Layer 2 interface.

The following table shows the number of port groups available in U9016B switch by model.

Table 39 Overview of Port Group

| Model | Number of port groups | Max. no of ports per group |
|--------|-----------------------|----------------------------|
| U9016B | 256 | 8 |

Port group configuration

The commands for configuring Port group are as follows.

Table 40 Port Group Configuration Commands

| Command | Description | Mode |
|---|---|-------------|
| Channel-group <1-256> mode on | Includes the interface in the Port group, and creates a Port group interface. | interface |
| no port-group ifname | Deletes the port-group | config |
| port-channel load-balance src-dst-mac | Refers to MAC address for load-balance. | config |
| port-channel load-balance src-dst-ip | Refers to ip field for load-balance. | config |
| port-channel load-balance src-dst-port | Refers to tcp/udp port for load-balance | config |
| no channel group | Excludes the interface from the Port group. | Interface * |
| no interface Channel-group <1-256> | Deletes the Port group interface. Used when there is no member in the Port group. | config |
| show etherchannel | Shows port group configuration | Privileged |



Notice

For more detailed description on Port group, refer to the LACP manual.

Chapter 3. VLAN

This chapter describes the VLAN of system.

Virtual LAN (VLAN hereinafter) is the logical group of network users and resources. The users and resources are connected through the ports of the switch. VLAN enables simplified network management that was once time-consuming tasks of network administration, while increasing efficiency in network operations.

This chapter covers the following subjects

- VLAN overview
- VLAN types
- VLAN settings
- Displaying VLAN Settings

VLAN Introduction

VLAN (Virtual LAN) is an advanced LAN technology for devices to communicate as if they were on the same physical LAN regardless of their physical network. Devices that belong to the same VLAN constitute a broadcast domain. VLAN is logically classified by a certain function, organization, or application, prevents traffic from flowing into other VLANs, and transmits traffic only to the same VLAN equipment to improve the network performance and security. That is, with VLAN, LAN segments are not classified by the physical hardware connection but flexibly by the logical groups made by the administrator.

For example, all the workstations and servers used by a particular workgroup can be connected in a same VLAN regardless of their physical network connection. That is, the system administrator can reconfigure a network just through a software configuration without physical movement or arrangement of equipment or cable.

VLAN is used to provide segmentation service, which was provided by routers in the conventional LAN configuration. VLAN provides scalability, security, and network management. In VLAN configuration, a router provides broadcast filtering, security, short address, and traffic flow control. The switch in the defined group does not deliver any frames including the broadcast frames between two VLANs.

Advantages of VLAN

VLAN has the advantages as follows:

Efficient Traffic Control

With traditional networks, network congestion can be caused by broadcast traffic that is transmitted to all network devices, regardless of whether they require it or not. Only the devices in the same VLAN are the members of the same broadcast domain and receive all broadcast packets. Meanwhile, broadcast traffic is not transmitted to the port of the switch in another VLAN. Therefore VLAN prevents broadcast traffic from spreading to other networks and increases network efficiency.

Enhanced Network Security

With traditional networks, anybody who accesses the network can access the network resources. That is, if a user accesses to the network analyzer through a hub, he/she can see the network flow. In a VLAN, only the devices in the same VLAN can and the users can no longer access all the network resources just by connection a computer to the switch port. If a device in VLAN *A* wants to communicate with a device in VLAN *B*, the traffic must pass through a routing device.

Flexible Network and Device management

System administrators of traditional networks spend much of their time in dealing with moves and changes of facilities. For example, if the equipment is moved to other sub-network, the network administrator should update the IP addresses of each terminal manually. However, the network administrator can solve this problem by implementing logical network through VLAN that ensures easy movement of equipment to support flexible network management.

VLAN Types

U9016B switch supports up to 4094 VLANs and creates VLANs according to the following criteria:

- Physical port
- 802.1Q tag
- Hybrid type (Combination of the port-based VLAN and Tag-based VLAN)

Port-based VLANs

In a port-based VLAN, a VLAN name is given to a group of one or more ports on the switch. A switch port can be a member of only one port-based VLAN. The switch port assigned to a port-based VLAN is called the *access port*. One access port belongs to only one port-based VLAN. Basically, all ports are assigned as the access ports of VLAN 1 (default VLAN).

For example, U9016BA switch assigns 2 ports to each VLAN A and VLAN B, and 4 ports to VLAN C.

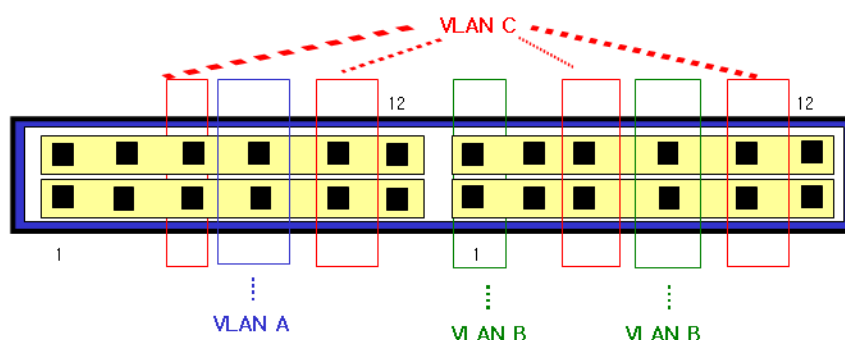


Figure 2. Example of a Port-based VLAN configuration (U9016B Switch)

For the members of different VLANs to communicate with one another, they are physically in the same I/O module and the traffic must be routed by the switch. This means each VLAN must be set as a router interface with a unique IP address.

Connecting Switches with a Port-based VLAN

To connect two switches with a port-based VLAN, do the following tasks.

1. Assign access ports of each switch to the VLAN.
2. Use one of the access port assigned from each switch to the VLAN to connect the two switches with cable. To connect several VLANs, you have to connect the switches for each VLAN with cable.

The following figure illustrates how to bind two systems into one VLAN. First, 2 ports of the switch 1 are assigned to VLAN A, and 2 ports of the switch 2 are assigned to an access port of VLAN A. Two switches are connected each other and form single broadcast domain like the following figure.

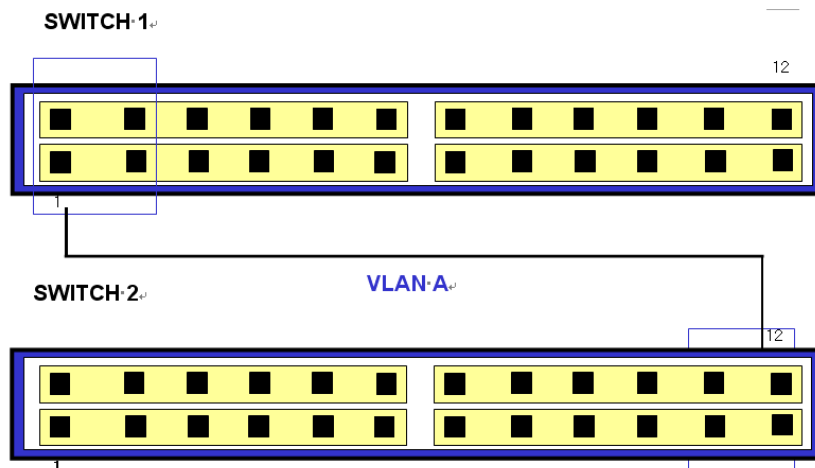


Figure 3. Single Port-based VLANs Connecting 2 Switches

To create multiple VLANs that span two switches in a port-based VLAN, a port on switch 1 must be cabled to a port on switch 2 for each VLAN you want to have span across two switches. At least one port on each system must be assigned as the access port of the corresponding VLANs, as well. The following figure illustrates two VLANs spanning two systems. Port 1 and 2 in a switch 1 is an access port of VLAN A, and Port 5, 6, 7 and 8 are assigned as an access port of VLAN B. Port 1 and 2 in a switch 2 are an access port of VLAN A, and Port 9, 10, 11 and 12 are assigned as an access port of VLAN B.

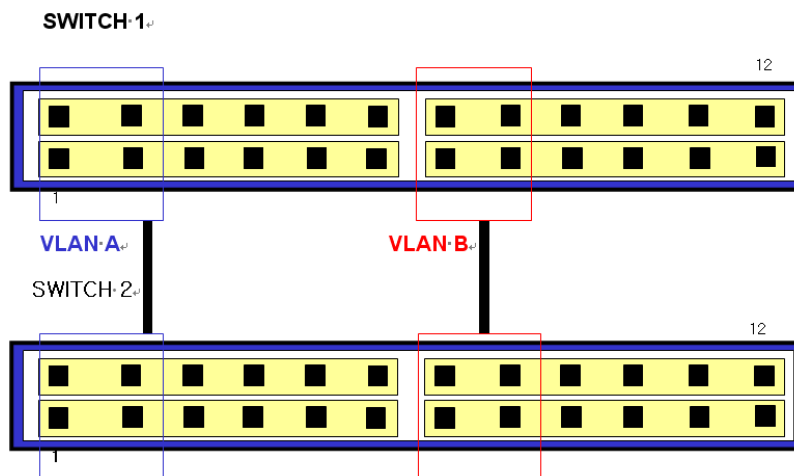


Figure 4. Two Port-based VLANs Connecting 2 Switches

VLAN A binds a switch 1 and switch 2 as connecting a port 2 of a switch 1 and a port 1 of a switch 2. VLAN B binds a switch 1 and switch 2 as connecting a port 8 of a switch 1 and a port 9 of a switch 2.

With this way of configuration, you can create multiple VLANs that connect many switches in a daisy-chained fashion. Each switch must have a dedicated access port for each VLAN connection and each dedicated access port must be connected to the access port that is a member of its VLAN on the next switch.

Tagged VLANs

Tagging is the process of inserting markers (called a *tag*) into the Ethernet frame. The tag contains the identification number of a specific VLAN, called the *VLANid*.

**Notice**

With 802.1Q tag frame, you can generate a frame larger than 1,518 bytes, the maximum size of IEEE 802.3/Ethernet frame. However, this large frame can affect the frame error counter of other devices that do not support 802.1Q and can cause network connection problems, if there are any bridge and router that do not support 802.1Q on the path.

Uses of Tagged VLANs

Tag is the most common way to generate a VLAN binding many switches. A point-to-point link connecting two switches or a switch and a router is called *trunk*. A trunk can transmit many VLANs traffic and extends VLANs from one switch to another switch. The port that is a member of a tagged VLAN and that sends and receives tagged frames is called *trunk port*. Using tags, several VLANs can send and receive frames by using one or more trunks.

As previous figure describes, in a port-based VLAN, a pair of ports must be assigned in each VLAN to connect two switches. But in a tagged VLAN, multiple VLANs connecting two switches can be generated with a single trunk.

Another advantage of a tagged VLAN is that a port can be a member of multiple VLANs. A tagged VLAN is particularly useful for the network equipment (such as a server) that must belong to multiple VLANs. In this case, the network equipment must be equipped with a network interface card (NIC) that supports 802.1Q tagging.

Assigning a VLAN Tag

Each VLAN may be assigned VLANid when generated. When a port is assigned and used as a trunk port of a tagged VLAN, the port uses a frame with 802.1Q VLAN tag. In this case, the VLANid of the tagged VLAN is used as the frame tag.

Not all ports of VLAN must be tagged. When the traffic from a port is forwarded out of a switch, the switch determines whether each destination port of the frame should use tagged or untagged frame formats for that VLAN. The switch adds or deletes tags, as required, based on the port configuration for that VLAN.

**Notice**

When a frame with VLAN tag is sent to a port with no VLAN configured, the frame is discarded. For example, if a frame whose VLANid is 30 is sent to a port that is a member of VLANs whose ids are 10 and 20, the switch discards the frame.

The following figure illustrates the physical configuration of a network using tagged frames and untagged frames.

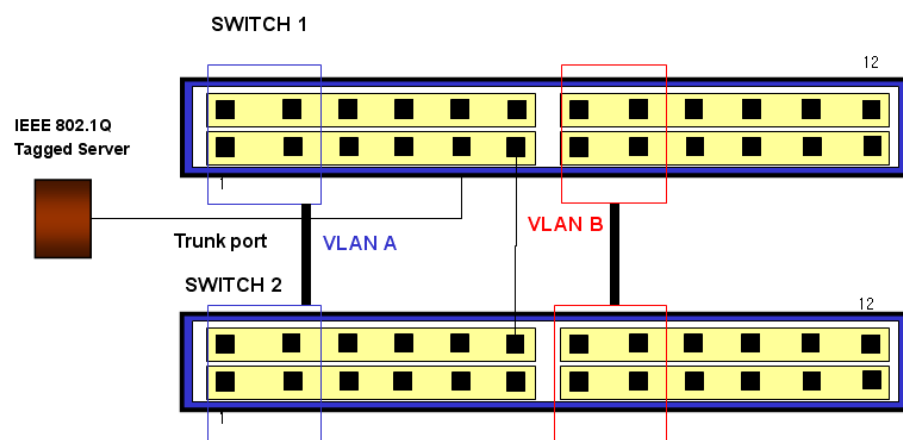


Figure 5. Physical Diagram of Tagged and Untagged frame

The following figure shows the logical diagram of the same network.

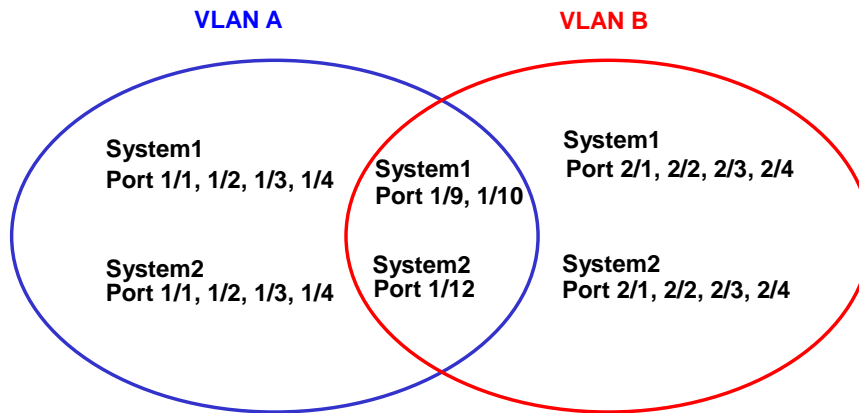


Figure 6. Logical Diagram of Tagged Frame and Untagged frame

- In previous figures, the trunk port (tagged port) of each switch transmits the traffic for both VLAN A and VLAN B.
- The trunk port of each switch transmits the frame tagged.
- The server connected to port 17 of System 1 is equipped with the NIC that supports 802.1Q tagging
- All other terminals send and receive untagged frames.

When a frame passes through a switch, the switch decides whether to use tagged frames or untagged frames for the destination port. All the frames from/to the server/the trunk port are tagged, but the frames from/to other devices of the network are not tagged.

Hybrid VLAN (Mixing Port-based VLAN and Tagged VLAN)

You can use both a port-based VLAN and a tagged VLAN in one switch. Under the condition that there is only one port-based VLAN that a port belongs to, a port can be a member of many VLANs. That is, a port can be a member of one port-based VLAN and many tagged VLANs at the same time.

VLAN Configuration

VLAN ID

You can use a number between 1 and 4094 as VLANid, the identifier of VLAN. When a switch is initialized, a VLAN 1 is generated as *default VLAN*. Therefore, newly generated VLANs cannot use 1 as their VLANid.

VLANid is used as the tag that the port belonging to the tagged VLAN attaches to a frame when it operates in the trunk mode. If you set a wrong VLANid, frames may be sent to a wrong VLAN, so you have to consider the entire network configuration to set the VLANid.

Default VLAN

Each switch has a default VLAN with the following characteristics.

- Default VLAN uses 1 as VLANid.
- It contains all the interface ports on a new or initialized switch.
- Default VLAN does not use any tags.
- All the ports in the switch initialization status have native VLAN as the default VLAN.

Native VLAN

Each physical port has Port VLAN ID (PVID). In all 802.1Q ports, the ports' native VLAN IDs are assigned as PVID. All the untagged frames are sent to the VLAN that the PVID indicates. When a tagged frame is sent to a port, the tag is used as it is. However, if an untagged frame is sent to a port, the PVID in the frame is regarded as a tag.

As shown in the following figure, since untagged frames and frames with PVID can co-exist in the network, the bridges or end station supporting VLAN can be connected with the bridges or end station not supporting VLAN through cable.

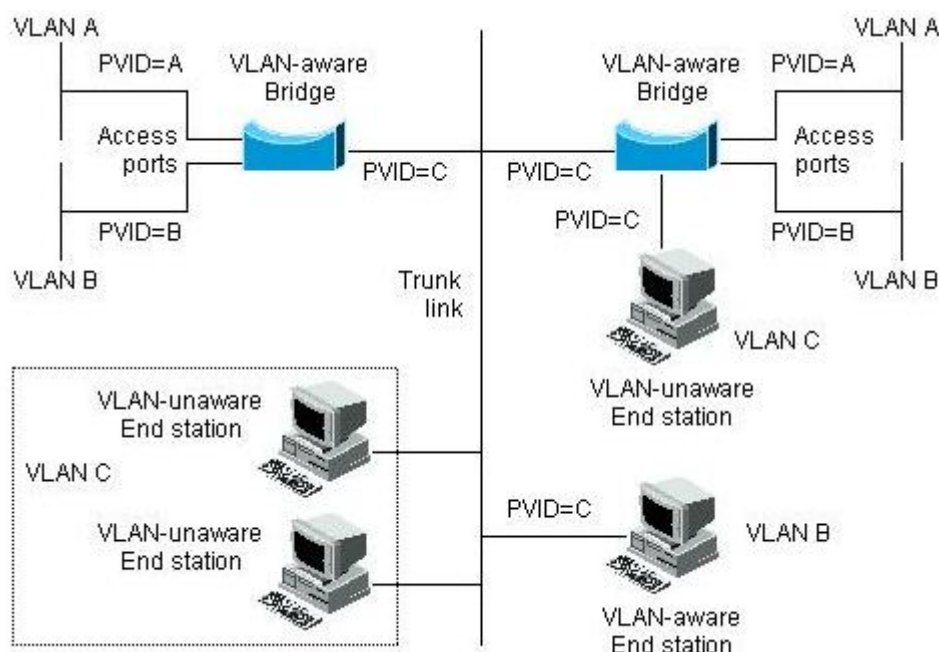


Figure 7. Native VLAN

For example, assume that two end stations not supporting VLAN are connected through the trunk link as shown in the left bottom of above figure. The two end stations cannot be aware of VLAN, but since the PVID of the bridge that recognizes VLAN is configured as VLAN C, they are included in VLAN C. The end stations that cannot be aware of VLAN transmit only untagged frames, and when a bridge that recognizes VLAN receives these untagged frames, it sends them to VLAN C.

VLAN Setting

This section describes the commands used for VLAN configuration on Premier U9016BA switch. VLAN configuration has the following steps.

1. Create and name the VLAN.
2. Set the mode of the port according to the type of the VLAN where the port will be assigned
3. Assign one or more ports to the VLAN. When you add each port to the VLAN, decide whether to use 802.1Q tags or not.

Commands for VLAN Configuration

The following table is the commands used for VLAN configuration.

Table 41 Commands for VLAN Configuration

| Commands | Description | Mode |
|---|---|---------------|
| vlan database | Access to the VLAN database mode | config |
| vlan <i>vlanid</i> | Creates VLAN as a value of <i>vlanid</i> Default VLAN (VLANid=1) name cannot be changed. <i>vlanid</i> : The unique VLAN identifier, a number between 2-4094 | vlan database |
| vlan <i>vlanid</i> name WORD (state (enable disable)) | Creates VLAN as a value of <i>vlanid</i> WORD: vlan ascii value | vlan database |
| vlan <i>vlanid</i> bridge <1-256> name WORD (state (enable disable)) | Creates VLAN as a value of <i>vlanid</i> WORD: vlan ascii value Creates valn to bridge. | |
| switchport | Changes type of port as L2. If it changes to L2 port, it becomes member of VLAN to access mode. | Interface |
| switchport mode {access hybrid trunk} | Set the type of VLAN on the corresponding port. <i>access</i> : Set the port as an access mode (Port-based VLAN). It works as an interface of a single VLAN that sends and receives untagged frames. <i>hybrid</i> : Set the port as a hybrid mode <i>trunk</i> : Set the port as a trunk mode (Tagged-VLAN). The port sends and receives tagged frame. In case of untagged frame, it regards as native VLAN ID. | Interface |
| switchport access vlan <i>vlanid</i> | Set the port as VLAN access port. When the access mode is set, the port works as a member of the VLAN. <i>Vlanid</i> : VLANid, a number between 2 and 4094 | Interface |
| Switchport hybrid vlan <i>vlanid</i> | Sets VLAN member port. In case that the received frame is untagged, set relevant frame as VLAN id. <i>Vlanid</i> : 2-4094 | Interface |

| | | |
|---|---|-----------|
| switchport trunk allowed vlan (add all except) <i>vlanid</i> | Sets port as trunk port of VLAN. <i>Vlanid</i> : 2-4094 | Interface |
| switchport trunk native <i>vlanid</i> | If the port is 802.1Q trunk mode, that is, a trunk port of a tagged VLAN set a native LAN for the untagged traffic that is sent and received. If a native VLAN is not set, the default VLAN (VLANid = 1) is set as the native VLAN. <i>vlanid</i> : a number between 2 and 4094 | Interface |
| switchport trunk (remove none) <i>vlanid</i> | Exclude the port from the members of the specified VLAN. <i>vlanid</i> : a number between 2 and 4094. <i>none</i> : Exclude from all VLAN members. | Interface |

Examples of VLAN Configuration

The following example shows how to configure VLAN whose VLAN id is 1000, assign the IP address 132.15.121.1 to VLAN, and assign the VLAN into two ports.

```
shu#
shu#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
shu(config)#vlan database
shu(config-vlan)#vlan 1000
shu(config-vlan)#exit
shu(config)#interface Vlan 1000
shu(config-if-Vlan1000)#ip address 132.15.121.1/24
shu(config-if-Vlan1000)#interface GigabitEthernet 6/1
shu(config-if-Giga6/1)#switchport
shu(config-if-Giga6/1)#switchport mode access
shu(config-if-Giga6/1)#switchport access vlan 1000
shu(config-if-Giga6/1)#interface GigabitEthernet 6/3
shu(config-if-Giga6/3)#switchport
shu(config-if-Giga6/3)#switchport mode access
shu(config-if-Giga6/3)#switchport access vlan 1000
shu(config-if-Giga6/3)#end
shu#show vlan
```

| VLAN Name | Status | Ports |
|------------|--------|-------|
| 1 default | active | Gi6/2 |
| 2 VLAN0002 | active | |
| 3 VLAN0003 | active | |
| 4 VLAN0004 | active | |
| 5 VLAN0005 | active | |
| 6 VLAN0006 | active | |
| 7 VLAN0007 | active | |

| | | | | |
|-------------|-----------------|---------------|--------------|--------------|
| 8 | VLAN0008 | active | | |
| 9 | VLAN0009 | active | | |
| 10 | VLAN0010 | active | | |
| 11 | VLAN0011 | active | | |
| 12 | VLAN0012 | active | | |
| 100 | VLAN0100 | active | | |
| 1000 | VLAN1000 | active | Gi6/1 | Gi6/3 |

shu#

The following example shows how to configure tagged VLAN and to assign trunk port. The example creates tagged VLAN which vlanid is 2000 and adds two ports as a trunk port of VLAN 2000.

```
shu#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
shu(config)#vlan database
shu(config-vlan)#vlan 2000
shu(config-vlan)#exit
shu(config)#interface GigabitEthernet 6/4
shu(config-if-Giga6/4)#switchport
shu(config-if-Giga6/4)#switchport mode trunk
shu(config-if-Giga6/4)#switchport trunk allowed vlan add 2000
shu(config-if-Giga6/4)#interface GigabitEthernet 6/5
shu(config-if-Giga6/5)#switchport
shu(config-if-Giga6/5)#switchport mode trunk
shu(config-if-Giga6/5)#switchport trunk allowed vlan add 2000
shu(config-if-Giga6/5)#end
shu#show vlan all
```

| Bridge | VLAN ID | Name | State | Member ports (u)-Untagged, (t)-Tagged |
|--------|---------|----------|--------|--|
| 0 | 1 | default | ACTIVE | Gi6/1 (u) Gi6/4 (u) Gi6/5 (u) |
| 0 | 2 | VLAN0002 | ACTIVE | |
| 0 | 3 | VLAN0003 | ACTIVE | |
| 0 | 4 | VLAN0004 | ACTIVE | |
| 0 | 5 | VLAN0005 | ACTIVE | |
| 0 | 6 | VLAN0006 | ACTIVE | |
| 0 | 7 | VLAN0007 | ACTIVE | |
| 0 | 8 | VLAN0008 | ACTIVE | |
| 0 | 9 | VLAN0009 | ACTIVE | |
| 0 | 10 | VLAN0010 | ACTIVE | |
| 0 | 11 | VLAN0011 | ACTIVE | |
| 0 | 12 | VLAN0012 | ACTIVE | |
| 0 | 100 | VLAN0100 | ACTIVE | |
| 0 | 1000 | VLAN1000 | ACTIVE | Gi6/2 (u) Gi6/3 (u) |

| | | | | |
|---|------|----------|--------|---------------------|
| 0 | 2000 | VLAN2000 | ACTIVE | Gi6/4 (t) Gi6/5 (t) |
|---|------|----------|--------|---------------------|

shu#

The following example shows how to configure hybrid VLAN (Tagged, Untagged VLAN). Two ports are set to VLAN 3000 as hybrid port and VLAN 4000 as tagged ports.

```
shu#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
shu(config)#vlan database
shu(config-vlan)#vlan 3000
shu(config-vlan)#vlan 4000
shu(config-vlan)#exit
shu(config)#interface GigabitEthernet 6/6
shu(config-if-Giga6/6)#switchport
shu(config-if-Giga6/6)#switchport mode hybrid
shu(config-if-Giga6/6)#switchport hybrid vlan 3000
shu(config-if-Giga6/6)#switchport hybrid allowed vlan add 4000 egress-tagged enable
shu(config-if-Giga6/6)#interface GigabitEthernet 6/7
shu(config-if-Giga6/7)#switchport
shu(config-if-Giga6/7)#switchport mode hybrid
shu(config-if-Giga6/7)#switchport hybrid vlan 3000
shu(config-if-Giga6/7)#switchport hybrid allowed vlan add 4000 egress-tagged enable
shu(config-if-Giga6/7)#end
shu#show vlan all
```

| Bridge | VLAN ID | Name | State | Member ports (u)-Untagged, (t)-Tagged |
|--------|---------|----------|--------|--|
| 0 | 1 | default | ACTIVE | Gi6/1 (u) Gi6/4 (u) Gi6/5 (u) |
| 0 | 2 | VLAN0002 | ACTIVE | |
| 0 | 3 | VLAN0003 | ACTIVE | |
| 0 | 6 | VLAN0006 | ACTIVE | |
| 0 | 7 | VLAN0007 | ACTIVE | |
| 0 | 8 | VLAN0008 | ACTIVE | |
| 0 | 9 | VLAN0009 | ACTIVE | |
| 0 | 10 | VLAN0010 | ACTIVE | |
| 0 | 11 | VLAN0011 | ACTIVE | |
| 0 | 12 | VLAN0012 | ACTIVE | |
| 0 | 100 | VLAN0100 | ACTIVE | |
| 0 | 1000 | VLAN1000 | ACTIVE | Gi6/2 (u) Gi6/3 (u) |
| 0 | 2000 | VLAN2000 | ACTIVE | Gi6/4 (t) Gi6/5 (t) |
| 0 | 3000 | VLAN3000 | ACTIVE | Gi6/6 (u) Gi6/7 (u) |
| 0 | 4000 | VLAN4000 | ACTIVE | Gi6/6 (t) Gi6/7 (t) |

shu#

The following example shown in the following figure creates a *sales* VLAN whose VLAN id is 120. VLAN includes both tagged port (trunk port) and untagged port (access port). Port gi 6/1 and gi 6/2 has tags, and port gi 6/3 and gi 6/4 are untagged. If not explicitly set, ports are configured as untagged.

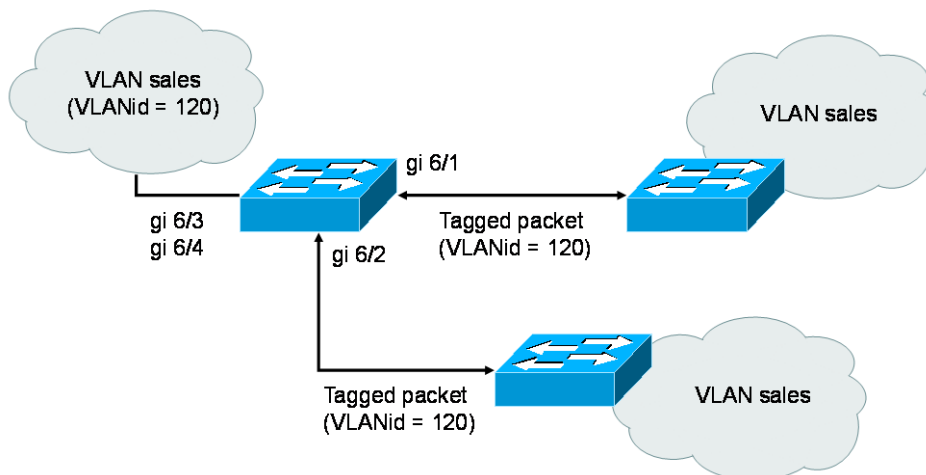


Figure 8. Configuration Example – Tagged and Untagged VLAN

```
shu#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
shu(config)#vlan database
shu(config-vlan)#vlan 120
shu(config-vlan)#exit
shu(config)#interface GigabitEthernet 6/1
shu(config-if-Giga6/1)#switchport
shu(config-if-Giga6/1)#switchport mode trunk
shu(config-if-Giga6/1)#switchport trunk allowed vlan add 120
shu(config-if-Giga6/1)#interface GigabitEthernet 6/2
shu(config-if-Giga6/2)#switchport
shu(config-if-Giga6/2)#switchport mode trunk
shu(config-if-Giga6/2)#switchport trunk allowed vlan add 120
shu(config-if-Giga6/2)#interface GigabitEthernet 6/3
shu(config-if-Giga6/3)#switchport
shu(config-if-Giga6/3)#switchport access vlan 120
shu(config-if-Giga6/3)#interface GigabitEthernet 6/4
shu(config-if-Giga6/4)#switchport
shu(config-if-Giga6/4)#switchport access vlan 120
shu(config-if-Giga6/4)#end
shu#show vlan all
```

| Bridge | VLAN ID | Name | State | Member ports (u)-Untagged, (t)-Tagged |
|--------|---------|----------|--------|--|
| 0 | 1 | default | ACTIVE | Gi6/1 (u) Gi6/2 (u) Gi6/5 (u) |
| 0 | 120 | VLAN0120 | ACTIVE | Gi6/1 (t) Gi6/2 (t) Gi6/3 (u) Gi6/4 (u) |

shu#

The following example shows how to configure port gi 6/1 as a member of the port-based VLAN *Marketing* and the tagged VLAN *Engineering*. VLAN *Marketing* VLAN ID is 200, and VLAN *Engineering* VLAN ID is 400.

shu#configure terminal

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

shu(config)#**vlan database**

shu(config-vlan)#**vlan 200**

shu(config-vlan)#**vlan 400**

shu(config-vlan)#exit

shu(config)#interface GigabitEthernet 6/1

shu(config-if-Giga6/1)#**switchport mode trunk**

shu(config-if-Giga6/1)#**switchport trunk allowed vlan add 200**

shu(config-if-Giga6/1)#**switchport trunk native vlan 200**

shu(config-if-Giga6/1)#**switchport trunk allowed vlan add 400**

shu(config-if-Giga6/1)#end

shu#show vlan all

| Bridge | VLAN ID | Name | State | Member ports (u)-Untagged, (t)-Tagged |
|--------|---------|----------|--------|--|
| 0 | 1 | default | ACTIVE | Gi6/1 (t) |
| 0 | 100 | VLAN0100 | ACTIVE | |
| 0 | 120 | VLAN0120 | ACTIVE | Gi6/1 (t) |
| 0 | 200 | VLAN0200 | ACTIVE | Gi6/1 (u) |
| 0 | 400 | VLAN0400 | ACTIVE | Gi6/1 (t) |

shu#

When port gi 6/1 receives untagged frames, the switch sends the frames to the member port of VLAN *marketing*.

Displaying VLAN Settings

The following command is used to display VLAN configuration information.

Table 42 Displaying VLAN Settings

| Command | Description | Mode |
|--------------------------------------|--|------|
| show vlans | Display VLAN information in summary: VLANid Member port | Exec |
| show vlan all | Display VLAN information as below: VLANid Member port tag, untagged | Exec |
| show interface trunk (module <1-6>) | Display VLAN information as below: Port VLAN Mode Native VLAN, Trunk VLAN | Exec |
| show interface summary vlan | Display VLAN information as below: Vlan id | Exec |

The following example shows how to display the VLAN information.

shu#**show vlan all**

| Bridge | VLAN ID | Name | State | Member ports (u)-Untagged, (t)-Tagged |
|--------|---------|----------|--------|--|
| 0 | 1 | default | ACTIVE | Gi6/1 (t) Gi6/2 (u) Gi6/5 (u) |
| 0 | 2 | VLAN0002 | ACTIVE | |
| 0 | 10 | VLAN0010 | ACTIVE | |
| 0 | 11 | VLAN0011 | ACTIVE | |
| 0 | 12 | VLAN0012 | ACTIVE | |
| 0 | 100 | VLAN0100 | ACTIVE | |
| 0 | 120 | VLAN0120 | ACTIVE | Gi6/1 (t) Gi6/2 (t) Gi6/3 (u) Gi6/4 (u) |
| 0 | 200 | VLAN0200 | ACTIVE | Gi6/1 (u) |
| 0 | 400 | VLAN0400 | ACTIVE | Gi6/1 (t) |
| 0 | 1000 | VLAN1000 | ACTIVE | |
| 0 | 2000 | VLAN2000 | ACTIVE | Gi6/5 (t) |
| 0 | 3000 | VLAN3000 | ACTIVE | Gi6/6 (u) Gi6/7 (u) |
| 0 | 4000 | VLAN4000 | ACTIVE | Gi6/6 (t) Gi6/7 (t) |

shu#

shu#**show vlan**

| VLAN Name | Status | Ports |
|-----------|--------|-------|
| ----- | | |

Displaying VLAN Settings

| | | | | | |
|------|----------|--------|-------|-------|-------|
| 1 | default | active | Gi6/1 | Gi6/2 | Gi6/5 |
| 120 | VLAN0120 | active | Gi6/1 | Gi6/2 | Gi6/3 |
| | | | Gi6/4 | | |
| 200 | VLAN0200 | active | Gi6/1 | | |
| 400 | VLAN0400 | active | Gi6/1 | | |
| 1000 | VLAN1000 | active | | | |
| 2000 | VLAN2000 | active | Gi6/5 | | |
| 3000 | VLAN3000 | active | Gi6/6 | Gi6/7 | |
| 4000 | VLAN4000 | active | Gi6/6 | Gi6/7 | |

| VLAN | MTU | BridgeNo | Stp Enabled | BrdgMode |
|------|------|----------|-------------|------------------|
| 1 | 1500 | 0 | Yes | rstp-vlan-bridge |
| 120 | 1500 | 0 | Yes | rstp-vlan-bridge |
| 200 | 1500 | 0 | Yes | rstp-vlan-bridge |
| 400 | 1500 | 0 | Yes | rstp-vlan-bridge |
| 1000 | 1500 | 0 | Yes | rstp-vlan-bridge |
| 2000 | 1500 | 0 | Yes | rstp-vlan-bridge |
| 3000 | 1500 | 0 | Yes | rstp-vlan-bridge |
| 4000 | 1500 | 0 | Yes | rstp-vlan-bridge |

shu#

802.1 Q-in-Q

QinQ is basically prohibited to be used in 802.1Q network because 802.1Q provides only 4094 VLAN ID's. In order to resolve this problem so that QinQ can be used, the system has inserted 802.1 QinQ layer between the two 1Q layers. 802.1QinQ is consisted of two VLAN IDs of service providing VLAN ID and service receptive VLAN ID. The service receptive VLAN ID is the VLAN ID which the traffic originally designates. And the service providing VLAN ID is the additive VLAN ID for service providers.

When Q-in-Q is used, first of all you need to make the decision to apply QinQ to the whole network system. For this purpose, 4 bytes will be added to the user port traffic.

- Service Provider Ethertype: Set up ethertype of an outer tag (default value: 0x8100).
- Service Provider VLAN ID: Use the native VLAN ID value of customer port for outer tag VLAN ID
- Port mode: When Q in Q is applied, each port has to be set to one of the options. Port mode can add an outer tag to user port and the outer tag shall be removed from the port which provides service.

Table 43 802.1 QinQ Command set

| Command | Description | Mode |
|---|---|-----------|
| (no) encapsulation q-in-q | Sets QinQ to be enable / disable | Config |
| (no) q-in-q tunneling ethertype VALUE | Sets the ether type of outer tag. While ether type is not configured, the default value is to be 0x8100. | Config |
| encapsulation q-in-q (default customer core) | Sets the port mode. <i>default:</i> 0x8100. <i>core:</i> add outer tag as an ethertype <i>customer:</i> configure user port type | Interface |



Example gi1 → gi3

| DA | SA | Ether Type | Tag | Ether Type | Tag | Len/Etype | Data | FCS |
|--------|-----|------------|-----|------------|-----|-----------|------|-----|
| 0x8101 | 100 | 0x8100 | 10 | | | - | - | - |

Figure 9. Configuring 802.1 QinQ

The following example shows how to set QinQ.

```
Switch# configure terminal
Switch(config)# vlan 10,20,30,40,50,60,100,200
Switch(config)# interface gi1/1
Switch(config-if-gi1/1)# switchport access vlan 100
Switch(config-if-gi1/1)# interface gi2/1
Switch(config-if-gi2/1)# switchport access vlan 200
Switch(config-if-gi2/1)# int gi1/1
Switch(config-if-gi1/1)# switchport mode trunk
Switch(config-if-gi1/1)# switchport trunk add 10,20,30
Switch(config-if-gi1/1)# int gi2/1
Switch(config-if-gi2/1)# switchport mode trunk
Switch(config-if-gi2/1)# switchport trunk add 40,50,60
Switch(config-if-gi2/1)# int gi3/1
Switch(config-if-gi3/1)# switchport mode trunk
Switch(config-if-gi3/1)# switchport trunk add 100,200
Switch(config-if-gi3/1)# end
```

```
Switch# show switchport
U : untagged packet drop
```

| IFNAME | SWMODE | N-VLAN | TAGGED-VLAN-LIST |
|--------|--------|--------|------------------|
| gi1/1 | trunk | 100 | 10 20 30 |
| gi2/1 | trunk | 200 | 40 50 60 |
| gi3/1 | trunk | 1 | 100 200 |

total 12 interfaces listed

```
Switch# configure terminal
Switch(config)# encapsulation q-in-q
Switch(config)# interface gi1/1
Switch(config-if-gi1/1)# encapsulation q-in-q customer
Switch(config-if-gi1/1)# interface gi2/1
Switch(config-if-gi2/1)# encapsulation q-in-q customer
Switch(config-if-gi2/1)# interface gi3/1
Switch(config-if-gi3/1)# encapsulation q-in-q core (in case ethertype changed, or
encapsulation q-in-q default)
Switch(config)# q-in-q tunneling ethertype 0x8101
Switch(config)#
```

Private Edge VLAN

Private edge VLAN is the ports existing in a segment, in other words within the VLAN, but they can communicate only between allowed ports, while the communications between other ports are blocked on Layer 2. In other words, it is to make vlan inside the vlan. So the location in the switch is important in the Private Edge VLAN. Another important thing is the independence between two ports that are being protected between different switches. The protected ports do not generate any traffic (unicast, multicast, broadcast) to other ports, and other ports in the same switch also do not generate any traffic to the protected ports.

Traffic can not be send to the ports protected on L2, and all the traffics can be communicated between the protected ports only through L3 equipment.

Two methods to set the uplink between private edge VLANs in U9016BA:

- IFNAME

Specify the uplink using the port name (ex. gi1/1, gi2/1, po1...)

- VLANID

In the network in which STP/RSTP is used, an uplink of root port for the STP and RSTP need to be set. In this case, the uplink can be changed.

Table 44 Private Edge VLAN Setting table

| Command | Description | Mode |
|---|--|------------|
| (no) private-edge-vlan | Enable/disable Private-edge-vlan. | Config |
| (no) private-edge-vlan <i>IFNAME</i> | Enter the IFNAME to set as uplink of the private edge vlan to specific Interface. | Interface |
| (no) private-edge-vlan stp-root-port <i>VLANID</i> | Set the uplink of the private edge vlan as root port of <i>VLANID</i> 's root at specific interface. | Interface |
| Show private-edge-vlan | Retreive Private-edge-vlan settings. | Privileged |

The ports to be protected are gi2/1 and gi3/1, and uplink is gi1/1. The traffics between the protected ports are now allowed, but only the traffic of gi1/1 is allowed.

```
Switch# configure terminal
Switch(config)# private-edge-vlan
Switch(config)# interface gi2/1
Switch(config-if-gi2)# private-edge-vlan gi1/1
Switch(config-if-gi2)# interface gi3/1
Switch(config-if-gi3)# private-edge-vlan gi1/1
```

The ports to be protected are g1/1, po1, and po2. For uplink setup in the STP, same VLAN1 is used. In this case, the root port of VLAN1 in the STP is "po2". If src/dest private-edge-vlan port is same, they are marked with "*", and only the changed port of the STP is stored.

```
Switch# configure terminal
Switch(config)# int po1
Switch(config-if-po1)# private-edge-vlan stp-root-port 1
Switch(config-if-po1)# int po2
```

```
Switch(config-if-po2)# private-edge-vlan stp-root-port 1
Switch(config-if-po2)# int gi1/1
Switch(config-if-gi1/1)# private-edge-vlan stp-root-port 1
Switch(config-if-gi1/1)# end
```

```
Switch# show private-edge-vlan
Private Edge Vlan Mode : enabled
Static Private Edge Vlans: none
STP-ROOT-PORT Private Edge Vlans
Target Switch Port: STP Root of vlan 1: po2
Members: gi1/1      po1      *po2
          -(*) : Temp Member
```

Abnormal MAC Drop

To drop the packets with abnormal MAC address or trap to the CPU, use the following commands.

Table 45 Abnormal MAC Drop commands

| Command | Description | Mode |
|--------------------------------|--|-----------|
| (no) broadcast-source-mac-drop | Enable/disable to drop the packets with broadcast MAC address as Source MAC address. | Interface |
| (no) gw-source-mac-drop | Enable/disable to drop the packets with own MAC address as Source MAC address. | Interface |
| (no) null-source-mac-drop | Enable/disable to drop the packets with all '0' MAC address as Source MAC address. | Interface |
| (no) self-dest-mac-trapcpu | Enable/Disable to trap to the CPU the packets with own MAC address as Destination MAC address. | Interface |

Chapter 4. IP Configuration

This chapter explains how to set IP address.

The basic requirement for IP configuration is to assign IP address to the network interface. With IP address assigned, the interface is activated as a Layer 3 interface.

- U9016B switch assign IP to the following interfaces.
- VLAN interface
- Loopback interface
- Management interface

Assigning an IP address

IP address identifies the network where the received IP datagram to be sent. Some IP addresses are reserved for some special purpose and they cannot be used for host, subnet, or network address. The following the range of IP addresses and it shows which addresses are reserved and which addresses are available.

Table 46 Available IP Addresses

| Class | Range | Status |
|-------|-----------------------------|-------------------------|
| A | 0.0.0.0 | Reserved |
| | 1.0.0.0 ~ 126.0.0.0 | Available |
| | 127.0.0.0 | Reserved |
| B | 128.0.0.0 ~ 191.254.0.0 | Available |
| | 191.255.0.0 | Reserved |
| C | 192.0.0.0 | Reserved |
| | 192.0.1.0 ~ 223.255.255.254 | Available |
| | 224.255.255.0 | Reserved |
| D | 224.0.0.0 ~ 239.255.255.255 | Multicast Group Address |
| E | 240.0.0.0 ~ 255.255.255.254 | Reserved |
| | 255.255.255.255 | Broadcast |

**Notice**

For official descriptions on IP address, refer to RFC1166, Internet Number.

**Notice**

To obtain a network number, ask your ISP (Internet Service Provider).

U9016B switch supports multiple IP addresses per interface. U9016B switch allows up to 10 IP addresses for an interface. Multiple IP addresses can be used in a variety of situations. The following are the most common applications:

There might not be enough host addresses for a particular network segment. For example, suppose your subnetting allows up to 254 hosts per logical subnet, but on one physical subnet you must have 300 host addresses. Using secondary IP addresses on the routers or access servers allows you to have two logical subnets using one physical subnet.

Many older networks were built using Level 2 bridges, and were not subnetted. The judicious use of secondary addresses can aid in the transition to a subnetted, router-based network. Routers on an older, bridged segment can easily be made aware that many subnets are on that segment.

Two subnets of a single network might otherwise be separated by another network. You can create a single network from subnets that are physically separated by another network by using a secondary address. In these instances, the first network is extended, or layered on top of the second network. Note that a subnet cannot appear on more than one active interface of the router at a time.

To assign an IP address to a network interface, use the following commands in Interface configuration mode.

Table 47 Commands for assigning IP address

| Command | Description |
|--|--|
| <code>ip address <i>ipaddress/prefixlen</i></code> | Assigns an IP address to an Interface. |



Notice

Prefixlen is the bit length to divide network among ip addresses.

ARP (Address Resolution Protocol)

To check the information of ARP table, use the following commands in privilege mode. You can set Static ARP and Proxy ARP.

Table 48 Commands for ARP configuration

| Commands | Description | Mode |
|----------------------------------|--|------------|
| Show arp | Shows the entries of ARP table. | Privileged |
| clear arp-cache | Deletes the entries of ARP table. | Privileged |
| Clear arp-cache interface IFNAME | Deletes ARP entry of the interface. | Privileged |
| arp <i>ip-address</i> <i>MAC</i> | Sets static ARP entry in the ARP table <i>ip-address</i> : Shows the IP address of ARP entry: <i>MAC</i> : Shows 48bit Ethernet address of ARP entry. Alias | config |
| no arp <i>ip-address</i> | Deletes the ARP entry of the ip address. | config |
| arp-ageing-timeout <1-3000> | Sets the ageing timeout of ARP entry of the interface | interface |
| no arp-ageing-timeout | Sets the ARP entry ageing timeout of the interface to the default value (default : 7200 sec) | interface |

The following example is to show how to set a static ARP and an ARP timeout. To set ARP, there should be an interface with an IP address.

```
Switch#
shu#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
shu(config)#arp 192.168.1.3 0111.1111.1213
% Interface does not exist
shu(config)#int GigabitEthernet 6/1
shu(config-if-Giga6/1)#ip address 192.168.1.3/24
shu(config-if-Giga6/1)#exit
shu(config)#arp 192.168.1.3 0111.1111.1213
shu(config)#end
shu#show arp
Protocol  Address           Hardware Addr  Type          Interface
-----
Internet  192.168.1.3       0111.1111.1213 static       Giga6/1
Internet  10.1.17.104       0022.1926.2db3 dynamic      eth0
Internet  10.1.17.254       0007.7045.a36f dynamic      eth0
shu#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
shu(config)#no arp 192.168.1.3
shu(config)#end
shu#show arp
Protocol  Address           Hardware Addr  Type          Interface
```

```
Internet 10.1.17.254      0007.7045.a36f dynamic  eth0
shu#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
shu(config)#interface GigabitEthernet 6/1
shu(config-if-Giga6/1)#arp-ageing-timeout 2000
shu(config-if-Giga6/1)#
```

Configuring Static Routes

The static route is the route defined by the user to send the packets along the specified path from the source to the destination. If the routing protocol cannot be used to configure the route to a destination, the static route is very important. It is also useful to indicate the gateway where the packets that cannot be routed will be sent. To configure a static route, use the commands below.

Table 49 Commands for configuring Static route path

| Commands | Description |
|---|---|
| <code>ip route {destination-prefix mask destination-ipaddress/mask} {gateway-ipaddress null0} [distance-value]</code> | <p>Registers a static route.</p> <p>Destination-prefix: Specifies the network number of the destination-prefix destination.</p> <p>Mask: Specifies the mask of the mask destination network.</p> <p>Gateway-IP Address: Specifies the IP address of the gateway device.</p> <p>Null: Sets the null interface as a gateway.</p> <p>Distance-value : A number between 1 and 255 is used</p> |

A system remembers the static route until it is deleted (Use no format of IP route command in the global config mode). However, the static route can be overlapped with dynamic routing information by carefully assigning the administrative distance value. Each dynamic routing protocol has the default administrative distance value as listed in table. If you want a static route is overlapped with the dynamic routing protocol information, set the administrative distance of the static route to be larger than the dynamic protocol value.

Table 50 Default administrative distances of dynamic routing protocol

| Item | Default |
|---------------------------------------|------------------|
| Route Source | Default Distance |
| Connected interface | 0 |
| Static route | 1 |
| Exterior Border Gateway Protocol(BGP) | 20 |
| OSPF | 110 |
| RIP | 120 |
| Interior BGP | 200 |
| Unknown | 255 |

When an interface is disconnected, all the static routes passing through the interface are deleted from the IP routing table. When no more hop is available for forwarding router address in a static route, the static route is deleted from IP routing table.

To display the static route information, use the following command in the privileged mode.

Table 51 Showing IP route Information

| Command | Description |
|-----------------------------------|-----------------------------|
| <code>show ip route static</code> | Shows IP route information. |

IP Configuration Example

This section provides IP configuration examples:

- Assign IP address to network interface
- Creating a Network from Separated Subnets Examples
- ARP
- Static Route

The following example shows how to assign a C class IP address, 192.10.25.1 to vlan5 interface of the switch.

```
Switch(config)# interface vlan5
Switch(config-int-vlan5)# ip address 192.10.25.1/24
```

In the following example, Subnet 1 and 2 of 131.108.0.0 network are separated by the backbone network. Two networks are configured as a logical network.

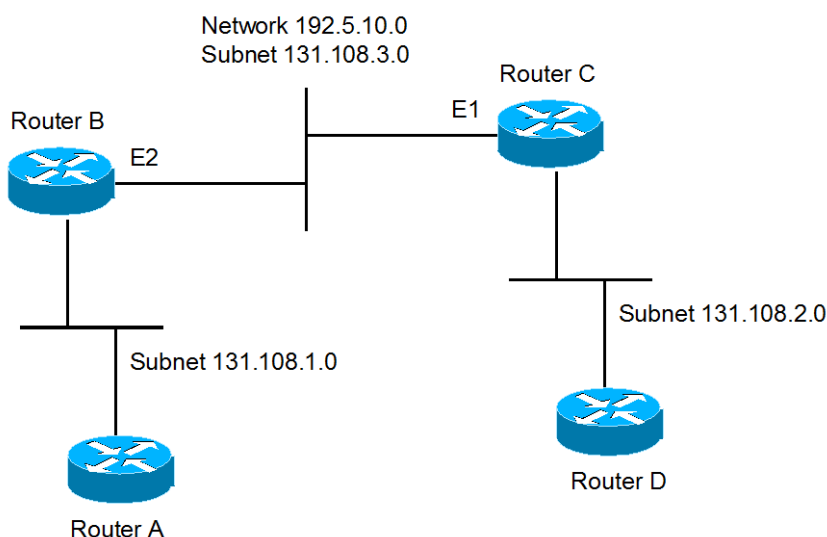


Figure 10. Network Configuration Example – multiple IP address

The following example shows how to set multiple IP configurations.

Router B configuration

```
Switch(config)# interface vlan2
Switch(config-int-vlan2)# ip address 192.5.10.1/24
Switch(config-int-vlan2)# ip address 131.108.3.1/24
```

Router C configuration

```
Switch(config)# interface vlan2
Switch(config-int-vlan2)# ip address 192.5.10.2/240
Switch(config-int-vlan2)# ip address 131.108.3.2/24
```

The following example is to show the contents of an ARP table.

Switch# **show arp**

| IP Address | MAC Address | IPF | PORT | RefCnt | Flags |
|-------------|----------------|--------|-------|--------|-------|
| 10.1.2.254 | 0007.7089.1123 | vlan2 | gi1/1 | 1 | S |
| 10.1.11.46 | 0006.2bfc.146e | vlan11 | gi6/1 | 1 | S |
| 10.1.13.1 | 0001.0281.f775 | vlan13 | gi2/1 | 1 | R |
| 10.1.13.190 | 0000.f083.f6d4 | vlan13 | gi6/2 | 1 | K |

The following command is used to register a static ARP entry to an ARP table.

Switch(config)# **arp** 142.10.52.196 0010.073c.0514 vlan1 gi2/1

Switch# **show arp**

| IP Address | MAC Address | IPF | PORT | RefCnt | Flags |
|---------------|----------------|-------|-------|--------|-------|
| 142.10.52.196 | 0010.073c.0514 | vlan1 | gi2/1 | 1 | P |

The following command is used to delete a static ARP entry from the ARP table.

Switch(config)# **no arp** 142.10.52.196

The following example shows how to configure a static route that allows the host connected to 20.1.1.0 network to communicate with a host in 192.168.2.0 network.

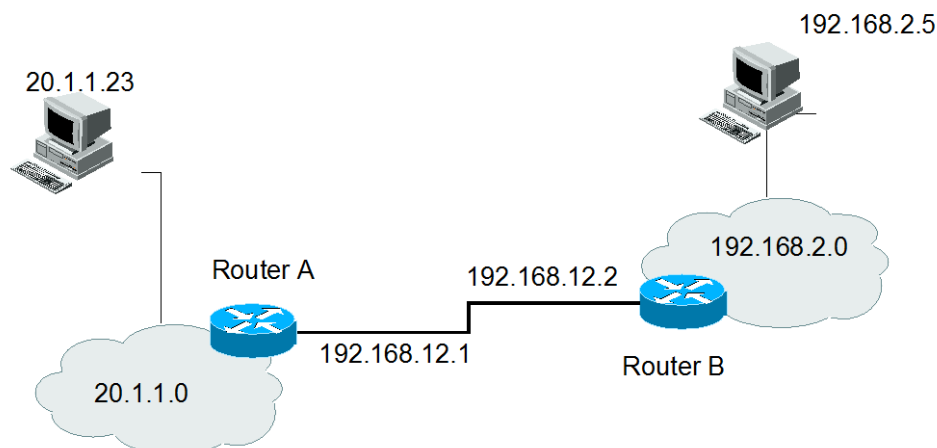


Figure 11. Network Configuration Example – Static route

Router A configuration

```
Switch(config)# ip route 192.168.2.0/24 192.168.12.2
```

```
Switch(config)# show ip route static
```

Codes: C - connected, S - static, R - RIP, O - OSPF,

B - BGP, > - selected route, * - FIB route

```
S> * 192.168.2.0/24 [1/0] via 192.168.12.2 vlan2
```

```
Switch(config)#
```

Router B configuration

```
Switch(config)# ip route 20.1.1.0/8 192.168.12.1
```

```
Switch(config)# show ip route static
```

Codes: C - connected, S - static, R - RIP, O - OSPF,

B - BGP, > - selected route, * - FIB route

```
S 20.1.1.0/8 [1/0] via 192.168.12.1 vlan2
```


Chapter 5. DHCP

This chapter describes the DHCP configuration of system.

DHCP Server Features and Configuration

Overview of DHCP Server Functions

Dynamic Host Configuration Protocol (DHCP) assigns reusable IP addresses and configuration parameters to other IP hosts (DHCP clients) in IP network. DHCP is designed for the configuration of large-scale network and complex TCP/IP software in which reduces the workload on the IP network administrator. The most important configuration information that a client receives from the server is the IP address of the client.

DHCP is an extension of BOOTP, but there are two big differences between the two:

- DHCP sets a client to be assigned IP addresses for a limited time span so that the IP addresses can be reassigned to other clients.
- DHCP provides the method for a client to set additional IP configuration parameters required to work in a TCP/IP network.

U9016B server provides the DHCP server functions, assigning IP addresses from the address pool in the switch to a client and managing the addresses. If DHCP cannot satisfy DHCP requests in its database, it may send the requests to one or more assistant DHCP servers that the administrator has configured.

IP Address Allocation of DHCP Server

DHCP supports three ways for IP address allocation as follows:

- Automatic allocation – DHCP allocates a permanent IP address to the client.
- Manual Allocation – The network administrator assigns an IP address to a client and DHCP is used simply to convey the assigned address to the client.
- Dynamic Allocation – DHCP assigns an IP address to a client for a limited period of time.

The available configuration parameters are listed in RFC 2131 and main parameters are as follows:

- Subnet mask
- Router
- Domain
- Domain Name Server(DNS)

U9016BSwitch as a DHCP Server

The following figure shows the basic steps that occur when a DHCP client request an IP address from a DHCP server (U9016B).

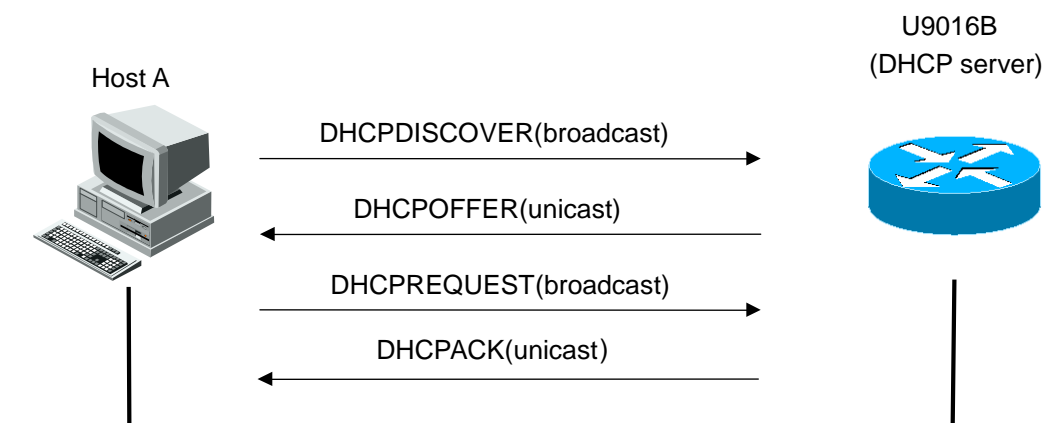


Figure 12. U9016BSwitch as a DHCP server

1. The Client Host A sends broadcast message *DHCPDISCOVER* to DHCP server.
2. DHCP server sends configuration parameters including IP address, a domain name, and a lease for the IP address, to the client by using the unicast message *DHCPOFFER*.



Notice

A DHCP client may receive offers from more than one DHCP server and can accept any one of the offers: however, the client usually accepts the first offer it receives. Additionally, the offer from the DHCP server is not a guarantee that the IP address will be allocated to the client: however, the server usually reserves the address until the client has had a chance to formally request the address.

3. The client sends the formal request for the supplied IP address to DHCP server by using the broadcast message *DHCPREQUEST*.
4. DHCP server verifies that the IP address is assigned to the client by sending the unicast message *DHCPACK* to the client.



Notice

The formal request for the offered IP address (the *DHCPREQUEST* message) that is sent by the client is broadcast so that all other DHCP servers that received the *DHCPDISCOVER* broadcast message from the client can reclaim the IP addresses that they offered to the client.

Advantages of DHCP Server

U9016B server features bring the following advantages:

- **Reduced Internet access cost** – Using automatic IP address assignment at each remote site substantially reduces Internet access costs. Static IP addresses are considerably more expensive to purchase than are automatically allocated IP addresses.
- **Reduced client configuration tasks and costs** – Since DHCP is easy to configure, you can minimize the costs related to equipment configuration and unprofessional users can also use DHCP with ease.
- **Centralized management** – Because the DHCP server maintains configurations for several subnets, an administrator only needs to update a single, central server when configuration parameters change.

Enabling DHCP Server Function

By default, the DHCP server functions of the switch are not enabled. To enable the features in which are disabled, use the following command in global configuration mode.

Table 52 Enabling DHCP Server Function

| Command | Description |
|---------------------|---|
| service dhcp | Enables the DHCP server functions of the switch. To disable the DHCP server functions, use no command. |

The following example shows how to enable DHCP server function.

```
Router# configure terminal
Router(config)# service dhcp
Router# show running-config
!
...
service dhcp server
...
!
```

DHCP Address Pool

U9016B server support Network Pool and Host Pool.

- **Network Pool** – Configure pool for automatic or dynamic allocation. Different subnets can share IP pool if different network pools are configured into one group.
- **Host Pool** – Configure pool for manual allocation, many hosts with common information can be set into one host pool.

DHCP Network Pool Configuration

You can configure a DHCPNetwork Pool with a name that is a symbolic string (such as "ubiquoss") or an integer (such as 0). For DHCP network pool setting, change the current mode into the DHCP pool configuration mode where you can set the parameters such as IP subnet number and default router. To set a DHCP address pool, you have to complete required tasks illustrated in the following section.



Notice

Different network pool can be configured into one group and different subnets of one VLAN should be in the same group.

Setting DHCP Network Pool Name and Entering DHCP Configuration mode

To configure the DHCP network pool name and enter DHCP pool configuration mode, use the following command in Global mode.

Table 53 IP DHCP Pool

| Command | Description |
|------------------------------------|--|
| <code>ip dhcp pool name</code> | Generate a name for DHCP Network Pool Enter the DHCP network pool configuration mode identified as “config-dhcp#” prompt. |

The following example shows setting a DHCP Network Pool name as ‘network_pool1’. You can use up to 31 characters.

```
Router# configure terminal
Router(config)# ip dhcp pool network_pool1
Router(config-dhcp)# exit
Router# show running-config
...
!
ip dhcp pool network_pool1
!
...
```

DHCP Subnet and Network Mask Configuration

To configure IP address for the newly created DHCP address pool and server network mask, use the following command in DHCP Network Pool Configuration mode.

Table 54 DHCP Subnet and Network Mask Configuration

| Command | Description |
|--|--|
| <code>network network-number/prefix-length</code> | Specify the sub network number and mask for DHCP address pool. |

The following shows an example where setting DHCP Subnet and Network mask for 100.0.0.0/24.

```
Router# configure terminal
Router(config)# ip dhcp pool network_pool1
Router(config-dhcp)# network 100.0.0.0/24
Router# show running-config
...
!
ip dhcp pool network_pool1
network 100.0.0.0/24
```

Setting IP Address Range to be Assigned in Network Pool

Set address range to assign to clients in DHCP network pool. Non-consecutive many addresses range can be assigned in one network pool.

Table 55 Setting IP Address Range to be Assigned in Network Pool

| Command | Description |
|---|---|
| <code>range lowest-address highest-address</code> | Set IP address range to be assigned to clients in subnet. This command should be used after DHCP subnet and Network Mask are set. |

The following example shows setting IP address range, from 100.0.0.1 to 100, which will be assigned in Network Pool.

```
Router# configure terminal
Router(config)# ip dhcp pool network_pool1
Router(config-dhcp)# range 100.0.0.1 100.0.0.100
Router# show running-config
...
!
ip dhcp pool network_pool1
network 100.0.0.0/24
range 100.0.0.1 100.0.0.100
!
```

Setting the Default Router for Client

After the DHCP client is booted, the client sends packets to its default router. The IP address of the default router must be on the same sub network as the client. The following command is used to set the default router for DHCP client in the DHCP pool configuration mode.

Table 56 Setting the Default Router for Client

| Command | Description |
|-------------------------------------|--|
| <code>default-router address</code> | Shows IP address of a default router for DHCP client |

The following example shows setting the default router for 100.0.1 for a client in DHCP server.

```
Router# configure terminal
Router(config)# ip pool network_pool1
Router(config-dhcp)# default-router 100.0.0.1
Router(config-dhcp)# exit
Router# show running-config
...
!
ip dhcp pool network_pool1
default-router 100.0.0.1
network 100.0.0.0/24
range 100.0.0.1 100.0.0.100
```

Setting DNS IP Server for Client

DHCP clients query DNS IP servers when they need to correlate host names to IP addresses. To configure the DNS IP servers that are available to a DHCP client, use the following command in DHCP pool configuration mode:

Table 57 Setting DNS IP Server for Client

| Command | Description |
|--|--|
| <code>dns-server <i>address</i></code> | Specify the IP address of the DNS server that the DHCP client can use. A new DNS Server IP will be added when a command is entered. |

The following is an example of setting DNS Server for 200.0.0.1, 200.0.0.2 in DHCP server for the client.

```
Router# configure terminal
Router(config)# ip dhcp pool network_pool1
Router(config-dhcp)# dns-server 200.0.0.1
Router(config-dhcp)# dns-server 200.0.0.2
Router(config-dhcp)# exit
Router# show running-config

...
!
ip dhcp pool network_pool1
  dns-server 200.0.0.1
  dns-server 200.0.0.2
  default-router 100.0.0.1
  network 100.0.0.0/24
  range 100.0.0.1 100.0.0.100
!
...
```

Setting the Domain Name for Client

The domain name of a DHCP client includes the client in the general network group. The following command is used to set the domain name string for a client in DHCP pool configuration mode.

Table 58 Setting the Domain Name for Client

| Command | Description |
|--|--------------------------------------|
| <code>domain-name <i>domain</i></code> | Specify the domain name for a client |

The following is an example of setting a domain name as “ubiquoss.com” in DHCP server for the client.

```
Router# configure terminal
Router(config)# ip dhcp pool network_pool1
Router(config-dhcp)# domain-name ubiquoss.com
Router(config-dhcp)# exit
Router# show running-config
```



```
...  
!  
ip dhcp pool network_pool1  
dns-server 200.0.0.1 200.0.0.2  
domain-name ubiquoss.com  
default-router 100.0.0.1  
network 100.0.0.0/24  
range 100.0.0.1 100.0.0.100  
!  
...
```

Setting Group for Network Pool

Network group includes multiple DHCP Network Pools, and Network Pool in the same group shares the IP Pool.

Table 59 Setting Group for Network Pool

| Command | Description |
|-------------------------------|---------------------|
| <code>group group-name</code> | Displays group name |



Notice

In case one interface consists of multiple IP addresses, Network Pool of each IP address should be configured with the same group name.

The following is an example of binding different Network Pools into “ubiquoss pool”.

```
Router# configure terminal  
Router(config)# ip dhcp pool network_pool1  
Router(config-dhcp)# group ubiquoss_pool  
Router(config-dhcp)# exit  
Router# show running-config  
...  
!  
ip dhcp pool network_pool1  
dns-server 200.0.0.1 200.0.0.2  
domain-name ubiquoss.com  
default-router 100.0.0.1  
network 100.0.0.0/24  
range 100.0.0.1 100.0.0.100  
group ubiquoss_pool
```

Setting the Address Lease Time

By default, each IP address assigned by a DHCP server comes with a one-hour lease, which is the amount of time that the address is valid. To change the lease value for an IP address, use the following command in DHCP pool configuration mode.

Table 60 Setting the Address Lease Time

| Command | Description |
|---|---|
| <code>lease {days [hours] [minutes]}</code> | Specifies the lease period Default : one hour Infinite: Use automatic allocation system leasing IP address permanently to the host. |

The following is an example of setting the lease time for 20 minutes.

```
Router(config)# ip dhcp pool network_pool1
Router(config-dhcp)# lease 0 0 20
Router(config-dhcp)# exit
Router# show running-config
...
!
ip dhcp pool network_pool1
  dns-server 200.0.0.1 200.0.0.2
  lease 0 0 20
  domain-name ubiquoss.com
  default-router 100.0.0.1
  network 100.0.0.0/24
  range 100.0.0.1 100.0.0.100
  group ubiquoss_pool
!
...
```

DHCP Host Pool Configuration

A manual binding is a mapping between the IP address and MAC (Media Access Control) address of a client. The IP address of a client can be assigned manually by an administrator or assigned automatically from a pool by a DHCP server and manual bindings are just special address pools. Enter DHCP Host Pool Configuration mode to set parameters such as IP and MAC.

To set a DHCP Host Pool, you should complete the required tasks illustrated in the following section.



Notice

A Host Pool is for clients that want to apply the common parameter. You can set multiple Hosts to a Host Pool. You can apply the parameter to all Hosts in the Pool by a single setting.

Setting DHCP Host Pool Name and Entering DHCP Configuration Mode

To configure the DHCP Host Pool name and enter DHCP Pool configuration mode, use the following command in Global Config mode.

Table 61 Setting DHCP Host Pool Name and Entering DHCP Configuration Mode

| Command | Description |
|------------------------------------|--|
| <code>ip dhcp pool name</code> | Generates a name for DHCP Host Pool Enters the DHCP Host Pool configuration mode identified as “config-dhcp#” prompt. |

The following is an example of setting the DHCP Host Pool Name as ‘host_pool1’. You can use up to 31 characters.

```
Router# configure terminal
Router(config)# ip dhcp pool host_pool1
Router(config-dhcp)# exit
Router# show running-config
...
!
ip dhcp pool host-pool
!
...
```

Table 62 Host Pool Configuration Command

| Command | Description |
|--|--|
| <code>default-router address</code> | Shows IP address of a default router for DHCP client |
| <code>dns-server address1 address2 address3</code> | Specifies the IP address of the DNS Server that the DHCP client can use One IP address is required, but you can specify up to three IP addresses in the command line. |
| <code>domain-name domain</code> | Specifies domain name for a client |
| <code>host ipaddr/prefix-len</code> | Manual Binding IP Network be specified in one Host Pool |



Notice

Manual Binding List in one Host Pool can be allocated in the network range by **network** command. And configurations of other commands are the same.

Client Configuration for DHCP Manual Binding

It configures clients to provide manual binding in host pool.

Table 63 Client Configuration for DHCP Manual Binding

| Command | Description |
|---------------------------------------|---|
| host <i>ip-address netmask</i> | Generates IP address and network mask for a client Enters the DHCP Host Configuration mode identified as "config-dhcp #" |

Table 64 Manual Binding Command

| Command | Description |
|---|--|
| hardware-address <i>hardware-address</i> | Specifies hardware address of the client |

The following example shows that allocating IP 110.0.0.1 to a user with a MAC address of 00:11:22:33:44:55. The command should be set after 'network A.B.C.D' command is set.

```
Router# configure terminal
Router(config)# ip dhcp pool host_pool1
Router(config-dhcp)# host 110.0.0.1/24
Router(config-dhcp)# hardware-address 0011.2233.4455
Router(config-dhcp)# exit
Router# show running-config
!
ip dhcp pool host_pool1
    host 110.0.0.1/24
    hardware-address 0011.2233.4455
!
```

Other Global Commands

Table 65 Global Command List

| Command | Description |
|--|--|
| ip dhcp max-lease {days [hours] [minutes]]infinite} | When DHCP client requests for a Lease time, DHCP server allocates time, which does not exceed max-lease time to DHCP client. Premier switch has the default value of one day. |

The following is an example of setting max-lease time for 2 days.

```
Router(config)# ip dhcp max-lease 2
Router# show running-config
!
ip dhcp max-lease 2
```

DHCP relay agent Features and Configuration

DHCP relay agent Overview

DHCP relay is the host forwarding DHCP packet between DHCP client and DHCP server in each different subnet.

DHCP relay agent records (DHCP packet's giaddr field) value on gateway address and insert relay agent information to DHCP packet. Then you can set to send it to server.

If you set U9016B as DHCP relay agent, DHCP client and DHCP server forwards DHCP packet each other.

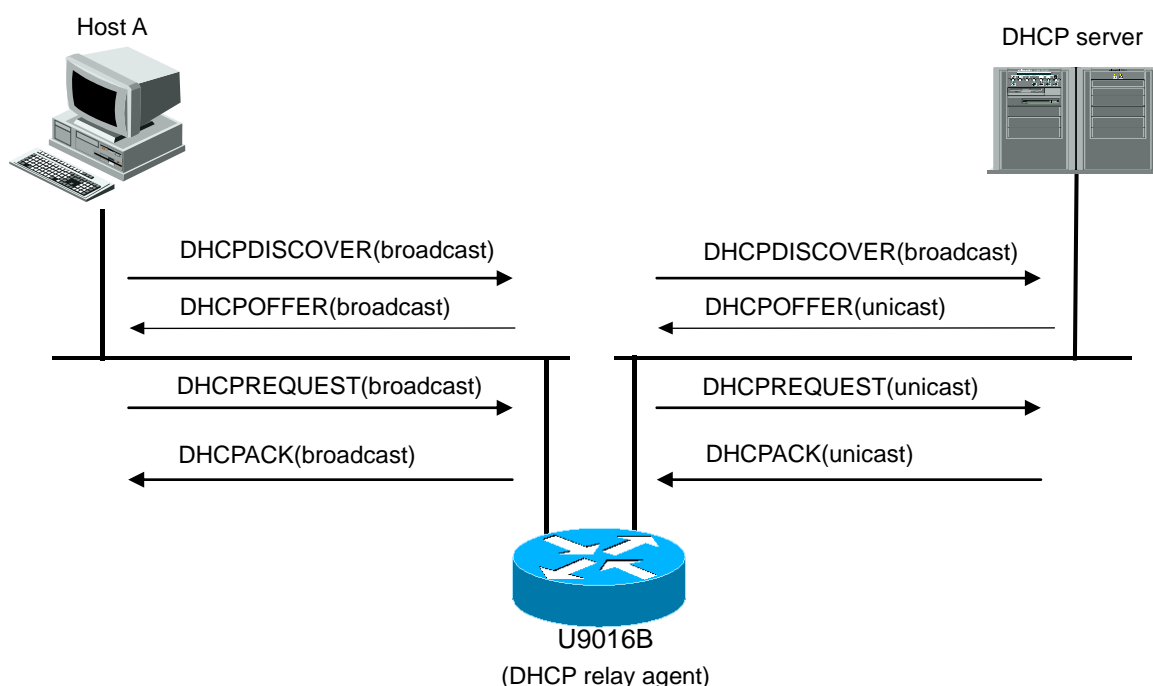



Figure 13. Message transmissions of DHCP server as a DHCP relay agent

1. DHCP client sends broadcast message, DHCPDISCOVER to request IP.
2. DHCP relay agent receives the IP request message from DHCP client, and sent the message to DHCP server by unicast.
3. When the DHCP server receives a message from the DHCP relay agent, it sends the DHCP OFFER message to the DHCP relay agent by unicast. The message contains information including IP address, default gateway etc. of the client (An IP address recorded in giaddr field is used as a destination IP).
4. The DHCP relay agent sends the DHCPOFFER message to the client.
5. DHCPREQUEST and DHCPACK messages are transferred by the DHCP relay agent in a same manner between the DHCP server and the client.

Enabling DHCP Relay Function

By default, the DHCP relay agent functions are not enabled. To enable the DHCP relay agent, use the following command in global configuration mode.

Table 66 Enabling DHCP Relay Function

| Command | Description |
|--------------------|---|
| service dhcp relay | <p>Enables DHCP Relay function of router</p> <p>Use no format of this command to disable the DHCP relay.</p> <hr/> <div>  <div> <p>Note</p> <p>You may not set DHCP relay and DHCP server together.</p> </div> </div> |

If system forward DHCP packet via DHCP Relay agent, switching chip of router does not forward the packet and traps packet with CPU. Then you need to set relay agent to precede the packet.

The following example shows how to enable DHCP relay agent when a user is connected to the port of Vlan10 and to DHCP server through vlan20.

```
Router#config terminal
Router(config)#class-map dhcp_user_class
Router(config-cmap)#match protocol udp
Router(config-cmap)#match layer4 source-port 68
Router(config-cmap)#exit
Router(config)#class-map dhcp_server_class
Router(config-cmap)#match protocol udp
Router(config-cmap)#match layer4 source-port 67
Router(config-cmap)#end
Router#show class-map
```

```
CLASS-MAP-NAME: dhcp_user_class (match-all)
  Match Source Port: 68
  Match Protocol: udp
```

```
CLASS-MAP-NAME: dhcp_server_class (match-all)
  Match Source Port: 67
  Match Protocol: udp
```

```
Router#config terminal
Router(config)#policy-map dhcp_user_map
Router(config-pmap)#class dhcp_user_class
Router(config-pmap-c)#trap-cpu
Router(config-pmap-c)#exit
Router(config-pmap)#exit
Router(config)#policy-map dhcp_server_map
Router(config-pmap)#class dhcp_server_class
Router(config-pmap-c)#trap-cpu
Router(config-pmap-c)#exit
Router(config-pmap)#exit
Router(config)#int vlan10
Router(config-if-Vlan10)#service-policy input dhcp_user_map
Router(config-if-Vlan10)#int vlan20
```

```
Router(config-if-Vlan20)#service-policy input dhcp_server_map
Router(config-if-Vlan20)end
Router#show policy-map
```

```
POLICY-MAP-NAME: dhcp_user_map
State: attached
```

```
CLASS-MAP-NAME: dhcp_user_class (match-all)
Trap-cpu
```

```
POLICY-MAP-NAME: dhcp_server_map
State: attached
```

```
CLASS-MAP-NAME: dhcp_server_class (match-all)
Trap-cpu
```

```
Router#show service-policy
Interface    Vlan20 : input  dhcp_server_map
Interface    Vlan10 : input  dhcp_user_map
Router# configure terminal
Router(config)# service dhcp relay
Router(config)# exit
Router# show ip dhcp relay
```

```
DHCP relay : Enabled
DHCP Smart Relay feature : Disabled
DHCP Smart Relay retry count : 3
DHCP server-id based relay : Disabled
Verification of MAC address : Enabled
Insertion of option 82 : Disabled
DHCP Option82 Management-IP : 0.0.0.0
DHCP maximum hop count : 10
```

```
DHCP helper-address is configured on following servers:
none
```

DHCP Server Configuration on DHCP Relay Agent

To run DHCP RELAY agent, you set DHCP server to DHCP DISCOVER/REQUEST message from DHCP client. Relay agent can set server to per interface receiving DHCP packet or server to forward regardless to interface receiving the packet.

To set DHCP server for each interface that received a DHCP message, use the following command.

Table 67 DHCP Server Configuration on DHCP Relay Agent

| Command | Description |
|---------|-------------|
|---------|-------------|

| | |
|--|---|
| ip dhcp helper-address <i>address</i> | Sets an IP address of a DHCP server which will forward the DHCP DISCOVER/REQUEST message that an interface has received. Only DHCP packets received on the interface are forwarded to the assigned server. To delete the DHCP server functions, use no command. |
|--|---|

When you set DHCP server regardless of interface with setting DHCP message with RX, use the following command.

Table 68 DHCP Server Configuration on DHCP Relay Agent

| Command | Description |
|--------------------------------------|--|
| ip dhcp-server <i>address</i> | Sets an IP address of the DHCP server that a DHCP relay agent will forward a DHCP DISCOVER/REQUEST message to. To delete the setting, use no command. |



Notice DHCP relay Agent of U9016B can have up to 256 helper-addresses.

The following example shows how to set a server address in DHCP relay agent.

```
Router#configure terminal
Router(config)#service dhcp relay
Router(config)#ip dhcp-server 192.168.0.254
Router(config)#exit
Router#show ip dhcp relay

DHCP relay                : Enabled
DHCP Smart Relay feature  : Disabled
DHCP Smart Relay retry count : 3
DHCP server-id based relay : Disabled
Verification of MAC address : Enabled
Insertion of option 82    : Disabled
DHCP Option82 Management-IP : 0.0.0.0
DHCP maximum hop count    : 10
DHCP helper-address is configured on following servers:
    192.168.0.254
Router#configure terminal
Router(config)#interface vlan1
Router (config-if-vlan1)#ip dhcp helper-address 100.0.0.1
Router(config)#end
Router#show ip dhcp relay

DHCP relay                : Enabled
DHCP Smart Relay feature  : Disabled
DHCP Smart Relay retry count : 3
DHCP server-id based relay : Disabled
```

Verification of MAC address : Enabled
Insertion of option 82 : Disabled
DHCP Option82 Management-IP : 0.0.0.0
DHCP maximum hop count : 10

DHCP helper-address is configured on following servers:
192.168.0.254, 100.0.0.1(vlan1)

DHCP Relay Agent Information option (OPTION82) Configuration

Premier DHCP relay agent, when it transfer DHCP request from a DHCP client to DHCP server, can provide DHCP relay information option by which the information of Premier DHCP relay agent itself and client interface. Then DHCP Server will assign IP address and determine host configuration policy by seeing the Option82 information. For example, if a certain specified port of a specified switch is correlated with a MAC address 'a', later when a request with the same port of the same switch combined with different MAC address, let's say 'b' would arrive in DHCP server, then DHCP server can reject or ignore it.

As shown in the following figure, DHCP Option82 is only used between DHCP Relay and DHCP Server. DHCP Relay shall add DHCP Option82 into the packet when it forwards the packet sent from a DHCP Client which is heading for DHCP Server, and remove it from the packet which is sent from DHCP Server to DHCP Client.

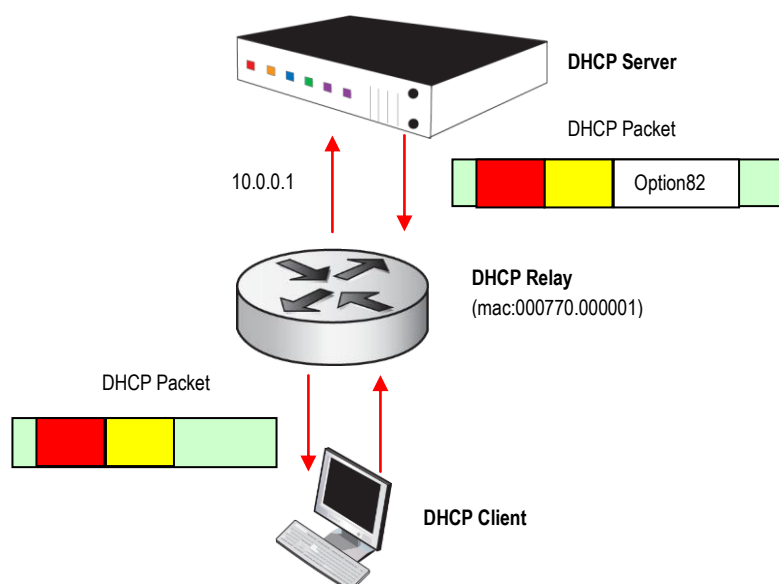


Figure 14. DHCP Relay Option82

Enabling DHCP relay agent information option

To enable relay information option function of U9016B DHCP Relay Agent, use the following command.

Table 69 Enabling DHCP relay agent information option

| Command | Description |
|---|--|
| ip dhcp relay agent information option | Enables DHCP relay agent information option By default, the feature is not enabled. Use no format to exclude relay agent information option in router. |

The following shows an example of adding the relay agent information option function of DHCP relay agent.

```
Router# configure terminal
```

```
Router(config)# ip dhcp relay agent information option
```

```
Router(config)# exit
```

```
Router#
```

```
Router# show ip dhcp relay
```

```
DHCP relay : Enabled
DHCP Smart Relay feature : Disabled
DHCP Smart Relay retry count : 3
DHCP server-id based relay : Disabled
Verification of MAC address : Enabled
Insertion of option 82 : Enabled
DHCP relay agent information option policy : replace
DHCP Option82 Management-IP : 0.0.0.0
DHCP maximum hop count : 10
```

DHCP helper-address is configured on following servers:

```
192.168.0.254
```

Relay agent information option reforwarding Policy Configuration

The default policy of the system is to replace the relay information of the packet received from DHCP client with the relay information of the Premier switch. You can change the default policy of the Premier switch using the following command in Global mode.

Table 70 Relay agent information option reforwarding Policy Configuration

| Command | Description |
|--|--|
| ip dhcp relay agent information option policy {drop keep replace} | <ul style="list-style-type: none"> The default is set to replace. Drop: deletes packets with relay agent information option keep: maintains the existing relay agent information option: and adds relay agent information option if no relay agent information option in router. replace: Replaces the relay agent information option in router with relay agent information option. Use no format command to go back to default. |

In the following example, DHCP Relay Information Option reforwarding is set to “drop”.

```
Router# configure terminal
```

```
Router(config)# ip dhcp relay agent information option policy drop
```

```
Router(config)# exit
```

```
Router# show ip dhcp relay
```

```
DHCP relay : Enabled
DHCP Smart Relay feature : Disabled
DHCP Smart Relay retry count : 3
DHCP server-id based relay : Disabled
```

Verification of MAC address : Enabled
 Insertion of option 82 : Enabled
 DHCP relay agent information option policy : drop
 DHCP Option82 Management-IP : 0.0.0.0
 DHCP maximum hop count : 10

DHCP helper-address is configured on following servers:
 192.168.0.254

DHCP Smart Relay Configuration

The system forward packet to DHCP server with configuring primary IP address of interface received DHCP packet from DHCP client with giaddr field of DHCP packet.

Normally, a DHCP relay agent forwards DHCP_DISCOVER message to a DHCP server only with a primary IP address on an interface, even if there is more than one IP address on the interface.

If the smart relay forwarding is enabled, a DHCP relay agent will retry sending DHCP_DISCOVER message with a secondary IP address, in case of no response from the DHCP server.

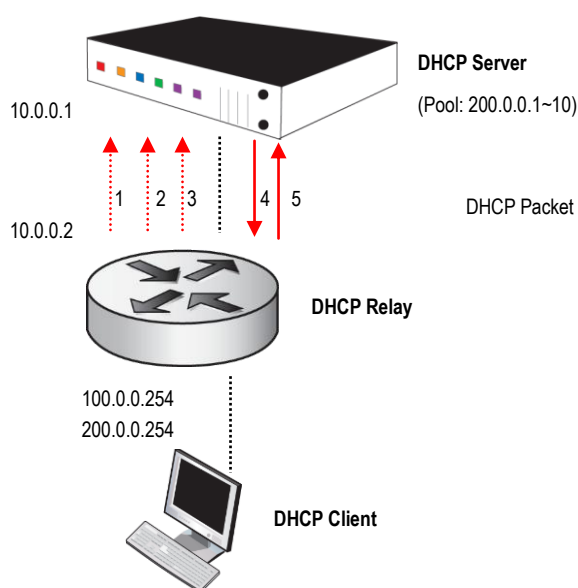


Figure 15. DHCP Smart-Relay running procedure

To enable DHCP smart-relay, use the following command.

Table 71 enabling DHCP smart-relay

| Command | Description |
|----------------------------|--|
| ip dhcp smart-relay | Enables DHCP smart-relay function By default, the feature is set to disabled. Use no format command to disable the function. |

To set the number of trials that a client can change IP address which a DHCP relay agent sets in the giaddr field, use the following command.

Table 72 the number of trials that a client can change IP address

| Command | Description |
|---|--|
| ip dhcp smart-relay retry <1-10> | Sets the number of trials that a relay agent sets in <1-10> giaddr field. The default is 3. To go back to the default, use no command. |

The following is an example of Setting up DHCP Smart-Relay.

```

Router# configure terminal
Router(config)# ip dhcp smart-relay
Router(config)# ip dhcp smart-relay retry 5
Router(config)# exit
Router# show ip dhcp relay

DHCP relay                : Enabled
DHCP Smart Relay feature  : Enabled
DHCP Smart Relay retry count : 5
DHCP server-id based relay : Disabled
Verification of MAC address : Enabled
Insertion of option 82    : Enabled
DHCP relay agent information option policy : drop
DHCP Option82 Management-IP : 0.0.0.0
DHCP maximum hop count    : 10

```

DHCP helper-address is configured on following servers:
192.168.0.254

DHCP Relay Agent Verify MAC-Address Configuration

DHCP relay agent uses the following items among fields of DHCP packets to recognize DHCP client that requests for IP.

6. source MAC address
7. client hardware address(chaddr field)
8. client identifier option (option61)

To block IP assigning request from vicious client, DHCP relay agent check above three fields of DHCP DISCOVER message. In case that the three fields are not the same, you can set not to forward DHCP DISCOVER message to the server.

To drop the DHCP DISCOVER message whose client hardware address or client identifier option has been changed, use the following command.

Table 73 DHCP Relay Agent Verify MAC-Address Configuration

| Command | Description |
|---|---|
| ip dhcp relay verify mac-address | When a client hardware address or client identifier option of DHCP DISCOVER message has been changed it does not forward the message to the server. |

| | |
|--|--|
| | By default this is enabled. To disable the function, use no command |
|--|--|

The following is an example of deleting the function of “DHCP relay agent verifies MAC-address”.

```
Router# configure terminal
Router(config)# no ip dhcp relay verify mac-address
Router(config)# exit
Router# show ip dhcp relay
```

```
DHCP relay : Enabled
DHCP Smart Relay feature : Enabled
DHCP Smart Relay retry count : 3
DHCP server-id based relay : Disabled
Verification of MAC address : Disabled
Insertion of option 82 : Enabled
DHCP relay agent information option policy : drop
DHCP Option82 Management-IP : 0.0.0.0
DHCP maximum hop count : 10
```

```
DHCP helper-address is configured on following servers:
192.168.0.254
```

DHCP Class based DHCP packet forwarding

This function is for selection of message receiving from client like ip dhcp-server and ip dhcp helper-address commands.

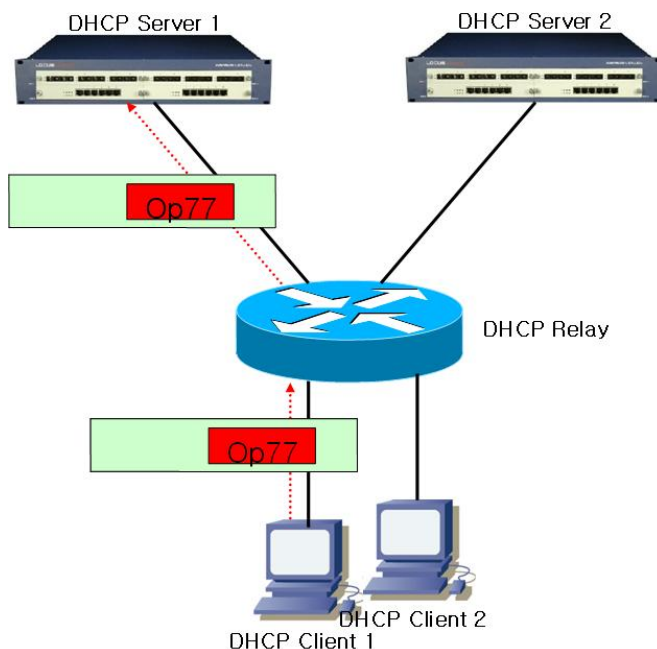



Figure 16. DHCP Class based on DHCP packet Relay

DHCP Class Configuration

To set DHCP class in U9016B DHCP relay agent, use the following command.

Table 74 DHCP Class Configuration

| Command | Description |
|--|---|
| ip dhcp class <i>class-name</i> | Assigns DHCP Class Name. Enters DHCP class setting mode which is recognized as "(dhcp-class) #". To delete the class, use no command. |
| option <1-255> {ascii hex} <i>WORD</i> | Set option-option value so that the DHCP message sent from a client can be categorized into this class. <1-255>: DHCP option number {ascii hex}: DHCP option value format (ascii string variable, hexadecimal) WORD: option value, <div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">  Notice </div> <div>For a hexadecimal format, you must use even number of digits. e.g. ip dhcp option 60 hex 1 (x) ip dhcp option 60 hex 01 (o)</div> </div> |

The following example shows how to set “test”.

```
Router(config)# configure terminal
Router(config)# ip dhcp class test
Router(dhcp-class)# option 77 ascii ubiquoss
```

DHCP Relay-Pool Configuration

To set DHCP Relay-Pool, use the following commands.

Table 75 DHCP Relay-Pool Configuration

| Command | Description |
|---------------------------------------|--|
| ip dhcp relay-pool <i>WORD</i> | <ul style="list-style-type: none"> Generates a DHCP relay-pool and enters DHCP relay-pool which is recognized as “(dhcp-pool)#”. WORD: name of relay-pool To delete relay-pool, use no command. |
| relay source <i>A.B.C.D/M</i> | <ul style="list-style-type: none"> Sets the subnet of relay-pool. To disable the function, use no command. |
| class <i>class-name</i> | <ul style="list-style-type: none"> Sets the DHCP class of a DHCP DISCOVER/REQUEST message that a client has sent so the message can be forwarded to the assigned server in the relay-pool. You can assign more than one class. To disable the function, use no command. |
| relay target <i>A.B.C.D/M</i> | <ul style="list-style-type: none"> Sets a server which will forward a DHCP DISCOVER/ REQUEST message. To disable the function, use no command. |

If you set “test” DHCP class and DHCP relay-pool “test-pool”, DHCP relay agent forwarding message included “ubiquoss” of ascii characters.

```
Router(config)# ip dhcp relay-pool test
Router(config-dhcp)# relay source 100.0.0.0/24
Router(config-dhcp)# exit
Router(config-dhcp)# class test
Router(config-class)# relay target 200.0.0.254
Router(config-class)# exit
Router(config)# service dhcp relay
```


DHCP Snooping Function

DHCP Snooping Function Overview

The DHCP snooping compiles an address binding table that is similar to the one made in the DHCP server based on DHCP messages exchanged between DHCP client and DHCP server.

The binding table is used as database to prevent malicious users. Snoop can also control messages between client servers. It can be enabled in the same way as DHCP agent and it cannot be used with DHCP server simultaneously.

Trust and Untrust Source

The DHCP Snooping classifies traffic sources into trusted and untrusted. Untrusted sources can do traffic attack and other conflict behaviors. To prevent these obstacles, the DHCP Snooping can filter messages from untrusted sources.

DHCP Snooping Binding Database

The DHCP Snooping makes a dynamic database using DHCP Message and maintains it. The database includes an entry of untrusted host of Vlan which has DHCP Snooping enabled. The database entry adds every DHCP message from DHCP server and client after Validation check. And it reports the result of validation check in state items. For a series of normal DHCP messages started from the same DHCP client, only the latest message is recorded in the database entry. When the IP address lease time has passed or when receiving a DHCPRELEASE message from a host, it is recorded as time expired or released on the state list. When the database entry has exceeded the max-value the oldest invalid entry will be deleted, and a new entry will be added.

The DHCP Snooping binding database includes MAC Address, Client Hardware Address, Client Identifier, leased IP address, lease time, received time, State, Vlan ID, information of interface port connected to the host.

Packet Validation

A switch verifies the validity of the DHCP packet received from the untrusted interface of VLAN which has DHCP Snooping enabled. In the following case a switch records each item in the state list of DHCP Snooping binding table.

A switch receives a DHCPDISCOVER packet that has a source MAC address not correspond with a DHCP client identifier or DHCP client hardware address from an untrusted interface

Packet Rate-limit

The DHCP Snooping applies rate-limit to DHCP packets from the same DHCP client. It allows up to two packets per second sent from the same type of DHCP client.

DHCP Snooping Function Activation

By default, DHCP Snooping of a switch is disabled. To enable the DHCP Snooping, use the following command in the global mode.

**Notice**

As in the relay agent setting, to enable the DHCP Snooping you must use class-map and policy-map so that a DHCP packet can be trapped to the CPU. Refer to the Section 6.2.2 for the configuration.

Table 76 DHCP Snooping Function Activation

| Command | Description |
|------------------|---|
| ip dhcp snooping | <ul style="list-style-type: none">Activates DHCP Snooping functionUse no format command to disable DHCP Snooping function. |

The following is an example of enabling DHCP Snooping function.

```
Router# configure terminal
Router(config)# ip dhcp snooping
Router(config)# exit
Router# show ip dhcp snooping
Router DHCP Snooping is enabled
Invalid entry keep time: 14400 mins
DHCP Packet rate-limit per client: 2 pps
Verification of hwaddr field is enabled
Insertion of option 82 is disabled
DHCP snooping is configured on following VLANs:
none
```

DHCP Snooping Vlan Configuration

In the DHCP Snooping Vlan Configuration, you will set a Vlan that will snoop DHCP packets. Packets passing by Vlans other than the one you have set will not be snooping.

Table 77 DHCP Snooping Vlan Configuration

| Command | Description |
|--------------------------------------|---|
| ip dhcp snooping vlan <i>vlan_ID</i> | Sets a Vlan which will snoop DHCP packets. To delete the DHCP Snooping Vlan, use no command. |

**Notice**

When you use DHCP Snooping and DHCP Relay simultaneously, DHCP Relay will forward a packet.

**Notice**

When you use DHCP Snooping and DHCP Relay simultaneously, you must set both Vlans connected to DHCP server and to DHCP client as Snooping Vlans.

The following example shows how to enable DHCP Snooping of vlan1.

```
Router# configure terminal
Router(config)# ip dhcp snooping vlan 1
Router(config)# exit
```

```
Router# show ip dhcp snooping
Router DHCP Snooping is enabled
Invalid entry keep time: 14400 mins
DHCP Packet rate-limit per client: 2 pps
Verification of hwaddr field is enabled
Insertion of option 82 is disabled
DHCP snooping is configured on following VLANs:
vlan1
```

DHCP Snooping Information option (OPTION82) Configuration

When DHCP Snooping snoops a DHCP request received from a DHCP client, it provides DHCP Snooping information option so the information the interface and switch connected to a DHCP client can be included.

Enable DHCP Snooping Information Option Function

To enable information option of U9016B Snooping, use the following command.

Table 78 Enable DHCP Snooping information option function

| Command | Description |
|--|--|
| ip dhcp snooping information option | Enables DHCP Snooping information (option-82 field). By default, this is disabled. |

The following example shows how to enable DHCP Snooping Information Option.

```
Router# configure terminal
Router(config)# ip dhcp snooping information option
Router(config)# exit
Router# show ip dhcp snooping
Router DHCP Snooping is enabled
Invalid entry keep time: 14400 mins
DHCP Packet rate-limit per client: 2 pps
Verification of hwaddr field is enabled
Insertion of option 82 is enabled [drop]
DHCP snooping is configured on following VLANs:
vlan1
```

DHCP snooping information option reforwarding policy Configuration

By default, DHCP Snooping information policy of U9016B drops packets with information option sent by DHCP client.

To change default policy of U9016B, use the following command in global mode.

Table 79 DHCP Snooping information option reforwarding policy Configuration

| Command | Description |
|-------------------------------------|-----------------------------|
| ip dhcp snooping information | The default is set to drop. |

| | |
|-----------------------------------|--|
| policy {drop keep replace} | drop: deletes packets with DHCP Snooping information. keep: maintains the existing DHCP Snooping information. replace: replaces the existing DHCP Snooping information with the DHCP Snooping information of Premier router. |
|-----------------------------------|--|

The following example shows how to set DHCP Snooping Information Option reforwarding policy as Keep.

```

Router# configure terminal
Router(config)# ip dhcp snooping information policy keep
Router(config)# exit
Router#
Router# show ip dhcp snooping
Router DHCP Snooping is enabled
Invalid entry keep time: 14400 mins
DHCP Packet rate-limit per client: 2 pps
Verification of hwaddr field is enabled
Insertion of option 82 is enabled [keep]
DHCP snooping is configured on following VLANs:
vlan1
  
```

DHCP Snooping Trust Port Configuration

To set a Trust Port (e.g. a DHCP server direction port), use the following command. When you set a Trust Port, a request packet will be forwarded as a trust port only.

Table 80 DHCP Snooping Trust Port Configuration

| Command | Description |
|-------------------------------|--|
| ip dhcp snooping trust | Sets an assigned port as a Trust Port. It will not conduct a Validation check for a DHCP packet received at the Trust Port. Request packets from the host will be forwarded only to the Trust Port. By default, all ports are untrust ports. |

The following is an example of setting port 'gi1/1' on Trust Port.

```

Router(config)# interface gi1/1
Router(config-if-Giga1/1)# ip dhcp snooping trust
Router(config-if-Giga1/1)# end
Router# show ip dhcp snooping interface

```

| Interface | Trust State | Max Entry |
|-----------|-------------|-----------|
| Giga1/1 | Trusted | 2000 |

DHCP snooping max-entry Configuration

To set the number of DHCP Snooping max-entry for each port, use the following command.

Table 81 DHCP snooping max-entry Configuration

| Command | Description |
|--|--|
| ip dhcp snooping max-entry <10-1000> | <ul style="list-style-type: none">Sets the number of DHCP Snooping max-entry for each port. It does not delete any entry that is valid (and in use of an IP) even when binding entries are generated because it exceeds the max-entry.By default, each port has 2000 Max-entries. |

The following example shows how to set DHCP Snooping Max-Entry of gi 1/1 with 100.

```
Router# configure terminal
Router(config)# interface gi1/1
Router(config-if-Giga1/1)# ip dhcp snooping max-entry 100
Router(config-if-Giga1/1)# end
Router# show ip dhcp snooping interface
```

| Interface | Trust State | Max Entry |
|-----------|-------------|-----------|
| Giga1/1 | Trusted | 100 |

DHCP Snooping Entry Time Configuration

To set the time restoring a DHCP Snooping Binding Entry that is not invalid (not in use of an IP address), use the following command.

Table 82 DHCP Snooping Entry Time Configuration

| Command | Description |
|---|--|
| ip dhcp snooping entry-time <5-65535> | Sets the time for an Invalid DHCP Snooping Binding Entry (not in use of an IP address) to be stored. The time is set in minutes. By default, entry time is 14400 minutes (10 days). |

The following example shows how to set Entry Time DHCP Snooping with 10 seconds.

```
Router# configure terminal
Router(config)# ip dhcp snooping entry-time 10
Router(config)# exit
Router# show ip dhcp snooping
Router DHCP Snooping is enabled
Invalid entry keep time: 10 mins
DHCP Packet rate-limit per client: 100 pps
Verification of hwaddr field is enabled
Insertion of option 82 is enabled [keep]
DHCP snooping is configured on following VLANs:
vlan1
```

DHCP Snooping Rate-Limit Configuration

To set the Rate-limit of DHCP Packet from the same DHCP client, use the following command.

Table 83 DHCP Snooping Rate-Limit Configuration

| Command | Description |
|------------------------------------|--|
| ip dhcp snooping rate-limit | <ul style="list-style-type: none">Sets the number of DHCP Packets, which are the same type, to be accepted sent from the same DHCP client per second.By default, it accepts two packets per second. |

The following example shows how to set DHCP Snooping Rate-Limit with 100.

```
Router# configure terminal
Router(config)# ip dhcp snooping rate-limit 100
Router(config)# end
Router#
Router# show ip dhcp snooping
Router DHCP Snooping is enabled
Invalid entry keep time: 14400 mins
DHCP Packet rate-limit per client: 100 pps
Verification of hwaddr field is enabled
Insertion of option 82 is enabled [keep]
DHCP snooping is configured on following VLANs:
vlan1
```

DHCP Snooping Verify MAC-Address Configuration

To drop a packet whose DHCP client Identifier or Client HW Address has changed, use the following command.

Table 84 DHCP Snooping Verify MAC-Address Configuration

| Command | Description |
|--|---|
| ip dhcp snooping verify mac-address | <ul style="list-style-type: none">Drops the packet whose DHCP client Identifier or Client HW Address has been changed.By default, this is enabled. |

The following example shows how to disable DHCP Snooping Verify Mac-Address.

```
Router# configure terminal
Router(config)# no ip dhcp snooping verify mac-address
Router(config)# exit
Router# show ip dhcp snooping
Router DHCP Snooping is enabled
Invalid entry keep time: 10 mins
DHCP Packet rate-limit per client: 100 pps
Verification of hwaddr field is disabled
```

Insertion of option 82 is enabled [keep]

DHCP snooping is configured on following VLANs:

vlan1

DHCP Snooping Manual Binding Configuration

To set DHCP Snooping Binding Entry manually, use the following command.

Table 85 DHCP Snooping Manual Binding Configuration

| Command | Description |
|--|--|
| ip dhcp snooping binding <i>H.H.H vlan <1-4094> A.B.C.D</i> interface IFNAME | Assigns IP A.B.C.D to a DHCP client whose MAC address is H.H.H in the assigned interface. Lease time is infinite. |

The following example shows the subscriber who has MAC address 1111.2222.3333 uses IP 100.0.0.10 connected with gi 1/1 of VLAN 1.

Router# **configure terminal**

Router(config)# **ip dhcp snooping binding 1111.2222.3333 vlan 1 100.0.0.10 interface gi1/1**

Router(config)# **exit**

Router#

Router#

Router# **show ip dhcp snooping binding**

State Codes: © - Invalid Client Identifier, (E) - Lease Time Expired

(H) - Invalid Client HW Address, ® - Rate Limit Dropped

(M) - Mac Validation Check Dropped

| Mac Address | IP Address | State | Lease(sec) | interface |
|------------------------|------------|--------|------------|-----------|
| 1111.2222.3333 | 100.0.0.10 | Manual | Infinite | Giga1/1 |
| total 4 bindings found | | | | |

DHCP server Monitoring and Management

DHCP server Pool Information Inquiry

To inquire DHCP Address Pool Information in DHCP server, use the following command in the privileged EXEC mode.

Table 86 DHCP server Pool Information Inquiry

| Command | Description |
|---|--|
| show ip dhcp pool | Shows DHCP Address of DHCP server information. |
| show ip dhcp pool pool [name] | Shows Network Pool information of DHCP server. |

DHCP Server Binding Information Search

To search the binding information of addresses provided by the DHCP server to the client, use the following command in privileged EXEC mode.

Table 87 DHCP Server Binding Information Search

| Command | Purpose |
|------------------------------------|--|
| show ip dhcp binding | Displays all bindings on DHCP server. |
| show ip dhcp binding detail | Displays all bindings on DHCP server in more detailed format |

DHCP Server Statistics Search

Table 88 DHCP Server Statistics Search

| Command | Purpose |
|---------------------------------------|---|
| show ip dhcp server statistics | Displays the statistics of the server and the information of counters of sent/ received messages. |

DHCP Server Conflict Search

Table 89 DHCP Server Conflict Search

| Command | Purpose |
|--|--|
| show ip dhcp conflict {poolname} | Displays all address conflicts recorded in the DHCP server. Displays the information of conflicts that occurred in the specific pool. |

DHCP Server Variables Initialization Command

Table 90 DHCP Server Variables Initialization Command

| Command | Purpose |
|---------|---------|
|---------|---------|

| | |
|-----------------------------------|--|
| clear ip dhcp binding {address} * | Deletes the automatic address binding function from the DHCP database. When you specify an address it will automatically bind of the specified address; when you use "*" it will delete all automatic bindings. |
| clear ip dhcp server statistics | Initializes all statistic counters of DHCP server. |

DHCP server Debug Command

Table 91 DHCP server Debug Command

| Command | Description |
|-------------------------|---|
| debug ip dhcp server on | Enables debugging function of DHCP server |

DHCP relay Monitoring and Control

Table 92 DHCP relay Monitoring and Control Command

| Command | Description |
|---|--|
| show ip dhcp helper-address | Show DHCP server list |
| show ip dhcp relay agent information option | Enable DHCP relay agent information option and show reforwarding policy. |
| show ip dhcp relay statistics | Show relay statistics and counted information of received message. |
| debug ip dhcp relay {events packets} | Enable debugging of DHCP relay. |

DHCP Snooping Monitoring and Control

Table 93 Showing DHCP Snooping and Control

| Command | Description |
|---|--|
| show ip dhcp snooping | Show global DHCP Snooping Configuration |
| show ip dhcp snooping binding {IFNAME valid invalid manual} | Show DHCP Snooping Binding Entry |
| show ip dhcp snooping interface | Show DHCP Snooping Configuration to interface. |
| show ip dhcp snooping statistics | Show DHCP Snooping statistics information. |
| show debugging ip dhcp snooping | Show DHCP Snooping debugging. |
| debug ip dhcp snooping | Enable DHCP Snooping debugging function. |

DHCP Configuration Examples

This section provides examples as follows.

- DHCP Network Pool Configuration Example
- DHCP Host Pool Configuration Example
- DHCP server Monitoring and Management Example
- DHCP relay agent Configuration Example
- DHCP relay agent Monitoring and Management Example

DHCP Network Pool Configuration

The following is the example of the generation of DHCP network pool that uses 192.168.1.0/24 network. The default router of the client is set as 192.168.1.1 and ubiquoss.com is used as the domain name. The IP address of the client is leased for one day and the address ranges to be assigned are 192.168.1.10~192.168.1.100 and 192.168.1.150~192.168.1.230.

```
Router(config)# configure terminal
Router(config)# ip dhcp pool marketing
Router(config-dhcp)# domain-name ubiquoss.com
Router(config-dhcp)# lease 1
Router(config-dhcp)# network 192.168.1.0/24
Router(config-dhcp)# default-router 192.168.1.1
Router(config-dhcp)# range 192.168.1.10 192.168.1.100
Router(config-dhcp)# range 192.168.1.150 192.168.1.230
```

The following shows the example of the generation of the DHCP network pool and group setting that uses 192.168.2.0/24 and 192.168.3.0/24 network. The default-router of 192.168.2.0/24 network is 192.168.2.1 and the address range is 192.168.2.10~192.168.2.240. Default-router of 192.168.3.0/24 network is 192.168.3.1 and address ranges are 192.168.3.10~192.168.3.50 and 192.168.3.100~192.168.3.230. And DNS servers are set as 1.2.3.4. and 1.2.3.5. Each client is guaranteed up to 12 hours of IP address lease.

```
Router(config)# configure terminal
Router(config)# ip dhcp pool sales1
Router(config-dhcp)# dns-server 1.2.3.4 1.2.3.5
Router(config-dhcp)# lease 0 12
Router(config-dhcp)# network 192.168.2.0/24
Router(config-dhcp)# default-router 192.168.2.1
Router(config-dhcp)# range 192.168.2.10 192.168.2.240
Router(config-dhcp)# group vlan10
Router(config-dhcp)# exit
Router(config)# ip dhcp pool sales2
Router(config-dhcp)# dns-server 1.2.3.4
Router(config-dhcp)# dns-server 1.2.3.5
Router(config-dhcp)# lease 0 12
Router(config-dhcp)# network 192.168.3.0/24
Router(config-dhcp)# default-router 192.168.3.1
Router(config-dhcp)# range 192.168.3.10 192.168.3.50
```

```
Router(config-dhcp)# range 192.168.3.100 192.168.3.230
Router(config-dhcp)# group vlan10
Router(config-dhcp)# exit
```

Example of DHCP Host Pool Configuration

The following shows an example of the host pool configuration in 192.168.4.0/24 network. The default-router is 192.168.4.1 and ubiquoss.com is used as the domain name. This is host pool for clients using 192.168.4.10 and 192.168.4.11 as DNS-server. And, an IP address of 192.168.4.114 and netmask of 255.255.255.0 are allocated to the client whose MAC address is 00:01:02:94:77:d7.

The IP address allocated in a manual binding is permanently used.

```
Router(config)# ip dhcp pool mars
Router(config-dhcp)# default-router 192.168.4.1
Router(config-dhcp)# dns-server 192.168.4.10
Router(config-dhcp)# dns-server 192.168.4.11
Router(config-dhcp)# domain-name ubiquoss.com
Router(config-dhcp)# host 192.168.4.114/13
Router(config-dhcp)# hardware-address 00:01:02:94:77:d7
Router(config-dhcp)# exit
```



Notice

The same IP address is always allocated to the client configured through manual binding.

DHCP server Monitoring and Control

The following example shows how to display DHCP Address Pool on DHCP server.

```
shu# show ip dhcp pool
Pool network :
  network: 44.1.1.0/24
  address range(s):
    add: 44.1.1.1 to 44.1.1.200
  lease <days:hours:minutes> <0:0:1>
  no domain is defined
  no dns-servers
  no default-routers

Pool host:
  host 3.1.1.1/24
  hardware Ethernet 11:11:11:11:11:11
  no domain is defined
  no dns-servers
```

```
no default-routers
shu#
```



Notice With show running-config command, you can see the configuration information that the administrator has set.

The following example shows the IP address that DHCP server assigned to Client.

Router# **show ip dhcp binding**

| IP address | Hardware address | Lease expiration | Type |
|---------------|-------------------|--------------------------|-----------|
| 192.168.4.114 | 00:01:02:94:77:d7 | Infinite | Maunal |
| 192.168.3.10 | 02:c7:f8:00:04:22 | Wed Mar 12 06:27:39 2003 | Automatic |

The following example shows the IP address that DHCP server assigned to Client in detail.

Router(Config)# **show ip dhcp binding detail**

| | |
|------------------------|---------------------|
| ----- | |
| TYPE | : Manual |
| IP addr | : 192.168.4.114 |
| HW addr | : 00:01:02:94:77:d7 |
| Client ID | : - |
| Host Name | : - |
| Lease | : Infinite |
| ----- | |
| TYPE | : Manual |
| IP addr | : 192.168.4.115 |
| HW addr | : 00:01:02:94:77:d8 |
| Client ID | : - |
| Host Name | : - |
| Lease | : Infinite |
| ----- | |
| TYPE | : Manual |
| IP addr | : 192.168.4.116 |
| HW addr | : 00:01:02:94:77:d9 |
| Client ID | : - |
| Host Name | : - |
| Lease | : Infinite |
| ----- | |
| total 3 bindings found | |

The following shows how to delete the binding information of the DHCP server so that the DHCP server can use an IP address that has been already bound to a client (DHCP server attempts to use the IP address of other client).

Router(Config)# **clear ip dhcp binding 192.168.3.10**

Router(Config)# **show ip dhcp binding**

| IP address | Hardware address | Lease expiration | Type |
|---------------|-------------------|------------------|--------|
| 192.168.4.114 | 00:01:02:94:77:d7 | Infinet | Manual |

The following example shows how to display the statistics of DHCP server.

Router# show ip dhcp server statistics

| Message | Received |
|--------------------|----------|
| Malformed messages | 0 |
| BOOTREQUEST | 0 |
| DHCPDISCOVER | 200 |
| DHCPREQUEST | 178 |
| DHCPDECLINE | 0 |
| DHCPRELEASE | 0 |
| DHCPINFORM | 0 |
| ICMPECHO | |
| Message | Sent |
| BOOTREPLY | 0 |
| DHCPOFFER | 190 |
| DHCPACK | 172 |
| DHCPNAK | 6 |

DHCP relay agent Configuration

The following example shows that the DHCP Relay Agent of the switch sets the DHCP server to transfer the requests of the client. If there is no DHCP address pool that satisfies the client's request, the switch transfers the request to the DHCP server located in another sub-network.

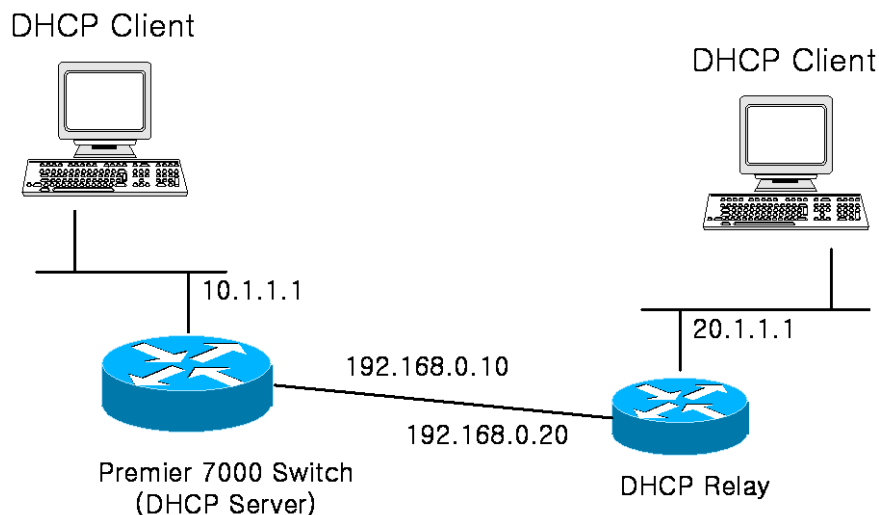


Figure 17. Network – DHCP Relay Agent Configuration

```
Router(config)# configure terminal
Router(config)# ip dhcp-server 10.1.1.2
Router(config)# service dhcp relay
Router (config)# end
Router# show ip dhcp helper-address
Server's IP address : 10.1.1.2
Router #
Router # show ip dhcp relay statistics
```

| | |
|------------------------|-------|
| Destination(Server) | Value |
| Client-packets relayed | 8 |
| Client-packets errored | 0 |

| | |
|------------------------|-------|
| Destination(Client) | value |
| Server-packets relayed | 6 |
| Server-packets errored | 0 |
| Giaddr errored | 0 |
| Corrupt agent options | 0 |
| Missing agent options | 0 |
| Bad circuit id | 0 |
| Missing circuit id | 0 |



Notice

To transfer a DHCP message to a DHCP server located in other sub-network, the route information on the network must be configured in the DHCP server of the switch.

| Item | Description |
|------------------------|--|
| Client-packets relayed | Successfully done forwarding a packet sent from a DHCP client to DHCP server. |
| Client-packets errored | Failed to forward a packet sent from a DHCP client to DHCP server. |
| Server-packets relayed | Failed to forward a packet sent from a DHCP server to DHCP client. |
| Server-packets errored | Failed to forward a packet sent from a DHCP server to DHCP client. |
| Giaddr errored | A DHCP packet sent from a DHCP server does not have a giaddr. |
| Corrupt agent options | When the insertion function of the DHCP relay agent or DHCP information option of snoop is enabled, the Option82 of DHCP packet, sent from a DHCP server, has an error (The Length field and the actual DHCP Option82 Length are different). |
| Missing agent options | When the insertion function of a DHCP relay agent or DHCP information option of snoop is enabled, the DHCP packet sent from a DHCP server does not have the information of Option82. |
| Bad circuit id | When the insertion function of a DHCP relay agent or DHCP information option of snoop is enabled, the circuit id (interface information of a member) from the information of DHCP packet Option82, sent from a DHCP server, has an error. (The port corresponding to the circuit id cannot be found by using the circuit id of option82 in a DHCP packet.) |
| Missing circuit id | When the insertion function of a DHCP relay agent or DHCP information option of snoop is enabled, the circuit id (interface information of a member) from the information of DHCP packet Option82, sent from a DHCP server, has an missing. (The port corresponding to the circuit id cannot be found by using the circuit id of option82 in a DHCP packet.) |

DHCP Snooping Configuration

The following example shows how to use U9016B as a DHCP Snoop located in between a DHCP Server and DHCP Client. The system DHCP Snoop generates a DHCP Snooping Binding Entry by Snooping the DHCP packet passing by the switch. The following example shows that the DHCP Client (0000.864a.c185), connected to the gi1/1 port, receives the IP 100.0.0.100 after sending a DHCP Request packet to the DHCP Server 100.0.0.254.

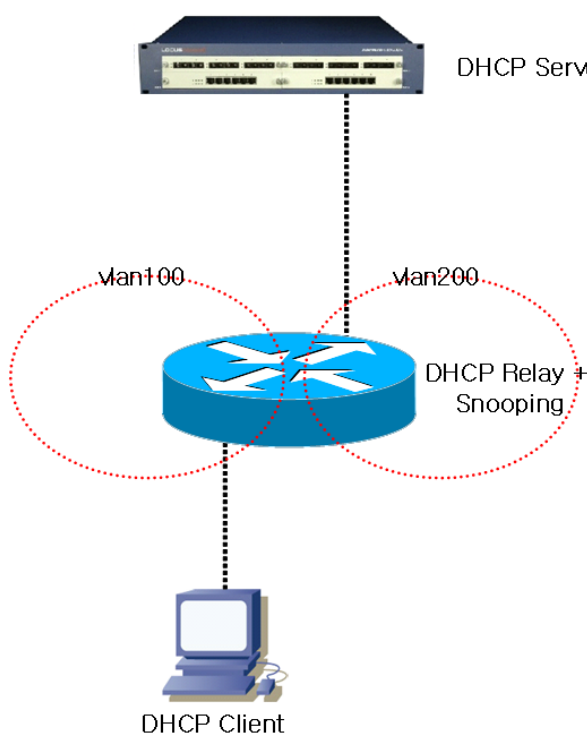


Figure 18. DHCP Snooping Configuration

Router# **configure terminal**

Router(config)# **ip dhcp snooping vlan 100**

Router(config)# **ip dhcp snooping vlan 200**

Router(config)# **ip dhcp snooping**

Router(config)# **ip dhcp-server 100.0.0.254**

Router(config)# **service dhcp relay**

Router# **show ip dhcp snooping binding**

State Codes: © - Invalid Client Identifier, (E) - Lease Time Expired

(H) - Invalid Client HW Address, (D) – Rate Limit Dropped

| MacAddress | IpAddress | State | Lease(sec) | VlanId | Port |
|----------------|-------------|-------|------------|--------|---------|
| 0000.864a.c185 | 100.0.0.100 | Ack | 87 | 100 | Giga1/1 |

Chapter 6. RIP

This chapter introduces how to set up RIP (Routing Information Protocol). RIP has been used for many years and is still used for IGP (Interior Gateway Protocol) of small network.

Information about RIP

RIP is an interior gateway protocol that has been used for many years and is still used for small network environment. RIP is one of routing protocols that is a classical distance-vector.

RIP broadcasts User Datagram Protocol (UDP) data packets to exchange routing information. By default routing information is advertised every 30 seconds. If a switch cannot receive an update from another switch for more than 180 seconds, it will say that the router information is from an irrelevant switch. If the switch does not receive any update until 240 seconds, it will remove the whole entries.

The metric using in RIP is hop count. Hop count is number of router going through to router.

A connected network has metric value of 0 and Unreachable router has metric value of 16. Because it uses small metric scope like this, it does not suit with routing protocol for big network. The switch can receive or make default network via update from another system.

In this case, default network become advertisement via RIP and another RIP neighbor.

How to Configure RIP

The following commands should be completed for RIP configuration.

- Enabling RIP
- Allowing Unicast Updates for RIP
- Passive interface
- Applying Offsets to Routing Metrics
- Adjusting Timers
- Specifying a RIP version
- Applying Distance
- Enabling Split Horizon

Enabling RIP

To enable RIP, do the following steps.

Table 94 Enabling RIP

| Step | Command or Action | Purpose |
|---------------|--|--|
| Step 1 | Configure terminal Example: Switch# configure terminal | Enters the Global configuration mode |
| Step 2 | router rip Example: Switch(config)# router rip | Enter the RIP routing configuration mode |
| Step 3 | network ip-address/prefix-len Example: Switch(config-router)# network 33.1.1.0/24 | Assigns network for advertising to another router via RIP. |
| Step 4 | End Example: Switch(config-router)# end | Enters the privileged EXEC mode |

Allowing Unicast updates for RIP

To allow unicast updates for RIP, use the following command in the router configuration mode.

Table 95 Allowing Unicast updates for RIP

| Command or Action | Purpose |
|---|---|
| neighbor ip-address Example: Switch(config-router)# neighbor 3.3.3.2 | Defines switch for neighboring to exchange routing information. |

Passive interface

To set passive interface, use the command in router configuration mode.

Table 96 Passive interface

| Command or Action | Purpose |
|--|------------------------|
| passive-interface IFNAME | |
| Example: Switch(config-router)# passive-interface gi2/1 | Sets Passive interface |

Applying Offsets to Routing metrics

Offset list is a mechanism to increase both incoming and outgoing metrics of RIP: it can be done by Access list and offset list. To increase the routing metric, use the following command in router configuration mode.

Table 97 Applying Offsets to Routing metrics

| Command or Action | Purpose |
|---|-----------------------------------|
| offset-list <i>access-list-name</i> {in out} <i>metric IFNAME</i> | |
| Example: Switch (router-config)# offset-list aa in 5 gi2/1 | To apply offset on routing metric |

Adjusting Timers

Routing protocol uses various timers. Network administrator can manage the timer that changes the routing protocol performance to match for the network. You can make adjustments as follows:

- Routing table update timer (default 30 seconds)
- Routing information timeout timer (180seconds)
- Garbage collection timer (120 seconds)

To adjust time value, use the following command in router configuration mode

Table 98 Adjusting Timers

| Command or Action | Purpose |
|---|--------------------------------|
| timer basic <i>update invalid holddown</i> | |
| Example: Switch(config-router)# timer basic 30 120 120 | Adjusts routing protocol timer |

Specifying a RIP Version

To set to change a RIP version, use the following command in router configuration mode

Table 99 Specifying a RIP Version

| Command or Action | Purpose |
|------------------------|-----------------------------|
| version {1 2} | Sets to change RIP version. |

| | |
|--|--|
| Example: Switch(config-router)# version 2 | |
|--|--|

To manage RIP version sent by a specific interface, use the following command in configuration mode of interface.

Table 100 Specifying a RIP Version

| Command or Action | Purpose |
|--|--|
| ip rip send version VERSION | |
| Example: Switch(config-if-Giga2/1)# ip rip send version 1 Switch(config-if-Giga2/1)# ip rip send version 2 Switch(config-if-Giga2/1/1)# ip rip send version 1 2 | Sets interface to receive only RIP packets that are relevant Note Both versions of 1 and 2 are supported when they are selected. |

To control packet version by interface, use the following command in interface configuration mode.

Table 101 Specifying a RIP Version

| Command or Action | Purpose |
|---|---|
| ip rip receive version VERSION | |
| Example: Switch(config-if-Giga2/1)# ip rip receive version 1 Switch(config-if-Giga2/1)# ip rip receive version 2 Switch(config-if-Giga2/1)# ip rip receive version 1 2 | Sets interface to receive only RIP packets that are relevant Note. Both versions of 1 and 2 are supported when they are selected. |

Applying Distance

Administrative distance represents the reliability of routing information source. In general, a large number means less reliability. The default of RIP is 120.

To adjust administrative distance value, use the following commands in router configuration mode.

Table 102 Applying Distance

| Command or Action | Purpose |
|--|--|
| distance VALUE A.B.C.D/M | |
| Example: Switch(config-router)# distance 90 10.1.1.1/24 | Changes the Administrative distance value. |

Enabling Split Horizon

Distance-vector routing uses split horizon mechanism to lower the risk of routing loop.

Use the following commands to enable Split horizon in interface configuration mode.

Table 103 Enabling Split Horizon

| Command or Action | Purpose |
|--|----------------------------------|
| ip rip split-horizon [poisoned] | |
| Example: Switch(config-if-Giga2/1)# ip rip split-horizon poisoned | To enable Split horizon poisoned |

Configuration Examples for RIP

RIP Construction

Let us investigate an example of RIP construction by looking at the Network Configuration in the following figure.

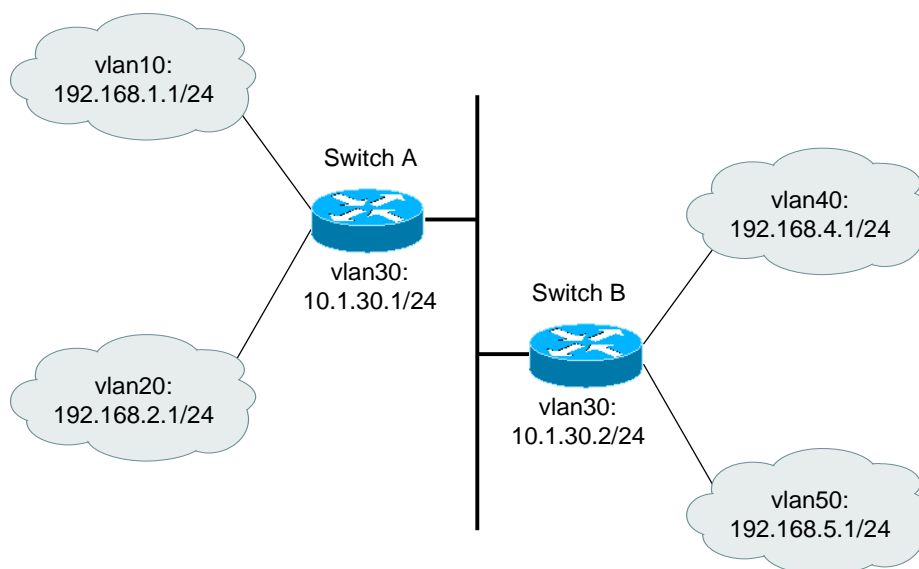


Figure 19. RIP Network Configuration Example and Diagram

| Switch A | Switch B |
|---|---|
| vlan10 192.168.1.1/24 vlan20 192.168.2.1/24 vlan30 10.1.30.1/24 | vlan30 10.1.30.2/24 vlan40 192.168.4.1/24 vlan50 192.168.5.1/24 |

To enable RIP protocol of each interface, use the following commands in the router configuration mode.

Switch A Configuration

Switch A(config)# **router rip**

Switch A(config-router)# **network** 192.168.1.1/24

Switch A(config-router)# **network** 192.168.2.1/24

Switch A(config-router)# **network** 10.1.30.1/24

Switch A(config-router)# **end**

Switch A# **show ip route database**

Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP

O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
> - selected route, * - FIB route, p - stale info

```
C>* 10.1.30.0/24 is directly connected, vlan30
C>* 192.168.1.0/24 is directly connected, vlan10
C>* 192.168.2.0/24 is directly connected, vlan20
R> 192.168.4.0/24 [120/1] via 10.1.30.2, vlan30, 00:01:42
R>* 192.168.5.0/24 [120/1] via 10.1.30.2, vlan30, 00:01:42
Switch A#
```

Switch B Configuration

```
Switch B(config)# router rip
```

```
Switch B(config-router)# network 192.168.4.1/24
```

```
Switch B(config-router)# network 192.168.5.1/24
```

```
Switch B(config-router)# network 10.1.30.2/24
```

```
Switch B(config-router)# end
```

```
Switch B# show ip route database
```

Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP

O - OSPF, IA - OSPF inter area

N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2

E1 - OSPF external type 1, E2 - OSPF external type 2

i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area

> - selected route, * - FIB route, p - stale info

```
C>* 10.1.30.0/24 is directly connected, vlan30
R>* 192.168.1.0/24 [120/1] via 10.1.30.1, vlan30, 00:02:13
R>* 192.168.2.0/24 [120/1] via 10.1.30.1, vlan30, 00:02:13
C>* 192.168.4.0/24 is directly connected, vlan40
C>* 192.168.5.0/24 is directly connected, vlan50
Switch B#
```

Offset-list Setting

The following example shows how to increase the metric value of all incoming RIP route to Router A by 2 using the offset-list.

```
Switch A(config)# router rip
Switch A(config-router)# offset-list 4 in 2
Switch A(config-router)# exit
Switch A(config)# access-list 4 permit any
Switch A(config)# end
Switch A# show ip route database
Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP
       O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       > - selected route, * - FIB route, p - stale info
C>* 10.1.30.0/24 is directly connected, vlan30
C>* 192.168.1.0/24 is directly connected, valn10
C>* 192.168.2.0/24 is directly connected, vlan20
R>  192.168.4.0/24 [120/3] via 10.1.30.2, vlan30, 00:06:26
R>* 192.168.5.0/24 [120/3] via 10.1.30.2, vlan30, 00:29:04
Switch A#
```

As shown above, the metric values of 192.168.4.0 and 192.168.5.0 have increased to 3. You can also set up outgoing setting as distribute-list.

Passive-interface Configuration

When you apply this command to a certain interface of the router, the interface does not advertise outgoing paths. For example, when Router A in the example network sets a passive-interface in vlan3 of Router A, Router A receives all the paths but Router B cannot get any update of the paths that Router A sends to vlan3.

```
Switch A(config)# router rip
Switch A(config-router)# passive-interface vlan30
Switch A(config-router)# end
Switch A# show ip route database
Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
        > - selected route, * - FIB route, p - stale info
C>* 10.1.30.0/24 is directly connected, vlan30
C>* 192.168.1.0/24 is directly connected, vlan10
C>* 192.168.2.0/24 is directly connected, vlan20
R> 192.168.4.0/24 [130/1] via 10.1.30.2, vlan30, 00:14:28
R>* 192.168.5.0/24 [120/1] via 10.1.30.2, vlan30, 00:37:06
Switch A#
Switch B# show ip route database
Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
        > - selected route, * - FIB route, p - stale info
C>* 10.1.30.0/24 is directly connected, vlan30
C>* 192.168.4.0/24 is directly connected, vlan40
C>* 192.168.5.0/24 is directly connected, vlan50
Switch B#
```

Chapter 7. OSPF

This chapter introduces OSPF routing protocol used in U9016B. OSPF routing protocol is described in RFC 2328.

OSPF Overview

OSPF is a link-state routing protocol that distributes routing information among the routers in one IP domain (*autonomous system (AS)*). In a link-state routing protocol, each router keeps database of autonomous system topology. Each participating router has an identical database maintained from the perspective of that router.

From Link-state DB (LSDB), each router generates the shortest path tree where it is root. This shortest path tree provides the paths to each destination in AS. If there are many paths for a destination and they cost the same, traffic can be distributed to all these paths. The path cost is expressed in a metric.

Link-state Database

When initialized, each router sends the Link State Advertisement (LSA) for its interface. LSAs are collected by each router and saved in LSDB of each router. OSPF uses Flooding to distribute LSAs between routers. Any changes in routing information are sent to all the routers in the network. All the routers in one area have one LSDB that is exactly the same.

The following table describes LSA type numbers.

Table 104 LSA Type number

| Type Number | Description |
|-------------|--------------------|
| 1 | Router link |
| 2 | Network link |
| 3 | Summary link |
| 4 | AS summary link |
| 5 | AS external link |
| 7 | NSSA external link |

Areas

In OSPF, parts of network can be grouped by area. The topology in one area is hidden from others in the autonomous system. Hiding the information enables a significant reduction in LSA traffic, and reduces the computations needed to maintain the LSDB. The routing within an area is determined by the topology of the area.

OSPF defines the type of router into the three categories as follows:

Internal Router (IR)

- An internal router has all of its interfaces within the same area.

Area Border Router (ABR)

- The router that has interfaces in many areas, ABR exchanges the summary advertisement with other ABRs.

Autonomous System Border Router (ASBR)

- ASBR works as the gateway between OSPF and other routing protocol, or other autonomous systems.

AREA 0

Any OSPF network that contains more than one area is required to have an area configured as area 0, also called the *backbone*. All the areas in autonomous system must be connected to the backbone. When you design a network, you have to start from area 0 and extend the network to other areas.

The backbone allows summary information to be exchanged between ABRs. Every ABR hears the area summaries from all other ABRs. The ABR then forms a picture of the distance to all network outside of its area by examining the collected advertisements, and adding in the backbone distance to each advertising router.

Stub areas

OSPF allows certain areas to be configured as *stub areas*. A stub area is connected to only one other area and contains a single exit point. The area that connects to a stub area can be the backbone area. All routing out of a stub area is based on default routes. Stub areas are used to reduce memory and computation requirements on OSPF routers.

Virtual links

In the situation when a new area is introduced that does not have a direct physical attachment to the backbone, a *virtual link* is used. A virtual link provides a logical path between the ABR of the disconnected area and the ABR of the backbone. A virtual link must be established between two ABRs that have a common area, with one ABR connected to the backbone.

Route Redistribution

RIP and OSPF can be enabled simultaneously on the switch. Route redistribution allows the switch to exchange routes, including static routes, between the two routing protocols.

**Notice**

Although RIP and OSPF can be run simultaneously on the switch, you cannot apply them both to the same VLAN.

OSPF Configuration

To use OSPF Routing Protocol, you must enable OSPF. The following explains the procedure.

- Enter from config mode to ospf mode.

```
router ospf [process id]
```

- Specify the network to enable OSPF protocol and the area where OSPF protocol to be located.

```
network (ip address/M | ip address wildcard mask) area (area id | area address)
```

After enabling OSPF, use the following commands to manage protocol according to the requirements and needs.

OSPF interface parameters

You must set some OSPF parameters with the same value about all router in a network. These parameters can be set with **ip ospf hello-interval**, **ip ospf dead-interval**, **ip ospf authentication-key** command. When you change OSPF parameters, you must change all interface parameters of all router in a network.

To change interface parameters, use the following commands in interface configuration mode.

Table 105 OSPF interface parameter CLI

| Command | Description |
|---|---|
| Router (config-if) # ip ospf cost <i>cost</i> | Sets the cost of packet sent by OSPF interface |
| Router (config-if) # ip ospf retransmit-interval <i>seconds</i> | Sets LSA retransmit-interval of OSPF interface |
| Router (config-if) # ip ospf transmit-delay <i>seconds</i> | Sets expected time of transmission sent by OSPF interface. |
| Router (config-if) # ip ospf priority <i>number-value</i> | Sets the priority used when selecting a OSPF designated router |
| Router (config-if) # ip ospf hello-interval <i>seconds</i> | Sets a interval of hello packet sent by OSPF interface |
| Router (config-if) # ip ospf dead-interval <i>seconds</i> | Sets OSPF dead-interval time. |
| Router (config-if) # ip ospf authentication-key <i>key</i> | Sets a password that will be used in network segment which uses OSPF simple password authentication |
| Router (config-if) # ip ospf message-digest-key <i>key-id md5 key</i> | Sets a key-id and key value that are used in OSPF MD5 authentication |
| Router (config-if) # ip ospf authentication { <i>message-digest null</i> } | Sets the Authentication type |

Different Physical Networks

There are three default network types depending on different medium of OSPF.

- Broadcast networks (Ethernet, Token Ring, FDDI)
- Nonbroadcast multi-access(NBMA) networks (Switched Multimegabit Data Service(SMDS), Frame Relay, X.25)
- Point-to-Point networks (High-Level Data Link Control(HDLC), PPP)

OSPF Network type

You can set OSPF network with broadcast or NBMA regardless of Default media type. For example, you can set broadcast network like NBMA network or NBMA network with broadcast Network.

OSPF point-to-multipoint interface is defined with numbered point-to-point having more than one neighbor. OSPF point-to-multipoint network has the merit as follows:

- Point-to-multipoint does not need neighbor setting, be easy because it does not select DR.
- Reduce cost because it does not need Full meshed topology.
- More reliable because it maintains connection on VC (virtual circuit) failure.

To set OSPF network type, use the following commands in interface configuration mode.

Table 106 OSPF network type CLI

| Command | Description |
|---|---|
| Router (config-if) # ip ospf network {broadcast non-bradcast {point-to- multipoint [non-broadcast] point-to- point}} | Sets OSPF network type of OSPF interface. |

Point-to-Multipoint, Broadcast Networks

You need not to set neighbor setting on broadcast network. However, if you change cost as relevant neighbor, you can set with using **neighbor** command. OSPF Hello, LS Update, LS acknowledgment message is sent to multicast. Even if Cost sets with `ip ospf cost` command, you can each different cost with using neighbor command in case that the broadband differs per neighbor actually.

To configure point-to-multipoint and broadcast network, do the following steps.

Table 107 P-to-Multipoint Network, Broadcast Network Configuration

| Step | Command | Description |
|---------------|---|---|
| Step 1 | Router (config-if) # ip ospf network point-to-multipoint | Sets Interface as Point-to-multipoint broadcast network type. |
| Step 2 | Router (config-if) # exit | Changes with Global configuration mode. |
| Step 3 | Router (config) # router ospf process-id | Changes with Router configuration mode. |
| Step 4 | Router (config-router) # neighbor ip-address cost number | Sets cost of specific neighbor. |

Nonbroadcast Networks

You must select DR (designated router) because many routers in OSPF network may exist. If you do not set broadcast capability, need to set specific parameter for selecting DR.

You need to set this parameter only to have nonzero priority to become DR/BDR (backup DR) by itself.

To set router setting of Nonbroadcast networks, use the following command in the router configuration mode.

Table 108 Nonbroadcast network CLI

| Command | Description |
|---|--|
| Router (config-router) # neighbor ip-address [priority number] [poll-interval seconds] | Connects router of Nonbroadcast network. |

To identify neighbors from point-to-multipoint nonbroadcast network, use neighbor command in router configuration mode.

To set the interface with point-to-multipoint to the system not applied broadcast, use the following commands with order.

Table 109 Nonbroadcast network Configuration

| Step | Command | Description |
|---------------|---|--|
| Step 1 | Router (config-if) # ip ospf network point-to-multipoint non-broadcast | Sets interface as Point-to-multipoint nonbroadcast network type. |
| Step 2 | Router (config-if) # exit | Changes with Global configuration mode. |
| Step 3 | Router (config) # router ospf process-id | Change with Router configuration mode. |

| | | |
|---------------|---|-------------------------------------|
| Step 4 | Router (config-router) # neighbor <i>ip-address [cost number]</i> | Sets cost of neighbor and neighbor. |
|---------------|---|-------------------------------------|

OSPF Area parameters

OSPF has the possible setting area parameters. These are stub area setting, authentication setting, and the cost setting about default summary route. The authentication setting cuts area access of non-authentication with setting password. Even if Stub area setting cuts access of external router, it sends default external route that ABR router creates to area. If you use **no-summary** keyword, cut summary route and reduce router number accessing to area.

To set OSPF area parameter, use the following command in the router configuration mode.

Table 110 OSPF area parameter CLI

| Command | Description |
|--|--|
| Router (config-router) # area area-id authentication | Sets authentication to OSPF area. |
| Router (config-router) # area area-id authentication message-digest | Sets MD5 authentication to OSPF area. |
| Router (config-router) # area area-id stub | Sets Stub area. |
| Router (config-router) # area area-id default-cost cost | Set cost of default summary route for Stub area. |

OSPF NSSA

NSSA extends OSPF function with setting between corporate router and remote router with stub area. The following figure shows OSPF Area 1 set with stub area. Because route redistribution is not allowed in Stub area, ISIS route can not be sent to OSPF routing domain.

But if you set OSPF Area 1 with NSSA, NSSA ASBR can flood ISIS route to OSPF NSSA after making Type 7 LSAs.

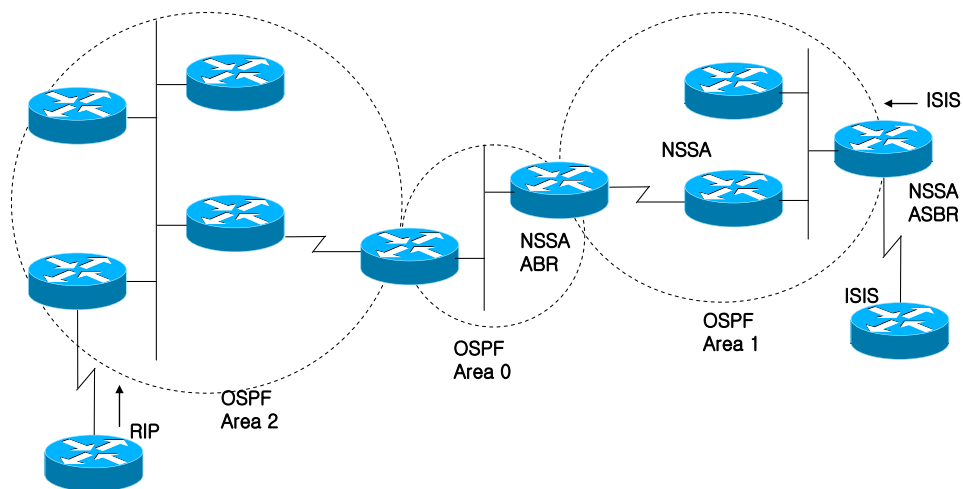


Figure 20. OSPF Network

Because NSSA is extension of stub area, Route redistributed from RIP does not income to OSPF Area 1. So It still maintains tendency of Stub area not incoming Type 5 LSAs.

To set OSPF NSSA, use the following command in router configuration mode.

Table 111 OSPF NSSA CLI

| Command | Description |
|---|-------------|
| Router (config-router) # area <i>area-id</i> nssa [no-redistribution] [default-information-originate] | Sets NSSA. |

OSPF Area Router Summarization

To set summary address range, use the following command on router configuration mode.

Table 112 OSPF area router summarization CLI

| Command | Description |
|---|---|
| Router (config-router) # area <i>area-id</i> range <i>ip-address mask</i> [advertise not-advertise] [cost <i>cost</i>] | Sets an address range for Summary route advertisement |

Route Summarization of Redistributed Routes

To summarize all redistributed routes with one route, use the following command in router configuration mode.

Table 113 External Router summarization CLI

| Command | Description |
|---|---|
| Router (config-router) # summary-address { <i>ip-address/prefix</i> } [not-advertise] [tag <i>tag</i>] | Sets an address including redistributed routes sent to one route. |

Virtual Links

To set Virtual Link, use the following command in router configuration mode.

Table 114 OSPF virtual link CLI

| Command | Description |
|--|--------------------|
| Router (config-router) # area <i>area-id</i> virtual-link <i>router-id</i> [authentication [message-digest null]] [hello-interval <i>seconds</i>] [retransmit-interval <i>seconds</i>] [transmit-delay <i>seconds</i>] [dead-interval <i>seconds</i>] [[authentication-key <i>key</i>] [message-digest-key <i>key-id md5 key</i>]] | Sets Virtual link. |

Generating a Default Router

To generate a default router with ASBR, use the following command on router configuration mode.

Table 115 OSPF default route CLI

| Command | Description |
|--|---|
| Router (config-router) # default-information originate [always] [metric <i>metric-value</i>] [metric-type <i>type-value</i>] [route-map <i>map-name</i>] | ASBR makes default route to OSPF routing domain |

Router ID Choice with a Loopback Interface

To assign IP address in Loopback interface, use the following commands in the order.

Table 116 Loopback Interface Configuration

| | Command | Description |
|---------------|--|-----------------------------------|
| Step 1 | Router (config-if) # interface Loopback 0 | Creates a Loopback interface |
| Step 2 | Router (config-if) # ip address ip-address/prefix | Assigns a IP address to Interface |

Default metric

To change reference-bandwidth, use the following command in router configuration mode.

Table 117 Reference bandwidth CLI

| Command | Description |
|---|-----------------------------|
| Router (config-router) # auto-cost reference-bandwidth <i>ref-bw</i> | Changes reference-bandwidth |

OSPF administrative Distance

To change OSPF distance, use the following commands in router configuration mode.

Table 118 OSPF distance CLI

| Command | Description |
|--|-----------------------|
| Router (config-router) # distance ospf {[intea-area <i>dist1</i>] [inter-area <i>dist2</i>] [external <i>dist3</i>]} | Changes OSPF distance |

Passive interface

To set passive interface, use the following command in router configuration mode.

Table 119 OSPF passive interface CLI

| Command | Description |
|---------|-------------|
|---------|-------------|

| | |
|---|--|
| Router (config-router) # passive-interface <i>interface-name</i> | Restricts hello packets that transmitting through interface. |
|---|--|

Route Calculation Timers

To set SPF delay time, use the following command in router configuration mode.

Table 120 OSPF SPF timer CLI

| Command | Description |
|--|-------------------------------------|
| Router (config-router) # timers throttle spf <i>spf-start spf-hold spf-max-wait</i> | Changes the calculation time of SPF |

Logging Neighbors Going Up/Down

To make system message about neighbor Up/Down, use the following command.

Table 121 OSPF adjacency LOG CLI

| Command | Description |
|--|--|
| Router (config-router) # log-adjacency-changes [detail] | Makes system message about OSPF neighbor UP/Down |

Blocking LSA Flooding

When OSPF receives new LSA, OSPF floods LSA to interface excepting the received interface. But this running may make bandwidth waste and CPU overload. If you use database-filter command, you can block LSA flooding to specific interface.

To block OSPF LSA flooding from Broadcast, non-broadcast, and point-to-point, use the following command.

Table 122 Block LSA CLI

| Command | Description |
|---|-------------------------------------|
| Router (config-router) # ip ospf database-filter all out | Restricts LSA flooding of interface |

Ignoring MOSPF LSA Packets

Because the system does not support LSA Type 6 Multicast OSPF (MOSPF), the system makes system message when receiving LSA. If receive many MOSPF LSA, the system makes many system message. If the system does not make system message, use this function.

To ignore MOSPF LSA Packets, use the following command.

Table 123 Ignore MOSPF LSA CLI

| Command | Description |
|--|--|
| Router (config-router) # ignore lsa mospf | When the system receives MOSPF LSA packet, ignores it. |

Monitoring and Maintaining OSPF

You can show the information about OSPF routing table, database, and connection status of neighbour router. This information can be used about solving the network trouble or resource management of switch.

To search information on OSPF, use the following commands in EXEC mode.

Table 124 Monitoring OSPF CLI

| Command | Description |
|--|---|
| Router # show ip ospf [<i>process-id</i>] | Searches OSPF routing process information |
| Router # show ip ospf border-routers | Searches all routing tables of ABR/ASBR |
| Router # show ip ospf [<i>process-id</i>] database | Searches OSPF database |
| Router # show ip ospf [<i>process-id</i>] database [<i>database-summary</i>] | |
| Router # show ip ospf [<i>process-id</i>] database [<i>router</i>] [<i>self-originate</i>] | |
| Router # show ip ospf [<i>process-id</i>] database [<i>router</i>] [<i>adv-router</i> [<i>ip-address</i>]] | |
| Router # show ip ospf [<i>process-id</i>] database [<i>router</i>] [<i>link-state-id</i>] | |
| Router # show ip ospf [<i>process-id</i>] database [<i>network</i>] [<i>link-state-id</i>] | |
| Router # show ip ospf [<i>process-id</i>] database [<i>summary</i>] [<i>link-state-id</i>] | |
| Router # show ip ospf [<i>process-id</i>] | |

| | |
|---|--|
| database [asbr-summary] [link-state-id] Router # show ip ospf [process-id] database [external] [link-state-id] Router # show ip ospf [process-id] database [nssa-external] [link-state-id] Router # show ip ospf [process-id] database [opaque-link] [link-state-id] Router # show ip ospf [process-id] database [opaque-area] [link-state-id] Router # show ip ospf [process-id] database [opaque-as] [link-state-id] | |
| Router # show ip ospf flood-list [interface-name] | Searches all LSAs that will be Flooding |
| Router # show ip ospf interface [interface-name] | Searches OSPF interface information |
| Router # show ip ospf neighbor [neighbor-id] [detail] | Searches OSPF neighbor information |
| Router # show ip ospf [process-id] summary-address | Searches all summary address information on Redistribution |
| show ip ospf [process-id] traffic | Searches OSPF traffic statistics |
| show ip ospf [process-id] virtual-links | Searches OSPF virtual link information |

Use the following command in EXEC mode to restart OSPF process.

Table 125 Maintaining OSPF CLI

| Command | Description |
|--|---|
| Router # clear ip ospf [process-id] {process redistribution counters traffic} | Restarts OSPF process/counters/redistribution/traffic |

Chapter 8. BGP

This chapter introduces BGP among available IP Unicast routing protocols of U9016B.

BGP Overview

BGP is a protocol that receives/sends routing information among Management Domains (Autonomous System: AS), and manages routing between domains unlike RIP and OSPF. U9016B support BGP-4.

BGP Configuration

BGP configuration includes Basic Configuration and Advanced Configuration. To use BGP protocol, configure the followings:

- Enabling BGP protocol
- BGP neighbor router configuration

Enabling BGP Protocol

To enable BGP Protocol, follow the steps below.

1. Enter BGP router configuration mode.
router bgp <14294967295>

The last number in the AS number, which is Autonomous System number given by network operator to distinguish BGP networks.

2. Flag a network as local to this autonomous system and enter it to the BGP table.
network A.B.C.D/M
3. Designate network informed via BGP.

Neighbor Configuration

Two switches connecting TCP to exchange BGP Routing Information are called peer or neighbor.

BGP supports two kinds of neighbors: internal and external. *Internal neighbors* are in the same autonomous system (iBGP Peer); *external neighbors* are in different autonomous systems (EBGP Peer). Normally, external neighbors (eBGP peer) are adjacent to each other and share a subnet, while internal neighbors (iBGP Peer) may be anywhere in the same autonomous system.

To configure such BGP neighbors, use the following command in router configuration mode.

```
neighbor ip-address remote-as number
```

After configuring BGP and neighbor, default BGP Protocol is run. Network operator sets the following items alternatively.

1. Filtering
2. BGP Attribute Configuration
3. Routing policy Modification
4. Other functions

BGP Filtering

BGP update sending/receiving can be managed by filtering functions such as route filtering, path filtering, and community filtering. Even though the functions have the same results, you need to choose the proper one based on the network configuration.

Route Filtering

To limit routing information that router receives or advertises, it filters BGP based on routing update going/coming to the specific neighbor. The specific Access-list is applied to the Input/Output update to the specific neighbor with the following command.

```
neighbor {ip-address|peer-group-name} distribute-list access-list-number {in|out}
```

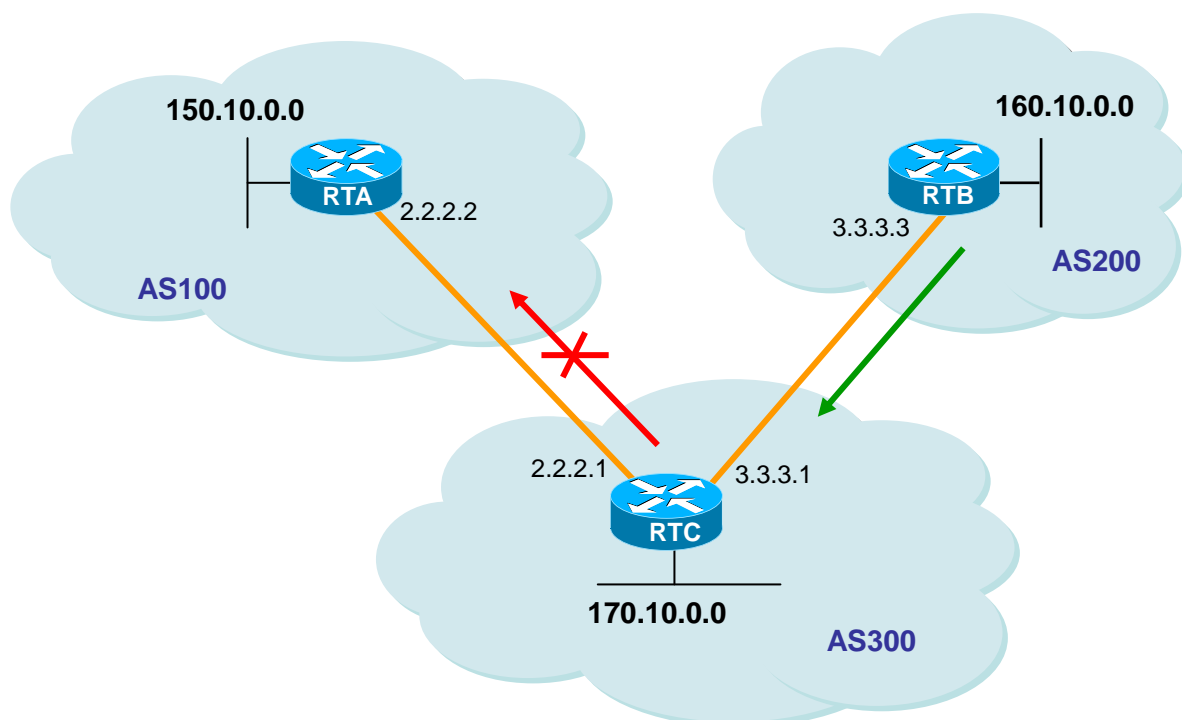


Figure 21. Route Filtering

RTB generates network 160.10.0.0 and transmits this information to RTC. If RTC does not transmit it to AS 100, apply Access-list and connection to RTA to filter the information update.

The following shows the construction of the operation.

```

/*-- RTC --*/
!
router bgp 300
 network 170.10.0.0
 neighbor 3.3.3.3 remote-as 200
 neighbor 2.2.2.2 remote-as 100
 neighbor 2.2.2.2 distribute-list 1 out
!
access-list 1 deny 160.10.0.0 0.0.255.255
access-list 1 permit 0.0.0.0 255.255.255.255
!-- filter out all routing updates about 160.10.x.x
!

```

Path Filtering

In addition to filtering routing updates based on network numbers, you can specify an access list filter on both incoming and outbound updates based on the BGP autonomous system paths. To block created information from AS 200 to AS 100, define access-list in RTC with the following command.

```
ip as-path access-list access-list-number {permit|deny} as-regular-expression
neighbor {ip-address|peer-group-name} filter-list access-list-number {in|out}
```

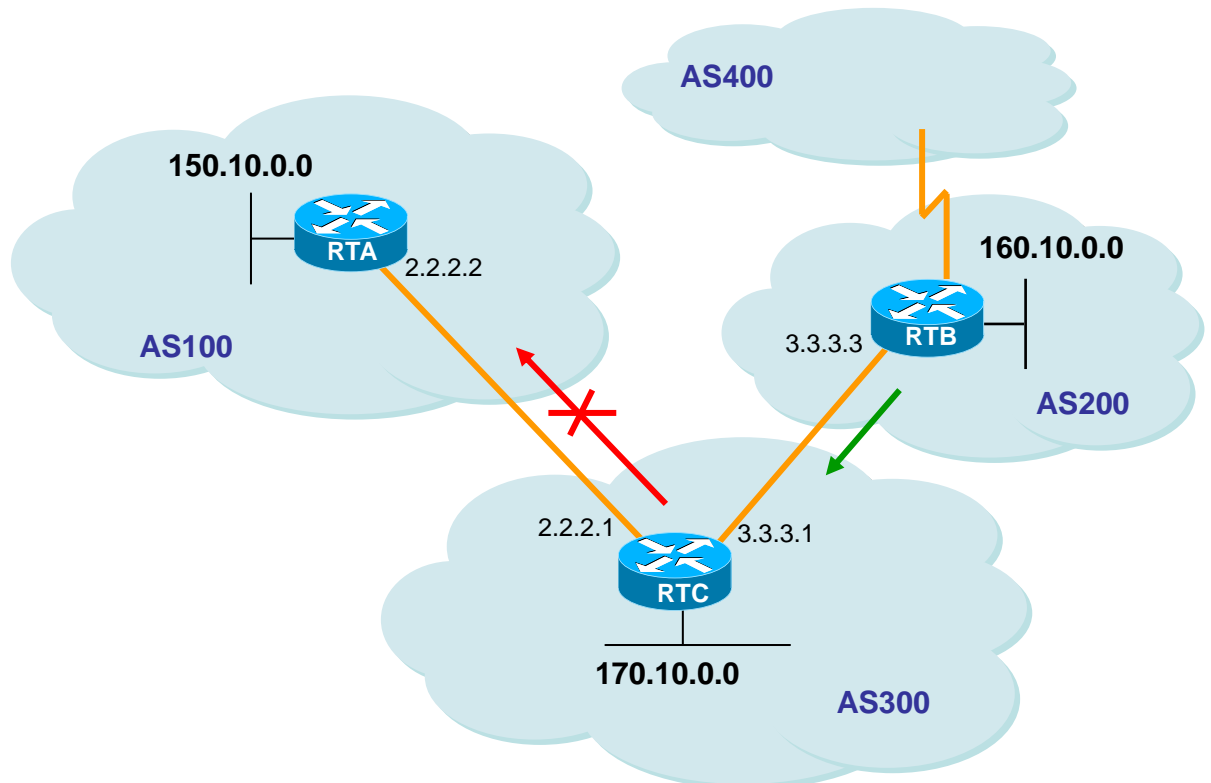


Figure 22. Path Filtering

The following shows the configuration that RTC updates 160.10.0.0 to RTA with the Path Filtering.

```
/*-- RTC --*/
!
router bgp 300
neighbor 3.3.3.3 remote-as 200
neighbor 2.2.2.2 remote-as 100
neighbor 2.2.2.2 filter-list 1 out
!-- the 1 is the access list number below
!
ip as-path access-list 1 deny ^200$
ip as-path access-list 1 permit .*
```

Community Filtering

The community attribute is a way to group destinations into communities and apply routing decisions based on the communities

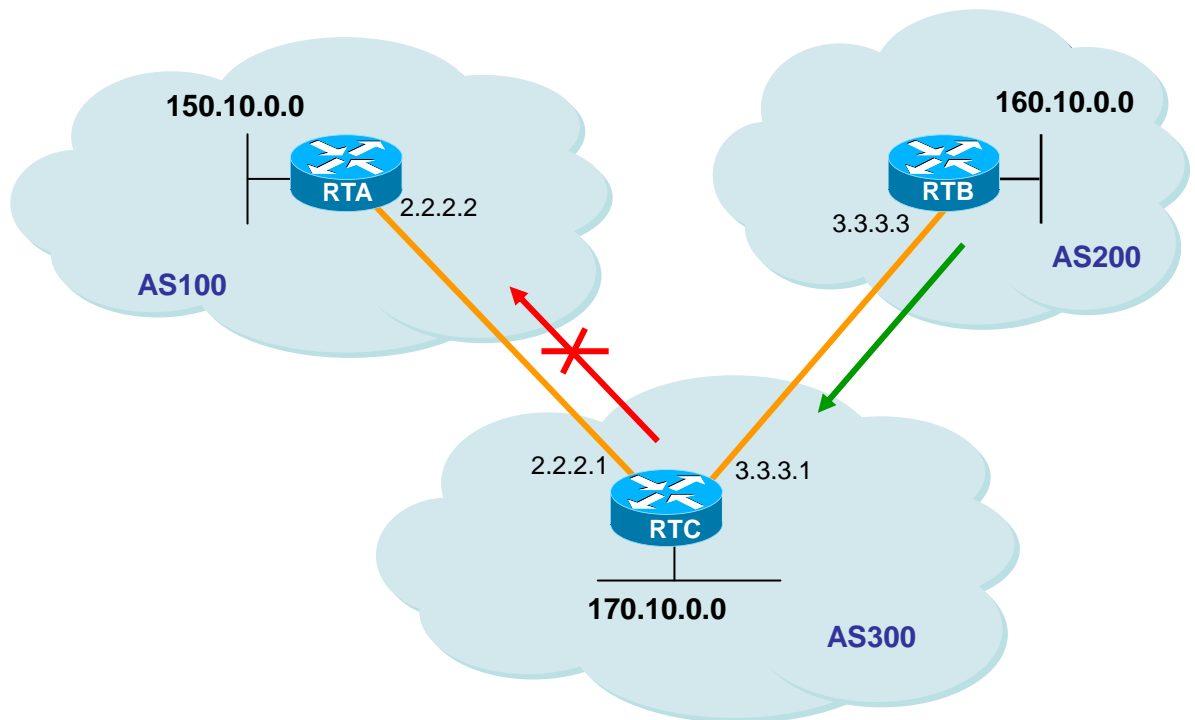


Figure 23. Community Filtering

As in the figure above, RTB sets Community attribute not to update routes from RTB to its dBGP Peer with 'no-export' community attribute.

```

/*-- RTB --*/
router bgp 200
network 160.10.0.0
neighbor 3.3.3.1 remote-as 300

neighbor 3.3.3.1 send-community
neighbor 3.3.3.1 route-map setcommunity out
!
route-map setcommunity
match ip address 1
set community no-export
access-list 1 permit 0.0.0.0 255.255.255.255
!

```

Cisco router uses “**neighbor send-community**” command to transmit this attribute to RTC but this system sets this command as a default. So, command ‘neighbor 3.3.3.1 send-community’ can be canceled, and command ‘no neighbor 3.3.3.1 send-community’ should be displayed to disable.

RTC does not transmit this information to its external peer RTA when RTC receives an update with no-export attribute.

The following shows the example that RTB adds 100 200 to the community attribute. This value 100 200 is added to the current community value before transmitting to RTC, or replacing the current community value with the value 100 200 when no additive command.

```
/*-- RTB --*/
!
router bgp 200
network 160.10.0.0
neighbor 3.3.3.1 remote-as 300
neighbor 3.3.3.1 route-map setcommunity out
!
route-map setcommunity
match ip address 2
set community 100 200 additive
!
access-list 2 permit 0.0.0.0 255.255.255.255
```

Community list specifies the communities used for Route Map Match Gate to set or filter the attribute based on the different community number list.

```
ip community-list community-list-number {permit|deny} community-number
```

The following shows how to define the route map.

```
!
route-map match-on-community
match community 10
!-- 10 is the community-list number
set weight 20
ip community-list 10 permit 200 300
!-- 200 300 is the community number
!
```

With this route map, the special parameter such as the metric value or weight can be filtered or set based on this community value in case of the special update. You can see RTB is transmitting Update having Community 100 200 to RTC. Configure the following to set Weight based on this value.

```
/*-- RTC --*/
!
router bgp 300
neighbor 3.3.3.3 remote-as 200
neighbor 3.3.3.3 route-map check-community in
!
route-map check-community permit 10
match community 1
set weight 20
!
```

```
route-map check-community permit 20
match community 2 exact
set weight 10
!
route-map check-community permit 30
match community 3
!
ip community-list 1 permit 100
ip community-list 2 permit 200
ip community-list 3 permit internet
!
```

The route with the community attribute 100 is matched with List 1 and weight is set as 20. The route with the community attribute 200 is matched with List 2 and Weight is set as 10. The keyword “exact” shows that there should not be other values if community should have community 200. The last community list is used to prevent other updates from dropping because a route not matched is dropped to the default. The keyword “internet” is all routes because this is a member of Internet community.

BGP Attribute Configuration

The following shows the attributes used by BGP.

- As-path attribute
- Origin attribute
- Nexthop attribute
- Local Preference attribute
- Metric attribute
- Community attribute
- Weight attribute

As_path Attribute

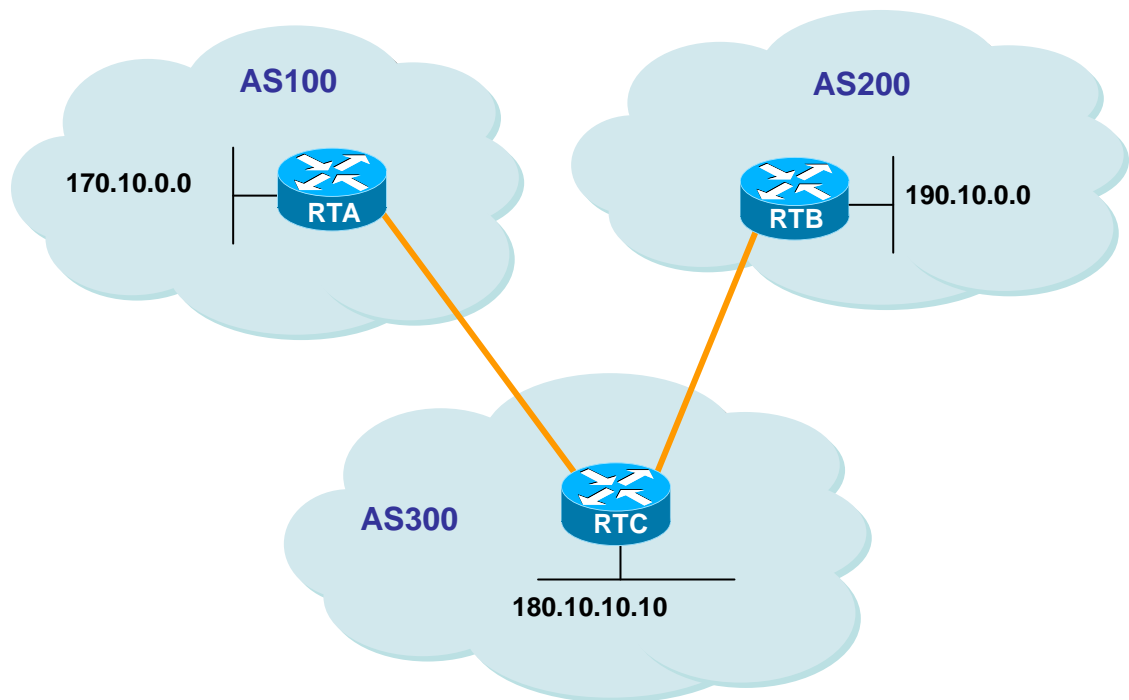


Figure 24. As_path Attribute

When one route passes one AS, the AS number is added to the update of route.

AS_Path attribute is AS number list that one route passes through to get the certain destination. AS_SET is all AS groups that one route passes through. Network 190.10.0.0 is displayed by RTB in AS200, and RTC adds AS300 to this route AS-path when this route passes AS300. So, the path for RTA to get to 190.10.0.0 is (300,200). The same applies to 170.10.0.0 and 180.10.0.0. RTB should pass AS300 and AS100 to reach 170.0.0. RTC should pass AS200 to reach 190.0.0, and AS100 to reach 170.10.0.0.

Origin Attribute

This is an attribute to define Pass Information Source and there are three mechanisms.

- **IGP:** NLRI(Network Layer Reachability Information) is inside of the AS. This is used when BGP Network command is used or IGP information is redistributed to BGP. This pass information origin is IGP and displayed as "i" in the BGP table.
- **EGP:** NLRI is got through BGP and displayed as "e" in the BGP table.
- **INCOMPLETE:** NLRI is unknown or got through the miscellaneous ways. This is used when the static route is redistributed to BGP and displayed "?" in the BGP table.

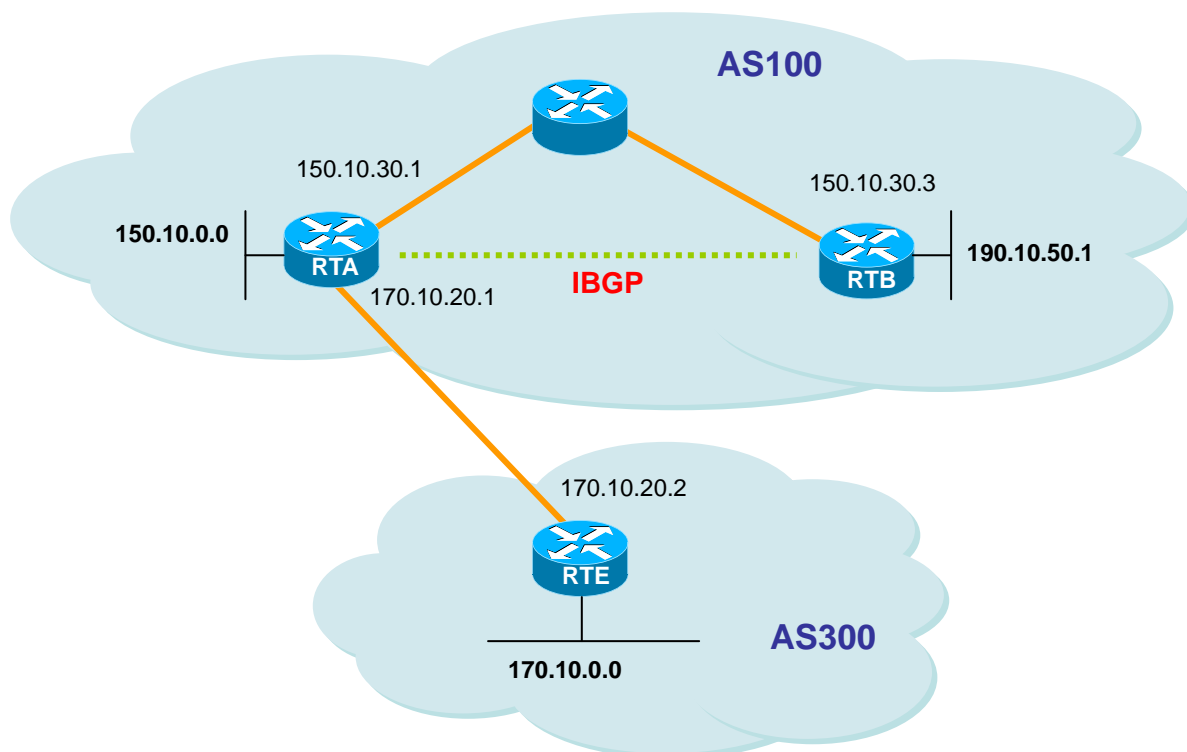


Figure 25. Origin Attribute

```

/*-- RTA --*/
!
router bgp 100
network 150.10.0.0
redistribute static
neighbor 150.10.30.3 remote-as 100
neighbor 170.10.20.2 remote-as 300
!
ip route 190.10.0.0/24 null
!

/*-- RTB --*/
!
router bgp 100
network 190.10.50.0
neighbor 150.10.30.1 remote-as 100
!

/*-- RTE --*/
!
router bgp 300
network 170.10.0.0
neighbor 170.10.20.1 remote-as 100
!

```

The configuration above shows:

- RTA gets to 170.10.0.0 through 300i.
(The next AS pass is 300 and the route origin is IGP.)
- RTA gets to 190.10.50.0 through i.
(The means the next AS pass is 100 and the route origin is IGP.)
- RTA gets to 150.10.0.0 through 100i.
(The means the next AS pass is 100 and the route origin is IGP.)
- RTA gets to 190.10.0.0 through 100?.
(The means the next AS pass is 100 and the route origin is Incomplete.)

BGP Nexthop Attribute

The nexthop attribute is the nexthop IP address to get to the certain destination. EBGP is the assigned neighbor IP address by neighbor command. The configuration below shows RTC transmits nexthop 179.10.20.2 when transmitting 170.10.0.0 to RTA, and RTA transmits nexthop 170.10.20.1 when transmitting 150.10.0.0 to RTC. According to protocol, the nexthop by EBGP itself should be transmitted with IBGP. RTA transmits nexthop to 170.10.20.2 when transmitting 170.10.0.0 to its IBGP peer RTB, and RTB transmits nexthop to not 150.10.30.1 but 170.10.20.2.

Policy is needed for RTB to get to 170.10.20.2 with IGP and if not, RTB discards the packet toward 170.10.0.0.

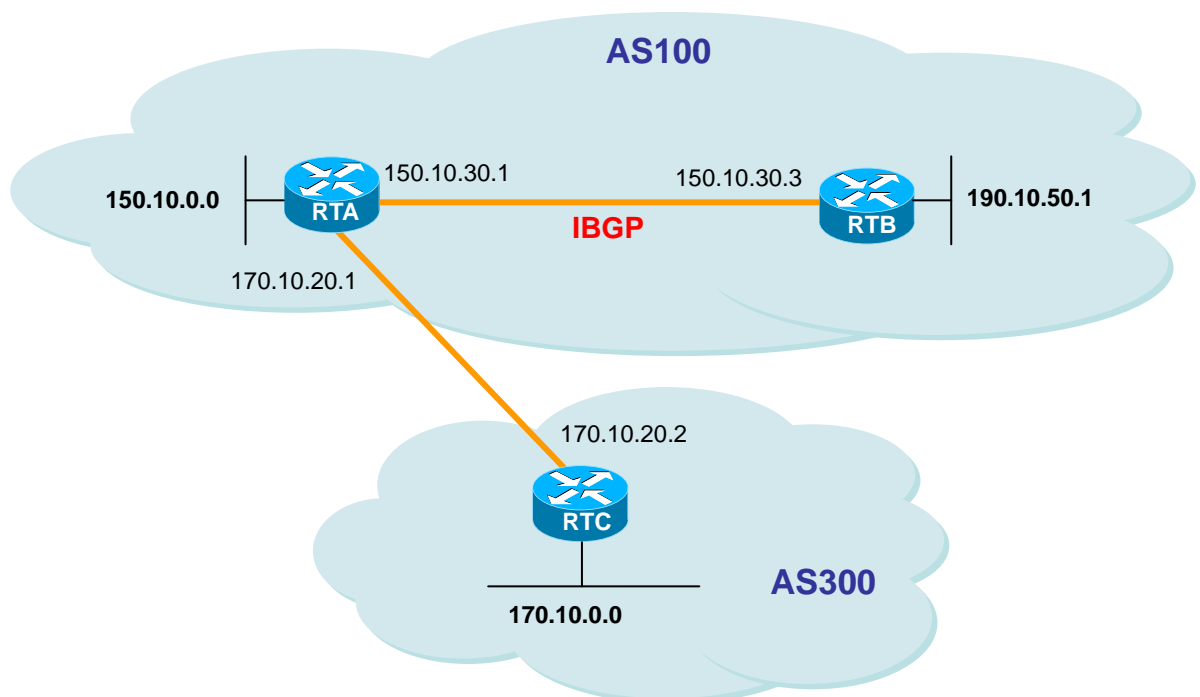


Figure 26. BGP Nexthop Attribute

```
/*-- RTA --*/
!
router bgp 100
network 150.10.0.0
neighbor 170.10.20.2 remote-as 300
neighbor 150.10.30.3 remote-as 100
```

```
!  
  
/*-- RTB --*/  
!  
router bgp 100  
neighbor 150.10.30.1 remote-as 100  
!  
  
/*-- RTC --*/  
!  
router bgp 300  
network 170.10.0.0  
neighbor 170.10.20.1 remote-as 100  
!
```

When RTC transmits 170.10.0.0 to RTA, the nexthop turns into 170.10.20.2.

When RTA transmits 170.10.0.0 to RTB, the nexthop turns into 170.10.20.2.

The following shows you should be careful in the multi access network and NBMA network.

BGP Nexthop (Multiple access networks)

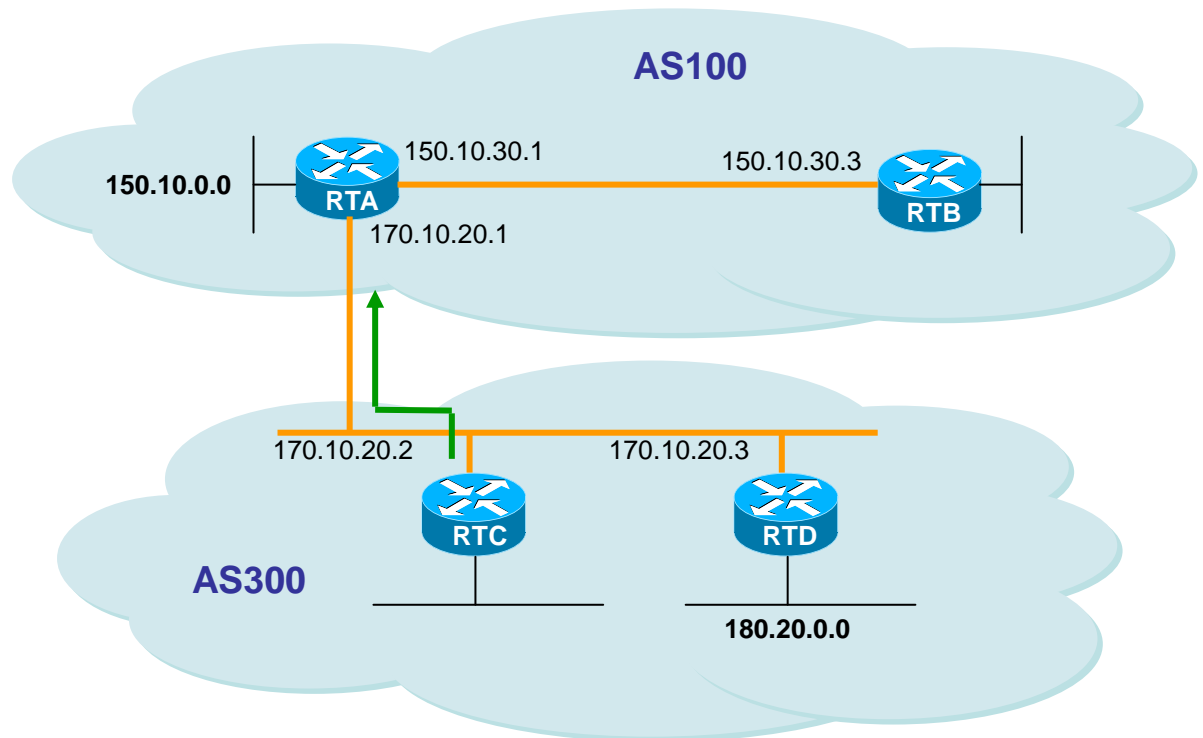


Figure 27. BGP Nexthop (Multiple access networks)

RTC connects RTA and EBGP. RTC get access to 180.20.0.0 through 170.10.20.3, and when it transmits 180.20.0.0 information with BGP update to RTA, it uses not its IP 170.10.20.2 but 170.10.20.3 as a next hop. The reason is that the network among RTA, RTC, and RTD is a multi-access network and it is more useful to use RTD as a next hop for RTA to get to 180.20.0.0.

NBMA network, the common media among RTA, RTC, and RTD, causes more complicated problems.

BGP Nexthop (NBMA)

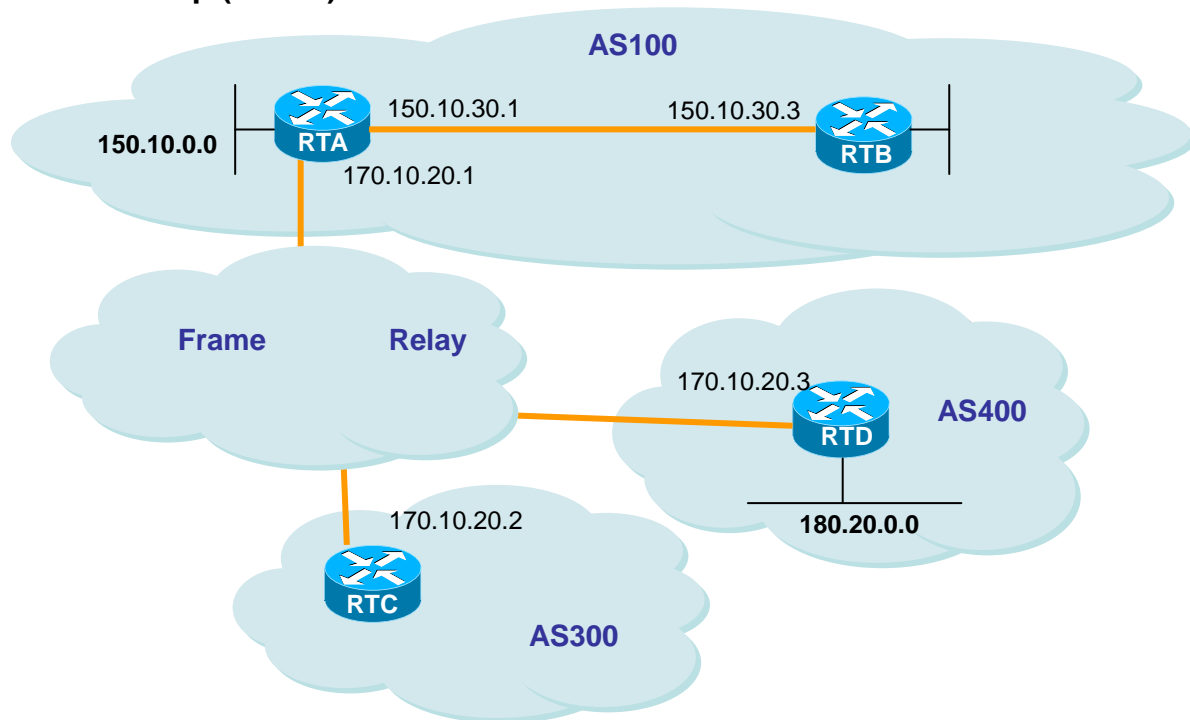


Figure 28. BGP Nexthop (NBMA)

If the common media is NBMA network like Frame Relay, RTC uses 170.10.20.3 as the next hop when transmitting 180.20.0.0 information to RTA. If RTA does not have the direct PVC and cannot get access to the next hop, the routing is failed. For this kind of situation the Next-hop-self command was created

Next-hop-self

With the next-hop-self command, the protocol does not assign the nexthop and the assigned IP is used for the nexthop. The command is as follows.

```
neighbor {ip-address|peer-group-name} next-hop-self
```

In case of the previous example, the following shows how to solve the problem.

```
/*-- RTC --*/
!
router bgp 300
neighbor 170.10.20.1 remote-as 100
neighbor 170.10.20.1 next-hop-self
!
```

RTC transmits 180.20.0.0 to nextHop = 170.10.20.2.

Local Preference Attribute

Local preference notices path preference to AS in order to get the specific network from the AS. The path with higher value local preference is preferred more and the default is 100. The local preference is an attribute to be exchanged among routers in the same AS unlike weight attribute.

This is set with **bgp default local-preference < value>** command or route map.

The **bgp default local-preference < value>** command changes local preference value for moving to the peer router in the same AS. The following example shows two AS update 170.10.0.0 of AS256. Local preference helps the way to get out of AS256 to get to the same network. Supposing RTd is the exit point. The following shows the local preference value is set as 200 for AS 300 update, 150 for AS 150.

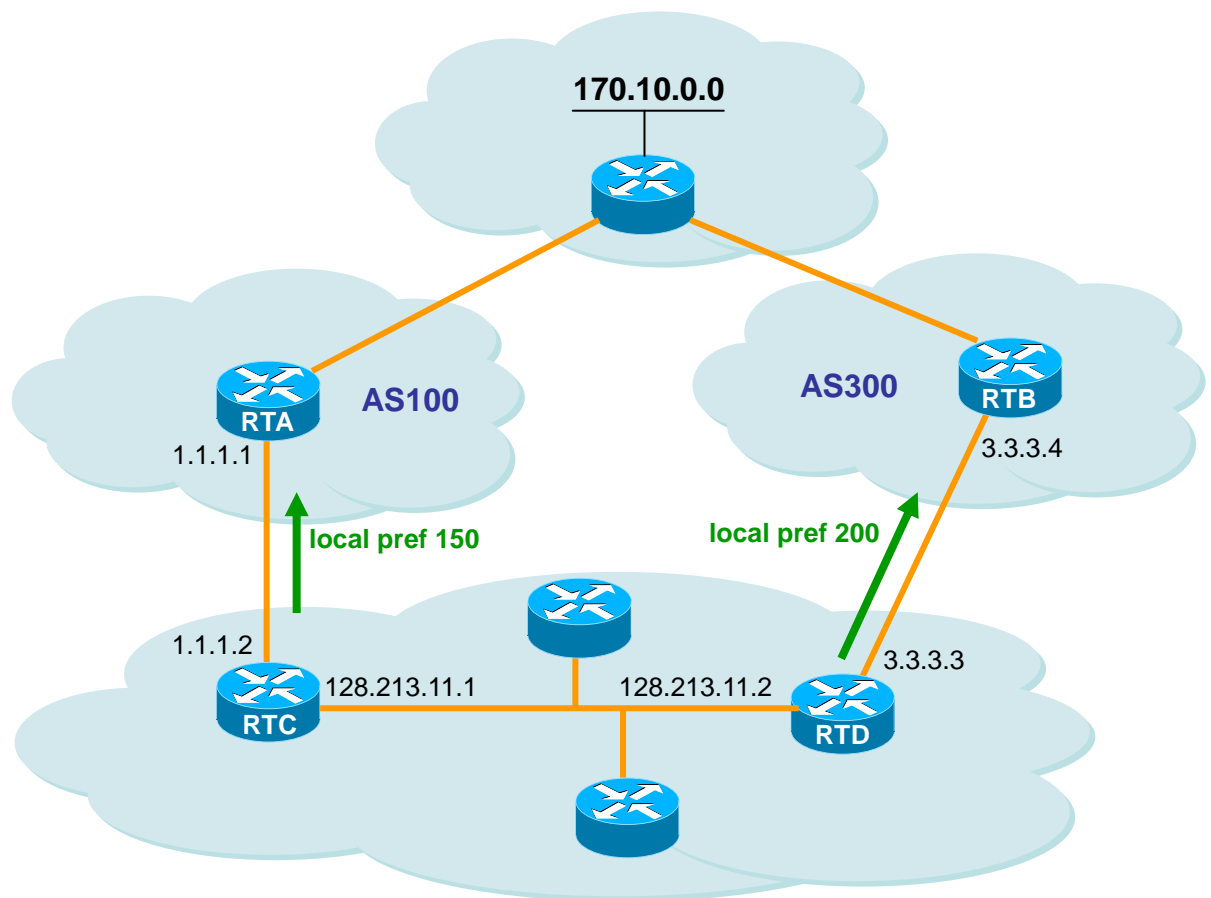


Figure 29. Local Preference Attribute

```

/*-- RTC --*/
!
router bgp 256
bgp default local-preference 150
neighbor 1.1.1.1 remote-as 100
neighbor 128.213.11.2 remote-as 256
!

/*-- RTD --*/

```

```
!  
router bgp 256  
  bgp default local-preference 200  
  neighbor 3.3.3.4 remote-as 300  
  neighbor 128.213.11.1 remote-as 256  
!
```

RTC sets the local preference of all update as 150 and RTD as 200. RTC and RTD recognized that the network 170.10.0.0 information from AS300 has the higher local preference than one from AS100. So, all traffic of AS256 assigned as 170.10.0.0 is transmitted to RTD.

However, using route map provides flexibility. In the example above, all updates that RTD receives are set for local preference 200. This can be inappropriate. As you can see in the box below, a specific update uses the route map only when setting as specific local preference.

```
/*-- RTD --*/  
!  
router bgp 256  
  neighbor 3.3.3.4 remote-as 300  
  neighbor 3.3.3.4 route-map setlocalin in  
  neighbor 128.213.11.1 remote-as 256  
!  
  ip as-path access-list 7 permit ^300$  
!  
  route-map setlocalin permit 10  
    match as-path 7  
    set local-preference 200  
!  
  route-map setlocalin permit 20  
    set local-preference 150  
!
```

With the configuration above, the update from AS300 is set as Local preference 200 and other updates from AS34 are set as Local preference 150.

Metric Attribute

Metric Attribute, Multi_exit_discriminator (MED), provides path preference for the specific AS to the external route. When there are various entry points to the specific AS, it helps other AS to choose the point to get to the route and the path with the lower value is chosen.

Unlike local preference, metric is exchanged among AS. It is transmitted to one AS and remained in AS. Metric is used to choose the path in AS when update with the certain metric comes in AS. When the same update information is sent to other AS, metric value is set as 0(default). Compare the metric from neighbor in the same AS when no specific setting and it needs special configuration command “bgp always-compare-med” to compare metric from neighbor in different AS.

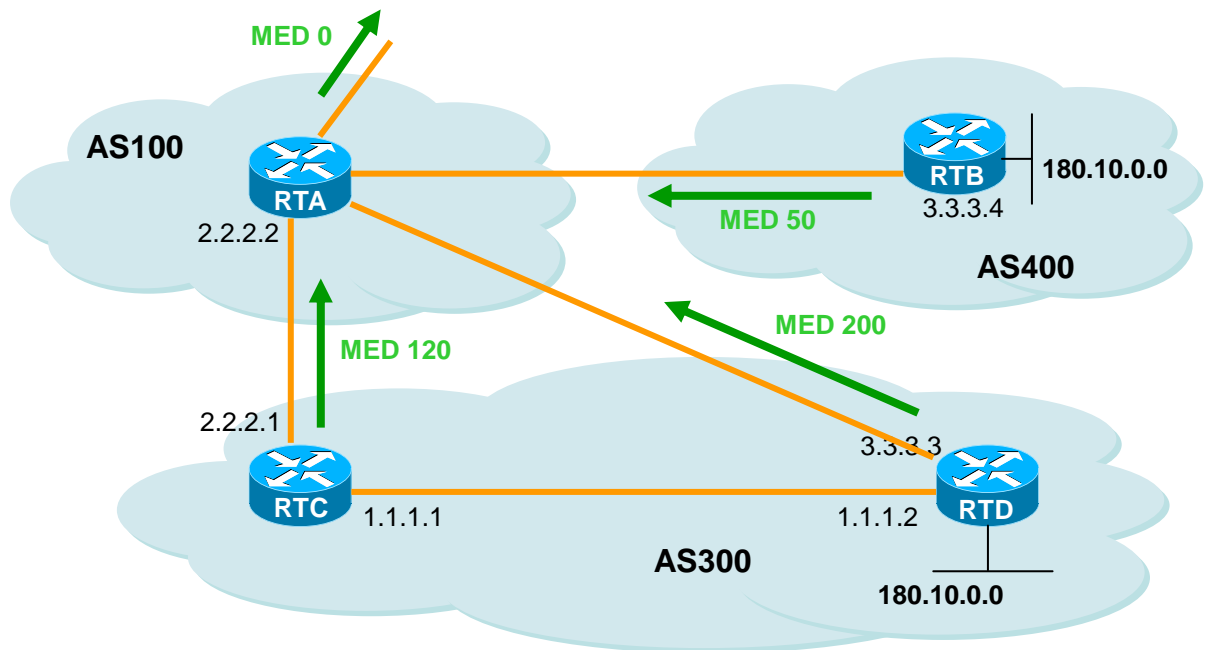


Figure 30. Metric Attribute

AS100 gets network information of 180.10.0.0 through RTC, RTD, and RTB. RTC and RTD are in AS300 and RTB is in AS400.

Suppose that the metric from RTC is set as 120, from RTD as 200, and from RTB as 50. By default, router compares the metric from neighbor in the same AS. RTA can only compare the metric from RTC, and RTD and chooses RTC as the best nexthop because netric value 120 is lower than 200. When RTA gets the information with metric 50 from RTB, it cannot compare this value with metric 120 because RTC and RTB are in the different ASs (RTA chooses the path based on the different attributes.).

The following shows to add **bgp always-compare-med** command to RTA in order RTA compares the metric.

```

/*-- RTA --*/
!
router bgp 100
neighbor 2.2.2.1 remote-as 300
neighbor 3.3.3.3 remote-as 300
neighbor 4.4.4.3 remote-as 400
!
/*-- RTB --*/
!
router bgp 400
neighbor 4.4.4.4 remote-as 100
neighbor 4.4.4.4 route-map setmetricout out
!
route-map setmetricout permit 10
set metric 50

```

```

!

/*-- RTC --*/
!
router bgp 300
neighbor 2.2.2.2 remote-as 100
neighbor 2.2.2.2 route-map setmetricout out
neighbor 1.1.1.2 remote-as 300
!
route-map setmetricout permit 10
set metric 120
!

/*-- RTD --*/
!
router bgp 300
neighbor 3.3.3.2 remote-as 100
neighbor 3.3.3.2 route-map setmetricout out
neighbor 1.1.1.1 remote-as 300
!
route-map setmetricout permit 10
set metric 200
!

```

From the configuration above, RTA chooses RTC as the nexthop. (Supposing the different attributes are same). The following shows how to configure RTA in order to compare the metric.

```

/*-- RTA --*/
!
router bgp 100
bgp always-compare-med
neighbor 2.2.2.1 remote-as 300
neighbor 3.3.3.3 remote-as 300
neighbor 4.4.4.3 remote-as 400
!

```

RTA chooses RTB as the best nexthop to get to 180.10.0.0, and also set metric value as redistributing the route to BGP with the command “**default-metric number**”. The following shows the configuration when RTB redistributes static information.

```

/*-- RTB --*/
!
router bgp 400
redistribute static

```

```
default-metric 50
!
ip route 180.10.0.0 255.255.0.0 null 0
!
!-- Causes RTB to send out 180.10.0.0 with a metric of 50
```

Community Attribute

Community attribute is an optional and transitive attribute from the value 0 to 4,294,967,200, and groups many destinations as the special communities to apply routing decide (accept, prefer, and redistribute). To set the community attribute, use the following route map.

```
set community community-number [additive]
```

The following shows the common community-number.

- **no-export** (Do not advertise to EBGp peers)
- **no-advertise** (Do not advertise this route to any peer)
- **internet** (Advertise this route to the internet community, any router belongs to it)

The following shows the route map that sets community.

- route-map communitymap
- match ip address 1
- set community no-advertise
- route-map setcommunity
- match as-path 1
- set community 200 additive

If additive keyword is set, the value 200 replaces the current community value, and if additive keyword is set, the value 200 is added. After setting the community attribute, this system transmits this to the neighbor by default. But Cisco system should use the following command.

```
neighbor {ip-address|peer-group-name} send-community
```

```
/*-- RTA --*/
!
router bgp 100
neighbor 3.3.3.3 remote-as 300
neighbor 3.3.3.3 send-community
neighbor 3.3.3.3 route-map setcommunity out
```

By default, this system enables the neighbor send-community and the command 'neighbor 3.3.3.3 send-community' is not needed.

Weight Attribute

Weight Attribute defined by this system has the same function as Cisco system and is applied to the certain router. This is between 0~65535. The path by itself has the value 32768 by default and the others have "0".

With many routes to the same destination, the route with the higher weight is chosen.

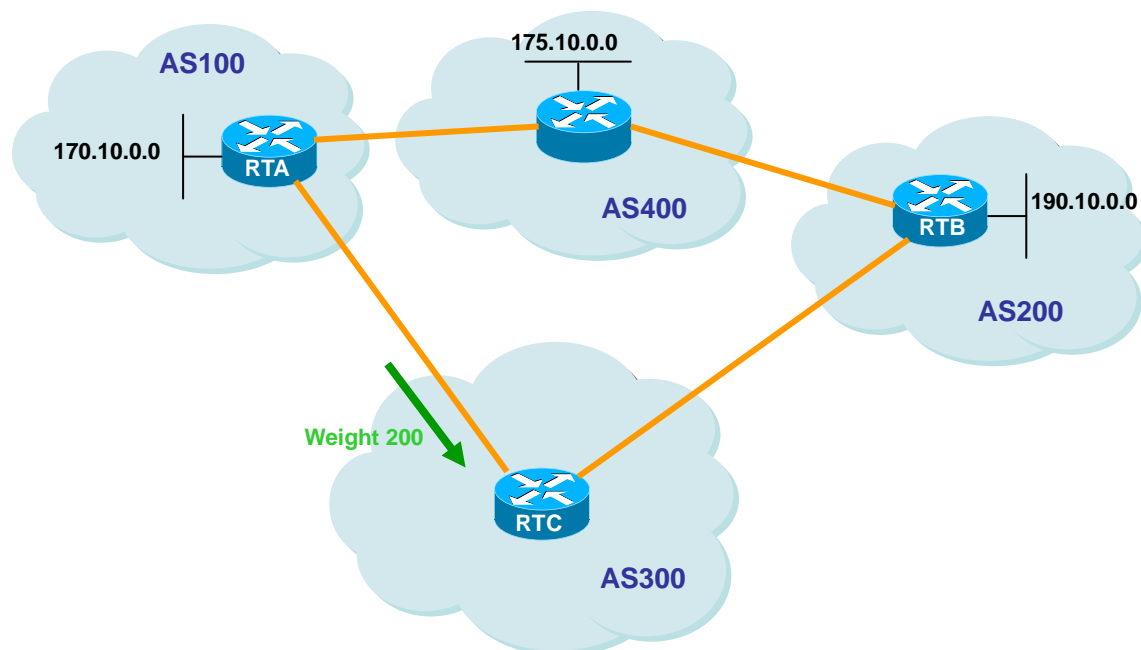


Figure 31. Weight Attribute

RTA and RTB get the information of network 175.10.0.0 from AS4 and transmits it to RTC. And RTC has two paths to network 175.10.0.0. If RTC gives the higher weight to RTA, RTC chooses RTA as the next hop. This can be done by several methods:

- Using the **neighbor** command: **neighbor** {ip-address|peer-group} **weight** weight.
- Using AS path access-lists: **ip as-path access-list** access-list-number {permit|deny} as-regular-expression **neighbor** ip-address **filter-list** access-list-number **weight** weight.
- Using route-maps.

With many routes to the same destination, the route with the higher weight is chosen. The following shows the three mechanisms with the example above

Neighbor Weight Command

```
/*-- RTC --*/
!
router bgp 300
neighbor 1.1.1.1 remote-as 100
neighbor 1.1.1.1 weight 200
!-- route to 175.10.0.0 from RTA has 200 weight
neighbor 2.2.2.2 remote-as 200
neighbor 2.2.2.2 weight 100
```

```
!-- route to 175.10.0.0 from RTB will have 100 weight
!
```

IP as-path and filter-list

```
/*-- RTC --*/
!
router bgp 300
neighbor 1.1.1.1 remote-as 100
neighbor 1.1.1.1 filter-list 5 weight 200
neighbor 2.2.2.2 remote-as 200
neighbor 2.2.2.2 filter-list 6 weight 100
!
ip as-path access-list 5 permit ^100$
!-- this only permits path 100
ip as-path access-list 6 permit ^200$
!
```

Route Map

```
/*-- RTC --*/
!
router bgp 300
neighbor 1.1.1.1 remote-as 100
neighbor 1.1.1.1 route-map setweightin in
neighbor 2.2.2.2 remote-as 200
neighbor 2.2.2.2 route-map setweightin in
!
ip as-path access-list 5 permit ^100$
!
route-map setweightin permit 10
match as-path 5
set weight 200
!-- anything that applies to access-list 5, such as packets from AS100, have weight 200
!
route-map setweightin permit 20
set weight 100
!-- anything else would have weight 100
!
```

Routing Policy Modification

Routing Policy helps to choose the information with Route-map, Filter-list, and Prefix-list when sending/receiving the neighbor router and routing information. And BGP has new routing information for the new policy as canceling the current routing information or recovering the current path when the routing policy is modified.

In order BGP router get the information for the new policy, it sets the Inbound reset, and in order to provide the new information, it sets "Outbound reset". As the new information for the new policy is provided, the neighbor router gets the new information.

If BGP router and neighbor router in the user network supports route refresh capability function, they can renew routing information with "Inbound reset". The following shows the advantages of routing reset.

- Needless additional operation setting of operator
- Needless additional memory for routing information modification

The following shows the command to confirm the neighbor router supports Route Refresh Capability function.

```
neighbor capability route-refresh
```

This command specifies Route Refresh Capability function to the neighbor router, and if the neighbor router supports this function, the message "Received route refresh capability from peer" is printed out.

With Route Refresh Capability function by all BGP routers, user gets path information sent already with Soft reset. The following shows the command to set routing information for the new policy.

```
clear ip bgp [* | AS | address] soft in
```

On the other hand, Outbound reset transmits the routing information again with the command "Soft" without setting beforehand. The following shows the command to provide the routing information again.

```
clear ip bgp [* | AS | address] soft out
```

To recover the modified routing policy to the default, operator uses Route Refresh Capability function and does not need to cancel modified policies individually.

The switch without Route Refresh Capability function cancels the routing information with the command "Neighbor Soft-reconfiguration". But, operator should be careful to use because network can have the problem.

To create new information not reset BGP information, operator should store all information to BGP network, which is not recommendable because of memory loading. But, providing modified information does not need memory, and neighbor routers get the modified information consecutively after BGP router transmits this.

The following show the procedures how to reset BGP with the Routing policy.

1. After reconfiguring BGP router, all information from the neighbor router are stored in BGP router from this point.
neighbor ip address soft reconfiguration inbound
2. Register the modified information in table with the stored information.
clear ip bgp [* | AS | address] soft in

The following shows the command to confirm the modified routing information with the routing table and BGP neighbor router.

```
show ip bgp neighbors ip-address [advertised-routes|received-routes|routes]
```

BGP Peer Groups

BGP Peer Groups is a BGP Neighbor groups for the same update policy that is set by route map, distribute-list, and filter-list. They define the same policies to each neighbor but apply them as naming Peer group. Every member of the peer group has all configuration options, and overrides it as defining new options with no effect on the member or output update.

The following shows the configuration to define the peer group.

```
neighbor peer group name peer group
```

BGP backdoor

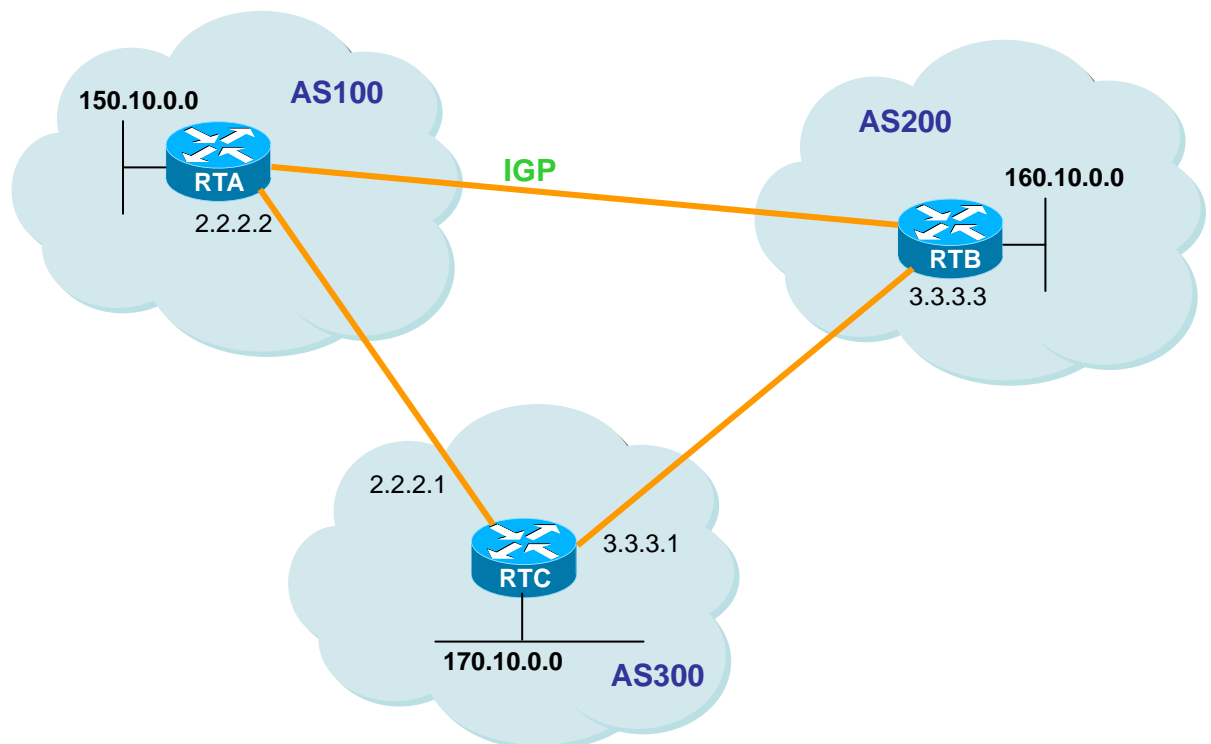


Figure 32. BGP backdoor

The configuration above shows that RTA & RTC and RTB & RTC are connected with EBGP. RTA and RTB use IGP protocol (OSPF and RIP). EBGP update has “20” of distance value smaller than IGP distance value. By default, RIP distance value is 120 and OSPF has 110.

RTA transmits update information of 160.10.0.0 with the two routing protocols. One is EBGP with distance value 20 and the other is IGP with distance value more than 20.

The following shows the default distance value of BGP and it can be changed by distance command.

```
distance bgp external-distance internal-distance local-distance  
external-distance:20  
internal-distance:200  
local-distance:200
```

RTA chooses EBGP update information from RTC having smaller distance value. The following shows what RTA needs to do to get information of 160.10.0.0 through RTB.

- Change the external distance value of EBGP or the external distance value of IGP. (not recommended)
- Use BGP backdoor

The following shows the command that BGP backdoor makes IGP route as the preferred route.

```
network address backdoor
```

The assigned address is a network address to receive through IGP. And BGP is recognized as the assigned network locally.

```
/*-- RTA --*/
!
router ospf
!
router bgp 100
neighbor 2.2.2.1 remote-as 300
network 160.10.0.0 backdoor
```

Network 160.10.0.0 is recognized as the local entry but is not transmitted like the common network entry. RTA gets information of 160.10.0.0 from RTB through OSPF with distance value 110 and RTC through EBGP with distance value 20 simultaneously. EBGP is usually preferred but OSPF is chosen due to backdoor command.

BGP Multipath

Maximum path [ibgp] number

To use Multipath function, set the following commands to RTA.

```
/*-- RTA --*/
!
router bgp 100
maximum-paths ibgp 3
neighbor 10.1.1.1 remote-as 200 /* RTB */
neighbor 20.1.1.1 remote-as 200 /* RTC */
neighbor 30.1.1.1 remote-as 200 /* RTD */
!
```

BGP graceful-restart

bgp graceful-restart [stalepath-time seconds]

To use BGP graceful-restart, you set the following commands in RTA.

```
/*-- RTA --*/
!
```

```
router bgp 100
bgp graceful-restart stalepath-time 200
neighbor 10.1.1.1 remote-as 200 /* RTB */
```

BGP default-metric

To use this function, you set the following command.

```
default-metric number
```

BGP redistribute-internal

```
bgp redistribute-internal
```

BGP Password encryption

```
neighbor ip-address password KEY
neighbor ip-address password 0 KEY
neighbor ip-address password 7 KEY
```

You can encrypt password of neighbor. The password level before encryption is 0. After encryption, password level changes to 7. But you can not set password level 7 before encryption.

BGP disable-adj-out

The system does not maintain out bound table basically. It is for reducing overhead of memory. To disable this function, use the following command in the configuration mode.

```
no bgp disable-adj-out
```



Notice

When the system does not maintain Out bound table, you do not use "show ip bgp neighbors *ip-address* advertised-routes" command.

Use of set as-path prepend Command

You will change the path information to adjust BGP decision process sometimes.

To change path information, use the following command.

```
set as-path prepend <As-path#><As-path#>
```

Route Flap Dampening

Route Dampening minimizes the instability by oscillation between route flapping and network.

Flapping route gets penalty (default is 1000) for each flap. IF the accumulated penalty exceeds suppress-limit, route transmission is stopped. The penalty is decreased by 50% when it gets to "half-time" every 5 seconds. The route is retransmitted after the decreased penalty is under the defined "reuse-limit" value.

By default status, Route dampening is off. The following shows the command to adjust the Route dampening.

- **bgp dampening** (will turn on dampening)
- **no bgp dampening** (will turn off dampening)
- **bgp dampening <half-life-time>** (will change the half-life-time)

And the following shows command to change all parameters simultaneously.

- **bgp dampening <half-life-time> <reuse> <suppress> <maximum-suppress-time>**
- **<half-life-time>** (range is 1-45 min, current default is 15 min)
- **<reuse-value>** (range is 1-20000, default is 750)
- **<suppress-value>** (range is 1-20000, default is 2000)
- **<max-suppress-time>** (maximum duration a route can be suppressed, range is 1-255, default is 4 times half-life-time)

The following shows the terms for the Route dampening.

Table 126 Terminology used in route dampening

| Terminology | Description |
|-------------------------------|---|
| History state | This does not include the best path for the route but information for the route flapping |
| Damp state | This shows the penalty value exceeds and information is not transmitted to the neighbor. |
| Penalty | This is value added to router by the route flapping and the default is 1000. This is accumulated and the status is changed from "history" to "damp" by suppress limit. |
| Suppress limit | This is a suppress limit of penalty by route and the default is 200. |
| Half-life-time | The penalty imposed to route is to be half every 5 sec after the period set in Half-life-time (default is 15 min). |
| Reuse-limit | The path cleared is recovered if penalty imposed to flapping is under Reuse-limit. The default is 750 and the procedure to clear Path Invalid is performed every 10 seconds. |
| Maximum suppress limit | This is the maximum period that route can be invalid and the default is 4 times than half-lif-time. |

Chapter 9. IGMP Snooping

This chapter introduces IGMP Snooping Configuration.

IGMP Snooping Overview

In general, multicast traffic is processed as unknown MAC address or broadcast frame and all ports in VLAN are flooded.

IGMP Snooping does not forward multicast traffic to all ports in VLAN and add/delete ports for forwarding multicast traffic. Switch snoops IGMP traffic between host and router and get information for multicast group and member interface.

The procedure of IGMP Snooping in brief is as follows:

After receiving 'IGMP Join' message in the specific multicast group, add the received port into multicast forwarding table entry. After receiving 'IGMP Leave' message from host, delete the port from the table entry. And, after replaying IGMP Query message to all ports in VLAN, delete port that could not get an IGMP Join message.

IGMP Snooping Configuration

IGMP Snooping basically operates in global configuration.

Enable IGMP Snooping on a VLAN

To enable VLAN for IGMP Snooping, use the following command in the global configuration mode.

Table 127 Enable IGMP Snooping on a VLAN

| Command | Description |
|----------------------------|--------------------------------|
| ip igmp snooping | Enables IGMP Snooping of VLAN |
| no ip igmp snooping | Disables IGMP Snooping if VLAN |

```
Router# configure terminal
Router(config)# interface vlan22
Router(config-if-Vlan22)# ip igmp snooping
Router(config-if-Vlan22)# end
Router# show ip igmp interface
.....
Interface Vlan22 (Index 2022)
  IGMP Enabled, Active, Non-Querier, Version 2 (default)
  Internet address is 220.1.1.222
  IGMP interface has 10 group-record states
  IGMP activity: 0 joins, 0 leaves
  IGMP querying router is 0.0.0.0
  IGMP query interval is 125 seconds
  IGMP querier timeout is 262 seconds
  IGMP max query response time is 25 seconds
  Last member query response interval is 1000 milliseconds
  Group Membership interval is 275 seconds
  IGMP Snooping is enabled on this interface
  IGMP Snooping fast-leave is not enabled
  IGMP Snooping querier is not enabled
  IGMP Snooping report suppression is enabled
.....

Router#
```

Enable IGMP Snooping.

To configure functionalities of IGMP Snooping, use the following procedure.

IGMP Report-Suppression

This feature is applicable to IGMPv1 and IGMPv2 report messages only.

To set IGMP Report-Suppression, use the following command in the interface configuration mode.

Table 128 IGMP Report-Suppression

| Command | Description |
|---|---|
| ip igmp snooping report-suppression | Sets IGMP report-suppression to VLAN interface |
| no ip igmp snooping report-suppression | Disables the IGMP report-suppression of VLAN interface. |

```
Router# configure terminal
Router(config)# interface vlan22
Router(config-if-Vlan22)# no ip igmp snooping report-suppression
Router(config-if-Vlan22)# end
Router# show ip igmp interface
```

```
.....
Interface Vlan22 (Index 2022)
  IGMP Enabled, Active, Non-Querier, Version 2 (default)
  Internet address is 220.1.1.222
  IGMP interface has 10 group-record states
  IGMP activity: 0 joins, 0 leaves
  IGMP querying router is 0.0.0.0
  IGMP query interval is 125 seconds
  IGMP querier timeout is 262 seconds
  IGMP max query response time is 25 seconds
  Last member query response interval is 1000 milliseconds
  Group Membership interval is 275 seconds
  IGMP Snooping is enabled on this interface
  IGMP Snooping fast-leave is not enabled
  IGMP Snooping querier is not enabled
  IGMP Snooping report suppression is disabled
```

```
.....
```

```
Router#
```

IGMP Fast-Leave

After enabling the Fast-leave function of IGMP Snooping and receiving IGMPv2 Leave message from host, deletes the port in forwarding table at once.

This feature is only in case of one host in each port of VLAN. In case of being many hosts in a port, a host that does not send IGMPv2 Leave message does not possibly get traffic for multicast group for the specific time. It is available that every host uses IGMPv2 supporting Leave message.

Table 129 IGMP Fast-Leave

| Command | Description |
|---------------------------------------|---|
| ip igmp snooping fast-leave | Sets Fast-leave function to the specific VLAN |
| no ip igmp snooping fast-leave | Disables the Fast-leave function of VLAN |

Router# **configure terminal**

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

Router(config)# **interface vlan22**

Router(config-if-Vlan22)# **ip igmp snooping fast-leave**

Router(config-if-Vlan22)# **end**

Router# **show ip igmp interface**

.....

Interface Vlan22 (Index 2022)

IGMP Enabled, Active, Non-Querier, Version 2 (default)

Internet address is 220.1.1.222

IGMP interface has 10 group-record states

IGMP activity: 0 joins, 0 leaves

IGMP querying router is 0.0.0.0

IGMP query interval is 125 seconds

IGMP querier timeout is 262 seconds

IGMP max query response time is 25 seconds

Last member query response interval is 1000 milliseconds

Group Membership interval is 275 seconds

IGMP Snooping is enabled on this interface

IGMP Snooping fast-leave is enabled

IGMP Snooping querier is not enabled

IGMP Snooping report suppression is enabled

.....

Router#

IGMP Mrouter-Port

To set Multicast Router Port with static, use the following command in the interface configuration mode.

Table 130 IGMP Mrouter-Port

| Command | Description |
|---|--|
| ip igmp snooping mrouter interface IFNAME | Sets Mrouter port manually. IFNAME should be a Member-Port in VLAN. |
| no ip igmp snooping mrouter interface IFNAME | Disables the Mrouter port of VLAN |

```
Router# configure terminal
Router(config)# interface vlan22
Router(config-if-Vlan22)# ip igmp snooping mrouter interface gi2/2/5
Router(config-if-Vlan22)# end
Router# show ip igmp snooping mrouter vlan22
VLAN    Interface
22      Giga2/2/5

Router#
```

IGMP Access-Group

To set IGMP Access-Group, use the following command in the interface configuration mode.

Table 131 IGMP Access-Group

| Command | Description |
|---|-----------------------------|
| ip igmp snooping access-group <access-list> | Sets IGMP access group. |
| no ip igmp snooping access-group <access-list> | Disables IGMP access group. |

```
Router# configure terminal
Router(config)# access-list 10 permit 225.1.1.1
Router(config)# access-list 10 deny any
Router(config)# interface gi3/1/2
Router(config-if-Giga3/1/2)# ip igmp snooping access-group 10
Router(config-if-Giga3/1/2)# end
Router#
```

In case that relevant interface is the member of various VLAN interface, you can limit Multicast Group of IGMP Host only to specific VLAN interface.

To limit Multicast Group of IGMP Host only to specific VLAN interface set IGMP Access-Group, use the following command in the interface configuration mode.

Table 132 Multicast Group of IGMP Host only to specific VLAN interface

| Command | Description |
|---|--|
| ip igmp snooping access-group <access-list> vlan <vlan-id> | Limits Multicast Group of IGMP Host only to specific VLAN interface. |
| no ip igmp snooping access-group <access-list> vlan <vlan-id> | Disables the setting. |

```
Router# configure terminal
Router(config)# access-list 10 permit 225.1.1.1
Router(config)# access-list 10 deny any
Router(config)# interface gi3/1/2
Router(config-if-Giga3/1/2)# ip igmp snooping access-group 10 vlan 22
Router(config-if-Giga3/1/2)# end
Router#
```

IGMP Group-Limit

IGMP Snooping can limit Multicast Group number per each interface.

To limit Multicast Group number, use the following command in the interface configuration mode.

Table 133 IGMP Group-Limit

| Command | Description |
|---|--|
| ip igmp snooping limit <count> | Limits Multicast Group number received to relevant port. |
| ip igmp snooping limit <count> except <access-list> | Limits Multicast Group number received to relevant port. In case of no limitation Group, designate with access-list. |
| no ip igmp snooping limit <count> | Disables the setting. |

```
Router# configure terminal
Router(config)# interface gi3/1/2
Router(config-if-Giga3/1/2)# ip igmp snooping limit 10
Router(config-if-Giga3/1/2)# end
Router#
```

In case that relevant interface is the member of various VLAN interface, you can limit Multicast Group number only to specific VLAN interface. To limit Multicast Group number only to specific VLAN interface, use the following command in the interface configuration mode.

Table 134 Multicast Group number only to specific VLAN interface

| Command | Description |
|---|--|
| ip igmp snooping limit <count> vlan <vlan-id> | Limits Multicast Group received from relevant port to relevant VLAN. |
| ip igmp snooping limit <count> vlan <vlan-id> except <access-list> | Limits Multicast Group received from relevant port to relevant VLAN. In case of no limitation Group, designate with access-list. |
| no ip igmp snooping limit <count> vlan <vlan-id> | Disables Multicast Group number only to relevant VLAN interface. |

Router# **configure terminal**

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

Router(config)# **interface gi3/1/2**

Router(config-if-Giga3/1/2)# **ip igmp snooping limit 10 vlan 22**

Router(config-if-Giga3/1/2)# **end**

Router#

Display System and Network Statistics

Table 135 IGMP Snooping-related Monitoring Command

| Command | Description |
|---|--|
| show ip igmp snooping mrouter <IFNAME> | Displays Mrouter Port of VLAN |
| show ip igmp snooping statistics | Displays the statistics of IGMP snooping |

Chapter 10. Multicast Routing

This chapter describes IP multicast routing elements and IP multicast routing setting.

IP Multicast Routing Overview

IP Multicasting transmits packet in one Host group with many IP Hosts. This group includes switch in the local network, the private network, or outside of the local network. Host creating traffic transmits only one packet to host being received.

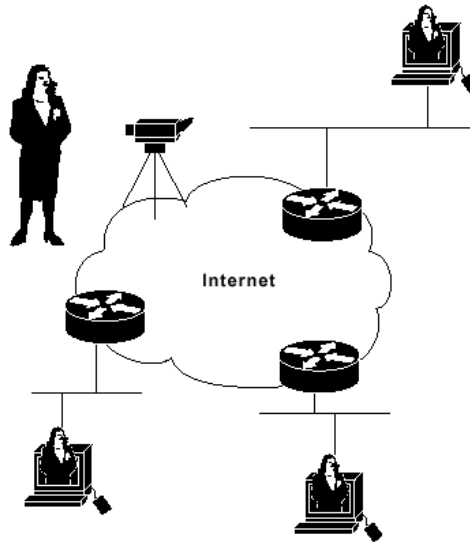


Figure 33. Multicasting to Transmit Traffic to Many Destinations

Many routing protocols such as Protocol-Independent Multicast (PIM), Distance-Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF) find multicast group and create the path for each group. <Table 1> summarizes requirements for each protocol unicast and flooding algorithm.

Table 136 Multicast Protocol

| Protocol | Unicast Protocol | Flooding Algorithm |
|-----------------|------------------|-----------------------------|
| PIM-dense mode | Any | Reverse path flooding (RPF) |
| PIM-sparse mode | Any | RPF / SPF (Switchover) |
| DVMRP | Internal | RPF |
| MOSPF | OSPF | Shortest-path first |

IGMP Proxy Overview

IGMP is a protocol that IP Host registers IP multicast group membership in a router. The router inquires membership regularly to renew group membership status, and the group remains registered if IP host answers.

IP Multicast uses Class D IP address for Multicast group address. This is defined in RFC2236.

If IGMP(Internet Group Management Protocol) Proxy receives the IGMP join/leave message from the host, it sends the IGMP join/leave message to the router instead of the host.

If it receives the IGMP query from the IGMP router, it transmits the IGMP query to the host instead of the router. In other words, it functions as IGMP router for the host and as IGMP host for IGMP router.

The limitation items when running IGMP Proxy configuration are as follows:

- Supports only for IGMP v2. IGMP v3 is not supported and mutual setting is not acceptable.
- One upstream interface and the others of many downstream interfaces are set at first.
- You can not set PIM-SM setting on upstream or downstream interface after Proxy setting is done.
- Upstream interface setting use Proxy-Service and downstream interface use Mroute-Proxy.
- You can not IGMP Snooping on the interface set with Proxy-Service.

PIM-SM Overview

PIM-SM is the protocol to connect small number of LANs for various multicast data stream and defines rendezvous point that is an entry point for easy multicast packet routing.

After the specific host transmits multicast packet, multicast router neighbored with the host transmits / registers multicast packet to the rendezvous point. And, multicast packet is transmitted from the sender to the rendezvous point and then, to the recipient.

PIM-SM includes the following improvements of PIM-SM v1.

- Boot Router (BSR) supports fault-tolerant and automatic RP discovery and distribution mechanism and maps group-to-RP dynamically without setting.
- Flexible encoding about Address family of PIM Join/Prune message is available.
- PIM packet is not included in IGMP packet any more.

Many Candidate BSRs can be set in PIM domain to prevent Single point of failure, and BSR is monitored among the candidate BSR. The router informs the prior BSR with the Bootstrap message and monitored BSR notifies to all routers in PIM domain as BSR.

Router that is set as the Candidate RP informs the group range to BSR with the unicast. BSR includes this information in the Bootstrap message and transmits it to PIM message in the domain. So all router get RP information about the specific multicast group. To say, if the router gets the Bootstrap message, router has the current RP map.

MVLAN Overview

In multicast VLAN networks, subscribers to a multicast group can exist in more than one VLAN. If the VLAN boundary restrictions in a network consist of Layer 2 switches, it might be necessary to replicate the multicast stream to the same group in different subnets, even if they are on the same physical network. Multicast VLAN routes packets received in a multicast source VLAN to one or more receive VLANs. Clients are in the receive VLANs and the multicast server is in the source VLAN. Multicast routing has to be disabled when Multicast VLAN is enabled.

To use MVLAN on status set PIM-SM or IGMP Proxy, you need the following procedure and caution.

- You must set Multicast VLAN. After MVLAN setting, all OIF belongs to relevant VLAN.
- You set Local IP for VLAN interface of MVLAN and enable MVLAN function after MVIF is made.
- The using of MVLAN is useful when necessary of reducing resource in the environment that many outgoing interface need.
- You may use MVLAN when the system is L3 Multicast Routing environment.

IP Multicast Routing Configuration

Enable IP Multicast Routing

To forward multicast packet, IP multicast routing should be enabled basically. The following shows the command in Global Configuration Mode.

Table 137 Enable IP Multicast Routing

| Command | Description |
|--------------------------------|---|
| ip multicast-routing | Enables IGMP, IGMP Snooping, PIM-SM for Multicast Routing. |
| no ip multicast-routing | Disables IGMP, IGMP Snooping, PIM-SM for Multicast Routing. |

```
Router# configure terminal
Router(config)# ip multicast-routing
Router(config)#
```

Enable IGMP and PIM on an interface

If PIM-SM protocol is enabled in the interface, IGMP Querier Functionality is also automatically enabled. To enable PIM, use the following command in Interface Configuration Mode.

Table 138 Enable IGMP and PIM on an interface

| Command | Description |
|------------------------------|---|
| ip pim sparse-mode | Enables PIM Sparse-Mode of the interface |
| no ip pim sparse-mode | Disables PIM Sparse-Mode of the interface |

```
Router# configure terminal
```



```
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip pim sparse-mode
Router(config-if-Giga2/1/1)# end
Router# show ip pim sparse-mode interface
```

| Address | Interface | VIFindex | Ver/ | Nbr | Query | DR | DR |
|---------|-----------|----------|------|-------|-------|-------|---------|
| | | | Mode | Count | Intvl | Prior | |
| 2.1.1.1 | Giga2/1/1 | 0 | v2/S | 0 | 30 | 1 | 2.1.1.1 |

```
Router#
Router# show ip igmp interface
Interface Giga2/1/1 (Index 1211)
  IGMP Active, Querier, Version 2 (default)
  Internet address is 2.1.1.1
  IGMP interface has 0 group-record states
  IGMP activity: 0 joins, 0 leaves
  IGMP query interval is 125 seconds
  IGMP querier timeout is 262 seconds
  IGMP max query response time is 25 seconds
  Last member query response interval is 1000 milliseconds
  Group Membership interval is 275 seconds
  IGMP Snooping is not enabled on this interface
  IGMP Snooping fast-leave is not enabled
  IGMP Snooping querier is not enabled
  IGMP Snooping report suppression is enabled
```

Configure Multicast Functionality

To configure features of Multicast, follow the steps below.

Router-Guard IP Multicast

Router-Guard IP Multicast blocks packets that can be generated at the Multicast Router among Multicast Control Packets sent to the Interface of the user's network. Then it compiles statistics.

Router-Guard IP Multicast blocks multicast control packets as follows.

- IGMP Query Message
- PIM Message
- DVMRP Message

To set the Router-Guard IP Multicast, use the following commands in the interface configuration mode.

Table 139 Router-Guard IP Multicast

| Command | Description |
|---------------------------------------|--|
| router-guard ip multicast | Sets Router-Guard IP Multicast in the corresponding interface. |
| router-guard ip multicast vlan | Sets Router-Guard IP Multicast only to specific |

| | |
|---|--|
| <1-4093> | members' interfaces of VLAN. |
| no router-guard ip multicast | Disables Router-Guard IP Multicast of the interface. |
| no router-guard ip multicast vlan <1-4093> | Sets Router-Guard IP Multicast to specific members' interface of VLAN. |

```

Router# configure terminal
Router(config)# interface GigabitEthernet 3/1/3
Router(config-if-Giga3/1/3)# router-guard ip multicast
Router(config-if-Giga3/1/3)# interface GigabitEthernet 2/1/2
Router(config-if-Giga2/1/2)# router-guard ip multicast vlan 22
Router(config-if-Giga2/1/2)# end
Router# show router-guard ip multicast

```

Globally enabled on interface gi3.1.3

Drop statistics

```

IGMP Queries      : 0
PIM Messages      : 0
DVMRP Messages    : 0
Invalid Messages  : 0

```

Enabled on interface gi2.1.2, vlan22

Drop statistics

```

IGMP Queries      : 0
PIM Messages      : 0
DVMRP Messages    : 0
Invalid Messages  : 0

```

Router#

Multicast Traffic Forwarding-TTL-Limit

Multicast Traffic Forwarding controlled at the Multicast Router diminishes one TTL transmitting multicast traffic, received from RPF interface, to downstream interface. When the diminished TTL is 0, it drops.

You can set the TTL of multicast traffic, forwarded from the Multicast Router, not to forward by setting a specific TTL value. Under this setting, when multicast traffic that has a TTL value of less than the specific value comes in from the RPF interface, it will not forward. To prevent Multicast Traffic to be forwarded, you must apply TTL to the RPF interface.

To set the TTL of Multi Traffic Forwarding, use the following commands in the interface configuration mode.

Table 140 Multicast Traffic Forwarding-TTL-Limit

| Command | Description |
|---|---|
| ip multicast ttl-threshold <1-255> | Applies TTL restriction on Multicast Traffic |
| no ip multicast ttl-threshold | Disables the TTL restriction on Multicast Traffic |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 3/1/3
Router(config-if-Giga3/1/3)# ip multicast ttl-threshold 10
Router(config-if-Giga3/1/3)# end
```

Static Multicast Route Path

PIM operates based on the Unicast Routing Table. However, depending on the network environment and router management, you can statically apply Multicast Route Path, which has the higher priority than Unicast Routing table, to the specific RP or Source. The Multicast Route Path is valid only in the PIM, and is always applied to in advance of the Unicast Routing Path.

To set the Static Multicast Route Path, use the following commands in the global configuration mode.

Table 141 Static Multicast Route Path

| Command | Description |
|---|---|
| ip mroute <i>A.B.C.D/M [A.B.C.D bgp isis ospf rip static]</i> <i>A.B.C.D</i> | Sets Static Multicast Route Path |
| no ip mroute <i>A.B.C.D [bgp isis ospf rip static]</i> | Disables assigned Static Multicast Route Path |

```
Router# configure terminal
Router(config)# ip mroute 100.1.1.1/32 static 20.1.1.2
Router(config)# exit
Router#
```

Global Multicast Group-Limit

You can set the global multicast group range to allow or block the Multicast Traffic of specific groups. The global multicast group range simultaneously applies to all multicast protocols such as IGMP or PIM of a router.

To set the global multicast group range, use the following commands in the global configuration mode.

Table 142 Global Multicast Group-Limit

| Command | Description |
|--|------------------------------------|
| ip multicast group-range <i>access-list</i> | Sets a Multicast group range |
| no ip multicast group-range | Disables the multicast group range |

```
Router# configure terminal
Router(config)# access-list 20 permit 224.1.1.0 0.0.0.255
Router(config)# access-list 20 deny any
Router(config)# ip multicast group-range 20
Router(config)# exit
```

Router#

Multicast Load-Split

PIM Router can have more than one RPF interfaces with the same Metric of SPT. For multiple RPF interfaces of a source, PIM selects an Upstream Interface and splits Multicast Traffic based on the Hash value determined by the Hash function of (S, G) entry. The load-split is different from the load-balance. Dealing with many multicast entries, each (S, G) entry has a RPF interface. So it intensifies the RPF interface less than using only one interface, and increases the efficiency of Network Bandwidth.

To set the Multicast Load-Split, use the following command in the global configuration mode.

Table 143 Multicast Load-Split

| Command | Description |
|----------------------------------|-----------------------------------|
| ip multicast multipath | Sets the Multicast load-split |
| no ip multicast multipath | Disables the Multicast load-split |

```
Router# configure terminal
Router(config)# ip multicast multipath
Router(config)# exit
Router#
```

Multicast Route-Limit

Multicast Router can limit the number of Multicast Routing Entries in the system.

To set the number of Multicast Routing Entries, use the following command in global configuration mode.

Table 144 Multicast Route-Limit

| Command | Description |
|---|--|
| ip multicast route-limit <1-2147483647> [<1-2147483647>] | Limits the number of Multicast routing entry (Default : 1000) |
| no ip multicast route-limit | Disables the number of Multicast routing entry |

```
Router# configure terminal
Router(config)# ip multicast route-limit 10000 9000
Router(config)# exit
Router# show ip mroute sparse count
```

```
IP Multicast Statistics
Total 0 routes using 0 bytes memory
Route limit/Route threshold: 10000/9000
Total NOCACHE/WRONGVIF/WHOLEPKT recvd from fwd: 0/0/0
Total NOCACHE/WRONGVIF/WHOLEPKT sent to clients: 0/0/0
```

```
Immediate/Timed stat updates sent to clients: 0/0
Reg ACK rcv/Reg NACK rcv/Reg pkt sent: 0/0/0
Next stats poll: 00:00:19
Forwarding Counts: Pkt count/Byte count, Other Counts: Wrong If pkts
Fwd msg counts: WRONGVIF/WHOLEPKT rcv
Client msg counts: WRONGVIF/WHOLEPKT/Imm Stat/Timed Stat sent
Reg pkt counts: Reg ACK rcv/Reg NACK rcv/Reg pkt sent
Router#
```

Configuring IGMP Functionality

To configure IGMP features, follow the steps below.

IGMP Version

The IGMP version of IGMP Querier, which operates by each network, works as the Default IGMPv2.

To change the IGMP Version, use the following command in the interface configuration mode.

Table 145 IGMP Version

| Command | Description |
|------------------------------------|---|
| ip igmp version <1-3> | Sets IGMP version of interface (Default: 2) |
| no ip igmp version | Sets the IGMP for default setting |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp version 3
Router(config-if-Giga2/1/1)# end
Router# show ip igmp interface
IGMP Enabled, Active, Querier, Configured for version 3
Internet address is 2.1.1.1
IGMP interface has 0 group-record states
IGMP activity: 0 joins, 0 leaves
IGMP query interval is 125 seconds
IGMP querier timeout is 262 seconds
IGMP max query response time is 25 seconds
Last member query response interval is 1000 milliseconds
Group Membership interval is 275 seconds
IGMP Snooping is not enabled on this interface
IGMP Snooping fast-leave is not enabled
IGMP Snooping querier is not enabled
IGMP Snooping report suppression is enabled
Router#
```

IGMP Access-Group

Multicast router transmits IGMP Host-query message to control multicast group that network hosts are in, and forwards packets to the member of this group. It can also configure filter in each interface to limit the multicast group that subnet host by the interface can be in.

To filter multicast group that interface permits, use the following command in the Interface Configuration mode.

Table 146 IGMP Access-Group

| Command | Description |
|---|---|
| ip igmp access-group <i>access-list</i> | Controls multicast group – subnet host that is serviced by the corresponding interface. |
| no ip igmp access-group | Disables multicast group – subnet host that is serviced by the corresponding interface. |

```
Router# configure terminal
Router(config)# access-list 1 deny 225.1.1.0 0.0.0.255
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp access-group 1
Router(config-if-Giga2/1/1)# end
```

IGMP Query-Interval

Multicast router sends IGMP Query message periodically for managing Multicast Membership.

To change IGMP Query message interval, use the following command in interface configuration mode.

Table 147 IGMP Query-Interval

| Command | Description |
|---|---|
| ip igmp query-interval <i><1-18000></i> | Sets igmp query-interval (Default: 125 seconds) |
| no ip igmp query-interval | Sets IGMP Query Interval as default. |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp query-interval 60
Router(config-if-Giga2/1/1)# end
Router# show ip igmp interface
Interface Giga2/1/1 (Index 1211)
  IGMP Enabled, Active, Querier, Version 2 (default)
  Internet address is 2.1.1.1
  IGMP interface has 0 group-record states
  IGMP activity: 0 joins, 0 leaves
  IGMP query interval is 60 seconds
  IGMP querier timeout is 262 seconds
  IGMP max query response time is 25 seconds
  Last member query response interval is 1000 milliseconds
  Group Membership interval is 275 seconds
  IGMP Snooping is not enabled on this interface
  IGMP Snooping fast-leave is not enabled
  IGMP Snooping querier is not enabled
  IGMP Snooping report suppression is enabled
Router#
```

IGMP Last-Member-Query-Count

IGMP Last-member-query-count assigns the number of occurrence of IGMP Group-Specific Query for finding another Host of Multicast Group that IGMP Querier withdraws.

To set IGMP Last-member-query-count, use the following commands in interface configuration mode.

Table 148 IGMP Last-Member-Query-Count

| Command | Description |
|--|---|
| ip igmp last-member-query-count <2-7> | Sets the number of occurrence of IGMP Group-Specific Query (Default : 2 times) |
| no ip igmp last-member-query-count | Sets the number of occurrence for default |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp last-member-query-count 3
Router(config-if-Giga2/1/1)# end
```


IGMP Last-Member-Query-Interval

Last-member-query-interval is available with IGMPv2 and is Max Response Time in Group-Specific Query message from IGMP querier as a response to 'IGMP Leave' message. It is an interval for Group-Specific Query message and the default is "1". This value is to control Leave Latency of network, and network can sense the last member existence of group faster with smaller value.

To set the interval, use the following commands in the interface configuration mode.

Table 149 IGMP Last-Member-Query-Interval

| Command | Description |
|--|--|
| ip igmp last-member-query-interval <1000-25500> | Sets the IGMP Last-member-query-interval (Default : 1000ms) |
| no ip igmp last-member-query-interval | Sets the IGMP Last-member-query-interval for default |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp last-member-query-interval 2000
Router(config-if-Giga2/1/1)# end
Router# show ip igmp interface
Interface Giga2/1/1 (Index 1211)
  IGMP Enabled, Active, Querier, Version 2 (default)
  Internet address is 2.1.1.1
  IGMP interface has 0 group-record states
  IGMP activity: 0 joins, 0 leaves
  IGMP query interval is 125 seconds
  IGMP querier timeout is 262 seconds
  IGMP max query response time is 25 seconds
  Last member query response interval is 2000 milliseconds
  Group Membership interval is 275 seconds
  IGMP Snooping is not enabled on this interface
  IGMP Snooping fast-leave is not enabled
  IGMP Snooping querier is not enabled
  IGMP Snooping report suppression is enabled
Router#
```

IGMP Immediate-Leave

Normally, a querier sends a group-specific or group-source-specific query message upon receipt of a leave message from a host. If you set a leave latency as 0 (zero), you can omit the querying procedure. When the querying procedure is omitted, the router immediately removes the interface from the IGMP cache for that group, and informs the multicast routing protocols.

To set the IGMP Immediate-leave, use the following commands in the interface configuration mode.

Table 150 IGMP Immediate-Leave

| Command | Description |
|---|--|
| ip igmp immediate-leave group-list <i>access-list</i> | Enables IGMP immediate-leave on relevant interface. |
| no ip igmp immediate-leave | Disables IGMP immediate-leave on the relevant interface. |

```
Router# configure terminal
Router(config)# access-list 2 permit 225.1.1.0 0.0.0.255
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp immediate-leave group-list 2
Router(config-if-Giga2/1/1)# end
```

IGMP Group Limit

You can use IGMP Group Limit to limit the number of IGMP states that can be joined to a router on a per-interface or global level. Membership reports exceeding the configured limits are not entered into the IGMP cache and traffic for the excess membership reports is not forwarded.

To set the IGMP Group Limit, use the following command in the interface configuration mode.

Table 151 IGMP Group Limit

| Command | Description |
|----------------------------------|--|
| ip igmp limit <1-2097152> | Sets IGMP Group Limit on the relevant interface. (Default : unlimited) |
| no ip igmp limit | Disables IGMP Group Limit on the relevant interface. |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp limit 100
Router(config-if-Giga2/1/1)# end
```

IGMP Global Limit

To set the IGMP Global Limit, use the following command in configuration mode.

Table 152 IGMP Global Limit

| Command | Description |
|----------------------------------|--|
| ip igmp limit <1-2097152> | Sets IGMP Group Limit to Global (Default: unlimited) |

| | |
|-------------------------|---|
| no ip igmp limit | Disables the IGMP Group Limit set to Global |
|-------------------------|---|

```
Router# configure terminal
Router(config)# ip igmp limit 100
Router(config)# end
```

IGMP Minimum-Version

You can limit a version of IGMP message be received. In case of setting IGMP Minimum-Version with 2, the received IGMPv1 message is limited and IGMPv2, IGMPv3 message is allowed. In case of IGMPv3 message, decide processing or not by IGMP Version of set interface.

To set the IGMP Minimum-Version, use the following commands in the interface configuration mode.

Table 153 IGMP Minimum-Version

| Command | Description |
|--|---|
| ip igmp minimum-version <2/3> | Sets IGMP minimum-version to relevant interface.. |
| no ip igmp minimum-version | Disables IGMP minimum-version. |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp minimum-version 2
Router(config-if-Giga2/1/1)# end
```

IGMP Querier-Timeout

There should be a single querier on a network segment to prevent duplicating multicast traffic for connected hosts. When there are several routers, if the router has the lowest IP address or if the router hears no queries during the timeout period, it becomes the querier.

To set the IGMP Querier-Timeout, use the following commands in the interface configuration mode.

Table 154 IGMP Querier-Timeout

| Command | Description |
|---|---|
| ip igmp querier-timeout <60-300> | Sets IGMP Querier timeout (Default : 262 seconds) |
| no ip igmp querier-timeout | Sets IGMP Querier timeout to default |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp querier-timeout 300
Router(config-if-Giga2/1/1)# end
```

```
Router# show ip igmp interface
Interface Giga2/1/1 (Index 1211)
  IGMP Enabled, Active, Querier, Version 2 (default)
  Internet address is 2.1.1.1
  IGMP interface has 0 group-record states
  IGMP activity: 0 joins, 0 leaves
  IGMP query interval is 125 seconds
  IGMP querier timeout is 300 seconds
  IGMP max query response time is 25 seconds
  Last member query response interval is 1000 milliseconds
  Group Membership interval is 275 seconds
  IGMP Snooping is not enabled on this interface
  IGMP Snooping fast-leave is not enabled
  IGMP Snooping querier is not enabled
  IGMP Snooping report suppression is enabled
Router#
```

IGMP Query-Max-Response-Time

In IGMP version 2 and 3, membership query messages include the maximum query response time field. This field specifies the maximum time allowed before sending a responding report. The maximum query response time allows a router to quickly detect that there are no more directly connected group members on a network segment.

To set the IGMP Query Max-Response-Time, use the following commands in the interface configuration mode.

Table 155 IGMP Query-Max-Response-Time

| Command | Description |
|--|---|
| ip igmp query-max-response-time <1-240> | Designates max-response-time. (Default : 25 second) |
| no ip igmp query-max-response-time | Returns to default setting. |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp query-max-response-time 10
Router(config-if-Giga2/1/1)# end
Router# show ip igmp interface
Interface Giga2/1/1 (Index 1211)
  IGMP Enabled, Active, Querier, Version 2 (default)
  Internet address is 2.1.1.1
  IGMP interface has 0 group-record states
  IGMP activity: 0 joins, 0 leaves
  IGMP query interval is 125 seconds
  IGMP querier timeout is 262 seconds
```

IGMP max query response time is 10 seconds

Last member query response interval is 1000 milliseconds
 Group Membership interval is 275 seconds
 IGMP Snooping is not enabled on this interface
 IGMP Snooping fast-leave is not enabled
 IGMP Snooping querier is not enabled
 IGMP Snooping report suppression is enabled

Router#

IGMP Rate

Multicast Router can limit PPS about IGMP Packet incoming to CPU. IGMP Packet over set IGMP Rate drop from CPU.

To limit IGMP Packet to PPS, use the following commands in the interface configuration mode.

Table 156 IGMP Rate

| Command | Description |
|---|----------------------------------|
| ip igmp rate <500-6000> | Sets the IGMP Rate in pps units. |
| no ip igmp query-max-response-time | Disables the IGMP Rate. |

Router# **configure terminal**

Router(config)# **interface GigabitEthernet 2/1/1**

Router(config-if-Giga2/1/1)# **ip igmp rate 100**

Router(config-if-Giga2/1/1)# **end**

Router# **show ip igmp rate-limit statistics**

IGMP Message Ratelimit (pps) for IP Multicast

| Ifname | Incoming rate | Rate-limit | Permit | Drop | Rx-Total |
|--------------------------|---------------|------------|--------|----------|----------|
| -----+-----+-----+-----+ | | | | | |
| gi2.1.1 | 0 | 100 | | 0 | 0 |

Router#

IGMP Robustness-Variable

You can statically configure the Querier's Robustness Variable (QRV) field in the membership query message for IGMP version 2 and 3. The QRV allows tuning for the expected packet loss on a network. If a network is expected to be lossy, the QRV value may be increased. When receiving the query message that contains a certain QRV value from a querier, a host returns the report message as many as the specified QRV value.

To set the IGMP Robustness-Variable, use the following commands in the interface configuration mode.

Table 157 IGMP Robustness-Variable

| Command | Description |
|--|--|
| ip igmp robustness-variable <2-7> | Sets the IGMP Robustness Variable (Default: 2) |
| no ip igmp query-max-response-time | Sets the IGMP Robustness Variable to default |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 2/1/1
Router(config-if-Giga2/1/1)# ip igmp robustness-variable 5
Router(config-if-Giga2/1/1)# end
Router# show ip igmp interface
Interface Giga2/1/1 (Index 1211)
  IGMP Enabled, Active, Querier, Version 2 (default)
  Internet address is 2.1.1.1
  IGMP interface has 0 group-record states
  IGMP activity: 0 joins, 0 leaves
  IGMP query interval is 125 seconds
  IGMP querier timeout is 637 seconds
  IGMP max query response time is 25 seconds
  Last member query response interval is 1000 milliseconds
  Group Membership interval is 650 seconds
  IGMP Snooping is not enabled on this interface
  IGMP Snooping fast-leave is not enabled
  IGMP Snooping querier is not enabled
  IGMP Snooping report suppression is enabled
Router#
```

IGMP Static-Group

When there are no more group members on a network segment or a host cannot report its group membership using IGMP, multicast traffic is no longer transmitted to the network segment. However, you may want to pull down multicast traffic to a network segment to reduce the time from when an IGMP join request is made to when the requested stream begins arriving at a host, which is called the zapping time.

The IGMP-Group reduces the zapping time by statically creating a virtual host that behaves like a real one on a port, even if there is no group member in the group where the port belongs.

As a result, a multicast router realizes there is still group member, allowing multicast traffic to be permanently reachable on the group.

To set an IGMP Static-Group, use the IGMP Class-Map. To generate an IGMP Class-Map, use the following commands in the global configuration mode.

Table 158 IGMP Static-Group

| Command | Description |
|---|-----------------------------|
| class-map type multicast-flows <i>name</i> | Makes an IGMP Class-Map. |
| no class-map type multicast-flows | Deletes the IGMP Class-Map. |

To set IGMP Class-Map, use the following command.

Table 159 IGMP Class-Map

| Command | Description |
|--|--|
| group <i>A.B.C.D</i> | Assigns an IGMPv2 Group (*, G). |
| group <i>A.B.C.D</i> source <i>A.B.C.D</i> | Assigns an IGMPv3 Group and Source (S, G). |
| group <i>A.B.C.D to A.B.C.D</i> | Assigns multiple IGMPv2 Groups (*, Gn). |
| group <i>A.B.C.D to A.B.C.D</i> source <i>A.B.C.D</i> | Assigns multiple IGMPv3 Groups and a Source(S, Gn). |
| no group <i>A.B.C.D</i> | Deletes the assigned IGMPv2 Group (*, G). |
| no group <i>A.B.C.D</i> source <i>A.B.C.D</i> | Deletes the assigned IGMPv3 and Source (S, G). |
| no group <i>A.B.C.D to A.B.C.D</i> | Deletes the assigned multiple IGMPv2 Groups (*, Gn). |
| no group <i>A.B.C.D to A.B.C.D</i> source <i>A.B.C.D</i> | Deletes the assigned multiple IGMPv3 Groups and a Source(S, Gn). |

The source setting, assigned in IGMP Class-Map, is valid only in IGMPv3.

```
Router# configure terminal
Router(config)# class-map type multicast-flows igmp_static
Router(config-mcast-flows-cmap)# group 225.1.1.1 to 225.1.1.10
Router(config-mcast-flows-cmap)# group 225.1.2.1
Router(config-mcast-flows-cmap)# end
Router# show ip igmp static-group class-map
```

```
Class-map igmp_static
description : -
Group address range 225.1.1.1 to 225.1.1.10
Group address 225.1.2.1
Router#
```

To set IGMP Static-Group, use the following command in interface configuration mode.

Table 160 IGMP Rate

| Command | Description |
|--|--|
| ip igmp static-group A.B.C.D | Sets the IGMPv2 Static-Group not using the IGMP Class-Map. |
| ip igmp static-group A.B.C.D interface IFNAME | For the VLAN interface with enabled IGMP Snooping, it sets the member port of VLAN interface when setting IGMPv2 Static-Group. |
| ip igmp static-group A.B.C.D source A.B.C.D | Sets an IGMPv3 Static-Group not using the IGMP Class-Map. |
| ip igmp static-group A.B.C.D source A.B.C.D interface IFNAME | For the VLAN interface with IGMP Snooping enabled, it sets the member port of VLAN interface when setting IGMPv3 Static-Group. |
| ip igmp static-group class-map name | Sets a Static-Group based on the information of the assigned Group in the IGMP Class-Map using IGMP Class-Map. |
| no ip igmp static-group A.B.C.D | Disables the IGMPv2 Static-Group. |
| no ip igmp static-group A.B.C.D interface IFNAME | Disables the IGMPv2 Static-Group that is set in the VLAN interface with enabled IGMP Snooping. |
| no ip igmp static-group A.B.C.D source A.B.C.D | Disables the IGMPv3 Static-Group. |
| no ip igmp static-group A.B.C.D source A.B.C.D interface IFNAME | Disables the IGMPv3 Static-Group that is set in the VLAN interface with enabled IGMP Snooping. |
| no ip igmp static-group class-map name | Disables the Static-Group of IGMP Class-Map. |

Router# **configure terminal**

Router(config)# **interface GigabitEthernet 2/1/1**

Router(config-if-Giga2/1/1)# **ip igmp static-group igmp_static**

Router(config-if-Giga2/1/1)# **end**

Router# **show ip igmp group**

IGMP Connected Group Membership

| Group Address | Interface | Uptime | Expires | Last Reporter |
|---------------|-----------|----------|----------------|---------------|
| 225.1.1.1 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.1.2 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.1.3 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.1.4 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.1.5 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.1.6 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.1.7 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.1.8 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.1.9 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.1.10 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |
| 225.1.2.1 | Giga2/1/1 | 00:01:42 | static 0.0.0.0 | |

Router# **show ip igmp static-group class-map interface gi2/1/1**

Giga2/1/1

Class-map attached : igmp_static

Group address range 225.1.1.1 to 225.1.1.10

Group address 225.1.2.1

Router#

IGMP SSM-MAP

The purpose of static SSM mapping is to provide SSM service on IGMPv1 and IGMPv2 messages. It means that it enables a multicast host to signal to a router which groups it wants to receive multicast traffic from, and from which sources this traffic is expected. You can specify a source address of multicast server to receive the multicast traffic from specified sources. If the system receives IGMPv1 or IGMPv2 report message from the host when static SSM mapping is enabled, it handles as if it receives IGMPv3 report messages.

By default, the PIM SSM is enabled. To disable the PIM SSM, use the following commands in the global configuration mode.

Table 161 IGMP SSM-MAP

| Command | Description |
|----------------------------------|----------------------|
| no ip igmp ssm-map enable | Disables the SSM-MAP |
| ip igmp ssm-map enable | Enables SSM-MAP |

Router# **configure terminal**

Router(config)# **no ip igmp ssm-map enable**

Router(config)# **exit**

Router# **show ip igmp ssm-map**

SSM Mapping : Disabled

Database : None configured

Router#

Router# **configure terminal**

Router(config)# **ip igmp ssm-map enable**

Router(config)# **exit**

Router# **show ip igmp ssm-map**

SSM Mapping : Enabled

Database : None configured

A group joined with IGMPv2 processes assigned source with mapping group assigned from database of IGMP SSM-MAP

To generate database of IGMP SSM-Map, use the following commands in the global configuration mode.

Table 162 IGMP SSM-MAP

| Command | Description |
|--|--|
| ip igmp ssm-map static <i>access-list</i> A.B.C.D | Adds ssm-map database using Access-list. |
| no ip igmp ssm-map static | Deletes the added ssm-map database using |

access-list A.B.C.D

Access-list.

```
Router# configure terminal
Router(config)# access-list 20 permit 224.1.1.0 0.0.0.255
Router(config)# access-list 21 permit 224.1.3.0 0.0.0.255
Router(config)# ip igmp ssm-map static 20 179.1.1.200
Router(config)# ip igmp ssm-map static 21 179.1.1.201
Router(config)# exit
Router# show ip igmp ssm-map
SSM Mapping : Enabled
Database      : Static mappings configured
Router#
Router# show ip igmp ssm-map 224.1.1.1
Group address: 224.1.1.1
Database      : Static
Source list   : 179.1.1.200
Router#
Router# show ip igmp ssm-map 224.1.2.1
```

Can't resolve 224.1.2.1 to source-mapping

```
Router#
Router# show ip igmp ssm-map 224.1.3.1
Group address: 224.1.3.1
Database      : Static
Source list   : 179.1.1.201
Router#
```

IGMP Proxy-Service

To enable IGMP Proxy service, you must set UPSTREAM in the Single Tree structure. The interface disperses traffic and works at the Host Side.

To set IGMP Proxy-Service, use the following commands in the interface mode.

Table 163 IGMP Proxy-Service

| Command | Description |
|---------------------------------|---|
| ip igmp proxy-service | Sets the selected interface for a Proxy upstream interface. |
| no ip igmp proxy-service | Disables the setting of Proxy upstream interface. |

```
Router# configure terminal
Router(config)# interface vlan10
Router(config-if-Vlan10)# ip igmp proxy-service
```

```
Router# show ip igmp interface
Interface Vlan10 (Index 2010)
IGMP Enabled, Active, Non-Querier, Version 2 (default) proxy-service
IGMP host version 2
Internet address is 10.0.1.114
IGMP interface has 0 group-record states
IGMP activity: 0 joins, 0 leaves
IGMP querying router is 10.0.1.111
IGMP query interval is 125 seconds
IGMP querier timeout is 262 seconds
IGMP max query response time is 25 seconds
Last member query response interval is 1000 milliseconds
Group Membership interval is 275 seconds
IGMP Snooping is not enabled on this interface
IGMP Snooping fast-leave is not enabled
IGMP Snooping querier is not enabled
IGMP Snooping report suppression is enabled
```

IGMP Mroute-Proxy

To do IGMP Proxy service, the setting about downstream in Single Tree structure is needed. The relevant interface take part in role of Router Side like receiving report or sending query.

To set IGMP Mroute-Proxy, use the following commands in the interface mode.

Table 164 IGMP Mroute-Proxy

| Command | Description |
|---|--|
| ip igmp mroute-proxy <i>IFNAME</i> | Sets the interface as a Proxy downstream interface. Enter Upstream interface for <i>IFNAME</i> . |
| no ip igmp mroute-proxy | Disables the setting of Proxy downstream interface. |

```
Router# configure terminal
Router(config)# interface vlan30
Router(config-if-Vlan30)# ip igmp mroute-proxy vlan10
```

```
Router# show ip igmp interface
Interface Vlan30 (Index 2030)
IGMP Enabled, Active, Version 2 (default)
IGMP mroute-proxy interface is Vlan10
IGMP interface has 0 group-record states
IGMP activity: 0 joins, 0 leaves
IGMP query interval is 125 seconds
IGMP querier timeout is 262 seconds
IGMP max query response time is 25 seconds
```

Last member query response interval is 1000 milliseconds

Group Membership interval is 275 seconds

IGMP Snooping is not enabled on this interface

IGMP Snooping fast-leave is not enabled

IGMP Snooping querier is not enabled

IGMP Snooping report suppression is enabled

Configure PIM-SM Functionality

To set various features of Protocol Independent Multicast (PIM), use the following commands.

PIM Hello-Interval

PIM periodically sends a Hello message. To set the interval, use the following commands in the interface configuration mode.

Table 165 PIM Hello-Interval

| Command | Description |
|--|--|
| ip pim hello-interval <1-65535> | Sets the interval of sending Hello messages. (Default : 30seconds) |
| no ip pim hello-interval | Sets the default for the assigned interval of Hello message. |

Router# **configure terminal**

Router(config)# **interface GigabitEthernet 3/1/3**

Router(config-if-Giga3/1/3)# **ip pim hello-interval 60**

Router(config-if-Giga3/1/3)# **end**

Router# **show ip pim sparse-mode interface**

| Address | Interface | VIFIndex | Ver/ Mode | Nbr Count | Query Intvl | DR Prior | DR |
|-----------|-----------|----------|-----------|-----------|-------------|----------|-----------|
| 3.1.3.222 | Giga3/1/3 | 0 | v2/S | 0 | 60 | 1 | 3.1.3.222 |

Router#

PIM Hello-Holdtime

PIM sends Hello message periodically, Neighbor receiving PIM Hello message must maintain PIM Hello message during set Holdtime.

To change PIM Hello-Holdtime, use the following commands in the interface configuration mode.

Table 166 PIM Hello-Holdtime

| Command | Description |
|---|--|
| ip pim hello-holdtime < 1-65535> | Sets the holdtime of a Hello message. (Default : 105s) |
| no ip pim hello-interval | Sets the holdtime of the Hello message for default. |

Router# **configure terminal**

Router(config)# **interface GigabitEthernet 3/1/3**

Router(config-if-Giga3/1/3)# **ip pim hello-holdtime 120**

```
Router(config-if-Giga3/1/3)# end
```

PIM DR-Priority

In PIM-SM, the designated router (DR) is normally the first-hop router of receivers (hosts), which is responsible to periodically send PIM join/prune messages toward the RP to inform it of the host group membership.

When there are multiple routers on the same subnet, one of them must be selected to act as the DR. To elect the DR, each PIM router examines PIM hello messages received from other neighbor PIM routers and compares its DR priority in those from neighbors. The router with the highest priority then is elected as the DR. In case of more than one router with the same highest priority value, the one with the higher IP address is elected. If no PIM hello message is received from the DR for a certain period of time, another DR election is held.

In PIM-DM, however, the DR only plays a role of the alternative IGMP querier using this DR election when multiple routers exist with IGMPv1, since IGMPv1 does not define any IGMP querier election process.

To change the DR Priority of PIM Hello, use the following commands in the interface configuration mode.

Table 167 PIM DR-Priority

| Command | Description |
|---|---|
| ip pim dr-priority <0-4294967294 > | Sets the DR Priority of a Hello message. (Default : 1) |
| no ip pim hello-interval | Sets the holdtime of the Hello message for default. |

```
Router# configure terminal
```

```
Router(config)# interface GigabitEthernet 3/1/3
```

```
Router(config-if-Giga3/1/3)# ip pim dr-priority 10
```

```
Router(config-if-Giga3/1/3)# end
```

```
Router# show ip pim sparse-mode interface
```

```
Address          Interface  VIFindex Ver/   Nbr   Query  DR   DR
                  Mode    Count  Intvl Prior
3.1.3.222        Giga3/1/3  0      v2/S   0     60    10   3.1.3.222
Router#
```

PIM Propagation-Delay

You can set a delay for implementing a PIM prune message on the upstream router on a multicast network for which join suppression has been enabled with this function. The router waits for the prune pending period to detect whether a join message is currently being suppressed by another router.

To change the propagation delay of the PIM Hello message, use the following commands in the interface configuration mode.

Table 168 PIM Propagation-Delay

| Command | Description |
|---------|-------------|
|---------|-------------|

| | |
|---|---|
| ip pim propagation-delay <1000-5000> | Sets the propagation delay of a PIM Hello message. (Default: 1000ms) |
| no ip pim propagation-delay | Disables the propagation delay of the PIM Hello message. |

```

Router# configure terminal
Router(config)# interface GigabitEthernet 3/1/3
Router(config-if-Giga3/1/3)# ip pim propagation-delay 5000
Router(config-if-Giga3/1/3)# end
Router# show ip pim sparse-mode interface detail
Giga3/1/3 (vif 0):
  Address 3.1.3.222, DR 3.1.3.222
  Hello period 30 seconds, Next Hello in 23 seconds
  Triggered Hello period 5 seconds
  Propagation delay is 1000 milli-seconds
  Configured Propagation-delay 5000 milli-seconds
  Generation ID : 795759275
  Neighbors:

```

Router#

PIM Exclude-Genid

PIM sends Hello message periodically and PIM Hello message can include Generation ID. If PIM Router receives PIM Hello message having another Generation ID from the same Neighbor of specific network, it knows relevant Neighbor to start or restart. Then it performs PIM Neighbor Discovery renewing RP information or PIM RPF.

To set a PIM Hello message not to include a Generation ID, use the following commands in the interface configuration mode.

Table 169 PIM Exclude-Genid

| Command | Description |
|--------------------------------|--|
| ip pim exclude-genid | Sets PIM hello message not to include a Generation ID. |
| no ip pim exclude-genid | Disables the setting of exclude-genid. |

```

Router# configure terminal
Router(config)# interface GigabitEthernet 3/1/3
Router(config-if-Giga3/1/3)# ip pim exclude-genid
Router(config-if-Giga3/1/3)# end
Router#

```

PIM Neighbor-Filter

PIM sends Hello message periodically, Neighbor receiving PIM Hello message selects DR of relevant network via PIM Hello message.

To set PIM neighbor-filter, use the following commands in the interface configuration mode.

Table 170 PIM Neighbor-Filter

| Command | Description |
|---|-----------------------------------|
| ip pim neighbor-filter <i>access-list</i> | Sets PIM neighbor-filter. |
| no ip pim neighbor-filter <i>access-list</i> | Disables the PIM neighbor-filter. |

```
Router# configure terminal
Router(config)# access-list 3 permit 3.1.3.1
Router(config)# interface GigabitEthernet 3/1/3
Router(config-if-Giga3/1/3)# ip pim neighbor-filter 3
Router(config-if-Giga3/1/3)# end
```

PIM BSR-Border

Bootstrap Router (BSR) makes Bootstrap message gathering information of RPs deployed in network. If you set BSR Border on specific interface, you can configure each different PIM Domain by limiting to send or receive Bootstrap message.

To set BSR Border, use the following commands in the interface configuration mode.

Table 171 PIM BSR-Border

| Command | Description |
|-----------------------------|---|
| ip pim bsr-border | Blocks sending and receiving of BSR messages of an interface. |
| no ip pim bsr-border | Disables sending and receiving of BSR messages of an interface. |

```
Router# configure terminal
Router(config)# interface GigabitEthernet 3/1/3
Router(config-if-Giga3/1/3)# ip pim bsr-border
Router(config-if-Giga3/1/3)# end
```

PIM JP-Timer

Multicast Router sends PIM join/Prune message periodically for maintaining Multicast Traffic forwarding to Upstream Multicast Router existing to Routing Path of SPT or RPT.

By default, the interval of the transmitting PIM Join/Prune messages is 60 seconds. To change the interval, use the following commands in the global configuration mode.

Table 172 PIM BSR-Border

| Command | Description |
|--|---|
| ip pim jp-timer <1-65535> | Sets the interval of transmitting PIM Join/Prune messages. (Default: 60 seconds) |
| no ip pim jp-timer | Sets the default for the interval of the PIM Join/Prune message. |

```
Router# configure terminal
Router(config)# ip pim jp-timer 120
Router(config)# exit
```

PIM Access-Group

Multicast Router maintains Multicast Traffic Forwarding with receiving periodic PIM Join message. In case of receiving PIM Join to Multicast Group that does not want to service, limits it.

To limit the PIM Join into a specific Multicast Group, use the following command in the interface configuration mode.

Table 173 PIM Access-Group

| Command | Description |
|---|--|
| ip multicast boundary access-list | Limits the PIM Join into a group on Access-List. |
| no ip multicast boundary access-list | Disables the limitation of the PIM Join. |

```
Router# configure terminal
Router(config)# access-list 3 deny 224.1.1.0 0.0.0.255
Router(config)# interface GigabitEthernet 3/1/3
Router(config-if-Giga3/1/3)# ip multicast boundary 3
Router(config-if-Giga3/1/3)# end
```

PIM Accept-Register

Multicast Router on running with RP manages Multicast source Entry with receiving PIM Register from 1st-Hop Multicast Router belonging to PIM Domain.

To limit the PIM Register message of a specific Source into a Multicast Router, use the following commands in the global configuration mode.

Table 174 PIM Accept-Register

| Command | Description |
|---|--|
| ip pim accept-register list <i>access-list</i> | Limits the source of incoming PIM Register message. |
| no ip pim register-filter-group | Disables the limited source of the PIM Register message. |

```
Router# configure terminal
Router(config)# access-list 30 permit 100.1.1.0 0.0.0.255
Router(config)# access-list 30 deny any
Router(config)# ip pim accept-register list 30
Router(config)# exit
```

PIM SPT-Threshold

PIM-SM provides the switching option to deliver multicast traffic on the SPT. Multicasting over the SPT may be more efficient than multicasting over the RPT, since it can substantially reduce the network latency.

When the switching option is enabled, once multicast traffic from sources arrives at the DR, the switchover to the SPT then occurs. This option only provides the binary option, meaning that the switching to the SPT occurs either when receiving the first multicast packet, or not at all; it is not rate-based. You can enable this option only for specified multicast groups using access lists.

To set the PIM SPT-Threshold, use the following commands in the global configuration mode.

Table 175 PIM Accept-Register

| Command | Description |
|--|--|
| ip pim spt-threshold [<i>group-list access-list</i>] | Sets PIM SPT Threshold |
| no ip pim spt-threshold [<i>group-list access-list</i>] | Disables the PIM SPT Threshold setting |

```
Router# configure terminal
Router(config)# ip pim spt-threshold
Router(config)# exit
```

PIM Cisco-Register-Checksum

When a multicast source registers with the RP, the DR encapsulates the multicast traffic from the source in the PIM register message, and unicasts it to the RP. The standard PIM protocol specifies that the checksum field in the register message contains the checksum for the entire register message excluding the data portion, the encapsulated multicast traffic.

The Cisco's routers, however, validate the checksum for the whole register message including the data portion, resulting in incompatibility with the standard-based routers. To guarantee compatibility with the Cisco's routers, the system provides the checksum option, which expands the range of the checksum calculation.

To set the Cisco Register-Checksum, use the following commands in the global configuration mode.

Table 176 PIM Cisco-Register-Checksum

| Command | Description |
|--|---|
| ip pim cisco-register-checksum | Sets all groups to be compatible with Cisco Router. |
| ip pim cisco-register-checksum group-list <i>access-list</i> | Sets the groups assigned on the Access-list to be compatible with Cisco Router. |
| no ip pim cisco-register-checksum | Disables the register-checksum of all groups. |
| no ip pim cisco-register-checksum group-list <i>access-list</i> | Disables the register-checksum of the groups assigned on the Access-list. |

```
Router# configure terminal
Router(config)# ip pim cisco-register-checksum
Router(config)# exit
```

```
Router# configure terminal
Router(config)# access-list 11 permit 224.1.1.0 0.0.0.255
Router(config)# ip pim cisco-register-checksum group-list 11
Router(config)# exit
```

PIM BSR-Candidate

A multicast Router should be included in PIM Domain to operate as a BSR Candidate.

To set Multicast Router for BSR Candidate, use the following command in global configuration mode.

Table 177 PIM Cisco-Register-Checksum

| Command | Description |
|---|--|
| ip pim bsr-candidate <i>ifname</i> [<i>hash-mask-length</i>] [<i>priority</i>] | Sets Multicast Router to work as a BSR candidate |
| no ip pim bsr-candidate [<i>ifname</i>] | Disables the BSR candidate |

```
Router# configure terminal
Router(config)# ip pim bsr-candidate lo0
Router(config)# exit
Router# show ip pim sparse-mode bsr-router
PIMv2 Bootstrap information
This system is the Bootstrap Router (BSR)
BSR address: 172.16.1.222
```

```
Uptime:      00:02:32, BSR Priority: 64, Hash mask length: 10
Next bootstrap message in 00:00:24
Role: Candidate BSR
State: Elected BSR
Router#
```

```
Router# configure terminal
Router(config)# ip pim bsr-candidate lo0 24 128
Router(config)# exit
Router# show ip pim sparse-mode bsr-router
PIMv2 Bootstrap information
This system is the Bootstrap Router (BSR)
BSR address: 172.16.1.222
Uptime:      00:05:01, BSR Priority: 128, Hash mask length: 24
Next bootstrap message in 00:00:59
Role: Candidate BSR
State: Elected BSR
Router#
```

PIM RP-Candidate

You set more than one Candidate BSR that should be connected to network backbone. RP supports the whole / part of IP multicast address. Candidate RP transmits candidate RP advertisement message to BSR.

To set a Multicast Router for a RP Candidate, use the following commands in the global configuration mode.

Table 178 PIM RP-Candidate

| Command | Description |
|---|--|
| ip pim rp-candidate <i>ifname</i> | Sets a Candidate RP operates as the Default value. |
| ip pim rp-candidate <i>ifname</i> priority <0-255> | Sets the Candidate RP with an assigned priority to work. |
| ip pim rp-candidate <i>ifname</i> priority <0-255> interval <1-16383> | Sets the Candidate RP to periodically send out a RP Advertisement message. |
| ip pim rp-candidate <i>ifname</i> priority <0-255> interval <1-16383> group-list <i>access-list</i> | Sets the Candidate RP to periodically send out a RP Advertisement message only to a group with an assigned priority. |

```
Router# configure terminal
Router(config)# ip pim bsr-candidate lo0
Router(config)# ip pim rp-candidate lo0
```

```
Router(config)# exit
Router# show ip pim sparse-mode bsr-router
This system is the Bootstrap Router (BSR)
  BSR address: 172.16.1.222
  Uptime:      00:03:56, BSR Priority: 64, Hash mask length: 10
  Next bootstrap message in 00:00:07
  Role: Candidate BSR
  State: Elected BSR

Candidate RP: 172.16.1.222(Loopback0)
  Advertisement interval 60 seconds
  Next C-RP advertisement in 00:00:36
Router#
Router# show ip pim sparse-mode rp mapping
PIM Group-to-RP Mappings
This system is the Bootstrap Router (v2)
Group(s): 224.0.0.0/4
  RP: 172.16.1.222
    Info source: 172.16.1.222, via bootstrap, priority 192
    Uptime: 00:00:08, expires: 00:02:24
Router#
```

PIM RP-Address

After setting PIM-SM, PIM-RP about the specific multicast group should be set statically or dynamically.

To set Static RP on a Multicast Router, use the following commands in the global configuration mode.

Table 179 PIM RP-Address

| Command | Description |
|--|---------------------------------------|
| ip pim rp-address A.B.C.D [access-list] [override] | Sets Static RP on a Multicast Router. |
| no ip pim rp-address A.B.C.D [access-list] | Disables the Static RP. |

```
Router# configure terminal
Router(config)# ip pim rp-address 172.16.0.1
Router(config)# exit
Router# show ip pim sparse-mode rp mapping
PIM Group-to-RP Mappings
Group(s): 224.0.0.0/4, Static
  RP: 172.16.0.1
    Uptime: 00:00:37
Router#
```

PIM Register-Source

When the system PIM Register from 1st-Hop Router to RP, the system can send to assign IP Source of PIM Register Packet statically.

To set PIM Register-Source, use the following commands in the global configuration mode.

Table 180 PIM Register-Source

| Command | Description |
|---|-----------------------------------|
| ip pim register-source [<i>ifname</i> / <i>A.B.C.D</i>] | Sets PIM Register-Source. |
| no ip pim rp-address <i>A.B.C.D</i> [<i>access-list</i>] | Disables the PIM Register-Source. |

```
Router# configure terminal
Router(config)# ip pim register-source lo0
Router(config)# exit
Router#
```

PIM SSM

If you set PIM SSM, RPT function is limited about group included in group range of set SSM and only SPT function is provided.

To set the Group Range of SSM, use the following commands in the global configuration mode.

Table 181 PIM SSM

| Command | Description |
|--|---|
| ip pim ssm default | Applies Default Group range (232/8) to PIM SSM. |
| ip pim ssm range <i>access-list</i> | Applies the Group Range, assigned on the Access-List, to PIM SSM. |
| no ip pim ssm | Disables the PIM SSM Group range. |

```
Router# configure terminal
Router(config)# ip pim ssm default
Router(config)# access-list 10 permit 224.1.1.0 0.0.0.255
Router(config)# ip pim ssm range 10
Router(config)# exit
Router#
```

Configuring MVLAN Functionality

When MVLAN is set, actually the displaying information of MFDB table is the same with previous display. By MVLAN MFDB, it runs internally and does not change externally.

Making MVLAN

To enable MVLAN, use the following commands in the vlan database.

Table 182 PIM SSM

| Command | Description |
|--|--------------------------------|
| vlan <i>vlanid</i> mvlan | Makes a mvlan id |
| no vlan <i>vlanid</i> | Deletes the generated mvlan id |

```
Router# configure terminal
Router(config)# vlan database
Router(config-vlan)# vlan 300 mvlan
Router# show vlan
```

| VLAN Name | Status | Ports |
|---------------------|---------------|-----------------------|
| 1 default | active | |
| 10 VLAN0010 | active | |
| 20 VLAN0020 | active | |
| 30 VLAN0030 | active | |
| 40 VLAN0040 | active | |
| 50 VLAN0050 | active | |
| 60 VLAN0060 | active | |
| 70 VLAN0070 | active | |
| 80 VLAN0080 | active | |
| 300 VLAN0300 | active | Multicast Vlan |

Enabling MVLAN

To generate an IP interface of a MVLAN ID, use the following commands.

The generated and enabled MLAN interface unifies all outgoing interfaces in the Internal MFWD and saves System Resource.

You can set an IP address as a Local Address. To set MVLAN, use the following commands in the Config Mode.

Table 183 Enable MVLAN

| Command | Description |
|---|---|
| ip mvlan <i>Vlanid A.B.C.D/M</i> | Generates a mvlan interface and enables it |
| no ip mvlan | Deletes the mvlan interface and disables it |

```
Router(config)# ip mvlan 300 182.1.2.3/24
```

MVLAN Status Information

To check the creation and status of activation of MVLAN, use the following commands.

Table 184 MVLAN Status Information

| Command | Description |
|---------|-------------|
|---------|-------------|

| | |
|----------------------|---|
| show ip mvlan | Check configuration and status of mvlan |
|----------------------|---|

Router# **show ip mvlan**
 IP Multicast Mvlan
 Status : Enabled
 Mvlan Id : 300
 Mvlan Vif : 7
 Mvlan IP : 180.1.2.3/24

Display System and Network Statistics

Table 185 Monitoring Commands of IP Multicast Routing

| Command | Description |
|--|--|
| show ip igmp groups | Displays the multicast group that hosts are in. |
| show ip igmp interface | Displays the multicast-related information. |
| show ip igmp rate-limit statistics | Displays the statistics of multicast packet of an interface with the rate-limit. |
| show ip igmp ssm-map | Displays configuration of ssm-map |
| show ip igmp static-group class-map | Displays the status of class-map to assign a static group. |
| show ip mcache | Displays the Routing cache of Multicast. |
| show ip mroute | Displays contents of the Routing table of Multicast. |
| show ip mvif | Displays the information of the Multicast Interface. |
| show ip pim sparse-mode anycast-rp | Displays the information of PIM anycast RP. |
| show ip pim bsr-router | Displays the information of BSR Router. |
| show ip pim sparse-mode interface | Displays the information of an interface with PIM. |
| show ip pim sparse-mode local-members | Displays the information of PIM local membership. |
| show ip pim sparse-mode mroute | Displays contents of the Routing Table of Multicast, managed by PIM. |
| show ip pim neighbor | Displays PIM neighbor. |
| show ip pim rp | Displays information of RP. |
| show ip pim rp-hash | Displays information of RP-HASH. |
| show ip rpf | Displays information of RPF. |
| show ip rpf event | Displays the information of received RPF events. |

Chapter 11. Statistics Monitoring

This chapter describes the monitoring function for the system and statistics of U9016B OLT systems.

- System Status Monitoring
- Interface Statistics
- Logging setting
- RMON (Remote Monitoring)
- Setting threshold value

The Statistics that U9016B system provide help system administrator to grasp the current status of network operation quickly. If you pay attention to statistic data then you will be able to forecast the future operation and prepare to prevent happening possible problem in advance.

Status Monitoring

The Status Monitoring provides information about U9016BA switch. With show and its sub-commands, it provides status information, which will be displayed on your terminal screen.

Table 186 Status Monitoring Command

| Command | Description | Mode |
|--|---|------------|
| show logging | Displays the current snapshot of the log | Privileged |
| show memory usage | Shows the status of the system memory usage | Privileged |
| show cpu usage | Shows the current CPU usage | Privileged |
| show environment [cooling temperature status scu] | Displays status of the system, FAN, and temperature cooling: FAN information temperature: shows the temperature status: shows information of Power, FAN, Temperature scu: the current SCU voltage Information | Privileged |
| show version | Displays the version of the system | Privileged |

System Threshold Configuration

You can set the threshold for the values of system module temperature, CPU and memory usage ratio. The threshold will have either upper limit or lower limit. If the value cross the limit it will induce syslog and SNMP trap.

Temperature Configuration

You can set the upper and lower thresholds of the temperature of the system.

Table 187 Temperature Configuration Command

| Command | Description | Mode |
|--|--|------------|
| temperature threshold <i>HIGHVAL LOWVAL</i> | It will set the threshold value for temperature. If the value cross the limit it will induce syslog and SNMP trap. | Config |
| show environment temperature | It will display current temperature and temperature threshold. In case FAN is available in the system, it also displays the status of FAN. | Privileged |

The example below shows setting a threshold for the temperature of the system.

```
Switch# configure terminal
Switch(config)# temperature threshold 80 20
Switch(config)# exit
Switch# show environment temperature
```

```
Temperature   : 74.2 (°C)
Threshold     : High 80 (°C) Low 20 (°C)
```

CPU Usage Configuration

You can set the threshold for CPU usage ratio. If the value crosses the threshold the system will notify the violation by syslog and SNMP trap.

Table 188 CPU Usage Threshold Command

| Command | Description | Mode |
|---|--|------------|
| cpu usage threshold low <30-100> high <40-100> | It will set the threshold value for CPU usage ratio. If CPU usage ratio will rise above the threshold or go down below the threshold the system will produce syslog. | Config |
| cpu usage time-period (<300> <5> <60>) | It will set the reference value for CPU usage in terms of time. | Config |
| show cpu usage | It shows current CPU usage. | Privileged |

Memory Usage Configuration

You can set the threshold for memory usage. If the remaining memory is lower than the threshold value the system will notify the violation by syslog and SNMP trap.

Table 189 Memory Usage Command

| Command | Description | Mode |
|-----------------------------------|---|------------|
| memory free low-watermark <10-70> | It sets the threshold value for the memory size to be kept. If the remaining memory is lower than the threshold or go up above the threshold again, the system will produce syslog. | Config |
| show memory usage | It shows current memory usage. | Privileged |

Application Memory Usage Display

To show the memory related information which are used by individual applications, use the following command.

Table 190 Memory Display Command

| Command | Description | Mode |
|---|--|------------|
| show memory (bfd bgp imi mstp nsm ospf pimd rip) | It shows the memory related information which are used by individual applications. | Privileged |

Port Statistics

U9016B system provides the statistics for individual ports of the system. To view the statistics, use the following commands.

```
show interface [ifname]
```

U9016B provides information of the port statistics as follows:

- **Received Packet Count (Rx Pkt Count)** – The total number of good packets that have been received by the port.
- **Received Byte Count (Rx Byte Count)** – The total number of bytes that were received by the port, including bad or lost frames. This number includes bytes contained in the Frame Check Sequence (FCS), but excludes bytes in the preamble.
- **Transmit Packet Count (Tx Pkt Count)** – The number of packets that have been successfully transmitted by the port.
- **Transmit Byte Count (Tx Byte Count)** – The total number of data bytes successfully transmitted by the port.
- **Received Broadcast (Rx Bcast)** – The total number of frames received by the port that are addressed to a broadcast address.
- **Received Multicast (Rx Mcast)** – The total number of frames received by the port that are addressed to a multicast address.
- **Transmit Collisions (Tx Coll)** – The total number of collisions seen by the port, regardless of whether a device connected to the port participated in any of the collisions.
- **Received Bad CRC Frames (RX CRC)** – The total number of frames received by the port that were of the correct length, but contained a bad FCS value.
- **Receive Oversize Frames (RX Oversize)** – The total number of good frames received by the ports that were of greater than the supported maximum length of 1,522 bytes.
- **Receive Dropped Frames (Rx Drop)** – The total number of dropped frames due to lack of system resources.

The following shows a display of the port information including statistic data by show interface command.

```
Switch# show interface GigabitEthernet 5/1
```

```
Giga5/1 is up, line protocol is up (connected)
Hardware is Ethernet, address is 0007.709e.2914 (bia 0007.709e.2914)
index 1111 metric 1 mtu 1500 arp ageing timeout 7200
Full-duplex, A-1000Mb/s, media type is 1000BaseLX
<UP,BROADCAST,RUNNING,MULTICAST>
VRF Binding: Not bound
Bandwidth 1g
inet 3.44.1.230/24 broadcast 3.44.1.255
VRRP Master of : VRRP is not configured on this interface.
Last clearing of "show interface" counters never
60 seconds input rate 88 bits/sec, 0 packets/sec
60 seconds output rate 72 bits/sec, 0 packets/sec
L2/L3 in Switched: ucast 30 pkt - mcast 20,532 pkt
L2/L3 out Switched: ucast 36 pkt - mcast 20,871 pkt
20,565 packets input, 1,782,898 bytes
```

Received 3 broadcast pkt (20,532 multicast pkt)
0 CRC, 0 oversized, 0 dropped
20,918 packets output, 1,790,946 bytes
0 collisions
0 late collisions, 0 deferred

Table 191 Commands for Port Statistics Check

| Command | Description | Mode |
|---|---|------------|
| show port counter [detail] | For the items below, it displays the accumulated statistics of all the interfaces. I-Kbps/ O-Kbps InOctets/ OutOctets InPkts/ OutPkts | Privileged |
| show port statistics {all IFNAME} | For the items below, it displays the accumulated statistics of the interface by unit of 5 seconds/1 minute/5 minutes. TX: bits/s, pkts/s RX: bits/s, pkts/s | Privileged |
| show port statistics avg type [IFNAME] | For the items that are classified per traffic types, it displays the accumulated statistics of the interface by unit of 5 seconds/1 minute/5 minutes. TX: Unicast/Multicast/Broadcast s RX: Unicast/Multicast/Broadcast | Privileged |
| show port statistics interface [IFNAME] | For the items below, it displays the statistics of the interfaces. InOctets/ OutOctets InUcastPkts/ OutUcastPkts InMcastPkts/ OutMcastPkts InBcastPkts/ OutBcastPkts IfInDiscards IfInErrors | Privileged |
| show port-mib IFNAME | It displays current statistics and the accumulated statistics of the interface in detail. | Privileged |
| show interface counters | For the items below, it displays the accumulated statistics of the interface. InOctets/ OutOctets InUcastPkts/ OutUcastPkts InMcastPkts/ OutMcastPkts InBcastPkts/ OutBcastPkts | Privileged |
| show interface counters errors | It displays the accumulated errors of the interface. | Privileged |

The following is the displayed content brought by 'show interface counter' command, which shows the accumulated statistics of all the ports.

Router#show interface counters

| | | | | |
|-------|----------|-------------|-------------|-------------|
| Port | InOctets | InUcastPkts | InMcastPkts | InBcastPkts |
| ----- | ----- | ----- | ----- | ----- |

| | | | | |
|-------|-------|---|----|---|
| Gi5/1 | 0 | 0 | 0 | 0 |
| Gi5/2 | 0 | 0 | 0 | 0 |
| Gi5/3 | 0 | 0 | 0 | 0 |
| Gi5/4 | 0 | 0 | 0 | 0 |
| Gi5/5 | 0 | 0 | 0 | 0 |
| Gi5/6 | 0 | 0 | 0 | 0 |
| Gi5/7 | 2,560 | 0 | 20 | 0 |
| Gi5/8 | 2,560 | 0 | 20 | 0 |

| Port | OutOctets | OutUcastPkts | OutMcastPkts | OutBcastPkts |
|-------|-----------|--------------|--------------|--------------|
| Gi5/1 | 0 | 0 | 0 | 0 |
| Gi5/2 | 0 | 0 | 0 | 0 |
| Gi5/3 | 0 | 0 | 0 | 0 |
| Gi5/4 | 0 | 0 | 0 | 0 |
| Gi5/5 | 37,466 | 0 | 305 | 0 |
| Gi5/6 | 37,220 | 0 | 303 | 0 |
| Gi5/7 | 36,974 | 0 | 301 | 0 |
| Gi5/8 | 36,605 | 0 | 298 | 0 |

Router#

The following is the displayed content brought by '**show port statistics**' command, which shows the accumulated statistics of a port in the unit of 5 seconds/1 minute/5 minutes..

Router#show port statistics gi5/5

Last clearing of counters 00:14:24

| Port | bits/s | TX pkts/s | bits/s | RX pkts/s |
|--------|--------|---------------|--------|--------------|
| Gi5/5 | | | | |
| 5 sec. | 392 | 0 | 0 | 0 |
| 1 min. | 488 | 0 | 0 | 0 |
| 5 min. | 488 | 0 | 0 | 0 |

The statistic of any interface has the average value and accumulated value. By use of the following commands, you can change the interval time to which the system refer, when it calculates the average value. Also by setting High and Low threshold values toward any interface you can monitor it whether it works out fine or not for certain duration of time.

Table 192 Commands for Port Statistics Configuration

| Command | Description | Mode |
|-------------------------------|---|-----------|
| load-interval <i>interval</i> | It sets the interval value - the system updates the average statistics of the interface for the | interface |

| | | |
|---|--|-----------|
| | period of the interval. | |
| no load-interval | It returns the interval value to default one. | interface |
| input-load-monitor <i>interval</i> <i>low-threshold high-threshold</i> | It sets High and Low threshold values which will be effective for the period of interval so that you can monitor whether it crosses the threshold. | interface |
| no input-load-monitor | It clears the monitoring setting. | interface |
| show port input-load-monitor | It shows the current monitoring setting. | interface |

You can use the following commands to initialize the accumulated statistic values.

Table 193 Command for Initialization of Port Statistic

| Command | Description | Mode |
|------------------------------|--|------------|
| clear counters | It initializes the accumulated statistic values of all the interfaces. | privileged |
| clear counters <i>IFNAME</i> | It initializes the accumulated statistic value of the specified interface. | privileged |



Notice For the statistics which are displayed toward SNMP, you cannot initialize them by using of **clear counter** command.

RMON (Remote MONitoring)

Using the Remote Monitoring (RMON) capabilities of U9016B allows network administrators to improve system efficiency and reduce the load on the network.

The following sections explain more about RMON and the features that U9016B switch supports.

RMON Overview

RMON is international standard defined by the Internet Engineering Task Force (IETF) documents RFC 1271 and RFC 1757, which allows remote LAN monitoring.

A typical RMON setup consists of the following two components:

RMON probe

- An intelligent, remotely controlled device or software agent that keeps collecting statistics about a LAN segment or VLAN.
- The probe transfers the information to a management workstation on request, or when a predefined threshold is crossed.

RMON Manager

- Communicates with the RMON probe and collects the statistics from it.
- The workstation does not have to be on the same network as the probe, and can manage the probe by in-band or out-of-band connections.

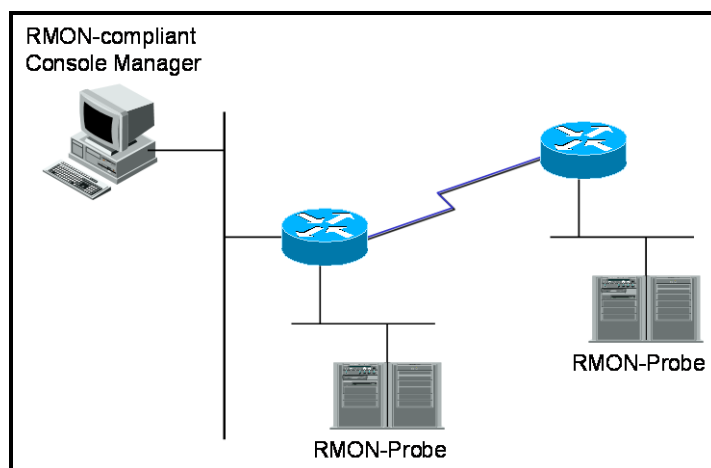


Figure 34. RMON Manager and RMON Probe

While the existing SNMP MIBs manage only gears with SNMP agent, RMON MIBs can extend the management object to the LAN segment where the device is connected. RMON agent informs the status of the entire traffic of LAN segment, each host connected to each segment, and the traffic status between hosts.

RMON agent must have the entire statistic data, history data, host-related data, host matrix and as well as the alarming function that warns when the threshold, which is set to predict and remove certain packets for filtering, is reached.

U9016B switch supports only statistics, history, alarm, and event groups among the nine RMON groups, as defined in <Table 8 >. All the RMON functions are set as disabled by default

Table 194 RMON Items

| Item | Description |
|--------------------|---|
| Statistics | Provide statistic information of the number of packets/bytes generated in one segment, the broadcast/multicast count, the conflict count, packet count by length, and errors (fragment, CRC Alignment, jabber, insufficient length, excessive length) |
| History | Provide the information on the traffic and errors generated during the time span that the operation manager has set. Setting short-term/long-term time span and the interval is limited to 1-3.600 seconds. Display of the usage by time and comparing the data with other segment data. |
| Alarm | Check a particular value regularly and report to the manager when the value reaches the standard and the agent has its record. Setting an absolute or relative value as the standard. An alarm occurs only when the value goes over or down the upper limit/the lowest limit in order to prevent continuous alarms. |
| Host | Manages the traffic of each device connected to the segment, and the error count by hosts. |
| N high level hosts | Find the host that generates the most traffic during a certain period among the hosts found in the above host table. The manager can get information by setting the data type, the interval, and the number of hosts that he/she wants. |
| Traffic matrix | Collect the information on the traffic and errors generated between two hosts based on data link layer, that is, MAC address. With this information, you can see who uses a certain host most often. If a host in other segment users the host the most, you cannot find the actual user because the user uses the host through the router. |
| Filter | Used by the manager to monitor the trend of a particular packet. |
| Packet collection | The manager collects and analyzes the packets generated in the segment. |
| Event | When a certain event occurs, this item saves the log and sends a warning message to the manager. The trap generation and the logging storage are optional. |

RMON Alarm and Event Group Configuration

The user can set RMON configuration through CLI or SNMP manager.

Table 195 Commands for RMON Alarm and Event Configuration

| Command | Description | Mode |
|---|---|------------|
| <code>rmon alarm <i>index</i></code> <code><i>variable</i> interval</code> <code><i>seconds</i></code> <code>{absolute delta}</code> <code>rising-threshold <i>value</i></code> <code>event <i>num</i></code> <code>falling-threshold <i>value</i></code> <code>event <i>num</i></code> <code>[owner <i>string</i>]</code> | <p>Adds a RMON alarm to RMON alarm table</p> <p><i>Index</i>: Alarm index</p> <p><i>Variable</i>: As the target of Alarm, any SNMP mib instance is specified</p> <p>Interval: Sampling time period (Unit: second).</p> <p>Absolute: Indicates the sampled alarm value to be set and monitored as absolute value.</p> <p>Delta: Indicates the sampled alarm value to be monitored in terms of the difference between current and previous values.</p> <p>Rising-threshold, falling-threshold <i>value</i>: The configured value which is used as the reference while the system generates alarm.</p> <p>event: Indicates the specified event to be invoked when the sampled alarm value reaches either rising-threshold or falling -threshold.</p> <p>owner: Registers the owner of the Alarm.</p> | Config |
| <code>rmon event <i>index</i></code> <code>[log]</code> <code>[trap <i>community</i>]</code> <code>[description <i>string</i>]</code> <code>[owner <i>string</i>]</code> | <p>Adds an event to RMON event table</p> <p><i>Index</i>: Event index.</p> <p>log: Sets the system to produce log when an Event happens.</p> <p>trap: Sets the system to transfer trap along with community when an Event happens.</p> <p>owner: Registers the owner of the Event.</p> <p>description: Registers the description about the Event.</p> | Config |
| <code>no rmon alarm <i>alarm-index</i></code> | Clears the setting of RMON alarm. | Config |
| <code>no rmon event <i>event-index</i></code> | Clears the setting of RMON event. | Config |
| <code>show rmon alarms</code> | Prints out RMON alarm information. | Privileged |
| <code>show rmon events</code> | Prints out RMON event information. | Privileged |

The following example demonstrates how to set rmon alarm with respect to GigabitEthernet 2/2. It shows that system will do sampling the inOctets value of GigabitEthernet 2/2 every 30 seconds and generate event whenever the value goes beyond the rising-threshold or under falling-threshold. When you set Rmon alarm you must set event or stats first.

Switch# configure terminal

```
Switch(config)# rmon event 1 log trap rmon_test description RisingAlarm
```

```
Switch(config)# rmon event 2 log trap rmon_test description FallingAlarm
```

```
Switch(config)# interface GigabitEthernet 2/2
```

```
Switch(config-if-Giga2/2)# rmon collection stats 1
```

```
Switch(config)# rmon alarm 1 etherStatsEntry.4.1158 interval 30 absolute rising-  
threshold 2000000 event 1 falling-threshold 1000000 event 2
```

```
Switch(config)# exit
```

```
Switch# show rmon alarm
```

```

Alarm 1 is active, owned by RMON_SNMP
Monitors etherStatsOctets.1158 every 30 second(s)
Taking Absolute samples, last value was 00
Rising threshold is 2000000, assigned to event 1
Falling threshold is 1000000, assigned to event 2
On startup enable rising or falling alarm alarmRisingThreshold : 15
alarmFallingThreshold : 0
alarmRisingEventIndex : 1
alarmFallingEventIndex : 1
alarmOwner : hong
Switch# show rmon event
event Index = 1
    Description RisingAlarm
    Event type Log & Trap
    Event community name rmon_test
    Last Time Sent = 5774:38:20
    Owner RMON_SNMP

event Index = 2
    Description FallingAlarm
    Event type Log & Trap
    Event community name rmon_test
    Last Time Sent = 00:00:00
    Owner RMON_SNMP
Switch# show rmon statistics
Collection 1 on Giga2/2 is active, and owned by RMON_SNMP,
Monitors ifEntry.1.1158 which has
Received 014354459 octets, 0195285 packets,
    03 broadcast and 021164 multicast packets,
    00 undersized and 00 oversized packets,
    00 fragments and 00 jabbers,
    00 CRC alignment errors and 00 collisions.
# of dropped packet events (due to lack of resources): 00
# of packets received of length (in octets):
64: 01585, 65-127: 0440336, 128-255: 0308
256-511: 04, 512-1023: 00, 1024-1518: 00

```

Table 196 Commands for RMON History Setting and Statistics

| Command | Description | Mode |
|---|--|-----------|
| rmon collection stats <i>index</i> [owner <i>string</i>] | Collects the statistics of physical interface. <i>Index:</i> etherStats index | Interface |
| rmon collection history <i>index</i> [buckets <i>number</i>] [interval <i>seconds</i>] [owner <i>string</i>] | Collects the history of physical interface. <i>Index:</i> History index, buckets: The number of history, Interval: Collection period (Unit: second) owner: Registers the owner of the History. | Interface |

| | | |
|--|---|------------|
| no rmon collection stats <i>index</i> | Clears the setting so as not to collect the statistics of physical interface. | Interface |
| no rmon collection history <i>index</i> | Clears the setting so as not to collect the history of physical interface. | Interface |
| show rmon history | Prints out RMON history information. | Privileged |
| show rmon statistics | Prints out RMON statistics information. | Privileged |
| rmon clear counters | Initializes the statistics of the interface. | Interface |

The following example shows how to set RMON with using maximum 30 numbers bucket per 10 seconds to gi 2/2

```
Switch# configure terminal
Switch(config)# interface GigabitEthernet 2/2
Switch(config-if-Giga2/2)# rmon collection stats 1
Switch(config-if-Giga2/2)# rmon collection history 1 buckets 30 interval 10
Switch(config-if-Giga2/2)# exit
Switch(config)#exit
Switch# show rmon history
Entry 1 is active, and owned by RMON_SNMP
Monitors ifIndex 1158 every 10 second(s)
Requested # of time intervals, ie buckets, is 30,
Sample # 1 began measuring    Received 14953616 octets, 203700 packets,
    3 broadcast and 21362 multicast packets,
    0 undersized and 0 oversized packets,
    0 fragments and 0 jabbers,
    0 CRC alignment errors and 0 collisions.
    # of dropped packet events is 0
Sample # 2 began measuring    Received 14956451 octets, 203740 packets,
    3 broadcast and 21363 multicast packets,
    0 undersized and 0 oversized packets,
    0 fragments and 0 jabbers,
    0 CRC alignment errors and 0 collisions.
    # of dropped packet events is 0
Sample # 3 began measuring    Received 14959509 octets, 203783 packets,
    3 broadcast and 21364 multicast packets,
    0 undersized and 0 oversized packets,
    0 fragments and 0 jabbers,
    0 CRC alignment errors and 0 collisions.
    # of dropped packet events is 0
```

Logging

U9016B switch log shows all information on configuration and alarm. The system message logging software saves log messages in the switch memory and sends messages to other devices. The system message logging function supports the followings.

- Enables the user to select the logging type to collect.
- Enables the user to select the device to which he/she sends the collected logging.

U9016B switch saves and sends debug-level logs in the internal buffer and the system console by default. The user can control system messages by using CLI. The switch saves up to 500 log messages in the system memory. The system administrator can monitor the system messages from local through console or from remote through Telnet or syslog server log.

U9016B switch has 0-7 severity levels as shown in the following table.

Table 197 U9016B Switch Log Level

| Severity Level | Description |
|-------------------|---|
| Emergencies (0) | System is not available. |
| Alerts (1) | An Immediate action is required. |
| Critical (2) | Critical Status |
| Errors (3) | Error Message |
| Warnings (4) | Warning Message |
| Notifications (5) | Normal status but important information |
| Informational (6) | Informational message given to user |
| Debugging (7) | Debugging message |

System Log Message Context

The system log messages of U9016B switch contains the following information.

Timestamp

- The timestamp records the month, day and year of the event, along with the time (hours, minutes, and seconds) in the form HH:MM:SS MM/DD/YYYY.

Severity level

- Indicates the log message level defined in the < > as in Table 12.
- Integer between 1 and 7

Log description

- Text string including detailed information on event

The following is the log message for system booting

```
May  6 11:53:48 [5] %REMOTE-CONNECT: login from console as lns
May  6 11:54:01 [5] IFM-NOTICE: Rate limit ra creation
May  7 02:10:24 [5] %REMOTE-CONNECT: login from console as lns
May  7 02:10:40 [5] IFM-NOTICE: Flow xx classified
```

```
May 7 02:10:48 [5] IFM-NOTICE: Flow xx match rate 10
May 7 05:17:56 [5] %REMOTE-CONNECT: login from console as lns
May 7 05:23:10 [5] IFM-NOTICE: Service pa add interface fa1
```

Default Logging Value

Table 198 System Log Default

| Configuration Parameter | Default |
|-----------------------------------|-----------------|
| Display logging to console | disabled |
| Display logging to Telnet session | disabled |
| Logging buffer size | 1MB |
| Display Time-Stamp | enabled |
| Logging Server | disabled |
| Syslog server IP address | None configured |
| Server facility | LOCAL7 |
| Server severity | Warnings (4) |
| Console Severity | Debuggings (7) |
| Telnet Severity | info (6) |

Table 199 Commands for System Message Logging Configuration

| Command | Description |
|---|---|
| logging console {<0-7> /alerts/critical/debugging/emergencies/errors/ informations/notifications/warnings} | Sets to print out the logging information toward console. |
| logging facility {auth cron daemon kernel local0/ local1 local2 local3 local4 local5/ local6 local7 lpr mail news syslog/ user uucp} | Sets the Facility parameter to which syslog messages are to be sent.. |
| logging A.B.C.D | Sets to send syslog messages toward external syslog server. |
| logging monitor /alerts/critical/debugging/emergencies/errors/ informations/notifications/warnings} | Sets to print out the logging information toward current session. |
| logging source-ip A.B.C.D | Sets the source ip of syslog packet. |
| logging trap /alerts/critical/debugging/emergencies/errors/ informations/notifications/warnings} | Sets the logging level of syslog server. |
| show logging | Prints out logging buffer and its settings. |

Examples of Logging Configuration

While accessing to Console if you want to have the log message with Log level notice(5) or below printed toward console, set as the following example demonstrates. When you want to stop printing the log message toward console, use “no logging console” command.

```
Switch# configure terminal
Switch(config)# logging console notifications
Switch(config)# end
Switch#
Switch# configure terminal
Switch(config)# no logging console
Switch(config)#
Switch#
Switch# configure terminal
Switch(config)# logging monitor warnings
Switch(config)# end
Switch#
Switch# configure terminal
Switch(config)# no logging session
Switch(config)#
```

While accessing via Telnet if you want to have the log message with Log level warn(4) or below printed toward telnet session, set as the following example demonstrates. When you want to stop printing the log message toward Telnet session, use “logging session disable” command.

```
Switch#
Switch# configure terminal
Switch(config)# logging monitor warnings
Switch(config)# end
Switch#
Switch# configure terminal
Switch(config)# no logging session
Switch(config)#
```

If you want to have the log message with Log level err(5) or below printed toward Log server 100.10.1.1, set as the following example demonstrates. When you want to stop printing the toward log server, use “no logging A.B.C.D” command. log message.

```
Switch# configure terminal
Switch(config)# logging 100.10.1.1
Switch(config)# logging trap errors
Switch(config)# end
Switch#
Switch# configure terminal
Switch(config)# no logging 100.10.1.1
Switch(config)#
```


sFlow

Ubiquoss U9016B supports sFlow in order to monitor the Traffic flow and collect statistics of individual interface. The objects scope of interface that sFlow takes care confine to physical port in Ubiquoss U9016B. sFlow consists of sFlow agent and sFlow collector; sFlow agent collects the status and statistics information of its switch or router while sFlow collector sorts out the collected information and reports to administrator. The following figure shows the basic operation of sFlow.

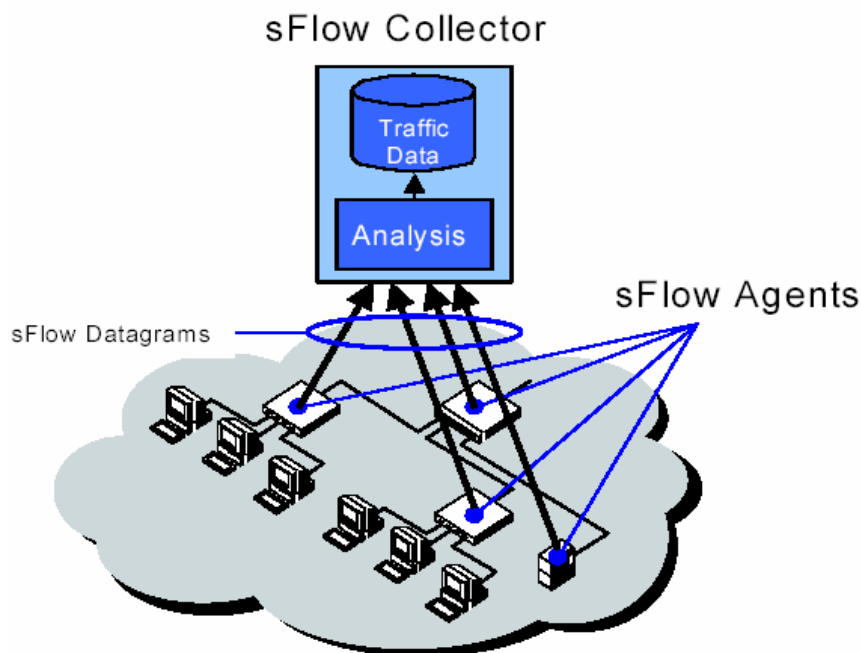


Figure35 Key Map of sFlow (sFlow agent and collector)

sFlow Agent

This section introduces the function and commands for sFlow agent. They have the command for setting IP address of agent and collector, flow sampling rate, counter(statistics) polling interval, sflow forward, and service sflow. The Agent IP is to be inserted into the sampling packet when sFlow agent sends out the sampling packet to sFlow collector, and sFlow collector must specify the Agent IP which is inserted to the sampling packet. sFlow is classified into two categories; one is Flow sampling which is packet based and the other is counter(statistics) sampling which is time based. Flow sampling rate determines the number of packets which come through the interface before system does sampling whereas counter polling interval determines the period in terms of seconds as to when the system does sampling the Interface statistics. By use of 'sflow forward' command, you can configure the physical interface (ex, gi1) for sampling upto maximum 4 interfaces. With 'service sflow' command you can initiate sflow service.

Table 200 sFlow Command

| Command | Description | Mode |
|--|---|---------------------|
| show sflow | Shows the commands that you can use to set sflow. | Privileged |
| service sflow | Makes the system start flow sampling and statistics sampling for the enabled interface. When you want to clear the command, use 'no' preposition. | Config |
| sflow forwarding | Sets to do sampling with respect to the packets which come through the interface. When you want to clear the command, use 'no' preposition. | Interface |
| sflow sample <10-65530> | Sets the sampling rate in terms of the number of packets which come through the interface. When you use 'no' preposition with this command, it sets to Default value. | Interfac, Config |
| sflow polling-interval <20-120> | Sets the sampling rate in terms of seconds. | Config |
| sflow agent A.B.C.D | Sets the ip address of sflow agent. When you use 'no' preposition with this command, it sets to Default value. | Config |
| sflow destination A.B.C.D | Sets the ip address of sflow collector. When you use 'no' preposition with this command, it sets to Default value. | Config |

sFlow Collector

This section describes sFlow collector. It shows statistics values to administrator after analyzing sampling packet. It consists of sflowtool, sFlowTrend, and Inmon Traffic Server. sflowtool and sFlowTrend are open version. You can download from inmon corporation homepage <http://www.inmon.com/index.htm>. The following describes sflowtool and sFlowTrend setting.

sflowtool Configuration

1. You can show sFlow sampling packet in port 6343.with the following command.

```
[Ins:/home/Ins] sflowtool -p 6343
startDatagram =====
datagramSourceIP 192.168.0.212
datagramSize 144
unixSecondsUTC 1136381882
datagramVersion 5
agentSubId 0
agent 192.168.0.212
packetSequenceNo 9512
sysUpTime 190157000
samplesInPacket 1
startSample -----
sampleType_tag 0:2
sampleType COUNTERSSAMPLE
endSample -----
endDatagram =====
```

2. You can show sFlow sampling packet by line unit with the following command.

```
[Ins:/home/Ins] sflowtool -l
CNTR,10.0.0.254,17,6,100000000,0,2147483648,175283006,136405187,2578019,297011,
0,3,0,0,0,0,0
,0,0,1
FLOW,10.0.0.254,0,0,00902773db08,001083265e00,0x0800,0,0,10.0.0.1,10.0.0.254,17,0x
00,64,3569
0,161,0x00,143,125,80
```

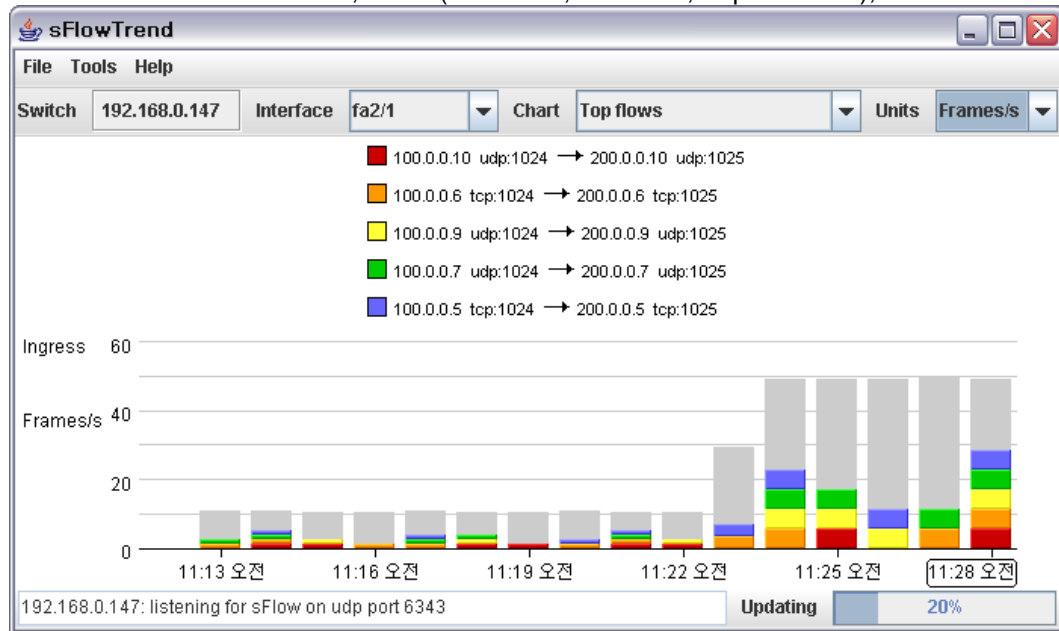
sFlowTrend Configuration

1. After executing sFlowTrend program, click the “Click to select” button at upper-left corner.



2. Type in the IP Address of sFlow Agent at the ‘Select switch/router to monitor’ dialog box.

- Once sFlowTrend has acquired sampling information, select the relevant option within the scroll down menu of Interface, Chart (Utilization, Counters, Top flows . . .), and Units.



sFlow Network Configuriton

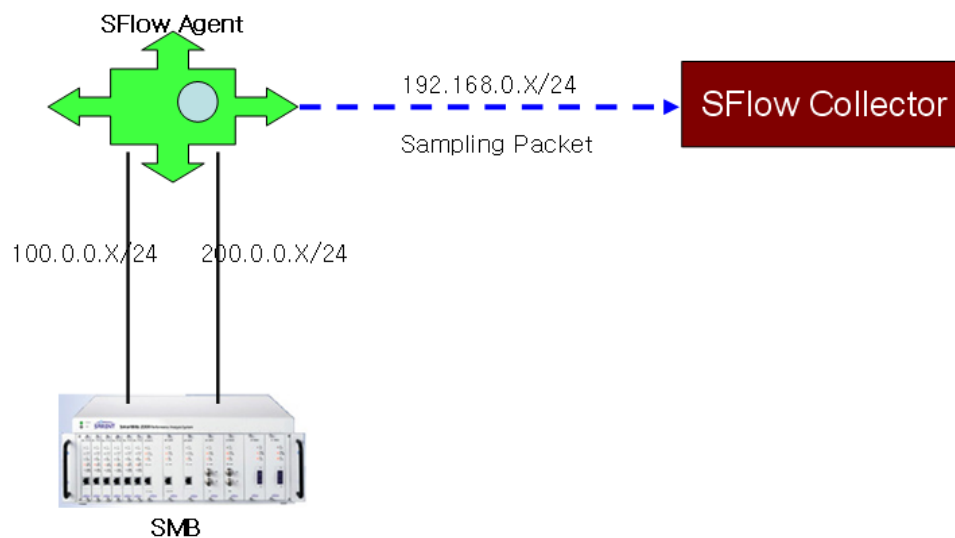


Figure36. sFlow Network Configuration

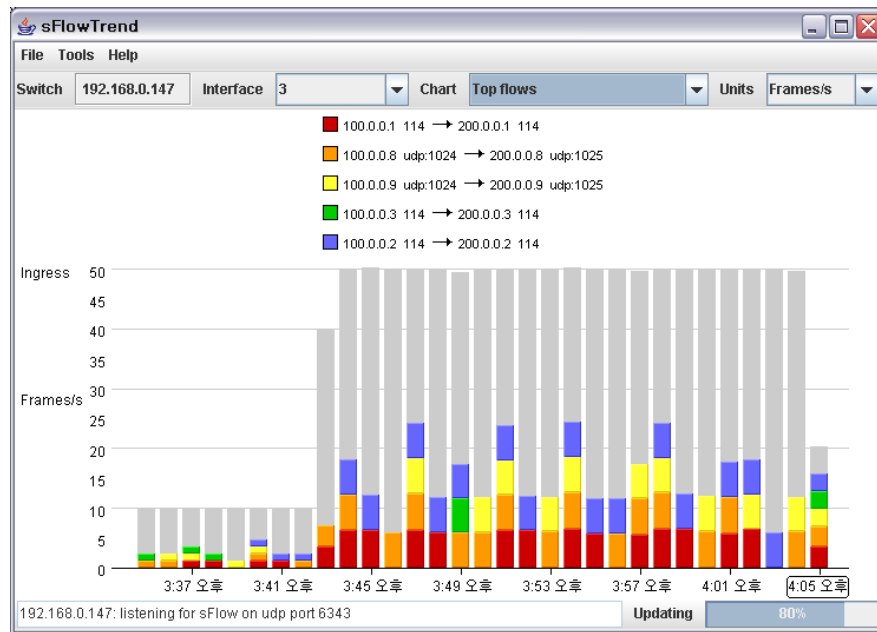
sFlow Sampling Test

sFlow sampling has traffic flow sampling and interface staticstics sampling. You can make sure sampling result via sFlow collector in the above figure.

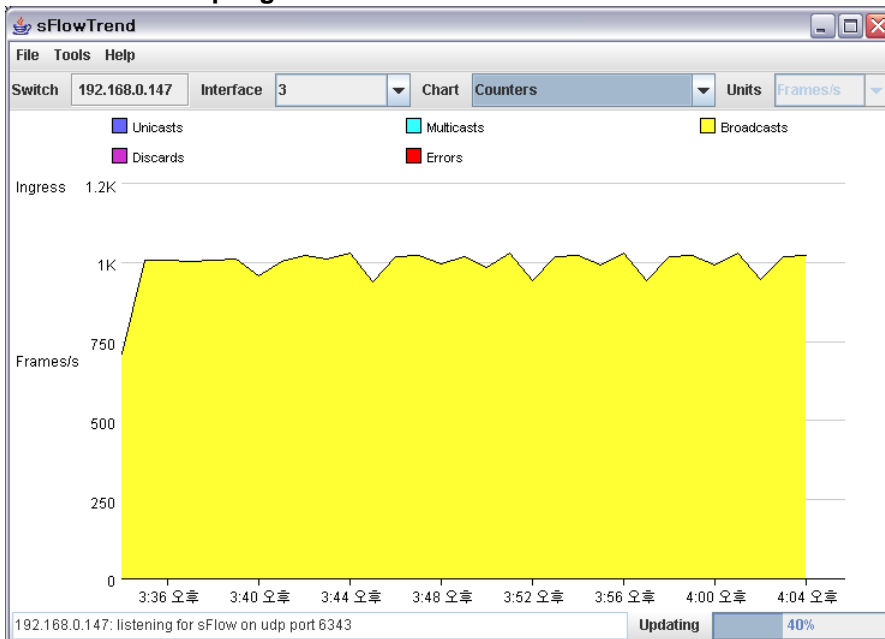
- Make traffic per various flows with using SMB and send to Sflow Agent.
- Do the sampling traffic of port connected with SMB in Sflow Agent.

3. To send this traffic to SFlow collector, set IP Address of SFlow Collector and SFlow Agent.
4. Enable SFlow Service.

```
Switch(config)# interface gi1
Switch(config-if-Giga5/1)# sflow forwarding
Switch(config-if-Giga5/1)# exit
Switch(config)# sflow agent 192.168.0.147
Switch(config)# sflow destination 192.168.0.200
Switch(config)# service sflow
```
5. To use sFlow Collector, make sure Traffic flow sampling and Interface statistics sampling.



Traffic flow sampling



Interface statistics sampling

Chapter 12. STP and SLD

This chapter introduces how to configure the Spanning Tree Protocol (STP) and Rapid Spanning Tree Protocol (RSTP) on the switch. It also explains frame transmission from Bridge.

**Note**

Refer to Command Reference for the complete format and instruction of commands mentioned in this chapter.

This chapter includes the following sections:

- Understanding Spanning-Tree Features
- Understanding RSTP
- Understanding MSTP
- Configuring Spanning-Tree Features
- Displaying the Spanning-Tree Status
- Configuring Bridge Mac Forwarding

Understanding Spanning-Tree Features

This chapter explains the following STP features:

- STP Overview
- Supported Spanning-Tree Instances
- Bridge Protocol Data Units
- Election of the Root Switch
- Bridge ID, Switch Priority, and Extended System ID
- Spanning-Tree Timers
- Creating the Spanning-Tree Topology
- Spanning-Tree Interface State

STP Overview

STP is a Layer 2 link management protocol which prevents self-loops and provides duplicated paths in a network. To let a Layer 2 Ethernet network operate normally, only one active path should be established between two random terminals. As spanning-tree operation is transparent to end stations, it is impossible to determine whether end stations are connected to a single LAN or to a switched LAN composed of several segments.

To configure a fault-free network, there should be no self-loops between nodes of the network. The spanning-tree algorithm calculates an optimized loop-free path over the switched Layer 2 network. The switch periodically sends and receives spanning-tree frames called bridge protocol data units (BPDUs). It does not forward these frames but processes them to create a loop-free path.

A loop is formed where there are several active paths between two end stations. If a loop exists in a network, the affected end stations will receive replicated frames. In such a case, MAC address of a certain end station will be registered for several Layer 2 interfaces in the switch. This situation makes the network unstable.

Spanning tree defines loop-free path from root switch to every switch in a Layer 2 network. Spanning tree makes replicated data paths enter standby (blocked) status. If faults are detected in a network containing replicated path, the spanning-tree algorithm recalculates the spanning-tree topology to enable the standby path.

Where two interfaces of a switch compose a part of loop, the spanning-tree port priority and path cost settings determine forwarding state and blocking state of these interfaces.

Bridge Protocol Data Units

The following shows elements provide stable active spanning-tree topology of a switched network:

- Unique bridgeID related to each VLAN (switch priority and MAC address)
- Spanning-tree path cost to the Root switch
- Port identifier assigned to each Layer 2 interface (port priority and port number)

When powered on, the switch acts as a root switch. Each switch sends the configuration BPDUs to all of its own ports. Switches exchange BPDUs each other to calculate a spanning-tree topology. Each configuration BPDU contains the following information:

- BridgeID of the Root switch
- Spanning-tree path cost to the Root
- Switch BridgeID transmitting BPDU
- Message age
- Switch interface identifier transmitting BPDU

- hello, forward-delay, max-age protocol timer value

When the switch receives a BPDU carrying information superior to that of the current port (lower BridgeID, lower path cost, etc.), it stores the information in the port that has received the BPDU. If the port is a root port, the switch updates the message and forwards it to the designated LAN.

The switch drops a BPDU containing information inferior to that of the current port. When the switch receives an inferior message from the designated LAN, it transfers the BPDU updated with the information stored in the port to LAN. In this way, inferior information is dropped and superior information is forwarded to the network.

The following shows the result from BPDU exchange:

- A switch is chosen as Root switch.
- Root port of each switch, except Root switch, is chosen. This port provides the best path (the lowest cost) for the switch to transmit packets to the Root switch.
- Designated switch for each LAN should be decided. The designated switch transmits the packet by the lowest path in which provides in the lowest cost.
- Designated switch, port or the designated switch connected to LAN, for each LAN is decided and provides the lowest path cost when LAN transmits packet to the root switch.
- Root ports and designated ports are configured in forwarding state.
- All interfaces not in the Spanning-tree are blocked.

Election of Root Switch

All switches with Spanning-tree gather information of other switches as exchanging BPDU, and the following shows results from message exchange:

- Only root switch first-out for each spanning-tree instance
- Designated switch first-out for all switched LAN segmentation
- Remove switched network loop by the block of L2 interface connected with redundant link

A switch with the highest priority(with the smallest value) in each VLAN is determined as the root switch. In case all switches are set to the default priority(32768), the switch with the smallest MAC address in the VLAN will be a root switch. Switch priority is carried by the most significant bit of BridgeID.

You can change the possibility of a switch to be a root switch by changing its switch priority. A larger switch priority has a lower probability to be a root switch.

Root switch is at the logical center of a spanning-tree topology in a switched network. Those paths unnecessary for reaching the root switch in a switched network go into blocking state in the spanning-tree.

A BPDU contains the information such as source switch and port, MAC address, switch priority, port priority and path cost. Spanning tree determines root switch, root port and designated port from the information.

Bridge ID, Switch Priority, and Extended System ID

In accordance with the IEEE 802.1D standard, each switch is assigned a unique bridge identifier (BridgeID) to select a root switch. Since each VLAN is logically regarded as an individual bridge, a unique BridgeID is assigned for each VLAN. A switch carries BridgeID of 8 bytes; the most significant 2 bytes are used for switch priority and the rest 6 bytes indicate MAC addresses of the switch. U9264H Series switch supports 802.1T spanning-tree extensions. As seen in the table, the two bytes used for switch priority are reallocated to 4-bit priority and 12-bit extended system ID identical to the VLAN ID.

Table 201 Switch Priority Value and Extended System ID

| Switch Priority Value | | | | Extended System ID(Set Equal to the VLAN ID) | | | | | | | | | | | |
|-----------------------|-------|-------|-------|--|-------|-------|------|------|------|------|------|------|------|------|------|
| Bit16 | Bit15 | Bit14 | Bit13 | Bit12 | Bit11 | Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 |
| 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Spanning tree creates BridgeID with extended system ID, switch priority and MAC address.

Spanning-Tree Timers

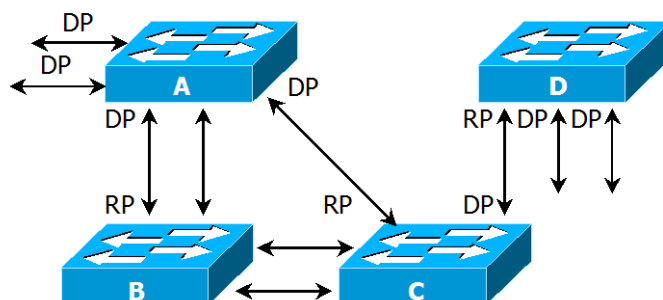
The following shows Spanning-tree timers that affect the spanning tree performance.

Table 202 Spanning-Tree Timers

| Variable | Description |
|---------------------|---|
| Hello timer | Decides the interval that the switch transmits Hello message to other switches |
| Forward-delay timer | Decides how long the interface is in listening and learning state before forwarding |
| Maximum-age timer | Decides the amount of time the switch stores received protocol information |

Creating the Spanning-Tree Topology

Assuming that switch priority of all switches in the figure is default (32768) and Switch A carries the lowest MAC address, Switch A becomes a root switch. However, Switch A is not an ideal root switch on account of the number of forwarding interfaces or link-type. It is possible to recalculate the spanning-tree topology to let an ideal switch elected as a root switch by increasing its switch priority (using a smaller value).



RP = Root Port
DP = Designated Port

Figure 37. Spanning-Tree Topology

When a spanning-tree topology is calculated based on the default settings, the path between a source terminal and a destination terminal would not be an ideal one. For instance, a high-speed link connected to an interface with a port number higher than that of the root port may result in changing the root port of the switch. The goal is to elect the fastest link as a root port.

For example, assume that a port of Switch B is a gigabit Ethernet link and another port (10/100 link) of Switch B is currently a root port. It is more efficient to transfer network traffic through the gigabit Ethernet link. It is possible to elect the gigabit Ethernet interface as a new root port by changing the port priority of the gigabit Ethernet interface to a priority (lower value) higher than the root port.

Spanning-Tree Interface States

Propagation delay occurs when protocol information is transferred through a switched LAN, resulting in changes in switched LAN configuration in a different place at a different time. A transient data loop may be formed if a Layer 2 interface not participating in the spanning-tree immediately goes into forwarding state. Therefore, prior to forwarding the frames, the switch should wait for new configuration information transferred through the switched LAN.

The following shows the states of each Layer 2 interface of the switch enabling Spanning tree:

- Blocking – The interface does not forward any frames.
- Listening – The state succeeding the blocking state when the interface decides to forward frames.
- Learning – The interface is ready to forward frames. MAC learning is carried out in this state.
- Forwarding – The interface forwards frames.
- Disabled – The interface does not participate in the spanning tree because the port is shutdown state, or no link is available for the port, or there is no spanning-tree instance under execution.

An interface can change its state as follows:

- From initial state to blocking state
- From blocking state to listening or disabled state
- From listening state to learning or disabled state
- From learning state to forwarding or disabled state
- From forwarding state to disabled state

The figure below shows state transition of an interface.

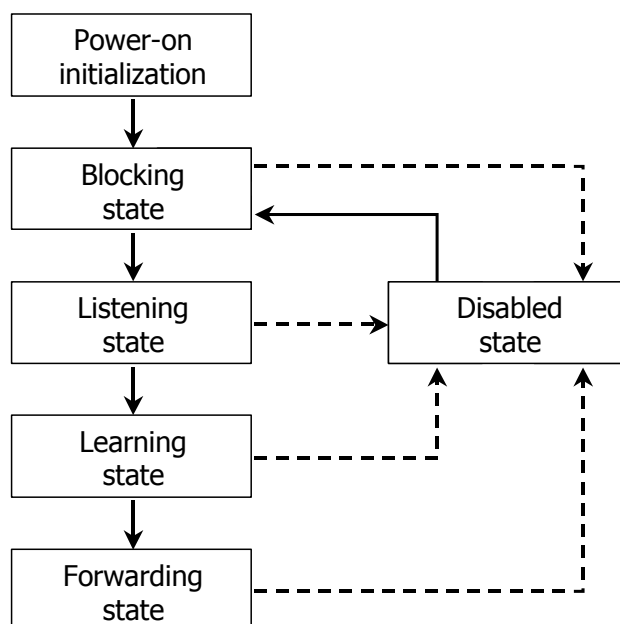


Figure 38. Spanning-Tree Interface States

When STP is enabled, all interfaces of the switch are in blocking state and then go into listening and learning state for a while. In a stabilized spanning tree, each interface is in forwarding state or blocking state.

If the spanning-tree algorithm decides to set a Layer 2 interface to forwarding state, the following process occurs:

6. Receiving the protocol information to set the interface to forwarding state, the interface goes into listening state.
7. Upon forward-delay time out, the spanning tree lets the interface go into learning state and sets the forward-delay timer again.
8. In learning state, the interface blocks forwarding while learning MAC address of the end station.
9. When the forward-delay timer expires, the spanning tree lets the interface enter forwarding state in which both learning and forwarding are permitted.

| Item | Description |
|------------------------|---|
| Blocking State | <p>A Layer 2 interface in blocking state does not forward frames. The switch transfers BPDUs to each interface after initialization. The switch acts as a root switch until it exchanges BPDUs with other switches. One switch of the network is elected as root switch through BPDU exchange. If only one switch is included in the network, BPDU exchange between switches does not occur and the interface goes into listening state after forward-delay timer out. The interface is always set to blocking state after switch initialization.</p> <p>An interface acts as following in blocking state:</p> <ul style="list-style-type: none"> • Drops the frames received through the port • Drops the frames switched from other interfaces • Does not perform address learning • Receives BPDUs |
| Listening State | Listening state comes after the blocking state. If an interface decides to forward the frames, it goes into listening state. |

| | |
|-------------------------|---|
| | <p>An interface acts as following in listening state:</p> <ul style="list-style-type: none"> • Drops the frames received through the port • Drops the frames switched from other interfaces • Does not perform address learning • Receives BPDUs |
| Learning State | <p>In learning state, a Layer 2 interface is ready to forward frames. The interface goes from listening state to learning state.</p> <p>In learning state, an interface acts as follows:</p> <ul style="list-style-type: none"> • Drops the frames received through the port • Drops the frames switched from other interfaces • Performs address learning • Receives BPDUs |
| Forwarding State | <p>In forwarding state, a Layer 2 interface forwards frames. The interface goes from learning state to forwarding state.</p> <p>In forwarding state, an interface acts as follows:</p> <ul style="list-style-type: none"> • Forwards the frames received through the port • Forwards the frames switched from other interfaces • Performs address learning • Receives BPDUs |
| Disable State | <p>In disabled state, a Layer 2 interface does not participate in frame forwarding or spanning tree.</p> <p>A disabled interface acts as follows:</p> <ul style="list-style-type: none"> • Drops the frames received through the port • Drops the frames switched from other interfaces • Does not perform address learning • Does not receive BPDUs |

Understanding RSTP

RSTP supports rapid convergence of spanning tree for point-to-point connection, which takes less than 1 second (In contrast, 802.1D spanning tree takes 50 seconds maximum by default.). This feature is efficient for a network which transmits traffic sensitive to delay such as voice and image.

This section explains the following operations of RSTP:

- RSTP Overview
- Port Roles and the Active Topology
- Rapid Convergence
- Bridge Protocol Data Unit Format and Processing

RSTP Overview

The operation of RSTP provides rapid recovery (in less than 1 second) of connectivity in case of failure of a switch, switch port, or a LAN. A new root port can transit rapidly to the forwarding port state, and the use of explicit acknowledgements between the switches allows the designated ports to transit rapidly to the forwarding port state.

Port Roles and the Active Topology

RSTP provides fast recovery of spanning tree by assigning port roles to determine an active topology. Like STP, RSTP selects a switch with the highest switch priority (the smallest priority value) as the root switch.

RSTP assigns one of following port roles to each port:

- Root port – It provides the best path (the lowest cost) when the switch forwards packet to the root switch.
- Designated port – Designated port – It connects to the designated switch and provides the lowest cost when LAN forwards packet to the root switch. The designated switch port connected to LAN is called the designated port.
- Alternate port – It provides an alternative path to the root switch by current root port.
- Backup port – It act as a backup port for the path to the leaves of the spanning tree. Backup port exists when two ports are connected together in a loopback by a point-to-point link or if there are two or more connection to the designated VLAN.
- Disabled port – It has no role for spanning tree operation.

A port with the root or designated port role is included in the active topology. A port with alternate or backup port role is excluded from the active topology.

RSTP guarantees that root port and designated port transit to forwarding state when whole network has the consistent port role. But all alternate port and backup port are always in discarding state (equivalent to blocking state). The following table compares 802.1D and RSTP port state.

Table 203 Port State Comparison

| Operational Status | STP Port State | RSTP Port State | Is Port Included in the Active Topology? |
|--------------------|----------------|-----------------|--|
| Enabled | Blocking | Discarding | No |
| Enabled | Listening | Discarding | No |
| Enabled | Learning | Learning | Yes |
| Enabled | Forwarding | Forwarding | Yes |
| Disabled | Disabled | Discarding | No |

For consistency with STP implementation, this document uses blocking state instead of discarding state. The designated port is initiated in listening state.

Rapid Convergence

RSTP provides rapid convergence for the failure of switch, port, or LAN. It also provides rapid recovery for edge port, new root port, and ports linked by point-to-point.

- Edge ports – If a port is configured as an edge port in RSTP switch by using the spanning-tree admin-edge-port command, edge port immediately transits to forwarding state. Edge port should set in the port connected to one end station.
- Root ports – If the RSTP selects a new root port, the old root port is blocked and new root port is to be forwarding state.
- Point-to-point links – When a port is connected to another port through point-to-point link, the local port becomes a designated port and negotiates fast transition to remove loops by exchanging proposal-agreement with other ports.

In the figure below, Switch A is connected to Switch B through point-to-point link and all ports are in blocking state. Assume that the priority value of Switch A is smaller than that of Switch B. Switch A transmits a proposal message (BPDU with proposal flag enabled) to Switch B and proposes itself as a designated switch.

Receiving the proposal message, Switch B selects the port that has received the proposal message as a new root port, sets all non-edge ports to blocking state, and sends an agreement message (BPDU with agreement flag enabled) through the new root port.

Receiving the agreement message of Switch B, Switch A changes the designated port to forwarding state. No loop is formed in the network because Switch B has blocked all nonedge ports and Switch A is connected to Switch B through point-to-point link.

A similar negotiation message is exchanged when Switch C is connected to Switch B.

Switch C selects a port connected to Switch B as a root port, and the two ports of the two switches transit to forwarding state. In the process of negotiation, more than one switch participates in the active topology. In the network recovery, such a proposal-agreement negotiation proceeds toward leaves of the spanning tree.

A switch determines link-type with the duplex port mode: a full-duplex port is regarded as

a point-to-point link and a half-duplex port is regarded as a shared link. You can change the default settings determined by duplex mode using the interface configuration command and the spanning-tree link-type command.

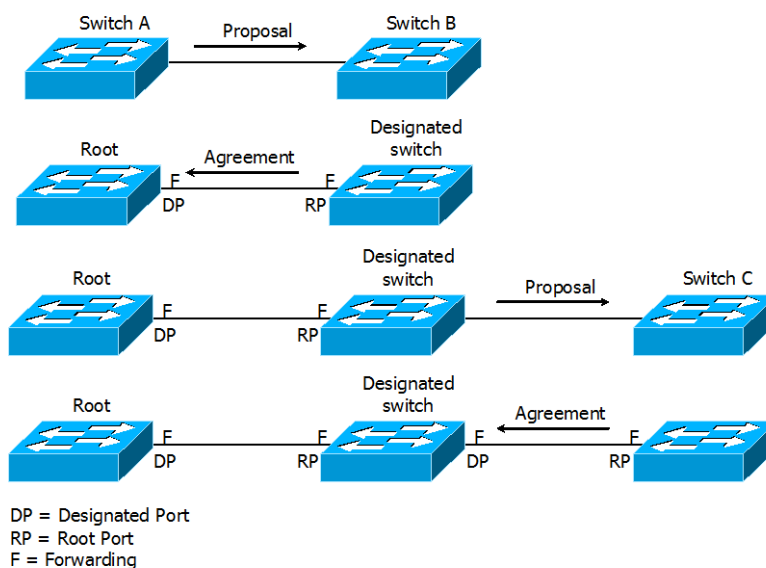


Figure 39. Proposal and Agreement Handshaking for Rapid Convergence

Bridge Protocol Data Unit Format and Processing

RSTP BPDU format is the same as IEEE 802.1D BPDU format except the protocol version field value is set to 2. The new 1 byte version 1 length field is set to 0, which does not include version 1 protocol information. The following table shows the RSTP flag field.

Table 204 RSTP BPDU Flags

| Bit | Function |
|------|---------------------------------------|
| 0 | Topology change (TC) |
| 1 | Proposal |
| 2-3: | Port role: |
| 00 | Unknown |
| 01 | Alternate port |
| 10 | Root port |
| 11 | Designated port |
| 4 | Learning |
| 5 | Forwarding |
| 6 | Agreement |
| 7 | Topology change acknowledgement (TCA) |

The switch proposing itself as the designated switch sets the proposal flag of RSTP BPDU and transmits it. The port role of the message is always set as the designated port.

The switch agreeing the proposal from other switches sets the agreement flag of RSTP BPDU and transmits it. The port role of the message is always set as the root port.

RSTP does not use independent topology change notification (TCN) BPDU. To notice topology change, use topology change (TC) flag of RSTP BPDU flag. But generate and process TCN BPDU to interwork with 802.1D switch.

Learning and forwarding flag are set according to transmitting port state.

About MSTP

MSTP (Multiple Spanning Tree Protocol) is defined in IEEE 802.1s and binds multiple VLAN with one group. Then it make spanning tree work. Because one spanning tree named instance in MSTP runs per VLAN group, the system need not to calculate a lot of spanning tree. So the sytem reduces load. For example, If you use PVST in network that uses 2000 numbers VLAN, the systems must calculate 2000 numbers spanning tree. But, If you divide 2000 numbers VLAN with 2 numbers group with using MSTP, the only 2 spanning trees are used. Forthermore if MSTP runs, BPDU transmmition quantity also reduces progressively. By using MSTP, the reason why the system can reduce spanning tree number is that it needs spanning tree only as many as path number that can do load balancing

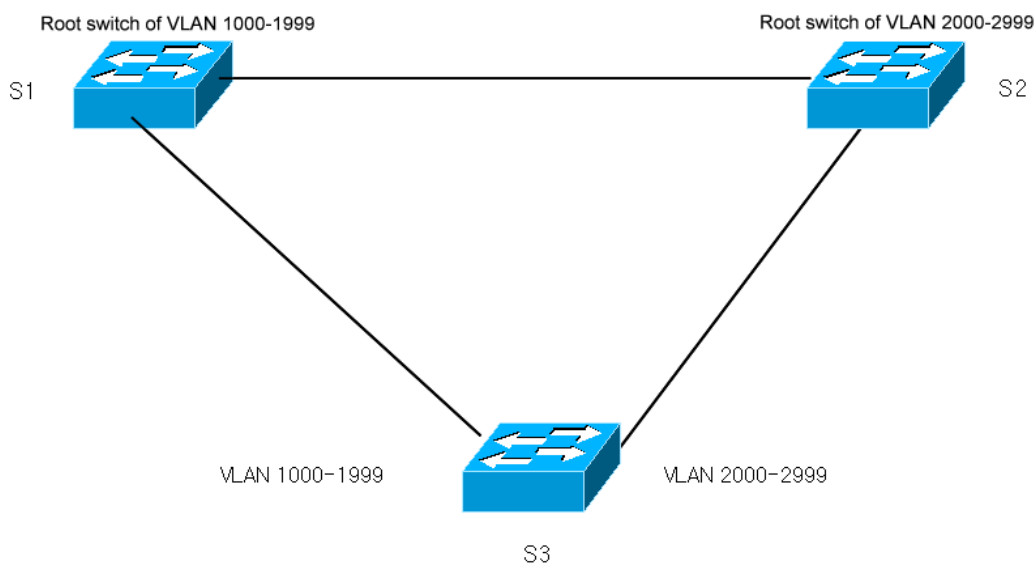


Figure 40. Load Balance

Even if the VLANs used from switch S3 is 2000 numbers from 1000 to 2999, if two spanning trees work, the system can get load balancing to S1, S2.

MST Region

The group of switches having the same MST setting value is called one MST region. It defines the switchs that have the same MST setting values - MST name, MST revision and VLAN list value of instance as the same MST region.

IST, CST and CIST

MSTP uses two kinds of spanning tree. IST (Internal Spanning Tree) runs in one MST region. You can run 63 number spanning trees in the same MST region. You can use the number from 0 to 63 on each spanning tree instance and instance 0 is called as IST. MST sends or receives BPDU only IST. Thus, the other spanning tree information of instance is included in BPDU of IST and the BPDU of numbers that the switch covers reduce more. CIST is a group of IST and CST. In IEEE 802.1Q, even if multi VLANs exist, the spanning tree runs only one. We define this spanning tree as CST (common Spanning Tree). The following figure shows the relation of IST, CST, and CIST.

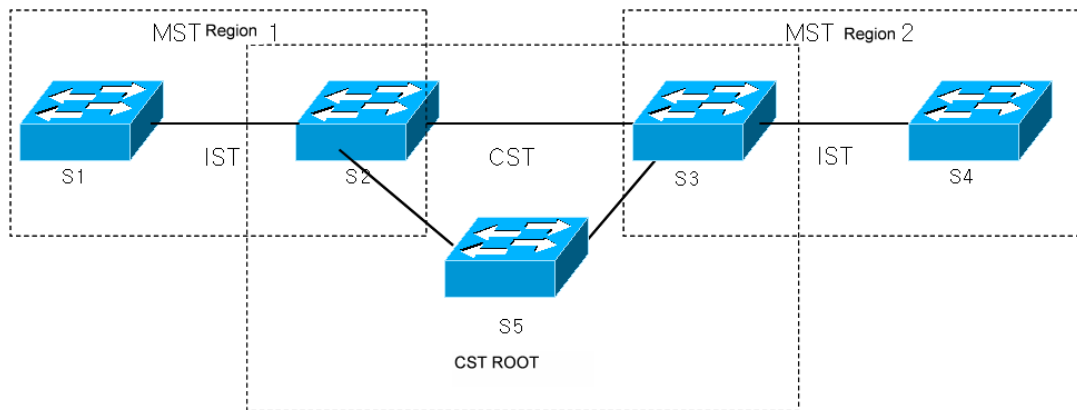


Figure 41. CST, IST, CIST

In case that MST region differs, IST also runs separately. Because MST region of S1 and S2 differs with region of S3, S4, IST running in each MST region runs separately. We define the switch having the least values about the path value to the CST root switch, bridge ID, port ID as IST master. If S5 is CST root switch, S2 and S3 run as IST master switch within each MST region. If CST root switch is outside of MST region, IST master always exist on border of CST and MST. In case that the switch network is configured with one MST region, the same switch run as CST root and IST master. CST run not only each different MST region but also between the switches running with 802.1D or between MST and 802.1D. From view of CST, it considers a total MST region as one switch. Thus, CST knows the previous network as knowing like the following figure.

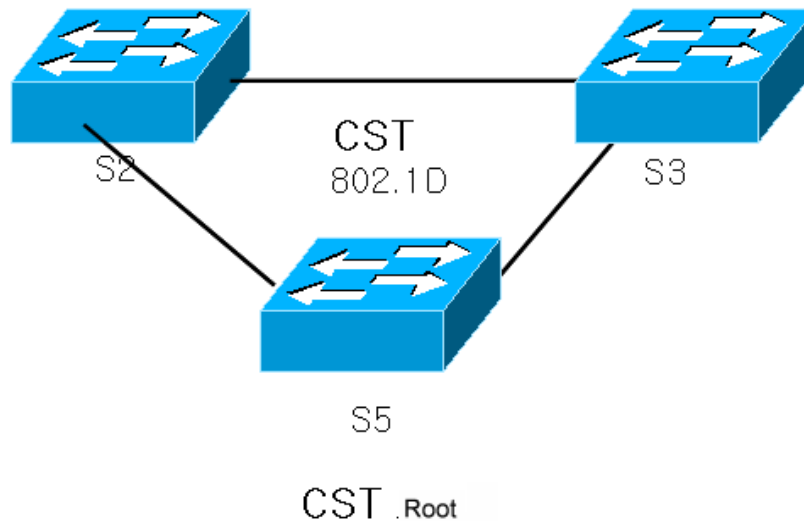


Figure 42. The network of View from CST

Configuring Spanning-Tree Features

This section describes how to configure spanning-tree features. The way of spanning-tree is different according to mode. It is set the same way in case of RSTP and STP. In case of MSTP, it has another way.

Default STP Configuration

The following table shows the default setting of STP.

Table 205 Default STP Configuration

| Feature | Default Setting |
|---|---|
| Enable state | Disabled. |
| Spanning-tree mode | IEEE 802.1w STP |
| System priority | 32768. |
| Spanning-tree VLAN port priority (configurable on a per-VLAN basis) | 128. |
| Spanning-tree VLAN port cost (configurable on a per-VLAN basis) | 10000 Mbps: 2. 1000 Mbps: 4. 100 Mbps: 19. 10 Mbps: 100. |
| Hello time | 2 sec. |
| Forward-delay time | 15 sec. |
| Maximum-aging time | 20 sec. |

STP Configuration Guidelines

The system does not provide PVST. So one spanning-tree runs in one Bridge and the VLAN included in the bridge does not affect anything. You can run spanning-tree per Bridge and create Bridge up to 256 numbers. VLAN can belong to only one Bridge. In case of trunk VLAN, it can belong to only default Bridge. When you set spanning-tree on Trunk VLAN, you must set one spanning-tree to the total VLAN.

Enabling STP

At first, STP does not work in the system. If the possibility that the loop exists is in the network, enable STP. When you enable STP, RSTP works basically.

To enable STP, do the following steps on the privileged EXEC mode.

| | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enter to Global configuration. |
| Step2 | spanning-tree enable | Enables STP on Default Bridge. |
| Step3 | exit | Back to Privileged EXEC mode. |
| Step4 | show spanning-tree | Shows current configuration. |
| Step5 | copy running-config startup-config | Saves current configuration to startup configuration. |

To disable STP, do **spanning-tree shutdown bridge-forward** command on global configuration mode.

The following shows how to enable spanning tree and show the result.

```
Switch#
Switch# configure terminal
Switch(config)# spanning-tree enable
Switch(config)# exit
Switch#
Switch# show spanning-tree
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
  Root ID      Priority    32768
      Address      00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
  Bridge ID  Priority    32768
      Address      00077074ff01
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300
Interface    Role Sts Cost      Prio.Nbr Type
-----
Giga5/3/2    Disb BLK 4      128.610 Shared
Switch#
Switch# configure terminal
Switch(config)# spanning-tree shutdown bridge-forward
Switch(config)# exit
Switch# show spanning-tree
Spanning tree instance(s) does not exist
Switch#
```

Enable STP in NO default Bridge

You can manage spanning-tree per Bridge. You create Bridge. After you include interface to want to be worked as spanning-tree, enable spanning-tree in the relevant Bridge.



Note

The interface included to run spanning-tree on Bridge can input on Bridge directly. After setting VLAN on the interface, you must set VALN on Bridge.

To enable STP in no default bridge, do the following steps on privileged EXEC mode.

| | Command | Purpose |
|--------------|--|----------------------------------|
| Step1 | configure terminal | Enter Global configuration mode. |
| Step2 | Bridge <1-255> protocol vlan-bridge | Creates Bridge. |
| Step3 | bridge <1-255> spanning-tree enable | Enables STP on Bridge. |
| Step4 | Bridge-group <1-255> | Includes VLAN on Bridge. |
| Step5 | copy running-config startup-config | Save the current configuration. |

The following example shows how to enable STP in no default bridge.

```
Switch#
Switch# show spanning-tree
Spanning tree instance(s) does not exist
Switch# configure terminal
Switch(config) bridge 1 protocol vlan-bridge
Switch(config) bridge 1 rapid-spanning-tree enable
Switch(config)# interface Vlan100
Switch (config-if-Vlan100)#bridge-group 1
Switch(config)# exit
Switch# show running-config
!
bridge 1 protocol vlan-bridge
bridge 1 spanning-tree enable
!
Switch#
Switch# configure terminal
Switch(config)# bridge shutdown 1 bridge-forward
Switch(config)# no bridge 1
Switch(config)# exit
Switch# show running-config
!
Switch#
```

Configuring the Port Priority

If a loop occurs, spanning tree decides the interface in the forwarding state with port priority.

It is possible to assign the higher priority (lower number) to the prior interface and the lower priority (higher number) to posterior interface. If all interfaces have same priority, spanning tree set interface with the lowest number in forwarding state, and block other interfaces.

To configure the port priority of interface, follow the procedures below:

Table 206 Configuring the Port Priority

| | Command | Purpose |
|--------------|--|--|
| Step1 | configure terminal | Enters Global configuration mode |
| Step2 | interface <i>interface-id</i> | Enters interface configuration mode, and specify an interface to configure. Available interface is physical interface and port group. |
| Step3 | spanning-tree port-priority <i>priority</i> | Sets VLAN port priority for an interface. |
| Step4 | exit | Changes to privileged EXEC mode |
| Step5 | show spanning-tree | Checks Configuration |
| Step6 | copy running-config startup-config | Saves the setting in configuration file (Optional) |

To return the default setting of interface, use interface configuration command “**no spanning-tree vlan *vlan-id* port-priority**”.

```
Switch#show spanning-tree
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
  Root ID    Priority    32768
             Address    00077074ff01
This bridge is the root
Hello Time  2 sec  Max Age 20 sec  Forward Delay  15 sec
  Bridge ID  Priority    32768
             Address    00077074ff01
Hello Time  2 sec  Max Age 20 sec  Forward Delay  15 sec
Aging Time  300
Interface    Role Sts Cost        Prio.Nbr Type
-----
Giga5/3      Disb BLK 4          128.138 Shared
Switch # configure terminal
Switch(config)#int GigabitEthernet 5/3
Switch(config-if-Giga5/3)#spanning-tree port-priority 0
Switch(config-if-Giga5/3)#exit
Switch # show spanning-tree
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
  Root ID    Priority    32768
             Address    00077074ff01
This bridge is the root
Hello Time  2 sec  Max Age 20 sec  Forward Delay  15 sec
  Bridge ID  Priority    32768
             Address    00077074ff01
Hello Time  2 sec  Max Age 20 sec  Forward Delay  15 sec
Aging Time  300
Interface    Role Sts Cost        Prio.Nbr Type
-----
```

```
Giga5/3    Disb BLK 4          0.138  Shared
Switch#configure terminal
Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#no spanning-tree port-priority
Switch(config-if-Giga5/3)#exit
Switch#show spanning-tree
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
  Root ID    Priority    32768
            Address    00077074ff01
This bridge is the root
Hello Time  2 sec  Max Age 20 sec  Foward Delay  15 sec
  Bridge ID  Priority    32768
            Address    00077074ff01
Hello Time  2 sec  Max Age 20 sec  Foward Delay  15 sec
Aging Time  300
Interface    Role Sts Cost        Prio.Nbr Type
-----
Giga5/3      Disb BLK 4          128.138  Shared
Switch#
```

Configuring the Path Cost

The default value of the path cost of spanning-tree is decided by the media speed of interface. If a loop occurs, spanning tree decides the interface in forwarding state with port cost. It is possible to assign the lower cost to the prior interface and the higher cost to posterior interface. If all interfaces have the same cost, spanning tree set interface with the lowest number in forwarding state, and block other interface.



Note

Port group cannot decide the path cost by interface speed but each member port can have different speed. Set path cost for the port group manually.

To configure the path cost of interface, follow the procedures:

Table 207 Configuring the Path Cost

| Step | Command | Purpose |
|-------|---|--|
| Step1 | configure terminal | To enter Global configuration mode |
| Step2 | interface <i>interface-id</i> | To enter interface configuration mode, and specify an interface to configure. Available interface is physical interface and port group. |
| Step3 | spanning-tree path-cost <i>cost</i> | Sets cost. |
| Step4 | exit | To return to privileged EXEC mode |
| Step5 | show spanning-tree | To check the setting |
| Step6 | copy running-config startup-config | To save the Setting in configuration file (Optional) |

To return the default setting of interface, use interface configuration command “**no spanning-tree vlan** *vlan-id* **cost**”.

In the case that bridge is not a default, the system use bridge<1-255> besides of spanning-tree.

Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

Root ID Priority 32768
 Address 00077074ff01
 This bridge is the root
 Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec

Bridge ID Priority 32768
 Address 00077074ff01
 Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
 Aging Time 300

| Interface | Role | Sts | Cost | Prio.Nbr | Type |
|-----------|------|-------|---------|----------|------|
| Giga5/3 | Disb | BLK 4 | 128.138 | Shared | |

Switch#configure terminal

Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#spanning-tree path-cost 10
Switch(config-if-Giga5/3)#exit
Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

Root ID Priority 32768
 Address 00077074ff01
 This bridge is the root
 Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec

Bridge ID Priority 32768
 Address 00077074ff01
 Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
 Aging Time 300

| Interface | Role | Sts | Cost | Prio.Nbr | Type |
|-----------|------|--------|---------|----------|------|
| Giga5/3 | Disb | BLK 10 | 128.138 | Shared | |

Switch#configure terminal

Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#no spanning-tree path-cost
Switch(config-if-Giga5/3)#exit
Switch#sh spanning-tree

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

Root ID Priority 32768
 Address 00077074ff01

```
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

Configuring the Switch Priority of a VLAN

To be a root switch, the switch priority can be changed. To return the default setting of switch, use global configuration command "**no spanning-tree vlan *vlan-id* priority**". In the case that bridge is not a default, the system use bridge<1-255> besides of spanning-tree.

To be a root switch, the switch priority can be changed.

To configure the switch priority for VLAN, do the following tasks.

Table 208 Configuring the Switch Priority of a VLAN

| Step | Command | Purpose |
|-------|---|--|
| Step1 | configure terminal | To enter Global configuration mode |
| Step2 | spanning-tree priority <i>priority</i> | priority is a multiple of 4096 between 0 and 61440. The default setting is 32768. A smaller number is more probable to be a root switch. Effective priority values include 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344 and 61440. Other values are not permitted. |
| Step3 | exit | To return to privileged EXEC mode. |
| Step4 | show spanning | To check the setting |
| Step5 | copy running-config startup-config | To Save Setting in the configuration file (Optional) |

To return the default setting of switch, use global configuration command "**no spanning-tree vlan *vlan-id* priority**".

```
Switch#show spanning-tree
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
Root ID    Priority    32768
Address    00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID  Priority    32768
Address    00077074ff01
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300

Interface  Role Sts Cost      Prio.Nbr Type
-----
Giga5/3    Disb BLK 4      128.138 Shared
Switch#
Switch#configure terminal
Switch(config)#spanning-tree priority 4096
Switch(config)#exit
Switch#show spanning-tree
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
Root ID    Priority    4096
Address    00077074ff01
```



```

This bridge is the root
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
Bridge ID Priority 4096
Address 00077074ff01
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
Aging Time 300
Interface Role Sts Cost Prio.Nbr Type
-----
Giga5/3 Disb BLK 4 128.138 Shared
Switch#conf t
Switch(config)#no spanning-tree priority
Switch(config)#exit
Switch#show spanning-tree
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
Root ID Priority 32768
Address 00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
Bridge ID Priority 32768
Address 00077074ff01
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
Aging Time 300
Interface Role Sts Cost Prio.Nbr Type
-----
Giga5/3 Disb BLK 4 128.138 Shared
Switch#

```

Configuring the Hello Time

As modifying the hello time, you can change the configuration BPDU interval that root switch transmits. To configure the hello time for a VLAN, do the following the procedures:

Table 209 Configuring the Hello Time

| Step | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | To enter Global configuration mode |
| Step2 | spanning-tree hello-time <i>seconds</i> | Hello time is a period for the root switch to send a configuration message, indicating that the switch is alive. • <i>seconds</i> ranges from 1 to 10. The default setting is 2. |
| Step3 | exit | To return to privileged EXEC mode |
| Step4 | show spanning-tree | To check the setting |
| Step5 | copy running-config startup-config | To save the setting in configuration file (Optional) |

To return the default setting of switch, use global configuration command “**no spanning-tree vlan *vlan-id* hello-time**”. In the case that bridge is not a default, the system use bridge<1-255> besides of spanning-tree.

```
Switch#show spanning-tree
```

```
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
```

```
Root ID    Priority    32768
Address     00077074ff01
This bridge is the root
Hello Time  2 sec  Max Age 20 sec  Foward Delay  15 sec
```

```
Bridge ID  Priority    32768
Address     00077074ff01
Hello Time  2 sec  Max Age 20 sec  Foward Delay  15 sec
Aging Time  300
```

```
Interface    Role Sts Cost        Prio.Nbr Type
-----
Giga5/3      Disb BLK 4          128.138 Shared
```

```
Switch#
```

```
Switch#configure terminal
```

```
Switch(config)#spanning-tree hello-time 9
```

```
Switch(config)#exit
```

```
Switch#show spanning-tree
```

```
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
```

```
Root ID    Priority    32768
Address     00077074ff01
This bridge is the root
Hello Time  9 sec  Max Age 20 sec  Foward Delay  15 sec
```

```
Bridge ID  Priority    32768
           Address     00077074ff01
           Hello Time  9 sec  Max Age 20 sec  Foward Delay  15 sec
           Aging Time  300
```

| Interface | Role | Sts Cost | Prio.Nbr | Type |
|-----------|------|----------|----------|--------|
| Giga5/3 | Disb | BLK 4 | 128.138 | Shared |

Switch#configure terminal

Switch(config)#no spanning-tree hello-time

Switch(config)#exit

Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

```
Root ID  Priority    32768
        Address     00077074ff01
        This bridge is the root
        Hello Time  2 sec  Max Age 20 sec  Foward Delay  15 sec
```

```
Bridge ID  Priority    32768
           Address     00077074ff01
           Hello Time  2 sec  Max Age 20 sec  Foward Delay  15 sec
           Aging Time  300
```

| Interface | Role | Sts Cost | Prio.Nbr | Type |
|-----------|------|----------|----------|--------|
| Giga5/3 | Disb | BLK 4 | 128.138 | Shared |

Configuring the Forwarding-Delay Time for a VLAN

To configure the forwarding-delay time for a VLAN, do the following the procedures:

Table 210 Configuring the Forwarding-Delay Time for a VLAN

| Step | Command | Purpose |
|-------|--|---|
| Step1 | configure terminal | To enter Global configuration mode |
| Step2 | spanning-tree forward-time <i>seconds</i> | Seconds range is between 4 and 30. The default is 15. |
| Step3 | exit | Exit the configuration mode |
| Step4 | show spanning-tree | To check the setting |
| Step5 | copy running-config startup-config | Saves current configuration file. |

To return the default setting of switch, use global configuration command “**no spanning-tree vlan *vlan-id* forward-time**”.

In the case that bridge is not a default, the system use bridge<1-255> besides of spanning-tree.

```
Switch#show spanning-tree
```

```
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
```

```
Root ID    Priority    32768
Address    00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

```
Bridge ID  Priority    32768
Address    00077074ff01
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300
```

```
Interface    Role Sts Cost      Prio.Nbr Type
-----
Giga5/3      Disb BLK 4      128.138 Shared
```

```
Switch#configure terminal
```

```
Switch(config)#spanning-tree forward-time 20
```

```
Switch(config)#exit
```

```
Switch#show spanning-tree
```

```
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
```

```
Root ID    Priority    32768
Address    00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 20 sec
```

```
Bridge ID  Priority    32768
```

```

Address      00077074ff01
Hello Time  2  sec  Max Age 20 sec  Foward Delay  20 sec
Aging Time  300

```

```

Interface      Role Sts Cost      Prio.Nbr Type
-----
Giga5/3      Disb BLK 4      128.138  Shared

```

Switch#configure terminal

```

Switch(config)#no spanning-tree forward-time
Switch(config)#exit
Switch#show spanning-tree

```

```

Default  Bridge up - Spanning Tree Enabled rstp-vlan-bridge
Root ID   Priority   32768
Address    00077074ff01
This bridge is the root
Hello Time  2  sec  Max Age 20 sec  Foward Delay  15 sec

```

```

Bridge ID  Priority   32768
Address    00077074ff01
Hello Time  2  sec  Max Age 20 sec  Foward Delay  15 sec
Aging Time  300

```

```

Interface      Role Sts Cost      Prio.Nbr Type
-----
Giga5/3      Disb BLK 4      128.138  Shared

```

Configuring the Maximum-Aging Time for a VLAN

To configure the maximum-aging time, do the follow ing the procedures:

Table 211 Configuring the Maximum-Aging Time for a VLAN

| Step | Command | Purpose |
|-------|--|---|
| Step1 | configure terminal | Enters Global configuration mode |
| Step2 | spanning-tree max-age <i>seconds</i> | Sets maximum-aging time <ul style="list-style-type: none"> Seconds range is between 6 and 30. The default is 20. |
| Step3 | exit | Returns to privileged EXEC mode |
| Step4 | show spanning-tree | Checks the setting |
| Step5 | copy running-config startup-config | Save Setting in the configuration file (optional). |

To return the default setting of switch, use global configuration command “**no spanning-tree vlan *vlan-id* max-age**”.

In the case that bridge is not a default, the system use bridge<1-255> besides of spanning-tree.

Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

Root ID Priority 32768
 Address 00077074ff01
 This bridge is the root
 Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec

Bridge ID Priority 32768
 Address 00077074ff01
 Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
 Aging Time 300

| Interface | Role | Sts | Cost | Prio.Nbr | Type |
|-----------|------|-----|------|----------|--------|
| ----- | | | | | |
| Giga5/3 | Disb | BLK | 4 | 128.138 | Shared |

Switch#configure terminal

Switch(config)#spanning-tree max-age 15

Switch(config)#exit

Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

Root ID Priority 32768
 Address 00077074ff01
 This bridge is the root
 Hello Time 2 sec Max Age 15 sec Foward Delay 15 sec

Bridge ID Priority 32768
 Address 00077074ff01
 Hello Time 2 sec Max Age 15 sec Foward Delay 15 sec
 Aging Time 300

| Interface | Role | Sts | Cost | Prio.Nbr | Type |
|-----------|------|-----|------|----------|--------|
| ----- | | | | | |
| Giga5/3 | Disb | BLK | 4 | 128.138 | Shared |

Switch#configure terminal

Switch(config)#no spanning-tree max-age

Switch(config)#exit

Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

Root ID Priority 32768
 Address 00077074ff01

Changing the Max-hops for switch

MSTP mode use hop count like TTL of IP instead of using max age and forward delay.

| | Command | Purpose |
|--------------|--|--|
| Step1 | configure terminal | Enters to Global configuration mode. |
| Step2 | Spanning-tree max-hops <i>count</i> | Changes max-hop. |
| Step3 | exit | Backs to privileged EXEC mode. |
| Step4 | show running-config | Shows current configuration. |
| Step5 | copy running-config startup-config | Saves current configuration to start-up configuration. |

```
Switch(config)#spanning-tree max-hops 10
Switch(config)#do show spa mst
#### MST1    vlans mapped:20,70
Bridge      address 0007.70de.ad99  priority    32768    (32768    sysid 0)
Root        address 0007.709e.12fd  priority    8000     (8000     sysid 0)
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 10
Interface      Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3        Mstr    FWD 20000    128.138 P2p
Giga5/4        Altn    BLK 20000    128.139 P2p
```

```
Switch(config)#no spanning-tree max-hops
Switch(config)#do show spa mst
#### MST1    vlans mapped:20,70
Bridge      address 0007.70de.ad99  priority    32768    (32768    sysid 0)
Root        address 0007.709e.12fd  priority    8000     (8000     sysid 0)
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface      Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3        Mstr    FWD 20000    128.138 P2p
Giga5/4        Altn    BLK 20000    128.139 P2p
```

Changing the Spanning-Tree mode for switch

To change the spanning-tree mode for switch, follow the procedures.

Table 212 Changing the Spanning-Tree mode for switch

| Step | Command | Purpose |
|--------------|--|------------------------------------|
| Step1 | configure terminal | To enter Global configuration mode |
| Step2 | spanning-tree mode {stp rstp mstp provider-mstp provider-rstp stp-vlan-bridge rstp-vlan- bridge} | To change the spanning-tree mode |

| | | |
|--------------|---|--|
| Step3 | exit | To return to privileged EXEC mode |
| Step4 | show running-config | To check the setting |
| Step5 | copy running-config startup-config | To save the setting in configuration file (Optional) |

Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

Root ID Priority 32768
Address 00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec

Bridge ID Priority 32768
Address 00077074ff01
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
Aging Time 300

| Interface | Role | Sts | Cost | Prio.Nbr | Type |
|-----------|------|-----|------|----------|--------|
| Giga5/3 | Disb | BLK | 4 | 128.138 | Shared |

Switch#configure terminal

Switch(config)#spanning-tree mode stp-vlan-bridge

Switch(config)#exit

Switch(config)#spanning-tree enable

Switch(config)#exit

Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled stp-vlan-bridge

Root ID Priority 32768
Address 00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec

Bridge ID Priority 32768
Address 00077074ff01
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
Aging Time 300

| Interface | Role | Sts | Cost | Prio.Nbr | Type |
|-----------|------|-----|------|----------|--------|
| Giga5/3 | Disb | DIS | 4 | 128.138 | Shared |

Switch#configure terminal

Switch(config)#spanning-tree mode mstp

Switch(config)#spanning-tree enable

Switch(config)#exit

Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled mstp

Root ID Priority 32768

Address 00077074ff01

This bridge is the root

Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32768

Address 00077074ff01

Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Aging Time 300

Configuring portfast for switch

The following example shows how to set portfast for switch.

```
Switch(config)#do show spa inter gi5/3
Default: Bridge up - Spanning Tree Enabled
Default: Root Path Cost 4 - Root Port 138 - Bridge Priority 32768
Default: Forward Delay 15 - Hello Time 2 - Max Age 20
Default: Root Id 80000007709e12fd
Default: Bridge Id 8000000770dead99
Default: last topology change Tue Jan 13 23:32:51 1970
0: 2 topology change(s) - last topology change Tue Jan 13 23:32:51 1970

Default: portfast bpdu-filter disabled
Default: portfast bpdu-guard disabled
Default: portfast errdisable timeout disabled
Default: portfast errdisable timeout interval 300 sec
Giga5/3: Port 138 - Id 808a - Role Rootport - State Forwarding
Giga5/3: Designated Path Cost 0
Giga5/3: Configured Path Cost 4 - Add type Explicit ref count 1
Giga5/3: Designated Port Id 8001 - Priority 128 -
Giga5/3: Root 80000007709e12fd
Giga5/3: Designated Bridge 80000007709e12fd
Giga5/3: Message Age 0 - Max Age 20
Giga5/3: Hello Time 2 - Forward Delay 15
Giga5/3: Forward Timer 0 - Msg Age Timer 4 - Hello Timer 0 - topo change timer 0
Giga5/3: forward-transitions 1
Giga5/3: Version Rapid Spanning Tree Protocol - Received RSTP - Send RSTP
Giga5/3: No portfast configured - Current portfast off
Giga5/3: portfast bpdu-guard default - Current portfast bpdu-guard off
Giga5/3: portfast bpdu-filter default - Current portfast bpdu-filter off
Giga5/3: no root guard configured - Current root guard off
Giga5/3: Configured Link Type point-to-point - Current point-to-point
```

Switch(config)#spanning-tree portfast bpdu-filter

```
Switch(config)#do show spa inter gi5/3
Default: Bridge up - Spanning Tree Enabled
Default: Root Path Cost 4 - Root Port 138 - Bridge Priority 32768
Default: Forward Delay 15 - Hello Time 2 - Max Age 20
Default: Root Id 80000007709e12fd
Default: Bridge Id 8000000770dead99
Default: last topology change Tue Jan 13 23:32:51 1970
0: 2 topology change(s) - last topology change Tue Jan 13 23:32:51 1970

Default: portfast bpdu-filter enabled
Default: portfast bpdu-guard disabled
Default: portfast errdisable timeout disabled
Default: portfast errdisable timeout interval 300 sec
```

```
Giga5/3: Port 138 - Id 808a - Role Rootport - State Forwarding
Giga5/3: Designated Path Cost 0
Giga5/3: Configured Path Cost 4 - Add type Explicit ref count 1
Giga5/3: Designated Port Id 8001 - Priority 128 -
Giga5/3: Root 80000007709e12fd
Giga5/3: Designated Bridge 80000007709e12fd
Giga5/3: Message Age 0 - Max Age 20
Giga5/3: Hello Time 2 - Forward Delay 15
Giga5/3: Forward Timer 0 - Msg Age Timer 4 - Hello Timer 0 - topo change timer 0
Giga5/3: forward-transitions 1
Giga5/3: Version Rapid Spanning Tree Protocol - Received RSTP - Send RSTP
Giga5/3: No portfast configured - Current portfast off
Giga5/3: portfast bpdu-guard default - Current portfast bpdu-guard off
Giga5/3: portfast bpdu-filter default - Current portfast bpdu-filter on
Giga5/3: no root guard configured - Current root guard off
Giga5/3: Configured Link Type point-to-point - Current point-to-point
```



Note

Before you set bpdu-guard or bpdu-filter, you set portfast.

Changing transmit-holdcount for switch

You can limit BPDU number to transmit for Maximum transmit rate (Default: 3 sec). It is saved to transmit-holdcount. (Default: 6)

| | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | spanning-tree transmit-holdcount holdcount | Changes Transmit-holdcount. |
| Step3 | exit | Back to Privileged EXEC mode. |
| Step4 | show running-config | Shows current running configuration. |
| Step5 | copy running-config startup-config | Saves current running configuration to Startup-configuration. |

```
#### MST1 vlans mapped:70
Bridge address 0007.70de.ad99 priority 32768 (32768 sysid 0)
Root address 0007.709e.12fd priority 8000 (8000 sysid 0)
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured hello time 2, forward delay 15, max age 20, max hops 20
Interface Role Sts Cost Prio.Nbr Type
-----
Giga5/3 Mstr FWD 20000 128.138 P2p
Giga5/4 Altn BLK 20000 128.139 P2p
```

```
U9264H_112(config)#no spanning-tree transmit-holdcount
U9264H_112(config)#do show spa mst
```

```
##### MST1    vlans mapped:70
Bridge      address 0007.70de.ad99 priority    32768    (32768    sysid 0)
Root        address 0007.709e.12fd priority    8000     (8000     sysid 0)
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 10
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface      Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3        Mstr    FWD 20000    128.138 P2p
Giga5/4        Altn    BLK 20000    128.139 P2p
```

Changing Cisco-interoperability for switch

Because BPDU defined by Cisco is different from standard BPDU, it needs to change Cisco-interoperability for switch.

| | Command | Purpose |
|--------------|--|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | spanning-tree cisco-interoperability {enable disable} | Sets if it is comparable with cisco. |
| Step3 | exit | Back to Privileged EXEC mode. |
| Step4 | show running-config | Shows current running configuration. |
| Step5 | copy running-config startup-config | Saves current running configuration to startup-configuration. |

Configuring autoedge for port

You can set to check if device connected to port is edge device. When you set it with autoedge, do the following steps.

| | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | Interface <i>interface-id</i> | Enters interface configuration mode. |
| Step2 | spanning-tree autoedge | Sets autoedge on port. |
| Step3 | exit | Back to Privileged EXEC mode. |
| Step4 | show running-config | Shows current running configuration. |
| Step5 | copy running-config startup-config | Saves current running configuration to startup-configuration. |

Configuring the Port as Edge Port

If a port is not defined as an edge port, 2 x Forward Time will be taken for the port to transit to the forwarding state.



Note

You should set a port connected to your terminal as an edge port. Otherwise, STP state of the port connected to the terminal will be affected by changes in the STP configuration of the network.

To define a port as an edge port, go through the following steps starting in privileged EXEC mode:

Table 213 Configuring the Port as Edge Port

| Step | Command | Purpose |
|-------|---|---|
| Step1 | configure terminal | Enters global configuration mode. |
| Step2 | Interface interface-id | Sets an interface and enters interface configuration mode. Effective interfaces include physical interfaces and port groups. |
| Step2 | spanning-tree edgeport | Sets a port as an edge port. |
| Step3 | exit | Changes to privileged EXEC mode. |
| Step4 | show running-config | Views the settings. |
| Step5 | copy running-config startup-config | Stores the (option) settings in the configuration file. |

To restore the default setting of the switch, use the interface configuration command `no spanning-tree admin-edge-port`.

```
Switch#show spanning-tree
```

```
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
```

```
Root ID Priority 32768
Address 00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID Priority 32768
Address 00077074ff01
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300
```

```
Interface Role Sts Cost Prio.Nbr Type
-----
Giga5/3 Disb BLK 4 128.138 Shared
```

```
Switch#configure terminal
Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#spanning-tree edgeport
Switch(config-if-Giga5/3)#exit
Switch#show spanning-tree
```

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

Root ID Priority 32768
Address 00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec

Bridge ID Priority 32768
Address 00077074ff01
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
Aging Time 300

| Interface | Role | Sts | Cost | Prio.Nbr | Type |
|-----------|------|-----|------|----------|------------------|
| Giga5/3 | Disb | BLK | 4 | 128.138 | Shared edge port |

Switch#configure terminal

Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#no spanning-tree edgeport
Switch(config-if-Giga5/3)#exit
Switch#show spanning-tree

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

Root ID Priority 32768
Address 00077074ff01
This bridge is the root
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec

Bridge ID Priority 32768
Address 00077074ff01
Hello Time 2 sec Max Age 20 sec Foward Delay 15 sec
Aging Time 300

| Interface | Role | Sts | Cost | Prio.Nbr | Type |
|-----------|------|-----|------|----------|--------|
| Giga5/3 | Disb | BLK | 4 | 128.138 | Shared |

Switch#Switch#

Specifying the Link Type to Ensure Rapid Transitions

When a port is connected to another port over a point-to-point link, the port becomes a designated port.

Basically, Link-type is determined by duplex mode of interface: a full-duplex port is regarded as a point-to-point link; and half-duplex mode is regarded as a shared link. If there is a half-duplex link connected to a port of the remote switch by point-to-point connection, you can enable fast transition to forwarding state by changing the default setting of link-type.



Note

In case of a port group, it is not feasible to determine the link type from duplex mode: the ports may have different duplex modes each other. Therefore, you should manually set link type for a port group.

To change the default link-type, go through the following steps starting in privileged EXEC mode:

Table 214 Specifying the Link Type to Ensure Rapid Transitions

| Step | Command | Purpose |
|-------|---|---|
| Step1 | configure terminal | Enters global configuration mode. |
| Step2 | interface <i>interface-id</i> | Enters interface configuration mode. |
| Step3 | spanning-tree link-type point-to-point | Sets the link type of port to point-to-point. |
| Step4 | exit | Changes to privileged EXEC mode. |
| Step5 | show running-config | Views the settings. |
| Step6 | copy running-config startup-config | Stores the (option) settings in the configuration file. |

To restore the default setting, use the interface configuration command **no spanning-tree link-type**.

Configuring force-version for port

To set force-version on port, do the following steps on privileged EXEC mode.

| | Command | Purpose |
|-------|---|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | Interface <i>interface-id</i> | Enters interface configuration mode. |
| Step2 | spanning-tree force-version <i>version</i> | Sets force-version on port. (0 : STP, 2 : RSTP, 3 : MSTP) |
| Step3 | exit | Back to Privileged EXEC mode. |
| Step4 | show running-config | Shows current running configuration. |
| Step5 | copy running-config startup-config | Saves current running configuration to startup-configuration. |

Default: Bridge up - Spanning Tree Enabled

Default: Root Path Cost 4 - Root Port 138 - Bridge Priority 32768

Default: Forward Delay 15 - Hello Time 2 - Max Age 20

Default: Root Id 80000007709e12fd

Default: Bridge Id 8000000770dead99

Default: last topology change Wed Jan 14 12:07:59 1970
0: 2 topology change(s) - last topology change Wed Jan 14 12:07:59 1970

Default: portfast bpdu-filter disabled
Default: portfast bpdu-guard disabled
Default: portfast errdisable timeout disabled
Default: portfast errdisable timeout interval 300 sec
Giga5/3: Port 138 - Id 808a - Role Rootport - State Forwarding
Giga5/3: Designated Path Cost 0
Giga5/3: Configured Path Cost 4 - Add type Explicit ref count 1
Giga5/3: Designated Port Id 8001 - Priority 128 -
Giga5/3: Root 80000007709e12fd
Giga5/3: Designated Bridge 80000007709e12fd
Giga5/3: Message Age 0 - Max Age 20
Giga5/3: Hello Time 2 - Forward Delay 15
Giga5/3: Forward Timer 0 - Msg Age Timer 5 - Hello Timer 0 - topo change timer 0
Giga5/3: forward-transitions 1
Giga5/3: Version Rapid Spanning Tree Protocol - **Received RSTP - Send RSTP**
Giga5/3: No portfast configured - Current portfast off
Giga5/3: portfast bpdu-guard default - Current portfast bpdu-guard off
Giga5/3: portfast bpdu-filter default - Current portfast bpdu-filter off
Giga5/3: no root guard configured - Current root guard off
Giga5/3: Configured Link Type point-to-point - Current point-to-point

Switch(config)#inter gi5/3
Switch(config-if-Giga5/3)#**spanning-tree force-version 0**
Switch(config-if-Giga5/3)#do show spa inter gi5/3
Default: Bridge up - Spanning Tree Enabled
Default: Root Path Cost 4 - Root Port 139 - Bridge Priority 32768
Default: Forward Delay 15 - Hello Time 2 - Max Age 20
Default: Root Id 80000007709e12fd
Default: Bridge Id 8000000770dead99
Default: last topology change Wed Jan 14 12:09:00 1970
0: 3 topology change(s) - last topology change Wed Jan 14 12:09:00 1970

Default: portfast bpdu-filter disabled
Default: portfast bpdu-guard disabled
Default: portfast errdisable timeout disabled
Default: portfast errdisable timeout interval 300 sec
Giga5/3: Port 138 - Id 808a - Role Designated - State Discarding
Giga5/3: Designated Path Cost 4
Giga5/3: Configured Path Cost 4 - Add type Explicit ref count 1
Giga5/3: Designated Port Id 808a - Priority 128 -
Giga5/3: Root 80000007709e12fd
Giga5/3: Designated Bridge 8000000770dead99
Giga5/3: Message Age 1 - Max Age 20
Giga5/3: Hello Time 2 - Forward Delay 15
Giga5/3: Forward Timer 14 - Msg Age Timer 0 - Hello Timer 0 - topo change timer 34


```
Giga5/3: forward-transitions 1
Giga5/3: Version Spanning Tree Protocol - Received None - Send STP
Giga5/3: No portfast configured - Current portfast off
Giga5/3: portfast bpdu-guard default - Current portfast bpdu-guard off
Giga5/3: portfast bpdu-filter default - Current portfast bpdu-filter off
Giga5/3: no root guard configured - Current root guard off
Giga5/3: Configured Link Type point-to-point - Current point-to-point
```

Configuring root guard for port

To set root guard on port, , do the following steps on privileged EXEC mode.

| | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | Interface <i>interface-id</i> | Enters interface configuration mode. |
| Step2 | spanning-tree guard root | Sets root guard on port. |
| Step3 | exit | Back to Privileged EXEC mode. |
| Step4 | show running-config | Shows current running configuration. |
| Step5 | copy running-config startup-config | Saves current running configuration to startup-configuration. |

Giga5/3 of MST1isRootport Forwarding

Edge port: no (default) **port guard : none (default)**

Link type: point-to-point (auto) bpdu filter :disable (disable)

bpdu guard:disable (disable)

Bpdus send 0

Instance Role Sts Cost Prio.Nbr Vlans mapped

1 Root FWD 20000 128.138

70

%

Switch#con t

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

Switch(config)#inter gi5/3

Switch(config-if-Giga5/3)#**spanning-tree guard root**

Switch(config-if-Giga5/3)#do show spa mst inter gi5/3

Giga5/3 of MST1isDesignated root-inconsistent

Edge port: no (default) **port guard : root (root)**

Link type: point-to-point (auto) bpdu filter :disable (disable)

bpdu guard:disable (disable)

Bpdus send 0

Instance Role Sts Cost Prio.Nbr Vlans mapped

1 Desg RIT 20000 128.138

70

Configuring hello-time for port

You can set hello-time per port. This way is the same as the setting way of switch except entering interface mode.

Configuring portfast for port

You can set portfast per port. This way is the same as the setting way of switch except entering interface mode.

Configuring transmit-holdcount for port

You can set transmit-holdcount per port. This way is the same as the setting way of switch except entering interface mode.

Configuring restricted-role for port

To set restricted-role for port, do the following steps on privileged EXEC mode.

| | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | Interface <i>interface-id</i> | Enters interface configuration mode. |
| Step2 | spanning-tree restricted-role | Sets restricted-role on port. |
| Step3 | exit | Back to Privileged EXEC mode. |
| Step4 | show running-config | Shows current running configuration. |
| Step5 | copy running-config startup-config | Saves current running configuration to startup-configuration. |

```
U9264H_112(config)#inter gi5/3
U9264H_112(config-if-Giga5/3)#spanning-tree restricted-role
U9264H_112(config-if-Giga5/3)#do show spa
```

Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge

```
Root ID    Priority    32768
          Address    0007709e12fd
          Cost        4
          Port        139 (Giga5/4)
          Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
```

```
Bridge ID  Priority    32768
          Address    000770dead99
          Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
          Aging Time  300
```

```
Interface    Role Sts Cost        Prio.Nbr Type
-----
Giga5/3      Altn BLK 4      128.138 P2p
Giga5/4      Root FWD 4      128.139 P2p
```

```
U9264H_112(config-if-Giga5/3)#no spanning-tree restricted-role
```

U9264H_112(config-if-Giga5/3)#do show spa

```

Root ID      Priority    32768
              Address     0007709e12fd
              Cost        20000
              Port        138 (Giga5/3)
              Hello Time  2 sec  Max Age 20 sec  Foward Delay 15 sec
  
```

```

Bridge ID    Priority    32768
              Address     000770dead99
              Hello Time  2 sec  Max Age 20 sec  Foward Delay 15 sec
              Aging Time  300
  
```

```

Interface      Role Sts Cost      Prio.Nbr Type
-----
Giga5/3        Root FWD 4      128.138 P2p
Giga5/4        Altn BLK 4      128.139 P2p
  
```

Configuring restricted-tcn for port

To set restricted-role for port, do the following steps on privileged EXEC mode.

| | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | Interface <i>interface-id</i> | Enters interface configuration mode. |
| Step2 | spanning-tree restricted-tcn | Sets restricted-tcn on port. |
| Step3 | exit | Back to Privileged EXEC mode. |
| Step4 | show running-config | Shows current running configuration. |
| Step5 | copy running-config startup-config | Saves current running configuration to startup-configuration. |

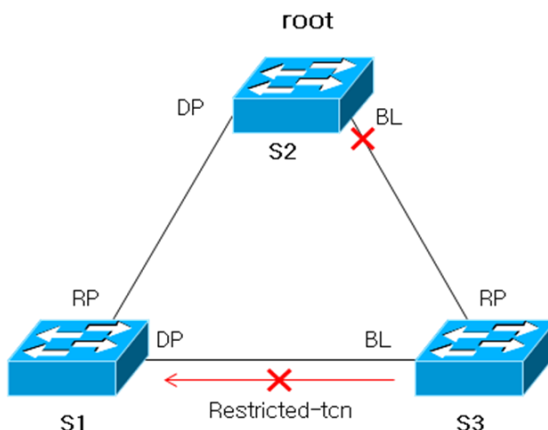


Figure 43. restricted-tcn

Configuring MSTP Features

This section describes how to set MSTP. In the MSTP. Because spanning-tree is consisted of per instance, it creates instance and includes VLAN in it. Also it sets hello time and port priority like STP or RSTP.

Instance Creation and VLAN Connection

To create instance and include VLAN in it, do the following steps on privileged EXE mode.

| | Command | Purpose |
|--------------|--|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | Spanning-tree mst configuration | Enters mst configuration mode to connect created instance and VLAN. |
| Step3 | instance <i>instance-id</i> vlan <i>vlan-id</i> | Creates Instance ID and includes VLAN in it. |
| Step4 | exit | Enters Global configuration mode. |
| Step5 | interface <i>interface-id</i> | Enters interface configuration mode. |
| Step6 | Spanning-tree instance <i>instance-id</i> | Set relevant port on Instance. |
| Step7 | exit | Back to Privileged EXEC mode. |
| Step8 | show running-config | Shows current running configuration. |
| Step9 | copy running-config startup-config | Saves current running configuration to startup-configuration. |

To delete instance, do **no instance** *instance-id* command.

```
Switch#show spanning-tree mst configuration
name      [Default]
Revision  0      Instances configured 0
%  Instance      VLAN
%  0:            2-3, 100
Switch#configure terminal
Switch(config)#spanning-tree mst configuration
Switch(config-mst)#instance 1 vlan 2
Switch(config-mst)#exit
Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#spanning-tree instance 1
Switch(config-if-Giga5/3)#exit
Switch#show spanning-tree mst configuration
name      [Default]
Revision  0      Instances configured 0
%  Instance      VLAN
%  0:            3, 100
%  1:            2
Switch# configure terminal
Switch(config)#spanning-tree mst configuration
Switch(config-mst)#no instance 1 vlan 2
Switch(config-mst)#exit
Switch#show spanning-tree mst configuration
name      [Default]
Revision  0      Instances configured 0
%  Instance      VLAN
%  0:            2-3, 100
Switch#
```

Instance and port configuration

To set priority on interface, do the following steps on privileged EXEC mode.

| | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | Spanning-tree instance <i>instance-id priority priority</i> | Sets priority on Instance. |
| Step3 | exit | Back to Privileged EXEC mode. |
| Step4 | show running-config | Shows current running configuration. |
| Step5 | copy running-config startup-config | Saves current running configuration to startup-configuration. |

The following example shows how to restore to default value.

```
Switch#show spanning-tree mst
#### MST1    vlans mapped:2
Bridge      address 0007.7074.ff01  priority      32768    (32768    sysid 0)
Root        this switch for the CIST
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface      Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3        Disb     BLK 20000    128.138  Shared
Switch#configure terminal
Switch(config)#spanning-tree instance 1 priority 4096
Switch(config)#exit
Switch#show spanning-tree mst
#### MST1    vlans mapped:2
Bridge      address 0007.7074.ff01  priority      4096    (4096    sysid 0)
Root        this switch for the CIST
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface      Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3        Disb     BLK 20000    128.138  Shared
```

To set priority value on port, do the following steps on privileged EXEC mode.

| | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | interface <i>interface-id</i> | Enters interface configuration mode. |
| Step3 | Spanning-tree instance <i>instance-id priority priority</i> | Sets priority on port. |
| Step4 | exit | Back to Privileged EXEC mode. |
| Step5 | show running-config | Shows current running configuration. |
| Step6 | copy running-config startup-config | Saves current running configuration to startup- |

| | | |
|--|-----------------------|----------------|
| | startup-config | configuration. |
|--|-----------------------|----------------|

The following example shows how to restore with default value

```
Switch#show spanning-tree mst
#### MST1    vlans mapped:2
Bridge      address 0007.7074.ff01  priority      32768 (32768  sysid 0)
Root        this switch for the CIST
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface      Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3        Disb     BLK 20000    128.138  Shared
Switch#configure terminal
Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#spanning-tree instance 1 priority 0
Switch(config-if-Giga5/3)#exit
Switch#show spanning-tree mst
#### MST1    vlans mapped:2
Bridge      address 0007.7074.ff01  priority      32768 (32768  sysid 0)
Root        this switch for the CIST
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface      Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3        Disb     BLK 20000    0.138   Shared
Switch#configure terminal
Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#no spanning-tree instance 1 priority
Switch(config-if-Giga5/3)#exit
Switch#show spanning-tree mst
#### MST1    vlans mapped:2
Bridge      address 0007.7074.ff01  priority      32768 (32768  sysid 0)
Root        this switch for the CIST
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface      Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3        Disb     BLK 20000    128.138  Shared
```

To set the path cost value of port, do the following steps on privileged EXEC mode.

| | Command | Purpose |
|--------------|--------------------------------------|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | interface <i>interface-id</i> | Enters to interface configuration mode. |
| Step3 | Spanning-tree instance | Sets path cost on port. |

| | | | |
|--------------|---|------------------|---|
| | <i>instance-id</i> <i>path-cost</i> | path-cost | |
| Step4 | exit | | Back to Privileged EXEC mode. |
| Step5 | show running-config | | Shows current running configuration. |
| Step6 | copy running-config startup-config | | Saves current running configuration to startup-configuration. |

To restore as default value, do **no spanning-tree instance** *instance-id* **path-cost** command.

```
Switch#show spanning-tree mst
#### MST1    vlans mapped:2
Bridge      address 0007.7074.ff01  priority      32768 (32768 sysid 0)
Root        this switch for the CIST
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface          Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3           Disb    BLK 20000    128.138  Shared
Switch#configure terminal
Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#spanning-tree instance 1 path-cost 1
Switch(config-if-Giga5/3)#exit
Switch#show spanning-tree mst
#### MST1    vlans mapped:2
Bridge      address 0007.7074.ff01  priority      32768 (32768 sysid 0)
Root        this switch for the CIST
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface          Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3           Disb    BLK 1        128.138  Shared
Switch#configure terminal
Switch(config)#interface GigabitEthernet 5/3
Switch(config-if-Giga5/3)#no spanning-tree instance 1 path-cost
Switch(config-if-Giga5/3)#exit
Switch#show spanning-tree mst
#### MST1    vlans mapped:2
Bridge      address 0007.7074.ff01  priority      32768 (32768 sysid 0)
Root        this switch for the CIST
Regional Root this switch
Operational hello time 2, forward delay 15, max age 20, txholdcount 6
Configured  hello time 2, forward delay 15, max age 20, max hops 20
Interface          Role    Sts Cost    Prio.Nbr Type
-----
Giga5/3           Disb    BLK 20000    128.138  Shared
Switch#
```


**Note**

To set MSTP on the port, you must create instance before.

Setting region and revision number for MST

To set revision number and Region, do the following steps on privileged EXEC mode.

| | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enters Global configuration mode. |
| Step2 | spanning-tree configuration mst | Enters mst configuration mode. |
| Step3 | Region <i>NAME</i> | Sets Region name. |
| Step4 | Revision <i>number</i> | Sets Revision number. |
| Step5 | exit | Back to Privileged EXEC mode. |
| Step6 | show running-config | Shows current running configuration. |
| Step7 | copy running-config startup-config | Saves current running configuration to startup-configuration. |

```

name      [Default]
Revision  0      Instances configured 2
Instance  VLAN
-----
0          1-69, 71-4000
1          70
-----

SWITCH(config-mst)#region TEST
SWITCH(config-mst)#revision 100
SWITCH(config-mst)#do show spa mst conf
name      [TEST]
Revision  100  Instances configured 2
Instance  VLAN
-----
0          1-69, 71-4000
1          70
-----

```

Pathcost for MSTP

The Pathcost value about MSTP is as follows:

| speed | Path cost |
|-------|-----------|
| 10M | 2000000 |
| 100M | 200000 |
| 1G | 20000 |
| 10G | 2000 |

Displaying the Spanning-Tree Status

To show spanning-tree status, do the following commands on privileged EXEC mode.

| Command | Purpose |
|--|---|
| show spanning-tree | Show spanning-tree information about total interface. |
| show spanning-tree interface <i>interface-id</i> | Shows spanning-tree information about specific interface. |
| show spanning-tree detail | Shows detailed spanning-tree information. |

The following example shows how to show the spanning-tree information.

```
Switch#show spanning-tree
Default Bridge up - Spanning Tree Enabled rstp-vlan-bridge
Root ID    Priority    32768
           Address    00077074ff01
           This bridge is the root
           Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID   Priority    32768
           Address    00077074ff01
           Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
           Aging Time 300
Interface   Role Sts Cost      Prio.Nbr Type
-----
Giga5/3     Disb BLK 4      128.138 Shared
Switch#show spanning-tree interface gi5/3
% Default: Bridge up - Spanning Tree Enabled
% Default: Root Path Cost 0 - Root Port 0 - Bridge Priority 32768
% Default: Forward Delay 15 - Hello Time 2 - Max Age 20
% Default: Root Id 800000077074ff01
% Default: Bridge Id 800000077074ff01
% Default: last topology change Thu Jan 1 00:00:00 1970
% 0: 0 topology change(s) - last topology change Thu Jan 1 00:00:00 1970
% Default: portfast bpdu-filter disabled
% Default: portfast bpdu-guard disabled
% Default: portfast errdisable timeout disabled
% Default: portfast errdisable timeout interval 300 sec
% Giga5/3: Port 138 - Id 8263 - Role Disabled - State Discarding
% Giga5/3: Designated Path Cost 0
% Giga5/3: Configured Path Cost 4 - Add type Explicit ref count 1
% Giga5/3: Designated Port Id 0 - Priority 128 -
% Giga5/3: Root 000000077074ff01
% Giga5/3: Designated Bridge 000000077074ff01
% Giga5/3: Message Age 0 - Max Age 0
% Giga5/3: Hello Time 0 - Forward Delay 0
% Giga5/3: Forward Timer 0 - Msg Age Timer 0 - Hello Timer 0 - topo change timer 0
% Giga5/3: forward-transitions 0
% Giga5/3: Version Rapid Spanning Tree Protocol - Received None - Sexit STP
% Giga5/3: No portfast configured - Current portfast off
```

```
% Giga5/3: portfast bpdu-guard default - Current portfast bpdu-guard off
% Giga5/3: portfast bpdu-filter default - Current portfast bpdu-filter off
% Giga5/3: no root guard configured - Current root guard off
% Giga5/3: Configured Link Type point-to-point - Current shared
%
%
Switch#show spanning-tree detail
Default is executing the rstp-vlan-bridgecompatible Spanning Tree protocol
Bridge Identifier has priority 8000 address 00077074ff01
Configured hello time 2, max age 20, forward delay 15
We are the root of the spanning tree
Topology change flag not set, detected flagnot set
Number of topology changes 0 last change occurred Thu Jan 1 00:00:00 1970
Times: hold 6, topology change 0, notification 5
hello 2, max age 20, forward delay 15
Timers: hello 0, topology change 25, notification 0, aging 300
Port 138 (Giga5/3) of Default is Discarding
Port path cost 0 Port priority 128, 128.138.
Designated root has priority 1280, address 0007.7074.ff01
Designated bridge has priority 8000, address 0007.7074.ff01
Designated port id is 0, designated path cost 4 Hello is not pending
Number of transitions to forwarding state: 0
Link type is Shared
BPDU: sent 0
```



Note

"show spanning-tree interface IFNAME" command does not run in MSTP.

Configuring Bridge MAC Forwarding

To do MAC learning, do the following commands on Config mode.

| Command | Purpose |
|---|--|
| spanning-tree acquire | Sets MAC learning of Default Bridge dynamically. (It is enabled by default.) |
| no spanning-tree acquire | Disables it. |
| bridge <1-255> acquire | Sets MAC learning of Bridge except default Bridge dynamically. . (It is enabled by default.) |
| no bridge <1-255> acquire | Disables it. |
| mac-address-table static MAC (forward discard) IFNAME | Forwards MAC address of relevant Bridge to interface or discards. |
| no mac-address-table static MAC (forward discard) IFNAME | Deletes the relevant forwarding entry of MAC address. |

The following example shows how to set MAC learning statically.

```
Switch#configure terminal
Switch(config)#mac-address-table static 1111.1111.1111 forward gi5/3
Switch(config)#exit
Switch#show mac-address-table
      vlan   mac address      type    fwd      ports
-----+-----+-----+-----+-----
      1  1111.1111.1111      static    1 Gi5/3
Switch(config)#no mac-address-table static 1111.1111.1111 forward gi5/3
Switch(config)#exit
Switch#show mac-address-table
      vlan   mac address      type    fwd      ports
-----+-----+-----+-----+-----
No entries present.
Switch#
```

To delete dynamic entry and static entry from MAC address table, do the following command.

| Command | Purpose |
|---|--|
| clear mac-address-table (dynamic multicast static) | Clears multicast MAC address entry in the relevant Bridge. |
| clear mac-address-table (static multicast dynamic) (address MACADDR interface IFNAME vlan VID) | Clears VLAN or the physical port of muticast MAC address entry in the relevant Bridge. |

The following example shows how to delete static MAC address entry.

```
Switch#show mac-address-table
      vlan  mac address      type    fwd      ports
-----+-----+-----+----+-----
      1  1111.1111.1111    static    1 Gi5/3
Switch#clear mac-address-table static
Switch#show mac-address-table
      vlan  mac address      type    fwd      ports
-----+-----+-----+----+-----
No entries present.
Switch#
```

To show MAC address entry, do the following command on EXEC mode.

| Command | Purpose |
|---|---|
| show mac-address-table | Shows MAC address table information. |
| show mac-address-table (static dynamic multicast) vlan <1-4094> | Shows MAC address table information as option. |
| show mac-address-table count (module <1-6> vlan <1-4094>) | Shows static and dynamic multicast address number in MAC address table. |

Self-loop Detection

This section describes how to set self-loop detection to detect the returned packets which have been transmitted by the switch itself.

Understanding Self-loop Detection

Although there are no dual paths in the user switch, a loop may be formed depending on a network configuration or on the status of cables connected to the switch.

A self-loop is formed when the packet transmitted through a port of the switch is returned through the same port. The figure below illustrates an environment where a self-loop is formed.

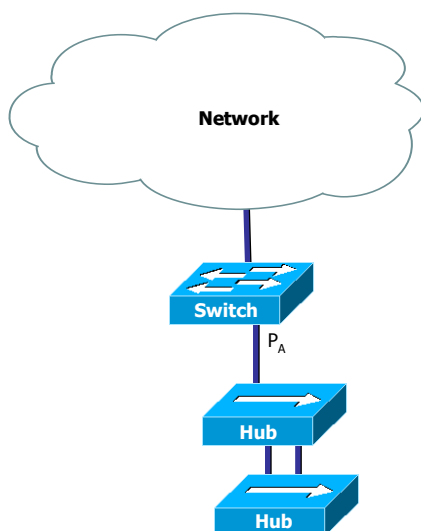


Figure 44. Environment Where a Self-loop is Formed

In the figure, a loop is formed by dual paths between two hubs. As STP is not enabled, the loop between those hubs would not be removed, resulting in instability of the network. In such a case, the packet transmitted through Port PA will be received through PA. If the self-loop detection feature is enabled in the switch, it detects the self-loop of port PA and makes it administrative disable status to protect other networks not connected to the switch and port PA. The loop exists in the equipment and networks connected to port PA as ever (Use STP to completely delete the loop from the network).

Configuring Self-loop Detection

This section describes how to set self-loop detection in a switch:

1. Enabling Self-loop Detection
2. Changing the Service Status of Port

The following example shows how to enable self-loop detection on port gi 1. as default limit time:

```
Switch# configure terminal
Switch(config)# interface vlan1
```

```
Switch(config-if-vlan1)# self-loop-detection
Switch(config-if-vlan1)# interface gi1
Switch(config-if-gi1)# self-loop-detection
Switch(config-if-gi1)# exit
Switch# show self-loop-detection
```

| ifname | ld | link | shutdown | set_time | remain_time | count | last-occur |
|--------|-----|------|----------|----------|-------------|-------|------------|
| gi1 | set | up | . | 5 min | . | 0 | . |
| gi2 | . | down | . | . | . | 0 | . |
| gi3 | . | down | . | . | . | 0 | . |
| gi4 | . | down | . | . | . | 0 | . |
| gi5 | . | up | . | . | . | 0 | . |
| | | | | | | | |
| gi25 | . | down | . | . | . | 0 | . |
| gi26 | . | down | . | . | . | 0 | . |

Changing the Service Status of Port

```
Switch# configure terminal
Switch(config)# interface vlan1
Switch(config-if-vlan1)# self-loop-detection
Switch(config-if-vlan1)# interface gi1
Switch(config-if-gi1)# no self-loop-detection
Switch(config-if-gi1)# exit
Switch# show self-loop-detection
```

| ifname | ld | link | shutdown | set_time | remain_time | count | last-occur |
|--------|----|------|----------|----------|-------------|-------|------------|
| gi1 | . | up | . | . | . | 0 | . |
| gi2 | . | down | . | . | . | 0 | . |
| gi3 | . | down | . | . | . | 0 | . |
| gi4 | . | down | . | . | . | 0 | . |
| gi5 | . | up | . | . | . | 0 | . |
| | | | | | | | |
| gi25 | . | down | . | . | . | 0 | . |
| gi26 | . | down | . | . | . | 0 | . |

Disabling Self-loop Detection

You can disable self-loop detection for an individual port or for a range of ports of a switch.

If a port has automatically been shut down by self-loop detection, you can disable self-loop detection after setting the port status to 'no shutdown'.

To disable self-loop detection, go through the following steps starting in privileged EXEC mode:

Table 215 Disabling Self-loop Detection

| Step | Command | Purpose |
|---------------|---------------------------|--|
| Step1 | Configure terminal | Enters global configuration mode. |
| Step2 | interface interface-name | Enters Interface configuration mode. |
| Step3a | no self-loop- | Self-loop-detection Shutdown caused by self-loop |

| | | |
|---------------|---|---|
| | detection | detection will automatically change to 'no shutdown' after 5 minutes. |
| Step4 | interface interface-name | Enters Interface configuration mode. |
| Step5a | no self-loop-detection | self-loop-detection |
| Step6 | exit | Changes to privileged EXEC mode. |
| Step7a | show running-config | Views the settings. |
| Step7b | show self-loop-detection | Views the self-loop settings. |
| Step8 | copy running-config startup-config | Stores the (option) settings in the configuration file. |

The following shows an example of disabling self-loop detection for Port fa1:

```
Switch# configure terminal
Switch(config)# interface fa1
Switch(config-if-fa1)# self-loop-detection
Switch(config-if-fa1)# end
Switch(config-if-fa1)# no self-loop-detection
Switch(config-if-fa1)# end
show self-loop-detection
```

```
-----
ifname sld link shutdown set_time remain_time count last-occur
-----
gi1 . up . . . 0 .
gi2 . down . . . 0 .
gi3 . down . . . 0 .
gi4 . down . . . 0 .
gi5 . up . . . 0 .
.....
gi25 . down . . . 0 .
gi26 . down . . . 0 .
Switch#
```

Displaying Self-loop Status

To display the self-loop detection settings for a port, use the privileged EXEC command show running-config or show self-loop-detection.

```
show self-loop-detection
```

Interface name (Port name)

* sld : self-loop-detection (set)

* link : Link status (up, down)

* shutdown : Shutdown by SLD (set)

* set_time : Limit time (minutes). If limit time is set to 0, shutdown caused by SLD will remain until the affected port is manually cleared to 'no shutdown'.

* remain_time : The remaining time until the normal state is recovered from shutdown state caused by SLD (minute:second)

* count : Number of shutdown events caused by SLD

* last-occur : The last shutdown time

Switch# **show running-config**

```
!
interface gi5
  self-loop-detection
!
interface vlan1
  self-loop-detection
  ip address 100.1.1.1/24
!
```

Switch#

Switch# **show self-loop-detection**

| ifname | ld | link | shutdown | set_time | remain_time | count | last-occur |
|--------|-----|------|----------|----------|-------------|-------|-------------------|
| gi1 | . | down | . | . | . | 0 | . |
| gi2 | . | up | . | . | . | 0 | . |
| gi3 | . | down | . | . | . | 0 | . |
| gi4 | . | down | . | . | . | 0 | . |
| gi5 | set | up | block | 5 min | . | 1 | SEP 04:48:39 2010 |
| gi6 | . | down | . | . | . | 0 | . |
| gi7 | . | down | . | . | . | 0 | . |
| gi8 | . | down | . | . | . | 0 | . |

Switch#

Chapter 13. BFD

This chapter describes BFD (Bidirectional Forwarding Detection). BFD is a protocol for rapid detecting the error of forwarding path. BFD independently runs regardless of network type and routing protocol.

This chapter consists of the following sections:

- Understanding BFD
- Restrictions BFD Configuration
- Default BFD Configuration
- Configuring BFD
- BFD Configuration Samples

Understanding BFD

BFD Operation

BFD can rapidly detect between the forwarding path error and interface, data link and forwarding layer error. The U9016B provides BFD asynchronous mode exchanging control message between two systems optionally. For making BFD session, you set BFD to two systems. If the BFD session is made by routing protocol, BFD transmission period is decided by negotiating between two routers. The two routers send BFD control message periodically.

BFD can rapidly detect the error between BFD systems regardless of network type and kinds of routing protocol. If BFD detect error, inform to routing protocol. Because routing protocol can rapidly reaccount routing table, it can reduce the time of changing routing table of total network. The following figure shows simple network set with two routers. Each router runs OSPF and BFD. When OSPF find out neighbor, OSPF requests BFD session to BFD process for making BFD session. Then BFD session is also made like OSPF neighbor.

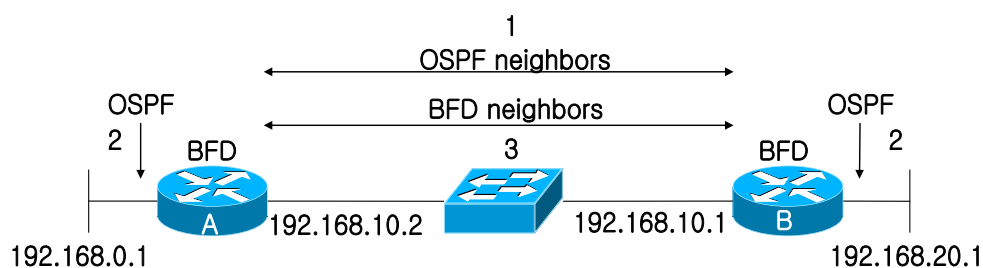


Figure 45. Establishing a BFD neighbor relationship

The following figure shows the link error to occur in the network. If OSPF neighbor and BFD session becomes down, the BFD informs to OSPF process that the system can not communicate with BFD peer. OSPF process disconnects the OSPF neighbor relation. If another path is, the router recalculates the routing table immediately.

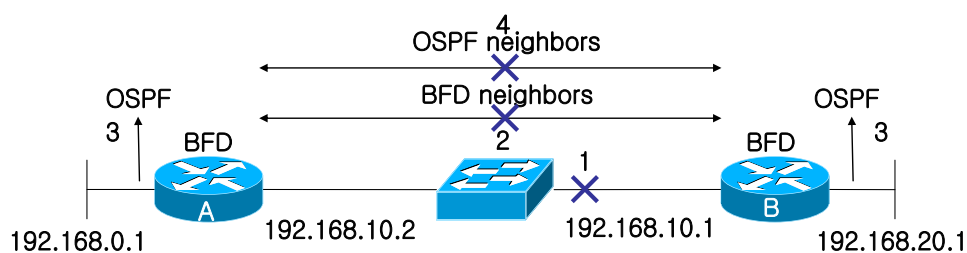


Figure 46. Tearing down an OSPF neighbor relationship

Benefits of using BFD for Failure Detection

BFD can provide failure detection in the routing protocol like OSPF. The merit of BFD is as follows:

- BFD can detect failure within one second.
- BFD can use failure detection of various routing protocol.

BFD Session Type

BFD uses BFD single hop session and BFD multi hop session according to network configuration.

BFD single hop session is used between two systems connected directly. The following figure shows BFD single hop configuration. Because the two systems are directly connected via specific interface, BFD single hop session is only made via this interface. After you set BFD session parameter on interface of U9016B with **bfd interval** command, BFD single hop session is made.



Figure 47. BFD single hop session

BFD multihop session is used when the connection path between two systems is optional. It differs according to routing table of network between two systems like the following figure. Therefore, BFD multihop session does not belong to specific interface. You can make BFD multihop session regardless of BFD session parameter setting on the interface. You can set BFD multihop session parameter with **bfd multihop-peer** command.

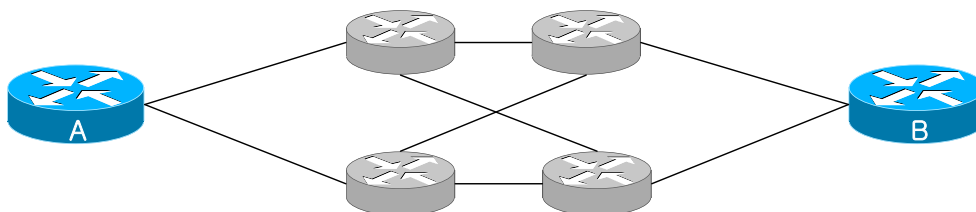


Figure 48. BFD multihop session

BFD Version Interoperability

U9016B switch provides not only BFD version 1 but also version 0. Even if All BFD sessions are made with version 1, it can interact with version 0.

After the system automatically detects BFD version, BFD session runs as the highest version that can use commonly with the interactive system.

For example, if one system uses version 0 and the other systems use version 0, all systems become to use version 0. You can make sure the version to use BFD session with **show bfd neighbor [details]**.

BFD Restrictions

The BFD restrictions of U9016B switch are as follows:

- It only supports asynchronous mode. It can start BFD session although some BFD peer.
- It supports BGP, OSPF, and static routing.
- It can make BFD session of maximum 128 numbers. When you make the session more than 128 number, the following message is displayed.
 - %BFD-5-SESSIONLIMIT: Attempt to exceed session limit of 128 neighbors.
- It provides all BFD functions from control plane. So if the CPU utilization increases, the error detection possibility by packet loss increases. In this case, you must adjust required minimum receive interval with proper value.

Default BFD Configuration

The following table shows the basic BFD configuration.

Table 216 Default BFD Configuration

| Feature | Default Setting |
|-----------------------------------|-----------------------------|
| BFD | Enable. |
| Interface passive mode | Active mode. |
| BFD Echo packet reception | Disable |
| BFD Echo mode | No use |
| Desired transmit interval | 750 msec (Multihop session) |
| Required minimum receive interval | 500 msec (Multihop session) |
| Multiplier | 3 (Multihop session) |
| BFD Slow-timer | 1000 msec |

Desired transmit interval, Required minimum receive interval and Multiplier are important BFD session parameters. To make BFD single hop session, you set this parameter value directly with **bfd interval** command.

If **bfd multihop-peer** configuration for BFD multihop session does not exist, use defined value in the table.

Configuring BFD

This section describes BFD configuration as follows:

- Configuring BFD session parameters on the interface
- Configuring BFD multi-hop session parameters
- Configuring BFD support for BGP
- Configuring BFD support for OSPF
- Configuring BFD support for static routing
- Configuring Passive Mode on the Interface
- Configuring BFD slow timer
- Configuring BFD echo mode
- Monitoring and Troubleshooting BFD

Configuring BFD session parameters on the interface

To configure BFD session parameters on the interface, do the following tasks.

Table 217 Configuring BFD session parameters on the interface

| Step | Command or Action | Purpose |
|---------------|--|---|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configuration mode. |
| Step 2 | interface <i>interface-name</i> Example: Switch(config)# interface gi2/2/1 | Enter the Interface configuration mode. |
| Step 3 | ip address <i>ip-address/prefix-length</i> Example: Switch(config-if-Giga2/2/1)# ip address 33.1.1.1/24 | Sets IP address on interface. |
| Step 4 | bfd interval <i>minlliseconds</i> min_rx <i>milliseconds</i> multiplier <i>interval-multiplier</i> Example: Switch(config-if-Giga2/2/1)# bfd interval 750 min_rx 500 multiplier 3 | Sets BFD parameter on interface. |
| Step 5 | end Example: Switch(config-if-Giga2/2/1)# end | Returns the privileged EXEC mode. |



Note

You must set BFD parameter on relevant interface with **bfd interval** command to make single-hop BDF session

Configuring multi-hop BFD session parameters

You must configure multi-hop BFD session parameters per BFD peer. To configure multi-hop BFD session parameters, do the following tasks.

Table 218 Configuring multi-hop BFD session parameters

| Step | Command or Action | Purpose |
|--------|---|---------------------------------------|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configuration mode. |
| Step 2 | bfd multihop-peer A.B.C.D interval minlliseconds min_rx milliseconds multiplier interval-multiplier Example: Switch(config)# bfd multihop-peer 10.1.1.1 interval 750 min_rx 500 multiplier 3 | Sets multi-hop BFD session parameter |
| Step 3 | End Example: Switch(config)# end | Returns the Privileged EXEC. |

Configuring BFD support for BGP

To configure BFD on BGP, do the following tasks.

Table 219 Configuring BFD support for BGP

| Step | Command or Action | Purpose |
|--------|---|---|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configuration mode. |
| Step 2 | router bgp as-tag Example: Switch(config)# router bgp 100 | Enters the BGP router mode. |
| Step 3 | neighbor ip-address fall-over bfd Example: Switch(config-router)# neighbor 3.3.3.2 fall-over bfd | Enables BFD for checking connection status with BGP neighbor. |
| Step 4 | end | Returns to the Privileged EXEC. |

| | | |
|--|--|--|
| | Example: Switch(config-router)# end | |
|--|--|--|

Configuring BFD support for OSPF

You can configure BFD on OSPF with the following ways.

- You can make BFD session for all OSPF interface excepting OSPF virtual link with **bfd all-interface** command in OSPF routing configuration mode.
- You can make BFD session for specific interface of OSPF with **ip ospf bfd** command in the interface mode.

Configuring BFD support for OSPF for all interface

To configure BFD session on all OSPF interface, do the following tasks.

Table 220 Configuring BFD support for OSPF for all interface

| Step | Command or Action | Purpose |
|---------------|---|---|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters Global configuration mode. |
| Step 2 | router ospf process-id Example: Switch(config)# router ospf 10 | Enter OSPF routing configuration mode. |
| Step 3 | bfd all-interfaces Example: Switch(config-router)# bfd all-interface | Set to make BFD session for all OSPF interface. |
| Step 4 | exit Example: Switch(config-router)# exit | Return to Global configuration mode. |
| Step 5 | interface type number Example: Switch(config)# interface gi2/1/1 | Enter Interface configuration mode. |
| Step 6 | bfd interval milliseconds min_rx milliseconds multiplier interval-multiplier Example: Switch(config-if-Giga2/2/1)# bfd interval 750 min_rx 500 min 3 | Sets BFD session parameter value on OSPF interface. |
| Step 7 | interface type number Example: Switch(config)# interface gi2/2/1 | Enters interface configuration mode (Optional). |
| Step 8 | ip ospf bfd [disable] Example: Switch(config-if-Giga2/2/1)# ip ospf bfd disable | Disable BFD session for specific OSPF interface. disable keyword command must be used only for interace |

| | | |
|---------------|--|---------------------------------|
| | | enabled BFD. |
| Step 9 | end Example: Switch(config-if-Giga2/2/1)# end | Return to Privileged EXEC mode. |

Configure BFD Support for OSPF for One or More Interface

To configure BFD session on the specific OSPF interface, do the following tasks.

Table 221 Configure BFD Support for OSPF for One or More Interface

| Step | Command or Action | Purpose |
|---------------|--|--|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters Global configuration mode. |
| Step 2 | interface <i>type number</i> Example: Switch(config)# interface gi2/1/1 | Enters Interface configuration mode. |
| Step 3 | bfd interval <i>minlliseconds</i> min_rx <i>milliseconds</i> multiplier <i>interval-multiplier</i> Example: Switch(config-if-Giga2/2/1)# bfd interval 750 min_rx 500 multiplier 3 | Sets BFD parameter on interface. |
| Step 4 | ip ospf bfd [disable] Example: Switch(config-if-Giga2/1/1)# ip ospf bfd | Sets to make BFD session via OSPF interface. |
| Step 5 | end Example: Switch(config-if-Giga2/1/1)# end | Return to Privileged EXEC mode. |

Configuring BFD support for Static routing

To configure BFD for Static routing, do the following tasks.

Table 222 Configuring BFD support for Static routing

| Step | Command or Action | Purpose |
|---------------|---|--|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configuration mode. |
| Step 2 | interface <i>interface-name</i> Example: Switch(config)# interface gi2/2/1 | Enters the Interface configuration mode. |
| Step 3 | ip address <i>ip-address/prefix-length</i> Example: | Assigns ip adderss on interface. |

| | | |
|---------------|---|--|
| | Switch(config-if-Giga2/2/1)# ip address 1.1.1.1/24 | |
| Step 4 | bfd interval milliseconds min_rx milliseconds multiplier interval-multiplier Example: Switch(config-if-Giga2/2/1)# bfd interval 750 min_rx 500 min 3 | Sets BFD session parameter value on interface. |
| Step 5 | Exit Example: Switch(config-if-Giga2/2/1)# exit | Return to Global configuration mode. |
| Step 6 | ip route A.B.C.D/M gateway-addr Example: Switch(config)# ip route 7.0.0.0/8 1.1.1.254 | Sets static router. |
| Step 7 | ip route static bfd IFNAME gateway-addr Example: Switch(config)# ip route static bfd gi2/2/1 1.1.1.254 | Assign BFD neighbor of static route. |
| Step 8 | end Example: Switch(config)# end | Return to Privileged EXEC mode. |

Configuring Passive Mode on the Interface

After BFD passive mode receives packet from another BFD neighbor to BFD control, start to send BFD control packet. In other words, it does not send BFD control packet at first. If BFD runs with passive mode, you set interface with the following tasks.

If you set all routers in the network with BFD passive mode, the BFD does not run. At least BFD of one system must run with active mode.

Table 223 Configuring Passive Mode on the Interface

| Step | Command or Action | Purpose |
|---------------|---|---------------------------------------|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configuration mode. |
| Step 2 | interface <i>interface-name</i> Example: Switch(config)# interface gi2/2/1 | Enters Interface configuration mode. |
| Step 3 | bfd passive Example: Switch(config-if-Giga2/2/1)# bfd passive | Sets interface with BFD passive mode. |
| Step 4 | end Example: Switch(config-if-Giga2/2/1)# end | Return to Privileged EXEC mode. |

Configuring BFD Echo Mode

The system that receives BFD echo packet from BFD echo mode returns this packet to the sending system. In case of using BFD Echo packet, the sending period of BFD control packet is longer. So you can reduce BFD control packet number sent or received between BFD neighbors. The default setting of BFD echo mode is enabled.

Table 224 Configuring BFD Echo Mode

| Step | Command or Action | Purpose |
|---------------|---|---|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configuration mode. |
| Step 2 | bfd echo [accept send] Example: Switch(config)# bfd echo | Enable BFD echo mode. - accept keyword use when it receive Echo packet. - send keyword use when it sends Echo packet. |
| Step 3 | end Example: Switch(config)# end | Returns Privileged EXEC mode. |

Configuring BFD slow timer

In case that BFD session status dose not Up, to configure BFD slow timer, do the following tasks.

Table 225 Configuring BFD slow timer

| Step | Command or Action | Purpose |
|---------------|--|---------------------------------------|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configuration mode. |
| Step 2 | bfd slow-timer <i>milliseconds</i> Example: Switch(config)# bfd slow-timer 2000 | Sets BFD slow timer. |
| Step 3 | end Example: Switch(config)# end | Returns Privileged EXEC mode. |

Displaying BFD information

Table 226 Displaying BFD information

| Step | Command or Action | Purpose |
|---------------|---|--|
| Step 1 | show bfd neighbor [detail] Example: Switch# show bfd neighbor details | Shows BFD adjacency database (optional). - Detail keyword shows all BFD protocol parameter and timer. |
| Step 2 | debug bfd [echo event fsm loopback neighbor nsm packet] Example: Switch# debug bfd packet | Shows debugging information about BFD (Optional). |

BFD Configuration Samples

The section includes the following examples:

- Sample One: Configuring BFD in an OSPF Network
- Sample Two: Configuring BFD in an BGP Network
- Sample Three: Configuring BFD for static routing

Sample One: Configuring BFD in an OSPF Network

This example describes the way of using BFD in OSPF network. Let us assume the following network configuration.

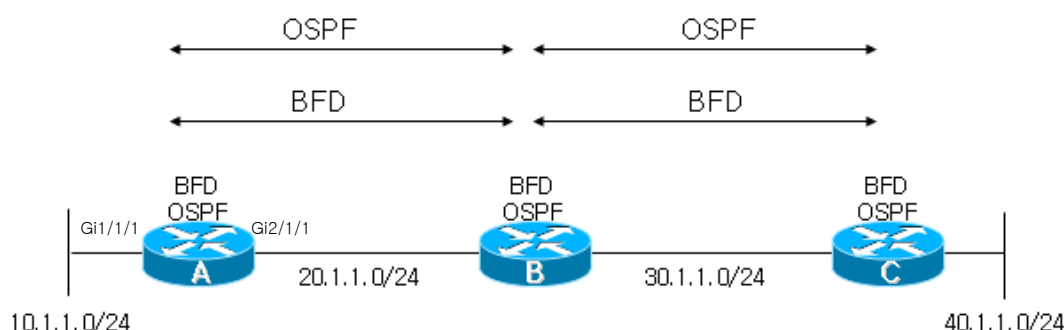


Figure 49. Configuring BFD in an OSPF Network

You must set BFD on OSPF interface. To set BFD on OSPF interface, do the following tasks.

- Set BFD on all OSPF interface.
- Set BFD on specific OSPF interface optionally.

Configuring BFD Support for OSPF for All Interfaces

To use BFD on all OSPF interface, do the following tasks.

Table 227 Configuring BFD in an OSPF Network

| Step | Description |
|--------|---|
| Step 1 | Set OSPF. Switch_A# configure terminal Switch_A(config)# router ospf 100 Switch_A(config-router)# network 10.1.1.0/24 area0 Switch_A(config-router)# network 20.1.1.0/24 area0 |
| Step 2 | Sets BFD session parameter. Switch_A# configure terminal Switch_A(config)# interface gi2/1/1 Switch_A(config-if-Giga2/1/1)# bfd interval 300 min_rx 300 multiplier 3 |
| Step 3 | Enables BFD on all OSPF interface. |

| | |
|--------|---|
| | Switch_A# configure terminal Switch_A(config)# router ospf Switch_A(config-router)# bfd all-interfaces |
| Step 4 | Disables BFD session to interface not to connect with OSPF neighbor. Switch_A# configure terminal Switch_A(config)# interface gi1/1/1 Switch_A(config-if-Giga1/1/1)# ip ospf bfd disable |
| Step 5 | Shows BFD peer information. Switch_A# show bfd neighbors |



Note

If you disable BFD at the specific interface only with being set the bfd all-interface status, use **ip ospf bfd disable** command.

The configuration of switch is as follows.

```
!
interface Giga1/1/1
 ip address 10.1.1.1/24
 ip ospf bfd diable
!
interface Giga2/1/1
 ip address 20.1.1.1/24
 bfd interval 300 min_rx 300 multiplier 3
!
router ospf 100
 network 10.1.1.0/24 area0
 network 20.1.1.0/24 area0
 bfd all-interfaces
!
```

Configuring BFD Support for OSPF for One or More Interfaces

To use BFD on specific OSPF interface, do the following tasks.

Table 228 BFD on specific OSPF interface

| Step | Description |
|--------|---|
| | Sets OSPF |
| Step 1 | Switch_A# configure terminal Switch_A(config)# router ospf 100 Switch_A(config-router)# network 10.1.1.0/24 area0 Switch_A(config-router)# network 20.1.1.0/24 area0 |

| | |
|--------|---|
| Step 2 | Sets Single hop BGP session and sets bfd session parameter. Switch_A# configure terminal Switch_A(config)# interface gi2/1/1 Switch_A(config-if-Giga2/1/1)# bfd interval 300 min_rx 300 multiplier 3 |
| Step 3 | Sets BFD on the specific OSPF interface. Switch_A# configure terminal Switch_A(config)# interface gi2/1/1 Switch_A(config-if-Giga2/1/1)# ip ospf bfd |
| Step 4 | Shows BFD peer information.. Shows BFD peer. Switch_A# show bfd neighbors |

The configuration of switch is as follows.

```

!
interface Giga2/1/1
ip address 20.1.1.1/24
ip ospf bfd
bfd interval 300 min_rx 300 multiplier 3
!
router ospf 100
network 10.1.1.0/24 area0
network 20.1.1.0/24 area0
!

```

Sample Two: Configuring BFD in an BGP Network

This example describes the way of using BFD in BGP network.

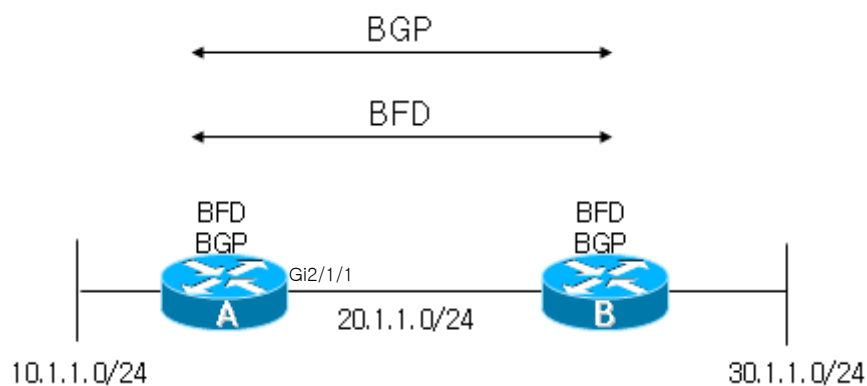


Figure 50. Configuring BFD in an BGP Network

You must configure BFD per each BGP neighbor. You set BGP to BGP neighbor and the ways setting BFD session parameter differ according to the following two cases.

- Configuring BFD Support for connected external BGP
- Configuring BFD Support for Multihop-External BGP and Internal BGP

Configuring BFD Support for connected external BGP

To use BFD about specific BGP peer on BGP, do the following tasks.

Table 229 Configuring BFD in an BGP Network

| Step | Description |
|---------------|--|
| Step 1 | Sets BGP. Switch_A# configure terminal Switch_A(config)# router bgp 80 Switch_A(config-router)# neighbor 20.1.1.81 remote-as 81 |
| Step 2 | Sets BFD to specific neighbor and session on BGP. Switch_A# configure terminal Switch_A(config)# router bgp 80 Switch_A(config-router)# neighbor 20.1.1.81 fall-over bfd |
| Step 3 | Enables Single hop BGP session and sets bfd session parameter. Switch_A# configure terminal Switch_A(config)# interface gi2/1/1 Switch_A(config-if-Giga2/1/1)# bfd interval 300 min_rx 300 multiplier 3 |
| Step 4 | Shows BFD peer information. Switch_A# show bfd neighbors |

The configuration of switch is as follows.

```
!
interface Giga2/1/1
 ip address 20.1.1.1/24
 bfd interval 300 min_rx 300 multiplier 3
!
router bgp 80
 neighbor 20.1.1.81 remote-as 81
 neighbor 20.1.1.81 fall-over bfd
!
```

Configuring BFD Support for Internal BGP

To use BFD on internal BGP, do the following tasks.

Table 230 BFD on internal BGP

| Step | Description |
|--------------------|--|
| Step 1 | Sets Internal BGP. Switch_A# configure terminal Switch_A(config)# router bgp 80 Switch_A(config-router)# neighbor 20.1.1.81 remote-as 80 |
| Step 2 | Sets BGP to use BFD to session with specific neighbor. Switch_A# configure terminal Switch_A(config)# router bgp 80 Switch_A(config-router)# neighbor 20.1.1.81 fall-over bfd |
| Step 3 (Option) | Sets Multihop bfd session parameter Switch_A# configure terminal Switch_A(config)# bfd multihop-peer 20.1.1.81 interval 900 min_rx 500 multiplier 3 |
| Step 4 | Shows BFD peer information. Switch_A# show bfd neighbors |

The configuration of switch is as follows.

```

!
interface Giga2/1/1
 ip address 20.1.1.1/24
!
bfd multihop-peer 20.1.1.81 interval 900 min_rx 500 multiplier 3
!
router bgp 80
 neighbor 20.1.1.81 remote-as 80
 neighbor 20.1.1.81 fall-over bfd
!

```

Sample Three: Configuring BFD for static routing

This example describes the way of using BFD in the network using static routing.

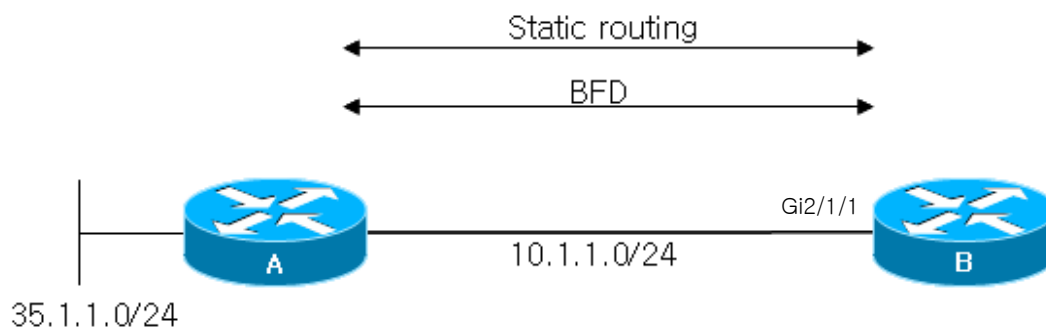


Figure 51. Configuring BFD for static routing

If you use BFD to check that next-hop to specific static router is active status actually, do the following tasks:

Table 231 Configuring BFD for static routing

| Step | Description |
|--------|--|
| Step 1 | Sets Static route. Switch_B# configure terminal Switch_B(config)# ip route 35.1.1.0/24 10.1.1.254 |
| Step 2 | Enables Single hop BGP session and sets bfd session parameter. Switch_B# configure terminal Switch_B(config)# interface gi2/1/1 Switch_B(config-if-Giga2/1/1)# bfd interval 300 min_rx 300 multiplier 3 |
| Step 3 | Enable BFD for failure detection with next hop of Static route. Switch_B# configure terminal Switch_B(config)# ip route static bfd gi2/1/1 10.1.1.254 |
| Step 4 | Shows BFD peer information. Switch_B# show bfd neighbors |



Note

To become BFD session to UP status, you must also set BFD on Switch A conneted with Switch B interface.

The configuration of Switch_B is as follows:

```
!  
interface Giga2/1/1
```

```
ip address 10.1.1.1/24
bfd interval 300 min_rx 300 multiplier 3
!
ip route 35.1.1.0/24 10.1.1.254
ip route static bfd gi2/1/1 10.1.1.254
```

Chapter 14. LACP

This chapter describes how to configure IEEE 802.3ad Link Aggregation Control Protocol (LACP) on the switch.

**Note**

For the syntax and direction of commands used in this chapter, refer to Command Reference.

This chapter consists of the following sections:

- Understanding the Link Aggregation Control Protocol
- Configuring 802.3ad Link Aggregation Control Protocol and static link aggregation
- Displaying 802.3ad Statistics and Status

Understanding Link Aggregation Control Protocol

Link Aggregation Control Protocol (LACP) is part of an IEEE specification (802.3ad) that allows you to bundle several physical ports together to form a single logical channel. LACP allows a switch to negotiate an automatic bundle by sending LACP packets to the peer.

This chapter includes the following descriptions:

- LACP Concept
- LACP Modes
- LACP Parameters

LACP Modes

Port group configuration of Premier U9016BA can be done manually or automatically with IEEE 802.3ad LACP (Link Aggregation Control Protocol).

To configure port group with LACP, use the active or passive mode. To start automatic port group configuration with LACP, at least one end of the link needs to be configured to active mode to initiate negotiating. This is due to that ports in passive mode passively respond to initiation and never imitate the sending LACP packets.

The following shows the possible mode in LACP.

Table 232 LACP Modes

| Mode | Description |
|---------|---|
| on | This mode do not create port group by LACP. It creates static port group. |
| passive | LACP mode that places a port into a passive negotiating state. The port responds to LACP packets only when it receives the LACP packets and does not start LACP packet negotiation first. |
| active | LACP mode that places the port into an active negotiating state, in which the port starts negotiations with other port by sending LACP packets. |

LACP Parameters

The parameters used in configuring LACP are as follows:

- System Priority

System priority must be assigned in the switch that is running LACP. System priority can be configured automatically or through the CLI. System priority is used with the switch MAC address to form the system ID and is also used during negotiation with other systems.

- Port Priority

Port priority must be configured in each port of the switch automatically or through CLI. The port priority is used with the port number to form the port identifier. The port priority is used to decide which ports should be configured in standby mode when there is a hardware limitation that prevents all compatible ports from aggregating.

- Administrative key

Administrative key is assigned to each port of switch according to feature of port automatically. Administrative key feature are bandwidth, vlan id, duplex, and mtu. In case of the same value, the port can be a part of logical interface.

When LACP is enabled, LACP always attempts to aggregate the maximum number of ports. If LACP is not able to aggregate all the ports that are compatible, then all the ports that cannot be aggregated are put in hot standby state and are used only if one of the port group ports fails.

Configuring LACP and SLA

This section describes how to configure port group with LACP:

- Specifying the System Priority
- Specifying the Port Priority
- Specifying an Administrative Key Value
- Specifying the Timeout Value
- Configuration LACP and static port group
- Clearing LACP Statistics

Specifying the System Priority

The system priority value should be an integer between 1 and 65535. Higher the number represents lower the priority. The default priority is 32768.

To specify LACP system priority, follow the step below from privileged EXEC mode:

Table 233 Specifying the System Priority

| Step | Command | Purpose |
|--------------|---|--|
| Step1 | configure terminal | Enters Global configuration mode |
| Step2 | lacp system-priority <i>priority</i> | Specifies the system priority |
| Step3 | end | Return the privileged EXEC mode |
| Step4 | show lacp sys-id | Checks the setting |
| Step5 | copy running-config startup-config | Saves the setting in configuration file (Optional) |

To return the system priority to default setting, use Global configuration command “no lacp system-priority”

This example shows how to specify the system priority as “20000”.

```
Switch# configure terminal
Switch(config)# lacp system-priority 20000
Switch(config)# end
```

Specifying the Port Priority

The port priority value should be an integer between 1 and 65535. Higher numbers represent lower priority and the default priority is 32768.

To specify the port priority, follow the step below from privileged EXEC mode.

Table 234 Specifying the Port Priority

| Step | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | To enter Global configuration mode. |
| Step2 | interface <i>interface-id</i> | To enter to interface configuration mode. |
| Step3 | lacp port-priority <i>priority</i> | To specify the port priority |
| Step4 | end | To return to privileged EXEC mode |
| Step5 | show running-config | To check the setting |

| | | |
|--------------|---|--|
| Step6 | copy running-config startup-config | To save the setting in configuration file (Optional) |
|--------------|---|--|

To return the port priority to default setting, use Interface Configuration Command “no lacp port-priority”

The following example shows how to set the port-priority of interface gi6/1 to 10.

```
Switch# configure terminal
Switch(config)# interface Giga6/1
Switch(config-if-Giga6/1)# lacp port-priority 10
Switch(config)# end
```

Specifying the Timeout Value

LACPDU Timeout Value of port can be specified. The timeout value can be short (1sec) or long (30 sec).



Note **lacp timeout** command affects to LACPDU sending period of the relative switch.

To specify the timeout value, follow the steps below from the Privileged EXEC Mode.

Table 235 Specifying the Timeout Value

| Step | Command | Purpose |
|--------------|--|--|
| Step1 | configure terminal | To enter Global configuration mode |
| Step2 | interface <i>interface-id</i> | Enter to interface configuration.mode. |
| Step3 | lacp timeout {short long} | To specify LACPDU Timeout |
| Step4 | end | To return to privileged EXEC mode |
| Step5 | show running-config | To check the setting |
| Step6 | copy running-config startup-config | To save the setting in configuration file (Optional) |

To return the LACPDU Timeout as default, use Interface Configuration Command “no **lacp timeout**”.

The following example shows how to set the transmission interval of LACPDU that is connected to gi6/1 to short.

```
Switch# configure terminal
Switch(config)# interface Giga6/1
Switch(config-if- Giga6/1)# lacp timeout short
Switch(config)# end
```

Configuration LACP and static port group

You can configure the interface of LACP mode.

To change the LACP mode, follow the steps below from the Privileged EXEC Mode.

Table 236 Configuration LACP and static port group

| Step | Command | Purpose |
|--------------|---|---|
| Step1 | configure terminal | Enters Global configuration mode |
| Step2 | interface <i>interface-id</i> | Enters the interface configuration mode. |
| Step3 | Channel-group <i>po-id</i> mode {active on passive} | Set port group mode. active, passive: LACP mode on: static port group |
| Step4 | end | Return the privileged EXEC mode |
| Step5 | show running-config | Checks the setting |
| Step6 | copy running-config startup-config | Saves the setting in configuration file (Optional) |

This example shows how to set the interface giga 6/1 as a port-group 1 member.

```
Switch# configure terminal
Switch(config)# interface Giga6/1
Switch(config-if- Giga6/1)# channel-group 1 mode active
Switch(config)# end
```

The following example shows how to create port-group by static mode.

```
Switch# configure terminal
Switch(config)# interface Giga6/1
Switch(config-if- Giga6/1)# channel-group 1 mode on
Switch(config)# end
```

Clearing LACP Statistics

To clear/delete LACP statistics, follow the steps below from the privilege EXEC mode.

Table 237 Clearing LACP Statistics

| Step | Command | Purpose |
|--------------|---|--|
| Step1 | clear lacp [<i>aggregator-id</i>] counters | Clears LACP statistics of the port group |
| Step2 | show lacp counters | Checks the modification |

The following is an example of deleting LACP statistics of port group 1.

```
Switch# clear lacp 1 counters
```

Displaying 802.3ad Statistics and Status

U9016B provides various commands to show the information of all ports.

Table 238 Displaying 802.3ad Statistics and Status

| Command | Purpose |
|----------------------------------|--|
| show etherchannel | Shows the information of port conneted with port group. |
| show etherchannel summary | Shows the brief information of port connected with port group. |
| show etherchannel detail | Shows the detail information of port conneted with port group. |

The following example shows how to show the information of the static port group.

```
shu#show etherchannel
Channel-group listing:
-----

Group: 1
-----
Group state = L2
Ports: 1    Max Maxports = 8
Port-channels: 1 Max Port-channels = 8
Protocol=    -

shu#show etherchannel summary
Flags:  D - down          P - bundled in port-channel
        I - stand-alone  s - suspended
        H - Hot-standby (LACP only)
        R - Layer3       S - Layer2
        U - in use       f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
Number of channel-groups in use: 1
Number of aggregators:          1

Group  Port-channel  Protocol    Ports
-----+-----+-----+-----
1      Po1(SD)        -           Gi6/1(D)

shu#show etherchannel detail
Channel-group listing:
-----

Group: 1
-----
Group state = L2
Ports: 1    Max Maxports = 8
Port-channels: 1 Max Port-channels = 8
Protocol=    -
```

Ports in the group:

Port: Gi6/1

Port state = Down Not-in-Bndl
Channel group = 1 Mode = On Gcchange = -
Port-channel = NULL GC = - Pseudo port-channel= Port-
chan
nel1
Port index = 0 Load = 0x00
Protocol = -

Age of the port in the current state: 0d:16h44m24s

Port-channels in the group:

Port-channel: Port-channel1

Age of the Port-channel = 0d:0h0m18s
Number of ports = 0
GC = 0x00000000 HotStandBy port= null
Port state = Down Ag-Not-Inuse
Protocol = -
shu#

To search/check LACP statistics, use the privileged EXEC command “**show lacp counters**”.

To search/check LACP statistics of the specific port group, use the privileged EXEC command “**show lacp aggregator-id counters**”.

To search/check LACP protocol information and status of switch, use the privileged EXEC command “**show lacp internal**”. To search/check LACP protocol information and status of the relative switch, use the privileged EXEC command “**show lacp neighbor**”.

Chapter 15. IP-OPTION

This chapter describes the IP-OPTION of system.

IP OPTION is the function to enable/disable the parameters related with attack prevention of the parameters under `/proc/sys/net/ipv4` provided by linux kernel.

IP OPTOIN command

The parameters that can be set by IP OPTION are as follows.

Table 239 IP OPTION command

| Command | Description | Mode |
|---|--|--------|
| ip option icmp-drop icmp-type (any <0-255> echo-request echo-reply) length <1-65535> | Sets the icmp-type and packet size for blocking ICMP packets. | Config |
| no ip option icmp-drop | Disables ICMP packet blocking. | Config |
| ip icmp-ttl-exceed-send | Enables/Disables to send TTL Exceed ICMP errors. Default: send | Config |
| no ip icmp-ttl-exceed-send | Disables to send TTL Exceed ICMP errors. | Config |
| ip option icmp-unreachable-send | Allows / blocks to send ICMP unreachable. Default: send | Config |
| no ip option icmp-unreachable-send | Disable to send ICMP unreachable errors. | Config |
| ip option ip_default_ttl VALUE | Sets the Default TTL size. Default: 64 | Config |
| no ip option ip_default_ttl | Changes the Default TTL size to the default value. | Config |
| ip option ipfrag_time VALUE | Sets the duration of IP fragment in the memory. Default: 30 | Config |
| no ip option ipfrag_time | Changes the duration of IP fragment in the memory to the default value. | Config |
| ip option tcp-conn-rate-limit profile-id <1-128> (any PORT) period <1-3600> count <1-65535> | Adds a TCP connection rate-limit profile. TCP connection trials to the TCP destination port within period for more than the count value can be logging or blocked. | Config |
| no ip option tcp-conn-rate-limit profile-id <1-128> | Deletes the TCP connection rate-limit profile for the Profile-id. | Config |
| ip option tcp_fin_timeout VALUE | Sets the socket duration in FIN-WAIT-2 state. Default: 60 | Config |
| no ip option tcp_fin_timeout | Change the socket duration in FIN-WAIT-2 state to the default value. | Config |
| ip option tcp_keepalive_probes VALUE | Sets the number of keepalive probe message to generate by the time the connection is determined to be disconnected. | Config |

| | | |
|---|--|--------|
| | Default: 9 | |
| no ip option tcp_keepalive_probes | Changes the number of Keepalive probe messages to the default value. | Config |
| ip option tcp_keepalive_time <i>VALUE</i> | Sets the keepalive message transmit time when Keepalive is activated. Default: 7200 | Config |
| no ip option tcp_keepalive_time | Changes the Keepalive message transmit time to the default value. | Config |
| ip option tcp_max_syn_backlog <i>VALUE</i> | Sets the maximum value of TCP syn backlog queue. Default: 1024 | Config |
| no ip option tcp_max_syn_backlog | Changes the maximum value of TCP syn backlog queue to the default value. | Config |
| ip option tcp_max_tw_buckets <i>VALUE</i> | Sets the number of Timewait sockets. Default: 18700 | Config |
| no ip option tcp_max_tw_buckets | Changes the number of Timewait sockets to the default value. | Config |
| ip option tcp_retries1 <i>VALUE</i> | Sets the number of retransmits for suspected TCP session. Default: 3 | Config |
| no ip option tcp_retries1 | Changes the number of retransmits for suspected TCP session. | Config |
| ip option tcp_retries2 <i>VALUE</i> | Sets the number of retransmits before termination. Default: 15 | Config |
| no ip option tcp_retries2 | Changes the number of retransmits before termination to the default value. | Config |
| ip option tcp_syn_retries <i>VALUE</i> | Sends the initialization SYN packet after the specified time for retransmission in active TCP connection. Default: 5 | Config |
| no ip option tcp_syn_retries | Changes the TCP syn re-transmission time to the default value. | Config |
| ip option tcp_syncookies (default disable enable) | Sets Syn flood attack defense. Default: enable | Config |
| ip option telnet-acl access-group <1-99> | Sets to allow/block Telnet from accessing to the access-groups. | Config |
| no ip option telnet-acl access-group <1-99> | Disables telnet access limit configuration by Access-group. | Config |

Chapter 16. VRRP

This chapter describes the VRRP configuration of system.

Virtual Router Redundancy Protocol (VRRP) is a protocol that allows two or more routers to have same virtual IP address to provide multiple access routes in the LAN, with one of the routers elected as a virtual router. VRRP router uses VRRP protocol to communicate with other routers connected to the LAN. If a router is elected as a master virtual router in VRRP configuration, the other routers will stand by as backup in case of any failure in the master virtual router.

Information about VRRP

VRRP Operation

- Proxy ARP – The client uses Address Resolution Protocol (ARP) to get its own destination and the router will reply to the ARP request using its own MAC address.
- Routing protocol – The host makes its routing table with using update information of dynamic routing protocol.
- IRDP (ICMP Router Discovery Protocol) client – The client runs Internet Control Message Protocol (ICMP) router discover client.

If you use dynamic protocol, need to set about host and it occurs overhead by running protocol. Moreover, when router has trouble, the switching may be delayed to another router.

One of alternatives to the dynamic protocol is to set a default router for the clients. This method is very simple in terms of client configuration and operation. But if there is any failure in the default gateway, the LAN client will be disconnected from the external network.

VRRP can solve static configuration problems. VRRP allows router groups to form a virtual router. LAN client elects the virtual router as its own default gateway. The virtual router standing for the router group is also called VRRP group.

The following figure describes the topology of LAN with VRRP set. In this example, the router A, B and C are the VRRP routers (VRRP running routers) that consists virtual routers. The IP address of the virtual router is set to the IP address same as that of the router A (10.0.0.1).

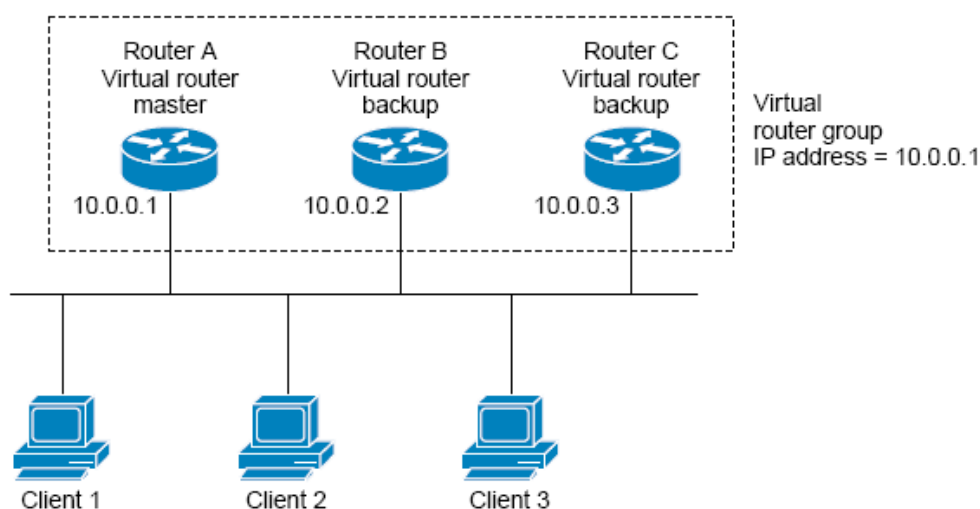


Figure 52. Basic VRRP Topology

Because the virtual router uses the physical address of the router A, router A takes the role of master virtual router and is called IP address owner. The router A, as the master virtual router, controls the IP address of the virtual router, and takes in charge of forwarding of packets forwarded to this IP address. Set the IP address of the default gateway to 10.0.0.1 for Client 1 through 3.

The router B and C work as backup virtual routers. If there is a failure in the master virtual router, the router with higher priority becomes the master virtual router to continue provision of services to the LAN hosts. If the router A is recovered from the failure, it becomes the master virtual router again.

The following figure shows the example in which the VRRP is set to make the router A and the router B share the traffic. The router A and the router B work as backup virtual routers for each other.

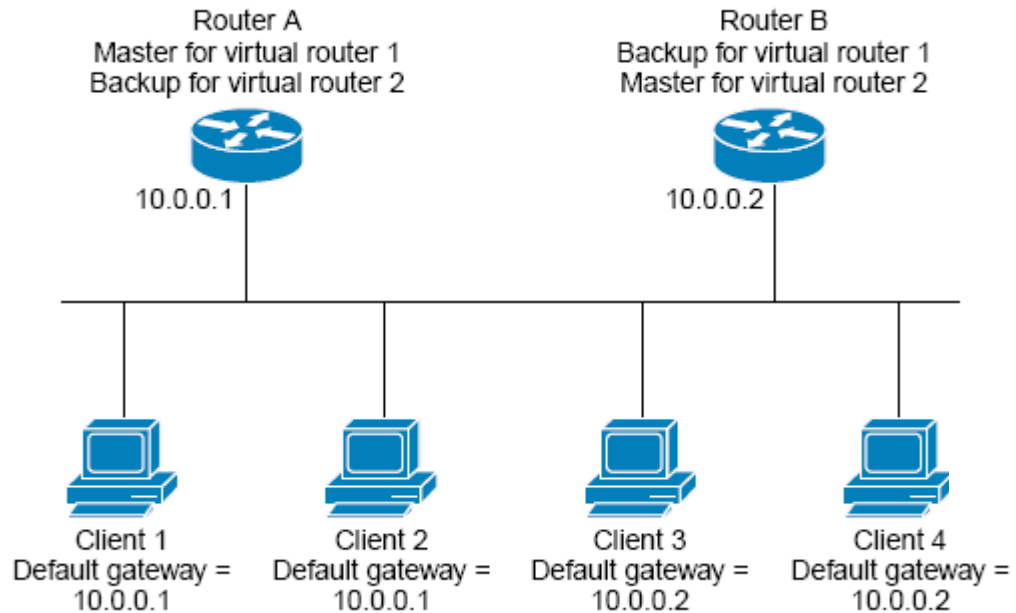


Figure 53. Load Sharing and Redundancy VRRP Topology

In this topology, two virtual routers are configured. In the virtual router 1, the router A is the host of IP address 10.0.0.1 and the master virtual router, while router B is the backup virtual router for the router A. Client 1 and 2 use 10.0.0.1 for the IP address of the default gateway.

In the virtual router 2, the router B is the owner of IP address 10.0.0.2 and the master virtual router, and the router A is a backup virtual router for the router B. The client 3 and the client 4 use 10.0.0.2 for the IP address of the default gateway.

VRRP Benefits

Redundancy

VRRP enables you to set two or more routers as default gateway router. This decreases the risk of single point of failure in the network.

Load Sharing

VRRP can be set to make the traffic from LAN clients to be distributed to multiple routers. In this way, the load of traffics can be distributed to several routers.

Multiple Virtual Routers

VRRP supports up to 255 virtual routers (VRRP group). By supporting several virtual routers, it is possible to support redundancy and load sharing in the LAN configuration.

Preemption

The redundancy scheme of VRRP allows the router with higher priority, when it becomes available, to be elected as the master virtual router on behalf of other backup virtual routers.

Advertisement Protocol

VRRP uses exclusive Internet Assigned Numbers Authority (IANA) standard multicast address (224.0.0.18) for VRRP advertisement. IANA assigns the IP protocol No. 112 to VRRP.

VRRP circuit fail-over

By changing VRRP priority according to status of interface, VRRP circuit fail-over supports that optimum VRRP router becomes master virtual router.

Multiple Virtual Router Support

For single physical interface of a router, maximum 255 virtual routers can be set. The number of actual virtual routers that a router can support is affected by the following factors:

- Process capability of the router
- Memory capacity of the router
- Maximum number of MAC addresses that the interface of router can provide

VRRP Router Priority and Preemption

One of important factors in VRRP redundancy function is VRRP router priority. If there is a failure in the master virtual router, the role of VRRP router is determined according to the priority.

If a VRRP router has the IP address of the virtual router as the IP address of its own physical interface, this router works as the master virtual router.

The priority becomes the basis for electing the master virtual router among the VRRP routers working as back virtual routers when there is a failure in the master virtual router. **vrrp priority** command can be used to set the priority of backup virtual routers in the range of 1 ~ 254.

For example, if there is a failure in the router A, that is, the master virtual router in the LAN, alternative master virtual router should be elected among the backup virtual router B and C according to the election procedure. If the priority of the router B and the router C is set to 101 and 100 respectively, the router B becomes the master virtual router since its priority is higher. If the priority of both router B and router C is set to 100, the backup virtual router with higher IP address will be elected as the master virtual router.

The preemptive scheme will be applied to allow the backup virtual router with higher priority to become the master virtual router. **no vrrp preempt** command can be used to bring preemptive scheme to an end. If Preemption is inactivated, the backup virtual router that has become the master virtual router continues to carry out the role of the master till the original master virtual router is recovered to become the master again.

VRRP Advertisements

The master virtual router transmits the VRRP advertisement to other VRRP routers in the same group. In this Advertisement, the priority and status information of the master virtual router are included. VRRP advertisement is made in IP packet and transmitted to the IPv4 multicast address assigned to the VRRP group. The advertisement is transmitted every second by Default, and the transmission interval can also be set.

VRRP Circuit failover

The circuit failover function of VRRP monitors interface status. You can set interface for monitoring with **circuit-falover** command. VRRP reduces or increase priority value of virtual router according to tracking interface status

How to Configure VRRP

This section covers the following procedures:

- Enabling VRRP
- Disabling VRRP
- Customizing VRRP
- Configuring VRRP circuit fail-over

Enabling VRRP

To enable VRRP, do the following steps.

Table 240 Enabling VRRP

| Step | Command or Action | Purpose |
|--------|--|--|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters Global configure mode |
| Step 2 | interface interface-name Example: Switch(config)# interface gi2/2/10 | Enters Interface configuration mode |
| Step 3 | ip address ip-address/prefix-length Example: Switch(config-if-Gi2/2/10)# ip address 33.1.1.1/24 | Specifies the IP address of interface |
| Step 4 | router vrrp virtual-ID interface-name Example: Switch(config)# router vrrp 3 gi2/2/10 | Enters the Router configuration mode |
| Step 5 | virtual-ip ip-address Example: Switch(config-router)# virtual-ip 33.1.1.1 | Enables VRRP on the interface and set virtual-ip Note: All the routers in the VRRP group should be set to the same IP address. If other IP address is to be set, the routers in the VRRP group can't communicate with each other, and the router with wrong configuration will work as the master by itself. |
| Step 6 | enable Example: | Enables vrrp session |

| | | |
|---------------|---|--|
| | Switch(config-router)# enable | |
| Step 7 | End Example: Switch(config-router)# end | Returns the privileged EXEC mode |
| Step 8 | show vrrp Example: Switch# show vrrp | Shows the status of VRRP group of the router (Optional) |
| Step 9 | show vrrp <i>virtual-ID interface-name</i> Example: Switch# show vrrp gi2/2/10 | Shows information of VRRP group set in a specific interface (Optional) |

Disabling VRRP on an Interface

It is possible to disable only the protocol operation while keeping VRRP settings, by disabling VRRP on the interface. Using **show running-config** command you can check the settings of VRRP group and whether or not VRRP is working.

Table 241 Disabling VRRP on an Interface

| Step | Command or Action | Purpose |
|---------------|---|--------------------------------------|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configure mode |
| Step 2 | router vrrp <i>virtual-ID interface-name</i> Example: Switch(config)# router vrrp 3 gi2/2/10 | Enters the Router configuration mode |
| Step 3 | disable Example: Switch(config-router)# disable | Disables a specific vrrp session |

Customizing VRRP

To customize options, follow the steps below.

Table 242 Customizing VRRP

| | Command or Action | Purpose |
|---------------|---|--------------------------------------|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configure mode |
| Step 2 | router vrrp <i>virtual-ID interface-name</i> Example: Switch(config)# router vrrp 3 gi2/2/10 | Enters the Router configuration mode |

| | | |
|---------------|---|---|
| | Example: Switch(config)# router vrrp 3 gi2/2/10 | |
| Step 3 | advertisement-interval interval Example: Switch(config-router)# advertisement-interval 3 | Sets VRRP advertiment period sending from VRRP master. - default : 1 second Note: You must set routers in one VRRP group with the same period. |
| Step 4 | preempt-mode [true false] Example: Switch(config-router)# preempt-mode true | Sets to allow if the router that is higher priority than current virtual master router as a new master. |
| Step 5 | priority level Example: Switch(config-router)# priority 200 | Sets the priority of VRRP router - default is 100 |

Configuring VRRP circuit failover

If you set VRRP circuit failover, do the following task. If the set interface is down with this command, the VRRP reduce priority value of router as much as specific value.

If VRRP group is owner of IP address, the priority of VRRP group fixes 255. The priority does not change with circuit failover.

Table 243 Configuring VRRP circuit failover

| Step | Command or Action | Purpose |
|---------------|---|---|
| Step 1 | configure terminal Example: Switch# configure terminal | Enters the Global configure mode |
| Step 2 | router vrrp virtual-ID interface-name Example: Switch(config)# router vrrp 1 gi2/2/1 | Enters the Router configuration mode |
| Step 3 | circuit-failover interface-name PriorityDelta Example: Switch(config-router)# circuit-failover gi1/1/1 10 | Sets the interface that effect to priority of VRRP group with interface status and value reducing priority value. |
| Step 4 | show vrrp Example: Switch# show vrrp | Shows the status of VRRP group of the router (Optional) |

Configuration Examples for VRRP

Configuring VRRP: Example

In the following examples, the switch A and the switch B belong to 3 VRRP groups. The configuration of each group is as follows:

- Group 1:

The virtual IP address is 10.1.0.10.

The switch A becomes the master of this group, since its priority value is 120.

Advertising interval is 3 seconds.

Preemption is activated.

- Group 5:

The switch B becomes the master of this group, since its priority value is 200.

Advertising interval is 10 seconds.

Preemption is activated

- Group 100:

The switch A becomes the master of this group, since it has highest IP address (10.1.0.2).

The Advertising interval is 1 second by default.

Preemption is inactivated.

Router A

```
router vrrp 1 vlan1
    virtual-ip 10.1.0.10 backup
advertisement-interval 3
priority 120
router vrrp 5 vlan1
    virtual-ip 10.1.0.50 backup
    advertisement-interval 10
router vrrp 100 vlan1
    virtual-ip 10.1.0.100 backup
    preempt-mode false
```

Router B

```
router vrrp 1 vlan1
    virtual-ip 10.1.0.10 backup
    advertisement-interval 3
router vrrp 5 vlan1
    virtual-ip 10.1.0.50 backup
    priority 200
    advertisement-interval 10
router vrrp 100 vlan1
    virtual-ip 10.1.0.100 backup
    preempt-mode false
```

VRRP circuit failover: Example

In the following examples, the tracking process is set to track the line protocol status of interface vlan10. VRRP on the interface vlan1 is registered to the tracking process to be able to get the information on changes of protocol status in the interface vlan10. If the line protocol status of interface vlan10 turns to down, the priority value of VRRP group decreases by 15.

```
router vrrp 3 vlan1
    virtual-ip 33.1.1.1 backup
    priority 120
    circuit-failover vlan10 15
```

VRRP Circuit fail-over Verification: Example

The following example is to track the settings made in “VRRP circuit failover: Example” section.

```
Switch# show vrrp
Address family IPv4
  State is Master
  Virtual IP address is 33.1.1.1 (Not-owner)
  Virtual MAC address is 0000.5e00.0101
  Advertisement interval is 1 sec
  Preemption is enabled
  Priority is 120, Current priority is 120
  Master Router is 33.1.1.3 (), priority is 120
  Master Advertisement interval is 1 sec
  Master Down interval is 4 sec
  Circuit failover interface vlan10, Priority Delta 15, Status UP
```

Disabling a VRRP Group on an Interface: Example

The following example explains how to shutdown the VRRP group on interface vlan1 while keeping the settings of interface VRRP group.

```
router vrrp 3 vlan1
  virtual-ip 33.1.1.1 backup
  priority 120
  disable
```

Chapter 17. NTP

This chapter describes the NTP configuration of system.

U9016B provides time-of-day service. NTP (Network Time Protocol) synchronizes timekeeping among a set of distributed time servers and clients. This synchronization allows events to be correlated when system logs are created and other time-specific events occur.

Understanding Time Sources

The system has two clocks. One is hardware clock (Refer to “calendar” Command) maintained by battery. The other is software clock (Refer to “clock” Command). These two clocks are managed separately.

The default time source is software clock. The software clock maintains current time from system start time. The software clock can be set from variable source and sent with various ways to another system. When system initializes or restarts, software clock initializes with using hardware clock. You can changes with using the following sources.

- Network Time Protocol (NTP)
- Passive Setting (Hardware clock)

Software clock manages time information based on Coordinated Universal Time (UTC) or Greenwich Mean Time (GMT). You can set time zone and daylight savings time for supporting time information of the place where the system run in.

Network Time Protocol

NTP (Network Time Protocol) synchronizes timekeeping among a set of distributed time servers and clients. This synchronization allows events to be correlated when system logs are created and other time-specific events occur.

Hardware Clock

Even if the system is restarted or turned off, the system has hardware clock maintained by battery for maintaining current time. When the system is restarted, you use the hardware clock for initializing software clock.

Configuring NTP

This chapter describes how to configure NTP with the following procedure.

- Configuring Poll-Based NTP Associations
- Configuring NTP Authentication
- Configuring the Source IP Address for NTP Packets
- Configuring the System as an Authoritative NTP Server
- Updating the Hardware Clock

Configuring Poll-Based NTP Associations

The network system using NTP provides various modes in order to synchronize between time source and system clock. There are two ways for obtaining the time information from network. One is poll-based association from host server and the other is listening NTP information from broadcast network. This section describes server request mode from Server.

The following modes are server request modes used by user generally.

- Client mode
- Symmetric active mode

In case of client mode, the system researches the time servers for getting current time information. The system synchronizes one of them. In this case, because the system and time servers are client and server relation, the system does not use time information that another-client equipment sends. This mode is useful for system that does not provide time information to another local client. You can use `ntp server` command for setting time server that you want to synchronize time to client mode.

In case of Symmetric active mode, the system researches the time servers for getting current time information and provides time information to local host. Because this mode is peer- to-peer relation, the system also saves the time information of local network equipment on networking. This mode must use when mutual crossing servers exist via complex network path. Most of stratum 1 and stratum 2 sever use this type network setting. When you set Symmetric active mode, use `ntp peer` command.

To decide NTP mode depend on equipment's role (server or client) and statum 1 server setting.

Table 244 Setting NTP Server

| Command | Purpose |
|--|--------------------------------|
| Switch(config)# ntp server <i>ip-adress</i> | Sets NTP with Client mode. |
| Switch(config)# ntp peer <i>ip-adress</i> | Sets NTP with Symmetric active |

Configuring NTP Authentication

Before you use NTP, you must do authentication procedure. This procedure starts from creating NTP packet.

After NTP authentication is set correctly, the system synchronizes reliable time source and time. When you send or receive encrypted NTP packet, use the following command in the global configuration mode.

Table 245 Configuring NTP Authentication

| Step | Command or Action | Purpose |
|---------------|---|--|
| Step 1 | Switch(config)# ntp authenticate | Enables NTP authentication. |
| Step 2 | Switch(config)# ntp authentication-key <i>key-number md5 value</i> | Defines authentication key. |
| Step 3 | Switch(config)# ntp trusted-key <i>key-number</i> | Defines trusted-key. If authentication key is trusted key, the system tries to synchronize time with the system using this key in NTP packet. |
| Step 4 | Switch(config)# ntp server <i>ip-address</i> key <i>key-number</i> | Enables to synchronize software clock and NTP time server. |

Configuring the Source IP Address for NTP Packets

When the system sends NTP packet, the source IP address of NTP packet is set with interface address that sends NTP packet. If you want to set specific interface IP address, execute the following command.

Table 246 Configuring the Source IP Address for NTP Packets

| Command | Purpose |
|---|-------------------------------------|
| Switch(config)# ntp source <i>interface</i> | Assign interface to get ip address. |

Configuring the System as an Authoritative NTP Server

When you synchronize hardware clock with NTP time, execute the following command in the config mode.

Table 247 Configuring the System as an Authoritative NTP Server

| Command | Purpose |
|---|----------------------------|
| Switch(config)# ntp master [<i>stratum</i>] | Sets system as NTP server. |

The system provides stratum 1 service. However, we do not recommend this service because the RF or Atom clock that can connect to equipment does not exist.

Updating the Hardware Clock

You can set to update hardware clock by software clock from equipment having hardware clock. We recommend the NTP because software clock is more accurate than hardware clock.

When you synchronize hardware clock with NTP time, execute the following command in the config mode.

Table 248 Updating the Hardware Clock

| Command | Purpose |
|--|--|
| Switch(config)# ntp update-calendar | Sets update calendar with software clock periodically. |

Configuring Time and Date Manually

If you have not available time source, you can set current time directly after system runs.

Configuring the Time Zone

When you set timezone information, execute the following commands in the config mode.

Table 249 Configuring the Time Zone

| Command | Purpose |
|--|---|
| Switch(config)# clock timezone <i>zone hours-offset [minutes-offset]</i> | Sets timezone. Zone: name of timeband. Minutes-offset: interval minutes with UTC. |

Configuring Summer Time (Daylight Savings Time)

If you set daylight savings time, execute the following commands in the config mode.

Table 250 Configuring Summer Time (Daylight Savings Time)

| Command | Purpose |
|---|---|
| Switch(config)# clock summer-time <i>zone recurring [week day month hh:mm week day month hh:mm [offset]]</i> | Sets recurring start and end summer time. Offset: minute |

If daylight saving time does not repeat per every year, you can set the exact day when daylight saving time start. The following command shows how to set it.

Table 251 Configuring Summer Time

| Command | Purpose |
|--|--|
| Switch(config)# clock summer-time <i>zone date month date year hh:mm month date year hh:mm [offset]</i> | Sets specific start and end summer time. Offset: minute |
| or | |
| Switch(config)# clock summer-time <i>zone date date onth date year hh:mm date month year hh:mm [offset]</i> | |

Manually Setting the Software Clock

Generally, if system has hardware clock or synchronizes effective way like NTP, you do not need set software clock. If you have not useful time source, use this following command.

When you set software clock directly, use the following commands.

Table 252 Manually Setting the Software Clock

| Command | Purpose |
|---|----------------------|
| Switch# clock set <i>hh:mm:ss day month year</i> | Sets software clock. |
| or | |
| Switch# clock set <i>hh:mm:ss month day year</i> | |

Using the Hardware Clock

The system has hardware clock. The hardware clock is a chip that has chargeable battery. Even though you restart the system, the system can maintain the information of time.

The software clock must receive the time information from reliable time source for maintaining exact time information. The software clock must update hardware clock time periodically while the system runs.

The following tasks are for setting hardware clock.

- Setting the Hardware Clock
- Setting the Software Clock from the Hardware Clock
- Setting the Hardware Clock from the Software Clock

Setting the Hardware Clock

Hardware clock manages the time separately. The hardware clock runs continuously even if the system is restarted or turned off. Generally, the hardware clock is only set once when the system is set up.

If you have reliable external time source, you must not set hardware clock directly. The time will synchronize with using NTP.

If you have not external time source, execute the following command in EXEC mode in order to hardware clock.

Table 253 Setting the Hardware Clock

| Command | Purpose |
|--|---------------------|
| Switch# calendar set <i>hh:mm:ss day month year</i> or Switch# calendar set <i>hh:mm:ss month day year</i> | Sets Hardware Clock |

Setting the Software Clock from the Hardware Clock

When you set software clock with new hardware clock setting, execute the following commands in EXEC mode.

Table 254 Setting the Software Clock from the Hardware Clock

| Command | Purpose |
|------------------------------------|--|
| Switch# clock read-calendar | Sets software clock with hardware clock. |

Setting the Hardware Clock from the Software Clock

When you set hardware clock with new software clock setting, execute the following commands in EXEC mode.

Table 255 Setting the Hardware Clock from the Software Clock

| Command | Purpose |
|--------------------------------------|---|
| Switch# clock update-calendar | Sets hardware clock with softwareclock. |

Monitoring Time and Calendar Services

When you show clock, calendar, and NTP information, use the following commands.

Table 256 Monitoring Time and Calendar Services

| Command | Purpose |
|---|---|
| Switch# show calendar | Shows current hardware clock information. |
| Switch# show clock | Shows current software clock information. |
| Switch# show ntp associations [detail] | Shows NTP association status. |
| Switch# show ntp status | Shows ntp status. |

Configuration Examples

Clock, Calendar, and NTP Configuration Examples

The system that has hardware clock connects with two server system and update hardware clock periodically. Clock timezone KST 9

```
ntp update-calendar
ntp server 192.168.13.57
ntp server 192.168.11.58
```


Chapter 18. DAI

This chapter describes the function of dynamic Address Resolution Protocol (ARP) inspection (DAI) which is used for inspecting ARP packet.

**Note**

Refer to the command reference for detailed description on the CLI commands used in this chapter.

This chapter consists of the following sections:

- Understanding DAI
- Default DAI Configuration
- DAI Configuration Guidelines and Restrictions
- Configuring DAI
- DAI Configuration Samples

Understanding DAI

This section describes the basic function of DAI and the method to protect the ARP spoofing attack by using of DAI function. This section comprises following subsections:

- Understanding ARP
- Understanding ARP Spoofing Attacks
- Understanding DAI and ARP Spoofing Attacks
- Interface Trust States and Network Security
- Rate Limiting of ARP Packets
- Relative Priority of ARP ACLs and DHCP Snooping Entries
- Logging of Dropped Packets

Understanding ARP

ARP allows correlating IP address and MAC address by putting into a mapping table so that IP communication can be conducted within Layer 2 broadcast domain. For example, when host B wants to transmit data to host A, let's assume that there would be no registered MAC address of host A within the ARP table in host B.

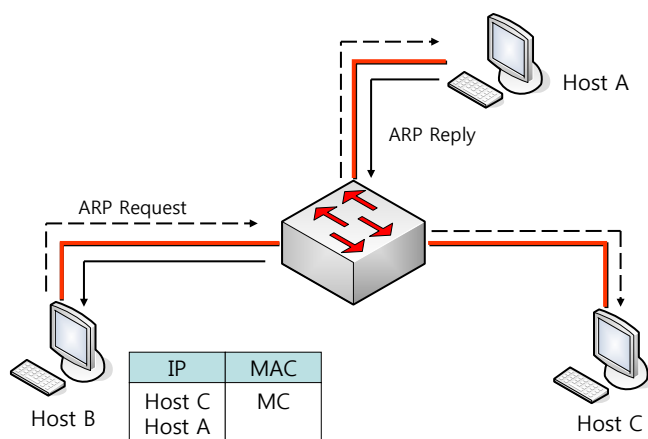


Figure 54. Understanding ARP

To find out the MAC address for host A's IP address, host B sends out broadcast message (ARP request) to all the hosts in the broadcast domain. Then all the hosts in the broadcast domain shall receive the ARP request which was sent by host B and host A will reply to this request with its MAC address.

Understanding ARP Spoofing Attacks

ARP unintentionally gets to have ARP table changed by the gratuitous reply which is sent by a host who has not received ARP request. Due to this defect, the ARP spoofing attack or ARP cache poisoning might happen. After this attack, the traffic of the victimized switch shall be transferred to other routers, switches or hosts via the attacker's computer.

ARP spoofing attack affects the ARP cache of the host, switch, or router which are connected in the Layer 2 network. And it intercepts the traffics which are intended for other network. The following figure shows the example of ARP cache poisoning.

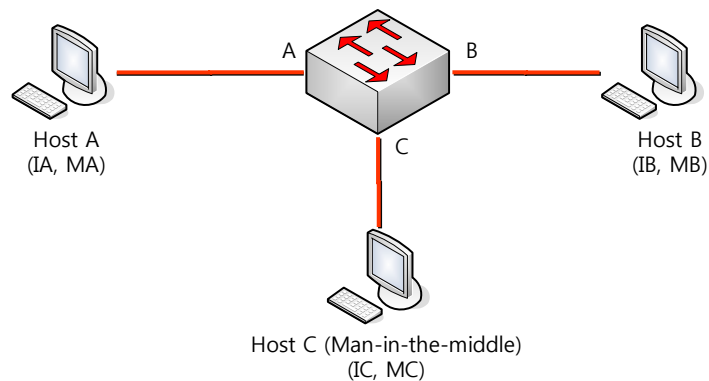


Figure 55. Understanding ARP Spoofing Attacks

Host A, B and C are interconnected through the interfaces A, B, and C of the switch centered in the picture, and they are all in same subnet. The IP address and MAC address are shown in parenthesis in the figure. For example, host A uses IP address, 'IA' and MAC address, 'MA'. When host A needs to communicate with host B in IP layer, in order to know the related MAC address of IP address 'IB' it sends out ARP request in broadcast manner. And if the switch and host B receive the ARP request, they update their ARP cache so as to replace the IP address IA and MAC address MA with latest values.

Host C may pollute the ARP cache of host A and host B by which it sends out broadcasted ARP response that includes the faked MAC address, 'MC' at here for IP address IA (or IB). The host that has a polluted ARP cache shall use the MAC address of MC as the destination for the traffic which is intended to be heading for IA or IB. This means that host C intercepts the traffic. Host C knows the genuine MAC address of IA and IB, it can forward the intercepted traffic by inserting the right MAC address to the originally targeted host. Thus host C is placed in between host A and host B, and this symptom is called as '*man-in-the middle attack*'.

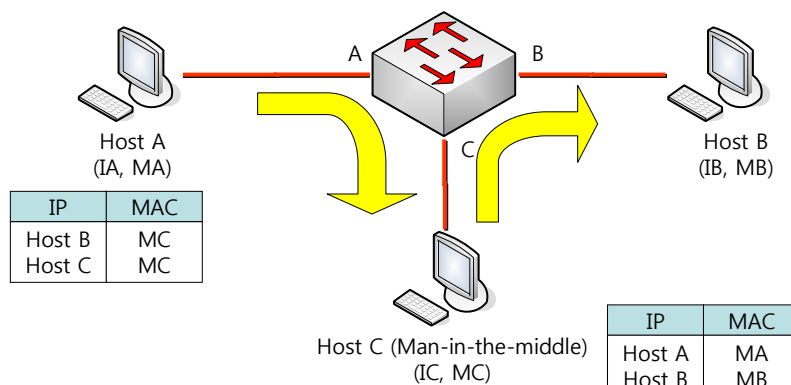


Figure 56. Understanding ARP Spoofing Attacks

Understanding DAI and ARP Spoofing Attacks

DAI is a security function that is used to check out ARP packet. DAI inspects invalid IP-to-MAC address binding and drop the ARP packet after logging the relevant information. This feature protects network from the man-in-the-middle attack.

DAI makes sure the ARP table be changed only by valid ARP request and response. The switch that is enabled for DAI function behaves as the following:

- Check out and inspect all ARP packets that come through the untrusted ports.
- Check out the received packets whether it has the valid IP-to-MAC address binding before updating its own ARP cache.
- Drop the invalid ARP packets.

When DAI checks out the validity of ARP packet, it utilizes the reliable data, which is an IP-to-MAC address binding stored in the DHCP snooping binding database.

**Note**

When switch and VLAN are enabled for DHCP snooping, by DHCP snooping the DHCP snooping binding database is created.

Switch behaves as follow according to the characteristics of the interface which receives the ARP packet:

- Switch does not inspect the ARP packet that come through the trusted interface.
- Switch permits only the valid packets in case the packets have arrived through the untrusted interface.

DAI may use ARP access control lists (ACLs) which administrator has defined with respect to a host that has statically assigned IP address. The switch may leave a log for the discarded packets.

In case of the following condition, DAI may be configured to discard ARP packets:

- When the IP address of the packets are invalid – for example 0.0.0.0, 255.255.255.255 or IP multicast address.
- When the MAC address in ARP packet body and the address of Ethernet header is not consistent.

Interface Trust States and Network Security

DAI basically maintains the information of trust status of each interface in the switch. With respect to the packets that come through the trusted interface, DAI will not take any forms of DAI inspection. On the contrary, for the packets from untrusted interface, DAI inspection will duly take place.

In a typical network formation, the switch ports which are connected to a host are to be configured as 'untrusted' and the switch ports to another switch are to be configured as 'trusted'. In this configuration, all the coming ARP packets into the switch will be inspected. And no more validity inspections in VLAN or other network segment will be needed. To configuring trust setting, you can use the command **'ip arp inspection trust'**.



Caution

For security check purpose, if you want to have the switch inspect all the ARP packets, a particular function is required. That is to say, DAI should be able to have the switch CPU get trapped so that unicast ARP packets to be forwarded through forwarding engine can be inspected. To enable the unicast ARP packets to be inspected, refer to the section 19.4.1.

In the figure below, consider that the DAI would be enabled for the VLAN which contains host 1 and host 2 of switch A and switch B respectively. If host 1 and host 2 have been assigned IP address from the DHCP server that is connected to switch A, then only switch A has the IP-to-MAC address mapping information for host 1. Therefore, if the interface between switch A and switch B would be untrusted, then the ARP packet that host 1 has sent out will be discarded at switch B. Thus, host 1 and host 2 cannot communicate each other.

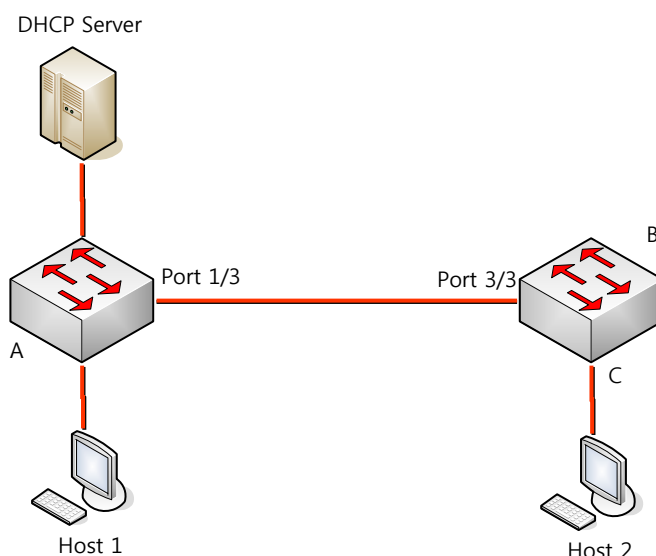


Figure 57. Interface Trust States and Network Security

If there would be any unreliable device within the network when an interface is set to be trusted, there could be a certain kinds of security defects. If DAI is not enabled in switch A, host 1 might pollute the ARP cache of switch B (And if the interface between the switches is set to trusted, then as many as including host 2). This kind of anomaly would happen even when DAI in switch B is in active.

A switch that is enabled to execute DAI prevents its connected hosts from polluting other host's ARP cache. However, DAI is not able to prevent the unwanted pollution that might affect other hosts which are in DAI active.

In this case, you need to configure the interface between DAI-enabled switch and DAI-disabled switch to be untrusted. And to make sure to inspect the packets from the DAI-disabled switch, you need to set the ARP ACLs in DAI-enabled switch. If this configuration would be unable to be set, you ought to separate switches as to whether it uses DAI or not.



Note

U9016B switch support the DAI features that inspect all ARP packets.

Rate Limiting of ARP Packets

The DAI-enabled switch will control the number of ARP packets that come into the switch CPU. As a default value, with respect to untrusted interface, 15 ARP packets per second (15 pps) are allowed meanwhile there is no limitation on the rate for trusted interface. You can configure the setting by use of the command **ip arp inspection limit**.

If the rate of ARP packets at a specified port would be over the predefined value, the switch will discard all the received ARP packets at the port. This behavior shall be maintained until user would change the configuration. By use of the command **ip arp inspection limit auto-recovery**, you can make the port get back to available status after a certain amount of time.



Note

The rate limit function toward ARP packets are performed at CPU in software manner, you cannot count on it for Denial-of-Service (DoS) attack.

Relative Priority of ARP ACLs and DHCP Snooping Entries

When DAI checks out the IP-to-MAC address mapping, it used DHCP snooping binding database.

ARP ACLs are used for inspection before DHCP snooping binding database. The switch will use ACL only when it is configured by '**ip arp inspection filter**' command. The switch will inspect ARP packets with ARP ACLs. If the ARP packet is consistent with the deny condition of ARP ACLs, the packet will be discarded even when there is valid binding that has been made by valid DHCP snooping.

Logging of Dropped Packets

The switch will keep the information about the discarded packets at log buffer and generate system message according to the ratio that has been set in advance. Once the message is generated, the corresponding information at the log buffer will be deleted. In each log there are the flow information including received VLAN id, port number, source and destination IP address, source and destination MAC address.

By use of global configuration command '**ip arp inspection log-buffer**' you can adjust the size of buffer and number of log per unit time so as to control the total volume of created messages. And with the global configuration command '**ip arp inspection vlan logging**' you can specify the type of packets to log.

Default DAI Configuration

The following table shows the default DAI configuration.

Table 257 Default DAI Configuration

| Feature | Default Setting |
|------------------------------------|--|
| DAI | 'Inactive' for all VLAN. |
| Interface trust state | 'Untrusted' for all interfaces. |
| Rate limit of incoming ARP packets | 15 pps for untrusted interfaces. In case of Trusted interfaces, there is no limitation on rate. Burst interval is 1second. The rate limit for interfaces is in 'Disabled' status. |
| ARP ACLs for non-DHCP environments | ARP ACLs is not defined. |
| Validation checks | No inspection is to be conducted. |
| Log buffer | When DAI is enabled, all ARP packet which is denied or dropped will be logged. The number of log entry is 32. The number of system message generated is 5 per second. The period of logging-rate 1 second . |
| Per-VLAN logging | All ARP packet which is denied or dropped will be logged. |

DAI Configuration Guidelines and Restrictions

When DAI is configured, you have to keep the followings in mind:

- DAI basically takes care of the ARP table only in the switch. As a better method to protect whole network, the trap function which will have ARP packet to be processed in CPU.
- DAI is intended to be used as an ingress security tool. You ought not to use it at an egress port.
- DAI is not effective for the hosts that are connected to the DAI-disabled switch. As the man-in-the-middle attack is confined to a single Layer 2 broadcast domain, you ought to separate a domain which adopts DAI from other domains which don't use DAI. This will make sure that the ARP table of the switch that are in DAI activated domain.
- DAI uses the DHCP snooping binding database in order to check the IP-to-MAC address binding of the coming ARP request and ARP response packets. To allow the ARP packets which will have dynamically assigned IP address, you ought to activate DHCP snooping.
- If DHCP snooping is inactive or DHCP is not in use, then you can utilize ARP ACL to permit or deny packets.
- Configure to set the rate of ARP packets considering the characteristics of the port.

Configuring DAI

In this section, the way to configure DAI is explained:

- Enabling DAI on VLANs (Mandatory)
- Configuring the DAI Interface Trust State (Optional)
- Applying ARP ACLs for DAI Filtering (Optional)
- Configuring ARP Packet Rate Limiting (Optional)
- Enabling DAI Error-Disabled Recovery (Optional)
- Enabling Additional Validation (Optional)
- Configuring DAI Logging (Optional)
- Displaying DAI Information

Enabling DAI on VLANs

When DAI is enabled for a VLAN, the switch will inspect the ARP packets that come through the VLAN as following:

- Broadcasted ARP packet
- ARP request packets that ask for MAC address of switch
- Reply packets that answer to the requesting ARP request
- All unicast ARP packets that are transferred among terminals

After checking out these packets, it only replies the valid packets and updates the ARP table.

To enable DAI on a VLAN, execute the following commands.

Table 258 Enabling DAI on a VLAN

| Command | Purpose |
|--|---------------------------------|
| Switch# configure terminal | Enter Global configuration mode |
| Switch(config)# ip arp inspection vlan <i>vlan-id</i> | To enable DAI on a VLAN |
| Switch(config)# no ip arp inspection vlan <i>vlan-id</i> | To disable DAI on a VLAN |
| Switch# show ip arp inspection | To check the setting |



Note

When you enable DAI on a VLAN, all the ARP packets that flow through the VLAN will be inspected. In other words, the ARP cache of the switch and network are to be protected.

The following example shows how to enable DAI on VLAN 200:

```
Switch# configure terminal
Switch(config)# ip arp inspection vlan 200
```

The following example shows how to retrieve current settings:

Switch# **show ip arp inspection**

DHCP Snoop Bootstrap : Disabled

Source MAC Validation : Disabled

Destination MAC Validation : Disabled

IP Address Validation : Disabled

ARP Field Validation : Disabled

| Vlan | Config | Operation | ACL Match | Static ACL | ACL Log | DHCP Log |
|------|---------|-----------|-----------|------------|---------|----------|
| 200 | Enabled | Active+ | | No | Deny | Deny |

If the system uses DAI about unicast ARP packet, you must set a trap to send ARP packet to CPU with using class-map and policy-map.

The following example shows how to set received ARP packet on VLAN 200 to CPU..

Switch(config)#class-map arp_trap_class

Switch(config-cmap)#match ethertype 0806

Switch(config-cmap)#end

Switch#show class-map

CLASS-MAP-NAME: arp_trap_class (match-all)

Match Ethertype: 0806

Switch#config terminal

Switch(config)#policy-map arp_trap_map

Switch(config-pmap)#class arp_trap_class

Switch(config-pmap-c)#trap-cpu

Switch(config-pmap-c)#exit

Switch(config-pmap)#exit

Switch(config)#int vlan200

Switch(config-if-Vlan200)#service-policy input arp_trap_map

Switch#show policy-map

POLICY-MAP-NAME: arp_trap_map

State: attached

CLASS-MAP-NAME: arp_trap _class (match-all)

Trap-cpu

Switch#show service-policy

Interface Vlan200 : input dhcp_user_map

Configuring the DAI Interface Trust State

Switch will not inspect the ARP packets that come from trusted interface.

The received ARP packets that come through the untrusted interface will be inspected to verify whether it has valid IP-to-MAC address mapping. Switch will discard invalid packets and save a packet log in log buffer by use of '**ip arp inspection vlan logging**' command.

To configure the trust status of an interface, use the following commands.

Table 259 IP OPTION command

| Command | Purpose |
|-----------------------------------|------------------------------------|
| Switch# configure terminal | To enter global configuration mode |

| | |
|---|---|
| Switch(config)# interface <i>ifname</i> | To specify the interfaces that are connected to other switched and also get in the mode of configuring interface. |
| Switch(config-if-Giga1/1)# ip arp inspection trust Switch(config-if-Giga1/1)# no ip arp inspection trust | To configure the interface to be trusted (default: untrusted) |
| Switch(config-if-Giga1/1)# end | To get back to Enable mode |
| Switch# show ip arp inspection interfaces | To check the setting |

The following example shows how to set Gigabit port 1/1 for trust.

```
Switch# configure terminal
Switch(config)# interface gi1/1
Switch(config-if-Giga1/1)# ip arp inspection trust
Switch(config-if-Giga1/1)# end
Switch# show ip arp inspection interfaces
```

| Interface | Trust State | Rate (pps) | Burst Interval | Auto Recovery |
|-----------|-------------|------------|----------------|---------------|
| Giga1/1 | Trusted | None | 1 | Disabled |

Applying ARP ACLs for DAI Filtering

To utilize ARP ACL feature, use the following commands.

Table 260 Applying ARP ACLs for DAI Filtering

| Command | Purpose |
|--|--------------------------------------|
| Switch# configure terminal | Enters the global configuration mode |
| Switch(config)# ip arp inspection filter <i>arp_acl_name</i> vlan <i>vlan-id</i> [static] | Enters apply ARP ACL to a VLAN |
| Switch(config)# end | Return the Enable mode. |
| Switch# show ip arp inspection | Shows the running information. |

The following example shows how to apply the ARP ACL whose name is "example_arp_acl" to VLAN 200.

```
Switch# configure terminal
Switch(config)# ip arp inspection filter example_arp_acl vlan 200
Switch(config)# end
Switch# show ip arp inspection
```

| DHCP Snoop Bootstrap | | | | : Disabled | | | |
|---------------------------------------|---------|-----------|-----------------|------------|---------|----------|--|
| Source MAC Validation | | | | : Disabled | | | |
| Destination MAC Validation : Disabled | | | | | | | |
| IP Address Validation | | | | : Disabled | | | |
| ARP Field Validation | | | | : Disabled | | | |
| Vlan | Config | Operation | ACL Match | Static ACL | ACL Log | DHCP Log | |
| 200 | Enabled | Active | example_arp_acl | No | Deny | Deny | |

Configuring ARP Packet Rate Limiting

Once DAI is enabled then all ARP packets are to be inspected, which will take a lot of CPU capability. Then consequently the switch will be vulnerable to the DoS attack which mainly bombarded ARP packets. Thus by putting a certain amount of limitation on the CPU it can control the amount of ARP packets to be processed rate and lessen the burden of CPU.



Note

The ARP rate limit that is provided by DAI is a software feature, so it cannot control the usage rate of CPU in direct measure. However by reducing the ARP packets which are to be handled by DAI, the CPU usage rate by DAI can be lowered.

To set the rate limit upon ARP packets for a port, do the following steps.

Table 261 Configuring ARP Packet Rate Limiting

| Command | Purpose |
|---|---|
| Switch# configure terminal | Enters global configuration mode |
| Switch(config)# interface <i>ifname</i> | Specifies the interface that is connected to other switches and to enter interface configuration mode |
| Switch(config-if-Giga1/1)# ip arp inspection limit { <i>rate pps</i> [<i>burst interval seconds</i>] none } | Sets ARP packet rate limit (Optional) |
| Switch(config-if-Giga1/1)# no ip arp inspection limit | To go back to default configuration |
| Switch(config-if-Giga1/1)# ip arp inspection limit enable | To enable the ARP rate limit of an interface |
| Switch(config-if-Giga1/1)# no ip arp inspection limit enable | To disable the ARP rate limit of an interface |
| Switch(config)# end | To go back to Enable mode |
| Switch# show ip arp inspection interfaces | To check the setting |

When you set the ARP packet rate limit, pay attention to the following items.

- Default value for untrusted interface is 15 pps (packet per second), and for trusted interface is no limitation at all.
- **rate** is the upper limit value in terms of *pps* which may have between 0 to 2048.
- **rate none** means there is no limitation on the rate of received ARP packets.
- **burst interval seconds** (default is 1) is the time duration for which the system will watch to see if ARP packet rate is over the upper limit. Thus, if the value of **rate** is reached during the time lapse of **burst interval**, then the incoming ARP packets will be restricted. The range is 1 ~ 15 (Optional).
- If the incoming ARP packet rate is over the predefined value, the switch will discard all the received ARP packets at the port. This setting will be maintained until the operator would change the setting.
- While the rate-limit of an interface is not changed, if the trust status of an interface is changed, then the default value of the rate-limit of an interface will be changed. Once rate-limit value is changed, then even though the trust status would be changed, the configured value will be maintained. By use of the command '**no ip arp inspection limit**' the rate-limit of an interface will be returned to default value.
- After configuring by use of the command '**ip arp inspection limit enable**' the rate limit for ARP packet will be activated.

The following example shows how to configure ARP packet rate limit upon gi1/1.

```
Switch# configure terminal
Switch(config)# interface gi1/1
Switch(config-if-Giga1/1)# ip arp inspection limit rate 20 burst interval 2
Switch(config-if-Giga1/1)# ip arp inspection limit enable
Switch(config-if-Giga1/1)# end
Switch# show ip arp inspection interfaces
```

| Interface | Trust State | Rate (pps) | Burst Interval | Auto Recovery |
|-----------|-------------|------------|----------------|---------------|
| Giga1/1 | Untrusted | 20 | 2 | Disabled |

Enabling DAI Error-Disabled Recovery

Use the following steps in order to restore the restricted port, which has been restricted due to the rate limit for ARP packets, to normal.

Table 262 IP OPTION command

| Command | Purpose |
|--|---|
| Switch# configure terminal | Enter global configuration mode |
| Switch(config)# interface ifname | Specifies the interface that is connected to other switches and to enter interface configuration mode |
| Switch(config-if-Giga1/1)# ip arp inspection limit auto-recovery seconds Switch(config)# no ip arp inspection limit auto-recovery | Enables the automatic recovery function (Optional) To disable the automatic recovery function |
| Switch(config)# end | Return the Enable mode |
| Switch# show ip arp inspection interfaces | Checks the setting |

The following example shows the setting of recovering after 10 seconds automatically when ARP packet receiving on interface of gi 1/1 is disconnected by ARP rate limit.

```
Switch# configure terminal
Switch(config)# interface gi1/1
Switch(config-if-Giga1/1)# ip arp inspection limit auto-recovery 10
Switch(config-if-Giga1/1)# ip arp inspection limit enable
Switch(config-if-Giga1/1)# end
Switch# show ip arp inspection interfaces
```

| Interface | Trust State | Rate (pps) | Burst Interval | Auto Recovery |
|-----------|-------------|------------|----------------|---------------|
| gi1/1 | Untrusted | 20 | 2 | 10 |
| gi1/2 | Untrusted | 15 | 1 | Disabled |

Enabling Additional Validation

DAI can verify the validity of ARP packet's destination MAC address, sender and target IP address, source MAC address.

Use the following steps for validity check for IP address or MAC address.

Table 263 Enabling Additional Validation

| Command | Purpose |
|---|---|
| Switch# configure terminal | Enters global configuration mode |
| Switch(config)# ip arp inspection validate {dst-mac ip src-mac} | Enables additional validation test (Optional) (default: none) |
| Switch(config)# no ip arp inspection validate {dst-mac ip src-mac} | Disables additional validation test |
| Switch(config)# end | Goes back to Enable mode |
| Switch# show ip arp inspection | Checks the setting |

To enable the validation test, pay attention to the following items.

- At least one keyword among options should be used.
- Each '**ip arp inspection validate**' command nullify the former command. If, **ip arp inspection validate** command has enabled **src-mac** and **dst-mac** inspection first, and then the second command '**ip arp inspection validate**' enables only **ip** inspection, then the **src-mac** and **dst-mac** inspection will be disabled and only the **ip** inspection will be in its effect.
- Additional validation tests according to command arguments are as below :
 - **dst-mac** – With respect to the ARP response packet, it makes comparison between the destination MAC address in Ethernet header and the target MAC address in ARP body.
 - **ip** – It checks out the invalid IP address in ARP body. Thus addresses like 0.0.0.0 or 255.255.255.255 or multicast IP address will be discarded. It also verifies the sender IP address of ARP request and the sender/target IP address of ARP response.
 - **src-mac** – With respect to all ARP packets, it makes comparison between the source MAC address in Ethernet header and the sender MAC address in ARP body.

The following example shows how to enable the additive validity inspection as to the command argument 'src-mac':

```
Switch# configure terminal
Switch(config)# ip arp inspection validate src-mac
Switch(config)# end
Switch# show ip arp inspection
DHCP Snoop Bootstrap      : Disabled
Source MAC Validation     : Enabled
Destination MAC Validation : Disabled
IP Address Validation      : Disabled
ARP Field Validation      : Disabled
Vlan  Config  Operation  ACL Match  Static ACL  ACL Log  DHCP Log
----  -
200   Enabled  Active           No         Deny       Deny
```

The following example shows how to enable the additive validity inspection as to the command argument 'dst-mac':

Switch# **configure terminal**

Switch(config)# **ip arp inspection validate dst-mac**

Switch(config)# **end**

Switch# **show ip arp inspection**

DHCP Snoop Bootstrap : Disabled

Source MAC Validation : Disabled

Destination MAC Validation : Enabled

IP Address Validation : Disabled

ARP Field Validation : Disabled

| Vlan | Config | Operation | ACL Match | Static ACL | ACL Log | DHCP Log |
|------|---------|-----------|-----------|------------|---------|----------|
| 200 | Enabled | Active | | No | Deny | Deny |

The following example shows how to enable additional validation test as to command argument "ip".

Switch# **configure terminal**

Switch(config)# **ip arp inspection validate ip**

Switch(config)# **end**

Switch# **show ip arp inspection**

DHCP Snoop Bootstrap : Disabled

Source MAC Validation : Disabled

Destination MAC Validation : Disabled

IP Address Validation : Enabled

ARP Field Validation : Disabled

| Vlan | Config | Operation | ACL Match | Static ACL | ACL Log | DHCP Log |
|------|---------|-----------|-----------|------------|---------|----------|
| 200 | Enabled | Active | | No | Deny | Deny |

The following example shows to enable the additional validation test as to the command arguments 'src-mac' and 'dst-mac'.

Switch# **configure terminal**

Switch(config)# **ip arp inspection validate dst-mac src-mac**

Switch(config)# **end**

Switch# **show ip arp inspection**

DHCP Snoop Bootstrap : Disabled

Source MAC Validation : Enabled

Destination MAC Validation : Enabled

IP Address Validation : Disabled

ARP Field Validation : Disabled

| Vlan | Config | Operation | ACL Match | Static ACL | ACL Log | DHCP Log |
|------|---------|-----------|-----------|------------|---------|----------|
| 200 | Enabled | Active | | No | Deny | Deny |

Configuring DAI Logging

This section explains on DAI logging.

- DAI Logging Overview
- Configuring the DAI Logging Buffer Size
- Configuring the DAI Logging System Messages
- Configuring DAI Log Filtering

DAI Logging Overview

Switch saves information about the discarded packets into log buffer and generates a system message according to the pre-configured generation rate. Once the message is generated, relevant information in the log buffer shall be deleted. Each log has the flow information: such as a received VLAN id, port number, source and destination IP address, source and destination MAC address.

A log buffer entry can hold information of more than one packet. For example if a VLAN receives packets with ARP parameters through the same interface, DAI will create a log buffer entry for these packets and generate one system message.

Configuring the DAI Logging Buffer Size

Use the following commands in order to adjust the size of DAI log buffer.

Table 264 Configuring the DAI Logging Buffer Size

| Command | Purpose |
|---|---|
| Switch# configure terminal | Enters global configuration mode |
| Switch(config)# ip arp inspection log-buffer entries <i>number</i> | Sets the size of DAI log buffer (range: 0~1024) |
| Switch(config)# no ip arp inspection log-buffer entries | Returns to the default, 32 |
| Switch(config)# end | Returns to Enable mode |
| Switch# show ip arp inspection log | Checks the setting |

The following example shows how to set the size of log buffer of DAI to be 64.

```
Switch# configure terminal
Switch(config)# ip arp inspection log-buffer entries 64
Switch(config)# end
Switch# show ip arp inspection log
Total Log Buffer Size: 32
Syslog rate : 5 entries per 1 seconds.
No entries in log buffer.
```

Configuring the DAI Logging System Messages

To configure the log message that DAL generates, use the following commands.

Table 265 Configuring the DAI Logging System Messages

| Command | Purpose |
|--|------------------------------------|
| Switch# configure terminal | To enter global configuration mode |
| Switch(config)# ip arp inspection log-buffer logs <i>number_of_messages</i> <i>interval length_in_seconds</i> | To configure the DAI log buffer |
| Switch(config)# no ip arp inspection log-buffer logs | To return to default |
| Switch(config)# end | To return to Enable mode |
| Switch# show ip arp inspection log | To check the setting |

You must pay attention to the following when you configure the logging system message of DAI.

- As to '**logs number_of_messages**' (default: 5): the range is from 0 to 1024. If it is set to be 0, then log message will not be generated.
- As to '**interval length_in_seconds**' (default: 1): the range is from 0 to 86400 (one day). If it is set to be 0, then a log message will be generated immediately. That means that the log buffer is constantly empty.
- The system log message shall be generated in the ratio of '**number_of_messages**' times per '**length_in_seconds**' duration.

The following example shows how to configure the system to generate 12 DAI log messages every 2 seconds.

```
Switch# configure terminal
Switch(config)# ip arp inspection log-buffer logs 12 interval 2
Switch(config)# end
Switch# show ip arp inspection log
Total Log Buffer Size: 32
Syslog rate : 12 entries per 2 seconds.
No entries in log buffer.
```

Configuring the DAI Log Filtering

After an inspection of ARP packets you can selectively generate the system message according to the result.

Use the following commands in order to configure the log filtering of DAI.

Table 266 Configuring the DAI Log Filtering

| Command | Purpose |
|--|-------------------------------------|
| Switch# configure terminal | To enter global configuration mode |
| Switch(config)# ip arp inspection vlan <i>vlan-id</i> { acl-match { matchlog none } dhcp-bindings { all none permit }} | To apply log filtering to each VLAN |
| Switch(config)# end | To return to Enable mode |
| Switch# show running-config | To check the setting |

You must pay attention to the following items setting the logging system message of DAI.

- All denied packets will be logged as default.

- **acl-match matchlog** - it makes logging work based upon ACL setting. If '**matchlog**' is specified and '**log**' keyword is used in the **permit** or **deny** command of ARP access-list configuration, the ARP packets that are permitted or denied by ACL will be logged.
- **acl-match none** - it will NOT log for the packets that are consistent with ACL.
- **dhcp-bindings all** - it will do log for the packets that are consistent with DHCP binding.
- **dhcp-bindings none** - it will NOT log for the packets that are consistent with DHCP binding.
- **dhcp-bindings permit** - it will do log for the packets that are allowed by DHCP binding

The following example shows how to configure the system not to generate log message for the packets that are consistent with ACL.

```
Switch# configure terminal
Switch(config)# ip arp inspection vlan 200 logging acl-match none
Switch(config)# end
Switch# show ip arp inspection
DHCP Snoop Bootstrap      : Disabled
Source MAC Validation     : Disabled
Destination MAC Validation : Disabled
IP Address Validation      : Disabled
ARP Field Validation      : Disabled
Vlan  Config   Operation ACL Match      Static ACL  ACL Log  DHCP Log
-----
200   Enabled   Active                No          None     Deny
```

Displaying DAI Information

To retrieve information, use the following commands.

Table 267 Displaying DAI Information

| Command | Description |
|--|--|
| show arp access-list | Shows the information of ARP ACL. |
| show ip arp inspection interfaces | Shows the trust status of the interface. |
| show ip arp inspection vlan [vlan-id] | Shows the DAI configuration and its behavior of a VLAN. |
| show ip arp inspection arp-rate | Shows the rate of ARP packet reception in the interface. |

To retrieve or initialize DAI statistics, use the following commands.

Table 268 Initialize DAI Statistics

| Command | Description |
|---|--|
| clear ip arp inspection statistics | To initialize DAI statistics |
| show ip arp inspection statistics [vlan vlan-id] | To display the DAI statistics of ARP packets |

To show or initialize the DAI logging information, use the following commands.

Table 269 Initialize the DAI logging information

| Command | Description |
|---------|-------------|
|---------|-------------|

| | |
|------------------------------------|---|
| clear ip arp inspection log | To initialize DAI log buffer |
| show ip arp inspection log | To display the configuration and contents of DAI log buffer |

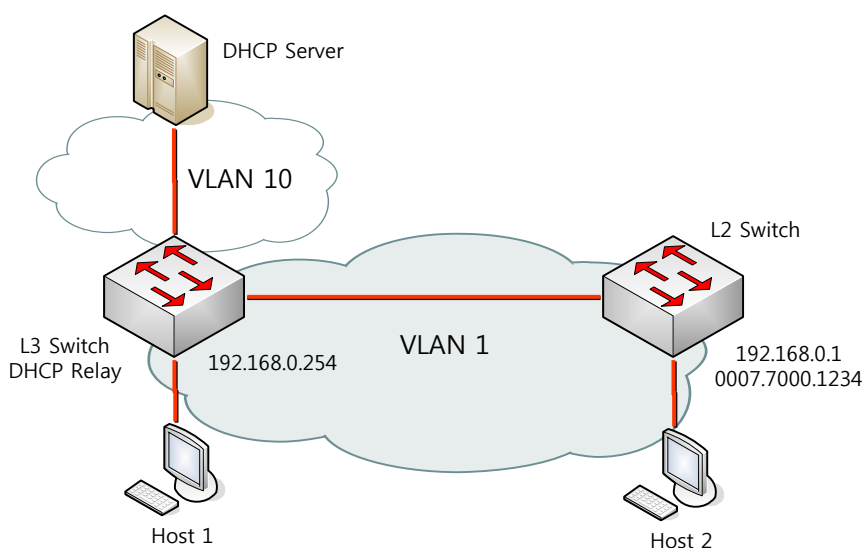
DAI Configuration Samples

This section includes the following examples:

- Sample One: Interoperate with DHCP Relay
- Sample Two: Interoperate with DHCP Server

Sample: Interoperate with DHCP Relay

This example explains how you can configure DAI upon a switch that uses DHCP snoop function. Consider the network in the figure below.



L3 switch relays DHCP message to DHCP server via VLAN 10 and connects with host or L2 switch.

The L2 switch connected to L3 switch uses static ip address. The host 1 and host 2 is assigned via DHCP. All switches and hosts also place with VLAN 1.



Note

The DAI in this configuration depends on DHCP snooping binding information about IP-to-MAC binding information. Refer to DHCP snooping chapter about DHCP snooping configuration.

To use DAI on a switch that is enabled for DHCP relay function, do the following steps.

Table 270 DAI Configuration

| Step | Description |
|---------------|---|
| Step 1 | Enables DHCP relay function. |
| | Switch# configure terminal |
| | Switch(config)# ip dhcp helper-address 10.1.1.1 |
| | Switch(config)# service dhcp relay |
| Step 2 | To configure IP-to-MAC binding information of host assigned IP from DHCP, |

| | |
|--------|--|
| | <p>enable DHCP snooping within VLAN 10 to build up the IP-to-MAC binding information of a host.</p> <pre>Switch# configure terminal Switch(config)# ip dhcp snooping vlan 1 Switch(config)# ip dhcp snooping vlan 10 Switch(config)# ip dhcp snooping</pre> |
| Step 3 | <p>To permit ARP packet of switch using static ip, set ARP ACL.</p> <pre>Switch# configure terminal Switch(config)# arp access-list permit-switch Switch(config-arp-nacl)# permit ip host 192.168.0.1 mac host 0007.7000.1234 Switch(config-arp-nacl)# exit Switch(config)# ip arp inspection filter permit-switch vlan 1 Switch(config)# end</pre> <p>To see if the configuration has been set correctly.</p> <pre>Switch# show ip arp inspection vlan 1</pre> |
| Step 4 | <p>Enables DAI to VLAN1 connected with host.</p> <pre>Switch# configure terminal Switch(config)# ip arp inspection vlan 1 Switch(config)# end</pre> <p>To see if the configuration has been set correctly.</p> <pre>Switch# show ip arp inspection vlan 1</pre> |

The setting of L3 switch is as follows:

```
!
arp access-list permit-switch
    permit ip host 192.168.0.1 mac host 0007.7000.1234
!
ip arp inspection vlan 1
ip arp inspection filter permit-switch vlan 1
!
ip dhcp helper-address 10.1.1.1
service dhcp relay
ip dhcp snooping vlan 1
ip dhcp snooping vlan 10
ip dhcp snooping
!
```


Chapter 19. QoS and ACL

This chapter describes the QoS configuration and the ACL of system.

QOS

Global Configuration

Use the following commands to enable QOS global.

Table 271 QOS Global Configuration Command

| Command | Description | Mode |
|---------------------|---|--------|
| mls qos | Enables QOS global configuration | Config |
| no mls qos | Disables QOS global configuration | Config |
| show mls qos | Searches the status of QOS global configuration | Exec |

All QOS-related settings of a U9016B work only under global configuration. Most of the QOS-related commands are not possible to set if Mls qos is not enabled.

TX Scheduling Configuration

U9016B provides SPQ (Strict Priority Queue) and WRR (Weighted Round Robin) for Scheduling. These two ways can be used together.

The WRR provided by U9016B is SDWRR (Shaped Deficit Weighted Round Robin) Method. DWRR operates as WRR, but has additional feature of managing quota. It controls the amount of incoming data that come regularly and those are burst in. Another feature, shaping is added to SDWRR in order to reduce latency of data flow.

When weights are given to 2 queues at the ratio of 5:3, WRR (or DWRR) allocates queues in order of 1,1,1,1,1,0,0,0,1,1,1,1,0,0,0. On the other hand, SDWRR allocates queues in order of 1,0,1,0,1,0,1,1,0,1,0,1,0,1,1 and controls the amount of packets and reduces the latency of traffic.

Each port has 8 queues: Queue 7 has the highest priority, and Queue 0 has the lowest priority.

The following table shows an example about scheduling per queue.

Table 272 TX Scheduling Configuration

| Queue | Description |
|---------|------------------|
| Queue 7 | SPQ |
| Queue 6 | SPQ |
| Queue 5 | WRR group 1 (50) |
| Queue 4 | WRR group 1 (30) |
| Queue 3 | WRR group 1 (20) |
| Queue 2 | WRR group 2 (60) |
| Queue 1 | WRR group 2 (40) |
| Queue 0 | SPQ |

- Q7 and Q6 are set for SPQ. Q7 will be treated as the highest priority because it is the first in order and is SPQ at the same time. Then Q6 will be treated the next.

- Q5, 4, and 3 are set for WRR group 1, and are allocated in the ratio of 50:30:20 of weight. WRR group 1 is lower in rank than SPQ, but is higher than WRR group 2. These two have different ranks as SPQ.
- Q2 and 1 are set for WRR group 2, and are allocated in the ratio of 60:40 of weight. WRR group 2 will be treated after all queues mentioned above are treated.
- Q0 is declared as SPQ, but has the lowest priority. Q0 works only after Q7 to Q1 are treated.



Notice

Do not mix 2 WRR groups (e.g. set WRR1 for Q5 and Q2, and WRR2 for Q4 and Q1): or do not use SPQ in between of WRR groups or to the lower Q. It may work different from the configuration in the scheduling.

In the scheduling setting, it first generates a mapping table then applies to a port. It can apply seven maps to each module.

In fact, it can apply eight maps in total, but queue 0 is used as the default SPQ and it cannot be changed. Therefore you can manage only seven of them.

Table 273 Tx-Scheduling Map Configuration Command

| Command | Description | Mode |
|---|--|--------|
| mls qos map tx-scheduling NAME queueing-method <0-7> (strict wrr1 wrr2) | Sets the queueing-method of nth queue of the mapping table. When no mapping table, it generates a new one. | Config |
| mls qos map tx-scheduling NAME queueing-method <0-7> (wrr1 wrr2) <1-100> | When setting wrr1 or wrr2, you can set WRR weights simultaneously. (Default: 1) | Config |
| mls qos map tx-scheduling NAME wrr-weight <0-7> <1-100> | Sets the weight for WRR of the selected queue. | Config |
| no mls qos map tx-scheduling NAME queueing-method <0-7> | Disables the queueing-method of the queue. Then it changes into the default, strict. | Config |
| no mls qos map tx-scheduling NAME wrr-weight <0-7> | Disables the weight of the queue that is set for WRR. (Default :1) | Config |
| no mls qos map tx-scheduling NAME | Deletes mapping table with the relevant name. | Config |
| show mls qos map tx-scheduling | Displays configuration of Tx-scheduling. | Exec |

Set a mapping table of tx-scheduling to a designated port using the following settings.

Table 274 Tx-scheduling Configuration Command

| Command | Description | Mode |
|--------------------------------------|---|-----------|
| mls qos tx-scheduling NAME | Sets a mapping table to a relevant port interface with the correct name | interface |
| no mls qos tx-scheduling NAME | Disables the mapping table with the name from the port interface. | interface |

Port Trust Mode

To carry out QoS of traffic leaded into a port, it is designed to check out COS of a packet or the value of DSCP first, and then organize the priority based on the figures found. However you need to determine whether the values of COS and DSCP can be trusted.

With no configuration, it does not refer to COS or DSCP, and operates by the default COS value. The default COS is used for packets with no COS or DSCP (e.g. untagged packet) to define the basic operation.

You can set “trust mode” to COS and DSCP: you can enable both, or neither.

- When a packet has a DSCP and is in Trust DSCP (or BOTH) mode, then use this.
- When a packet has a COS and is in trust COS (or BOTH) mode, then use this.
- When a packet has no COS and is in trust COS (or BOTH), then use default COS.
- In other cases, use default COS.

When a packet has a DSCP and is in trust DSCP mode, it operates QoS based on DSCP. Otherwise, it operates QoS based on COS.

Table 275 Port Trust Configuration Command

| Command | Description | Mode |
|--------------------------------------|--|-----------|
| mls qos trust (cos dscp both) | Sets a port interface for the trust mode. | interface |
| no mls qos trust | Disables the interface set for trust mode. Then it will be set as none. | interface |
| mls qos cos <0-7> | Sets the default COS value of a port. | interface |
| no mls qos cos | Disables the default COS value of a port. | interface |

DSCP Conversion Map Configuration

When a packet is carried out by DSCP as a standard in Trust DSCP mode, the packet will be operated as follows.

- Queueing operation by DSCP value
- COS marking (or remarking) operation by DSCP value
- DSCP remarking operation by DSCP value

DSCP to queue Configuration

In queueing operation a packet is carried out depending on DSCP. The process works all the time without a setting of enable/disable. For this operation DSCP-queue map is maintained the global setting.

Table 276 dscp-queue map Configuration Command

| Command | Description | Mode |
|--|--|--------|
| mls qos map dscp-queue <0-63> ... <0-63> to <0-7> | Sets Dscp-queue map | config |
| no mls qos map dscp-queue | Initializes Dscp-queue map | config |
| show mls qos map dscp-queue | Shows the current dscp-queue map configuration | Exec |

Switch#show mls qos map dscp-queue

DSCP-TO-QUEUE MAP

| d1 : | d2 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-------|----|---|---|---|---|---|---|---|---|---|---|
| ----- | | | | | | | | | | | |
| 0 : | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1 : | | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| 2 : | | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| 3 : | | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 4 : | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 |
| 5 : | | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 |
| 6 : | | 7 | 7 | 7 | 7 | | | | | | |

DSCP to COS Configuration

A packet can be carried out COS marking (or remarking) operation depending on DSCP values. This can be set as “enable” or “disable”, and the default is “disable”. For this operation DSCP to COS map is maintained the global setting.

Switch#show mls qos map dscp-cos

DSCP-TO-COS MAP

| d1 : | d2 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-------|----|---|---|---|---|---|---|---|---|---|---|
| ----- | | | | | | | | | | | |
| 0 : | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1 : | | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| 2 : | | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| 3 : | | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 4 : | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 |
| 5 : | | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 |
| 6 : | | 7 | 7 | 7 | 7 | | | | | | |

DSCP to DSCP Configuration

A packet can be carried out DSCP remarking operation depending on DSCP values. This is called “mutation” because it changes DSCP of itself. Each port can be set as enable/disable, and the default is “disable”. For this operation DSCP to DSCP map is maintained the global setting. The default is 1:1. Change the map to apply to the port interface before use.

Table 277 cos-dscp map Configuration Command

| Command | Description | Mode |
|--|--|-----------|
| mls qos map cos-dscp <0-7> <0-63> | Configures Cos-dscp map. | config |
| no mls qos map cos-dscp | Initializes Cos-Dscp map. | config |
| mls qos cos-dscp | Sets cos-dscp marking on the port interface. | interface |
| no mls qos cos-dscp | Disables cos-dscp marking on the port interface. | interface |
| show mls qos map cos-dscp | Displays current settings of cos-dscp map. | Exec |

```
Switch#show mls qos map dscp-mutation
```

```
DSCP MUTATION MAP
```

```

d1 :  d2  0   1   2   3   4   5   6   7   8   9
-----
0 :    0   1   2   3   4   5   6   7   8   9
1 :   10  11  12  13  14  15  16  17  18  19
2 :   20  21  22  23  24  25  26  27  28  29
3 :   30  31  32  33  34  35  36  37  38  39
4 :   40  41  42  43  44  45  46  47  48  49
5 :   50  51  52  53  54  55  56  57  58  59
6 :   60  61  62  63

```

COS Conversion Map Configuration

When a packet is carried out by COS as a standard in Trust COS mode, the packet will be operated as follows.

- Queueing operation by COS value
- DSCP marking (or remarking) operation depending on COS value
- COS remarking operation depending on COS value

COS to queue Configuration

A packet is carried out queueing operation depending on COS value. It works all the time without a setting of enable/disable. For this operation COS-queue map is maintained the global setting.

Table 278 cos-queue map Configuration Command

| Command | Description | Mode |
|---------|-------------|------|
|---------|-------------|------|

| | | |
|--|--|--------|
| mls qos map cos-queue <0-7> <0-7> | Sets Cos-queue map | config |
| no mls qos map cos-queue | Initializes Cos-queue map | config |
| show mls qos map cos-queue | Displays the current settings of cos-queue map | Exec |

COS to DSCP Configuration

A packet can be carried out DSCP marking (or remarking) operation depending on COS value. Each port interface can be set as either “enable” or “disable”, and the default is “disable”. This operation COS to DSCP map is maintained the global setting.

Table 279 cos-dscp map Configuration Command

| Command | Description | Mode |
|--|--|-----------|
| mls qos map cos-dscp <0-7> <0-63> | Configures Cos-dscp map. | config |
| no mls qos map cos-dscp | Initializes Cos-Dscp map. | config |
| mls qos cos-dscp | Sets cos-dscp marking on the port interface. | interface |
| no mls qos cos-dscp | Disables cos-dscp marking on the port interface. | interface |
| show mls qos map cos-dscp | Displays current settings of cos-dscp map. | Exec |

```
Switch# show mls qos map cos-dscp
COS-TO-DSCP MAP
COS :  0   1   2   3   4   5   6   7
-----
DSCP:  0   8  16  24  32  40  48  56
```

COS to COS Configuration

A packet can be carried out COS remarking operation depending on COS values. This is called “mutation” because it changes COS of itself. Each port can be set as enable/disable, and the default is “disable”. For this operation DSCP to DSCP map is maintained the global setting. The default is 1:1. Change the map to apply to the port interface before use.

Table 280 cos-mutation Map Configuration Command

| Command | Description | Mode |
|---|--|-----------|
| mls qos map cos-mutation <0-7> <0-7> | Sets Cos-mutation map. | config |
| no mls qos map cos-mutation | Initializes Cos-mutation map. | config |
| mls qos cos-mutation | Sets cos remarking on the port interface. | interface |
| no mls qos cos-mutation | Disables cos remarking on the port interface. | interface |
| show mls qos map cos-mutation | Displays the current settings of cos-mutation map. | Exec |

ACL Configuration

U9016B have various options in ACL configuration including a feature sorting packets into easily acceptable ones and not easily acceptable ones.

U9016B provides three ACLs: standard IP ACL, extended IP ACL, and MAC ACL.

Standard IP ACL classifies packets by source IP only. Ranges of <1-99> and <1300-1999> are assigned for Standard IP ACL, and it can be generated with names other than numbers.

Extended IP ACL sorts packets by source IP, destination IP, and protocol type. It can sort TCP and UDP packets by L4 src and dst port, ICMP packets by icmp-type, and IGMP packets by igmp-type. The ranges of <100-199> and <2000-2699> are assigned, and it can be generated with names other than numbers.

MAC ACL sorts packets by MAC address. The command “mac-access-list” is used. The range of <1100-1199> is assigned for MAC ACL.

Standard IP ACL

Standard IP ACL classifies packets by source IP. A figure or a series of access-list can be connected, each condition can take a permit or deny.

Standard IP ACL was originally designed to set 99 ACLs of <1-99>, and 700 expanded areas of <1300-1999> were added later as additional ACLs are needed. And it is possible to add almost unlimited numbers of ACLs using names by letters.

Table 281 Standard IP ACL Configuration Command

| Command | Description | Mode |
|--|---|--------|
| access-list <1-99> (permit deny) SRC_IP_ADDRESS | Enables Standard IP ACL | config |
| no access-list <1-99> (permit deny) SRC_IP_ADDRESS | Disables Standard IP ACL | config |
| no access-list <1-99> | Deletes all ACL with the relevant names (numbers) | config |
| access-list <1-99> remark LINE | Adds the description of the relevant ACL | config |
| access-list <1300-1999> (permit deny) SRC_IP_ADDRESS | Sets Standard IP ACL of Expanded range | config |
| no access-list <1300-1999> (permit deny) SRC_IP_ADDRESS | Disables Standard IP ACL of Expanded range | config |
| no access-list <1300-1999> | Deletes all ACL with the relevant numbers | config |
| access-list <1300-1999> remark LINE | Adds the description of the relevant ACL | config |
| access-list standard WORD (permit deny) SRC_IP_ADDRESS | Sets Named Standard IP ACL | config |
| no access-list standard WORD (permit deny) SRC_IP_ADDRESS | Disables Named Standard IP ACL | config |

| | | |
|-------------------------------------|--|--------|
| no access-list standard WORD | Deletes all ACLs with the relevant names | config |
| access-list WORD remark LINE | Adds the description of the relevant ACL | config |
| Show access-list | Searches ACL configuration | Exed |

The command, **SRC_IP_ADDRESS** can be set as follows.

Table 282 SRC_IP_ADDRESS

| Command | Description |
|------------------------|---|
| A.B.C.D A.B.C.D | IP range can be set in the form of wildcard. As opposed to the general IP configuration, marking value is 0 |
| host A.B.C.D | Add a host prefix to indicated only one IP address. |
| A.B.C.D | It will be treated the same as host A.B.C.D when only one IP is provided. |
| any | Use any when assigning all IP addresses. |



Notice

10.1.1.0/24 means the same as 255.255.255.0 when indicating an IP range in general. This implies an IP range of 10.1.1.0 ~ 10.1.1.255. However ACL configuration of wildcard needs the opposite way: you should set 10.1.1.0.0.0.255 when assigning the IP range of 10.1.1.0 ~ 10.1.1.255.

Extended IP ACL

Extended IP ACL uses both src ip and des tip addresses while standard IP ACL uses only src ip address to sort packets. It is possible to sort packets using protocol type. You can sort TCP and UDP packets using L4 src and dst port, ICMP packets using icmp-type, and IGMP packets using igmp-type.

Extended IP ACL was originally designed to set 100 ACLs of <100-199>, and 700 expanded areas of <2000-2699> were added later as additional ACLs are needed. And it is possible to add almost unlimited numbers of ACLs using names by letters.

Table 283 Extended IP ACL Configuration Command

| Command | Description | Mode |
|--|---|--------|
| access-list <100-199> (permit deny) (<0-255> icmp igmp ip ospf pim tcp udp) SRC_IP_ADDRESS DST_IP_ADDRESS | Sets Extended IP ACL. | config |
| access-list <100-199> (permit deny) icmp SRC_IP_ADDRESS DST_IP_ADDRESS ICMP-TYPE | Sets Extended IP ACL of ICMP type. | config |
| access-list <100-199> (permit deny) igmp SRC_IP_ADDRESS DST_IP_ADDRESS IGMP-TYPE | Sets Extended IP ACL of IGMP type. | config |
| access-list <100-199> (permit deny) (tcp udp) SRC_IP_ADDRESS DST_IP_ADDRESS | Sets Extended IP ACL of TCP / UDP type. | config |

| | | |
|---|---|--------|
| eq <0-65536> | | |
| no access-list <100-199> (permit deny) (<0-255> icmp igmp ip ospf pim tcp udp) SRC_IP_ADDRESS DST_IP_ADDRESS | Disables Extended IP ACL. | config |
| no access-list <100-199> | Deletes all ACLs with the relevant name (number). | config |
| access-list <100-199> remark LINE | Adds the description of the relevant ACL. | config |
| access-list <2000-2699> (permit deny) (<0-255> icmp igmp ip ospf pim tcp udp) SRC_IP_ADDRESS DST_IP_ADDRESS | Sets Extended IP ACL of Expanded range. | config |
| access-list <2000-2699> (permit deny) icmp SRC_IP_ADDRESS DST_IP_ADDRESS ICMP-TYPE | Sets Extended IP ACL of Expanded range of ICMP type. | config |
| access-list <2000-2699> (permit deny) igmp SRC_IP_ADDRESS DST_IP_ADDRESS IGMP-TYPE | Sets Extended IP ACL of Expanded range of IGMP type. | config |
| access-list <2000-2699> (permit deny) (tcp udp) SRC_IP_ADDRESS DST_IP_ADDRESS eq <0-65536> | Sets Extended IP ACL of Expanded range of TCP / UDP type. | config |
| no access-list <2000-2699> (permit deny) (<0-255> icmp igmp ip ospf pim tcp udp) SRC_IP_ADDRESS DST_IP_ADDRESS | Disables Extended IP ACL. | config |
| no access-list <2000-2699> | Deletes all ACLs with the relevant name. | config |
| access-list <2000-2699> remark LINE | Adds the description of the relevant ACL. | config |
| access-list extended WORD (permit deny) (<0-255> icmp igmp ip ospf pim tcp udp) SRC_IP_ADDRESS DST_IP_ADDRESS | Sets Named Extended IP ACL. | config |
| access-list extended WORD (permit deny) icmp SRC_IP_ADDRESS DST_IP_ADDRESS ICMP-TYPE | Sets Extended IP ACL of ICMP type. | config |
| access-list extended WORD (permit deny) igmp SRC_IP_ADDRESS DST_IP_ADDRESS IGMP-TYPE | Sets Extended IP ACL of IGMP type. | config |
| no access-list extended WORD (permit deny) (<0-255> icmp igmp ip ospf pim tcp udp) SRC_IP_ADDRESS DST_IP_ADDRESS | Disables Named Extended IP ACL. | config |

| | | |
|-------------------------------------|--|--------|
| no access-list extended WORD | Deletes all ACLs with the relevant. name | config |
| access-list WORD remark LINE | Adds the description of the relevant ACL | config |
| Show access-list | Searches the configuration of ACL | Exec |

The command, **SRC_IP_ADDRESS** and **DST_IP_ADDRESS** can be set as follows.

| Command | Description |
|------------------------|--|
| A.B.C.D A.B.C.D | IP range can be set in the form of wildcard. As opposed to the general IP configuration, |
| host A.B.C.D | Add a host prefix to indicated only one IP address. |
| any | Use any when assigning all IP addresses. |



Notice A.B.C.D is not supported in extended IP ACL to prevent confusion. Host A.B.C.D is used to appoint a single IP.



Notice An address such as 10.1.1.0/24 has the same meaning as 10.1.1.0.255.255.255.0 when indicating the IP range of 10.1.1.0 ~ 10.1.1.255.
However ACL configuration of wildcard needs the opposite way: you should set 10.1.1.0.0.0.255 when assigning the IP range of 10.1.1.0 ~ 10.1.1.255.

MAC ACL

MAC ACL uses MAC address to sort packets. MAC ACL was originally designed <1100-1199> of ACL. Unlike IP ACL, MAC ACL uses mac-access-list.

Table 284 standard IP ACL Configuration Command

| Command | Description | Mode |
|---|--|--------|
| mac-access-list <1100-1199> (permit deny) SRC_MAC_ADDRESS DST_MAC_ADDRESS <1-8> | Enables MAC ACL | config |
| no mac-access-list <1100-1199> (permit deny) SRC_MAC_ADDRESS DST_MAC_ADDRESS <1-8> | Disables MAC ACL | config |
| no mac-access-list <1100-1199> | Deletes all ACLs with the relevant names | |
| Show mac-access-list | Retrieves the configuration of MAC ACL | Exec |

SRC_IP_ADDRESS and **DST_IP_ADDRESS** can be set as follows. However SRC_MAC and DST_MAC cannot be **any** simultaneously.

| Item | Description |
|-------------|--|
| H.H.H H.H.H | You can set MAC address bandwidth as wildcard. |
| any | Use any when assigning all MAC addresses. |

Application of ACL to Interface

The ACL set as above can be applied to an interface as follows. The interfaces mentioned here means VLAN interfaces, and they are applicable to port interfaces set as router ports.

Table 285 Commands for the Application of ACL to Interface

| Command | Description | Mode |
|---|--|-----------|
| ip access-group { <1-199> <1300>2699> WORD} {in out} | Sets acl to the relevant interface | Interface |
| no ip access-group { <1-199> <1300>2699> WORD} {in out} | Disables acl of the relevant interface | Interface |



Notice

Router port means a port with no switchport.



Notice

Service-policy can set up to 16000 rules in the input direction, 4000 rules in the output direction summed with ACLs.



Notice

In the input direction, you can set service and ACL simultaneously. For the output direction, you can set only either one at a time.

Service-policy Configuration

For configurations of complicated QOS you can set various forms of rules and actions using class-map and policy-map.

Class-map sorts packets using one of the choices from ACL, ethertype, cos, vlan, protocol, dscp, ip-precedence(TOS), l4 port, tcp flag, and mlps flag, etc.

Such traffic that is sorted as a class-map carries out the basic works as permit / drop, and also other works as queueing, cos, marking / remarking, dscp marking / remarking, rate-limit etc. PBR (Policy Based Routing) is available when nexthop is linked together. It enables other operations, which is not related to QOS, such as trap-cpu, mirrot, redirect, netflow, etc.

Class-map

A class-map is produced for the purpose of sorting packets. Basically ACL is used in sorting packets, and other means can also be used, such as ethertype, cos, vlan, protocol, dscp, ip-precedence (TOS), l4 port, tcp flag, mlps flag to sort packets.

ACL may use both ip acl and mac-acl together, or only one of the two. Each ACL can have up to 1000 items. In order to apply more than 1000 ACLs, you need to divide ACLs into several groups and generate class-map for each.

Sorting options including ACL basically run AND operation. For example if both ACL and DSCP are enabled, only packets that satisfy the two conditions will be sorted.

Table 286 Class-map Configuration Command

| Command | Description | Mode |
|--|--|--------|
| class-map WORD | Generates a class-map that is classified according to AND operation and moves to the node. | Config |
| class-map match-all WORD | Generates a class-map that is classified according to AND operation and moves to the node. | Config |
| class-map match-any WORD | Generates a class-map that is classified according to OR operation and moves to the node. | Config |
| no class-map WORD | Deletes the Class-map. | Config |
| match access-group NAME | Sets the classification criteria using ACL. | cmap |
| match cos <0-7> | Sets the classification criteria using COS. | cmap |
| match ethertype WORD | Sets the classification criteria using Ethertype. | cmap |
| match ip-dscp <0-63> | Sets the classification criteria using DSCP. | cmap |
| match ip-precedence <0-7> | Sets the classification criteria using IP-Precedence. | cmap |
| match layer4 {source-port destination-port} <1-65536> | Sets the classification criteria using L4 port. | cmap |

| | | |
|---|---|------|
| match mpls exp-bit topmost <0-7> | Sets the classification criteria using MPLS flag. | cmap |
| match tcp-control VALUE | Sets the classification criteria using TCP-control. | cmap |
| match vlan <1-4095> | Sets the classification criteria using VLAN. | cmap |



Notice

Ethertype is classified as a 4-digit hexadecimal. For example, you can enter 0806 for ARP type.



Notice

TCP-control is classified as a six-digit binary number. For example, you can see the fifth digit, SYN flag by declaring 00010.

Policy-map

Such traffic that is sorted as a class-map carries out the basic works as permit / drop, and also other works as queueing, cos, marking / remarking, dscp marking / remarking, rate-limit etc. PBR (Policy Based Routing) is available when nexthop is linked together. It enables other operations, which is not related to QOS, such as trap-cpu, mirrot, redirect, netflow, etc.

Each policy-map can assign up to 100 operations. Each Class-map can have up to 1000 entries of ACL, which means a policy-map should control 100,000 entries in theory. However it is not possible to control so many entries due to the restriction of H/W.

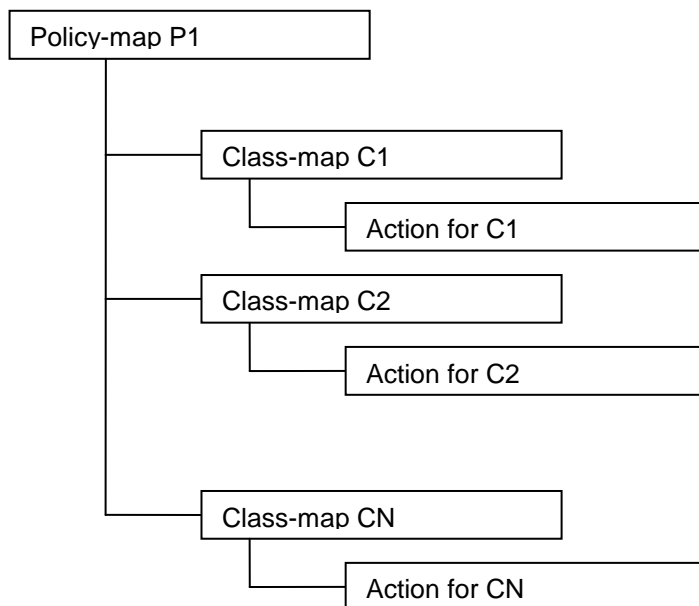


Figure 58. Hierarchy of Policy-Map

Marking and remarking are used without distinction. When there is a correspondent field to a incoming packet remarking will work, when no correspondent field marking will work. It enables other operations, which is not related to QOS, such as trap-cpu, mirrot, redirect, netflow, etc.

Table 287 Class-map Configuration Command

| Command | Description | Mode |
|--|---|--------|
| policy-map NAME | Generates a policy-map and moves to the corresponding node. | Config |
| no policy-map NAME | Deletes the policy-map. | Config |
| class NAME | Moves to the sub node which assigns the operation of Class-map. | pmap |
| no class NAME | Deletes the class-map setting. | pmap |
| drop | Drops traffic that is classified according to the class-map. | pmap-c |
| set cos <0-7> | Cos marking setting. | pmap-c |
| set drop-precedence <0-2> | Drop precedence setting. | pmap-c |
| set ip-dscp <0-63> | Dscp marking setting. | pmap-c |
| set ip-precedence <0-7> | Ip precedence (tos) setting. | pmap-c |
| set queueing <0-7> | Queueing setting. | pmap-c |
| police <1-10000000> <1-10000000> exceed-action drop | Rate-limit setting. | pmap-c |
| police aggregate NAME | Aggregated rate-limit setting. | pmap-c |
| nexthop A.B.C.D { priority <1-8> } | PBR nexthop setting and nexthop priority setting. | pmap-c |
| netflow | Netflow setting. | pmap-c |
| redirect IFNAME | Redirect setting. | pmap-c |
| mirror | Mirror setting. | pmap-c |
| trap-cpu { high-priority } | CPU trap setting. | pmap-c |

Service-policy

The policy-map as above applies to vlan interface or router port interface. It can be set as either direction of input or output. The policy-map set as above can be applied to vlan interface or router port interface. It can be set as either direction of input or output. However, the output direction can have only one of service-policy or ACL; the input direction can have the two simultaneously.

Table 288 Service-Policy Configuration Command

| Command | Description | Mode |
|--|--|-----------|
| service-policy { input output } NAME | Applies a policy-map of the relevant name to an interface. | interface |
| no service-policy { input output } NAME | Deletes the relevant policy-map from the interface. | interface |



Notice A router port means a port with no switchport.



Notice Service-policy can set up to 16000 rules in the input direction, 4000 rules in the output direction summed with ACLs.



Notice In the input direction, you can set service and ACL simultaneously. For the output direction, you can set only either one at a time.

COPP

COPP (Control Plane Policing) means the application of rate-limit and QOS policies of traffic which flow into CPU. Various controlling packets, relating to the protocol, flow into the CPU. An excessive inflow of a specific packet can cause a problem in the CPU. In this case, a packet with a higher priority of another protocol may not be carried out. Therefore, a feature that prioritizes packets and sets rate-limits is required in order to organize traffic.

Service-policy on COPP

The unit performs Policing for traffic that flows into the CPU by applying service-policy in the control plane.

Table 289 Commands for Control-plane of Service-policy Configuration

| Command | Description | Mode |
|-------------------------------------|---|---------------|
| control-plane | Enters Control-plane mode. | configure |
| service-policy input NAME | Applies a policy-map to a control-plane. | Control-plane |
| no service-policy input NAME | Disables the policy-map on the control-plane. | Control-plane |



Notice

When Service-policy is in use in Control-plane, only **police**, **drop**, and **set queueing** operate.

Rate-limit on COPP

You can set a rate-limit of a specific traffic that flows into CPU.

Table 290 Commands for Control-plane of Rate-limit Configuration

| Command | Description | Mode |
|---|---|---------------|
| rate-limit arp-reply <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows arp-reply among all traffic that flows into the CPU. | Control-plane |
| rate-limit arp-request <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows arp-request among all traffic that flows into the CPU. | Control-plane |
| rate-limit igmp <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows igmp among all traffic that flows into the CPU. | Control-plane |
| rate-limit ip-control-over-multicast <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows ip-control among all traffic that flows into the CPU. | Control-plane |

| | | |
|---|---|---------------|
| rate-limit ipv6-neib-sol <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows ipv6 ns among all traffic that flows into the CPU. | Control-plane |
| rate-limit l4-port (both tcp udp) (both multicast unicast) <1-65535> <1-65535> <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows L4 traffic among all traffic that flows into the CPU. | Control-plane |
| rate-limit mld <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows mld among all traffic that flows into the CPU. | Control-plane |
| rate-limit multicast <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows multicast among all traffic that flows into the CPU. | Control-plane |
| rate-limit protocol <1-255> <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows a specific protocol among all traffic that flows into the CPU. | Control-plane |
| rate-limit ripv1 <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows rip(version 1) among all traffic that flows into the CPU. | Control-plane |
| rate-limit tcp-syn <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows tcp-syn among all traffic that flows into the CPU. | Control-plane |
| rate-limit udp-broadcast <1-1000000> <0-7> | Selects the quantity of traffic (PPS) and queue of traffic that allows udp broadcast among all traffic that flows into the CPU. | Control-plane |

Chapter 20. Utilities

This chapter describes other functions required for operation of the system.

Status dump command

Commands

“show tech-support” is used to dump the system logging messages of each module (system configuration, multicast, routing, driver, etc.).

show tech support

If a problem occurs in system operation, you need to enter various commands to check the behavior of the modules. This command makes predefined critical commands run for the modules, and shows the result message, enabling the module admins to check the fault immediately.

Because the output messages are not paged, the output of messages continue until running of the command is finished. In order to stop the output during the running of the command, you should enter Ctrl+C.

See the following example.

Show tech command provides considerable amount of load to CPU, and it takes a long time to process the command.

As CPU continues to run at 100%, there can be a routing interruption. Therefore, the program requests the operator to confirm whether to run the command.

Switch# show tech-support

```
--- Display the system information ---  
-----
```

```
MODEL-NAME      : U9016B  
SERIAL-NO       :  
System MAC-ADDRESS: 00:07:70:74:ff:01
```

```
--- Display the system version ---  
-----
```

```
Ubiquoss Switch Operating System Software  
U9016B Software (U9016B), Version 1.1.0  
Technical Support: http://www.ubiquoss.com  
Copyright © 2001-2010 by Ubiquoss Inc.
```

```
BOOTLDR: U9016B Software (u92h_bsp.r005), Version 1.3.5
```

```
Router uptime is 6 minutes  
Time since Router switched to active is 4 minutes
```

System restarted at 1970:01:01-00:08:59
System image file is "tftp://192.168.0.9/u92h.r110_ssj"

If you require further assistance, contact us by sending email to
spot.team@ubiquoss.com.

Router Router processor with RouterM bytes of memory.
Processor board ID
460EX CPU at 1000Mhz, Rev 24.162 (pvr 1302 18a2), 1024KB L2 Cache
Last reset from h/w reset
131072K bytes of Flash internal SIMM (Sector size 256K).

--- Show current system's time ---

14:26:50 UTC Thu Feb 18 2010

--- Display elapsed time since boot ---

0 days, 5 hours, 11 mins, 39 secs since boot

--- CPU information ---

...

Command History Function

This function shows the commands used by the administrator in order or in reverse order based on time. This function can be used to retrieve the commands used by the administrator, thus helps to identify the cause of problem and to recover upon system malfunction.

Table 291 Command history Function

| Command | Description | Mode |
|----------------------------|---|------------|
| show history | Shows the commands used. | Privileged |
| show history back | Show the commands in reverse time order. | Privileged |
| show history detail | Shows additional information including the time of command used/User/Access IP. | Privileged |

When a command is used repeatedly, it is saved just once.

Output Post Processing

Overview of output post processing

Most of the commands that show the current status or setting of a system begins with 'show'. The show commands generally show the results on a page, but there are cases that the result is very long.

For example, show mac-address-table may result in thousands of lines, and show interface also provide considerable amount of result. If the result is very long, it is difficult to find the desired part. In this case, you may use the output post processing function provided by this system.

This function is similar with the Unix pipe function. This system provides 3 predefined output post processing functions. In order to use the output post processing function, you should attach a bar (|) after the show command, and then, use the following commands.

Table 292 Overview of output post processing

| Commands | Description |
|---------------------|---|
| include WORD | Show the string containing a specific word. |
| exclude WORD | Show the string without a specific word. |
| begin WORD | Show the lines after a string containing a specific word. |

'show mac-address-table' outputs a large amount of results. You should use 'include' to get the mac addresses containing the desired part only.

```
Switch#  
Switch# show run | inc service  
service password-encryption  
service dhcp
```

'show ip interface' outputs a large amount of results. You should use 'begin' to get the result after a specific vlan interface.

```
Switch#show ip interface | begin Vlan1  
...skipping  
Vlan1 is up, line protocol is up  
  Internet protocol processing disabled  
  IP Flow switching is disabled  
Vlan33 is administratively down, line protocol is down  
  Internet address is 20.1.3.2/24  
  Broadcast address is 20.1.3.255  
  MTU is 1500 bytes  
  Ingress service-policy is not set.  
  Egress service-policy is not set.  
  IP Flow switching is disabled  
Vlan200 is down, line protocol is down  
  Internet address is 200.1.1.236/24  
  Broadcast address is 200.1.1.255  
  MTU is 1500 bytes  
  Ingress service-policy is not set.
```

Egress service-policy is not set.
IP Flow switching is disabled

DDM (Digital Diagnostic Monitoring)

U9016B switch supports the commands that show the status of GBIC with DDM in detail. The Monitoring items are as follows.

Table 293 IP OPTION command

| Item | Description |
|-------------|------------------------------|
| Temperature | GBIC Port Temp |
| Voltage | GBIC Port Voltage |
| Current | GBIC Port Current |
| RxPower | GBIC Port Optic Input Power |
| TxPower | GBIC Port Optic Output Power |

GBIC DDM Monitoring

The following commands are used to check the status of the GBIC with DDM.

Table 294 GBIC DDM Monitoring

| Commands | Mode | Description |
|----------------------------|------------|---|
| show interface transceiver | Privileged | Checks the status of DDM supporting gbic. |

Switch# **show interface transceiver**

If device is externally calibrated, only calibrated values are printed.

++ : high alarm, + : high warning, - : low warning, -- : low alarm.

NA or N/A: not applicable, Tx: transmit, Rx: receive.

mA: milliamperes, dBm: decibels (milliwatts).

| Port | Temperature | | Voltage | | Current | | Optical Tx Power | | Optical Rx Power | |
|---------------|-------------|---------|---------|-------|---------|-------|------------------|-------|------------------|------------|
| | (Celsius) | | (Volts) | | (mA) | | (dBm) | | (dBm) | |
| ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Gi2/3 | 42.6 | | 3.32 | | 17.4 | | -7.7 | | -40.0 | -- |
| Gi2/4 | 41.5 | | 3.32 | | 15.5 | | -6.7 | | -40.0 | -- |
| | | | | | | | | | | |
| gi3 | gbic | ddm | | | 50.6°C | | 3.5 V | | 14.0 mA | -6.08 dBm |
| | | | | | | | | | | -40.00 dBm |
| | | | | | Normal | | Normal | | Normal | Alarm(L) |
| Alarm(L) | | | | | | | | | | |
| | | (warn) | 100.0 | -10.0 | 4.0 | 1.0 | 131.0 | 0.0 | 8.00 | 0.00 |
| 8.00 | 0.00 | | | | | | | | | |
| | | (alarm) | 100.0 | -10.0 | 4.0 | 1.0 | 131.0 | 0.0 | 8.00 | 0.00 |
| 8.00 | 0.00 | | | | | | | | | |
| gi1/2 . | | | | | | | | | | |
| | | | | | Normal | | Normal | | Normal | Normal |
| Normal | | | | | | | | | | |

DDM (Digital Diagnostic Monitoring)

| | | | | | | | | |
|-------|---------|--------------|-----|-----|-------|-----|-------------|-------------|
| | (warn) | 128.0 -128.0 | 6.6 | 0.0 | 131.0 | 0.0 | 8.20 -40.00 | 8.00 - |
| 40.00 | | | | | | | | |
| | (alarm) | 128.0 -128.0 | 6.6 | 0.0 | 131.0 | 0.0 | 8.20 -40.00 | 8.00 -40.00 |
| | | | | | | | | |

Chapter 21. Saving Config File and Software Upgrade

This chapter describes Flash File System management and using USB or Compact Flash (CF) memory. OS Image and Configuration File are saved in the File System provided by U9016B. When you boot the system, the system load the saved OS Image and Configuration file. This chapter describes the following commands:

- File system commands for operation
- OS Image and Configuration File management
- Booting Mode Setting

The function described in this manual can be changed because of our condition.

File System

The system basically provides Flash File system for saving OS image and Configuration file. Moreover, the system supports USB Port. This chapter describes several file system of this product. Flash file system is used for saving OS image and Configuration file.

USB memory can connect or disconnect on the system. When it is connected on the system, you can manage it like Flash File System.

The basic commands for management system file are as follows:

Table 295 File Management Command

| Command | Description | Mode |
|--|---|------------|
| show flash: | Shows flash file status. | Privileged |
| show usbflash: <0-9> | Shows USB memory status. | Privileged |
| dir (usbflash: flash:) (<0-9>) directory | Shows relevant file system. | Privileged |
| erase (flash:) <i>filename</i> | Erase the saved file in flash memory. | Privileged |
| erase (usbflash:) (<0-9>) <i>filename</i> | Erases the file in CF memory, USB memory. | Privileged |
| rename (usbflash: flash:) (<0-9>) <i>filename</i> (usbflash: flash:) (<0-9>) <i>change</i> | Renames file name and changes the place of file system. | Privileged |

The following example shows how to show the file system.

```
Router#show flash:
-length- -----type/info----- CN path
1260    text file                -- dconfig
616     text file                B* igmp_cpuha
3571    text file                -- econfig
1893    text file                -- igmp_mvlan_final
2048    text file                -- igmp_cpuha_bk
50274956 [U9016B] 1.1.0         -- u92h.r110
59537056 [U9016B] 1.1.1         -- u92h.r111
1196    text file                -- lacp_test

19060 Kbytes available (112012 Kbytes used, 86% used)
Router#
```

The following example shows how to erase file in USB memory.

```
shu#show usbflash:
```

```
-----filename----- -----type/info----- CN -length-
1.avi                  binary data file           -- 732508160
2.avi                  binary data file           -- 731899904
.....
```

```
1474004 Kbytes available (2147920 Kbytes, 28 % used)
```

```
shu#erase usbflash: 1.avi
```

```
shu#show usbflash:
```

```
-----filename----- -----type/info----- CN -length-
2.avi                  binary data file           -- 731899904
.....
```

```
2189344 Kbytes available (1432580 Kbytes, 19 % used)
```

```
shu#
```

Image/Configuration/BSP Down/Up Load

You can download the Image and configuration file from a remote TFTP or FTP server. You can upload the image and configuration file to a remote FTP (TFTP) server.

To download or upload software from a remote TFTP or FTP server to the System, perform the following tasks:



Warning Do not select image for upgrading without permission because images are different as system model and version. Obey our introduction.



Warning The configuration applied via FTP/TFTP is added or changed on the configuration of current system. In other word, the configuration of current system is not deleted perfectly and changed with the downloaded configuration perfectly.

Download/Upload with the FTP

The following table shows the download/upload commands with using the FTP.

Table 296 Download/Upload with the FTP

| Command | Description | Mode |
|---|---|------------|
| copy ftp: (usbflash: disk1: flash:) (<0-9>) | Saves OS image file from FTP to Flash, USB, and CF. | Privileged |
| copy (usbflash: disk1: flash:) (<0-9>) ftp | Saves OS image from Flash, USB, and CF to FTP. | Privileged |
| copy ftp: config-file | Saves Configuration file from FTP to Flash. | Privileged |
| copy ftp: running-config | Applies Configuration file with the current running-config from FTP | Privileged |
| copy running-config (usbflash: disk1: flash:) (<0-9>) <i>filename</i> | Saves running-config with file filename to relevant file system. | Privileged |
| copy running-config ftp: | Saves current running-config to FTP server. | Privileged |
| copy ftp: bootloader | | Privileged |

The following example shows how to download a file with using FTP.

```
Switch# copy ftp: flash
IP address of remote host ? 10.1.13.4
User ID ? evolution
```

```

Password ?
Source file name ? 0621
Destination file name ? 0621
Warning: There is a file already existing with this name
Do you want to over-write [yes/no]? y
Over-writing 0621 file to flash memory

```

```

Switch# copy ftp bootloader
IP address of remote host ? 192.168.0.1
User ID ? Ins
Password ?
Source file name ? E7xg.bsp
Bootloader key (0xaabb) ? 0x860011
FTP:: 10.1.13.4//E7xg.bsp --> bootloader
Continue [yes/no]? yes
(생략)

```

The following example shows how to save running-config file in the USB memory.

```

shu#copy running-config usbflash: evol.cfg
shu#show usbflash:

-----filename----- -----type/info----- CN -length-
2.avi                  binary data file          -- 731899904
evol.cfg              text file                  --    7131
.....
2189336 Kbytes available (1432588 Kbytes, 19 % used)

shu#

```



Warning The downloaded configuration is added to the current configuration or replaced with the current configuration on the system. That is, the current system configuration is not totally removed or replaced by the downloaded configuration.

Down/UpLoading File with the TFTP

To download and upload the file with the TFTP, use the following command.

Table 297 Down/UpLoading File with TFTP

| Command | Description | Mode |
|--|--|------------|
| copy tftp: (usbflash: disk1: flash:) (<0-9>) | Saves OS image file from TFTP to Flash, USB, and CF. | Privileged |
| copy (usbflash: disk1: flash:) (<0-9>) tftp: | Saves OS image from Flash, USB, and CF to TFTP. | Privileged |

| | | |
|---------------------------|--|------------|
| copy tftp: config-file | Saves Configuration file from TFTP to Flash. | Privileged |
| copy tftp: running-config | Applies Configuration file with the current running-config from TFTP | Privileged |
| copy running-config tftp: | Saves running-config with file filename to relevant file system. | Privileged |
| copy tftp: bootloader | Saves current running-config to TFTP server. | Privileged |

The following example shows how to download a file from TFTP.

shu#**copy tftp: usbflash:**

IP address of remote host ? 10.1.13.4

Source file name ? evol.r137

Destination file name ? evol.r137

TFTP::10.1.13.4//evol.r137 --> usbflash: 0 [evol.r137]

Proceed [yes/no]? y

Switch# **copy tftp bootloader**

IP address of remote host ? 10.1.13.4

Source file name ? E7x.bsp

Bootloader key (0xaabb) ? 0x860011

TFTP:: 10.1.13.4// E7x.bsp --> bootloader

Proceed [yes/no]? yes

()

Configuration File Management

The system configuration file is a text file that has commands for system configuration when the system is booting. It is convenient that you do not need to input commands manually for the system configuration, whatever the system booting.

The System contains two types of configuration files: the running (current operating) configuration and the startup (last saved) configuration.

The feature of the files is as follows:

Running configuration

The running configuration is the current (unsaved) configuration that reflects the most recent configuration changes. When a user changes the system configuration, the system configuration is saved in the running configuration file of DRAM and is applied immediately to the system. You can upload or download the running configuration file via FTP or TFTP.

Startup configuration

The startup configuration is the saved configuration in DRAM and is used when the system initializes. The startup configuration is not removed when the system power is turned off. You can upload or download the startup configuration file via FTP or TFTP.

Table 298 Configuration Management Command

| Command | Description | Mode |
|------------------------------------|--|------------|
| show startup-config | Shows the configuration of Booting config File saved in the flash memory | Privileged |
| show running-config | Shows the current configuration. | Privileged |
| copy running-config startup-config | Saves running-config as startup-config in the flash memory. | Privileged |
| erase startup-config | Deletes startup configuration file saved in the flash memory. | Privileged |

Saving Configuration File

If you apply the current running configuration file when the next system's booting, save the current running configuration file to the startup configuration file before the system is reset or powered off.

To save the current running configuration file to the startup configuration file, use the following command.

```
Switch# show running-config
```

```
!
```

```
no service dhcp
```

```
!
```

```
no logging console
```

```
!
```

```
ip domain-lookup
```

```
!  
spanning-tree mode rstp-vlan-bridge  
... < > ....  
SWITCH#  
SWITCH# copy running-config startup-config  
Overwrite 'system.cfg'? [yes/no] y  
SWITCH# show startup-config  
!  
no service dhcp  
!  
no logging console  
!  
ip domain-lookup  
!  
spanning-tree mode rstp-vlan-bridge  
... < > ....  
SWITCH#
```

Configuration File Erase

When the system restart, the system reload startup-config file in the flash memory. If you want to use another configuration file, you must erase the startup-config. After you set another configuration file, restart the system.

```
SWITCH# erase flash: System1.cfg  
Warning: System1.cfg is booting config file  
Do you want to erase it [yes/no]? y  
SWITCH# boot config System2.cfg  
SWITCH# reload
```

Boot Mode Setting and System Restart

You can set OS Image and Config file to the system for applying to next booting. When you restart system, the set OS image and config file apply to the system. So you must be careful.

The following table shows how to set OS image and config file for next booting.

Table 299 Boot Mode Setting and System Restart

| Command | Description | Mode |
|---|---|------------|
| <code>boot system flash <i>filename</i></code> | Sets OS image applied when next booting. | Privileged |
| <code>boot system tftp <i>filename</i> A.B.C.D</code> | Sets OS image applied when next booting. | Privileged |
| <code>boot config <i>filename</i></code> | Sets filename as Start-up configuration file. | Privileged |
| <code>reload</code> | Restarts the system. | Privileged |

Boot Mode Setting

You must be careful as follows:

- When you execute boot flash command, you must use OS image only for U9016B.
- When you execute boot config command, you must use Config file only for U9016B.

```
Switch#  
Switch# boot system flash u92h.r111  
Switch#  
Switch# boot config Ins.cfg  
Switch#
```

System Reload

You can restart the system with the power switch on/off or reload command. Moreover, you can reserve restarting time with the following commands.

Table 300 Boot Mode Setting and System Reload

| Command | Description | Mode |
|---|--|------------|
| <code>reload</code> | Restarts the system. | Privileged |
| <code>reload {in <i>time</i> at <i>time</i> [<i>day</i>] [<i>month</i>]} [<i>reason</i>]</code> | Reserves time for system restart. <ul style="list-style-type: none">▪ <i>in</i>: in time▪ <i>at</i>: at time▪ <i>time</i>: HH:MM▪ <i>day</i>: 1 - 31▪ <i>month</i>: (ex. Jan or January)▪ <i>reason</i>: reason for restart | Privileged |
| <code>reload cancel</code> | Cancels the reserved system restart. | Privileged |

| | | |
|-------------|--|------------|
| show reload | Shows the reserved information that the system restarts. | Privileged |
|-------------|--|------------|

The following example shows how to restart system with **reload at** command and cancel the schedule with reload cancel command.

Switch# **show clock**

23:52:01 UTC Thu Sep 14 2010

Switch# **reload at 13:00 19 Feb For reload test**

System configuration has been modified. Save? [y/n]: y

Building configuration...

[OK]

Reload scheduled for 13:00:00 KST Fri Feb 19 2010 in (13 hours 7 minutes)

Reload Reason: For reload test

continue to reboot ? [yes/no]: y

Switch# **show reload**

Reload scheduled for 13:00:00 KST Fri Feb 19 2010 in (13 hours 7 minutes 28 seconds)

on vty/0 (10.1.20.99)

Reload reason: For reload test

Switch#

Switch# **reload cancel**

*** --- SHUTDOWN ABORTED ---

Switch# **show reload**

No reload is scheduled.

Switch#



Warning

Before you restart system, you always save running configuration in Flash memory. When you execute reload command in config mode, you always make sure if you save file as follows.

System configuration has been modified. Save? [y/n]: y



Warning

Do not restart system by force when system is saving file in Flash File System.

Chapter 22. GE-PON

This chapter describes how to make the setting in relation with GE-PON in the U9016B. This chapter consists of the following sections:

- GE-PON Overview
- OLT Management
- ONU/ONT Management
- GE-PON Setting

**Note**

Refer to the command reference for detailed description on the CLI commands used in this chapter.

GE-PON Overview

PON (Passive Optical Network) is an optical access network implementation method that enables a single OLT (Optical Line Termination) to multi ONUs (Optical Network Unit) or ONTs (Optical Network Termination) access through a passive optical network on the fiber cable.

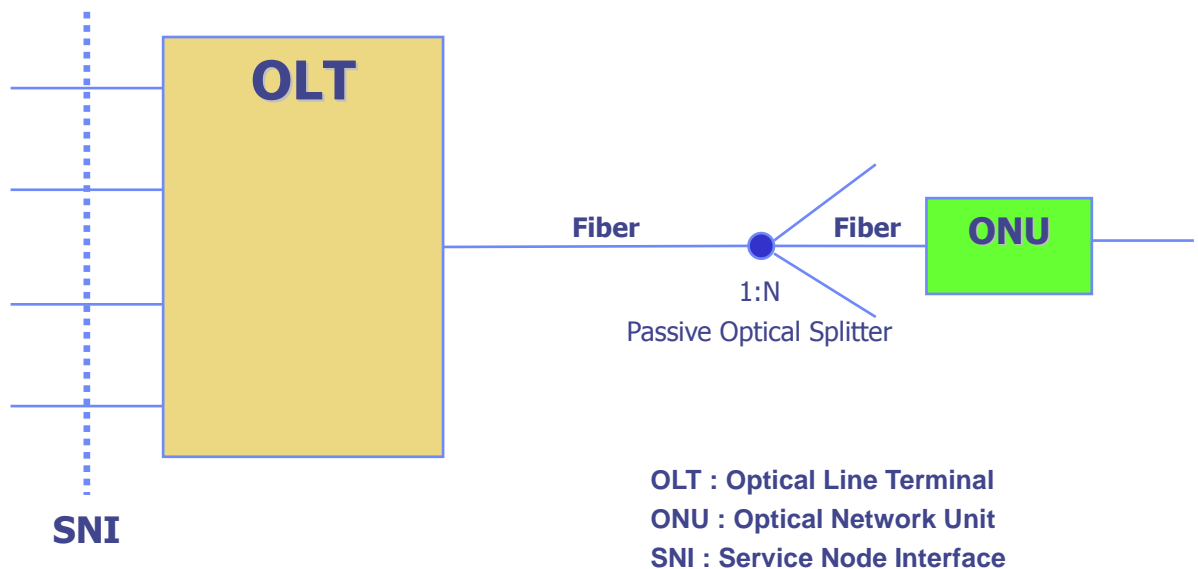


Figure 59. Basic Structure of PON

PON provides the point-to-multi point (P2MP) network so that the total bandwidth can be shared by multiple users through a passive optical splitter, saving the network implementation cost. The passive optical splitter does not require any power supply, providing convenience in field operation.

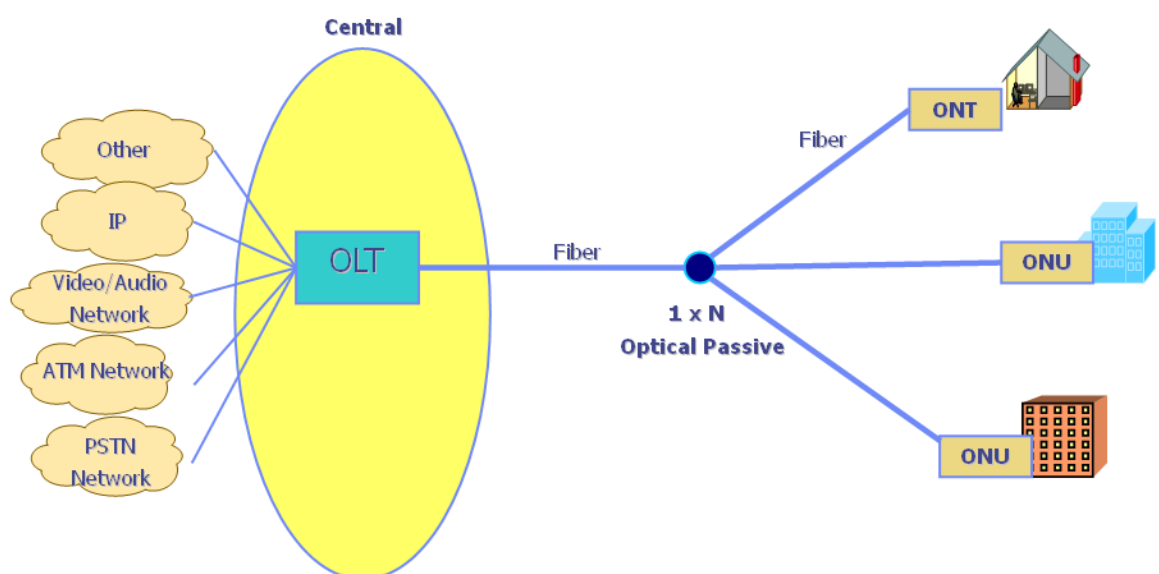


Figure 60. EPON Structure

GE-PON is a type of PON. In this network, OLT is typically installed in the telephone office or the service provider, and is connected with numbers of ONUs or subscriber ONTs in 1:N.

GE-PON adopts the broadcasting method for downstream and TDMA (Time Division Multiple Access) for upstream transmission.

On the downstream channel, each packet contains the ONU/ONT id (LLID) in the header, and the optical splitter divides and sends the packets to each ONU. Each ONU receives the packet for itself, and discards all other packets for other ONUs.

On the upstream channel, thanks to the characteristics of the optical splitter, the packet sent from an ONU/ONT is not sent to other ONU (ONT). Because the packets of an ONU share a fiber, it is important to prevent collision between packets. TDMA is adopted so that ONU/ONT sends the data on the upstream channel during the time slot distributed by OLT.

OLT Management

This section describes the guideline on OLT setting and OLT management.

PON OLT, PORT, ONU/ONT status setting/view

You can set the Administrative State for the PIN interface card which plays an important role of PON. It is performed in PON_MODE, and you should enter the 'pon' command in the CONFIG_MODE. The PON port status of the system is 'enabled' in the factory default. The following table lists the commands to change and view the status.

Table 301 Commands for OLT status

| Command | Description | Mode |
|-----------------------------------|--|------------|
| show pon topology olt | Shows all pon states of OLT | Enable |
| show pon topology IF_NAME | Shows PON Port status, onu status and link status. | Enable |
| [no] shutdown port IF_NAME | - Changes the administrative status of the PON port to [disable] enable. - Sets IF_NAME slot/port | Config-pon |
| [no] shutdown onu IF_NAME | IF_NAME slot/port-onu setting | Config-pon |

```
U9016B# show pon topology olt
```

```
PON NETWORK OLT TOPOLOGY INFORMATION
```

```
=====
===
SLOT      MAC ADDR      ADMIN  OPER      MODE      IPC STATE
-----
1         000d.b637.2300  ENABLE  UP        MIXED      UP
8         000d.b637.2300  ENABLE  UP        MIXED      UP
9         000d.b637.2300  ENABLE  UP        MIXED      UP
=====
```

```
U9016B# show pon topology 8/1
```

```
PON NETWORK TOPOLOGY INFORMATION
```

```
=====
IF_NAME    MAC ADDR      ADMIN  OPER      SYSTEM TYPE  LLID
RANGE
```

| | | | | | |
|---------|----------------|--------|----|-------|------|
| 8/1 | 000d.b637.2300 | ENABLE | UP | ---- | |
| 8/1-1 | 0007.7000.0056 | ENABLE | UP | C501B | |
| 8/1-1.1 | 0007.7000.0056 | ENABLE | UP | ---- | ---- |
| 8/1-2 | 0007.7000.0012 | ENABLE | UP | C501B | |
| 8/1-2.1 | 0007.7000.0012 | ENABLE | UP | ---- | ---- |
| 8/1-3 | 0007.7010.0044 | ENABLE | UP | C501B | |
| 8/1-3.1 | 0007.7010.0044 | ENABLE | UP | ---- | ---- |
| 8/1-4 | 0007.7000.0034 | ENABLE | UP | C501B | |
| 8/1-4.1 | 0007.7000.0034 | ENABLE | UP | ---- | ---- |

U9016B# configure terminal

U9016B(config)# pon

U9016B(config-pon)# shutdown port 8/1

U9016B(config-pon)# end

U9016B# show pon topology 8/1

PON NETWORK TOPOLOGY INFORMATION

| IF_NAME | MAC ADDR | ADMIN | OPER | SYSTEM TYPE | LLID |
|---------|----------------|---------|------|-------------|------|
| RANGE | | | | | |
| 8/1 | 000d.b637.2300 | DISABLE | DOWN | ---- | |
| 8/1-1 | 0007.7000.0056 | ENABLE | DOWN | C501B | |
| 8/1-1.1 | 0007.7000.0056 | ENABLE | DOWN | | ---- |
| 8/1-2 | 0007.7000.0012 | ENABLE | DOWN | C501B | |
| 8/1-2.1 | 0007.7000.0012 | ENABLE | DOWN | | ---- |
| 8/1-3 | 0007.7010.0044 | ENABLE | DOWN | C501B | |
| 8/1-3.1 | 0007.7010.0044 | ENABLE | DOWN | | ---- |

| | | | | |
|---------|----------------|--------|------|-------|
| 8/1-4 | 0007.7000.0034 | ENABLE | DOWN | C501B |
| 8/1-4.1 | 0007.7000.0034 | ENABLE | DOWN | ---- |



Note Shutdown port command makes all the links of the port down.

ONT registration and view

In order to use ONU/ONT as a resource of the system, you should register ONU/ONT with a specific index. The traffic on unregistered ONU/ONT is blocked.

It is performed in the PON_MODE, and in this mode, PON is divided into OLT and ONU. The available ONT types at the moment are C501A, C501B, C504A, C504B and C501G.

Enter the interface name, the MAC address, the type and the location of the ONU/ONT. The administrative state of the registered ONU/ONT is 'enable'.

If the administrative state of PON OLT is 'enable', it is automatically registered.

Table 302 Commands for ONT

| Command | Description | Mode |
|---|---|------------|
| Topology onu IF_NAME MAC_ADDR onutype(c501a c501b c501g c504a c504b hybridonu hybridonu 2 og-3500ec) loc LOCATION | Registers ONU/ONT as a system resource. - IF_NAME : Index(slot/port-onu) - MAC_ADDR : xxxx.xxxx.xxxx - c501a : TK3714, 1FE-1G Module - c501b : TK3714, 1FE-2.5G Module - c501g : TK3714, 1GE-2.5G Module - c504a : TK3714, 4FE-1G Module - c504b : TK3714, 4FE-2.5G Module - hybridonu : TK3713, 1G Module - hybridonu2 : TK3714, 2.5G Module - og-3500ec : TK3713, 1FE - LOCATION : Location information string | Config-pon |
| show pon topolgy onu IF_NAME | Shows the registration | Enable |

| | | |
|---------------------------------------|--|--------|
| | status of ONU. - IF_NAME : OLT Index(slot/port) | |
| show pon blocked-links IF_NAME | Shows the unregistered and blocked ONU/ONT. - IF_NAME : OLT Index(slot/port) | Enable |

```

U9016B# configure terminal
U9016B(config)# pon
U9016B(config-pon)# topology onu 2/2-1 0007.7000.1005 onutype C504A
U9016B(config-pon)# end
U9016B# show pon topology onu 2/2
  PON NETWORK ONU TOPOLOGY FOR OLT(2/2) INFORMATION
=====
=
  IF_NAME      MAC ADDR      ADMIN   OPER (DOWN DUR) ONU TYPE
DISTANCE
      LOCATION
-----
  2/2-1      0007.7000.1005 ENABLE   DOWN (3 secs)   C504A           0 m
=====
U9016B#

```

ONU registration mode setting/view and release

ONU registration can be performed in 3 modes (MIXED, HYBRID, REAL).

In the MIXED mode, both MPS/TPS ONU and HYBRID ONU are registered.

In the HYBRID mode, only HYBRID ONU is registered, while in the REAL mode, only MPS/TPS ONU is registered. The default mode is MIXED mode. If you finish the REAL mode or the HYBRID mode, the default MIXED mode is returned.

Table 303 Commands for ONU registration

| Command | Description | Mode |
|--|---|------------|
| topology mode IF_NAME MODE_NAME | The registration ode set in the OLT port interface - IF_NAME : olt interface name - MODE_NAME : Name of the ONU registration mode | Config-pon |
| no topology mode IF_NAME | Releases the ONU registration mode. - IF_NAME : olt interface name | Config-pon |
| show pon topology olt | Shows the ONU registration mode. | enable |

ONU/ONT information change and deletion

In order to change or delete ONU/ONT, you should change the administrative status of ONU/ONT to 'disable'. You can use this function with the 'shutdown' command.

Table 304 Commands for ONU/ONT information

| Command | Description | Mode |
|---|--|------------|
| Shutdown onu <i>IF_NAME</i> no topology onu <i>IF_NAME</i> topology edit-onu mac <i>IF_NAME MAC_ADDR</i> topology edit-onu loc <i>IF_NAME LOCATION</i> | - Changes the ONU status to 'disable'. - Deletes the registered ONU/ONT. - Changes the MAC address of the registered ONU/ONT. - Changes the location of the registered ONU/ONT. | Config-pon |
| show pon topolgy onu <i>IF_NAME</i> | Shows the registration status of ONU. - IF_NAME : OLT Index(slot/port) | Enable |

```

U9016B# configure terminal
U9016B(config)# pon
U9016B(config-pon)# shutdown onu 2/2-1
U9016B(config-pon)# edit-onu loc 2/2-1 UBIQUOSS
U9016B(config-pon)# end
U9016B# show pon topology onu 2/2
PON NETWORK ONU TOPOLOGY FOR OLT(2/2) INFORMATION
=====
=
IF_NAME      MAC ADDR      ADMIN    OPER    ONU TYPE
      LOCATION
-----2/2-1      0007.7000.1005
DISABLE up      C504A
      UBIQUOSS
=====
U9016B(config-pon)# no topology onu 2/2-1
U9016B(config-pon)# end
U9016B# show pon topology onu 2/2
PON NETWORK ONU TOPOLOGY FOR OLT(2/2) INFORMATION
=====
=
IF_NAME      MAC ADDR      ADMIN    OPER    ONU TYPE
      LOCATION
-----
=====
U9016B#

```

In order to use ONU/ONT as a resource of the system, you should register ONU/ONT with a specific index. The traffic on unregistered ONU/ONT is blocked.

It is performed in the PON_MODE, and in this mode, PON is divided into OLT and ONU. The available ONT types at the moment are C501A, C501B, C504A, C504B and C501G.

ONT registration and view

Enter the interface name, the MAC address, the type and the location of the ONU/ONT. You cannot use ONU/ONT as a system resource without registering it manually. If the administrative state of a PON port is 'enable', you can view information on ONU/ONT which is blocked as it is not registered. You can register the blocked ONU/ONT to use it as a system resource. The administrative state of the registered ONU/ONT is 'enable'.

Table 305 Command for ONT registration

| Command | Description | Mode |
|---|---|------------|
| Topology onu IF_NAME MAC_ADDR onutype(c501a c501b c501g c504a c504b hybridonu hybridonu 2 og-3500ec) loc LOCATION | Registers ONU/ONT as a system resource. - IF_NAME : Index(slot/port-onu) - MAC_ADDR : xxxx.xxxx.xxxx - c501a : TK3714, 1FE-1G Module - c501b : TK3714, 1FE-2.5G Module - c501g : TK3714, 1GE-2.5G Module - c504a : TK3714, 4FE-1G Module - c504b : TK3714, 4FE-2.5G Module - hybridonu : TK3713, 1G Module - hybridonu2 : TK3714, 2.5G Module - og-3500ec : TK3713, 1FE - LOCATION : Location information string | Config-pon |
| show pon topology onu IF_NAME | Shows the registration status of ONU - IF_NAME : OLT Index(slot/port) | Enable |
| show pon blocked-links IF_NAME | Shows the unregistered and blocked ONU/ONT. - IF_NAME : OLT Index(slot/port) | Enable |

```
U9016B# show pon unadmin-onu-list 10/1
LIST OF UNADMINED ONUS FOR OLT (10/1)
```

```
=====
IDX  MAC ADDRESS      VENDOR-SPECIFIC INFORMATION
-----
[ 1] 0007.7000.1005   c504a
=====
```

```
U9016B# configure terminal
U9016B(config)# pon
U9016B(config-pon)# topology onu 2/2-1 0007.7000.1005 onutype c504a
U9016B(config-pon)# end
U9016B# show pon topology onu 2/2
PON NETWORK ONU TOPOLOGY FOR OLT(2/2) INFORMATION
```

```
=====
IF_NAME      MAC ADDR      ADMIN  OPER  ONU TYPE
      LOCATION
-----
2/2-1      0007.7000.1005  ENABLE  up    C504A
=====
```

U9016B#

ONU/ONT information change and deletion

In order to change or delete ONU/ONT, you should change the administrative status of ONU/ONT to 'disable'. You can use this function with the 'shutdown' command.

Table 306 Commands for ONU/ONT information change

| Command | Description | Mode |
|---|---|------------|
| Shutdown onu <i>IF_NAME</i> no topology onu <i>IF_NAME</i> topology edit-onu mac <i>IF_NAME</i> <i>MAC_ADDR</i> topology edit-onu loc <i>IF_NAME</i> <i>LOCATION</i> | - Changes the ONU status to 'disable'. - Deletes the registered ONU/ONT. - Changes the MAC address of the registered ONU/ONT. - Changes the location of the registered ONU/ONT | Config-pon |
| show pon topology onu <i>IF_NAME</i> | Shows the registration status of ONU. - IF_NAME : OLT Index(slot/port) | Enable |

U9016B# configure terminal

U9016B(config)# pon

U9016B(config-pon)# topology edit-onu loc 2/2-1 Ubiquoss

U9016B(config-pon)# end

U9016B# show pon topology onu 2/2

PON NETWORK ONU TOPOLOGY FOR OLT(2/2) INFORMATION

```
=====
IF_NAME      MAC ADDR      ADMIN  OPER  ONU TYPE
      LOCATION
-----2/2-1      0007.7000.1005
ENABLE  up      C504A
Ubiquoss
=====
```

U9016B(config-pon)# no topology onu 2/2-1 0007.7000.1005

U9016B(config-pon)# end

U9016B# show pon topology onu 2/2

PON NETWORK ONU TOPOLOGY FOR OLT(2/2) INFORMATION

```
=====
=
IF_NAME      MAC ADDR      ADMIN  OPER  ONU TYPE
      LOCATION
-----

=====
U9016B#
```

PON Environment Setting

This section shows the commands and examples of PON OLT and ONU environment setting.

To set PON, you should write the service profile, and apply the profile to the interface. OLT / ONU Service Profile and the commands for OLT and ONU are available in OLT_QOS_MODE and ONU_QOS_MODE, respectively, which are sub-modes of PON_MODE.

PON OLT Environment Setting

The OLT service profile consists of Policy-map and Bridge-map.

The Policy-map consists of the aggregated bandwidth setting and the DBA environment setting. The Bridge-map is composed of the bridging configuration setting.

The initial system setting is made on the service profile called 'oltProfile', and it contains 'oltPmap' as the Policy-map, 'oltBmap' as the Bridge-map, and 'oltlmap' as the lgmp-map.

Writing and application of OLT service profile

To write the OLT service profile, you should write Policy-map and Bridge-map first. The following tables show the commands for writing and deletion of service profiles, and application to the OLT port interface:

Table 307 Commands for OLT service profile

| Command | Description | Mode |
|--|--|-----------------------|
| olt-qos | Switches to the OLT Service Profile write mode. | Config-pon |
| service-map PROFILE_NAME policy-map POLICY_NAME bridge-ap BRIDGE_NAME | Writes OLT Service Profile. - PROFILE_NAME : Service Profile Name - POLICY_NAME : Policy-map Name - BRIDGE_NAME : Bridge-map Name | Config-pon- oltqos |
| no service-map PROFILE_NAME | Deletes OLT Service Profile. - Default Profile (oltProfil) and the profile applied to the current interface are not deleted. | Config-pon- oltqos |
| no policy-map MAP_NAME | Deletes OLT Policy-map. - The map in service is not deleted. | Config-pon- oltqos |
| no bridge-map MAP_NAME | Deletes OLT Bridge-map. - The map in service is not deleted. | Config-pon- oltqos |
| service-policy IF_NAME service-map PROFILE_NAME | IF_NAME : Name of the OLT port interface PROFILE_NAME : OLT service profile name | Config-pon- oltqos |
| show pon service-map olt (PROFILE_NAME) | Shows the OLT Service profile list or the details of a specific service profile. | enable |
| Show pon service-policy olt (IF_NAME) | Shows the service profile applied to the OLT port interface. | enable |

Writing OLT Policy-map

OLT Policy-map consists of OLT port aggregated bandwidth and DBA parameter setting. Change the OLT_QOS_MODE to OLT_PMAP_MODE with the 'policy-map' command.

Table 308 Commands for OLT policy map

| Command | Description | Mode |
|--|---|------------------------|
| olt-qos | Switches to the OLT Service Profile write mode. | Config-pon |
| policy-map MAP_NAME | Switches to the Policy-map write mode. | Config-pon-oltqos |
| aggregate bandwidth (upstream downstream) <0-2000000> <0-256> | Sets Aggregated Bandwidth. - Aggregate bandwidth(Kbps) - <0-256> : Max burst size(KB) | Config-pon-oltqos-pmap |
| Bcstsla (minimum maximum) (disable enable) | Sets SLA state for broadcast LLID. | Config-pon-oltqos-pmap |
| bcstsla control (minimum maximum) <0-2000000> <1-256> <0-3> <1-256> | Sets SLA for Broadcast LLID. - Minimum Guaranteed Bandwidth(Kbps) - Maximum Allowed Bandwidth(Kbps) - Max burst size(KB) - Priority - Weight(KB) | Config-pon-oltqos-pmap |
| dba drop-down weight <0-16383> <0-16383> <0-16383> <0-16383> | Sets the upstream drop-down weight for the priority order level (Unit : KB). - Drop-down for Level 0 - Drop-down for Level 1 - Drop-down for Level 2 - Drop-down for Level 3 | Config-pon-oltqos-pmap |
| dba polling rate <1-65535> <1-65535> <1-65535> <1-65535> | Sets the DBA rolling rate for the priority order level (Unit : 65.5 us). - Polling rate at Level 0 - Polling rate at Level 1 - Polling rate at Level 2 - Polling rate at Level 3 | Config-pon-oltqos-pmap |
| shaper dba drop-down weight (upstream downstream) <0-16383> <0-16383> <0-16383> <0-16383> | Sets the Upstream/Downstream Drop-down weight for the shaper priority order level (Unit : KB) - Drop-down for Level 0 - Drop-down for Level 1 - Drop-down for Level 2 - Drop-down for Level 3 | Config-pon-oltqos-pmap |
| Map-end | Finishes writing the Policy-map and moves to the upper mode. (if you don't enter this command, no map is created. Therefore, you should always write this command to move to the upper mode.) | Config-pon-oltqos-pmap |
| Show pon policy-map olt (MAP_NAME) | Shows the OLT Policy-map list or the details of a specific Policy-map. | enable |

Writing OLT Bridge-map

OLT Bridge-map consists of the OLT port Bridge setting. Change the mode from OLT_QOS_MODE to OLT_BMAP_MODE with the 'bridge-map' command.

Table 309 Commands for OLT bridge map

| Command | Description | Mode |
|--|---|------------------------|
| olt-qos | Switches to the OLT Service Profile write mode. | Config-pon |
| bridge-map MAP_NAME | Switches to the Bridge-map write mode. | Config-pon-oltqos |
| Bridgeconfig allow-simple-bridging(on off) | Allow Simple Bridging | Config-pon-oltqos-bmap |
| Bridgeconfig allow-vlan-tags-on-simple-bridge(on off) | Allow Tagged Frames on Simple Bridge | Config-pon-oltqos-bmap |
| Bridgeconfig discard-unknown-mac(on off) | Discard Unknown MAC Option | Config-pon-oltqos-bmap |
| Bridgeconfig downstream-frame-reset-age(on off) | Downstream Frames Reset Age | Config-pon-oltqos-bmap |
| Bridgeconfig learned-entry-age-limit <0-32768> | Learned entry age limit(Unit : 10 ms) - 2 ⁿ | Config-pon-oltqos-bmap |
| Bridgeconfig mac-learning-overwrite(on off) | MAC Learning overwrite | Config-pon-oltqos-bmap |
| Bridgeconfig number-of-bridged-vlans <0-30> | Number of Bridged VLANs | Config-pon-oltqos-bmap |
| Map-end | Finishes writing the Bridge-map and moves to the upper mode. (if you don't enter this command, no map is created. Therefore, you should always write this command to move to the upper mode.) | Config-pon-oltqos-bmap |
| Show pon bridge-map olt (MAP_NAME) | Shows the OLT Bridge-map list or the details of a specific Bridge-map. | enable |

PON ONU Environment Setting

The ONT service profile consists of Queue-map, Policy-map, Bridge-map, Igmp-map and sla-map.

Queue-map consists of queue assignment to the upstream link and the downstream port. Policy-map consists of packet classification and filtering setting.

Bridge-map consists of bridging configuration setting. Igmp-map contains the IGMP Snooping parameter setting, and sla-map contains the SLA setting for the link.

Queue-map and Policy-map are used to generate a service-map. If you generate a service-map in the system to meet the ONT type, the system automatically sets the appropriate service-map every time an ONT is registered.

The default service map for the ONT type is set by the system vendor, and you are rarely required to change the service map. You only need to add a service map when you register a new ONT type.

Bridge-map, Igmp-map and sla-map are the elements of service-policy. The service-policy is the service profile applied to the registered ONT.

The default service policy to meet the ONT type is already set in the system. When an ONT is registered, the default service policy for the matching ONT is automatically set. You can also set the ONT for Bridge-map, Igmp-map and sla-map, respectively.

The following table shows the default service-map list for the current ONU types.

Table 310 Commands for ONU environment setting

| ONU Type | Basic Service Profile | |
|------------|-----------------------|--|
| C501A | onu-c501a | onuQmapForOg501a onuPmapFor501a |
| C501B | onu-c501b | onuQmapForOg501b onuPmapFor501b |
| C501G | onu-c501g | onuQmapForOg501g onuPmapFor501g |
| C504A | onu-c504a | onuQmapForOg504a onuPmapFor504a |
| C504B | onu-c504b | onuQmapForOg504b onuPmapFor504b |
| HYBRIDONU | hybridOnu | onuQmapForHybridOnu onuPmapForHybridOnu |
| HYBRIDONU2 | hybridOnu2 | onuQmapForHybridOnu2 onuPmapForHybridOnu2 |
| OG-3500EC | onu-3500ec | onuQmapForOg3500-ec onuPmapForOg3500-ec |

You can write the ONU service profile in ONU-QOS_MODE, which is the sub-mode of PON_MODE.

Table 311 Command for getting in ONU setting mode

| Command | Description | Mode |
|----------------|---|-------------------|
| onu-qos | Switches to the ONU Service Profile write mode. | Config-pon-onuqos |

Generation, view and deletion of ONU service-map

To write a ONU service-map, you should write the Queue-map and the Policy-map first. The following table lists the commands to write or delete Service-map.

Table 312 Commands for handling ONU service map

| Command | Description | Mode |
|--|--|-------------------|
| service-map PROFILE_NAME queue-map QUEUE_NAME policy-map POLICY_NAME (onu-c501a onu-c501b | Writes the ONU service profile. - PROFILE_NAME : Service Profile Name - QUEUE_NAME : Queue-map Name - POLICY_NAME : Policy-map Name | Config-pon-onuqos |

| | | |
|---|---|-----------------------|
| onu-c501g onu-c504a onu-c504b hybridOnu hybridOnu2 onu-3500ec) | - ONU Type | |
| no service-map PROFILE_NAME | Deletes the ONU service profile - The system default profile and the profile applied to the current interface are not deleted. | Config-pon- onuqos |
| show pon service-map onu (PROFILE_NAME) | Shows the ONU Service-map list or the details of a specific Service-map. | enable |

Generation, view and deletion of ONU default service-map

In order to write an ONU default service-map, you should write the Queue-map and Policy-map first. The ONU type must be matched between the service-map and the Reference_ONU_TYPE used to generate a default service-map. The following table lists the commands to write or delete Default Service-map.

Table 313 Commands for default ONU service map

| Command | Description | Mode |
|---|--|-----------------------|
| default service-map ONUNAME service-map SERVICE_MAP | Changes the default service-map of the existing ONU type. | |
| default service-map ONUNAME Reference_ONU_TYPE service-map SERVICE_MAP | Writes the ONU Default service-map. | |
| no default service-map ONUNAME | Deletes the ONU Service-map. - The system default profile and the profile applied to the current interface are not deleted. | Config-pon- onuqos |
| show pon default service- map | Shows the ONU default Service-map list. | enable |

[What is REF ONU TYPE?](#) == onu-c501a | onu-c501b | onu-c501g | onu-c504a | onu-c504b | hybridOnu | hybridOnu2 | onu-3500ec

ONU default service-policy setting and view

Once an ONU default service-policy is set, when an ONT is registered, the default profile for the ONT is set automatically.

Table 314 Commands for handling default ONU service policy

| Command | Description | Mode |
|---|---|-----------------------|
| default service-policy sla- map SLA_NAME bridge- map BRIDGE_NAME igmp- map IGMP_NAME | Sets the ONU default service-policy. - SLA_NAME : Sla-map Name - BRIDGE_NAME : Bridge-map Name - IGMP_NAME : Igmp-map Name | Config-pon- onuqos |
| default service-policy hybridonu sla-map | Sets the hybrid ONU default service- policy. | Config-pon- onuqos |

| | | |
|---|---|--------|
| SLA_NAME bridge-map BRIDGE_NAME igmp-map IGMP_NAME | - SLA_NAME : Sla-map Name - BRIDGE_NAME : Bridge-map Name - IGMP_NAME : Igmp-map Name | |
| show pon default service-policy | Shows the ONU default Service-policy. | enable |

Generation, view and deletion of ONU service-policy

Table 315 Commands for handling ONU service policy

| Command | Description | Mode |
|---|--|-------------------|
| service-policy IFNAME sla-map SLA_NAME bridge-map BRIDGE_NAME igmp-map IGMP_NAME | Sets the ONU service-policy. - IFNAME : Interface_Name - SLA_NAME : Sla-map Name - BRIDGE_NAME : Bridge-map Name - IGMP_NAME : Igmp-map Name | Config-pon-onuqos |
| no service-policy IFNAME | Deletes the Service-policy applied to ONU. - The profile applied to the ONU in service is not deleted. | Config-pon-onuqos |
| show pon service-policy onu IFNAME | Shows the Service-policy applied to ONU. | enable |

Generation and view of ONU Queue-map

ONU (Optical Network Unit) Queue-map sets the queue assignment to upstream/downstream links and ports.

The system can assign queues to 4~8 upstream links. The total queue size is 240 (Unit : 4 KB). In the downstream, up to 11 queues are assigned to 2 ports. The total queue size must be not more than 120 (unit: 1 KB). To write a queue-map, switch the mode from ONU_QOS_MODE to ONU_QMAP_MODE with the 'queue-map' command.

Table 316 Commands for ONU queue map

| Command | Description | Mode |
|---|---|------------------------|
| onu-qos | Switches to the ONU Service Profile write mode. | Config-pon-onuqos |
| queue-map MAP_NAME (onu-c501a onu-c501b onu-c501g onu-c504a onu-c504b hybridOnu hybridOnu2 onu-3500ec) | Switches to the queue-map write mode. | Config-pon-onuqos |
| no queue-map MAP_NAME | Deletes the ONU Queue-map. - The map in service is not deleted. | Config-pon-onuqos |
| Queueconfig upstream <1-4> <0-240> <2-240> ... | Assigns a queue to an upstream link. | Config-pon-oltqos-qmap |
| Queueconfig downstream <1-2> <0-120> <2-120> ... | Assigns a queue to a downstream port. | Config-pon-oltqos-qmap |
| Map-end | Finishes writing the queue-map and moves to the upper mode. (if you don't | Config-pon-oltqos-qmap |

| | | |
|--|--|--------|
| | enter this command, no map is created. Therefore, you should always write this command to move to the upper mode.) | |
| Show pon queue-map onu (MAP_NAME) | Shows the ONU queue-map list or the details of a specific queue-map. | enable |

Generation and deletion of ONU Class-map

The ONU Class-map, with the OLT Class-map, sets the rule to classify the packet. This map is used in Policy-map as the condition for the classification rule and the filtering rule. (The elements of the rule is the same as those of the OLT Class-map. Refer to OLT Class-map for description on each element.) To write the map, you should switch the mode from ONU_QOS_MODE to ONT_CMAP_MODE with the 'class-map' command.

Table 317 Commands for handling ONU class map

| Command | Description | Mode |
|---|--|------------------------|
| onu-qos | Switches to the ONU Service Profile write mode. | Config-pon-onuqos |
| class-map MAP_NAME | Switches to the Class-map write mode. | Config-pon-onuqos |
| no class-map MAP_NAME | Deletes the ONU Class-map - The map in service is not deleted. | Config-pon-onuqos |
| (no) classrule FIELD LOOKUP_VALUE OPERATOR | Adds/deletes a rule to/from Class-map. - See below for FIELD, LOOKUP_VALUE, OPERATOR. | Config-pon-onuqos-cmap |
| Map-end | Finishes writing the Class-map and moves to the upper mode. (if you don't enter this command, no map is created. Therefore, you should always write this command to move to the upper mode.) | Config-pon-onuqos-cmap |
| Show pon class-map onu (MAP_NAME) | Shows the ONU Class-map list or the details of a specific Class-map. | enable |

Writing and deleting ONU Policy-map

The ONU Policy-map consists of the packet classification rule and the packet filtering rule. To write the map, you should switch the mode from ONU_QOS_MODE to ONU_PMAP_MODE with the 'policy-map' command.

Table 318 Commands for handling ONU policy map

| Command | Description | Mode |
|--|---|-------------------|
| onu-qos | Switches to the ONU Service Profile write mode. | Config-pon-onuqos |
| policy-map MAP_NAME (onu-c501a onu-c501b onu-c501g onu-c504a onu-c504b hybridOnu hybridOnu2 onu-3500ec) | Switches to the Policy-map write mode. | Config-pon-onuqos |
| no policy-map MAP_NAME | Deletes the ONU Policy-map. - The map in service is not deleted. | Config-pon-onuqos |

| | | |
|---|---|------------------------|
| (No I) filtering through downstream <1-2> <0-16> <1-7> class-map CLASS_MAP | Sets or deletes the classification rule that designates the destination for the packet received from the ONU downstream EPON port. - <1-2> : Egress User Port Number - <0-16> : Egress Downstream Queue - <4-6> : Priority of the rule - CLASS_MAP : ONU Class-map Name | Config-pon-onuqos-pmap |
| (no I) filtering discard onu port upstream <1-2> <1-7> class-map CLASS_MAP | Sets or deletes the filtering rule that discards the packet received from the ONU upstream user port. - <1-2> : Ingress User Port Number - <0-7> : Priority of the rule - CLASS_MAP : ONU Class-map Name | Config-pon-onuqos-pmap |
| (no I) filtering discard onu port downstream <1-7> class-map CLASS_MAP | Sets or deletes the filtering rule that discards the packet received from the ONU downstream EPON port. - <0-7> : Priority of the rule - CLASS_MAP : ONU Class-map Name | Config-pon-onuqos-pmap |
| Map-end | Finishes writing the Policy-map, and moves to the upper mode. If you don't enter this command, no map is created. Therefore, you should always write this command to move to the upper mode. | Config-pon-onuqos-pmap |
| Show pon policy-map onu (MAP_NAME I) | Shows the ONU Policy-map list or the details of a specific Policy-map. | Enable |

Writing and deleting ONU SLA-Map

The ONU Policy-map consists of the SLA setting of the ONU link. To write the map, you should switch the mode from ONU_QOS_MODE to ONU_SMAP_MODE with the 'sla-map' command.

Table 319 Commands for handling ONU SLA map

| Command | Description | Mode |
|---|--|-------------------|
| onu-qos | Switches to the ONU Service Profile write mode. | Config-pon-onuqos |
| sla-map MAP_NAME up <0-1000000> <256-1000000> down <0-1000000> <256-1000000> | Generates the ONU sla-map. - Upstream minimum bandwidth - Upstream maximum bandwidth - Downstream minimum bandwidth - Downstream maximum bandwidth | Config-pon-onuqos |
| sla-map MAP_NAME | Switches to the sla-map write mode. | Config-pon-onuqos |

| | | |
|---|---|------------------------|
| Sla control <1-4> (upstream downstream) (maximum minimum) <256-1000000> <1-256> <4-32> | Sets Upstream/Downstream SLA of the ONU link. - Link Index : 1~4 - Minimum Bandwidth - Maximum Bandwidth - Max burst size(KB) | Config-pon-onuqos-pmap |
| Sla priority <1-4> (upstream downstream) <0-2> <0-3> | Sets Upstream/Downstream SLA priority of the ONU link. | Config-pon-onuqos-pmap |

Writing and deleting ONU Bridge-map

The ONU Bridge-map includes the ONU user port bridge setting, the link bridge mode setting, and the key exchange timer setting for data encryption of the link.

To write the map, you should switch the mode from ONU_QOS_MODE to ONU_BMAP_MODE with the 'bridge-map' command.

Table 320 Commands for handling ONU Bridge map

| Command | Description | Mode |
|--|--|------------------------|
| onu-qos | Switches to the ONU Service Profile write mode. | Config-pon-onuqos |
| bridge-map aa mac-limit MAC_LIMIT | Generates the ONU bridge-map. | Config-pon-onuqos |
| bridge-map MAP_NAME | Switches to the Bridge-map write mode. | Config-pon-onuqos |
| no bridge-map MAP_NAME | Deletes the ONU Bridge-map. - The map in service is not deleted. | Config-pon-onuqos |
| Bridgeconfig <1-2> <0-64> <0-32768> | Sets MAC limit to the ONU user port. - <1-2> : ONU User Port Number - <0-64> : automatic learning entry limit - <0-32768> : learned entry age limit (2 ⁿ) | Config-pon-onuqos-bmap |
| Bridgemode <1-4> (simple-bridge shared-vlan transparent-vlan priority-simple-bridge priority-shared-vlan transparent-priority-shared-vlan) <0-4095> | Sets the bridging mode of the ONU link. - <1-4> : ONU Link Number - Bridging Mode - <0-4095> : mac tabe entry limit | Config-pon-onuqos-bmap |
| Key exchange timer <1-4> <0-65535> | Sets the key exchanger timer for ONU link encryption. - <1-4> : ONU Link Number - <0-65535> : Timeout Value(Unit : sec), 0 or 60~65535 | Config-pon-onuqos-bmap |
| Map-end | Finishes writing the Bridge-map and moves to the upper mode. (if you don't enter this command, no map is created. Therefore, you should always | Config-pon-onuqos-bmap |

| | | |
|--|--|--------|
| | write this command to move to the upper mode.) | |
| Show pon bridge-map onu (MAP_NAME) | Shows the ONU Bridge-map list or the details of a specific Bridge-map. | enable |

The following 6 bridging modes are available. The following table lists the upstream/downstream bridging actions in each mode. (Refer to 'VLAN setting to link' for VLAN settings by bridge mode.)

Simple Bridge

Table 321 Behavior in simple bridge mode

| Upstream | | |
|--------------------|-------------------------|----------------------------|
| Source MAC Address | | Bridging Action |
| Unicast | | Learn SA Forward |
| Multicast | | Forward |
| Broadcast | | Forward |
| Downstream | | |
| VLAN Tag | Destination MAC Address | Bridging Action |
| No | Learned | Forward to Link |
| No | Unlearned | Flood on broadcast channel |
| Yes | N/A | Drop |

Shared VLAN

Table 322 Behavior in shared VLAN mode

| Upstream | |
|-------------------------|--|
| Source MAC Address | Bridging Action |
| Unicast | Learn SA Add provisioned tag Forward |
| Multicast | Forward |
| Broadcast | Forward |
| Downstream | |
| Destination MAC Address | Bridging Action |
| Learned | Strip Tag Forward to Link(based on L2 DA + VID) |
| Unlearned | Strip Tag Broadcast o VLAN(based on VID only) |

Transparent VLAN

Table 323 Behavior in transparent VLAN mode

| Upstream | |
|---|---|
| VLAN Tag Present | Bridging Action |
| Yes | Forward without modification(based on VID only) |
| No | Forward without modification(based on VID only) |
| Downstream | |
| Bridging Action | |
| Forward without modification(based on VID only) | |

Priority Simple Bridged

Table 324 Behavior in priority simple bridge mode

| Upstream | | | |
|--------------------|-------------------------|------------------------------------|----------------------------|
| Source MAC Address | | Bridging Action | |
| Unicast | | Learn SA Forward | |
| Multicast | | Forward | |
| Broadcast | | Forward | |
| Downstream | | | |
| VLAN Tag | Destination MAC Address | Priority | Bridging Action |
| No | Learned | Within Provisioned Priority Range | Forward to Link |
| | | Outside Provisioned Priority Range | Drop |
| No | Unlearned | Don't Care | Flood on broadcast channel |
| Yes | N/A | N/A | Drop |

Priority Shared VLAN

Table 325 Behavior in priority shared VLAN mode

| Upstream | | | |
|---------------------------|------------------|---|---|
| VLAN Tag Present | | Bridging Action | |
| Yes | | Strip Tag Add Provisioned Tag(VID + Upstream CoS) Forward | |
| No | | Add Provisioned Tag Forward | |
| Downstream(Switch on ToS) | | | |
| ToS in Range | Tx-Non-ToS-Frame | L2 DA Learned | Bridging Action |
| Yes | N/A | Yes | Strip Tag Forward(based on DA + VID + ToS) |
| | | No | Strip Tag Broadcast on VLAN(based on VID + |

| | | | |
|----------------------------------|-------------------------|----------------------|--|
| | | | ToS) |
| No | Yes | Yes | Strip Tag Forward(based on DA + VID) |
| | | No | Strip Tag Broadcast on VLAN(based on VID) |
| | No | N/A | Drop |
| Downstream(Switch on CoS) | | | |
| CoS in Range | Tx-Non-ToS-Frame | L2 DA Learned | Bridging Action |
| Yes | N/A | Yes | Strip Tag Forward(DA + VID + CoS) |
| | | No | Strip Tag Broadcast on VLAN(VID + CoS) |
| No | N/A | N/A | Drop |

Transparent Priority Shared VLAN

Table 326 Behavior in transparent priority shared VLAN mode

| Upstream | | | |
|---------------------------|------------------|---|---------------------------------------|
| VLAN Tag Present | | Bridging Action | |
| Yes | | Strip Tag Add Provisioned Tag(VID + Upstream CoS) Forward | |
| No | | Add Provisioned Tag Forward | |
| Downstream(Switch on ToS) | | | |
| ToS in Range | Tx-Non-ToS-Frame | L2 DA Learned | Bridging Action |
| Yes | N/A | Yes | Forward(based on DA + VID + ToS) |
| | | No | Broadcast on VLAN(based on VID + ToS) |
| No | Yes | Yes | Forward(based on DA + VID) |
| | | No | Broadcast on VLAN(based on VID) |
| | No | N/A | Drop |
| Downstream(Switch on CoS) | | | |
| CoS in Range | Tx-Non-ToS-Frame | L2 DA Learned | Bridging Action |
| Yes | N/A | Yes | Forward(DA + VID + CoS) |
| | | No | Broadcast on VLAN(VID + CoS) |
| No | N/A | N/A | Drop |

Writing and deleting ONU Igmp-map

ONU Igmp-map includes the IGMP snooping setting of ONU. To write the map, you should switch the mode from ONU_QOS_MODE to ONU_IMAP_MODE with the 'igmp-map' command.

Table 327 Commands for ONU IGMP map

| Command | Description | Mode |
|---|--|------------------------|
| onu-qos | Switches to the ONU Service Profile write mode. | Config-pon |
| igmp-map MAP_NAME | Switches to the Igmp-map write mode. | Config-pon-onuqos |
| no igmp-map MAP_NAME | Deletes the ONU Igmp-map. - The map in service is not deleted. | Config-pon-onuqos |
| Igmp snooping onu <1-16> <0-6> | Sets the ONU IGMP snooping parameter. - <1-16> : robustness count - <0-6> : last member query count | Config-pon-onuqos-imap |
| Igmp snooping port <1-2> <0-64> <0-10> | Sets snooping to the ONU user port. - <1-2> : ONU User Port Number - <0-64> : Number of IGMP groups (0 : snooping disabled) - <0-10> : relative queue for downstream classification | Config-pon-onuqos-imap |
| Map-end | Finishes writing the Igmp-map and moves to the upper mode. (if you don't enter this command, no map is created. Therefore, you should always write this command to move to the upper mode.) | Config-pon-onuqos-imap |
| Show pon igmp-map onu (MAP_NAME) | Shows the ONU Igmp-map list or the details of a specific Igmp-map. | enable |

VLAN setting to link

This section describes how to set VLAN by the bridge mode set to the link.

As already mentioned in ONU Bridge-map, there are 6 bridge modes. The following table lists the VLAN setting commands for each mode:

Table 328 Root word for commands per bridge mode

| Link Bridge Mode | VLAN Setting Command |
|----------------------------------|----------------------|
| Simple Bridge | N/A |
| Shared VLAN | Vlntag |
| Transparent VLAN | Vlntag |
| Priority Simple Bridged | Priority-vlan |
| Priority Shared VLAN | Priority-vlan |
| Transparent Priority Shared VLAN | Priority-vlan |

Table 329 Commands for VLAN setting

| Command | Description | Mode |
|--|--|------------|
| (no l) vlantag IF_NAME <1-4> <1-4093> <0-4093> | Sets the VLAN tag to the link for shared VLAN, transparent VLAN mode. - IF_NAME : ONU Interface Name - <1-4> : ONU Link Number - <1-4093> : Network VLAN Tag - <0-4093> : translated vlan ID | Config-pon |
| (no l) priority-vlan IF_NAME <1-4> <0-4093> <0-7> (cos tos) <0-7> <0-7> (on off) | Sets the priority VLAN to the link for priority VLAN mode. - IF_NAME : ONU Interface Name - <1-4> : ONU Link Number - <1-4093> : Network VLAN ID ('0' for priority-simple-bridge) - <0-7> : Upstream CoS (All the links included in the priority VLAN group must have the same value.) - (cos tos) : Priority Selector - <0-7> : Minimum Priority Value - <0-7> : Maximum Priority Value - (on off) : Transmit Non-ToS Frame | Config-pon |
| Show pon vlan-for-link IF_NAME <1-4> | Shows the VLAN set to the link. | Enable |
| Show pon links-for-vlan IF_NAME <1-4093> | Shows the link list set to a specific VLAN of OLT. | Enable |
| Show pon priority-vlan IF_NAME <1-4> | Shows the priority VLAN set to the link. | Enable |

Advanced rule setting to ONU port

This section describes how to add or delete rules to or from the ONU lookup engine. By setting this rule, you can change the VLAN tag of the received packet, or change CoS. The priority value of the rule included in the commands in this section is corresponding to twice of the priority value of the classification rule or the filtering rule written in ONU policy-map.

Table 330 Commands for handling advanced rule setting

| Command | Description | Mode |
|--|--|------------|
| (no l) filtering (add-tag del-tag add-tag-fwd clr-add-tag clr-add-tag-fwd clr-del-tag clr-del-tag-fwd clr-replace-tag clr-replace-tag-fwd del-tag del-tag-fwd replace-tag replace-tag-fwd) onu port upstream IF_NAME <1-2> <0-15> class-map CLASS_MAP | Changes the VLAN tag for the packet from the ONU upstream user port, which meets the Class-map condition. - add-tag : Add VLAN tag - clr-add-tag : Clear Add Tag - clr-del-tag : Clear Delete Tag - clr-replace-tag : Clear Replace Tag - del-tag : Delete Tag - replace-tag : Replace Tag - IF_NAME : ONU Interface Name | Config-pon |

| | | |
|--|---|------------|
| | <ul style="list-style-type: none"> - <1-2> : ONU User Port Number - <0-15> : Priority of the rule - CLASS_MAP : ONU Class-map Name | |
| (no) filtering (add-tag add-tag-fwd clr-add-tag clr-add-tag-fwd clr-del-tag clr-del-tag-fwd clr-replace-tag clr-replace-tag-fwd del-tag del-tag-fwd replace-tag replace-tag-fwd) onu port downstream IF_NAME <0-15> class-map CLASS_MAP | <p>Changes the VLAN tag for the packet from the ONU downstream EPON port, which meets the Class-map condition.</p> <ul style="list-style-type: none"> - add-tag : Add VLAN tag - clr-add-tag : Clear Add Tag - clr-del-tag : Clear Delete Tag - clr-replace-tag : Clear Replace Tag - del-tag : Delete Tag - replace-tag : Replace Tag - IF_NAME : ONU Interface Name - <0-15> : Priority of the rule - CLASS_MAP : ONU Class-map Name | Config-pon |
| (no) filtering (set-vid-and-add-tag set-vid-and-add-tag-fwd replace-tag-and-set-vid replace-tag-and-set-vid-fwd) onu port upstream IF_NAME <1-2> <0-15> <0-4093> class-map CLASS_MAP | <p>Sets the VLAN ID for the packet from the ONU upstream user port, which meets the Class-map condition.</p> <ul style="list-style-type: none"> - set-vid-and-add-tag : Set VID ; Add Tag - replace-tag-and-set-vid : Replace Tag ; Set VID - IF_NAME : ONU Interface Name - <1-2> : ONU User Port Number - <0-15> : Priority of the rule - CLASS_MAP : ONU Class-map Name | Config-pon |
| (no) filtering (set-vid-and-add-tag set-vid-and-add-tag-fwd replace-tag-and-set-vid replace-tag-and-set-vid-fwd) onu port downstream IF_NAME <0-15> <0-4093> class-map CLASS_MAP | <p>Sets the VLAN ID for the packet from the ONU downstream EPON port, which meets the Class-map condition.</p> <ul style="list-style-type: none"> - set-vid-and-add-tag : Set VID ; Add Tag - replace-tag-and-set-vid : Replace Tag ; Set VID - IF_NAME : ONU Interface Name - <0-15> : Priority of the rule - CLASS_MAP : ONU Class-map Name | Config-pon |
| (no) filtering (set-cos set-cos-fwd) onu port upstream IF_NAME <1-2> <0-15> <0-7> class-map CLASS_MAP | <p>Sets the CoS value for the packet from the ONU upstream user port, which meets the Class-map condition.</p> <ul style="list-style-type: none"> - <1-2> : ONU Interface Name - <0-15> : Priority of the rule - <0-7> : CoS Value - CLASS_MAP : ONU Class-map Name | Config-pon |
| (no) filtering(set-cos set-cos-fwd) onu port downstream IF_NAME <0-15> <0-7> class-map CLASS_MAP | <p>Sets the CoS value for the packet from the ONU downstream EPON port, which meets the Class-map condition.</p> <ul style="list-style-type: none"> - <0-15> : Priority of the rule - <0-7> : CoS Value - CLASS_MAP : ONU Class-map Name | Config-pon |

| | | |
|--|--|------------|
| (no) filtering (copy-field-to-cos copy-field-to-cos-fwd copy-field-to-vid copy-field-to-vid-fwd) onu port upstream IF_NAME <1-2> <0-15> class-map CLASS_MAP | Sets the CoS value for the packet from the ONU upstream user port, which meets the Class-map condition. - <1-2> : ONU Interface Name - <0-15> : Priority of the rule - CLASS_MAP : ONU Class-map Name | Config-pon |
| (no) filtering (copy-field-to-cos copy-field-to-cos-fwd copy-field-to-vid copy-field-to-vid-fwd) onu port downstream IF_NAME <0-15> class-map CLASS_MAP | Sets the CoS value for the packet from the ONU downstream EPON port, which meets the Class-map condition. - <0-15> : Priority of the rule - CLASS_MAP : ONU Class-map Name | Config-pon |
| Show pon filtering rules onu port upstream IF_NAME <1-2> | Shows the rule set to the ONU upstream user port. | Enable |
| Show pon filtering rules onu port downstream IF_NAME | Shows the rule set to the ONU downstream EPON port. | Enable |

ONT Switch Setting

This section describes how to set the EPON ONT Switch configuration.

VLAN setting

This clause describes how to set the ONT Switch VLAN.

Table 331 ont switch vlan setting

| Command | Description | Mode |
|---|--|----------------|
| vlan-database | Enters the vlan-database mode. (Mode for vlan generation and deletion) | subs_mode |
| (no) vlan <2-4093> IF_NAME | Generates / deletes VLAN. | subs_vlan_mode |
| switchport mode (access trunk) IF_NAME | Sets the port to (access truck) mode. | subs_mode |
| switchport access vlan <1-4093> IF_NAME | Sets the access port to a VLAN member. | subs_mode |
| no switchport access vlan IF_NAME | Deletes the access port from VLAN member. | subs_mode |
| switchport trunk (add remove) <2-4093> IF_NAME | Adds/removes the trunk to/from the VLAN member. | subs_mode |
| switchport trunk native <2-4093> IF_NAME | Sets the trunk port native VLAN. | subs_mode |
| no switchport trunk native IF_NAME | Disables the trunk port native VLAN. | subs_mode |
| show subscriber vlan IF_NAME | Shows the overall VLAN settings. | Privileged |
| show subscriber interface switchport IF_NAME | Shows the port information by bridge. | Privileged |

L2 Common configuration setting

Table 332 ont switch l2 common setting

| Command | Description | Mode |
|--|--|-----------|
| auto-negotiation (on off) IF_NAME | Enables the auto negotiation function. | subs_mode |
| duplex (full-duplex half-duplex) IF_NAME | Sets duplex to the port. | subs_mode |
| speed (10 100) IF_NAME | Sets the speed to the port. | subs_mode |
| (no) flowcontrol IF_NAME | Enables/disables flow control to the port. | subs_mode |
| mac-limit <1-16> IF_NAME | Enables the mac-limit to the port. | subs_mode |
| no mac-limit IF_NAME | Disables the mac-limit to the port. | subs_mode |
| mac-clear IF_NAME | Deletes the mac learning table. | subs_mode |
| (no) shutdown IF_NAME | Sets the admin status of the port. | subs_mode |
| bridge spanning-tree (enable disable) IF_NAME | Enables/disables STP. | subs_mode |

| | | |
|--|--|-----------|
| bridge ageing-time <10-1000000> IF_NAME | Sets the aging time of MAC learning information. | subs_mode |
| no bridge ageing-time IF_NAME | Disables the aging time of MAC Learning information. | subs_mode |
| bridge forward-time <4-30> IF_NAME | Sets the forwarding delay time. | subs_mode |
| no bridge forward-time IF_NAME | Disables the forwarding delay time. | subs_mode |
| bridge hello-time <1-10> IF_NAME | Sets the BPDU Hello message interval. | subs_mode |
| no bridge hello-time IF_NAME | Disables the BPDU Hello message interval. | subs_mode |
| bridge max-age <6-40> IF_NAME | Sets the maximum aging time for root bridge setting. | subs_mode |
| no bridge max-age IF_NAME | Disables the maximum aging time. | subs_mode |
| bridge priority <0-61440> IF_NAME | Sets the bridge priority. | subs_mode |

L2 Common configuration view

Table 333 ont switch l2 common configuration view

| Command | Description | Mode |
|---|--|------------|
| show subscriber auto-negotiation IF_NAME | Shows auto-negotiation of the ONT Port. | Privileged |
| show subscriber flowcontrol IF_NAME | Shows the flow control setting. | Privileged |
| show subscriber bridge IF_NAME | Shows information on the bridge. | Privileged |
| show subscriber interface IF_NAME | Shows interface performance information. | Privileged |
| show subscriber mac-limit IF_NAME | Shows the MAC limit setting of ONT. | Privileged |
| show subscriber port-state IF_NAME | Shows the overall port status. | Privileged |
| show subscriber spanning-tree IF_NAME | Shows the spanning-tree status. | Privileged |

IGMP configuration setting and view

Table 334 ont switch igmp setting and view

| Command | Description | Mode |
|--|---|------------|
| (no) ip igmp snooping IF_NAME | Enables/disables the IGMP snooping function. | subs_mode |
| ip igmp snooping maxgroup <10-35> IF_NAME | Sets the IGMP Snooping multicast max group. | subs_mode |
| ip igmp snooping robustness-count <0-12> IF_NAME | Designates the robustness count of the IGMP Snooping parameter. | subs_mode |
| ip igmp snooping last-member-query-count <0-12> IF_NAME | Shows the query interval. | subs_mode |
| show subscriber ip igmp | Shows IGMP snooping by port. | Privileged |

| | | |
|--|--------------------|------------|
| snooping IF_NAME | | |
| show subscriber ip igmp groups IF_NAME | Shows IGMP groups. | Privileged |

QOS configuration setting

Class-map setting

Table 335 ont switch qos class-map setting

| Command | Description | Mode |
|--|----------------------------------|-----------------|
| class-map MAP_NAME | Enters the class-map write mode. | subs_mode |
| qos mapping-type (cos tos diffserv) port <1-5> | Registers policy by port. | subs_class_mode |
| no qos mapping-type port <1-5> | Disables policy by port. | subs_class_mode |
| qos map cos <0-7> queue <0-3> | Registers the CoS profile item. | subs_class_mode |
| qos map tos <0-7> queue <0-3> | Registers the ToS mapping item. | subs_class_mode |
| qos map diffserv <0-63> queue <0-3> | Registers the DSCP mapping item. | subs_class_mode |
| no class-map CLASS_NAME | Deletes the class-map. | subs_mode |

Policy-map setting

Table 336 ont switch qos policy-map setting

| Command | Description | Mode |
|---|--|------------------|
| policy-map MAP_NAME | Enters the policy-map write mode. | subs_mode |
| qos wrr queue-config <1-55> <1-55> <1-55> <1-55> | Sets the scheduling queue. | subs_policy_mode |
| qos scheduling (spq wrr) | Sets the QOS scheduler. | subs_policy_mode |
| port <1-5> rate-limit (ingress egress) <64-125000> | Sets ingress/egress Rate-Limit by port. | subs_policy_mode |
| no port <1-5> rate-limit (ingress egress) | Disables ingress/egress Rate-Limit. | subs_policy_mode |
| qos cos-remap (enable disable) | Enables/disables CoS remapping. | subs_policy_mode |
| user-priority-regen-table user-priority <0-7> regenerated-user-priority <0-7> | Enables the COS remarking. | subs_policy_mode |
| port <1-5> user-priority <0-7> | Sets the 802.1p priority order by port. | subs_policy_mode |
| port <1-5> storm-control (broadcast dlf-multicast) | Enables the port storm control function. | subs_policy_mode |
| port <1-5> storm-control kbps <1000- | Sets the port storm control | subs_policy_mode |

| | | |
|---|---|------------------|
| 125000> | rate. | de |
| no port <1-5> storm-control (broadcast dlf-multicast) | Disables the port storm control function. | subs_policy_mode |
| no policy-map POLICY_NAME | Deletes the policy-map. | subs_mode |

Profile configuration setting

Table 337 ont switch qos class-map setting

| Command | Description | Mode |
|---|----------------------------------|-----------|
| service-policy CLASS_NAME POLICY_NAME IF_NAME | Applies the profile to the port. | subs_mode |

QOS configuration view

Table 338 ont switch qos configuration view

| Command | Description | Mode |
|--|---|------------|
| show subscriber rate-limit IF_NAME | Shows the ONT bandwidth limit setting. | Privileged |
| show subscriber qos scheduling IF_NAME | Shows the status of QoS scheduling. | Privileged |
| show subscriber qos IF_NAME (diffserv-map cos-map tos-map) | Shows the status of QoS mapping. | Privileged |
| show subscriber user-priority interface IF_NAME | Shows the user priority setting. | Privileged |
| show subscriber user-priority-regen-table interface IF_NAME | Shows the status of the user priority regeneration table. | Privileged |
| show subscriber qos mapping-type interface IF_NAME | Shows the QoS mapping type by port. | Privileged |
| show subscriber storm-control IF_NAME | Shows the storm-control setting. | Privileged |
| show subscriber class-map (CLASS_MAP) | Shows the Class-map setting. | Privileged |
| show subscriber policy-map (POLICY_MAP) | Shows the QOS policy setting. | Privileged |
| show subscriber service-policy IF_NAME | Shows the application status of QOS policy. | Privileged |

PON Ports Redundancy

The system provides the PON Ports Redundancy. This section describes how to set the EPON Ports Redundancy configuration. The following diagram shows an example how to configure the PON Ports Redundancy.

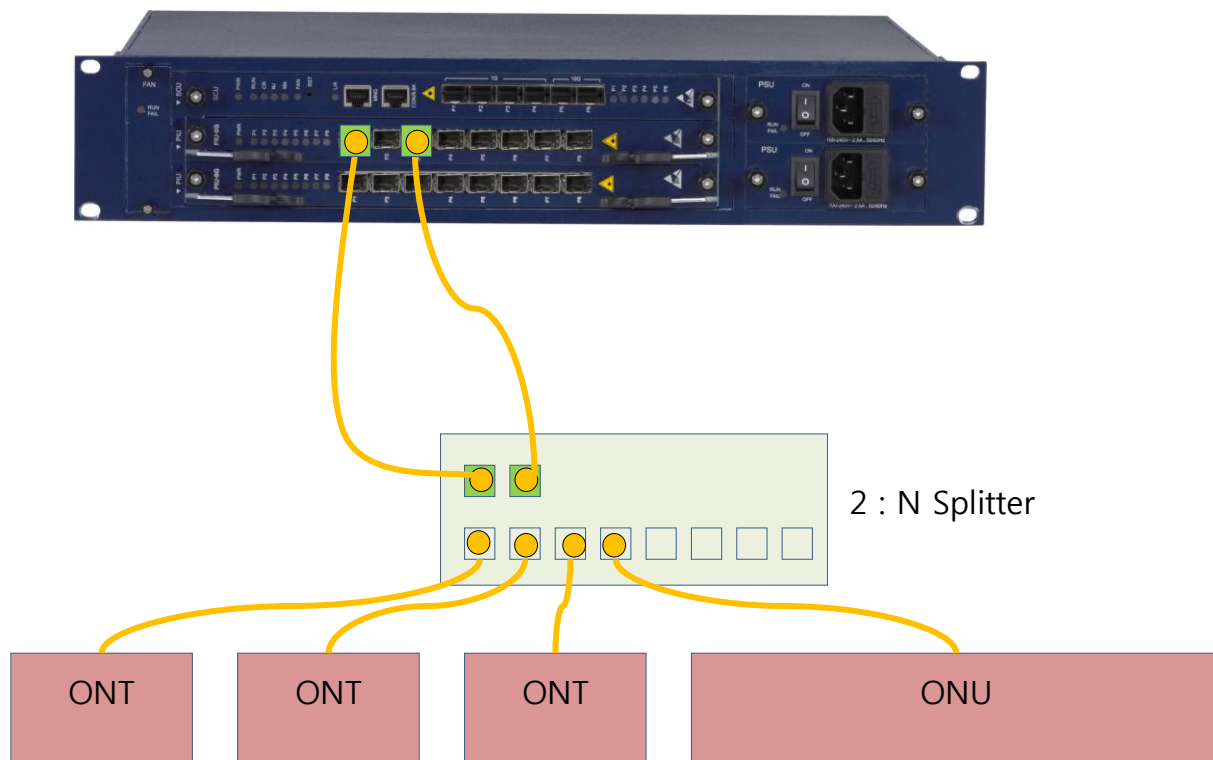


Figure 61. Basic Configuration Diagram

To set or show the pon port redundancy, use the following commands.

Table 339 Redundancy PON Port Command

| Command | Description | Mode |
|--|------------------------------------|------------|
| redundancy-pon-port IFNAME1 IFNAME2 | Sets pon ports redundancy. | Configured |
| no pon-port-redundancy IFNAME1 IFNAME2 | Disables pon ports redundancy. | Configured |
| show redundancy-pon-port | Shows redundancy pon port status.. | Privileged |
| redundanc pon-port force-switchover IFNAME | Switchover pon port forcely. | Configured |

The following example shows how to set the pon ports redundancy and display the result.

Set command

```
config> redundancy-pon-port IFNAME1 IFNAME2
config> no pon-port-redundancy IFNAME1 IFNAME2
```

View command

```
#show redundancy-pon-port
```

Forced switchover command

```
#redundanc pon-port force-switchover IFNAME
```



Note

If IFNAME1 and IFNAME2 are in the same slot, it's not possible to set this feature.

The port placed in the left hand (the one with lower slot number) will always have the priority.

All the configurations are to be applied to IFNAME1.

ETC Function

Auto shutdown of ONU with optic module error

This function detects ONT, which is the optic module error, and automatically shuts down the ONT.

The system detects ONT and automatically shuts down the ONT in the following flow:

1. If an optic fail occurs, PIU notifies MCU of the event, and MCU sends the “Optic Module Alarm ON” event to EMS.
2. MCU finds the suspicious ONT and commands it to test the optic module.
3. Upon receiving the optic module test command, ONT tests the optic module, and if the optic module is defective, shuts down by itself by blocking the power.
4. Upon receiving the optic fail clear signal from PIU, MCU sends the “Optic Module Alarm OFF” event to EMS.

Table 340 Idshutdown setting

| Command | Description | Mode |
|--------------------------------------|------------------------------------|------|
| Idshutdown (enable disable) | Enable/disable Idshutdown function | pon |

ONU default restore

Onu default restore resets all the ONU settings to the factory default values.

Table 341 onu default restore

| Command | Description | Mode |
|------------------------------|-------------------------------------|------|
| reset onu IFNAME init | Initializes to the factory default. | pon |